Thesis for the degree of Doctor of Philosophy

Capacity utilisation in short sea shipping

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Abstract

Shipping is a capital-intensive industry and is characterised by high fixed costs and economies of scale. Trade imbalances and demand variations, market fluctuations and customer demands for high frequency create a situation where shipping companies tend to operate with a high level of unutilised vessel capacity. The purpose of the research is to identify the potential for enhancement of the physical vessel capacity utilisation, with the aim of reducing the cost per transported unit. The research is based on both qualitative and quantitative data included in three studies of short sea vessel concepts: ferries, RoRo vessels and container feeders.

Vessel capacity utilisation can be enhanced by applying short-term and long-term measures and by counterbalancing supply and demand. Appropriate vessel design, efficient sailing schedules, stand-by cargo, price differentiation and improved communication between companies in the transport chain are among the most important improvement measures. Two approaches are available when matching supply and demand: to increase demand through larger market share, and to change supply in smaller and more frequent steps.

Route characteristics and market conditions all affect the selection of an appropriate strategy for enhancement of vessel capacity utilisation. The different approaches are: the Cut peaks strategy, the Never say no strategy, or a combination of the two. The purpose of the Cut peaks strategy is to have a high average capacity utilisation by keeping the maximum capacity lower or increasing the market share. The Never say no strategy allows a higher level of unutilised capacity in order to have good flexibility, a possibility to grow in the market, and the ability to maintain a high service level.

Knowledge gained from the research resulted in a framework for short sea shipping companies that are aiming at enhancing their vessel capacity utilisation. The framework consists of four elements: selection of capacity utilisation strategy, definition of sailing schedule, improvement measures for established vessel capacity, and improvement measures for changes in vessel capacity.

The main objective of applying a conscious strategy and suitable improvement measures is to attain a long-term economic sustainable shipping service with a reasonable service level, flexibility and reliability towards customers. Consequently, both shipping companies and shippers benefit from the enhancement. Furthermore, society also gains if goods can be moved from road to sea, as short sea shipping is efficient in terms of environmental performance and energy efficiency and can ease road congestion.

Keywords: liner short sea shipping, vessel capacity utilisation, unutilised capacity, improvement measures, strategies, route characteristics, and sailing schedule.

Acknowledgement

A day much longed for has finally come, the day to close this book and put it on the shelf where I want to keep it for a while. I knew this day would come, because my stubbornness did not allow me to quit, but I was not aware of the effort required and the great need of support and encouragement from family, colleagues and friends when I started. I am happy to receive all this, and I would like to take this opportunity to say thank you.

First and foremost I would like to thank my tutor, Kent Lumsden and my assistant tutor, Gunnar Stefansson; they are sources of good advice who have encouraged and prodded me throughout these years. Thank you for the pleasant cooperation and for your support especially in the final phase. Next, I would like to thank my colleagues at SSPA and at the Division of Logistics and Transportation at Chalmers University of Technology. A special thanks to Joanne Ellis for the talks and to Claes Källström, former head of SSPA Research and my manager for eight years, for helping me find the time and space necessary to finish this work.

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I have met many skilled and experienced people in the port and shipping industry, both in Europe and in Japan during my years working with this thesis. Without these meetings and exchange of ideas, this work would not have been possible. Above all, I would like to express my special acknowledgments to all the anonymous respondents who have taken their time to share their knowledge and experiences with me.

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During the last several months, life has been quite busy. I guess completing a doctor's thesis is never easily achieved, but being pregnant and having children definitely doesn't make the work less complicated, only more great and fun. I am very grateful to my parents, Monica and Guy Styhre, and my in-laws, Aino and Sven Carlsson, for all their support and help during this period. Your care is priceless! Thank you! I am also especially grateful to my parents due to the fact that they have always supported me in my decisions and have encouraged me to go my own way.

[...]

The sun is shining and the Swedish summer is as wonderful as ever. Our two-month-old baby girl is sleeping in my arms while I am typing on my laptop with my free hand, a rather unexpected skill that I have developed during the finalisation of my thesis. Our soon to be four-year-old son is running around, playing, singing, and trying to get the attention he deserves, and my beloved Mattias is building a fence in the garden. Soon I will join them. My first and last thoughts to my family, especially to Mattias, Sebastian and Amelie: Thank you for everything!

Linda Styhre
Göteborg, August 6, 2010

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Publication list

Research carried out for this thesis has resulted in three papers:

Styhre, L. (2009) Strategies for capacity utilisation in short sea shipping. *Journal of Maritime Economics & Logistics* 11(4), pp. 418-437.

Styhre, L. (2009) *Introduction of new vessel capacity in existing sea links and ports.* Proceedings of the 4th International Conference Maritime Transport; 27-29 April 2009, Barcelona, Spain.

Styhre, L. and Lumsden, K. (2007) *Vessel* capacity utilisation in ferry services and the bridge substitute dilemma. *Journal of Maritime Research*, 4(3), 55-66.

Terminology

Cabotage is the exclusive right of a country to operate the traffic within its territory (AHD, 2006).

Cassette is an open-ended steel platform with a cargo capacity of 60 tonnes. It measures 12.25 metres in length and is 2.60 metres wide. Cassettes are loaded by special trucks called translifters, and are positioned on board within centimetres of one another so that no further lashing is required (SCA, 2009).

Feeder service is a short sea shipping service which connects at least two ports in order for the containers to be consolidated or redistributed to or from a deep sea service in one of these ports (UN/ECE, 2001).

Gross tonnage (GT) is a function of the moulded volume of all enclosed spaces of the vessel and is used to determine things such as a ship's manning regulations, safety rules, and registration (IMO, 1969).

Hub port is a central port for the collection, sorting, transshipment and distribution of goods for a particular area (UNECE, 2009).

Intermodal transportation is the movement of goods in one and the same loading unit or road vehicle, which uses two or more successive modes of transportation without handling the goods themselves in changing modes (UN/ECE, 2001).

LoLo Lift-on/lift-off description of a vessel in which containers are worked vertically either by an on-board crane or, more usually, by a quayside crane (Stopford, 1997).

MAFI is a roll-trailer for RoRo vessel operators to transport cargo such as containers and project goods, e.g., large equipment and over-sized vehicles. (Equip-right, 2009).

Nautical mile (Nm) = 1852 metres.

Panamax is a ship with dimensions that allow it to pass through the Panama Canal: maximum length 295 metres, maximum beam overall 32.25 metres, and maximum draught 13.50 metres (UN/ECE, 2001).

Post-Panamax is a ship with at least one dimension greater than Panamax (UN/ECE, 2001).

RoRo Roll-on/roll-off is a description of a ship in which cargo is worked horizontally on wheeled vehicles via a ramp and through doors in the vessel's wall (Stopford, 1997).

Short sea shipping (SSS) is the movement of cargo and passengers by sea between ports which do not involve an ocean crossing. Short sea shipping includes domestic and international maritime transport, including feeder services, along the coast and to and from the islands, rivers and lakes (EC, 1999).

Slot is the space within a vessel for the carriage of a container, usually expressed in TEU (Stopford, 1997).

TEU (Twenty-foot equivalent unit) is a statistical unit based on an ISO container of 20 foot length (6.10 m) to provide a standardised measure of containers of various capacities and for describing the capacity of container ships or terminals. One 20 Foot ISO container equals 1 TEU (UNECE, 2009).

Transshipment is the unloading of cargo from one ship and its loading onto another to complete a journey, even where the cargo may have dwell time ashore before its onward journey (UNECE, 2009).

PART I Opening section

1. Vessel capacity utilisation in short sea shipping

This opening chapter presents relevant features of the shipping industry and the shipping market that have an influence on this research. Background is also given on the research field from both practical and theoretical points of view. The research takes a short sea shipping perspective and the application of the research is directed towards short sea shipping companies, even though also shippers and society benefit from enhancement of vessel capacity utilisation.

1.1 Background

Short sea shipping is a vital part of regional transport networks and an important component in supporting the commercial needs of transportation and logistics in Europe and in other parts of the world with similar conditions. Waterborne transportation within Europe has increased over the last years although the market development for short sea shipping has faced some challenges, for example; the construction of fixed links, new regulations and a dramatic increase in the price of fuel (Notteboom and Vernimmen, 2009). This has been caused by technological development, the growth of trade and greater integration of parts of the supply chain (Heaver, 2001). Short sea shipping currently accounts for roughly 37% of all cargo moved in Europe and has increased over the years, while the market share has been stable (European Communities, 2009).

Short sea shipping is the movement of cargo and passengers by sea between ports which do not involve an ocean crossing (EC, 1999). A liner provides regular services between specified ports according to a fixed sailing schedule and usually carries cargo for a number of different shippers (UNCTAD, 2004). The main advantages of short sea shipping are an alleviation of congestion, a reduction of the environmental impact, a decrease in overall costs to the shipper and that it is much less prone to theft and damage (PROPS, 2008). As a consequence, the European Commission has an active policy to promote short sea shipping to meet the goal of the European sustainable transport policy (EC, 2009).

Shipping is a capital-intensive industry and is characterised by high fixed costs and economies of scale. In addition to the large investments in vessels, there are a great deal of sunk costs in extensive transport networks, dedicated terminals, intermodal arrangements and information systems, as well as advertising and creating goodwill on a route (Sjostrom, 2004). Consequently, the shipping companies often strive for a high vessel capacity utilisation as a high degree of utilisation can justify the large investments required. However, liner shipping exhibits characteristics that have led to unutilised capacity for much of its history. Customer demands for available vessel capacity when needed, regularity and frequency requirements (Mangan et al., 2002; Higginson and Dumitrascu, 2007) combined with large vessels (Haralambides, 2007) and the industry's inherent excess capacity due to demand variation and trade imbalances (Davies, 1983; Fusillo, 2004; Haralambides, 2004) can easily lead to low vessel capacity utilisation.

The market conditions have a large effect on shipping and its vessel capacity utilisation. Matching supply and demand is difficult because of large fluctuations in demand and often fixed vessel capacity supply in the short run (Fusillo, 2004). Charter costs, freight rates and vessel prices react immediately to a change in the demand/supply balance, while the vessel capacity responds much slower (UNCTAD, 2009). When recession sets in and trade declines, shipping companies face a decrease of the average capacity utilisation and a decline in freight rates (Davies, 1983).

The diminishing demand for transportation in the autumn of 2008, due to the financial crisis and the economic downturn, in combination with the arrival of many new-built vessels from the shipyards, resulted in a great level of excess capacity in the world fleet (UNCTAD, 2009). In order to adjust the supply to the decline in demand, the shipping companies stopped ordering new tonnage, demolished old vessels, terminated orders at the shipyards and withdrew existing tonnage from service (UNCTAD, 2009). Furthermore, the shipping companies also decreased speed, i.e., used slow steaming, to decrease the excess capacity by tying up existing capacity and to save costs in bunker fuel.

Figure 1.1 shows the growth in the world fleet since the 70s. Between 2009 and 2012 the forecast indicates an annual increase of 6.6%, even though many of the vessels in the shipyards' order books have been cancelled (Pålsson, 2009). Considering market fluctuations, the long depreciation time of the vessels, and the considerable time between the ordering and installing of new capacities, the timing of the investment in vessel capacity is a very important factor of business success. Due to the dynamic structure of the maritime transportation industry, a high level of managerial effort is required for executing the shipping investment decisions (Celik et al., 2009).

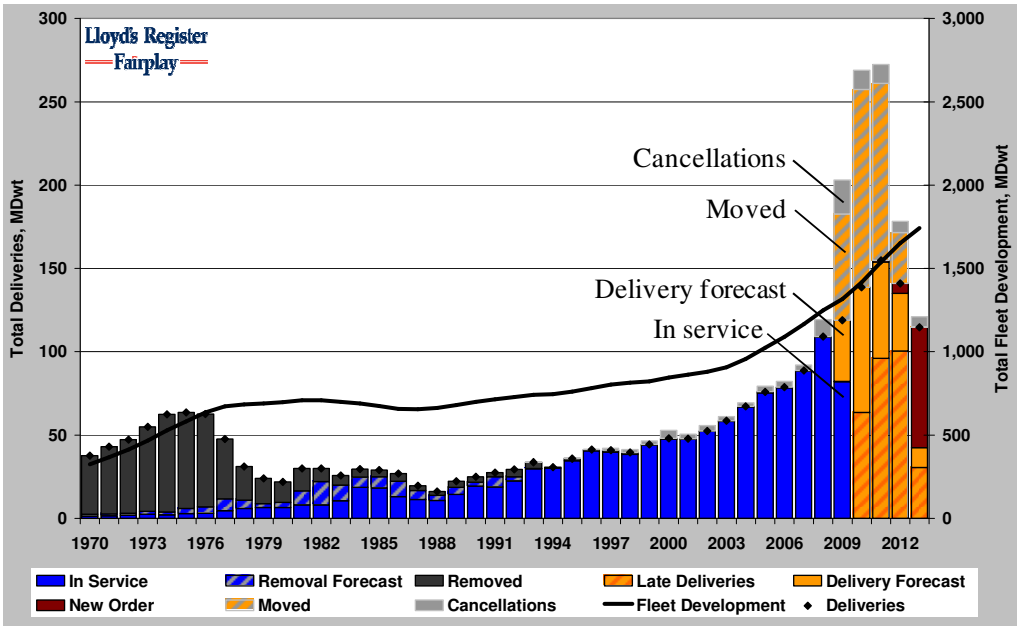

Figure 1.1 Total fleet development and forecast between the years 1970 and 2012. Source: Lloyd's Register Fairplay.

General oversupply in vessel capacity is also a result of a market mechanism that is not adapted to getting rid of the excess capacity. Each shipping company has a weak incentive to reduce its capacity in isolation (Jansson, 1974). First, the requirements on departure frequency mean that by taking a vessel out of service on a certain route, the shipping company may not be able to provide the requisite frequency of service with the fleet that remains. This is particularly the case for some high-rated traffic that is highly sensitive to frequency. Consequently, some customers are likely to leave and the remaining vessels will sail with an unchanged or even reduced utilisation level compared with the situation before the change in frequency (Jansson, 1974; Davies, 1983; Franck and Bunel, 1991). Therefore, it is not uncommon that shipping companies continue even the severest of trading and financial problems without selling off or decreasing the number of vessels on a route (Fusillo, 2003), especially considering that many companies have spent years, some even decades, developing the services (Davies, 1983). Second, there are significant economies of scale to be earned from operating larger vessels as opposed to small (Cullinana and Khanna, 2000). As the shipping companies benefit from a lower cost per transported unit, they tend to operate larger vessels than necessary. If the cost of supply shortage is higher than the cost of carrying unutilised capacity, the companies are more likely to accept unutilised capacity rather than be caught short during periods of high demand (Fusillo, 2003), which can lead to oversizing of vessels in waterborne transportation.

Research in capacity utilisation in general (e.g., Wenders, 1971; Hilke, 1984; Spence, 1977; Liebermann, 1987; Esposito and Esposito, 1974, etc.) and in shipping in particular (e.g., Jansson, 1974; Jansson and Shneerson, 1978 and 1982; Davies, 1983, etc.) had a peak period in the 70s and in the beginning of 80s; many references in this thesis originate from that period. More recent papers (e.g., Cariou, 2002; Fusillo, 2003 and 2004; Haralambides, 2002, 2004 and 2007) focus on capacity utilisation in ocean shipping, while research in capacity utilisation in liner short sea shipping is very limited. Ocean shipping has received a greater amount of research attention due to the scope and scale of activities, while short sea shipping has generally received much less research efforts (Gouvernal et al., 2009), even though policy interest in short sea shipping has increased in recent years.

1.2 Introduction to the research in liner short sea shipping

The term vessel capacity utilisation refers to the relationship between transported units and maximum capacity within a certain time. Capacity utilisation per departure is often expressed in terms of vessel's load factor. As the load factor describes in a very limited time frame the vessel capacity utilisation without the possibility to change maximum capacity of the shipping service or to influence fixed costs, the definition of vessel capacity utilisation represents a broader perspective.

This thesis focuses on the physical vessel capacity utilisation, with the aim of reducing the average cost per transported unit in the short-run as well as in the long-run perspective. Profit, defined as the difference between price and cost, is not part of this research. Prices fluctuate greatly in the shipping market, customers charge different freight rates and the variation in prices between shipping services is significant. Further, profits in shipping can be described as being speculative and a "result from buying and selling ships at the right time, rather than from shipping by itself" (Franck and Bunel, 1991). These emphasise the advantages of focusing on the more stable and consistent approach of the physical utilisation, rather than on profitability or

economic capacity utilisation. Economic theories, e.g., price differentiation, are part of the theoretical framework. The purpose is, however, not to increase the profitability of the service by using these theories, but to present measures that attract more customers to a shipping service in order to enhance the physical vessel capacity utilisation.

Only unitised cargo is considered, e.g., containers, trailers, trucks, and cargo on cassettes[1] and MAFIs[2], and three different types of short sea liner vessel concepts are included: ferries, RoRo vessels and container feeders. The aim is to include a large part of the short sea shipping fleet including both RoRo (roll-on/roll-off) and LoLo (lift-on/lift-off) techniques, with the intention to cover diverse characteristics, such as transport units, possibilities to accommodate passenger or drivers, departure frequency, and determination of departure time. Further, the shipping concepts' importance to transportation in Northern Europe was a determining factor for the selection of research objects. The three types of short sea shipping concepts included in the research and their general characteristics are shown in Table 1.1.

Table 1.1 General characteristics of the short sea shipping concepts included in the thesis.

	Roll-on/roll-off		**Lift-on/lift-off**
	Ferry and RoPax	**RoRo**	**Container feeder**
Transport units	Passenger vehicles, buses, trucks, trailers	Trucks, trailers, project cargo, containers on MAFIs or cassettes	Containers
Passengers	Yes	No	No
Accompanied transport	Yes	No (yes, some cases)	No
Departure frequency	Several departures/day or week	Several departures/week	Several departures/week
Determine departure time	Passengers	Industry	Deep sea vessel

The high fixed costs in shipping often suggest a significant improvement in short-run profitability if the vessel capacity utilisation level can be increased with unchanged freight rates. However, the situation in the long-run can be the opposite if the service level decreases and customers are getting dissatisfied with the shipping service. The aim is to level the demand peaks and valleys in order to open up for new customers, and to attain an economic sustainable service with a reasonable and acceptable service level, flexibility and reliability towards customers. The fundamental idea of this research is therefore to find the most suitable choice for each shipping service, taking into consideration specific route characteristics and market conditions, and also to gain knowledge of the consequences of the approach taken. Consequently, both shipping companies and shippers benefit from the enhancement of vessel capacity utilisation.

Furthermore, society gains from sustainable and attractive shipping services with an adequate level of vessel capacity utilisation, as short sea shipping is efficient in terms of environmental performance and energy efficiency (EC, 2009). Thus, an increase in the utilisation level can make it possible to reduce the environmental footprint caused by the transport system if goods are

[1] An open-ended steel platform for RoRo vessel operators, see terminology.
[2] A roll-trailer for RoRo vessel operators to transport cargo such as containers and project goods, see terminology.

moved from road to sea. The modal shift also means that road congestion problems affecting many densely populated parts of the world (EC, 2009), and land borne infrastructure can to a larger extent be used for passenger transportation rather than goods.

The characteristics of the shipping industry and the shipping market, in combination with difficulties in reaching a high level of capacity utilisation, point to the importance of applying conscious strategies and well worked out improvement measures on strategic, tactical and operational levels to reach a satisfactory level of vessel capacity utilisation in shipping.

2. Research design and focus

This chapter presents the purpose, which is to identify the potential for enhancement of vessel capacity utilisation, and the scope of the work. Three research questions and their relation to the research areas are introduced. The research design reveals the interrelations between the research questions and the three studies this thesis is based upon. Finally, an outline of the thesis is drawn to give the reader an overview of the contents in the parts and the chapters.

2.1 The purpose and research questions

The purpose of this thesis is to identify the potential for enhancement of the physical vessel capacity utilisation in short sea shipping. The overall aim is to reduce the cost per transported unit of TEU[3] or lane meter[4]. Both a conscious strategy and short-term and long-term measures adjusted to the shipping company's route characteristics and market facilitate an enhanced utilisation of vessel capacity. The research takes a shipping perspective and the application of the research is directed towards short sea shipping companies. Three research questions are divided into two research areas:

1) Vessel capacity utilisation strategies

- **Research Question I:** What route characteristics affect vessel capacity utilisation?
- **Research Question II:** What strategies are employed by the shipping companies to enhance vessel capacity utilisation?

2) Measures to improve vessel capacity utilisation

- **Research Question III:** How can vessel capacity utilisation in short sea shipping be enhanced?

2.2 Scope and delimitations

Shipping concept

This thesis' primary focus is liner short sea shipping, and the work includes ferries, RoRo vessels and container feeders that serve a pre-defined number of ports on a fixed sailing schedule. Consequently, the results are best applied to these, even though the institutional similarities within the group of short sea shipping (e.g., river shipping, costal shipping, etc.), as well as liner ocean shipping, to some extent allows for a generalisation of the results. However, the diverse

[3] Twenty-foot equivalent unit, see terminology.
[4] A lane meter is an area of deck one lane wide and one metre long.

characteristics of tramp shipping and industrial shipping compared with liner shipping mean that these are out of the scope of this thesis.

All studies take a short sea shipping perspective, even though the last study, Container feeders in transport chains, expands the focus to also include ports and connecting deep sea links. This intermodal approach allows for an analysis of the transport actors' effect on the feeder services and the operators' possibilities to utilise their vessel capacities in the transport chain. However, capacity utilisation in ocean shipping, ports and hinterland transportation are not included.

Types of cargo
Only unitised cargo, such as containers, trailers, trucks, and cargo on cassettes and on MAFIs is included in the research. Unitised cargo is a necessity for intermodal transportation that puts emphasis on seamless flows through the entire chain rather than separate activities carried out independently of each other (Lee and Billington, 1992). Thus, utilised cargo means that more efficient and integrated shipping services can be developed, which can more successfully compete with road and rail.

Definition of capacity utilisation
Studies in capacity utilisation employ either an engineering approach or an economic approach (Esposito and Esposito, 1974; Nelson, 1989; Felthoven, 2001; Coelli et al., 2002). Economists use different types of cost-based definitions of capacity utilisation (for a comparison between economic definitions of capacity, see Coelli et al., 2002). This thesis focuses on the physical vessel capacity utilisation, with the aim of reducing the average cost per transported unit. The benefit of concentrating on the physical utilisation is to provide a stable approach to capacity utilisation, which allows for a comparison between shipping services and shipping concepts. In contrast, price and profitability fluctuate greatly in shipping and the price levels differ between shipping services. However, even though economic capacity utilisation is not part of this thesis, economic theories that affect the physical utilisation of vessel capacity are important to comprehend strategies and analyse measures to enhance vessel capacity utilisation.

The scope and delimitation of this work is shown in Figure 2.1.

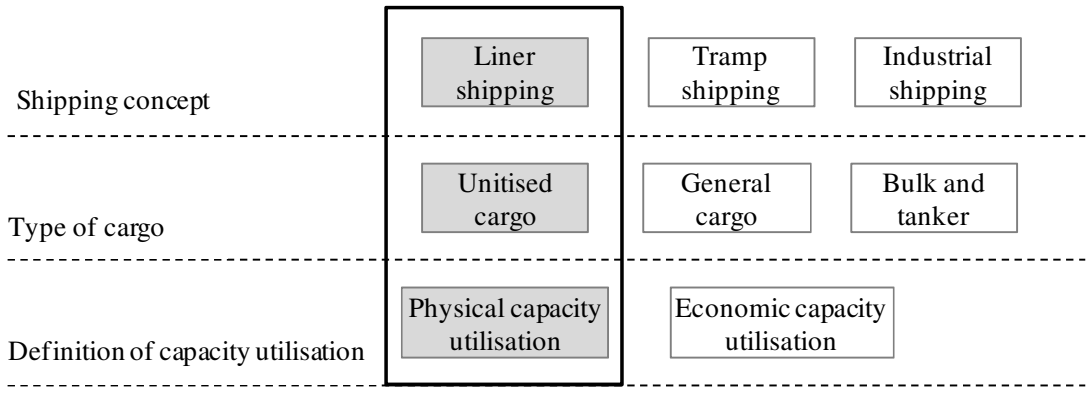

Figure 2.1 Scope and delimitation of the research.

2.3 Research design

The first research question is a result of prior theoretical knowledge: *What route characteristics affect vessel capacity utilisation*? In the author's licentiate thesis (see Styhre, 2005), capacity utilisation is identified as one of the key areas for intermodal efficiency, and the interest in capacity utilisation is a consequence of work carried out in the period. The first research question was investigated in two studies: *Capacity utilisation in ferry services* (Study I), a quantitative study that analyses 19 ferry services; and *Capacity utilisation strategies for RoRo shipping* (Study II), based on qualitative case research.

The purposes of Study I are to explore vessel capacity utilisation in ferry services and to analyse how route characteristics affect vessel capacity utilisation. The study explored the research field and drew attention to the difficulties in reaching a high level of vessel capacity utilisation, and showed the relationship between frequency and capacity utilisation. The work resulted in the paper *Vessel capacity utilisation in ferry services and the bridge substitute dilemma* published in Journal of Maritime Research (see Styhre and Lumsden, 2007).

When planning for the second study, the importance of capacity utilisation strategies was recognised. This is reflected in the second research question: *What strategies are employed by the shipping companies to enhance vessel capacity utilisation?* The purposes of Study II are to analyse capacity utilisation strategies and examine measures aimed at improving vessel capacity utilisation. The study resulted in two papers: *Introduction of new vessel capacity in existing sea links and ports*, proceedings of the 4th International Conference Maritime Transport (see Styhre, 2009a), and *Strategies for capacity utilisation in short sea shipping* published in Journal of Maritime Economics & Logistics (see Styhre, 2009b).

The third research question is a result of the first study that proved to have a fairly low vessel capacity utilisation: *How can vessel capacity utilisation in short sea shipping be enhanced*? This was investigated in Study II and, additionally, in Study III, *Container feeders in transport chains.* The purpose of Study III is to examine measures to improve the vessel capacity utilisation in feeder shipping. As the second study showed that port activities have an effect on vessel capacity utilisation, interfaces between short sea shipping and ports and ocean shipping were consequently included in the last study.

A recurrence of the last research question in Study III deepened the knowledge of improvement measures by including another shipping concept, feedering, and the interfaces towards port and ocean shipping in the transport chain. Furthermore, the study consists of two cases; one case was conducted in Northern Europe and the other in Japan. These involved a verification of the results from the previous study and facilitated an assessment of geographical similarities and disparities, which gave the thesis an increased international relevance. The relationship between the three research questions and the studies is shown in Figure 2.2.

Research area: Vessel capacity utilisation strategies	Study I Ferry	Study II RoRo	Study III Feeder
RQ I: What route characteristics affect vessel capacity utilisation?	x	x	
RQ II: What strategies are employed by the shipping companies to enhance vessel capacity utilisation?		x	
Research area: Measures to improve vessel capacity utilisation			
RQ III: How can vessel capacity utilisation in short sea shipping be enhanced?		x	x

Figure 2.2 Three research studies' answers to three research questions. Research Question I (RQ I) and II (RQ II) are related to the research area *Vessel capacity utilisation strategies* and Research Question III (RQ III) is related to *Measures to improve vessel capacity utilisation*.

2.4 Outline of the thesis

This thesis consists of six parts:

- **Part I:** Opening section,
- **Part II:** Methodology,
- **Part III:** Theoretical framework,
- **Part IV:** Empirical outcomes,
- **Part V:** Analysis, and
- **Part VI:** Closing section.

The first three parts are closely intertwined as the problem description, purpose and research questions were developed in an iterative process simultaneously with the theoretical framework and methodology. The selected research questions have together with literature, previous research, methodological considerations and methods influenced the empirical outcomes in Part IV and the analysis in Part V. Finally, the closing section in Part VI sums up and reviews the results from the analysis, and presents the theoretical contribution and the practical implications of the research.

The two chapters in *Part I Opening section, Vessel capacity utilisation in short sea shipping* and *Research design and focus* provide a background to the field and give an overview of the research. The purpose is derived from the problem description, which raises three research questions relevant to the field under investigation. The research design illustrates the connections between the research questions and the three studies.

Part II Methodology presents in *Chapter 3 Methodology* the scientific approach, the research process and research quality. Further, the three studies this thesis is based on are described from a methodological point of view and the interrelations between the studies are highlighted.

Part III Theoretical framework consists of relevant literature and prior conducted research in the fields that form the foundation of the thesis. In *Chapter 4 Waterborne transportation,* shipping,

port and intermodal operations are described. *Chapter 5 Capacity utilisation in waterborne transportation* defines capacity utilisation and related terminologies and concepts. Finally, *Chapter 6* F*undamental principles of transport economy* describes economic theories that have an influence on this work: economies of scale, marginal pricing, price differentiation and price elasticity. This work focuses on the physical capacity utilisation of vessels, but economic theories are important to comprehend capacity utilisation strategies and capacity utilisation enhancement possibilities.

Part IV Empirical outcomes presents the results of the three studies that were carried out in the same chronological order as the three chapters in this part: *Chapter 7 Capacity utilisation in ferry services*, *Chapter 8 Capacity utilisation strategies for RoRo shipping*, and *Chapter 9 Container feeders in transport chains*. The empirical material has been interpreted to some extent with the intention of presenting it in a more easily accessible manner, while the in-depth analysis, using theories and literature to reflect upon the result in a broader sense in order to answer the research questions, is found in the next section: *Part V Analysis*. *Chapter 10 Strategies and measures to enhance vessel capacity utilisation* answers the three research questions and *Chapter 11 Framework for enhancement of vessel capacity utilisation* is a synopsis of the analysis in the previous chapter, including a course of action for applying strategies and improvement measures.

The last part of this thesis is *Part VI Closing section*. *Chapter 12 Conclusions* summarises the findings and closes the discussions about capacity utilisation in liner short sea shipping, Finally, *Chapter 13 Contributions and future research* contains a discussion about the theoretical contributions to the research community and the practical contribution to practitioners. Suggestions for future research are included in the last chapter.

PART II Methodology

3. Methodological considerations

This chapter gives the scientific approach to the research field and how that has affected work and interpretation. The work rests upon critical realism and the research is based on both qualitative and quantitative data. It also gives a methodological description of the three studies this thesis is based on: I) Capacity utilisation in ferry services; II) Capacity utilisation strategies for RoRo shipping; and III) Container feeders in transport chains. The method of analysis describes the analysis and the interpretation of the materials, while a summary of the interviews and the analysis models to categorise answers for Study II and Study III are attached in appendices. Further, the chapter contains research quality and a description of the research process. Prior theoretical knowledge and alterations between empirical and theoretical parts of the studies are also included to give a background to the selection of research questions.

3.1 Scientific approach

Logistics research has been influenced by a number of disciplines including among others engineering, operational research, marketing and philosophy, though economics is often considered the most immediate field (Mentzer and Kahn, 1995; Kent and Flint, 1997; Stock, 1997). As a result, researchers in logistics and transportation have different kinds of attitudes towards ontology, epistemology and methodology, which affect the researcher's view of knowledge, the way the world is perceived and how methods, techniques and tools are used.

Ontology

The view of the world that this thesis relies upon is a critical realistic orientation. Realism presumes the existence of an external world in which events and experiences are triggered by underlying and often unobservable mechanisms and structures (Bhaskar, 1975). Realism believes that "social phenomena exist not only in the mind but also in the objective world, and that some lawful and reasonably stable relationships are to be found among them" (Miles and Huberman, 1994, p. 4).

Epistemology

Since the emergence of logistics as a scientific discipline in the early 1960s, the dominant stream of research has been proposed on a positivistic paradigm (Mentzer and Kahn, 1995; Kent and Flint, 1997), even if some contributions have called for other scientific approaches which would strengthen the discipline in terms of new research questions and answers (Arlbjørn and Halldorsson, 2002; Näslund, 2002; Gammelgaard, 2003). The position in this thesis is to explore the field related to the research questions and to seek valid explanatory knowledge.

Methodology

Many books in methodology make a distinction between qualitative and quantitative studies (Widerberg, 2002). However, even if epistemological and ontological viewpoints are often related to certain research methods, the relation is not of a deterministic kind (Miles and

Huberman, 1994; Bryman, 2002). In this thesis, the approach to research methods is that there is no meaningful epistemological difference between qualitative and quantitative methods. Instead, the selected methods depend on the type of research question posed and on the purpose of the study. The first study that is based on quantitative data explores the research field and analyses statistics to increase the knowledge of levels of capacity utilisation and the relation between route characteristics and vessel capacity utilisation. The study raised further questions related to strategies and possibilities to improve the utilisation of the vessels. The following two studies are foremost based on qualitative data, which provide a good understanding of the dynamics underlying the relationships (Eisenhardt, 1989).

A case study design is suitable when data is gathered about a large number of variables (Ellram, 1996) and is the preferred strategy when the researcher has little or no control over events and when the focus is on a contemporary phenomenon within some real-life context (Yin, 1994). Case studies provide a means of developing theory by utilising in-depth insights of empirical phenomena and their context (Dubois and Gadde, 2002). The broad and comprehensive approach taken in this thesis implies that a qualitative case study research is a suitable method (Hellevik, 1987) as a complement to the initial quantitative study. The properties of the critical realism also ensure a match with the particular characteristics of case research, which provide a justification for the case-based knowledge claims (Easton, 1995).

3.2 Literature studies

Literature studies have been carried out throughout the whole research period with the purpose of identifying the state of research and areas of interest for further investigation. The literature databases searched include Science direct, Emarald Library, Taylor & Francis Online Journals, Jstor, Proquest, and Elsevier. A combination of database search, reviews of literature citations and references in published books or journals, and targeted searches on the Internet for specific authors were carried out. Different search words and phrases were used and combined to cover diverse terms that are used within the research community. Furthermore, researchers, tutors and colleagues have recommended further publications, which have contributed to the research. Finally, references in key papers from authors such as Haralambides, Fusillo, Davies, Jansson, Zerby and Conlon, and Cariou have been searched through to find additional literature.

Literature related to capacity utilisation in this thesis originates foremost from the 70s and 80s (e.g., Jansson, 1974; Esposito and Esposito, 1974; Zerby and Conlon, 1978; Jansson and Shneerson, 1978 and 1982; Davies, 1983; Liebermann, 1987), as this research field had a peak period during these decades. However, as both the shipping industry and the research field have developed greatly since, these references have been carefully used, and newer ones have been added as well.

3.3 Three research studies

This thesis is based on three studies, carried out in chronological order: I) Capacity utilisation in ferry services, II) Capacity utilisation strategies for RoRo shipping, and III) Container feeders in transport chains. Table 3.1 is an overview of the research questions posed, selection of vessel concepts, geographical coverage and methodologies in the three studies.

Table 3.1 Overview of the three studies.

Research study	Research Question	Vessel concept	Geography	Focus	Methodology
Study I: Capacity utilisation in ferry services	**RQ I:** What route characteristics affect vessel capacity utilisation?	Ferry	Scandinavia	Short sea shipping	Quantitative study
Study II: Capacity utilisation strategies for RoRo shipping	**RQ I:** What route characteristics affect vessel capacity utilisation? **RQ II:** What strategies are employed by the shipping companies to enhance vessel capacity utilisation? **RQ III:** How can vessel capacity utilisation in short sea shipping be enhanced?	RoRo	Northern Europe	Short sea shipping	Qualitative case study
Study III: Container feeders in transport chains	**RQ III:** How can vessel capacity utilisation in short sea shipping be enhanced?	Container feeder	Northern Europe/ Japan	Short sea shipping, ocean shipping and ports	Qualitative case study

3.3.1 Study selection and purposes

This research includes three types of short sea liner vessel concepts: ferries, RoRo vessels and container feeders. The study objects were selected to cover a large part of the short sea shipping fleet including both RoRo and LoLo techniques. A focus on intermodal transportation and unitised cargo was selected early, thus excluding regional general cargo and dry bulk transportation. The diverse characteristics of the shipping concepts, e.g., transport units, possibilities to accommodate passengers or drivers, and departure frequency allowed for an increased understanding of how to enhance vessel capacity utilisation in short sea shipping.

In all the three studies, well-established shipping companies and stable services were selected. Thus, it was possible to focus on the issues concerned with the fundamental structure of short sea shipping and not only on teething troubles and temporary solutions. As the purpose was to analyse strategies and improvement measures it was necessary to find successful and capable shipping companies and ports. All the companies in the studies have good reputations and are doing well in their business segments.

The studies were mainly conducted in a Northern European setting, with the exception of one part of Study III that was carried out in Japan. Consequently, the results are best applied to similar conditions, which involve developed consumption and production regions divided by sea that trade extensively with each other. RoRo shipping is more developed in Northern Europe than in most other parts of the world. The fleets in the North Sea and the Baltic Sea are fairly new and large, and the vessels are often big and reliable. Some new technologies for increasing the efficiency of short sea shipping have been invented in the region, e.g., semi-automatic trestles for lashing trailers and cassettes for double stacking containers, which can be block stowed on cargo decks.

Study I Capacity utilisation in Scandinavian ferry services
The purposes of Study I are to explore vessel capacity utilisation in ferry services and to analyse how route characteristics affect vessel capacity utilisation. The study relies on statistics and answers the first research question posed in this thesis: *What route characteristics affect vessel capacity utilisation?* In order to find out average levels of vessel capacity utilisation for different shipping services, and the relations between route characteristics and vessel capacity utilisation, availabilities of statistics were searched for in an early stage when planning for the study. When goods data was available for 21 Scandinavian ferry services[5] and as ferries were a suitable study object for the purpose of the research, it was decided to include the shipping services in the first study. Two of the services were later excluded due to data quality; see Chapter 3.3.3 Method of analysis. The coverage of the most important shipping companies and services in the region also spoke in favour of the selection of study objects.

Study II Capacity utilisation strategies for RoRo shipping
Study II explores vessel capacity utilisation strategies and improvement measures and answers all three research questions: *What route characteristics affect vessel capacity utilisation? What strategies are employed by the shipping companies to enhance vessel capacity utilisation?* and *How can vessel capacity utilisation in short sea shipping be enhanced?* The purposes of the study are to analyse capacity utilisation strategies and examine measures aimed at improving vessel capacity utilisation.

The study is based on a RoRo shipping company, which operates primarily RoRo (roll-on/roll-off) and RoPax (roll-on/roll-off and passengers) vessels in the North Sea and in the Baltic Sea. The shipping company is very well-established and has a large and quite new fleet with innovative technologies, which were the reasons for selecting the company. Further, it has different kinds of shipping services and is operating a few of its own terminals.

Seven of the existing 11 shipping services were selected to the study. The choice was made together with the shipping company to obtain a diverse sample, which was necessary in order to understand different applicable capacity utilisation strategies. Routes differed from each other with respect to capacity utilisation, potential for development, frequency, cargo imbalances and demand variations, types of customers, and the competitive situation.

Study III Container feeders in transport chains
Study III focuses on another important short sea shipping concept: container feedering. The study is a continuation and a geographical enlargement of the second study. The study takes a broader perspective, by also including ports and ocean shipping and how these affect the capacity utilisation of the feeder vessels. The value of including other parts of the transport chain was recognised in the previous study. Feeder shipping is greatly affected by other actors in the transport chain, especially ports and ocean shipping companies, and therefore is an appropriate study object for the last study. The purpose is to examine measures to improve the vessel capacity

[5] Statistics originate from Danmarks Statistiks: opgørelse af transport i internationalt færgefart til og fra Danmark 2004. Background material included in the report: Denmarks Statistik, Transport: Skibsfarten på danske havne 2004, 2005:12.

utilisation in feeder shipping. The following research question was posed: *How can vessel capacity utilisation in short sea shipping be enhanced?*

The study covers two geographical areas: Northern Europe and Japan. By including a region outside Europe, it was possible to increase the international relevance of the result of the work. Japan was selected due to its similarities to Europe, e.g., population density, production and consumption patterns, long traditions of trading, geographical conditions, developed ports and many shipping services, etc., but also because of its good reputation when it comes to port handling efficiency and technology development. The same research design and data collection methods were used in both cases, including interviews with an ocean shipping company, a hub port, a feeder service and a satellite port.

The starting point for selection of feeder operators and ports to include in the study was the ocean shipping company Maersk Line that in both cases represented the deep sea-leg of the transport chain. The scale of their operation being the largest container shipping company in the world and the success of their business concept were important reasons for including them. One hub port Maersk Line calls at in each region was identified and selected, and representatives of Maersk Line suggested feeder operators and routes they believed could be of interest. Finally, the satellite ports were identified by the feeder operators and were in both cases small or medium sized terminals the feeder vessels called at several times per week. Two of the respondents in the study wished their companies to remain anonymous. As a result, the names of all ports and feeder operators in Study III, as well as the RoRo shipping company in Study II, were removed from the material. However, as funding was received from Maersk Group, Maersk Line's role as ocean shipping company in Study III was rather expected. Consequently, their name is revealed in the thesis.

3.3.2 Interviews and questionnaires

Study II and Study III are mainly based on interviews, while internal documents, goods statistics, etc. have been used as complementary sources of information in the two studies. The interview methodology has been based on semi-structured interviews, which give a structure to the data collection at the same time as they allowed for interruption when clarification was necessary to reach a deeper understanding. Data was collected through face-to-face interviews (with the exception of the last two interviews in Study III), and all interviews were audio taped with the permission of the respondents, and later transcribed. In both studies, all suggested respondents were willing to participate. The interview protocols include questions that originate from literature studies, interactions with members of the shipping industry, and from previous studies, with the aim of answering the research questions posed.

Study II is mainly based on seven 1.5 hour, in-depth interviews carried out in December 2007 and in January 2008. All respondents had good knowledge of the operations on both tactical and operational levels, and extensive experience in the shipping industry, with an average of 18 years within the company. Only key persons were interviewed: three business area managers, one director for industrial customers, one operational manager, one market director, and one branch manager. The offices were located in Sweden, Germany and Great Britain. Modification of the protocol was made after the questions were tested on a researcher from the University of Gothenburg and on a manager in a shipping company. The same protocol was used for each

interview in order to make a comparison between respondents' answers possible. The interview protocol is found in Appendix B and a summary of the respondents' answers in Appendix C. In some cases, the respondents did not answer the questions, which is the reason for a few blank boxes. The answers have been shortened and rearranged when necessary to give an apprehensible synopsis of the answers, and a few answers that were not relevant for the analysis have been left out. Further, confidential information related to capacity utilisation, transported lane meters, etc. has also been excluded. The seven interviews in the original version covered 76 pages.

In Study III, two different interview protocols were used for the shipping companies and for the ports respectively; see Appendix E. However, most questions were the same or similar in order to compare the answers. An overview of the respondents' answers and a summary of the interviews are found in Appendix F. The answers have been shortened and rearranged when necessary; the eight original interviews covered 58 pages, and confidential information has been left out. Respondents were selected based on the same criteria as for Study II, i.e., extensive knowledge of the operations and long experiences. The Japanese case includes four interviews with a total of eight persons, and was carried out in November and December of 2008. The European case was accomplished in spring 2010 and includes four interviews with four persons. The respondents were one shipping string manager, four managers, three assistant managers, one terminal marine manager, one key account manager, and two representatives of operation. The Japanese respondents had been employed on average 16 years, and the European respondents on average 8 years.

Questionnaires were also used to collect information about the shipping services and the terminal operations in Study III. The questionnaires, one for the shipping companies and one for the terminals, are attached in Appendix G. These questions cover quantitative data and were developed to verify questions in the interview protocol and to collect statistics for the case descriptions. The results are not published due to the confidential nature of the information, but were useful for the understanding of the companies' diverse situations and conditions.

3.3.3 Method of analysis

Statistical study of the ferry services
The goods data in the statistical study of ferry services was collected by Statistics Denmark for the year 2004. Statistics were available for 21 routes but two services were excluded from the analysis as one accommodated only passengers and no cargo, and the other experienced a lot of problems through the year with ship accidents, changed vessels and cancelled departures. 10 shipping companies operated the routes. Goods statistics were reported as number of vehicles on a monthly basis for export and import, categorised into the following groups: private cars, caravans, buses, motorcycles, bicycles, semi-trailers with/without a tow car and trucks with/without a trailer. Number of departures and passengers were also specified.

In order to calculate vessel capacity utilisation, figures related to the routes and the vessels were collected. Vessel particularities and design were used to calculate the maximum capacity of each vessel. Lloyd's Register of Ship online[6] was a helpful tool, but since the figures (ramps, lane

[6] http://www.sea-web.com/

meters, etc.) are not completely reliable, these were compared with information found on the Internet (e.g., shipping companies' home pages and shipyards' ship descriptions). However, ferry capacity is not always stated in lane meters, which is the common way of indicating capacity for roll-on/roll-off vessels. Instead, numbers of cars and trailers are in some cases used, which need to be converted to lane meters in order to make a comparison between shipping services possible. In such cases, often two extreme values indicate the maximum vessel capacity: first if only private cars are transported, and second with an upper limit of trailers. In the latter, private cars can often also be transported as the design of most vessels allows cars on car decks and hoistable decks which are spaces that cannot accommodate larger cargo units. As maximum ferry capacity often depends on the cargo and vehicle mix, a "cargo versus car factor" was calculated for all vessels in order to describe the relationship between cargo units and private car capacity:

$$\text{Cargo versus car factor} = (A + (B - C))/A.$$

A = lane meters (lm) onboard where it is possible to store cargo units
B = lane meters (lm) onboard if only private cars are transported
C = total lane meters (lm) onboard with a mixture of cargo units and private cars

For example, one vessel is reported to hold: "562 cars; or 750 lm trailer and 362 cars". Accordingly, *A* is 750 lm, *B* is 562*4.5[7]=2529 lm, and the total lane meters with private cars and a maximisation of cargo units, *C*, is 750+362*4.5= 2379 lm. In this example the cargo versus car factor is: (750+(2529-2379))/750 = 1.2. This means that each lane meter of trailers or trucks transported represents 1.2 metres of car capacity.

23 out of the 33 vessels had a cargo versus car factor above 1 (the maximum lane meters are reduced when cargo instead of passenger vehicles are transported); 4 vessels had a factor of 1 (maximum lane meter is the same for both cargo and passenger vehicles); 4 vessels only transported passenger vehicles; and 2 vessels only transported cargo. If more than one vessel operated a route, sailing schedules for 2004 were used to find out how many departures each vessel made. This was included in the calculation to reflect the actual maximum capacity on each route per month.

Transported lane meters were necessary to calculate in order to determine capacity utilisation. The number of vehicles (private cars, caravans, buses, motorcycles, semi-trailers with/without tow cars and trucks with/without trailers) were converted into transported lane meters. Before this was possible, average standard lengths for each vehicle were established. Table 3.2 shows the lengths and their sources.

[7] A private car is in average 4.5 meters, see Table 3.2.

Table 3.2 Lengths of vehicles to calculate transported lane meters onboard.

Vehicle	Standard length	Source
Private car	4.5 m	mean value selection of vessels
Caravan	6.5 m	estimated, based on different data bases
Bus	12.2 m	reference shipping company
Motorcycles	0.5 m	reference shipping company
Truck without trailer	12 m	estimated, based on different data bases
Truck with trailer	16.6 m	reference shipping company
Semi-trailer without tow car	13.8 m	reference shipping company
Semi-trailer with tow car	16.6 m	reference shipping company

The length of private cars originates from shipping companies' specifications stated in the ship particulars. 4.5 metres is the mean value reported by the shipping companies in the study that had the information available. The lengths of trucks with trailers, semi-trailers with/without tow cars and motorcycles are figures received from a RoRo shipping company that transport cargo within Northern Europe. It is possible to stow motorcycles beside each other in the same lane, which is the reason for the short average length. The size of caravans and trucks without trailers were estimated comparing different sources, e.g., the Swedish National Road Administration, truck manufacturers, etc.

It is not easy, or even possible, to find the correct vehicle lengths as there are many different kinds of cars, semi-trailers and trucks. Further, the markets the shipping companies operate differ from each other, which means that the types of vehicles also vary between the geographical regions.[8] However, the calculations give a good estimation of the sizes. Accordingly, the cargo versus car factor does not give a completely true value of the maximum capacity, but they provide a uniform way to calculate capacities. A "true value" sometimes never exists and in some cases 100% of capacity utilisation is impossible to reach due to the cargo mix, low lane heights, movable decks, internal ramps, etc.

Qualitative case studies of RoRo and feeder services
Study II and Study III are qualitative case studies based on interviews. Quantitative data, e.g., vessel capacity utilisation, goods statistics, transport time, frequency, number of vessels, etc. were linked to qualitative data in order to enable triangulation and to provide richer details.

When analysing the interviews, three main sections were used to sort the information, which reflect the *research questions* posed in the studies[9]: route characteristics (RQ I); capacity utilisation strategies (RQ II); and, enhancement of vessel capacity utilisation (RQ III). Respondents' answers that contributed to answering the research questions and to the understanding of the case under investigation were divided into subgroups, *1st level of contribution to research question.* When analysing the material, the subgroups emerged and all interesting information and statements were cut and sorted into these groups, with the name of the respondent attached to the sentences. When necessary, the groups were divided into *2d level of*

[8] For example, Sweden and Finland allows a 25.25 m truck trailer combination, while most other countries have a shorter maximum length.
[9] Study II answers all three research questions, while Study II answers the last question.

contribution to research question in order to divide or refine the information. This analysis model, used in both Study II and Study III, is shown in Figure 3.1. In Appendix D and Appendix H are the analyses for the two respective studies.

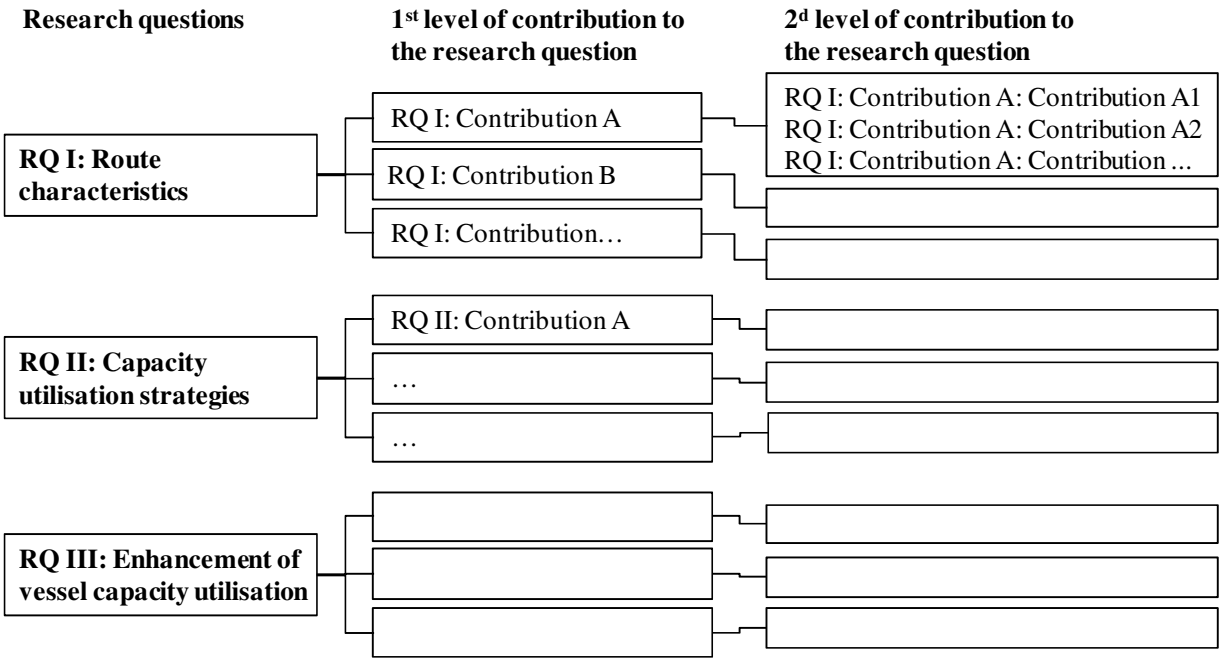

Figure 3.1 The analysis model to categorise answers to the research questions (RQ) in the qualitative case studies.

The subgroups emerged and were expanded throughout the process of analysing the material. This structure facilitated a comparison between the respondents' answers and gave a good overview of the data. Once the interviews were rearranged, evidences for answering the research questions were easily found.

3.4 The research process

The relation between the empirical and the theoretical world is often expressed in terms of inductive and deductive research. Inductive research concludes general laws from individual cases (Arbnor and Bjerke, 1997) and theory is systematically generated from data (Dubois and Gadde, 2002). Deductive research is concerned with developing propositions from current theory, thus making them testable in the real world (Dubois and Gadde, 2002). However, since research activities seldom follow a linear process, abduction is perhaps a better approach to create knowledge (Kovács and Spens, 2005). The scope of this thesis has evolved at some stages in the research process, according to the abductive approach. The abductive research is an iterative process characterised by alterations between theory and empirical data, which are constantly reinterpreted (Alvesson and Sköldberg, 1994). An abductive approach is regarded as different from a combination of deductive and inductive approaches, since new elements are added: the empirical field of application is developed during the process, while theories are getting more

sophisticated and refined (Alvesson and Sköldberg, 1994). The research process and the generation of research questions are shown in Figure 3.2.

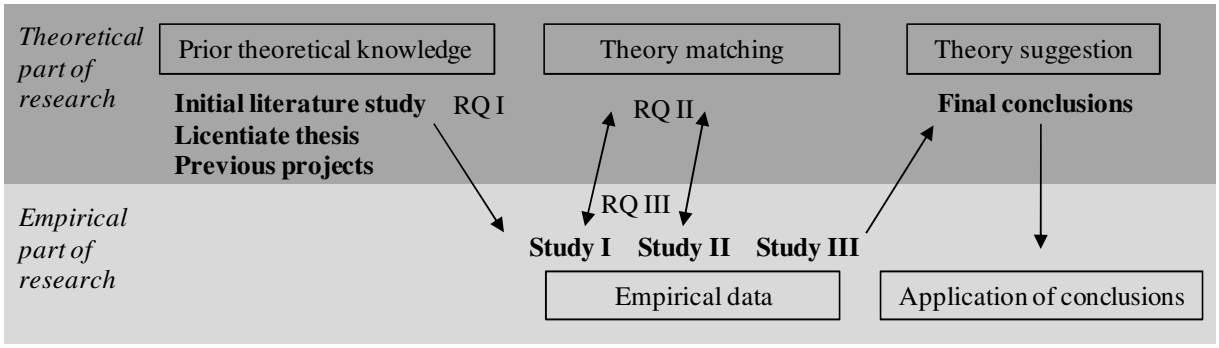

Figure 3.2 The abductive research approach shows iteration between empirical and theoretical parts of the research and the development of research questions in relation to final conclusions and applications (adapted from Kovacs and Spens, 2005).

Prior theoretical knowledge
Between 2002 and 2006 the author participated in more than 10 research projects and several consulting assignments in the fields of intermodal transportation, maritime information services, port design, risk assessments and shipping logistics. Research carried out between 2003 and 2005 also included analysis of intermodality and port performance, which resulted in the licentiate thesis, *Port performance in intermodal transportation,* finalised in the summer of 2005. The focus was on efficiency and effectiveness of intermodal transportation from a port perspective. Three key areas essential in order to attain high performance in transportation were examined: 1) physical and organisational interfaces, 2) chain integration and 3) capacity utilisation. Capacity utilisation was identified as "an important performance aspect on the effectiveness and competitiveness of any transport assignment" (Styhre, 2005, p. 35) and is suggested to be a focal point for future research in order to strengthen waterborne transportation. Thus, the interest in capacity utilisation was established early.

There is no direct relationship between this PhD thesis and previous work or the licentiate thesis. The research object has also changed: while the previous thesis is directed towards ports and intermodal transportation, this work takes the shipping company's perspective. However, knowledge of shipping and the port industry in general and capacity utilisation in particular, and experiences of research methodologies and analysis gained in that period have by indirect means provided significant input to this work.

Alteration between real life observation and theory matching
Prior theoretical knowledge including an unpublished study carried out in 2002 at the Division of Logistics and Transportation at Chalmers University of Technology indicated a relationship between frequency and vessel capacity utilisation. These resulted in Research Question I: *What route characteristics affect vessel capacity utilisation?* When there was an opportunity to participate in the project *Nordic Transportpolitical Network* funded by the European Commission for Interreg IIIB, the focus was set on vessel capacity utilisation in shipping. Cargo and passenger

statistics for Scandinavian ferry services were available within the project, and the study became the starting point for this work. The data contributed to answer the first research question, exploring the research field and increasing the knowledge of capacity utilisation in short sea shipping. The research established a correlation between frequency and capacity utilisation, and questions raised in this phase provided important input for the following studies. Due to the nature of the statistical material, the research question could only in part be answered in the first study. Consequently, Study II focuses also on the question and further determined frequency as an important feature. Additionally, the study established three other route characteristics that affect vessel capacity utilisation: trade imbalances and demand variations, types of customers and cargo, and competitive situation.

Research Question II evolved when planning for the second study and was a result of the exploration of the research field from a theoretical point of view: *What strategies are employed by the shipping companies to enhance vessel capacity utilisation?* In Study II, the focus changed from ferries including both passengers and cargo to RoRo vessels for pure cargo shipping. The research was funded by *Hugo Hammar's foundation for research in ship design* and *Logistics and Transportation Foundation*, and was based on a study of seven shipping services operated by one of the largest RoRo shipping companies in Northern Europe. The fairly low average vessel capacity utilisation in the Scandinavian ferry services lead to Research Question III: *How can vessel capacity utilisation in short sea shipping be enhanced*? Two extreme strategies for vessel capacity utilisation as well as external and internal factors that affect capacity utilisation and measures for improvement were identified and analysed in Study II.

Thus, Study II answered all three research questions. When the study was finalised, the work covered, at that point, ferries and RoRo shipping. As container feedering is also a very important component in regional transport networks, and as there are diversities between the roll-on/roll-off (RoRo) and the lift-on/lift-off (LoLo) concepts, it was decided that the last study should focus on feeder shipping. New questions were raised in the previous studies, from literature, and with interactions with practitioners related to the involvement of other actors in the transport chain. After an extended literature study including among other things transport chain integration and power structures in transportation, these ideas were incorporated in the third study. Further, the role of the terminals, which was briefly examined in Study II, proved to be important for vessel capacity utilisation. This also emphasised the decision to expand the focus to include parts of the transport chain other than merely the sea leg. Port and ocean shipping were consequently added in Study III.

A project proposal for the third study was favourably received by *A.P. Møller & Wife Chastine Mc-Kinney Møller's Foundation* ("Almenfonden"). As Maersk Line is part of the AP Møller group, naturally Maersk Line's container feeder connections were the next research object. The study covered two geographical regions: Northern Europe and Japan. Scholarships were received from *Scandinavia-Japan Sasakawa Foundation, Lars Hiertas Memorial Foundation* and *Friends of Chalmers*, in order to conduct the case study of Japanese container feeders and ports at Tokyo University of Marine Science and Technology in Japan. Later, additional funding was received from *Hugo Hammar's foundation for research in ship design* and *Hugo Hammar's foundation for international research in shipping* to carry out the European case study. As one part of the study was conducted in Japan and the other part in Northern Europe, this allowed for an assessment of geographical similarities and disparities, and gave the work an increased

international relevance. Research Question III was answered both in Study II and in Study III. Consequently, part of Study III was a reiteration of the previous study in order to compare RoRo and container feedering, while another part embraced issues related to intermodality, chain integration and demand structures in transportation.

The theoretical framework in this thesis was developed in conjunction with the research questions. Even though this work employs a physical approach to capacity utilisation, cost factors and economic aspects of shipping are included in the theoretical framework as they are essential in order to understand the shipping industry in general and capacity utilisation strategies in particular. This became apparent when reading papers of key authors such as Haralambides and Fusillo, and also during interviews in Study II when issues such as freight rates and economies of scale were discussed on many occasions. The shift from a statistical analysis in Study I to a qualitative approach taken in the two case studies is a consequence of the research questions and of striving to understand strategies and improvement measures in short sea shipping. A shipping perspective is applied in all three studies, even though the transport chain and interfaces towards ports and ocean shipping are examined in the last study.

3.5 Research quality

Research quality is often expressed in terms of validity, reliability and objectivity. Since these are terms that have been developed in quantitative research, there is an opinion that they are not suitable for qualitative research. Lincoln and Guba (1985) suggest that credibility, transferability, dependability and conformability need to be established to ensure trustworthiness in qualitative research findings. These four terms are the equivalents of the conventional internal validity, external validity, reliability and objectivity, but are introduced to make clear the distinction between different paradigms. However, the critical realism approach taken in this thesis allows the conventional terms to be used, but viewed from a more qualitative perspective instead of statistical. This could be handled by assimilation of the definitions to qualitative research without fundamentally changing their content but neutralising the issues regarding measurements (Bryman, 2002).

3.5.1 Internal validity

Internal validity refers to the extent to which the findings accurately describe reality. Triangulation, which is the use of different techniques to study the same phenomenon (e.g., Easterby-Smith et al., 1991; Alvesson and Sköldberg, 1994; Ellram, 1996), has been used to increase the findings' credibility in this thesis. Easterby-Smith et al. (1991) advocate four types of triangulation to overcome the potential bias in using a single-method approach. Three of these four (investigator triangulation where different investigators independently collect data is not included) have been employed:

- **Data triangulation,** where data was collected at different times and from different sources. For example, as several persons were interviewed within the same company in Study II, information in Study III was verified when possible at interviews with other companies in the transport chain, and some statements were validated by using sources other than interviews, such as documentation and statistics;

- **Methodological triangulation**, where both quantitative and qualitative techniques were employed. Semi-quantitative and quantitative data were collected and compared with respondents' statements; for example, regarding actual capacity utilisation and route characteristics;
- **Triangulation of theories**, where theories were taken from other disciplines to explain a phenomenon in shipping and logistics. The application of theories from different domains is most central for this research. Economies of scale, price elasticity and transport chain power and integration have been adopted from economics and business science to explain some phenomena in shipping, e.g., unutilised capacity and oversized ships. Inter-organisational relations are explained by organisational theories.

To facilitate internal validity of the two qualitative case studies, data were collected from different sources that later were compared: interviews, questionnaires, statistics and published company information. The risks of misinterpretation during the interviews were reduced by: a careful formulation of questions; an introduction letter with guidelines that was sent out a few days before the interviews; a short presentation at the beginning of the interview; and by providing the respondents with definitions of capacity utilisation and related terms. These strengthen the confidence in the quality of the interviews. In order to get information from different sources, seven key persons were interviewed in Study II and the same questions were asked in each interview. In Study III, interviews were carried out both with actors involved in feeder shipping and ocean shipping and port, which allowed the same matter to be viewed from different perspectives. Further, two cases, a European and a Japanese, allowed for some comparison to increase the internal validity.

All interviews were audio taped and transcribed, which reduced the risk of misunderstandings and facilitated a low interference description of the cases. Interpretations and conclusions were discussed with two of the respondents in Study II for verification and additional insight. The conclusions from all studies were discussed with other researchers and practitioners on seminars, meetings, workshops, etc. In order to establish evidence of the validity of the result in the statistic study, T-test and one way ANOVA were performed to ensure confidence in the findings.

3.5.2 External validity

External validity deals with the problem of knowing whether a study's findings are possible to generalise beyond the immediate case or not (Yin, 1994). In the quantitative Study I, there was a clear and unambiguous relation between vessel capacity utilisation and frequency, also proved by the ANOVA test and the t-test. It is most likely that the findings from the study are possible to generalise to similar contexts and settings, especially considering the possibilities to logically describe and understand the reasons behind the relations.

Even though transferability is hard for a qualitative case researcher to attain, steps were taken in the direction of generalisation. Study II includes seven shipping services, thus it was possible to compare the findings for the different services and see how route characteristics affected the outcome, which facilitates external validity. The geographical coverage in the last study of feeder services was expended from Northern Europe to include Japan. Some diversity between European and Japanese feeder shipping could be derived from the analyses, although no strict comparative analysis was carried out. However, these dissimilarities do not significantly affect

the possibilities to apply measures to improve capacity utilisation presented in this thesis. This awareness strengthens the external validity of the research. Further, the last research question was asked in both Study II and Study III, and the findings in the two studies coincide in a way that show that transferability between different shipping concepts in short sea shipping is most likely.

3.5.3 Reliability

Reliability describes to what extent data is consistent so replication of the study result is possible (Yin, 1994), representing the degree to which the findings are independent of accidental circumstances of the research (Kirk and Miller, 1986). Replication of this research is facilitated by accuracy in the accomplishment of the study and by the comprehensive description of the processes taken, such as data collection methods and data analysis.

A replication of the result in the statistical study of ferry services should be possible on the condition that the same methods for calculation of maximum and average capacity utilisation are used and that the context is similar. The semi-structured interview protocols used in Study II and Study III were developed to ensure reliability. Improvement measures were investigated in both these studies, and the same questions were asked to the respondents, which allows for a confirmation of the results. Interviews have been carried out with a total of 19 respondents in four shipping companies and in four ports within a time frame of two and a half years. The different respondents' statements are generally speaking without contradiction, which means that the overall conclusions and description of strategies and approaches taken by shipping companies to handle capacity utilisation are not likely to be affected by these circumstances.

3.5.4 Objectivity

Objectivity, or confirmability, is about whether findings have emerged from the context and the respondents, and not from the researcher. Traditionally, objectivity has been emphasised in science as the essential basis of all good research (Patton, 2002). Realising that absolute objectivity of the pure positivist variety is impossible to attain, a realist still believes that objectivity is worth striving for (Kirk and Miller, 1986). This can be done by emphasising good and solid empirical findings with firm description and analysis, without showing personal perspective or voice.

In Study I, all assumptions and figures (e.g., vehicles' lengths, the calculation of the "cargo versus car factor", etc.) were set before the analysis started and no figures were then changed, which reduced the risk of the outcomes being manipulated by the researcher. The study was planned together with Professor Kent Lumsden at Chalmers University of Technology but accomplished by the author alone.

In Study II and in the European case in Study III, all interviews were conducted, transcribed and analysed by the author herself. To reach objectivity and avoid misunderstandings, the findings were presented and discussed with two of the respondents in the second study after all interviews were carried out. Two of the respondents in the last study were reviewing the summary of the transcribed interviews to ensure that the researcher had not misinterpreted any information. In the Japanese case in Study III, the interviews were conducted, transcribed and quality checked together with a master student with good knowledge of Japanese, while the author carried out the

analysis by herself. To ensure objectivity and elucidate the interpretation of the material, all interviews are attached in the appendix. The results were also on a few occasions discussed with a Japanese researcher who is familiar with the field and the involved companies, and the empirical outcomes and analysis have been verified by another Japanese researcher.

The author was involved in all of the research proposals and solely responsible for writing the proposals for Study II and scholarship applications for Study III. Study II and Study III were planned by the authors alone, but the work was throughout the whole research process discussed with a tutor, an assistant tutor, researchers and practitioners. The first two studies resulted in three papers that were reviewed for publication. Finally, findings have been presented and discussed with experts from the academy and the shipping industry at different meetings, seminars and conferences in Sweden, Japan, Spain, Norway and the US.

PART III Theoretical framework

4. Waterborne transportation

This chapter is dedicated to shipping, port and intermodal operations. Enclosed are descriptions of the two shipping concepts, RoRo and LoLo, the hub and spoke system, as well as port structure and capacity. The chapter also gives a brief overview of intermodality, transport chain integration and power structures in transportation, and how these affect liner short sea shipping.

4.1 Shipping operations

Traditionally, the maritime transport industry has been divided into two major sectors: liner shipping and tramp shipping. Liner shipping provides regular services between specified ports according to timetables and usually carries cargo for a number of different shippers, whereas tramp shipping is irregular in time and space, and the vessels are usually chartered to carry a full shipload of cargo (UNCTAD, 2004). Some liner services commute between two ports and others visit a string of ports in a fixed sequence. Furthermore, a third general mode of operation in shipping is sometimes also used, in which the cargo owner or the shipper controls the vessels: industrial shipping (Christiansen et al., 2004).

Maritime transportation planning can be classified in the traditional manner according to the planning horizon into strategic, tactical and operational levels. Among the strategic issues, we find: market and trade selection, ship design, network and transportation system design, and port/terminal location (Christiansen et al., 2007). The tactical issues include adjustments to fleet size and mix, and routing and berth scheduling such as most favourable speed in relation to cost. Special attention related to port selection includes port charges, bunker facilities, port technologies, port turnaround time, etc. (Branch, 1998). The operational issues involve: sailing speed selection if adjustment to the sailing schedule is necessary, ship loading and unloading, and weather routing (Christiansen et al., 2007).

Important factors that influence customers' choice of shipping company for their cargo are space available onboard the vessel when needed, service frequency (Matear and Gray, 1993; Mangan et al., 2002), and transit time reliability, e.g., punctuality (Matear and Gray, 1993; Murphy and Hall, 1995; Cullinane and Toy, 2000; Mangan et al., 2002; Shinghal and Fowkes, 2002). Good predictability and reliability of cargo movements in liner shipping are important issues for manufacturers and traders because that can lead to inventory savings (Lagoudis et al., 2002). Thus, these requirements are important for the shipping companies to meet.

4.1.1 Shipping concepts

Liner shipping can be divided into two parts depending on how the vessels are loaded and unloaded: roll-on/roll-off (RoRo) and lift-on/lift-off (LoLo). Roll-on/roll-off vessels[10] are vessels such as ferries, RoRo vessels for pure cargo transportation, RoPax vessels built for cargo with

[10] Henceforth only RoRo vessels for pure cargo transportation and ferries are considered in the thesis.

passenger accommodation, and car carriers. The vessels have built-in ramps and are designed to carry wheeled cargo; for example, trucks, trailers, train wagons, cars, and cargo on roll-trailers (MAFIs) or cassettes (open-ended steel platforms that are loaded by special trucks called translifters). LoLo vessels[11] include, e.g., deep sea container vessels, feeder vessels and dry bulk cargo barges, and transport containers that are loaded and unloaded with container cranes.

The RoRo vessels are purposely built to eliminate the need for cranes and to load and unload the cargo quickly, and they offer some advantages over LoLo shipping. Most notably is the speed at which the crossing can be accomplished with modern ships and the short turnaround time in port (Lowe, 2005). The vessels do not require expensive port facilities and equipment to handle the cargo, as trailers and RoRo units are driven off the vessel through ramps. RoRo vessels are vital parts of regional liner service networks and often compete with road and rail transportation. Congested road and rail transport networks, environmental concerns, and other issues affecting contiguous land transport networks have resulted in an increased focus on this shipping concept (Mangan et al., 2008). Nevertheless, an unfavourable deadweight coefficient[12] compared with LoLo vessels means that RoRo vessels (with the exception of car carriers) mainly operate short sea shipping routes where the short turnaround time of the vessel accounts for a large percentage of the transport (Xie, 2009). This means that the cargo capacity of a LoLo vessel compared with a RoRo vessel in the same size is higher. As a consequence, the price of carrying transport units on a RoRo vessel is in general higher than for a LoLo.

General dissimilarities between different types of RoRo vessels are foremost related to types of vehicles and permission to take onboard passengers and/or drivers. RoRo is a pure cargo carrying vessel for trailers, cars, containers on MAFIs and cassettes, often with accommodations for a maximum of 12 drivers. The industry determines the departure time, and there are often several departures per week. Ferries are often used to provide a shuttle service between two ports and are custom built to serve a particular route (Christiansen et al., 2007). They transport passengers together with passengers' vehicles, buses and trucks on the car deck, and the sailing schedule is often set to fit the passengers. A RoPax vessel transports both passengers and cargo, and departure time and frequency are determined by the stakeholder that the service mainly relies upon; i.e., shippers or passengers. In contrast to ferries and RoPax, the LoLo vessels allow no passengers nor accompanied transport units. The diverse characteristics of the shipping vessel concepts are summarised in Table 1.1 in Chapter 1.2 Introduction to the research in liner short sea shipping.

4.1.2 Hub and spoke system

While short sea shipping is the transport of cargo in the same continent, ocean shipping refers to the transport of cargo across oceans. The ocean shipping industry is segmented and consists basically of container vessels, bulk carriers, conventional cargo vessels and car carriers. Deep sea vessels, also known as mother vessels and ocean going vessels, are in general much bigger than short sea vessels. In order to cover the high fixed costs, the ocean shipping companies use their largest vessels on the major routes and limit their calls to few and major hub ports, which can offer the necessary cargo handling capacities (Gouvernal et al., 2009). Existence of the hub ports

[11] Henceforth only deep sea vessels and feeder vessels are considered in the thesis.
[12] The deadweight coefficient is calculated as the deadweight divided by the displacement.

is a consequence of economies in density in shipping, see Chapter 6.1 Economies of scale and density. The concentration of traffic demand and transport services exhibits a positive correlation with transportation efficiency (Mori and Nishikimi, 2002).

The selection of hub ports is often based on location and port capacity. The planning problem consists of selecting which of a possible huge set of predefined routes to use and how many voyages to sail along the chosen string, while maximising the profit (Christiansen et al., 2007). By limiting the number of port calls, the round voyage time can be shortened, which means a greater number of round trips per year and/or that fewer vessels are required for a specific liner shipping service. However, fewer ports means access to fewer cargo catchment areas and higher costs for feeder services and transshipments in order to reach end-customers and end-producers (Notteboom, 2006). A hub and spoke system requires feeder vessels. The feeders provide the link between hub ports and satellite ports and often operate under the schedule of the deep sea vessels (Paixao and Marlow, 2002). Feeders are mainly for collecting cargo within a region and they normally visit a string of ports; see Figure 4.1. They often have a more flexible time schedule and provide higher frequency of port calls than the deep sea vessels (Imai et al., 2009).

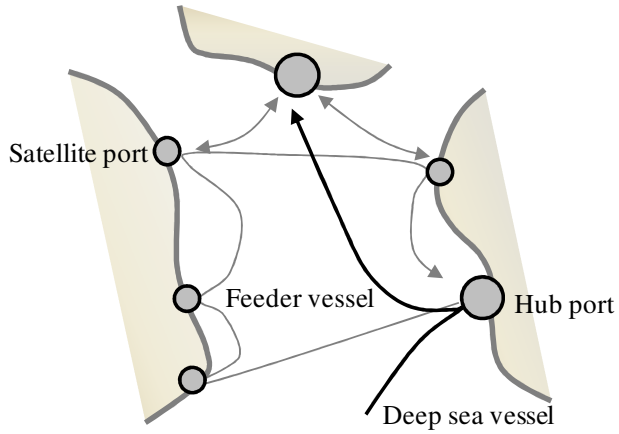

Figure 4.1 Hub and spoke system of direct calls and feeder services.

4.2 Port operations

Ports are vital intermodal nodes where ships, barges, trucks and trains converge and where collaboration between waterborne and land modes must exist (Charlier and Ridolfi, 1994). They are therefore illustrative when addressing the importance of well functioning interfaces between actors in transportation. Physical compatibility is a precondition for an intermodal transport chain, and standardisation of load units and handling equipment facilitates a transfer of load units between actors. Load units must nevertheless be accompanied with correct information in order to enable the physical movements.

4.2.1 Port structure and organisation

Both vertical and horizontal integration in the transport industry have resulted in a concentration of power at the port demand side, which has led to the shipping companies' increased market control over ports (Heaver et al., 2001; Notteboom, 2002; Song, 2002; Ha, 2003). For many

years, there have been organisational, technological and commercial changes with the aim of delivering door-to-door transport solutions rather than port-to-port services (e.g. Robinson, 2002; Paixaõ and Marlow, 2003). This has enlarged the port's hinterland and foreland and there is currently competition among many ports to grow and become hub ports for large shipping companies. Ports have been developed in conjunction with industrial and commercial businesses (Paixão and Marlow, 2003) into important nodes in the transport network. Consequently, the port's earlier narrow focus on cargo handling has been replaced with the establishment of a wide range of logistics and value-added activities. Thus, ports have gradually been breaking away from their traditional passive function in transportation and have taken a more active, initiative role (Mangan et al., 2008). Today the port has a high priority in the shipping companies' strategy when formulating sailing schedules. This involves analysis of port selection criteria and a definition of the port's function in the international supply chain from both the ship operator's and the shipper's standpoints (Branch, 1998).

Due to containerisation and the importance of obtaining economies of scale in vessel size, the hub ports have to make huge investments in container cranes, infrastructures and other equipment. A port may have two options: either to become a large hub port or to take a role as a satellite port in the regional hub and spoke system (Chang et al., 2008). The small and medium sized satellite ports which do not target mega large container vessels can complement the hub port by targeting niche markets, especially in feedering, rather than competing with them (Cullinane and Khanna, 2000). This also removes much of the need for investment in the most expensive infrastructure away from the satellite port.

4.2.2 Port capacity

Shipping companies prefer using terminals with unutilised capacity as this decreases the risk of congestion and increases the chances of being served faster on the sea side. The competitiveness of a port can be measured in short turnaround times (Steenken et al., 2004). In response to the spectacular increase in the maximum size of container vessels, ports have to respond to market demand by making large and rapid investments in infrastructure and equipment to cope with these new vessel sizes (Cullinane and Khanna, 2000). Sometimes ports need to invest above the optimal level in order to attract important customers (Musso et al., 2006), and often they have to make new investments in terminal facilities and cargo handling equipment of a speculative nature (McCalla, 1999; Nooteboom and Winkelmans, 2001).

Consequently, port capacity often needs to meet or exceed vessel capacity, as enough cargo-handling equipment and facilities are indispensable in order to keep a short turnaround time for the vessels and to avoid port congestion (Tongzon, 2009). Port congestion arises when port users interfere with one another in the utilisation of port capacities. Congestion is defined as the accumulation of transported items at a certain point in time and space (Dekker, 2005). In order to provide a high service level and not to reject any customers, the capacity must be adapted to the highest volume peak as demands fluctuate (Hultén, 1997). The situation in which shippers favour ports that can ensure a fast turnaround time with no delays, together with large weekly or seasonal variations in demand normally implies that the average capacity utilisation in port will be low. Since the share of fixed costs is high, the marginal cost for additional volumes becomes low. Therefore, terminal operators strive to increase throughput in order to increase profit. As a result, there is a need to balance between the shortage in capacity and unutilised capacity in port:

unutilised capacity indicates the presence of oversupply, which may lead to competition between ports and lower price, while shortages in capacity lead to port congestion and delays, and often a decreased demand for the congested port (Dekker, 2005).

Raise and reduction in port capacity can be carried out by structural measures or non-structural measures (Dekker, 2005). Structural measures result in facilities expansion and are capital intensive, show economies of scale, and require a long time between planning and installing. Non-structural measures implies an improved utilisation of existing capacity by supply management measures (e.g., improved information handling, better terminal design, smother changes of work shift, etc.) and demand management measures (e.g., congestion pricing and redirection of cargo flows).

4.3 Intermodal operations

Intermodal transportation is the movement of goods in one and the same loading unit between two destinations utilising more than one mode of transportation (see for example UN/ECE, 2001). The aim of intermodality is to facilitate transportation that is competitive on the transport market by combining comparative advantages of different modes. Each mode has its own advantages; for example, capacity, flexibility, energy consumption and environmental impact. Intermodality allows each mode to take its share of the transport chain, which is more efficient and cost-effective (Walton, 1993; Rodrigue et al., 2009). In order to achieve the aim of intermodality, there is a need for a focus on the activities as part of one entity where organisations are integrated and not simply interfaced (Holmberg, 2000). As activities of individual actors are not isolated, the overall performance depends on the joint effort of all actors (Lee and Billington, 1992; Notteboom, 1998).

Vertical and horizontal integration among the actors in the transport chain have become a common feature of the shipping industry. “The global alliances among shipping lines, the growth of container terminal management companies with global operations and the increase of logistical services offered by transport companies” is evidence of the increased integration amongst suppliers of logistics services (Heaver, 2001, p. 293). Globalisation and outsourcing have resulted in increased vertical integration along the transport chain, where foremost forwarders and shipping companies have played the leadership roles (Notteboom and Winkelmans, 2001). The term *vertical integration* describes a style of management control, and integrated companies are united through a hierarchy with a common owner. Motives for vertical integration among the shipping companies are the aspirations to achieve greater control of the transport chain and to reduce the transaction costs that would otherwise exist between the separate businesses (Hayuth, 1987; Heaver et al., 2001). As a consequence of this, shipping companies are becoming more involved with port management (Heaver, 2001).

The scale of operation is an important aspect for margin maximisation in the transport industry (Notteboom and Winkelmans, 2001). This is achieved by *horizontal integration* strategies, e.g., mergers, acquisitions and strategic alliances (Notteboom and Winkelmans, 2001; Slack et al., 2002). These mean that larger vessels with lower cost per unit can be employed, and it makes it easier to adjust capacity to demand than otherwise would have been the case (Davies, 1983). Rationalisation in the container shipping industry means that the number of operators has been reduced through competitive failure, merger and acquisition. An important consequence of the

integration is a concentration of power into the hands of fewer main players, while smaller operators have to confine themselves to niche markets (Cullinane and Khanna, 2000).

Companies exert differing levels of power in a transport chain and do so in different chains and at different times (Robinson, 2004). Even though competition has changed from individual companies to supply chains (Christopher, 1992), companies seek to improve terms and conditions of exchange through bargaining (Crook and Combs, 2007). Bargain power enables stronger companies to gain favourable exchange and exert their power during negotiations to get a larger percentage of transport chain's gains. Companies have power to the degree that others depend on them for resources that create dependencies when they are important or when control over them is relatively concentrated (Pfeffer and Salancik, 1978). Consequently, chain members offering high magnitude or critical resources who participate in highly concentrated industries are stronger and thus amass bargain power (Crook and Combs, 2007). Power is seen to be ". . . the ability of a firm (or an entrepreneur) to own and control critical assets in markets and supply chains that allow it to sustain its ability to appropriate and accumulate value for itself by constantly leveraging its customers, competitors and suppliers" (Cox et al., 2002). Critical resources are seen, therefore, as the basis for exerting dominance over actors in the chain. Transport chain power is based on owning or controlling a chain resource that combines high degrees of both utility and scarcity in the context of a particular transaction (Cox et al., 2002).

5. Capacity utilisation in waterborne transportation

This chapter defines vessel capacity and physical capacity utilisation of RoRo vessels and LoLo vessels. There is a difference between unutilised capacity and excess capacity related to planning that is also described in the chapter.

5.1 Vessel capacity

The method of measuring *vessel capacity* of ferry and RoRo vessels is maximum available lane meters. A lane meter is an area of deck one lane wide and one metre long. Container vessels are measured in number of TEUs. The twenty-foot equivalent unit (TEU) is a unit of cargo capacity often used to describe the capacity of both container vessels and container terminals (UNECE, 2009).

However, liner vessels seldom have a precise and accurate maximum capacity (Wu, 2009). The capacity of the RoRo and ferries depends on the cargo mix in relation to movable decks, internal ramps, lane heights, etc. that can be limited factors of how much cargo a vessel can accommodate. The formal maximum capacity of container vessels is easier to calculate as it corresponds to the number of container slots onboard the vessel, but also LoLo shipping faces some difficulties that normally decrease the maximum capacity. For example, stability of the vessel and dead weight restrictions limit the number of loaded containers.

5.2 Vessel capacity utilisation

Vessel capacity utilisation is the relation, usually expressed as a percentage, between transported units (actual output) and maximum units (potential output) within a certain time frame. The potential output represents the maximum output that may be produced per unit of time with existing equipment, provided that the availability of variable factors of production are not limited (Gold, 1955). For RoRo shipping this represents transported lane meters/maximum lane meters, and for LoLo shipping this is transported TEU/maximum TEU onboard the vessel.

Capacity utilisation per departure is often expressed in term of vessel's load factor. The load factor only describes the utilisation level in a very short time perspective without the possibility to change maximum capacity of the shipping service or to influence fixed costs. Thus, it becomes a rather narrow and irrelevant key performance indicator from a tactical or a strategic point of view, while the definition of vessel capacity utilisation represents a broader perspective. This includes, for example, how the maximum capacity can be increased with existing fleet by adding departures and seeing how long-term improvement measures, e.g., finding new customers for the low-volume sea leg, can increase transport volumes.

Unutilised capacity can be defined as planned losses in capacity utilisation and is caused by structural or strategic motives (OECD, 1993; Fusillo, 2003). Structural reasons for keeping

unutilised capacity are, for example, cyclical or stochastic demand variations (Lieberman, 1987) and ought to be seen as an unavoidable cost rather than an indication of inefficiency or waste of resources (Haralambides, 2002). Hence, a certain amount of unutilised capacity in liner shipping will have to be tolerated, as it arises from the specific characteristics of the industry, e.g., demand variations and trade imbalances, and the capital it employs (Davies, 1983; Fusillo, 2003). Shipping companies may also choose to maintain unutilised capacity as a part of a conscious strategy. Unutilised capacity may perform the function of a buffer for precautionary reasons (Driver, 2000) or may be employed as a strategic defence against rivals when a threat of entry or expansion is revealed (Wenders, 1971; Spence, 1977; Hilke, 1984; Lieberman, 1987; Driver, 2000; Fusillo, 2003; Sjostrom, 2004). The shipping company can immediately increase output or decrease prices when entry is threatened without incurring large costs. The probability of entry is thereby decreased by reducing the revenue prospects of potential entrants (Spence, 1977). This strategy is only effective in industries with high fixed costs (Driver, 2000) or with moderate increases in demand because rapid growth in demand quickly erodes existing unutilised capacity.

Furthermore, it can be argued that maintenance of capacity as an entry barrier is too costly and inconsistent with the assumption of profit maximisation (Benoit and Krishna, 1991). However, if the vessels themselves do not pose hindrances to entry, extensive global networks, dedicated terminals, investments in information systems, and intermodal arrangements, as well as advertising and creating goodwill on a route (Sjostrom, 2004) are to a great extent sunk costs and therefore entry deterring (Haralambides, 2004). Thus, large investments erect formidable barriers to entry in the form of capital requirements, which give shipping companies already in the market a great competitive advantage. Therefore, entry to the liner market does not often refer to new companies appearing but rather to existing ones expanding their network of services (Franck and Bunel, 1991; Haralambides, 2004).

Some authors replace the term unutilised capacity with chronic excess capacity (e.g., Bain, 1956), reserved capacity (e.g., Davies, 1983), or planned excess capacity (e.g., Driver, 2000), whereas others do not distinguish between the terms unutilised capacity and excess capacity. In this thesis, unutilised capacity is planned losses in capacity utilisation, while *excess capacity* is unplanned losses in capacity utilisation. Figure 5.1 shows excess capacity, unutilised capacity, maximum capacity and average utilised capacity when imbalances and variations are present. The system illustrated in the figure is designed to handle the highest peak. Consequently, the excess capacity represents the gap between maximum capacity and the utilised capacity of the highest peak, as this is unplanned losses in capacity utilisation.

However, the system can also be set to have a higher level of unutilised capacity than the highest peak. Thus there is planned unutilised capacity at times of maximum peak demand. In such a case there is no excess capacity but the level of unutilised capacity becomes higher. Reasons for planning for unutilised capacity even when there is a peak demand, are a belief that the market will grow substantially, structural reasons, e.g., high trade imbalances, and strategic reasons, e.g., to hinder new competitors from entering the market.

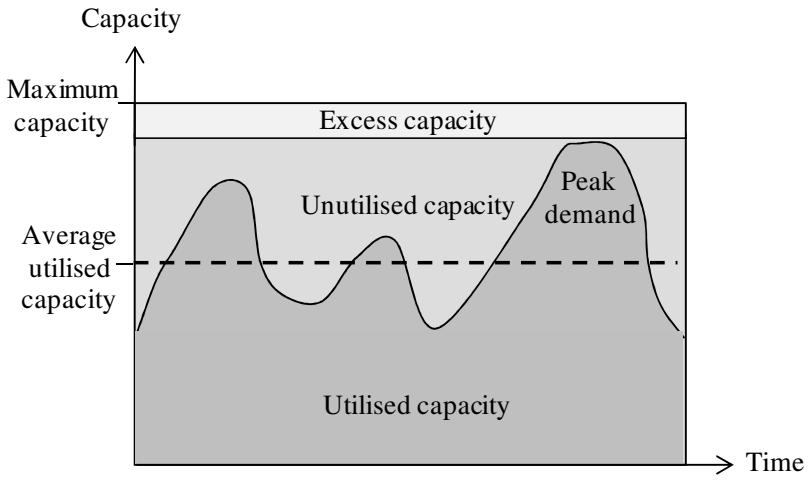

Figure 5.1 Illustration of unutilised capacity and excess capacity over a period of time when variations in demand are present.

When demand increases, shipping companies have to invest and expand capacity in indivisible portions because capacity is often added in large and discreet sizes in shipping (Fusillo, 2003). Often the addition of a new vessel will both add massively to total capacity of a service, much of which cannot immediately be utilised (Davies, 1983). The inability to vary supply with variations in demand in the short run is one of the main factors behind excess capacity that plagues many companies within the liner shipping industry (Fusillo, 2004). Excess capacity may as well occur when demands have gone down due to the state of the market or due to new entrants or when resources are inherently lumpy or subject to economics of scale (Lieberman, 1987). Consequently, excess capacity involves overinvestment in vessels and equipment, and implies inefficient allocation and a waste of economic resources (Esposito and Esposito, 1974; Kirkley et al., 2002).

6. Fundamental principles of transport economy

Economic aspects of shipping have an effect on capacity utilisation strategies and potential for improvements in liner short sea shipping. This chapter deals with economic theories that increase the understanding of the physical utilisation of vessel capacity: economies of scale, marginal pricing, and price differentiation and elasticity.

6.1 Economies of scale and density

The demand for vessel capacity has greatly increased over the last decades due to globalisation and increased trade. Further, containerisation has indeed caused a huge enlargement in container vessel capacity. The containerisation process started in the maritime sector in the 1960s as a response to raised demands on high transport performance and also as there was an increase in trade during the 1950s (Rehnström and Olsson, 2003). Due to the standardised boxes, the transshipment between modes has been significantly improved (Hayuth, 1987), and economies of scale can be obtained through consolidation of small and dispersed goods flows, thus allowing more advanced transport chains to be developed. This has led to a considerable reduction in the maritime transport costs (OECD, 2000).

The cost structure in shipping is generally perceived in terms of fixed costs and variable costs. Capital costs, e.g., interest and depreciation of the vessels, and operating costs, e.g., costs for labour, insurance, maintenance, etc. belong to the first group, whereas voyage costs, e.g., fuel and supply costs, port dues, etc. belong to the latter (UNCTAD, 2004). In liner shipping, the fixed costs are very high, which arise from both the capital intensiveness of shipping and from the committed nature of scheduled transport services (Davies, 1983). Once the schedule has been agreed upon, costs that could be regarded as variable in other industries (e.g., fuel, crew wages, maintenance, etc.) become fixed and cannot be avoided within the short-run planning horizon.

The cost structures give the shipping companies already in the market a tremendous competitive advantage (Paixao and Marlow, 2002). Thus, entry to the liner shipping market does not often refer to new companies appearing but rather to existing ones increasing capacity in existing routes or expanding their network of services (Franck and Bunel, 1991; Haralambides, 2004). This is a result of large investments in vessels, but also the great extent of sunk costs in extensive transport networks, dedicated terminals, intermodal arrangements and information systems, as well as advertising and creating goodwill on a route (Sjostrom, 2004).

The significant economies of scale in shipping mean that the marginal cost decreases with increased volumes (Cullinana and Khanna, 2000). As a result, there is a trend towards bigger vessels not only in ocean shipping (Mangan et al., 2008) but also in the short- and medium-distance trades (UNCTAD, 2007). Consequently, many shipping companies tend to operate larger vessels than necessary, which has led to an oversizing of vessels and excess capacity in the shipping market (Wu, 2009). Excess capacity can bring about severe competition among shipping

companies; the advantages of larger vessels can therefore be outweighed by deteriorated capacity utilisation and lower freight rates (Lim, 1998). Another disadvantage of large (post-Panamax) vessels is the reduced flexibility, as it has a deleterious effect on the revenue-earning potential through charting-out and on the second-hand value of the vessel (Cullinane and Khanna, 2000). Nevertheless, the benefit of larger vessels due to economies of scale is significant, especially for smaller or medium sized vessels (Talley et al., 1986; Cullinane and Khanna, 2000; Stopford, 2002). If the cost of supply shortage is higher than the cost of carrying unutilised capacity, the companies are more likely to accept unutilised capacity rather than be caught short during periods of high demand (Fusillo, 2003).

Even if there are strong economies of scale in ship operations, there are diseconomies in port operations due to the cost of dredging, congestion, distributing cargo from hub ports and associated logistic issues (Stopford, 2002). Further, larger vessels stay longer in port and the cargo handling time per transport unit increases as the time for loading and unloading vessels with different sizes is non-linear (Cullinane and Khanna, 2000). This implies that the large vessel sizes are of greater benefit on longer routes where the vessels spend a longer time at sea. Consequently, the optimal vessel size is obtained by trading off economies of scale in shipping with diseconomies of scale in port operations (Rodrigue et al., 2009). The optimal vessel size can be defined as the size that minimises cost both at sea and in port (Jansson and Shneerson, 1982).

There is a demand on high frequency in shipping (see for example Lagoudis et al., 2002; Mangan et al., 2002; Shinghal and Fowkes, 2002), which can lead to inventory savings (Lagoudis et al., 2002) and the establishment of more efficient transport chains. The higher frequency brings about a trade-off with economies of scale for the shipping company: a shipping service with smaller vessels allows more frequent departures that meet shippers' demand for high frequency compared with larger but fewer vessels. The larger vessels will, however, let the shipping company benefit from economies of vessel size (Notteboom, 2006). Jansson (1974, p. 299) describes the relation between vessel size and frequency: "So long as an increase in the frequency of sailings has a value to shippers [...] profit maximisation results in a liner service performed by ships that *never* will be as big as the ship that minimises the shipowner's cost, because the trade-off between cost savings from a bigger ship size and cost savings from an increase in the frequency of sailings will not cease until shippers become indifferent to getting a still more frequent service". This points out that shippers' demand on high frequency counterbalances a bigger vessel size up to a certain level.

On one hand, transport accessibility clearly affects the location of manufacturers, since they want to save shipping costs. On the other hand, the industrial location pattern influences the shape of the transport network in the presence of density economies (Mori and Nishikimi, 2002). Economies of density are a prevalent feature of the shipping industry and the concentration of traffic demand and transport services exhibits a positive correlation with the efficiency of transportation. Consequently, a greater concentration of industries in a given region generates a larger transport flow and lowers the cost of transportation via the region, which in turn attracts a greater number of companies (Mori and Nishikimi, 2002). A successful region eventually emerges as an international transport hub as well as an industrial centre. This means that shipping costs are lower on routes processing large volumes of cargo if they are linked to hub ports because specialised services and large scale infrastructure can be profitably developed in these

regions (Behrens et al., 2006). The increasing containerisation of world commodity trade provides an illustration of both aspects.

6.2 Marginal pricing

The marginal cost in shipping is the derivative of the total costs with respect to the quantity of cargo to be transported. It indicates additional cost required to transport the next container or trailer. If the vessel has a large extent of unutilised capacity and demand increases, the marginal cost is very low due to the cost structure in shipping. However, if the capacity utilisation is high, the marginal costs for transporting additional cargo increase significantly (Jansson, 1974) as a consequence of increased turnaround time in port or higher speed at sea, increased administrative expenses, decreased flexibility, etc. Further, if additional capacity needs to be added the marginal cost increase sharply and the costs per transport unit increases.

In high fixed-cost industries, marginal costs are below average total costs when the capacity utilisation is low. Competition in liner shipping combined with unutilised capacity tends to push prices down to short-run marginal costs (Haralambides, 2002; Cristiansen et al., 2007). Thus, competition based on marginal costs will lead to deficits and to a service that is unsustainable in the long run, as operators are unable to cover full costs (Jansson, 1974; Cariou, 2002; Haralambides, 2004), which is indicated in Figure 6.1. In ocean liner shipping, destructive competition has been prevented since the 1870s by setting fixed prices and the allocation of capacities in the shipping conferences (for a review see Sjostrom (2004)). In the mid-1990s, large shipping companies began merging and forming global alliances with formal agreements among carriers in order to avoid destructive competition (Cariou, 2002).

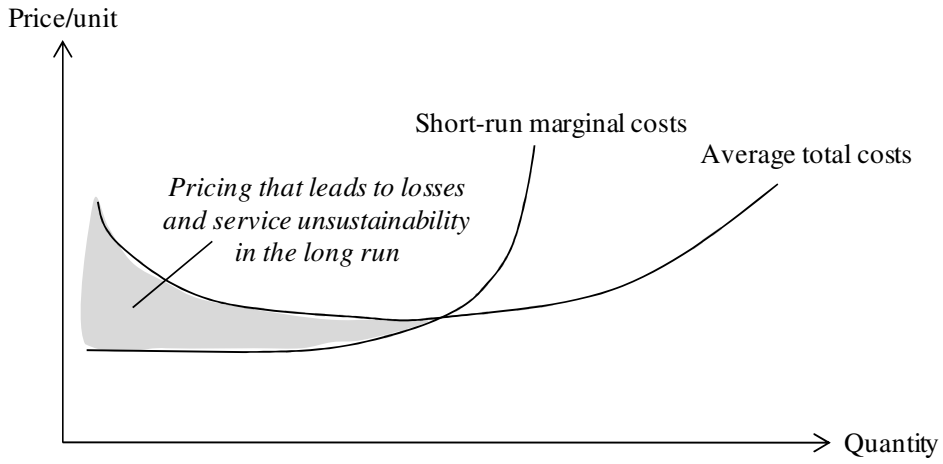

Figure 6.1 Pricing based on short run marginal costs.

The U-shape average total cost is due to economies and diseconomies of scale, which are described in the chapter above. Profit is highly sensitive to the level of capacity utilisation, and the break-even point for profitability varies according to the nature of the individual trade. Examples of factors that affect the break-even are imbalances in exports and imports, variations in demand, freight rates and type of vessels employed (Davies, 1983).

6.3 Price differentiation and price elasticity

Price differentiation exists when sales of identical goods or services are transacted at different prices. The different prices mean that some customers are charged more than *the long-run average cost* (LRAC) and some considerably less. A necessary condition for applying price differentiation is that the market is fragmented into customer groups with different elasticity of demand for shipping services (Zerby and Conlon, 1978). Price elasticity of demand is a measure of the degree of responsiveness of demand to a given change in price (Pass et al., 2000): if a change in price results in a more than proportionate change in quantity demanded, the demand is price-elastic; if a change in price produces a less than proportionate change in the quantity demanded, then demand is price-inelastic.

Under a single-rate system some customers may leave the service if it is necessary to increase the price. With a careful individual rate adjustment with knowledge of different customers' price elasticity, it is easier for the shipping company to maintain a high vessel capacity utilisation (Zerby and Conlon, 1978). In many cases, shipping of cargo is price-inelastic as long as the freight rate is lower than for a substitute choice (Franck and Bunel, 1991). Knowledge about the price which the market can bear is therefore of great importance when maximising vessel capacity utilisation. Deakin and Seward (1973) divided the customers into four groups depending on the freight rate, as shown in Figure 6.2.

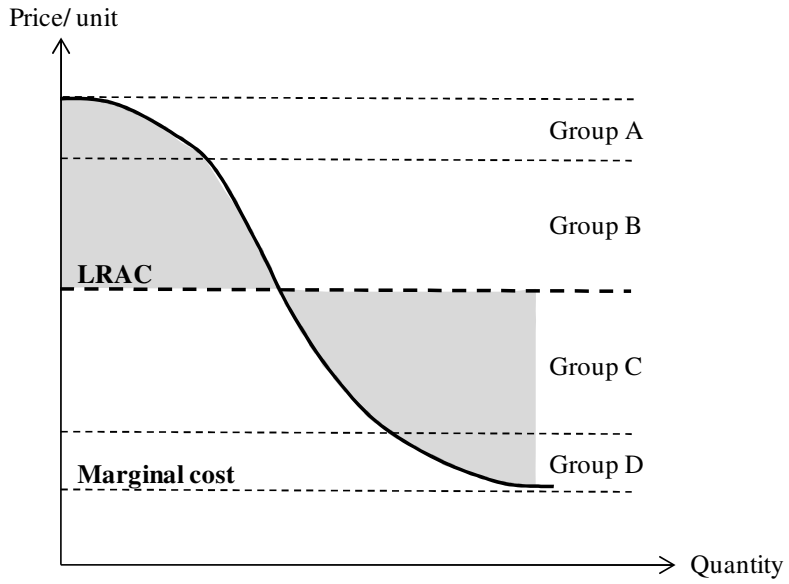

Figure 6.2 Theoretical average revenue function for differential pricing policy (adapted from Deakin and Seward, 1973). LRAC is the long-run average cost.

Group A represents the high value cargo and commodities with high freight rates. For example, the ocean shipping companies charge larger markups on goods with relatively inelastic demand, and on goods where the transport cost represents a small percentage of the price to end customers (Hummels et al., 2009). For some routes, competition between liner shipping and air transportation involves a relatively high elasticity of demand for this group. Similarly, many low-

rated commodities are capable of being transported by bulk carriers and, therefore, experience a relatively high elasticity of demand. Obviously there are exceptions; for example, large and heavy project cargo (machines, heavy equipment, etc.) that often are transported in RoRo vessels that are paying high freight rates. These products cannot be transported on rail or road due to large dimensions or heavy weight. Deakin and Seward (1973) observed that profits occurred mainly from group B, and these profits offset the losses incurred by group C and D.

A larger number of competitors on a route can lower the freight rate (Haralambides, 2007) and the ability of shipping companies to price discriminate across products (Zerby and Conlon, 1978). Demand for individual shipping services seems to be elastic if there are many alternatives as shippers in many cases easily and quickly can change their transport provider if better conditions are available in the market, which leads to price level volatility (Alcedo et al., 2009). Because of the nature of supply and demand in liner shipping, prices fluctuate with changes in capacity, which creates non-stable price equilibrium (Abito, 2005).

The physical volume of trade on any route is rarely balanced in both directions, and therefore, unutilised capacity exists in one direction. Thus, the freight rates must be adjusted upwards until they cover the cost of unutilised volumes. As rates are lower in the low volume sea-leg where it is more difficult to secure cargo (Franck and Bunel, 1991), the freight rates must be increased in the high volume sea-leg (Jansson, 1974).

PART IV Empirical outcomes

7. Capacity utilisation in ferry services

Study I is a quantitative study based on goods statistics of 19 Scandinavian ferry services within and to/from Sweden, Denmark and Norway operated by 10 shipping companies. An overview of the shipping services is attached in Appendix A. The purposes are to explore vessel capacity utilisation in ferry services and to analyse how route characteristics affect vessel capacity utilisation. Route characteristics that were investigated are: departure frequency, distance, trade imbalances and demand variations.

7.1 Case description of Scandinavian ferry services

This study relies upon goods and passenger data for the year 2004 collected by Statistics Denmark[13] (2005). Most major ferry operators in Scandinavia are included in the study, while smaller companies are also represented; see Table 7.1. In total, 19 shipping services operated by 10 shipping companies were analysed. All services operated by Color Line, Fjordline, HH-ferries, Rømø-Sylt Linie and Smyril Line were investigated, while, due to data availability, a selection of the other companies' services was included: Bornholmstrafikken, DFDS Seaways, Polferries, Scandlines and Stena Line.

Table 7.1 Summaries of the 10 shipping services included in the study of ferry services.

Shipping company	Total no. of services	Vessels in the fleet	Countries of operation
Bornholmstrafikken	3	4	Denmark, Sweden, Germany
Color Line	4	4	Norway, Sweden, Denmark
DFDS Seaways	3	5	Denmark, Great Britain, Norway, The Netherlands
Fjord Line	1	1	Norway, Denmark
HH - ferries	1	2	Sweden, Denmark
Polferries	3	4	Poland, Denmark, Sweden
Rømø-Sylt Linie	1	1	Denmark , Germany
Scandlines	10	23	Denmark, Germany, Sweden, Latvia, Lithuania, Finland
Smyril Line	1	1	Denmark, Faroe Islands, Iceland
Stena Line	14	24	Sweden, Denmark, Poland, Germany, Norway, Great Britain, The Netherlands, Ireland

Sources: bornholmstrafikken.dk; colorline.no; dfdsseaways.se; fjordline.com; hhferries.se; polferries.com; syltfaehre.de; Scandlines.com; smyril-line.com; and stenaline.se (access December 2009).

[13] Danmarks Statistiks: opgørelse af transport i internationalt færgefart til og fra Danmark 2004. Background material included in the report: Denmarks Statistik, Transport: Skibsfarten på danske havne 2004, 2005:12.

In total, 33 vessels operated the 19 shipping services; one vessel each was used for nine of the routes, while the other 10 used between two and four vessels. The services had in total more than 129,000 departures and transported approximately 41 million lane meters of cargo and passenger vehicles in 2004. Approximately 36% of the transported lane meters were used for cargo and 64% for passenger vehicles, but there were large seasonal variations both in the share and in the total number of cargo and passenger vehicles. The 33 vessels accommodated more than 25,700,000 passengers in 2004. The vessels commuted between two ports in most of the cases, with the exception of the routes operated by Fjordline and Smyril Line that called a string of ports. The ports in the study were located in Denmark, Sweden, Norway, Germany, Poland, Iceland and the Faeroe Islands.

Most services are well-established and have been running for many years, even though some of the routes have experienced some changes since 2004. Two of Color Line's services and one of Scandlines' services included in the study have been cancelled and three shipping companies, Color Line, Fjord Line and Rømø-Sylt Linie, have renewed their fleet. The diversity of the 19 ferry services, including transport time, distance, frequency and number of vessels is shown in Appendix A.

7.2 Level of vessel capacity utilisation in ferry services

The empirical data of the 19 ferry services showed that the average annual utilisation of the vessels reached 42.3% with a standard deviation of 12.8. Table 7.2 shows the average monthly capacity utilisation for the 19 routes. The disparities between the services were large, with an annual mean value per route that varied between 23.5% and 62.9%. The great fluctuation in the maximum and minimum values per month is shown in the table below. Four of the services had all their departures cancelled some months, normally during low season. These routes are not included in the mean value for that particular month. The wide spread of the average level of vessel capacity utilisation is a consequence of the diversity of the route characteristics, and to what extent they rely on cargo or passenger traffic, including foot passengers that travel without vehicles.

Table 7.2 Average vessel capacity utilisation (%) per month for the 19 ferry services[14].

	Jan	Feb	Mar	Apr	Maj	Jun	Jul	Aug	Sep	Okt	Nov	Dec
Mean	35.9	37.9	40.7	43.2	44.6	44.4	53.8	50.7	41.5	41.2	35.4	36.5
Maximum	63.1	67.7	93.7	73.5	78.3	72.8	81.0	100.8	74.6	68.6	62.2	64.2
Minimum	18.5	21.5	24.3	20.2	20.2	12.7	19.9	25.6	4.4	18.2	18.0	17.8
Standard deviation	13.9	12.9	17.1	17.3	16.6	15.6	15.5	19.1	17.6	15.0	11.4	11.9

The monthly reported transport figures did not allow for an analysis of single departures. Thus, it was not possible to detect any daily or weekly variations from the data. Some of the departures during high season were most certainly fully booked even if the monthly capacity utilisation was lower.

[14] In August, the maximum value exceeded 100%. This is probably a consequence of the conversion from number of vehicles to lane meters that were carried out in the study or due to the inaccurate method of specifying maximum capacity and measuring transported lane meters by the shipping companies.

7.3 Demand variations and trade imbalances in goods and passenger flows

The ferry services showed in general large seasonal variations. The monthly capacity utilisation in the busiest month of July came to 53.8% on average, whereas November was as low as 35.4%, as shown in the table above. The figures for the autumn and winter months would have been even lower if most shipping companies (14 routes out of 19) would not have reduced the number of departures during that period. The seasonal variations were mostly due to a great reduction in passenger vehicles in the low season, while the cargo volumes were relatively stable. However, summer implied a small reduction of trailers and trucks as a result of the general industry holiday in Scandinavia and a reduction in production capacity. In July, the share of cargo was only 17.5%, but from November to March cargo represented approximately 45% to 50% of the total transported lane meters.

The significant increase in passengers in July and August due to summer holidays implies that the majority of the vessels' capacities were engaged with personal cars, caravans and buses. The total transported lane meters in 2004 for the 19 ferry services are shown in Figure 7.1. Roughly 41 million lane meters were transported by the 33 vessels.

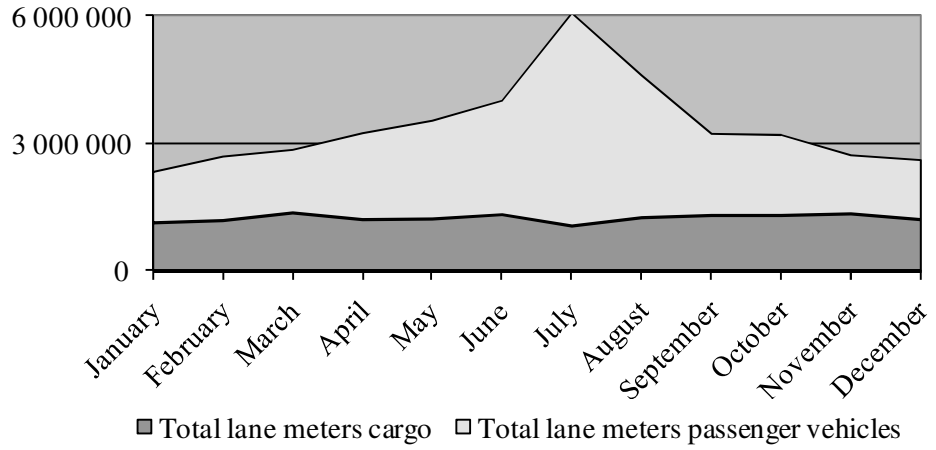

Figure 7.1 Total transported lane meters per month for the ferry services show seasonal variations of goods and passenger vehicles.

All the studied ferry services showed trade imbalances of export and import of goods and/or passenger vehicles. On average, the trade imbalances reached 11.4%. However, there was a clear distinction between two groups of services[15]: one that seemed to have none or few problems with trade imbalances (including 12 shipping services with imbalances less than 10%), and one with large trade imbalances that probably forced the shipping companies to take some actions to counterbalance the figures (including 5 shipping services with imbalances above 10%). The t-test confirms that the differences between the two groups were significant ($P<0.05$).

The first group showed an average level of imbalances of 2.9% (standard deviation 2.2) and the latter 31.7% (standard deviation 11.5) when both cargo and passenger vehicles were included in the calculations. The deviations in the incoming and the outgoing passenger flows were more

[15] In two cases, the figures for export and import were summarised and not possible to analyse.

even than the cargo flows. If only cargo was considered the trade imbalances were 7.4% (standard deviation 9.0) for the first group and 44.7% (standard deviation 19.7) for the latter. Accordingly, the share of cargo in relation to passenger vehicles was higher for the group of large imbalances: 58.3% compared with 32.4%.

7.4 Route characteristics and vessel capacity utilisation

The relationships between characteristics of individual shipping services and vessel capacity utilisation were examined in the study. Route characteristics included in the analysis are: departure frequency, distance, trade imbalances and demand variations.

The empirical outcome showed a relation between *departure frequency* and vessel capacity utilisation, as shown in Table 7.3. The utilisation level was significantly lower for routes with high frequency. The routes were divided into 3 groups with frequencies less than 10 departures per week; between 10-100 departures per week; and more than 100 departures per week. These included both inbound and outbound traffic. Thus, the shipping service with the highest frequency (above 43,000 departures per year) had 60 departures per day in each direction, which makes it among the busiest ferry services in Europe.

Table 7.3 Total vessel capacity utilisation for the 19 routes grouped into frequency ranges.

Departures/week	<10	10-100	>100
Average yearly vessel capacity utilisation (%)	46.8	44.3	33.6
Standard deviation	15.3	11.6	8.6
Average departures/week	6	27	448
Average distance	196	105	19
Numbers of routes	6	8	5

The result of one way ANOVA based on monthly figures for capacity utilisation indicated a significant difference between the three groups ($F = 28.24$, $P < 0.0001$), and the Tukey's method of post hoc comparison showed that there were significant differences between the three groups at the 0.05 level.

The ferry services with a frequency above 100 departures per week showed an average vessel capacity utilisation of 33.6%, which was significantly lower than the average annual vessel capacity utilisation of 42.3%. The middle group showed an average utilisation of 44.3% and the group of less than 10 departures per week reached 46.8%. The differences between the groups were significant on a monthly basis and clearly perceptible in the graphical presentation of the variations in capacity utilisation over the year. Figure 7.2 shows the monthly vessel capacity utilisation for the three groups of frequency. The shipping services with the highest frequency were Scandlines' services between Helsingborg – Helsingör, Rødby – Puttgarden, and Gedser – Rostock, Stena Line's service between Göteborg – Fredrikshamn and HH-ferries service between Helsingborg – Helsingör.

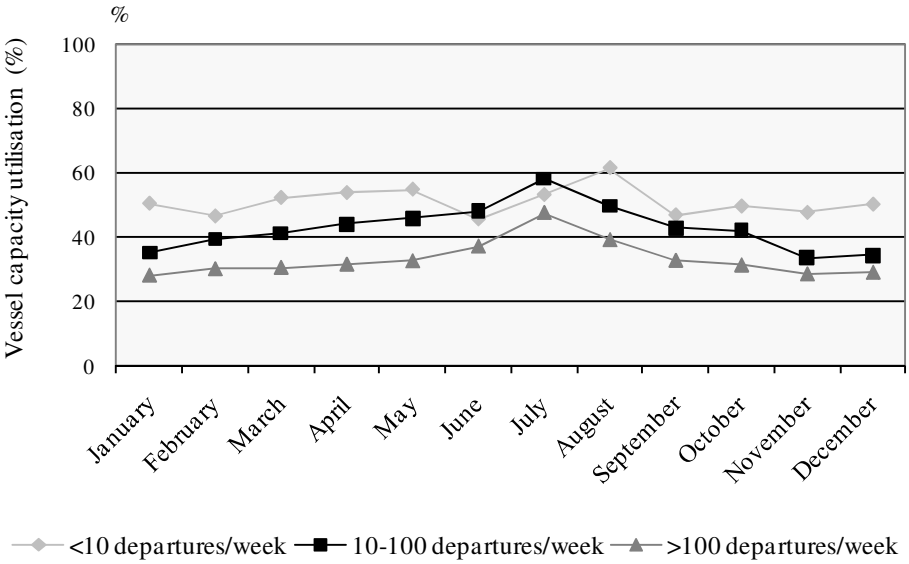

Figure 7.2 Relations between vessel capacity utilisation and frequency reported on a monthly basis.

The relationship between *distance* and capacity utilisation was also investigated. The distance is closely related to frequency, as shown in Table 7.3. The group of services with the lowest departure frequency had an average distance of 196 nautical miles, and the crossings of the high-frequency services were 19 nautical miles on average. This is likely a logical consequence of the fact that high frequency over long distances requires great goods volumes and a very large fleet. Scandinavia has a fairly low population of approximately 19.5 million inhabitants distributed over large land areas in Sweden, Norway and Denmark. Thus, high frequency over longer distances is not feasible in that type of region. Consequently, the strong correlation between capacity utilisation and frequency, and the link between frequency and distance, implied that there was no direct relationship between distance and capacity utilisation.

Trade imbalances and *monthly variations in demand* were investigated to determine their relationships to vessel capacity utilisation. The group of shipping services with less than 10% of imbalances showed an average monthly capacity utilisation of 43.6% and the group with more than 10% of trade imbalances 39.6%. However, the t-test showed no significant differences between the two groups. Finally, the hypothesis that monthly demand variations might affect vessel capacity utilisation was examined. However, the data gave no evidence of a relation between the monthly variation in demand and capacity utilisation. Thus, no conclusions could be drawn from the figures, even though it seemed likely from a logical point of view that imbalances and demand variations might affect vessel capacity utilisation.

8. Capacity utilisation strategies for RoRo shipping

The purposes of this study are to analyse capacity utilisation strategies and examine measures aimed at improving vessel capacity utilisation. The research is based on a RoRo shipping company that operates vessels in Northern Europe. The chapter includes a case description and an exposition of the seven diverse shipping routes included in the study, and presents factors that affect vessel capacity utilisation. The interview protocol that was developed and used in the study is found in Appendix B, and a summary of the seven respondents' answers in Appendix C. The relationship between route characteristics and applied capacity utilisation strategies, as well as the examination of improvement measures are found in *Part V Analysis.*

8.1 Case description

This study is based on a RoRo shipping company, which operates primarily RoRo (roll-on/roll-off) and RoPax (roll-on/roll-off and passengers) vessels in the North Sea and in the Baltic Sea, with subsidiaries in Sweden, Norway, Great Britain, the Netherlands, Belgium, Germany, Latvia, Lithuania and Russia. RoPax vessels are mainly used in the Baltic, where the market for accompanied trailers is larger than on the North Sea. The shipping company operates 11 RoRo/RoPax shipping services, of which seven are included in the study. Six of the services are solely for RoRo transportation and one is a RoPax service.

In order to improve the service level and secure port capacity, the company operates its own terminals in a few locations. The vessel strategy is to have a new fleet with a mixture of owned and chartered vessels. The advantages of chartering vessels are that capacities can be cancelled or added in shorter time and that the company has less tied up capital, while the main advantage of owning vessels is the possibility to design vessels that perfectly suit individual routes. The size of the vessels normally ranges from between 1800 and 4600 lane meters distributed between a main deck, weather deck and lower hold. The RoPax vessels accommodate different numbers of passengers, while the RoRo vessels normally accommodate only a maximum of 12 truck drivers. Approximately 10 million lane meters were transported in 2008.

The company has no formal expressed strategy for capacity utilisation, but is continuously working with issues related to vessel capacity utilisation on both operational and strategic levels. Furthermore, it appears that the respondents instinctively work for partly unexpressed schemes towards this. A company strategy exists for the routes: the idea is to create a dense and high-frequency network rather than to expand the network by including new ports. Reliability, frequency, cost efficiency and adaptability are described as key criteria of success. The main customers are international transport and shipping companies, trailer operators, large manufacturers of industrial goods and automotive manufacturers whose logistics include a significant element of transportation by sea.

Seven services are included in the second study. Six of the routes are located in the North Sea and one in the Baltic Sea. The following countries were connected to at least one of the routes: Sweden, Norway, Denmark, Great Britain, Germany, the Netherlands, Belgium and Lithuania. The services showed dissimilar features in terms of capacity utilisation, frequency, imbalances and market share, which are indicated in Table 8.1.

Table 8.1 The characteristics of the seven routes included in Study II.

	Route 1	Route 2	Route 3	Route 4	Route 5	Route 6	Route 7
Capacity utilisation	high	high	high	medium	medium	medium	low
Frequency	high	high	high	high	high	medium	low
Imbalances	medium	medium	medium	medium	high	high	medium
Market share	high	low	low	medium	medium	medium	medium

The quantification of the features in Table 8.1 is based on statistics and the interviews and is shown in Table 8.2. The classification of vessel capacity utilisation and trade imbalances are derived from goods statistics for the seven routes, combined with the respondents' views of the matter. High capacity utilisation in this context is considered to be more than 85%, while low represents less than 70%. High imbalances are above 10% and low are less than 5%. Customers, according to the respondents, in general consider departure frequency as high if there are at least six sailings per week and low if there are two sailings or less per week. Finally, the respondents labelled their market share of each route as being high, medium or low. Thereafter, transport volumes were compared with national transport statistics, and the market share was categorised as high if it exceeded 50% and low if it was less than 5%.

Table 8.2 Classification of capacity utilisation, frequency, imbalances and market share.

	Low	Medium	High
Capacity utilisation	<70%	70-85%	>85%
Frequency	<3/w	3-4/w	>4/w
Imbalances	<5%	5-10%	>10%
Market share	<5%	5-50%	>50%

8.2 Diversity of the RoRo services

As shown above, frequency, imbalances and market share varied significantly between the routes. This affected the approach taken by the shipping company to handle vessel capacity utilisation, which indicated that vessel capacity utilisation strategies and improvement measures need to be carefully applied on a route basis, and not on a company level.

Demand for departure frequency

Frequency was a central attribute for the shipping services. Higher frequency can increase the income and decrease the unit costs by allocating fixed costs to a greater number of departures. The study showed that daily departures on weekdays often met or exceeded customers' requirements for frequency. Routes 6 and Route 7 had less than 5 sailings per week. The plan for Route 6 was to increase frequency by investing in new vessels, as there was a market demand for

larger capacity. The situation was rather different for Route 7, which experienced both low frequency and low capacity utilisation. Increased frequency would probably imply an even lower level of capacity utilisation due to a limited market.

Imbalances and demand variations decrease capacity utilisation
The study showed that the likelihood of unutilised capacity increased with higher trade imbalances and daily or seasonal demand variations. All seven routes experienced demand variations and some degree of imbalances. The situation was worse for Routes 5 and Route 6 as they had more than 10% deviation between import and export volumes. Efforts were directed towards counterbalancing the figures by finding new customers and cargo in the low volume sea-leg or departure.

Market share and capacity utilisation
Competition affected the optimal level of average capacity utilisation. One respondent explained the situation for Route 2: "We have many competitors here. When you have a downward pressure on prices, you cannot afford any unutilised capacity. Sometimes you need to cut peaks and let someone else take the cargo." The shipping company was therefore aiming at a high level of capacity utilisation for the route.

There were also situations when a lower capacity utilisation was accepted. When competition is limited, it is difficult for customers to switch to another transport provider. The shipping company has a large market share on Route 1, and the employed strategy was to keep the unutilised capacity a bit higher compared to other routes in order to serve all customers[16]. One respondent stated: "We have a responsibility to provide a good service, since we are the only option. Therefore, we need to plan for unutilised capacity. Our product is well-paid and we need to provide the capacity."

8.3 Factors that affect RoRo capacity utilisation

The interview protocol (see Appendix B) includes two questions about external and internal factors that affect vessel capacity utilisation. External factors are beyond the control of the shipping company, while internal factors are a result of actions taken within the company. Several factors emerged when analysing the interviews, which were divided into six groups. External factors that affect RoRo capacity utilisation are related to the groups: *market factors*, *customer factors*, *port factors* and *surrounding factors*, while internal factors are associated with *management factors* and *vessel factors*. Factors that originate from Study II are included in Table 8.3. The table indicates no priority and the significance of individual factors was not investigated, although factors in the groups *market factors* and *vessel factors* seemed to be the most important according to the respondents' answers.

[16] Capacity utilisation for Route 1 was, however, "high" because market development had been better than expected.

Table 8.3 External and internal factors that affect RoRo vessel capacity utilisation.

Factors that affect RoRo vessel capacity utilisation		
External factors	**Market factors**	State of the market Available cargo in the market Imbalances export/import Daily or seasonal varitions in demand Cargo mix Competition annd cooperation
	Customer factors	Variations in produced output Late cancellations Double booking No-show Information exchange
	Port factors	Port capacity Infrastructure capacity Port performance
	Surrounding factors	Congestion Weather conditions Regulation and legislation
Internal factors	**Management factors**	Planning, organising or leading Sailing schedule
	Vessel factors	Vessel design, size, and age Stowage plans Maintenance of the vessel

Market factors that affected the shipping company to a great extent in various ways were the state of the market, available cargo in the market, trade imbalances, and daily or seasonal variations in demand for transportation. Some of these factors are difficult, and others are impossible to influence or control because they are a consequence of the global economic system. A cargo mix that corresponds with the design of the RoRo vessel was also pointed out as an important factor. For example, too many trailers means that hoistable car decks cannot be used, and too many cars decreases the trailer capacity on the main deck. Finally, new or disappearing competitors had an effect on both vessel capacity utilisation and price per transported unit.

Customer factors had an influence on the shipping company's ability to utilise their vessel capacities. Vacations, production cycles, production break downs and material shortages were sources of uncertainty. These variations create fluctuations in capacity demand, which can result both in periods of lower vessel capacity utilisation and periods of occasional capacity shortages when there is a sudden build-up of large transport volumes. Double booking means that the customers reserve more than one departure per unit in order to be more flexible and to be certain of obtaining at least one of the bookings. Double booking and late cancellations normally do not add extra costs for the customers, so there are no incentives for them to change their behaviour. No-show, also a common phenomenon in the travel industry, means that the customers do not show up prior to departures as agreed even though they have booked a departure. Information

exchange is both related to the daily contact with customers and also to the long-term commitments. The respondents' view of information accessibility was that customers could improve both their prognosis of expected transport volumes and the communication of information to the shipping company. However, the nature of the information being rather strategic was in some cases a hindrance for sharing this.

Port factors also proved to be important for vessel capacity utilisation, and lack of capacity when needed in port and in surrounding infrastructure could sometimes reduce the utilisation of the vessel's capacity. The respondents described situations where vessels were not served as required on weekends and on late arrivals, boycotts caused late departures and vessels needed to leave cargo behind because the cargo units were not loaded in time. These have an influence on vessel capacity utilisation as well as costs on the shipping company.

Surrounding factors that affected vessel capacity utilisation proved first and foremost to be: congestion, weather conditions, and legislation and regulation. Port congestion is not uncommon in many larger ports and can cause delays to vessels. The schedule unreliability this creates can cause additional fuel costs to shipping companies when increased speed is necessary to make up time. Examples of regulations and legislation that were given by the respondents were customs duties, export-import regulations, road tolls, driving and working hours, cargo handling and storing regulations, and the ship-reporting system that require time-consuming paperwork every time a vessel call at a port.

Management factors related to planning, organising, and leading a shipping company were also emphasised by the respondents. One respondent described the importance of cooperation between different functions of the company to reach a higher capacity utilisation of the vessels: "The cooperation between the agency function and the planners is very important. We have just transferred all our terminal management assistants from the terminal and they are now sitting here together with the booking class. They can together look at how to get the maximum volumes of cargo on the vessel. They can talk about what is the best cargo mix and which customers pay the most." Further, an efficient sailing schedule that attracts customers and makes efficient use of the vessels was stated as an important factor.

Finally, *vessel factors* are important to reach an adequate level of vessel capacity utilisation for the shipping company. Correspondence between transported load units and vessel design is crucial for RoRo shipping. Thus, vessel design, size and age are important factors. Old vessels are mainly a problem because of reduced service reliability. The shipping company's vessel strategy was to have a new fleet, a mixture of owned and chartered vessels, and to design the vessels to suit individual routes and their cargo. One respondent described why ship design is an important factor for capacity utilisation: "Every RoRo vessel has a different design. If you have a vessel that doesn't allow you to double stack containers high-wise, then financially it is difficult to make that service profitable. You need to focus on trailers or on other cargo. What we do in terms of optimising capacity is linked to, number one, the specific vessel design and, number two, the market and the cargo mix." Finally, maintenance of vessels decreases the average capacity utilisation on a yearly basis, even though the shipping company tried to remove the vessels from service during low season.

9. Container feeders in transport chains

The purpose of this study is to examine measures to improve the vessel capacity utilisation in feeder shipping. This last study expands the view from the sea-leg to also include ports and ocean shipping. This originates from the fact that shipping is not an isolated phenomenon. On the contrary, it is highly affected by other actors of the transport chain. The research covers two geographical regions, Northern Europe and Japan, and is based on qualitative interviews and complementary quantitative data. Each of the two cases includes the feeder operation and the interfaces towards ports and ocean shipping. In Appendix E are two interview protocols: one that was used for the shipping companies, and one for the terminals. A summary of the respondents' answers can be found in Appendix F. Two questionnaires were also used for data collection from the shipping companies and the terminals respectively. The questionnaires are attached in Appendix G.

9.1 Case description

This study covers two geographical regions: Northern Europe and Japan. In each case, part of a transport chain is examined, including: 1) an ocean shipping company, represented by Maersk Line, 2) a hub port, 3) a feeder operator, and 4) a satellite port. There are close points of similarity between the two regions. Both have comparable production and consumption patterns, long traditions of trading, developed ports and a dense network of shipping routes, and similar geographical conditions with long coast lines and land separated by water. However, there are also dissimilarities such as regulations, modal split and ownership of ports.

9.1.1 The North European case

Maersk Line is in both cases the representative of the ocean shipping leg of the transport chain. Maersk Line is the world largest container shipping company with more than 500 vessels in their fleet. They operate some of the biggest vessels in the world, with a carrying capacity up to 12,000 TEU. Maersk Line predominantly uses external common feeder operators in Europe, even though they own and operate a few services. The shipping string included in the study is operated by 10 vessels with a size of about 7,500 TEU. The vessels call at several large hub ports in Northern Europe, South East Asia and Japan, and it takes about 70 days to complete the shipping route.

Maersk Line is part of the A.P. Moller-Maersk Group that also owns APM Terminals. APM Terminals operates a global network of 49 terminals in 32 countries. The European hub included in the study is 50% owned by APM Terminals. The major client is Maersk Line, which has a share of roughly 90% of the terminal turnover. Approximately 3 million TEU were handled in 2009 and there are four berths for deep sea vessels.

The feeder operator has one of the largest feeder networks for container transshipment in Northern Europe, which covers ports in most countries around the North Sea and the Baltic Sea. The size of the vessels is on average roughly 900 TEU, and the fleet includes around 40 vessels.

The feeder operator's customers are all big ocean shipping companies. Further, the company has short sea shipping customers, whose volumes correspond to approximately 10% of the total cargo turnover. The short sea shipping cargo is transported together with the feeder cargo onboard the vessels.

The satellite port handles around 800,000 TEU on a yearly basis. The container terminal has short sea shipping calls, feeder calls to from the European continent, Great Britain and Iceland, as well as deep sea direct calls to and from the Mediterranean, North America, Central America and East Asia.

9.1.2 The Japanese case

Maersk Line is also the representative of the ocean shipping in the Japanese case. The shipping string included in the study is operated by 11 vessels that call at hub ports in Japan, South East Asia, the Middle East and Northern Europe. In Japan, Maersk Line does not operate any feeders by themselves due to the cabotage regulation that prohibits foreign companies from handling any domestic traffic within Japan.

The hub port included in the Japanese case is owned by a governmental body but leased by APM Terminals. Further, APM has outsourced the terminal operations to another company that in turn uses an external stevedoring company to load and unload the vessels and handle the containers. The terminal operator included in the study is one of the leading companies in intermodal transportation, warehousing and logistics in Japan. The Japanese hub port is among the largest in the region and consists of several terminals. The terminal included in the study handles approximately 1 million TEU annually.

The Japanese feeder operator included in the study is the biggest in Japan, and has approximately 50% of the market share. The fleet consists of around 20 vessels and their largest vessels have a carrying capacity of 250 TEU, which is considerably smaller than the European feeder vessels. The feeder operator has a wide domestic service network including (currently) about 30 Japanese ports, and is transporting foreign trade containers between international hub ports and local ports.

The satellite port in the study is, like most Japanese ports, owned by the local government. The container terminal is operated by two separate terminal operators that together handle about 200,000 TEU per year. The port has both domestic feeder services and regular ocean shipping services to Southeast Asia, North America, China and Korea.

9.2 Factors that affect feeder capacity utilisation

Factors affecting feeder capacity utilisation have been identified and divided into six groups: *market factors, customer factors, port factors, surrounding factors, management factors* and *vessel factors,* see tale 9.1. These are the same groups used in Study II for the RoRo services (see Table 8.3). The factors in the right column in the table below all originate from Study III, although many of the factors coincide with the outcome of Study II. The feeder operators' main customers are the ocean shipping companies.

Table 9.1 External and internal factors that affect feeder vessel capacity utilisation.

Factors that affect feeder vessel capacity utilisation		
External factors	**Market factors**	State of the market Imbalances export/import Daily or seasonal varitions in demand Cargo mix Competition and cooperation
	Customer factors	The schedule of the deep sea vessel Delays of the deep sea veesel Information exchange
	Port factors	Port capacity Infrastructure capacity Port performance
	Surrounding factors	Congestion Weather conditions Regulation and legislation
Internal factors	**Management factors**	Planning, organising or leading Sailing schedules
	Vessel factors	Vessel size and design Stowage plans

The *market factors* affect the feeder shipping industry in different ways: the state of the market, trade imbalances, and daily or seasonal variations in demand, mix of containers, and competition and cooperation. The mix of containers includes the numbers of refrigerated versus regular containers, the numbers of empty in relation to full containers and the types of dangerous goods to be transported. Refrigerated containers have integral refrigeration units that rely on electrical power points at the vessels. This means that some of these containers will be left behind in port if they exceed the number of power points onboard. A too large amount of full containers implies that the vessel's maximum permitted deadweight, the measure of how much weight a vessel can safely carry, will be exceeded. Because of these limitations one feeder operator stated: "We can't use 100% of the vessel capacity if all containers are full. This is our headache! Therefore, we carry 60% empty containers. We have an over-capacity due to heavy weights." Consequently, part of the vessel capacity cannot be utilised if too many loaded units are to be transported, and the containers need to wait for the next departure. Additionally, containers in odd sizes decrease the capacity utilisation. For example, tank containers have a weaker construction and cannot be stacked high. The risk associated with transportation of dangerous goods requires safety precautions related to separation of different types of hazardous materials onboard the vessels, which can affect the vessel capacity utilisation.

Competition and cooperation were mentioned by the respondents as important factors for capacity utilisation. Severe competition generally implies lower freight rates, which reduces the revenue per transported unit. Feeders compete with trucks, trains and other vessels. In Japan, short sea shipping has difficulty competing with road transportation. The Japanese feeder capacity is low and the geographical shape and size of the country suggests that the distance

between origin and destination is relatively short. Road network congestion increases the transport time, but road transportation still has a shorter transport time than shipping. The railway is not in any competitive position in Japan, as passenger transportation has higher priority and only a few tracks permit cargo. The severest of the competitive situations, described by both the Japanese and the European feeder operator, is when an ocean shipping company decides to call at a satellite port, either with a deep sea vessel or with a feeder vessel. In the first case, the satellite port becomes a hub port, and in the latter, the ocean shipping company enters the feeder market by operating its own feeder vessels. In both cases, the feeder operator often loses large transport assignments immediately. The European feeder operator elucidated this: "We know we carry Maersk's cargo when it suits them, but when a certain level is reached then we're out. That's the name of the game!"

Customer factors are related to the feeder operators' customers, who are the large ocean shipping companies. The sailing schedule of the feeder vessel is often a consequence of the departure and arrival times of the deep sea vessels. It is most crucial to deliver the export containers at the hub port in time so the cargo can catch the weekly departure of the deep sea vessel. Delays and short-term adjustments in the customers' sailing schedule make the planning of the feeder operations difficult and sometimes waiting times arise. Efficient information exchange is necessary for planning the activities. However, the two feeder operators and almost all ports in the study considered the information about changes in capacities or sailing schedules of the deep sea vessels to be forwarded too late.

Port factors have an effect on the possibilities for the feeder operators to utilise their vessel capacities. Capacities in port and in the surrounding infrastructure are important issues in order to keep the turnaround time short and to accommodate all vessels without delays. As the ports normally prioritise the deep sea vessels, the feeder operators are more sensitive to port congestion. Further, some ports do not have 24 hours open per day, which means that cargo sometimes is not in port at the departure of the vessel.

Surrounding factors are congestion, weather conditions, and legislation and regulation. In Japan, bad weather causes many problems, especially in typhoon season. Also, in Europe, strong winds and high waves are common in autumn and winter when crossing the North Sea. The weather can result in delays and increased bunker fuel consumption. There are legal restrictions in both regions for safety, security and environmental issues that have an effect on the transport systems, e.g., port inspections, crew restrictions and emission limitations. Examples of Japanese regulations are the cabotage that restricts trade to domestic carriers within Japan, restriction in some ports that separate domestic and international infrastructure to different terminals, and high license costs for operating domestic vessels in Japan. When a shipping company invests in a new vessel, a single payment needs to be made. One respondent explained the reason for Japanese feeder operators to have small vessels is the regulations; the shipping companies pay substantially higher license costs and a larger crew is necessary, which means high labour costs, for larger vessels.

There are *management factors* related to planning, organising, and leading a shipping company that influence vessel capacity utilisation. One respondent described a common conflict within shipping companies: "There is always a conflict within each company. The sales department is responsible for customer relations and they have one view of the business. Operations that handle

the cargo and the vessels have a totally different view. The financial department with their cost focus has a third view." A suitable sailing schedule is of great importance to reach a satisfactory utilisation level. Even though the feeder vessels have fixed timetables there are often opportunities for short-run adjustments in the sailing time, route and capacity if requested by a main shipping company. Both feeder operators in the study had a large fleet that allowed them to put in an extra vessel or change the size of the vessels on short notice. These give the ocean shipping company good flexibility when planning their transport moves.

Vessel factors are an important issue for capacity utilisation in container feedering. The standardised container means that a container vessel is more standardised compared with RoRo vessels and ferries. However, vessel particularities such as size, age, maximum speed, stability, and number of electrical power points for refrigerated containers affect the possibility to utilise the vessels. The respondents also emphasised that an excellent stowage plan facilitates higher vessel capacity utilisation, as it makes it possible to have a shorter turnaround time in port and load more containers to the vessel if all cargo and vessel restrictions are handled in an efficient manner.

9.3 Transport chain perspective

This study also includes ocean shipping and ports. Foremost, two areas were identified related to the transport chain perspective that affected the vessel capacity utilisation: transport chain integration and demand structures in transportation.

9.3.1 Transport chain integration

Information exchange is crucial for the planning of activities within the transport chain. The communication of strategic information was limited within the two cases, which were highlighted by the Japanese feeder operator: "Maersk informs us if they are investing in new capacity three months ahead of time. This is not enough time for planning. Earlier would have been better, but there is no other way due to Maersk's head office policy. But still it is better than Japanese shipping companies. They can change the mother vessel's schedule without any notice." Also the hub ports seem to receive strategic information late. One port described that they get the information about new capacity or changed sailing schedule one to two months ahead, but sometimes only through press releases, which is not considered being enough for their planning. There are no long-term contracts among the actors in the studied transport chains, which makes the planning more difficult. There are often one-year-contracts that only include prices per full and empty containers, but not quantities to be transported or handled. The Japanese feeder operator described their situation: "The uncertainty is if the feeder vessel service will be permanent or not, that is, if the ocean shipping companies will continue to use the feeder service. Ocean shipping companies also force us to minimise the price. And all risks are on our company."

However, operational matters such as delays, cargo volumes and required short-term adjustments in the sailing schedules of the feeder vessels are discussed daily between the actors in the chains. Even though feeder operators have pre-established sailing schedules, the arrival and departure times are not fixed. Thus, the terminal needs to have daily contact with the feeder operator in order to communicate berth windows and facilitate capacity planning. This communication is

particularly central with the hub port as the deep sea vessels often get priority, and as the container cranes are normally more occupied than in a smaller port.

9.3.2 Demand in transport chains

Companies have different possibilities to make demands on actors in the transport chain. Thus, their chances to gain from the cooperation vary. These demands affect the efficiency of the operations and ultimately the capacity utilisation of the feeder vessels. Maersk Line is the strongest actor due to the scale of their operations and their role as paying customers to ports and feeder operators. The demand structures of the companies included in the two cases are shown in Table 9.2

Table 9.2 Demands on the actors in the transport chain.

demand on	**Ocean shipping**	**Hub port**	**Feeder operator**	**Satellite port**
Ocean shipping		Berth window, low price, capacity, productivity, short turnaround time, flexibility	Suitable sailing schedule, low price, capacity, reliability, flexibility	No demand (no contact)
Hub port	Accurate cargo information, arrival time, reduced container storage time		Accurate cargo information, arrival time	No demand (no contact)
Feeder operator	Accurate cargo information, arrival time	Berth window		Berth window, capacity, short turnaround time, flexibility
Satellite port	Reduced container storage time	No demand (no contact)	Accurate cargo information, arrival time	

Maersk Line makes demands on the hub port due to the importance of always getting the required service for the large deep sea vessels. Enough port capacity, high productivity and short turnaround time decrease the time at port and facilitate an efficient sailing schedule, which in combination with low price are the most essential issues for profitability. Demands on flexibility in terms of open hours, service level, etc. and on access to berth windows emphasise the dominating role of larger ocean shipping companies over ports. However, there are situations where the power tends to move from the ocean shipping company towards the hub port. This is a result of high terminal capacity utilisation, terminal monopoly or customer demands that make it difficult for the shipping company to change ports. Requirements on the feeder operators are expressed in terms of suitable sailing schedules, low price, enough vessel capacity, reliability and flexibility in capacity and time.

The feeder operators are in no good position of making heavy demands on other actors in the transport chain. However, adequate terminal capacity and berth windows in port when the vessel arrives are necessary to avoid delays for the containers. The feeder operators' demands on the

ocean shipping companies are related to information exchange: to get accurate cargo information and arrival time of the vessels. The feeder operators are not as dependent on individual customers if they transport containers for a greater number of customers, which affects the negotiation power.

The ports' demands on the shipping companies are related to information accessibility. Accurate cargo information and estimated time of arrival are important for the terminal capacity planning and for offering a high service level for the customers. The Japanese ports included in the study experienced limitations in container yard areas, partly due to long dwell times for empty containers. The average turnaround time for full containers was 5-10 days and for empties 10-30 days. Consequently, the ports tried to make the owners of the containers, usually the ocean shipping companies, reduce the storage times to set valuable land areas free and delay the need of investment in new capacity.

PART V Analysis

10. Strategies and measures to enhance capacity utilisation

This chapter answers (in the three subchapters) the three research questions respectively as shown in figure 10.1. The research questions are related to the research areas *Vessel capacity utilisation strategies* and *Measures to improve vessel capacity utilisation*.

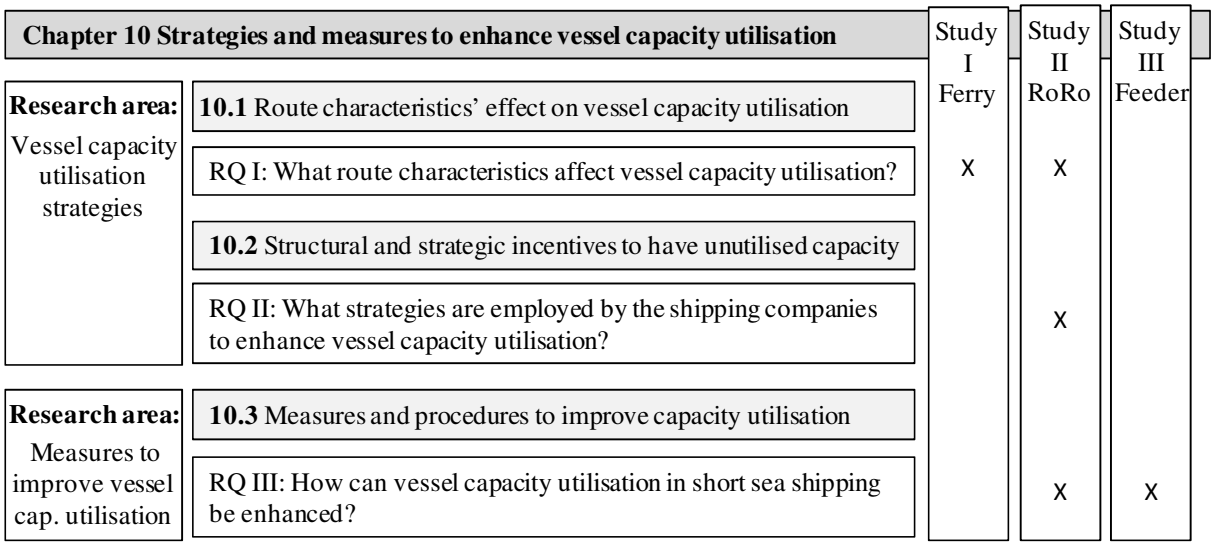

Figure 10.1 Relation between subchapters, research questions, research areas and studies.

10.1 Route characteristics' effect on vessel capacity utilisation

This subchapter answers the first research question: *What route characteristics affect vessel capacity utilisation*? The results show four route characteristics that have an influence on vessel capacity utilisation in short sea shipping:

- Frequency,
- Trade imbalances and demand variations,
- Types of customers and cargo, and
- Competitive situation.

Frequency was analysed in detail in the quantitative study of ferry services (Study I), which revealed a strong relationship between frequency and vessel capacity utilisation. Trade imbalances and demand variations were also investigated in the first study, but no conclusions about their correlation could be gathered from the statistics. The other two route characteristics were not possible to examine in the study due to the nature of the statistical material.

Analyses of the seven RoRo shipping services in Study II further determined frequency as an important feature and, additionally, established the three other route characteristics. Accordingly, it was necessary to ask the first research question in both the studies and to include quantitative data as well as qualitative. The four factors' importance in relation to each other has not been investigated.

10.1.1 Frequency

Study I showed a relationship between vessel capacity utilisation and departure frequency; the utilisation level was significantly lower for routes with higher frequency. The group of high-frequency shipping services included five routes, which were further analysed to find the reasons for what first seemed to be a poor result. On average the vessel capacity utilisation for the group was 33.6%. Table 10.1 shows the features of the services[17] including frequency, distance, transport time and average time between departures.

Table 10.1 The five shipping services with the highest frequency in Study I.

	Frequency (dep./week)	Distance (nm)	Transport time (h)	Average time between dep.
Gedser - Rostock	107	30	1h 45min	3h 8 min
Göteborg - Fredrikshamn	109	50	3h	3h 4 min
Helsingborg - Helsingør	505	2	20 min	40 min
Rødby - Puttgarden	684	10	45 min	29 min
Helsingborg - Helsingør	833	2	20 min	24 min

Even though the annual vessel capacity utilisation was relatively low for the five routes, the annual transported volumes were much higher compared with the remaining routes. The five services transported together 33.8 million lane meters in 2004, which corresponded to 82.5% of the total number of lane meters for the 19 routes. The share of high fixed costs in relation to variable costs in shipping means that increased frequency will bring about a decreased cost per departure for the shipping company. Consequently, a lower vessel capacity utilisation can be allowed. Study I focuses only on the physical capacity utilisation of the vessels. A calculation of the economic capacity utilisation, which is out of the scope of this thesis, would probably show a different result, both because of the great number of lane meters that are transported on an annual basis, but also due to the fact that most ferry services rely on earnings from passengers. Obviously, both passengers that take a rest from travelling, and foot passengers that travel without vehicles are eating, drinking and shopping onboard, which contributes to the shipping companies' turnover.

When analysing this group of shipping services, several common characteristics evolved that categorise the routes. The vessels operate high-frequency round-the-clock services and spend less time in ports compared to the other vessels in the study. This means that even though the vessels have low utilised capacity per departure (i.e., low load factor), the total utilisation of the vessels on an annual basis was still very high. Further, frequent departures also assure short waiting time for goods and passengers in port. All the routes have a frequency that exceeded 100 departures

[17] Two shipping companies operate the route Helsingborg – Helsingør.

per week, which means at least 7 departures per day in both directions. The average time between departures for the service with the highest frequency (Helsingborg – Helsingør) is 24 minutes. This corresponds to an average waiting time for the vehicles or passengers with random arrival in port to be as low as 12 minutes.

The high level of unutilised capacity for the shipping services in combination with high frequency means that customers, i.e., shippers and passengers, do not need to book the crossing in advance, except for some attractive departures in high season. Finally, another attribute is that the accessibility to the ports was very good. The routes were all integrated and complementary parts of the land based infrastructure and they bridged natural gaps over sounds and channels.

The characteristics of the routes suggest that the customers make higher demands on these types of shipping services. From a customer point of view, the shipping services within the high-frequency group fulfil the requirements for: 1) good accessibility to transport networks, 2) unutilised capacity, and 3) high frequency. The five shipping services actually stand out to such an extent that they are to be considered and classified as an own and diverse shipping concept within short sea shipping. As it intimately resembles the function of a bridge, it has been defined as a *Bridge substitute* (Styhre and Lumsden, 2007):

A bridge substitute bridges gaps between land borne transport networks, offering high-frequency departures and enough capacity in order to limit the waiting time for goods and passengers in port.

Frequency was further analysed in Study II, which also showed that frequency to a great extent affects vessel capacity utilisation. The demand on high frequency is very important for the shipping company to meet, even though this means that the vessel capacity utilisation per departure will be lower. The shipping company needs to choose between the risk of losing customers if the frequency is too low and the prospect of higher capacity utilisation. This can be described as the *Bridge substitute dilemma* (Styhre and Lumsden, 2007):

The bridge substitute dilemma is a trade-off between the demands for high frequency, accessibility to transport networks, and unutilised capacity as set by the shipping companies' customers, and internal goals for high vessel capacity utilisation.

10.1.2 Trade imbalances and demand variations

The study of RoRo shipping showed that high trade imbalances and daily or seasonal variations in demand pose a risk of a high level of unutilised capacity with preserved service level. The reason is that shipping companies have to deploy vessels larger than necessary to handle the peaks (Jansson and Shneerson, 1982; Haralambides, 2004). Thus, the higher the imbalances and demand variations the more difficult it will be to reach a satisfactory level of capacity utilisation.

The relationship between vessel capacity utilisation and trade imbalances and seasonal variations was also analysed in Study I, but no significant correlation between them could be established. This is probably due to the fact that frequency was the determining factor and that the services were too few or too diverse. However, the ferry concept includes passengers that have an effect

on both imbalances and variations. On one hand, passengers are levelling out the imbalances as the deviation in incoming and outgoing passenger flows is much lower than for cargo, i.e., passengers use the services in both directions to a larger extent than the shipper. Consequently, ferry services with a higher portion of passengers onboard do not suffer as much as goods ferry services when it comes to trade imbalances. On the other hand, seasonal variations are much higher in the ferry services due to the significant increase in passengers during the holiday months in July and August (see Figure 7.1). In order to handle the peak demand in summer, the capacity utilisation the rest of the year is rather low for the ferry services, in spite of the fact that the majority of the shipping companies reduce the number of departures during low season.

10.1.3 Competitive situation

The competitive situation affects the possibility to utilise the vessels. Furthermore, some of the respondents mentioned that severe competition often implies lower freight rates (see also Haralambides, 2007), which reduces the revenue per transported unit. Accordingly, a higher average vessel capacity utilisation is required for these services to reach above the breakeven for profitability, either by restricting the maximum capacity supply or by increasing the market share. When the situation is the opposite, i.e., when competition is limited, the customers are more loyal to their transport providers. In order to offer a high service level, a lower utilisation level has been accepted by the shipping company. This is also facilitated by, in general, higher freight rates for these routes.

10.1.4 Types of customers and cargo

Types of customers and cargo affect the shipping companies' ability to utilise vessel capacities. There are customers that need a higher service level than others, which means that the shipping company needs to plan for unutilised capacity. For example, available capacity, high frequency and reliability are essential for manufacturers producing on a just-in-time basis and make-to-order approaches (Haralambides 2007). If customers trust the transport system to deliver their cargo on time, they can reduce inventory costs and reduce the total lead time. Other priorities are loyal customers with long-term agreements, customers that pay higher freight rates (e.g., on-off assignments, heavy or bulky project cargo, etc.), or customers that transport perishables or project cargo that cannot be delayed. Thus, shipping services with a high amount of time-sensitive cargo and prioritised clients normally need to accept a lower level of vessel capacity utilisation. Further, the study showed that the shipping company also needed to plan for unutilised capacity due to sources of uncertainty caused by the customers, e.g., vacations, changes in the production cycles, production break downs, material shortages, as well as overbooking, no-show and late cancellations.

10.2 Structural and strategic incentives to unutilised capacity

This subchapter is based on Study II alone and answers the second research question posed in this thesis: *What strategies are employed by the shipping companies to enhance vessel capacity utilisation?* Two extreme strategies are identified: the Cut peaks strategy and the Never say no strategy. The first cuts demand peaks to reach a high vessel capacity utilisation, while the latter sets the maximum capacity to the highest peak in order to provide a better service level and avoid turning down transport assignments.

10.2.1 Two extreme capacity utilisation strategies

The optimal level of vessel capacity utilisation is a trade-off between short-term profitability and long-term development of the service (Styhre, 2009b). The cost and profit function states that a utilisation level close to 100% would maximise profit and minimise unit costs. However, variations in demand and the inability to change vessel capacity in the short run suggest that it is in practice impossible to utilise 100% of the vessel capacity. Furthermore, if a shipping company operates for an extended period of time at a very high capacity utilisation, it provides the opportunity for new companies to get a foothold in the market, and it causes damage to customer goodwill when cargo is occasionally left behind (see also Davies, 1983). This leads customers to look for alternative transport services.

Route characteristics affect the average capacity utilisation, but also the level of unutilised capacity that a shipping company would like to have. A certain level of unutilised capacity is particularly important for time sensitive cargo as described by one respondent: "A lot of the cargo is very time sensitive. We actually as a shipping company run on a just-in-time basis with some material coming into the factories. Therefore, we need the capacity to always ship everything on the day the customers are expecting it. We never want to say: 'We're full'."

Other route characteristics that affect the desirable level of unutilised capacity are demand variations and trade imbalances, and the competitive situation. The latter is illustrated by a respondent that compared two different shipping services included in the study: Service A where they have a large market share because of few competitors and Service B where they only have a small percentage of the market share: "In a situation when we have a large market share we can argue that actually we should keep the utilisation a little bit lower. For Service B, we take bookings, bookings, and bookings. When we are full, we are full, and the customers go with another shipping company. Those customers are not half as loyal as they are on Service A."

The state of the market and freight rates are market related factors that also affect the level of unutilised capacity that a service requires. Further, the possibility and cost of fast adding or cancelling appropriate tonnage to meet changes in demand, and the risks associated with a certain capacity utilisation, e.g., new competitors entering the market and risk of losing customers due to a low service level, are also important issues.

The analysis concludes there are two extreme strategies for vessel capacity utilisation, and that route characteristics and market factors all affect the selection of the appropriate strategy. The strategies are: the Cut peaks strategy and the Never say no strategy.

The *Cut peaks strategy* involves that demand peaks need to be cut to increase the vessel capacity utilisation. The purpose of the strategy is to have a high average capacity utilisation by keeping the maximum capacity lower or increasing the market share. Increased transport volumes are however often associated with price-reducing measures that could result in prices below the total average cost (Davies, 1983). The Cut peaks strategy is illustrated in Figure 10.2, and is in general suitable for the following: large trade imbalances and variations in demand, severe competition, customers that have other options, stagnated or moderate growing markets, and markets with low freight rates.

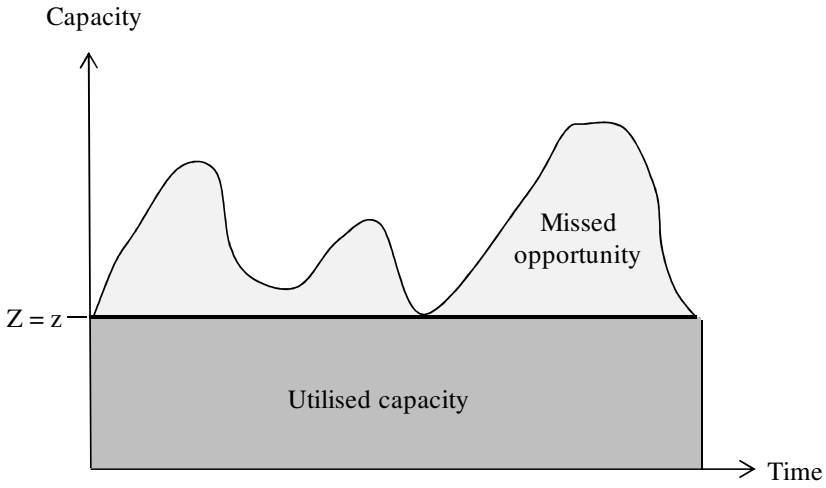

Figure 10.2 Illustration of the Cut peaks strategy. Z is the maximum capacity and z is the average utilised capacity, which both coincide in the case of 100% of vessel capacity utilisation.

On the contrary, the *Never say no strategy* allows a higher level of unutilised capacity in order to have good flexibility, a possibility to grow in the market, and the ability to maintain a high service level for customers by never turning down transport assignments. The strategy is shown in Figure 10.3. The Never say no strategy may be suggested for the following: small or medium trade imbalances and variations in demands, moderate competition, time sensitive cargo, customers with long-term relations, important customers with long-time relations or good-paying on-off assignments, growing markets and markets with medium or high freight rates.

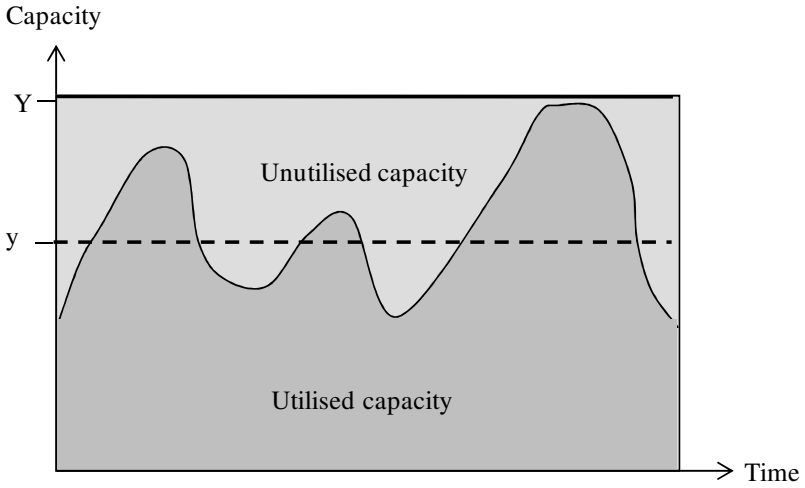

Figure 10.3 Illustration of the Never say no strategy. Y is the maximum capacity and y is the average utilised capacity.

When exceedingly large variations and imbalances are present, the Never say no strategy implies a low average vessel capacity utilisation as the capacity is set to the highest peak. If, instead, the Cut peaks strategy is employed and the vessel capacity utilisation is very high, the shipping company will fail to secure new customers and contracts, and will lose its market share in

growing markets. The missed opportunities mean that competitors are more eager to enter the market. Consequently, the approach taken is suggested to be a combination of the two strategies. This means that the shipping company allows the highest peaks to be cut in order to increase the average vessel capacity utilisation but keeps for rest of the time some level of unutilised capacity: see Figure 10.4.

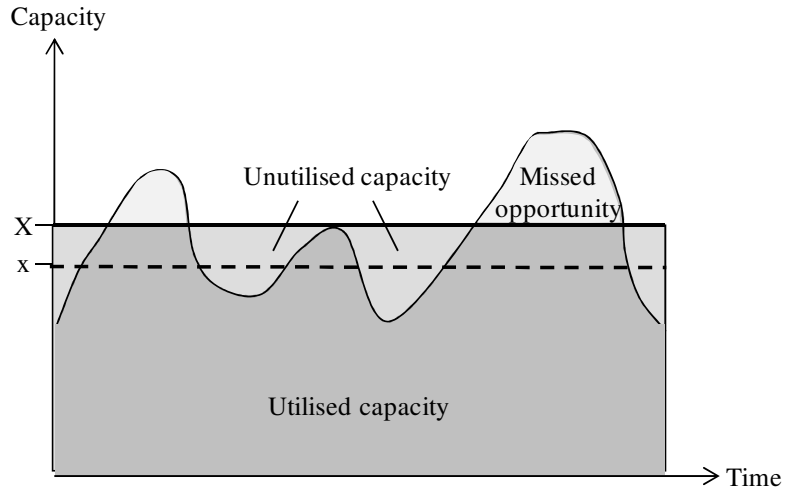

Figure 10.4 A combination of the two strategies allows some peaks to be cut but keeps unutilised capacity for the rest of the time. X is the maximum capacity and x is the average utilised capacity.

An important factor to consider when setting the maximum capacity is the balance between costs of capacity shortage and the costs of unutilised capacity. If the cost of supply shortage is higher than the cost of carrying unutilised capacity, it is acceptable to have a lower capacity utilisation to avoid losing transport assignments during peak demands (Fusillo, 2003). The capacity utilisation is the ratio between average utilised capacity and maximum available capacity, where $y/Y < z/Z$ in Figures 10.2 and Figure 10.3. The average utilised capacity indicated in the figures is not to be seen as a goal target that is not to be exceeded. The study shows that the individual shipping companies are always, at any particular time and service, trying to fill up the vessel in line with profit maximisation (also described by Davies, 1983). The unutilised capacity should be kept as low as possible for individual departures as this allows lower cost per unit, but without compromising the customer service level or long-run benefits.

10.2.2 The most desirable level of RoRo vessel capacity utilisation

Although high capacity utilisation often implies lower cost per transported unit, in the long run a certain amount of unutilised capacity is necessary. The most desirable level of capacity utilisation for the seven RoRo services has been investigated. The different features of the trade concerned cause the distribution of answers to lie in the range between 75% and 88%, with an average capacity utilisation of 81.8% (median 82%). Respondents argued that this is the right level for them to keep a reasonable and acceptable level of customer service, get a good price, and avoid high bunker fuel consumption and delays in port. One respondent stated: “I definitely believe that it is not good when we exceed 90% of vessel capacity utilisation. Prices fall since the customer does not really get what he wants. You get a dissatisfied customer that looks around for new

alternatives. With a capacity utilisation of 100%, there are risks of delays, prolonged turnaround time and increased bunker consumption. The whole system is more vulnerable, and the last trailer doesn't pay for that." Another respondent described why 14-15% of unutilised capacity is important: "We need the extra capacity in order to serve our customers when there are peaks in demand, and to serve our on-off customers or customers that show up occasionally. These are also important, since they are paying higher rates." This impression is also shared by Zerby and Conlon (1978): Once the load factor exceeds 80-90%, average costs will rise substantially.

The vessel capacity utilisation of the RoRo vessels was much higher compared with the ferry services in the previous study. The average vessel capacity utilisation is indicated in Table 8.2: three of the services had an average capacity utilisation above 85%, three of the services between 70% and 85%, and only one had less 70%.

10.2.3 Situations with low average capacity utilisation

The relationship between vessel capacity utilisation and profitability is not explored in this thesis, but it is clear that the earning per transported unit significantly differs between services. In general, competition or big customers that use price-reducing measures tend to diminish the price per transported unit. In some situations, like if there is a recession or if a competitor opens up a new service, costs can exceed incomes for a service. Since shipping is subject to large economies of scale, these routes can in a very short time turn into real money-consuming businesses. However, there are several reasons for keeping an unprofitable shipping service, within the limits of reason, for shorter and even for longer periods.

First, if a new route is opened it often takes 2-3 years to establish the business according to a respondent. With a belief that the service will turn into a lucrative commerce, long-term investments are required before reaching financial capacity.

Second, the shipping company is to a large extent a subject to trade conditions where recession or occasional economic downturns may require periods of unprofitability. In times of recession, it is difficult to find alternative routes for the vessels. If the vessels are chartered some capacity can be reduced, although the charter agreements often run for a few years. If a service is cancelled, the customers are forced to immediately find new transport alternatives. If the service is opened again in times of prosperity, it is difficult to convince the customers to change their routines again. Consequently, patience through bad times often implies returns in better times, as long as there is a market potential. If an individual vessel is withdrawn, the requisite frequency cannot be kept. This may result in fewer customers and thereby a decline in capacity utilisation of the remaining vessels (Jansson, 1974).

Third, if the unprofitable service is complementary to another main important service located in an adjacent geographical area, the right choice might be to keep the route even though the financial result is poor. The unprofitable service can protect the main service and impede competitors to come by the back door and get market shares from the important neighbouring market. A rival shipping company not only captures goods on the market, it also in most cases lowers the price per transported unit. Specially reduced introduction prices and the customers' improved bargaining position are reasons for the decline in freight rates. Competitors can be prevented from entering the market by providing enough vessel capacity and occupying port slots

that hinder them from setting up an efficient sailing schedule. Furthermore, the shipping company can use the secondary service when there is an occasional peak transport need in the main service.

Consequently, it is of great value for the long-term development of a shipping company to be present in the market, to occupy port slots, to indicate for existing and potential customers that there is a belief in the market, and to have patience in order to give new and potential markets a fair chance even though a service is temporarily unprofitable. However, in the long run, it is necessary to charge long-run average costs for the benefit of a sustainable, regular, frequent and reliable service, which also has been noticed by Haralambides and Veenstra (2000).

10.2.4 Efficient sailing schedule

The results show that an efficient sailing schedule is central for a service to be successful, and significant improvements of the economic performance of a fleet are expected from proper routing and scheduling (see for example Fagerholt, 2001). Schedule optimisation concerns assignment of departure and arrival times of vessels operating on a route, taking into account the turnaround time in ports, transport time, required frequency, and time slack for delays and maintenance of the vessels (Haralambides and Veenstra, 2000). Consequently, the shipping company needs to secure new port slots and communicate changed needs for capacities in an early stage. This is particularly the case when introducing a larger new vessel because it stays longer in port due to its bigger size and due to the fact that the cargo handling rate increases more than proportionally to the cargo carrying capacity (Laine and Vespäläinen, 1994).

The port slots and the turnaround time determine the arrival and departure time of the vessels. An efficient timetable provides customers with good logistics solutions. This means for example that the utilisation of the customers' resources can be increased and that congestion can be avoided. One respondent elucidated these: "The sailing schedule for service X is optimal. The vessel calls at the port early in the morning so the trailers can leave and collect cargo in the neighbouring industrial area during the day to catch the evening departure. The utilisation of the trailers is therefore high. On the other end, we have problems with congestion some times of the day. Therefore, we arrive at night so the customers can drive quite a bit before congestion starts in the morning. Consequently, we have a large hinterland, and the customer can use his time for driving instead of queuing."

The trade-off between ship size and departure frequency also needs to be handled when a sailing schedule is discussed. With high frequency, the average waiting time in the ports, and thereby the total transport time, can be decreased. Consequently, economies of scale that suggest a few large vessels reduce the costs per transport unit need to be matched with high frequency requirements.

10.3 Measures and procedures to improve capacity utilisation

This subchapter answers the third research question: *How can vessel capacity utilisation in short sea shipping be enhanced?* Both Study II and Study III contribute to the results in this chapter. Vessel capacity utilisation can be enhanced by applying different improvement measures for

established shipping services, and by better match supply and demand in shipping as well as in transport chains.

10.3.1 External and internal improvement measures

There are external and internal factors that affect vessel capacity utilisation, which have been identified in the studies of RoRo shipping and feeder operations (see Chapter 8.3 and Chapter 9.2). These factors are divided into six groups: market factors, customer factors, port factors, surrounding factors, management factors and vessel factors.

Measures to improve vessel capacity utilisation are summarised in Table 10.2. The importance of the measures in relation to specific routes was not included in the work and the internal connection between the measures was not investigated. Instead, enhancement of vessel capacity utilisation requires a combination of both long-term and short-term measures directed towards external factors as well as internal factors. Applying one measure is not in contradiction with applying another to improve the shipping service. A summary of the respondents' answers are found in Appendix C and Appendix F, respectively, for the two studies.

Table 10.2 Factors that affect capacity utilisation and improvement measures to handle these.

Factors that affect capacity utilisation			**Enhancement of capacity utilisation**
External factors	**Market factors**	State of the market Available cargo in the market Imbalances export/import Daily or seasonal variations in demand Cargo mix Competition and cooperation	Explore and understand the market Find cargo in low-volume sea-leg or departure Cooperate and communicate with shipping companies
	Customer factors	Variations in produced output Late cancellations Double booking No-show Information exchange The schedule of the deep sea vessel* Delays of deep sea vessel*	Stand-by cargo Overbooking Price differentiation Rescheduling of bookings Improve information exchange
	Port factors	Port capacity Infrastructure capacity Port performance	Cooperate and communicate with ports Improve cargo handling equipment
	Surrounding factors	Congestion Weather conditions Regulation and legislation	Route planning Lobbying
Internal factors	**Management factors**	Planning, organising or leading Sailing schedule	Cooperate and communicate within the company Develop flexible capacity management Change of sailing schedule
	Vessel factors	Vessel design, size, and age Stowage plans Maintenance of the vessel	Develop suitable vessel design Find the right type of cargo and customers Improve stowage plans Improve transport units

** These factors are foremost related to feeder shipping.*

Market factors
The state of the market greatly affects the shipping industry, but good knowledge of the market and its potential customers may lead to both a counterbalance of imbalances and variations and to the possibility of identifying new customers or even new customer segments. In order to prevent destructive competition in the shipping industry, which decreases the freight rate per transported unit (Haralambides, 2007), rival companies may form alliances, or merge or cooperate through formal agreements. Cooperation among short sea shipping companies exists even though it is not common. However, both the feeder operators in the last study have space charter agreements, which mean a predetermined number of container slots onboard some of their vessels is outsourced to another shipping company. The advantages, according to respondents, are to offer additional services to customers, to expand the transport network without the need of new investments and to increase vessel capacity utilisation. Other purposes of cooperation are to increase market power and to gain flexibility (Christiansen et al., 2004). Feeder operators sometimes cooperate with road hauliers in case of delays. The export containers, which are more time sensitive than import containers, can be quickly transported to the hub port to catch the weekly departure of the deep sea vessel.

Customer factors
Customers also affect the shipping companies' ability to utilise their vessels. In shipping, demand fluctuations in combination with late cancellations, double bookings (customers book more than one departure per unit), and no-shows (customers do not deliver cargo prior to departure as agreed) can be handled by stand-by cargo and overbooking. Overbooking is the acceptance of more reservations than the company has the physical capacity to serve and is a common measure in the travel industry. For example, most airlines overbook their scheduled flights to a certain extent in order to compensate for no-shows, and hotels tend to overbook on the basis that someone will cancel at the last minute. Stand-by cargoes help to level the peaks and raise the vessel capacity utilisation in slack periods. A lower stand-by rate can be charged to shippers who are prepared to let their cargo always take the end position in the queue.

If the shipping company knows how to prioritise customers and uses price differentiation, there are possibilities to increase the capacity utilisation by charging different rates. There are also possibilities to reduce the overall freight rates in order to attract new customers. In the same way, an increase in the freight rates can be a helpful tool in a strong market to set capacity free for new important customers or to raise profitability.

Figure 10.5 shows price per transported unit and procedures to increase capacity utilisation. The majority of the customers are found in groups B and C, which represent stable customers with relatively low price elasticity (Deakin and Seward, 1973). Customers in group D can be added to increase volumes temporarily when there is unutilised space onboard, but the number should not be high due to the freight rates that are below the long-run average cost (LRAC). Customers in group A should always be increased if possible as they contribute significantly to the profit of the service. These are, for example, the on-off customers, customers that show up occasionally, or customers with project cargo, i.e., heavy equipment, machines or parts that take up a lot of space onboard. Group B and C are the two biggest groups of customers that form the customer base of the service. Obviously, it is better, and necessary to increase group B as these customers to a higher degree contribute to the profit of the service as the freight rates are above the long-run average cost.

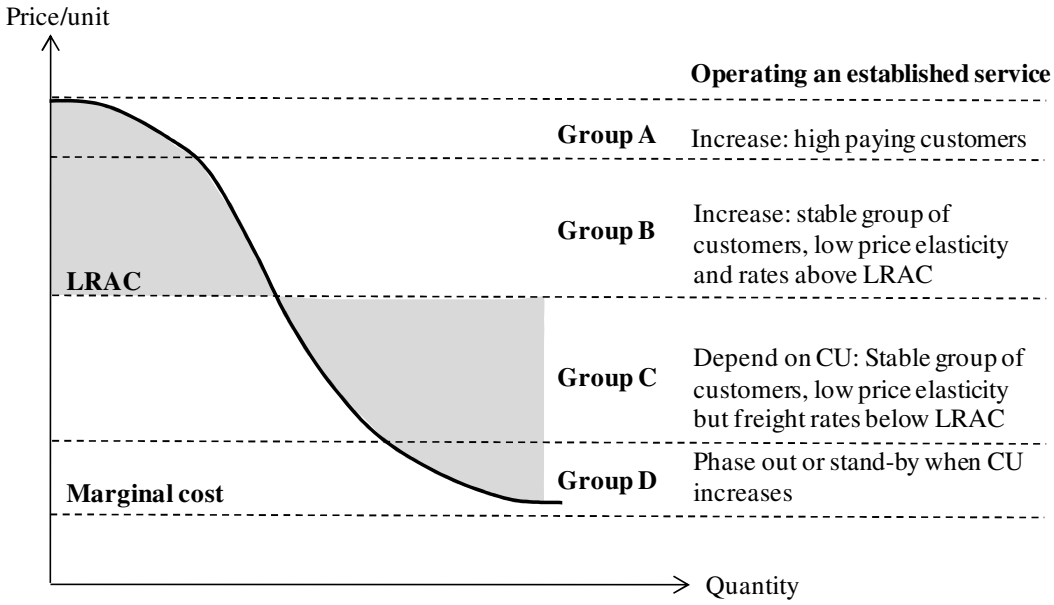

Figure 10.5 Price differentiation for increasing capacity utilisation (CU) when operating an established service. Developed from Deakin and Seward (1973).

There are different approaches of how to prioritise the customers on an operational basis when there is a shortage in capacity. A booking policy that always leaves the least paying cargo behind on the occasions when demand exceeds supply is sometimes described as optimal from the point of view of a particular route (e.g., Jansson, 1974). However, the RoRo shipping company suggested always having a list of customer priorities to increase customer satisfaction in the long run. In case of capacity shortage the cargo from the bottom of that list is moved to another day or, in the worst case, cancelled. Issues to consider when making the list are present and future expected volumes, type of cargo and customers, long-term agreements and profit margin. One respondent described: "If you have a situation when you need to prioritise customers, you prioritise the ones that pay the most, that you like the most… or whatever. The important thing is that you have a clear view of your priorities, to have a clear allocation list. We need to prioritise."

Rescheduling of bookings is an effective measure to enhance vessel capacity utilisation and to open up the most attractive departures to new customers or new cargo when cargo is moved from peak days to other days; see Figure 10.6. However, it is essential that customers both understand and agree with these rearrangements. Depending on the type of customers, suggested cargo for rescheduling includes less time-sensitive cargo, units that are stored for some time in receiving ports, cargo with low freight rates, and stable and steady base cargo flows. The base flows often consist of loyal customers with regular cargo that could allow for some adjustment of departure day if they get compensation, e.g., a general lower freight rate, a discount or higher priority for more important transport assignments.

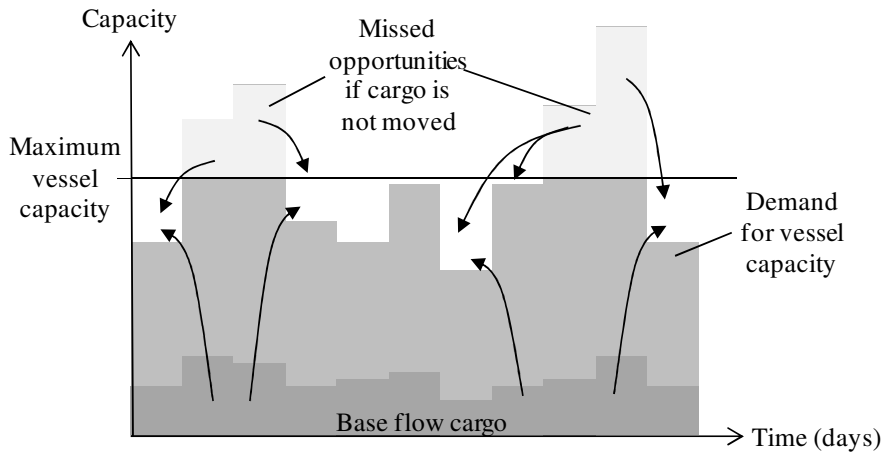

Figure 10.6 Movement of different cargo from peak days to increase capacity utilisation.

RoRo shipping companies' customers are cargo owners, forwarders, etc., while the feeder operators' main customers are the ocean shipping companies. Delays and short-term as well as long-term changes in sailing routes and capacities of the deep sea vessels greatly affect the feeder services. These changes need to be communicated as soon as possible in order to plan the operations in an efficient manner. As activities of individual actors in transportation are not isolated, the overall performance depends on the joint effort. Thus, a successful intermodal transport chain requires efficient information management and a high degree of cooperation and coordination among the actors (Hayuth, 1987; Christopher, 1992; Bowersox, 1996). Consequently, increased cooperation among the actors in the transport chain, and improved information exchanges about the daily operation and strategic decisions need to be shared at an earlier stage.

Port factors

The port and the ship-shore interface also affect the vessel capacity utilisation. Thus, adequate capacities, 24 hours per day, are needed in the port to keep the turnaround time short and in the surrounding infrastructure so that trucks and trains can reach the port on time and that the vessel can call without delay. Short turnaround time may result in fuel savings (fuel costs on liner shipping has been investigated by Notteboom and Vernimmen, 2009), or an increased number of round trips on a given route without the need for increased vessel speed. As high speed includes much greater fuel consumption and increased engine size (Evans and Marlow, 1990), the shipping company puts great demand on ports to reduce the turnaround time. Cooperation and communication with ports and installation of new equipment, e.g., semi-automatic trestles for lashing trailers, cassettes for double stacked containers that can be block stowed on cargo decks, and additional container cranes are actions taken by the shipping company, directed towards creating an efficient ship-shore interface.

Surrounding factors

A large majority of the respondents recognised bad weather and regulations and legislation as important factors related to surrounding factors, but nobody mentioned any possibilities to handle

these. However, two measures were found in documentations when collecting data for the case descriptions: route planning and lobbying.

A measure to deal with bad weather is to use route planning (Christiansen et al., 2004). On an operational basis, the vessel can in the short-term be redirected when there is bad weather. Further, on a tactical basis, route planning also helps the shipping company to establish efficient sailing schedules. Increased regulation, particularly related to environmental and security issues, is a growing feature of the maritime transport sector (Psaraftis, 2005), and the shipping industry attempts to influence legislators and officials through lobbying activities. The findings in Study III suggest that shipping and port regulations have a larger influence over transportation in Japan than in Europe. For example, the cabotage restriction has a great effect on the Japanese transport system. Compared with neighbouring countries, Japanese feeders are more expensive to operate due to, for example, higher salaries for crew members and licence costs for new vessels. Consequently, many ocean shipping companies deliver their containers to Busan in South Korea or ports on the east coast of China, and use Korean and Chinese feeder operators to transfer the cargo between the regions in order to save costs (Furuichi, 2005). This is possible as the cabotage restriction only applies to the transportation of cargo between Japanese ports.

Management factors

There are internal factors related to planning, organising, and leading a shipping company that ultimately affect vessel capacity utilisation. Good internal communication and cooperation are key aspects, including the possibilities to use and develop the skills of planners, stevedores, and commercial teams, the collaboration between office workers and vessel crews, and the creation of an understanding for the overall business strategy among a company's employees. Further, a more flexible capacity management is also important in order to enhance capacity utilisation (see for example Delfmann et al., 2002). There is an opportunity for improvement through the use of shared resources, such as the shifting of vessels between routes when there is an occasional local rise or drop in the demand for capacity. One aspect associated with this is to encourage the mental shift from individual routes to a network of routes. Study II showed that the performance indicators reported at route level might not support lending of a vessel, although it can increase the total turnover for the shipping company as a whole.

Changes in sailing schedules involve both short-term adjustments due to delays, temporary cargo to be transported, etc., and more permanent solutions such as adding or cancelling ports in a string. Schedule flexibility is a feature of feeder shipping and consequently short-term rescheduling of vessels is a common measure to improve the utilisation of the vessels. When capacity utilisation decreases, the shipping company can add a port to fill up the vessels. Both a feeder operator and Maersk Line used this strategy during the financial crisis in 2008. Maersk Line explained this issue: "During the financial crisis we did not have enough cargo and the more ports we added, the better chance we had to fill the vessels. Now when there is no crisis, we want to decrease the number of ports to save costs and we fill the vessel with fewer port calls."

Vessel factors

Correspondence between transported load units and vessel design is very crucial for RoRo shipping in order to create opportunities for high vessel capacity utilisation. It is sometimes difficult to load and unload large RoRo vessels in an efficient manner, especially if the routes include several port calls, due to the cargo hold design and the limited number and size of the

ramps. Finding the right cargo, improved stowage plans, and development of new transport units are actions taken by the RoRo shipping company in order to improve capacity utilisation. A balanced mix of cargo allows each unit to be loaded where it fits best: small vehicles on a car deck, double-stacked containers on the main-deck, and dangerous goods in trailers or containers on the weather deck. Accordingly, too many trailers means that the hoistable car deck cannot be used, and too many cars decrease the trailer capacity on the main deck. This means that cargo hold design and determination of capacity when ordering a new vessel are the most essential decisions for a RoRo shipping company. A container vessel is more standardised compared with RoRo vessels and ferries. However, vessel particularities such as size, maximum speed, stability, deadweight restriction, and number of electrical power points for the refrigerated containers affect the possibility to employ the vessel in a particular trade. The length of the LoLo vessel is the limiting factor for the number of container cranes that can work on the vessel at the same time, which define the cargo handling rate per hour. Enlarged width of the vessel raises the cargo handling time as the overhead cranes need to move longer distances, and enlarged height means that the crane is more sensible to strong winds and bad weather.

10.3.2 Matching supply and demand in shipping

Matching supply and demand is difficult in short sea shipping because of the features of the shipping industry and the fact that vessel capacity is rather fixed in the short run (Fusillo, 2004). These features mainly consist of fluctuations and variations in demand and the time, cost and large capacity step associated with the expansion of vessel capacity. Figure 10.7 summarises the main difficulties in handling the demand/supply balance when operating an established service and when changing the capacity supply.

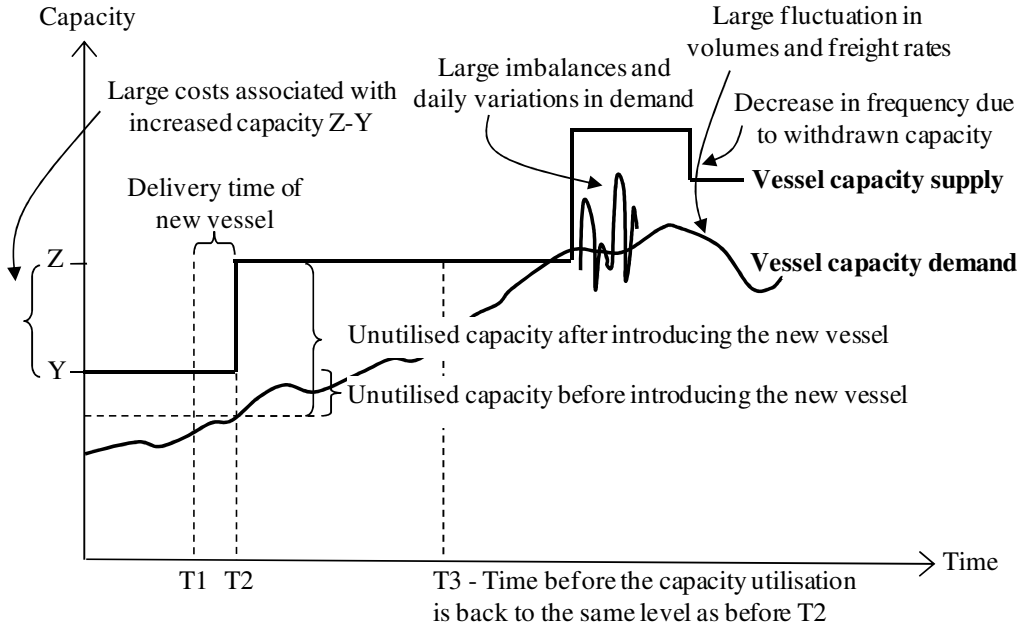

Figure 10.7 Development of demand and supply over time. T1 represents the order time of a new-build vessel, T2 the delivery time of the vessel, and T3 the time when the shipping service reaches the same average vessel capacity utilisation as before the investment in capacity Z-Y was made.

Recognised difficulties in handling the demand/supply balance are related to: 1) the volatility of the shipping market that includes a large fluctuation in volumes and freight rates over time, 2) imbalances and variations in demands in the short-run, 3) large costs associated with the investment in new vessel capacity, 4) the significant decrease in average vessel capacity utilisation when new capacity is introduced, 5) the long time before the new vessel capacity is established, 6) the uncertainty of the long delivery time of new vessels, and 7) the cut in frequency as a consequence of withdrawn vessel capacity.

A new-build or chartered vessel brought into a service normally involves an increased frequency and a more efficient sailing schedule. But the heavy investments associated with a new vessel also possess a risk of high costs due to the considerable amount of time, often a few years, before the transport volumes can be adjusted and the average vessel capacity utilisation can reach its former level (Styhre, 2009a). Introduction of new capacity was analysed in the study of RoRo shipping. The shipping company had a strategy to concentrate on fewer services with high departure frequency rather than to open up new routes. One respondent described why it is easier to add capacity than it is to open up a brand-new service. "In order to succeed, you need contracts corresponding to at least 50-60% of the vessel capacity utilisation. We have had services where we started with less and it didn't go well. The shareholders don't have that kind of economic endurance. When you open a new service you need to allow for three years of unprofitability even though it is a successful investment. It is not easy to open up new services; it is better to enlarge the existing services network or try to incorporate a competitor."

The two overall approaches of matching supply and demand a shipping company can employ are: 1) to increase demand through larger market share, and 2) to change supply in smaller and more frequent steps; see Figure 10.8.

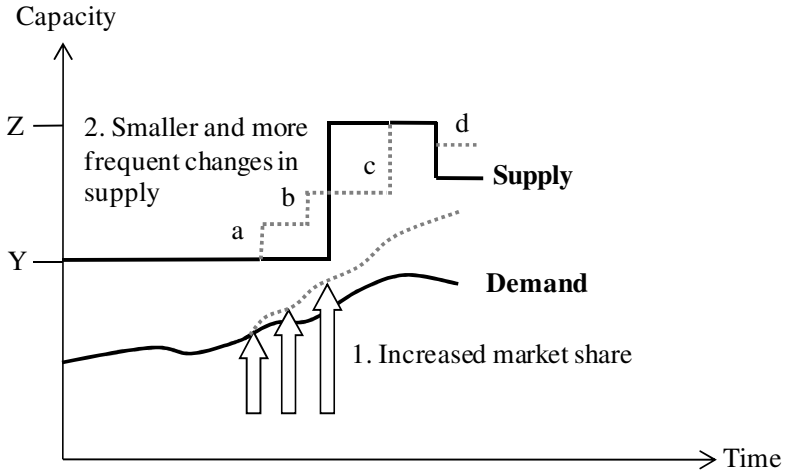

Figure 10.8 Measures directed towards improvement of vessel capacity utilisation through: 1) increased market share, and 2) changed capacity in smaller and more frequent steps.

1. Increased demand through larger market share
The shipping company can work intensively to increase the demand for the service and to gain market shares. One measure described by respondents is to use introductory prices to gather new customers that previously transported their cargo with land borne or seaborne competitors; another is to get a contract with one large customer. The latter means that it is possible to increase the capacity of the fleet without long periods of low vessel capacity utilisation. One respondent described: "Another way to handle the large capacity steps is to sign a contract with one big new customer. First you get the client, then you get the vessel, then you have a good capacity utilisation from the start." Thereby, the risk of low profit when introducing the new vessel can be reduced.

As described in Chapter 10.3.1 Internal and external improvement measures, a shipping company can use price differentiation to increase capacity utilisation when operating a service. Price differentiation can also be an effective measure when introducing new capacity to a service; see Figure 10.9.

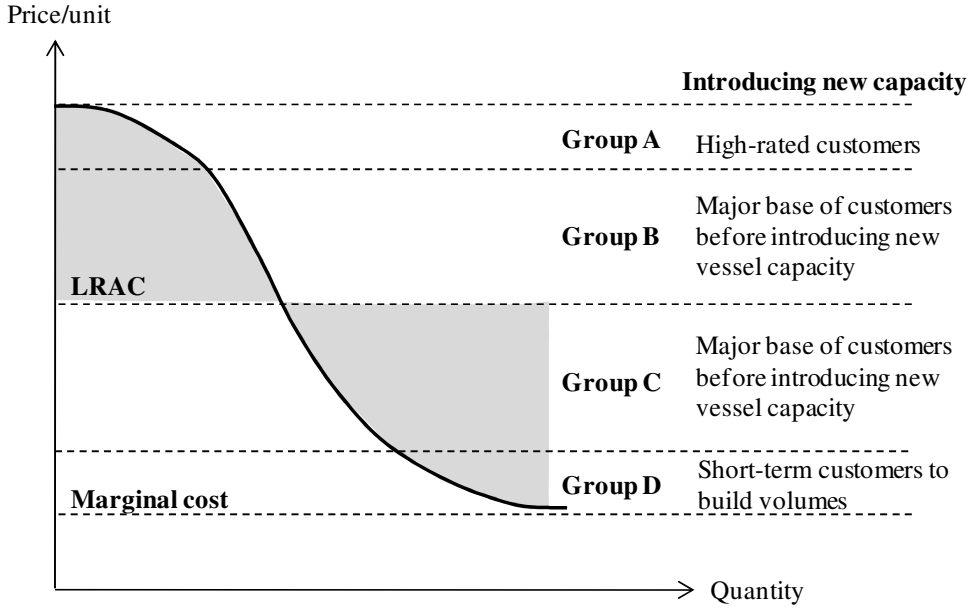

Figure 10.9 Price differentiation for increasing capacity utilisation when introducing new capacity. Developed from Deakin and Seward (1973). LRAC is the long-run average cost.

Before the new capacity is introduced it is necessary that some of the new volumes are already available. These customers are foremost found in group B and C in the figure. These groups represent stable customers with relatively low price elasticity. Customers in group D can be added to increase volumes initially, but as the freight rates are below the long-run average cost (LRAC), these should be phased out when capacity utilisation increases. Customers in group A contribute to the profit of the service and should be increased if possible. However, this is a fairly small group and does not normally contribute significantly to the long-term sustainability of the service. In the opposite situation, when capacity utilisation is too high, price differentiation can be used to decrease the capacity utilisation and set capacity free. Maersk Line uses this strategy to

bring down the physical capacity utilisation by increased freight rates: “What we are doing right now is actually bringing down the physical vessel capacity utilisation by pricing. We are pricing too high so we are losing out on business right now. But we do it on purpose. The point is to make more money with a lower utilisation level.” Changes in freight rates are, however, only possible in strong markets and are not proper measures during recessions or when there are competitors with unutilised capacity or who charge lower price.

To increase vessel capacity utilisation, the shipping company can look for new types of customers rather than the traditional ones. The feeder operators’ customers are normally the large ocean shipping companies. However, both feeder operators in Study III are identifying new customer segments, as described above. The RoRo shipping company described a similar strategy as the Japanese feeder operator, e.g., to sign contracts with customers from Group D in the figure above: “You can also attract a new segment of customers, such as container customers. You need to decrease prices as containers are more price-sensitive than RoRo cargo. When the capacity utilisation increases, you continuously add better paying customers and start to phase out the container customers. This is the old school. In principal we are borrowing and lending customers from each other.”

2. Changed supply in smaller and more frequent steps
Demand growth and high capacity utilisation signal the need for investment in additional capacity. The aim of an extended vessel or a new large vessel to replace an old smaller one is to decrease transport costs per unit. If, instead, an additional vessel is added, the shipping company will not enjoy the same level of return to scale, but departure frequency can be increased. Thus, the shipping company needs to balance the customers’ requirements of high service frequency and the scale economies of larger vessels providing lower unit costs.

Investments in a new vessel involve higher fixed costs and higher operational risks owing to fluctuating demands for transportation (Laine and Vesäläinen, 1994). During the interviews the respondents described their possibilities to divide the large capacity leap associated with an additional vessel into smaller steps, shown in Figure 10.8 above. Three approaches can be employed by the shipping company when adjustment in vessel capacity is needed: a) changes in vessel capacity within the existing fleet, b) introduction of smaller portions of vessel capacity, and c) investment in new vessels.

A flexible solution is to increase vessel capacity with the existing fleet. As a consequence, the decision to opt for further investment in capacity is deferred. The respondents suggested higher speed or shorter turnaround time in port, which facilitates a larger number of round trips per year. With higher speed the power requirements raise sharply and the bunker fuel consumption increases significantly (see for example Evans and Marlow, 1990; Lagoudis et al., 2002; Notteboom and Vernimmen, 2009), which results in an increase in short-run marginal cost (Jansson, 1974). Nevertheless, if the sailing schedule allows extra departures as a result of higher speed or if customers value the reduced transport time, increased speed could be an appropriate action.

If the existing fleet cannot provide further capacity, the shipping company can still add smaller portions of capacity before a new large vessel is introduced. The expansion of capacity can be achieved through a space charter arrangement or by adding a smaller temporary vessel borrowed

from another shipping service or chartered for a shorter period. This vessel can work up the market, which was emphasised by one of the respondents: “If we are planning to bring a big, new and expensive vessel into a service, we can start with a smaller vessel and build up volumes. Thus, we divide the development of the service into two steps.”

Finally, when the new permanent vessel is installed, the market is already prepared for the higher capacity. The smaller temporary vessel can be withdrawn and the service characteristics, e.g., speed, frequency, sailing schedule, etc. can be adjusted to the changed conditions and capacity. The shipping company can also replace an existing vessel with a larger one if there is a need for the old vessel in another service or if it is possible to enter the second-hand market.

If vessel capacity instead needs to be adjusted to a lower demand, it is important to carefully analyse the cost of carrying unutilised capacity in relation to reduction in returns. When demand declines, it is possible to withdraw a vessel or cancel a departure. Reducing the sailings during low seasons is common in ferry services, as shown in Study I. The purpose is to increase the capacity utilisation on the remaining sailings, but the action may actually result in the opposite: a decline in capacity utilisation due to losses in market shares caused by reduced frequency. Because withdrawing capacity is a risky and costly undertaking, Fusillo (2003) suggests that it may be more economical to sail vessels at very low levels of capacity utilisation. Further, speed can be reduced by slow steaming in order to cut costs when demand falls, but this action risks alienating existing customers and could result in loss of market share. The advantages of slow steaming were highlighted by Maersk Line: “We have changed the sailing schedule and prolonged the transit time. [...] By adding a vessel we take out capacity of the market and we save fuel. We have reduced the costs 10% by going slower. Environmental aspects are also advantages of slow steaming. Reliability is another advantage as we can catch up if we are late.”

10.3.3 Matching supply and demand in transport chains

All ports in Study III had capacity shortage in container storage areas, berths and/or container cranes. Land area can be set free with reduced container storage time or by stacking the containers higher. There are some limitations in height due to high pressure on the ground, safety and how high the equipment can reach, but the ports included in the study stated operational issues as the main reason for keeping the number of containers lower than necessary. One respondent described: “If you stack 5 containers high the yard utilisation is quite high. But high yard utilisation also means that productivity will go down as the straddle carriers drive longer and handle more containers to get the required containers out of the stacking area.” Another respondent described the drawbacks of increased stack height: “We stack five containers but the housekeeping activities increase the turnaround time of the vessel because it takes longer to get the containers from the yard to the quay. However, if the import container is stacked higher it doesn’t affect the vessel productivity so much as if export containers are stacked five containers per slot.” Thus, there is a trade-off between productivity and yard utilisation.

Both ports and shipping companies often need to handle a high level of unutilised capacity. One port has decided to invest in an additional container crane although the utilisation of the cranes today is only between 20% and 40%. The reason for the investment is that the turnaround time for the largest deep sea vessels can be reduced if an additional container crane operates simultaneously with the existing ones. This indicates the importance of a short turnaround time

for the vessels, which is a demand often and resolutely expressed by the shipping companies. Additionally, the ports are also aiming at a reduction in turnaround time since it means that the berths' utilisation can be increased.

One important issue for the shipping companies is the extra-large vessels, defined as the concept of oversized ships (Styhre and Lumsden, 2007). An oversized ship is in the short run too large for its transported cargo volumes, which results in a high level of unutilised capacity. Nevertheless, this extra capacity implies that the shipping company avoids turning down transport assignments and that they are in a better position with respect to competitors. Even though this involves higher costs, this does not mean that it will be unprofitable. However, the unutilised capacity should be increased only up to that point where the incremental benefits are matched by the incremental costs. Further, with demand growth over time and new capacity added in large and discreet sizes, oversized ships make future growth in volume possible, without the need for new investments in vessels. There could also be a purely strategic reason for having oversized ships, which is also emphasised in literature (see for example, Wenders (1971) or Hilke (1984)). One respondent described this: "We have extra capacity to keep the competitors away. It is a fact that you use this strategic thinking. Absolutely. It is a very fine balance, and what price do you put on that? It is the same as your question about at what point you close a service: if it is there for strategic reasons. All strategic situations are different but it is always a question of price and the value of that strategy." Consequently, a certain amount of unutilised capacity is often tolerable in the shipping industry. However, excess capacity is unplanned losses in capacity utilisation and is always to be avoided in transport chains.

If the shipping company and the port belong to the same group, it is easier to argue in favour of new investments in port, as revenues of the investment can be divided between the companies. For example, investing in a new container crane not only makes the port more attractive to new customers, but it also means shorter turnaround time for the vessels. If the shipping company has some control of the terminal it also makes it possible to set an efficient time schedule so both the vessel and the port facilities can be efficiently utilised. The main advantages of owning strategic terminals have been identified in the studies, to:

- Influence port activities and investments,
- Protect the long-term interests as a shipping line,
- Increase productivity, and
- Get higher priority.

The drawbacks of owning a terminal for a shipping company can be that it is not necessarily a profitable business. Cost was mentioned both as an advantage and a disadvantage by different respondents, and probably both could be right depending on cargo volumes, utilisation of port equipment, congestion in neighbouring ports, etc. Nevertheless, strategic motives, e.g., long-term interests, investments, productivity and priority, were the main reasons for the shipping company to operate terminals, while costs were of secondary interest.
Operating an own terminal means that the liner shipping services are tied to a system they cannot easily change. However, due to port congestion and customers' transport chains, it is never easy to change ports even though there are no long-term formal agreements or contracts. If the service includes several large vessels or large transport volumes, moving the operation can take many years to realise according to respondents. Further, the positions of the ports are even stronger in

countries that have port monopoly, as the shipping company cannot move to another terminal. One respondent mentioned capacity and monopoly as two strong factors that determine the negotiation power between ports and shipping companies: “In ports with unutilised capacity and open competition we can go to any terminal and discuss prices with the stevedoring companies. It doesn’t matter which terminal we call at as long as they have a ramp and tug masters that can handle trailers. It is a question of capacity and monopoly. In this port, we cannot go somewhere else and ask if they can unload our vessels, and we cannot change ports because the customers do not want that.”

The demands on actors in transportation reflect the power structure in the chain. The ocean shipping company often has the strongest negotiation power and determine or influence feeder vessels’ sailing schedules and applies price-reducing measures to ports and feeder operators. However, Maersk Line describes situations when the feeder operator has the upper hand: “The negotiation power depends on the situation. If an operator has a product going into certain ports and the demand from our side is not big enough for us to open our own service, they know that their price can be close to the cost for us to run our own service, and by that they have the upper hand.”

If the port has a high level of unutilised capacity and if the shipping company is dominant within a port, the shipping company can exert considerable negotiation power over the prices that ports charge (Cullinane et al., 2006). Significant imbalances in the ratios of strength between port and shipping companies may influence the investment decisions made at individual ports and have an impact on the oversizing phenomenon seen at ports, as described by Musso et al. (2006). In the opposite situation, when the capacity utilisation in port is high, it is difficult for the shipping company to get new port slots when opening up a new service or expanding their business. In such a case, the port often has the strongest negotiation power and the shipping company needs to adapt or search for new alternatives.

The ocean shipping company is in a strong position, while the feeder operator generally cannot make any demands on actors in the transport chain. Depending on the situation in the satellite port, feeder operators can have a dominant role or they can be interdependent. In the case study, both feeder operators answered that the satellite ports had the strongest negotiation power, though the European feeder operator explained this was due to terminal monopoly and customers' demands, while the Japanese feeder operator answered that it was due to terminal regulations.

11. Framework for enhancement of vessel capacity utilisation

This chapter contains a framework for liner short sea shipping companies that are aiming at enhancing their vessel capacity utilisation. The content of this chapter is a synopsis of the analysis in the previous chapter and emerged when analysing the results of the studies. The framework covers strategic, tactical and operational levels, and gives the practitioners a toolbox of strategies as well as long-term and short-term measures to improve their vessel capacity utilisation.

11.1 Outline of the framework

The framework for enhancement of vessel capacity utilisation consists of four elements that proved to be important for short sea shipping in order to attain a desirable and required level of vessel capacity utilisation. Even though its components have been recognised, the complete framework as such has not been validated or tested in real-life settings. The intention is not to cover all aspects of the field, but to offer a toolbox with important contents in order to enhance the vessel's utilisation and reduce the cost per transport unit. The elements, which are described in the following four subchapters, are the following (see also Figure 11.1):

- Selection of capacity utilisation strategy,
- Definition of sailing schedule,
- Improvement measures for established vessel capacity, and
- Improvement measures for changes in vessel capacity.

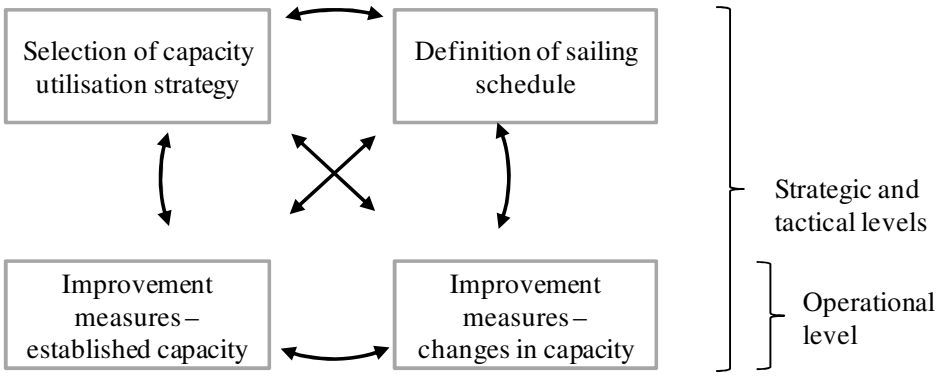

Figure 11.1 Outline of the framework for enhancement of vessel capacity utilisation in short sea shipping.

The arrows in the figure above symbolise that there is no strict sequence of activities, which may well be carried out in parallel. In some cases, for instance when a new vessel is added to an existing route, it is of great advantage to apply improvement measures on an operational level at

the same time a new sailing schedule is developed. The processes are repeated with the aim of approaching a desirable level of vessel capacity utilisation. The iteration normally starts when supply or demand for vessel capacity is changing due to, for example, new trade conditions, competitors entering the market, new customers, or when there is a need for investment in vessel capacity.

11.2 Selection of capacity utilisation strategy

Two extreme vessel capacity utilisation strategies have been described: the Cut peaks strategy and the Never say no strategy. Which one is the most suitable depends on route characteristics and market conditions. The route specific characteristics that affect vessel capacity utilisation identified in this thesis are frequency, trade imbalances and demand variations, competitive situation, and types of customers and cargo. Market conditions are related to state of the market and freight rates.

As the selected strategy in practice often is a mixture of the two extreme strategies, i.e., some peaks are cut while a certain level of unutilised capacity is kept, the result is to be seen as an indication of appropriate approach. These strategies are applicable on the assumption that there are variations or imbalances. If the utilisation level is even every departure, the size of the vessel can be a perfect match to the demand. This is, however, a rather theoretical discussion as there are always fluctuations in a shipping market where the shipping companies transport cargo for a number of shippers. Route characteristics and market conditions are the following:

Route characteristics: Frequency

High frequency is a central attribute for shippers, and often customers tend to leave if frequency is decreased below a critical number per week. High frequency is therefore a most important factor for business success. As frequency is important in most situations, no relation between frequency and applied strategy for vessel capacity utilisation has been noticed. Consequently, both strategies require a frequency that meets customer demand, even though the customers that are suggested for the Never say no strategy often are more demanding.

Route characteristics: Trade imbalances and demand variations

High trade imbalances and daily or seasonal variations in demands pose a risk of a high level of unutilised capacity as the shipping company needs larger vessels in order to handle the peak demand with preserved service level. Thus, the Cut peaks strategy is more suitable for routes with large variations and imbalances, while the Never say no strategy is better to apply in situations where the shipping company only needs to deal with small or medium sized fluctuations.

Route characteristics: Competitive situation

A larger number of competitors on a route normally lowers the freight rate, and affects the possibilities of shipping companies to use price differentiation across customers. Severe competition points towards the Cut peaks strategy, while moderate competition indicates that a Never say no strategy can be applied. If the competition is very limited, and consequently there are none or very few alternatives for the customers, unutilised capacity is necessary.

Route characteristics: Types of customers and cargo
Some customers require a higher service level than others, which affects the selection of strategy. Such are, for example, prioritised customers with long-term agreements and customers that transport time-sensitive cargo. As a consequence, shipping companies with a high level of prioritised customers normally need to accept a higher level of unutilised capacity.

Market conditions: State of the market
A shipping company that operates a service in a growing market needs to have a certain level of unutilised capacity, otherwise the shipping company needs to turn down assignments and will lose market shares in the long-run. In such situations, high capacity utilisation also allows for new competitors to enter the market. In stagnated or declining markets, on the other hand, a Never say no strategy means that the shipping company runs the risk of a high level of unutilised capacity, which can lead to unprofitability.

Market conditions: Freight rates
In markets with lower freight rates, a higher portion of utilised capacity is necessary to reach the break even for profitability. As a result, some peaks need to be cut and, consequently, the Cut peaks strategy is the most suitable choice.

The purposes of the two strategies as well as route characteristics and market conditions are shown in Table 11.1.

Table 11.1 Route characteristics and market conditions of the two identified strategies for capacity utilisation.

		Cut peaks strategy	**Never say no strategy**
Purpose		High average capacity utilisation by keeping the maximum capacity lower or increasing the market share	Higher level of unutilised capacity to have good flexibility, a possibility to grow, and never turning
Route characteristics	**Frequency**	Important for both strategies	Important for both strategies
	Imbalances and variations	Large	Small or medium
	Competitive situation	Severe	Moderate
	Customers and cargo	Customers that have other options or paying low freight rates	Long-term relations, JIT-producers, good-paying on-
Market conditions	**State of the market**	Declining, stagnated or moderate growing	Growing
	Freight rates	Low to high	Medium to high

11.3 Definition of sailing schedule
Appropriate vessels and sailing schedules for the cargo available in the market are essential when it comes to creating a profitable service with an adequate level of capacity utilisation. Important issues for a successful service are which ports to call, arrival and departure times, departure frequency, and number and type of vessels:

Ports to call
Some services commute between two ports and others visit a string of ports in a fixed sequence. A larger number of ports means that the capacity utilisation can be reduced or that the turnaround time in port can be prolonged when cargo needs to be rearranged on the vessel or in the container yard. RoRo vessels and ferries are more sensitive to these housekeeping activities than feeder vessels due to their design with a few cargo decks and ramps. However, if cargo is available and it is possible to set an efficient timetable, the multi-port calls are a possible solution to include new ports or relations without starting a new service. Further, a critical level of cargo volumes can be reached if several ports are included in a string, which can involve higher frequency or higher vessel capacity utilisation.

Arrival and departure times
The arrival and departure times are important to get fitting berth windows and to provide customers with efficient logistics solutions and facilitate for a high capacity utilisation of their resources. Changes in sailing schedules need to be discussed with the port at an early state to secure port slots and to ensure there is enough port capacity in order to get a short turnaround time for the vessels and avoid port congestion.

Departure frequency
High departure frequency that many customers demand brings about a trade-off with economies of scale for the shipping company. The average waiting time in the ports, and thereby the total transport time, decreases often at the expense of unutilised capacity in the transport system. However, as long as there is a demand for the enlarged capacity, higher frequency increases income and decreases unit costs by allocating fixed costs to a greater number of departures. Thus, an increase in frequency brings about a more than proportional increase in revenue up to a certain point. Beyond that point, the marginal benefits of an extra departure decline.

Number and type of vessels
The size and the number of vessels in combination with departure frequency set the maximum capacity of the shipping service. Economies of scale suggest a few large vessels to reduce the costs per transport unit, but this needs to be matched with frequency requirements. Appropriate ship design, especially for RoRo vessels and ferries which have less standardised cargo holds than container vessels, is also very important to accommodate the diverse cargoes and load units available in the market without losing valuable space onboard.

11.4 Improvement measures for established vessel capacity

There are various factors that affect the ability of shipping companies to make efficient use of their vessels, but there are also several measures for improving capacity utilisation. Each shipping service needs to be analysed to find out which measures are most effective to apply in order to increase vessel capacity utilisation and reduce cost per transported unit. However, a combination of both long-term and short-term improvement measures that cover strategic, tactical and operational levels to reduce both external as well as internal factors is suggested.

There are two overall approaches when applying the improvement measures: one directed towards capacity demand and the other towards capacity supply. Enhancement in the capacity demand structure includes promoting the service, finding new cargo to be transported, and

moving existing assignments in time. Enhanced vessel design and sailing schedules, technical developments, and intense cooperation and communication are groups of activities focusing on enhancement of capacity supply. Both approaches can be short-term (operational) or long-term (tactical or strategic). Table 11.2 summarises and categorises the improvement measures described in the Chapter 10.3.1 External and internal improvement measures (see also Table 10.2). Most measures require long-term planning and aim at adjusting capacity supply.

Table 11.2 Short-term (days or weeks) and long-term (months or years) actions to enhance vessel capacity utilisation.

	Short-term actions	**Long-term actions**
Demand for vessel capacity	Stand-by cargo Overbooking Price differentiation Rescheduling of bookings	Explore and understand the market Find cargo in low-volume leg or departure Lobbying, e.g., to promote shipping Find the right type of cargo and customers
Supply of vessel capacity	Route planning, e.g. weather routing Change of sailing schedule	Cooperate and communicate with shipping companies Improve information exchange Cooperate and communicate with ports Improve cargo handling equipment Route planning Lobbying, e.g., development of fairways Cooperate and communicate within the comp. Develop flexible capacity management Develop suitable vessel designs Improve stowage plans Improve transport units

11.5 Improvement measures for changes in vessel capacity

Vessel capacity utilisation can be improved more quickly and smoothly when changing vessel capacity for a service. In order to better match supply and demand, several measures can be applied. These are directed towards: 1) increasing demand through larger market share, and 2) changing supply in smaller and more frequent steps. These two actions reduce the risks of the investment by building volumes before adding a new vessel, and also by postponing the need of the investment, by using existing capacity in a more efficient manner.

In order to increase the demand when changing vessel capacity, following measures are suggested:

- Introductory price to get new customers,
- Make a contract with one large customer,
- Find new types of customer segments, and
- Apply price differentiation among existing customers to get a suitable cargo and customer mix.

There are measures to apply when new capacity is needed without immediately investing in a new large vessel. These are in principal directed towards adding capacity within an existing fleet and with smaller portions of new capacity before realizing the permanent solution. Capacity can be introduced by gradually increasing capacity in several steps:

- Increase frequency by higher speed or reduced turnaround time in port,
- Space charter agreements,
- Extend existing vessel,
- Short-term vessel charter,
- Borrow a small vessel from another service,
- Replace an existing vessel with a larger one, and
- Increase the number of vessels for the service.

11.6 The iterative process of enhancement of vessel capacity utilisation

The shipping industry is based on a derived demand from the trade and manufacturing industry, and the shipping market is often described as volatile and unpredictable. Consequently, it is crucial to continuously adapt to the changes in order to be able to offer competitive and economic endurable shipping services.

The previous subchapters summarise the four elements of the framework that facilitate an enhancement in vessel capacity utilisation if they are well worked-out and carefully accomplished: the underlying strategy for a service, the efficient sailing schedule, improvement of capacity utilisation for established vessel capacity, and improvement of capacity utilisation when changing vessel capacity. These involve both long-term and short-term aspects, and cover the three research question investigated in this thesis.

In order to enhance vessel capacity utilisation and to handle the market changes, often more than one element simultaneously needs to be taken into consideration as they are closely intertwined. For example, a revision of the capacity utilisation strategy and application of new improvement measures for established vessel capacity might both be necessary if the demand for vessel capacity decreases when a competitor enters the market. These may for instance result in a decrease in the maximum vessel capacity, i.e., a movement towards the Cut peaks strategy, by changing the sailing schedule's arrival and departure time through slow steaming. Correspondingly, if new capacity needs to be added due to market growth, improvement measures for established vessel capacity suggests such as space charter agreements and reschedule of bookings to set capacity free during peak days; and suitable improvement measures for changes in vessel capacity are price differentiation and increased capacity by higher speed, which also means a redefinition of the sailing schedule.

The framework with its four elements and arrows that indicate the iterative processes to handle changes in supply and demand for vessel capacity is shown in Figure 11.2.

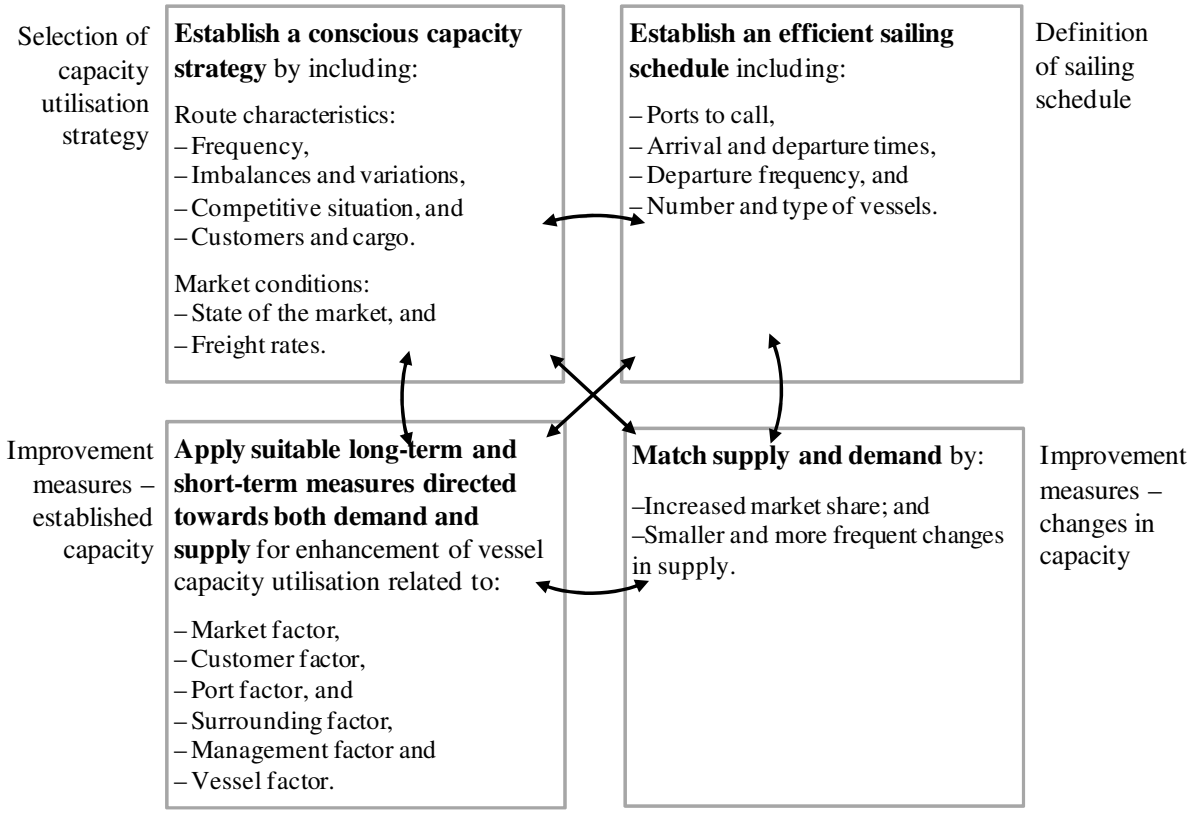

Figure 11.2 Iteration between the four elements of the framework for enhancement of vessel capacity utilisation.

PART VI Closing section

12. Conclusions

The overall purpose of this thesis is to identify the potential for enhancement of vessel capacity utilisation, with the aim of reducing transport cost per unit. The thesis includes both an analysis of capacity utilisation strategies and identification of short-term and long-term measures to improve vessel capacity utilisation in short sea shipping. Three research questions have been posed:

- What route characteristics affect vessel capacity utilisation?
- What strategies are employed by the shipping companies to enhance vessel capacity utilisation?
- How can vessel capacity utilisation in short sea shipping be enhanced?

The answers to the first two questions are summarised in the first subchapter: Vessel capacity utilisation strategies. The last question is answered in the second subchapter: Measures to improve vessel capacity utilisation. The work concludes in a framework for enhancement in vessel capacity utilisation in short sea shipping included in the last subchapter.

12.1 Vessel capacity utilisation strategies

Before a shipping company is applying a vessel capacity utilisation strategy, *route characteristics* and *market conditions* need to be analysed in order to identify an appropriate approach for the particular shipping service. Two extreme strategies have been identified and described in this thesis: the *Cut peaks strategy* and the *Never say no strategy*. The purpose of the Cut peaks strategy is to have a high average capacity utilisation by keeping the maximum capacity lower or increasing the market share. The purpose of the Never say no strategy is to allow higher unutilised capacity in order to have good flexibility, a possibility to grow and the ability to maintain a high service level for customers by never turning down transport assignments.

Often, the selected strategy is a mixture of the two: some peaks will be cut while a certain level of unutilised capacity still is tolerable. Although high vessel capacity utilisation can imply high short-run profitability, unutilised capacity is necessary in the long run to keep a reasonable and acceptable service level, to be flexible and to avoid high bunker fuel consumptions and delays. The idea is to find the best suitable choice and combination for the specific conditions on each individual route and to gain knowledge of the consequences of the approach taken. Route specific characteristics and market conditions of the two extreme strategies are shown in Table 12.1.

Table 12.1 Route characteristics and market conditions' effect on the selection of vessel capacity utilisation strategy.

		Cut peaks strategy	Never say no strategy
Route characteristics	**Frequency**	Important for both strategies	Important for both strategies
	Imbalances and variations	Large	Small or medium
	Competitive situation	Severe	Moderate
	Customers and cargo	Customers that have other options	Long-term relations, time sensitive cargo, good-paying on-off assignments
Market conditions	**State of the market**	Declining, stagnated or moderate growing	Growing
	Freight rates	Low to high	Medium to high

Route characteristics and market conditions shown in table above have been identified in this thesis. They all affect vessel capacity utilisation and applied strategy:

- **Route characteristic: Frequency**, vessel capacity utilisation is significantly lower for high-frequency routes. However, higher frequency facilitates a reduction in cost per transported unit due to the high fixed costs in shipping. Frequency is a central attribute when customers are determining mode choice, and it is important to reach a critical number of departures per week in order to avoid customers searching for new alternatives.

- **Route characteristic: Trade imbalances and demand variations**, trade imbalances and demand variations are an artefact of structural conditions of supply and demand in the transport market. They often involve substantially unutilised capacity in order to provide a high service level, as the shipping companies have to adjust their vessel capacity to handle the peak demand.

- **Route characteristic: Competitive situation**, server competition affects vessel capacity utilisation negatively. A larger number of competitors on a route normally also lowers the freight rate and the ability of shipping companies to apply price differentiation across customers. Thus, a higher level of average capacity utilisation is necessary.

- **Route characteristic: Types of customers and cargo**, some customers and cargoes require a higher service level than others, which affects the vessel capacity utilisation; for example, just-in-time clients and customers that transport perishables and project cargo that cannot be delayed. Thus, shipping companies with a high amount of time-sensitive cargo and prioritised customers normally need to accept a lower level of vessel capacity utilisation.

- **Market condition: State of the market**, a shipping company that operates a service in a growing market needs to have a certain level of unutilised capacity; otherwise they will lose market shares in the long-run. In such situations, high capacity utilisation also allows

for new competitors to enter the market. In stagnated or declining markets, on the other hand, the shipping company runs the risk of excess capacity.

- **Market condition: Freight rates**, in markets with lower freight rates, a higher portion of utilised capacity is necessary to reach the break even for profitability.

The necessity to have unutilised capacity is reflected both in literature and by the respondents' answers. The respondents suggested between 12% and 25% of unutilised capacity in RoRo shipping depending on route characteristics. There are also situations that allow lower average capacity utilisation, namely when:

- There is a recession,
- A service is newly opened and not yet established,
- Preventing competition, and
- The service is complementary to another important service.

Consequently, patience and economic endurance are important in times of recession and when exploring new markets. However, since shipping is subject to large economies of scale, it is necessary in the long-run to cover the long-run average costs to avoid maintaining a money-consuming shipping service.

The bridge substitute concept was identified when analysing the relation between frequency and capacity utilisation in ferry services: *A bridge substitute bridges gaps between land borne transport networks, offering high-frequency departures and enough capacity in order to limit the waiting time for goods and passengers in port.* The five Bridge substitutes included in Study I showed an average vessel capacity utilisation of 33.6%. The demand on high frequency is very important for the shipping company to meet, even though this means that the vessel capacity utilisation per departure will be lower. This is described as the bridge substitute dilemma: *The bridge substitute dilemma is a trade-off between the demands for high frequency, accessibility to transport networks, and unutilised capacity as set by the shipping companies' customers, and internal goals for high vessel capacity utilisation.*

12.2 Measures to improve vessel capacity utilisation

Short-term and long-term improvement measures to apply when operating an established shipping service have been identified and categorised. Combinations of measures directed towards both capacity demand and capacity supply facilitate an increased utilisation level. Most measures require long-term planning and aim at adjusting capacity supply.

Shipping services are highly affected by changes in the market situations and by new competitors entering and leaving the market, which need to be considered when investing in and operating vessels. This is rather difficult, considering the long depreciation times for vessels and the volatility of the shipping market, but can to some extent be handled by investing in vessels with a standardised design and flexible solutions. It thereby becomes easier to enter the second-hand market or move the vessel to another route if necessary in the future. Appropriate vessels and sailing schedules for the cargo available in the market are essential issues when it comes to

reaching an adequate level of capacity utilisation. Changes in schedules need to be discussed with the port at an early state to secure port slots and ensure there is enough capacity in order to maintain a short turnaround time for the vessels and to avoid port congestion. Stand-by cargo, overbooking and the rescheduling of bookings are efficient methods for levelling the peaks and valleys in demand and allowing new contracts on peak days. Additionally, price differentiation across customers can be applied but needs to be done carefully to avoid losing customers or causing dissatisfaction among them. Price differentiation can be used both when operating an established service and when introducing new capacity to an existing one.

Matching supply and demand is difficult in short sea shipping because of the features of the shipping industry and the fact that vessel capacity is rather fixed in the short run. Difficulties related to the demand/supply balance are foremost related to large fluctuations in volumes and freight rates over time, imbalances and variations in demands in the short run and often a significant decrease in average vessel capacity utilisation when new capacity is introduced. Measures to better match supply and demand in shipping in order to more quickly increase capacity utilisation when change in capacity is required have also been described. The two overall approaches of matching supply and demand are *to increase demand through larger market share*, e.g., price differentiation, and *to change supply in smaller and more frequent steps*, e.g., changed vessel speed, space charter agreements and usage of a smaller temporary vessel. These reduce the risks of the investment by building volumes before adding a new vessel, and also postpone the need of the investment in vessel capacity.

In the transport chain, capacity losses can also be due to uncertainty factors and lack of communication. This can be the result of a defective planning system among customers and other transport companies in the chain. Further, some information is considered to be strategic that implies that sometimes information is not shared. Communication and cooperation between companies in the transport chain, and also between employees within individual shipping companies, are essential aspects to better integrate different segments and functions. It is always of primary concern that transport companies receive the best possible information from other actors as this allows the shipping company to better plan its activities. The demands on actors in transportation reflect the power structure in the chain. The ocean shipping company often has the strongest negotiation power and often influences feeder vessels' sailing schedules and applies price-reducing measures to ports and feeder operators, which ultimately affect the capacity utilisation of the short sea vessels.

Both ports and shipping companies often need to handle a high level of unutilised capacity. Structural reasons for the unutilised capacity, e.g., trade imbalances and demand variations, have been recognised. Besides, there are also strategic motives for unutilised capacity. Shipping companies prefer, in general, using terminals with unutilised capacity as this decreases the risk of congestion and increases the chance of being served faster with shorter turnaround time. Consequently, ports need to have unutilised capacity to attract new customers. Also, the shipping companies have reasons for unutilised capacity; *the concept of oversized ships* is a result of economies of scale in shipping, and demand on high frequency means that it is risky to take a vessel out of service as it might result in a decrease in vessel capacity utilisation.

12.3 Framework for enhancement of vessel capacity utilisation in short sea shipping

Knowledge gained when answering the three research question resulted in the framework for enhancement of vessel capacity utilisation in short sea shipping. The framework consists of four elements:

Selection of capacity utilisation strategy

The aim of applying a conscious capacity strategy is to have an average vessel capacity utilisation that suits the conditions for the shipping service. For the shipping company, this facilitates offering a reasonable and acceptable service level to customers. The strategies are the Cut peaks strategy, the Never say no strategy, or a combination of the two.

Definition of sailing schedule

An efficient sailing schedule provides the customers with good logistics solutions and is central for a service to be successful. Important questions are if the route should include a string of ports or if the vessels should commute between two ports, and if there are available berth windows in the selected ports in order to provide a certain departure frequency. What needs to be decided to provide an efficient sailing schedule is ports to call, arrival and departure times, departure frequency, and number and type of vessels.

Improvement measures for established vessel capacity

Different short-term and long-term measures for enhancement of vessel capacity directed towards supply and demand have been described in this thesis. The appropriateness of a certain measure depends on the features of the individual route. The measures can be divided into one of six groups of factors:

- **Market factors**, e.g., explore and understand the market, find cargo in low-volume sea-leg or departure,
- **Customer factors,** e.g., stand-by cargo, overbooking, reschedule of bookings, price differentiation,
- **Port factors**, e.g., cooperate and communicate with ports, improve cargo handling equipment,
- **Surrounding factors**, e.g., route planning, lobbying,
- **Management factors**, e.g., cooperation and communication within the company, change of sailing schedule, and
- **Vessel factors**, e.g., develop suitable vessel design, improve stowage plans.

Improvement measures for changes in vessel capacity

When introducing new capacity to an existing service, there are measures to apply in order to more quickly and smoothly enhance vessel capacity utilisation. The measures reduce the risks of the investment in new vessel capacity by dividing the large capacity leap associated with a new vessel into smaller steps. They also facilitate a decrease in transport cost per unit as supply and demand for vessel capacity is better aligned. These are directed towards: 1) increasing demand through larger market share, and 2) changing supply in smaller and more frequent steps.

13. Contributions and future research

This closing chapter includes the theoretical and practical contributions of the findings, and suggests future potential research areas that are interesting to explore. Increased knowledge of enhancement of vessel capacity utilisation in short sea shipping can contribute both to the establishment of profitable and competitive shipping services as well as to the construction of more efficient transport systems with reduced environmental impacts caused by the transport industry.

13.1 Theoretical contribution

The theoretical contribution consists of an increased understanding of vessel capacity utilisation in short sea shipping. This is realised by the establishment of strategies and a framework for the enhancement of vessel capacity utilisation. By analysing route characteristics and market conditions, two strategies emerged, the Cut peaks strategy and the Never say no strategy, which affect the short sea shipping companies' possibilities to utilise their vessels and provide capacity to their customers. Selection of strategy is an essential element in the framework for enhancement of vessel capacity utilisation, together with the definition of sailing schedule and application of improvement measures. Identification and classification of factors that affect vessel capacity utilisation and measures to handle them, both when operating an established service and when changing vessel capacity, theoretical contributions that have been presented in this thesis.

The definition of capacity utilisation and related terms and concepts in short sea shipping has been an important part of this work. The bridge substitute, the bridge substitute dilemma, oversized ships, and excess capacity in relation to unutilised capacity are terms that have been described and defined in this context.

The application of theories from different domains to increase the theoretical comprehension of the short sea shipping industry is most central for this research. Economies of scale and density, price differentiation and marginal pricing have been adopted from economics; transport chain power and inter-organisational relations have been adopted from business science and organisational theories; and intermodality and transport chain integration have been adopted from logistics. These theories have been used to explain some phenomena in shipping, e.g., unutilised capacity, oversized ships and difficulties in matching supply and demand in waterborne transportation. Further, these have also expanded the knowledge base related to the research areas. Although the application of such theories in shipping is not new, their connection to the physical vessel capacity utilisation in short sea shipping is something that has not been explored enough.

13.2 Implication for practitioners

The practical implication of the research result has since the beginning been a central motive force of this research. The problem description points out that an adequate level of vessel capacity utilisation is of great importance for the establishment of a cost-efficient and long-term sustainable shipping service and, thus, for the competitiveness of short sea shipping. The capacity utilisation can be enhanced by applying conscious strategies, as well as short-run and long-run improvement measures. Research Questions I and II, which are directed towards capacity utilisation strategies, help the shipping companies to understand how different strategies under diverse market conditions and different route characteristics can be put into practice, and how selected strategy affects their business. Research Question III about how vessel capacity utilisation in short sea shipping can be enhanced is closely connected to practical matters that people involved in shipping and port operations deal with on a daily basis. Different measures can be applied simultaneously as most of them are independent of each other.

The recommendations for practitioners summarised in the framework in Chapter 11 Framework for enhancement of vessel capacity utilisation, cover strategic, tactical and operational levels when handling capacity utilisation in short sea shipping. These give the practitioners a toolbox of strategies and long-term and short-term measures to improve the vessel capacity utilisation and to decrease the cost per transported unit. The framework contains the following four elements:

- Selection of capacity utilisation strategy,
- Definition of sailing schedule,
- Improvement measures for established vessel capacity, and
- Improvement measures for changes in vessel capacity.

13.3 Future research

Suggested future research is directed towards gaining knowledge of the connection between economic capacity utilisation and physical capacity utilisation. This will increase the understanding of the relation between profitability and vessel capacity utilisation. The work includes identification of requirements among different customers, and a refinement of the price differentiation model in order to create a more sophisticated distinction between groups of customers. Thereby, the customers are more likely to pay the correct freight rates and get the right service level in relation to their demands and expectations, which facilitates an increased competitive advantage of short sea shipping. It also creates a transparent pricing policy within the company that backs the employees up when negotiating with their customers. An important outcome of this work is a tool for analysis of break-even points for profitability. The purpose is to determine what level of vessel capacity utilisation is necessary for a shipping service in order to be profitable. This tool should not only embrace freight rates, which give a formal answer to the question, but also include route characteristics and market conditions to estimate how vulnerable the service is to recessions, competition, the outcome of individual large customers, etc. Thereby, it is possible to calculate profitability and estimate how sensitive the outcome is to changes in demands. The tool should be possible to use for different types of services and short sea liner vessel concepts. The theoretical contribution of this research is also significant. The price differentiation model and the tool for break-even analysis of potential profitability combine

knowledge from different subject fields and it is likely, after minor modifications, to find applications for shipping concepts other than short sea shipping.

Analysis and quantification of losses in capacity utilisation in transport chains is also a promising research area. It would have been interesting to gain knowledge of how different losses affect the transport chain and how these can be reduced depending on the characteristics of the chain. This research is directed towards a decline in excess capacity in transportation and, accordingly, an improved competitiveness of transport chains involved in short sea shipping. Excess capacity is both from the firm perspective and the public perspective a waste of resources. It involves the fact that a larger number of vessels and vehicles with less cargo onboard are using the infrastructures, which can cause congestion and an increased risk of accidents. Excess capacity also raises the costs of logistics and transportation, as well as investment in new infrastructure.

Enhancement of capacity utilisation can result not only in improvement in the financial results of the shipping company, but can also make it possible to reduce the environmental impacts caused by the transport industry. The relationship between environmental issues and transport efficiency is suggested for future research. This work can include the calculation of reductions of pollution if different bunker- and energy-reducing measures are applied, e.g., slow steaming and route planning including weather routing. The effect of the individual measures should be calculated in order to find how these could be prioritised by the shipping companies. The results for the shipping company include that they can cut costs by reducing bunker fuel and offer their customers a reduction of their environmental footprint, an argument that is gaining ground due to end-users' of consumer goods increased environmental concerns.

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Appendix A The shipping services included in Study I

Shipping service	Shipping company	App. transport time (h)	App. distance (nm)	Frequency (dep./year)	Number of vessels
Frederikshavn-Larvik	Color Line	6.5	105	941	2*
Frederikshavn-Oslo	Stena Line	8.5	156	647	1
Gedser-Rostock	Scandlines	1.75	30	5577	3
Göteborg - Fredrikshamn	Stena Line	3	50	5687	4
Hanstholm-Egersund-Haugesund-Bergen	Fjordline	18	280	352	1
Hanstholm-Torshavn-Seydisfjördur	Smyril Line	35.5	550	118	1
Havneby-List	Rømø-Sylt Linie	0.6	3	2464	2
Helsingborg - Helsingör	Scandlines	0.33	2	43331	3
Helsingborg - Helsingör	HH - ferries	0.33	2	26285	2
Hirtshals-Kristiansand	Color Line	4.5	69	2105	2
Hirtshals-Larvik	Color Line	5.5	87	407	1*
Hirtshals-Oslo	Color Line	9	139	614	1
København-Oslo	DFDS Seaways	16.5	272	728	2
København-Swinoujscie	Polferries	9	130	496	1**
Rødby-Puttgarden	Scandlines	0.75	10	35544	3
Rønne-Sassnitz	Scandlines	3.5	52	334	1
Rønne-Swinoujscie	Polferries	5.25	76	24	1**
Varberg - Grenå	Stena Line	4.25	61	781	1
Ystad - Rønne	BornholmsTrafikken	2	36	2918	3

Figures are for 2004. Sources: Transport time: Shipping companies' sailing lists; Distances: www.world-register.org/dist.htm, www.distances.com, and users.pandora.be/tree/wreck/north-sea/distances.html; Frequency: Danmarks Statistiks opgørelse af transport i internationalt færgefart til og fra Danmark 2004.

** One vessel operated both Frederikshavn-Larvik and Hirtshals-Larvik;*
*** One vessel operated both København-Swinoujscie and Rønne-Swinoujscie.*

Appendix B Interview protocol Study II

Name of respondent:
Position:
Year in the company:
Shipping service/s:

1 Route characteristics (related to Research Question I)

1.1 What are the requirements necessary for an efficient short sea shipping link with good vessel capacity utilisation?
1.2 What type of customer do you have on the route?
1.3 Do you have demand variations and imbalances in import and export figures?
1.4 What is the competitive situation like?
1.5 Do you measure performance of your operations frequently? If yes, what kinds of performance measurement indicators do you use?
1.6 What are the following figures for: departure frequency; capacity utilisation; total transported lane meters; total available lane meters; number of vessels?

2 Vessel capacity utilisation strategy (related to Research Question II)

2.1 What is your business strategy?
2.2 Do you in general have a shortage of vessel capacity or unutilised vessel capacity?
2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation?
2.4 Under what circumstances can you continue a service with low vessel capacity utilisation?
2.5 What is important to consider when you set the sailing schedule?

3 Enhancement of vessel capacity utilisation (related to Research Question III)

3.1 What external factors affect the vessel capacity utilisation?
3.2 What internal factors affect the vessel capacity utilisation?
3.3 How can vessel capacity utilisation be enhanced in the short run, and in the long run?
3.4 What is difficult in vessel capacity planning?
3.5 Do you use price differentiation?
3.6 How long does it take to establish a new shipping service?
3.7 How do you handle the large capacity steps associated with introducing new vessel capacity?
3.8 Are the capacities in port in general enough regarding: personnel, facilities, and infrastructure?
3.9 What criteria do you base the decision upon when selecting terminals for your shipping service?
3.10 What demands do you have on the ports?
3.11 Who has the strongest position in negotiation, the port or the shipping company?
3.12 Why do you have a strategy to own and operate port terminals?

Appendix C Summary of respondents' answers in Study II

1 Route characteristics (RQ I)

	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Respondent 7
1.1 What are the requirements necessary for an efficient short sea shipping link with good vessel capacity utilisation?	Reliability, imbalances, competitive situation, customers, market conditions.	Frequency, reliability, type of customers, regularity, infrastructures capacity, quality, good solutions for customers.	Frequency, reliability, market focus.	Frequency, reliability, freight rate, transport time, infrastructure, market, accessibility, service level, flexibility.	Frequency, reliability, competitive situation, speed, efficient sailing schedule, costs, service level.	Frequency, reliability, adaptability, cost efficiency.	Frequency, reliability, efficient sailing schedule, information system, infrastructure capacity.
1.2 What type of customer do you have on the route?	Big customers for base flows, and others.	Mainly a few big customers that we are reducing as smaller customers pay higher rates.	Both cargo and passengers. Many small customers.	Industrial customers that we are trying to increase; and trailer operators.	Industrial customers, trailer operators, special cargo; all with different requirements.	Trailer operators, industrial customers, project cargo.	Industrial customers, trailer operators, container operators, car manufacturers.
1.3 Do you have demand variations and imbalances in import and export figures?	Every service and market is different, but here we have huge imbalances especially for trailers.	Seasonal variations to a small extent; large trade imbalances. We are trying to find cargo in the low-volume sea-leg.	Weekly variations of cargo; seasonal variations of passengers; some trade imbalances due to the market.	Large seasonal variations and imbalances. Imbalances due to the market.	Weekly variations, imbalances in industrial cargo. We are trying to find cargo in the low-volume sea-leg.	Trade imbalances and demand variations, but managed to find cargo in low-volume sea-leg and departure.	Large imbalances.
1.4 What is the competitive situation like?	Keen competition means lower profits. There is overcapacity in shipping.	Compete with road. Road congestion and toll system helps RoRo shipping.	Shipping companies, rail.	Compete with road, rail, bridges, industrial transport systems. Varies between shipping services.	Compete with sea, road and rail, mainly for the trailers. There are long-term contracts for industrial cargo.	Service X: road and rail; Service Y: no competitors.	We keep competitors away by keeping unutilised capacity.
1.5 Do you measure performance of your operations frequently?	Yes, and we are updating them.	Yes, bunker consumption, turnaround time, costs, damages, accidents, claims, delays.	Yes, damages. We don't measure turnaround as the vessel stays long in port.	Yes, reliability, damages, claims, costs.	Yes, transported lane meter and volumes.		

2 Vessel capacity utilisation strategy (RQ II)

	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Respondent 7
2.1 What is your business strategy?	Vessel strategy, market strategy.	Vessel strategy.	Vessel strategy.	Customer strategy, vessel strategy.	Vessel strategy, network strategy, vessel capacity strategy, customer strategy.	Vessel strategy.	Customer strategy, network strategy, vessel capacity strategy.
2.2 Do you in general have a shortage of vessel capacity or unutilised vessel capacity?	Varies between services.		Shortage due to increased demand, but unutilised capacity some days.	Shortage due to increased demand.	Shortage.	Varies between departures.	Varies between services.
2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation?	80%; reliability, service level, demand variations, competition, freight rate, types of cargo and customers.	82%; freight rate, frequency.	75%; market situation, service level, demand variations.	80-85%; service level, flexibility, reliability, bunker consumption, freight rate, demand variations, market growth.	80%; competition, service level, demand variation.	85-86%; demand variation, bunker consumption.	87-88%; market situation, responsibility, freight rate, competition, type of customers.
2.4 Under what circumstances can you continue a service with low capacity utilisation?	Complement, strategic value, protect important market.						Complement, strategic value, keep competitors away.
2.5 What is important to consider when you set the sailing schedule?		Bunker consumption.		Flexibility, reliability, time slack.	Number and size of vessels, frequency, competition.		Arrival and departure times, reliability, expansion by connecting existing ports, and not by adding new.

3 Enhancement of vessel capacity utilisation (RQ III)

	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Respondent 7
3.1 What external factors affect the vessel capacity utilisation?	State of the market; demand variations; cargo mix; competition; port and infrastructure capacity; regulations.	Trade imbalances; demand variations; cargo mix.	Demand variations; competition; late cancellations; double booking; weather conditions; regulations.	Demand variations; variations in produced output; information exchange; weather conditions.	State of the market; demand variations; variations in produced output; information exchange; port/ infrastructure capacity; congestion.	Demand variations; variations in produced output; competition; no-show; infrastructure capacity.	State of the market; available cargo in the market.
3.2 What internal factors affect the vessel capacity utilisation?	Planning, organising or leading; vessel design; size and age.		Cargo mix; planning, organising or leading; sailing schedule; stowage plans; vessel design.	Planning, organising and leading; sailing schedule; stowage plans; maintenance of the vessel.	Vessel design, size and age; stowage plans.	Vessel design, size and age.	Planning, organising and leading; sailing schedule.
3.3 How can vessel capacity utilisation be enhanced?	Explore the market; type of cargo and customers; differentiation of customers; communicate within the company and port; change sailing schedule; suitable vessel design; improve stowage plans; change vessel capacity.	Type of cargo and customers; flexible capacity management; change vessel capacity.	Explore the market; rescheduling of bookings; improve information exchange; cooperate and communicate within the company; suitable vessel design; flexible capacity management; change vessel capacity.	Explore the market; type of cargo and customers; rescheduling of bookings; differentiation of customers; improve cargo handling equipment; suitable vessel design; improve transport units; change vessel capacity.	Type of cargo and customers; stand-by cargo; change sailing schedule; suitable vessel design; improve stowage plans; improve transport units; change vessel capacity; change speed.	Stand-by cargo; overbooking; rescheduling of bookings; improve information exchange; change sailing schedule; suitable vessel design; improve transport units; change vessel capacity.	Change vessel capacity.
3.4 What is difficult in vessel capacity planning?	To find the right vessels for a service.		The market situations and demand variations.	Large barriers to enter a market due to high fixed costs.	Time between ordering and installing of new capacity; and market fluctuations.	Time between ordering and installing new capacity; market fluctuations; find the right vessels.	The market situations; demand variations.
3.5 Do you use price differentiation?	Yes		No	Based on volumes, cheaper departures didn't go well.		No. We tried but cheaper departures didn't go well.	No need for it.
3.6 How long does it take to establish a new shipping service?	Need cargo from day 1, not more than a year to establish.		A year to establish. Shorter if the vessel is needed somewhere else.	Need 50-60% of contracts before start. 3 years before the service makes money. Better to expand existing services.			

3 Enhancement of vessel capacity utilisation (RQ III), cont.

	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Respondent 7
3.7 How do you handle the large capacity steps associated with introducing new vessel capacity?			Vessel pool; smaller and temporary vessel.		Start with a smaller vessel; find a base flow to start with.		Start with smaller vessel; find big customers; buy a competitor; new customer segment.
3.8 Are the capacities in port in general enough?	Yes, but some shortage on quay side operations on peak days.	Yes, they are also expanding. Road connection needs to be improved.	Yes, they are also expanding. Rail connection needs to be improved.	Yes, but the infrastructure is sensitive to disruptions. Management and motivation among employees need to be improved.	Yes, but the infrastructure is sensitive to disruptions. Motivation among employees need to be improved.	Yes, but can be improved by better usage of existing capacities and motivation among employees.	Yes, but management and motivation among employees need to be improved.
3.9 What criteria do you base the decision upon when selecting terminals for your shipping services?	Location, accessibility, infrastructure, labour.	Land and hinterland, short distance to enter the port, costs, frequency, customer priority, labour situation.	Flexibility, short distance to enter the port, infrastructure, location.	Service, market, infrastructure, costs, attitudes, adjustment, growth potential, possibility to own.	Location, accessibility, customers' location.	Customers' demands, accessibility, infrastructure, reliability.	Customers' demand, capacity, location.
3.10 What demands do you have on the ports?	Capacity, services.	Quality, flexibility, capacity, costs.	Value adding activities, flexibility.	Productivity, open hours, reliability, infrastructure.	Capacity, productivity, reliability, infrastructure, warehouse capacity.	Capacity, productivity, deadlines.	Infrastructure, information.
3.11 Who has the strongest position in negotiation, the port or the shipping company?	The port, due to terminal monopoly.	Shipping company, as the most important customer.	Shipping company, as a very important customer without long-term contract.	The port, due to terminal monopoly and large customers' demands.	The port, due to our demands on infrastructure and capacity.	The port, due to terminal monopoly.	The port, due to terminal monopoly and large customers' demands.
3.12 Why do you have a strategy to own and operate port terminals?	Strategic important ports: flexibility, costs, investment, long-term interest, scale of operations.	Reliability, control.	Strategic important ports: meet our needs, costs.	Increase market share, costs.	Strategic important ports: costs, possibilities to influence port activities.	Costs.	Control, costs, efficient sailing schedules.

Respondent 1

Route characteristics

Questions are foremost related to Research Question 1

1.1 What are the requirements necessary for an efficient short sea shipping link with good vessel capacity utilisation? There is a huge difference between the shipping services when it comes to capacity utilisation. We have a price sophistication project. We take each service and analyse what the profit is with 70% utilisation, 80% utilisation, etc. So we basically create a model that very quickly shows where we are financially. And once you pass 80%, and if you can have the same average rate per lane meter, the profit goes through the roof. You can really see the escalation. What you also can see when you do the calculation is that we have shipping services with an already high earning but still with very high potential and we have other services that never will make money. So, all the services, from a profitability point of view, are very different depending on the market and the competitive situation.

At a ship age above 25 years you start to ask for problems and above 30 years you are in trouble. You think you end up with low costs but in reality you end up with poor services and high costs because of all the hidden additional costs due to an unreliable service. You really can't calculate the costs. What business do you lose as a consequence? When you are planning in that situation, what do you prioritise? Do you prioritise certain customers? Which departure do you prioritise: the westbound or the eastbound? If the westbound has 25% more, because of the imbalance situation, you probably prioritise the westbound. But by doing that, you can erode a lot of cargo going eastbound. The other problem is, when you are in this situation you need to compensate your customers: you don't charge for the extra capacity; you do this, you do that. Therefore, you spend more and more money and the profitability gets worse and worse.

1.2 What type of customer do you have on the route? X is a good example of a big customer. There we have long-term contracts, which give you a base to build on. Long-term contracts are normally 10-15 years.

1.3 Do you have demand variations and imbalances in import and export figures? We have a huge imbalance: there are far more coming than going out. The imbalances are even higher for the trailer customers, because they need to reposition their empty trailers. From a shipping line point of view you don't get as much money compared to full trailers. So, it also influences us. A triangulation is taking place as well. The Danish market is almost entirely trailers. There are very few containers. Norway handles a lot of containers, but Sweden and Denmark handle very few for short sea shipping. Germany dominantly uses trailers, but containers are gaining ground. In Holland and Belgium, containers are gaining ground. Every service and every market is completely different.

1.4 What is the competitive situation like? The speed of the slowdown has more than doubled. And that picture has continued into 2008. 2008 will be a very interesting year. A lot of new tonnages have been introduced so there is an overcapacity even before the market potential started to decrease. The cost pattern has changed significantly compared to how it used to be. From a competitive point of view some volumes have moved to new ports. Congestion is part of it but it is more of a working time direction. You can't drive as many hours as you used to. So if the ship comes closer to your end destination you will get a better utilisation of your truck, within

the restrictions that you have legally. We know there will be a road tax at some point, although it is still in the future. It will be more costly, and fuel is also getting more costly.

In reality, where we have the highest competition we have the lowest profit.

1.5 Do you measure performance of your operations frequently? We are rewriting all our KPIs at the moment and we are updating the terminal management system. The biggest challenge is not creating KPIs; it is how you use the KPIs. We can sit on the semi-management level and look at the KPIs but do we really influence that much ourselves? Probably limited. What we try to do, and that is a very clear part of our strategy, is make the person responsible for the operation fully understand that operation. They need to know how to work with these KPIs. They need to understand the profitability of our operations as much as possible.

Vessel capacity utilisation strategies
Questions are foremost related to Research Question 2

2.1 What is your business strategy? You must have a strategy for a service; there is a vessel, knowledge of the market, the cargo mix, the type of services that are required. It is a roughly 50/50 mix of charter and owned vessels. It is part of a business strategy. You are free to cancel if you charter to some extent. When you own you need to spend a lot of the management time on the vessels. When you charter you outsource. If you go back several years we have some quite attractive charters. But prices have hardened; it is not easy to get an attractive charter.

If we are looking at our strategies we need to take the following into account: profitability, strategic reliability, traffic profitability at the terminal and what will happen to the volumes in the future.

2.2 Do you in general have shortage of vessel capacity or unutilised vessel capacity? Varies between services.

2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation? For Service A, they would say 70%: expensive ships; high market level, the whole operation works like clockwork; extremely reliable arrival and departure time; very seaworthy ships. The service level is very high and they would not be comfortable with leaving cargo for the next day and turning down volumes. There is also limited competition so it is not easy for the customers to go somewhere else. They can't. So there is a responsibility. You can have 3 weekdays out of 7 days when you have maybe 90% utilisation, and 4 days with 60-70%. So you can say that peak days in that particular situation tend to move you towards a lower average utilisation.

For Service B, I would like the average vessel utilisation to be 80%: it is a low rated market with a lot of competitors. To be profitable you need around 80%. It is a good comparison to take service A and B; there are completely different market forces. For service A, there is not much competition, and therefore we are a huge player; we are very high in terms of how much of the total market we move. If you take Service B, we are less than 2%. There are large variations in volumes for Service A: Monday and Sunday departures are very low and weekends are very high. A lot of the cargo is very time sensitive. We actually as a shipping company run on a just-in-time basis with some material coming into the factories. Therefore, we need the capacity to always ship everything on the day the customers are expecting it. We never want to say: "We're full". We don't want to push to the next day. In a situation when we have a large market share we can argue that actually we should keep the utilisation a little bit lower. For Service B, we take

bookings, bookings, and bookings. When we are full, we are full, and the customers go with another shipping company. Those customers are not half as loyal as they are on Service A. They move as they can. You are one of 20 ships; it doesn't matter what ship they are on.

We have extra capacity to keep the competitors away. It is a fact that you use this strategic thinking. Absolutely. It is a very fine balance, and what price do you put on that? It is the same as your question about at what point you close a service: if it is there for strategic reasons. All strategic situations are different but it is always a question of price and the value of that strategy.

2.4 Under what circumstances can you continue a service with low vessel capacity utilisation? If we feel that a service can't be profitable, we will close down if we have to. The networks we have complement each other, so to take one out can damage another. We like our total network to be the way it is, and we don't like to close a service. How long we can live with losses depends on the size of the losses and on the strategic importance of the market. There are many reasons to stay in the market. If you let a competitor in on one market that is closed to a key market you want to protect, you have a strategic value when the service protects others. If someone goes into the X market, they can drive directly into Y and become a competitor to Service Z. So you take the backdoor into another market, which we don't like. So if it is not making that much money, but if it protects something that makes good money, then you are more inclined to continue.

But to answer your question, our target is to make all services profitable. It they are not, there tends to be a combination of both volumes, tonnes available, and the cargo mix you need on that market, that is not so competitive.

Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

3.1 What external factors affect the vessel capacity utilisation? Regulations that don't allow you to load the vessel in a certain way. Obviously, market and economic developments you can't control. Competition. New developments: a new port is built or a new service is starting. You can have equipment or infrastructure shortcomings that make it difficult to use the vessel capacity.

3.2 What internal factors affect the vessel capacity utilisation? A number of factors. Starting with the strength of your commercial team. Do you go out to the market with the right message? Is the sales concept you deliver competitive or not? Do you hit the right nerve with the customers? Is the customer service ok? The skill of our planners; they do simulation to optimise the vessels. The cooperation between the agency function and the planners is very important. We have just transferred all our terminal management assistants from the terminal and they are now sitting here together with the booking class. They can together look at how to get the maximum volumes of cargo on the vessel. They can talk about what is the best cargo mix and which customers pay the most. If you have a situation when you need to prioritise customers, you prioritise the ones that pay the most, that you like the most… or whatever. The important thing is that you have a clear view of your priorities, to have a clear allocation list. We need to prioritise.

3.3 How can vessel capacity utilisation be enhanced? Borrow vessels from another service. It is not easy to do it in days, but in a week you can swap vessels. Find new customers. Open new markets. In the short run, you can stop a service and change your schedule. You adjust the schedule to generate savings, but you don't really change the capacity. But you can say you do it.

It costs a lot to keep the vessel in port. But, for example, if the total volume you carry in 7 days could be carried over 6 days then you do it, and we have done it. We have stopped a Sunday sailing.

You can make modifications to the ship. For a specific market you can put a car deck into a vessel or you can take a car deck out. If you have a lower hole with lifts and you find that it is a very slow operation which affects the schedule and the turnaround time of the vessel, you might pull the lift out and put a ramp in. We know that we can't use it for heavy equipment but only for a few cars. So you create a capacity of the ship that you can't use for trailers because you can't get into those corners, but you can do it with cars. If you look at how they stow RoPax ships, every corner is used. But they have another dimension; you need to find a way to get the freight but you mustn't ruin the travel experience of the passengers. There is a very fine balance.

Every RoRo vessel has a different design. If you have a vessel that doesn't allow you to double stack containers high-wise, then financially it is difficult to make that service profitable. You need to focus on trailers or on other cargo. What we do in terms of optimising capacity is linked to, number one, the specific vessel design and, number two, the market and the cargo mix.

We use price differentiation to get new customers. Every customer is looked into separately. Volume, type of cargo, how it fits in, is it attractive to get that specific type of cargo on a service where you are for the moment. It is difficult to raise prices after a while, and you also have long-term contracts. Getting the right price from the beginning is important. But you don't always dictate price; there are market forces and very often you have a lower limit you don't want to go below. Due to the market you need to take a different view of the business. When we were negotiating summer 2007 we knew that there was overcapacity in the market. We know more than likely that all the economic forecasts indicate a depressed consumer market. At that moment, say "I am going to insist on this high price, I don't care" or you say "maybe for the next two years we need to". You take all these factors into consideration.

You need to develop the business together, the shipping company and the port. Long-term planning is important for ports.

3.4 What is difficult in vessel capacity planning? Every vessel has registered a certain capacity based on optimum utilisation in an ideal world. You get a situation where you can't really achieve what we would like to achieve on those vessels. But we work around the problem. The whole challenge is to find the right tonnage on the right service. It is so critical. And if you have old ships and you would like to change them, it is very difficult right now because you can't just get out and get one at the market that suits your demands and if you build it, you will not get it before 2011. We have a project to create a new type of vessel that we would like to make more flexible. We looked last year to extend the vessels 25 metres. It is very cheap to do. You increase the capacity and decrease your average cost/m. It is very interesting and financially attractive but you create a ship that you can hardly move anywhere.

3.5 Do you use price differentiation? Yes, we use price differentiation among customers.

3.6 How long does it take to establish a new shipping service? Ideally you know you will get something from day 1. It is very expensive to speculate when you start a new service. Most shipping lines will tell you not more than a year. If you have a ship that cost you X Kr/day, a week is a long week if you have no cargo. Very quickly you lose millions of crones.

3.7 How do you handle the large capacity steps associated with introducing new vessel capacity? When you open a new service you need to be very sure you will get the volumes that make it profitable. Ideally you get a good spread of businesses and not a few big customers.

3.8 Are the capacities in port in general enough? Yes, we have quite a good supply of labour. We have enough facilities and equipment.

If you take river side operations, we are short on terminal capacity 4 days a week but full 3 days a week. If you talk about berthing for our conventional activities, we have a shortage of capacity. To generalise, we have enough capacity for the terminal. If the vessels were full every day, the terminal capacities could handle that. It is expensive for the terminal because you probably have more equipment than you really need on average business. The berths allow us to put much more volume through than the terminal land capacity allows us, so there is an over investment on the sea side right now. If you want to allow another service you can't because you are full 3 days. That is a problem.

3.9 What criteria do you base the decision upon when selecting terminals for your shipping service? Obviously, location. Accessibility (it is easy to get in and out). Infrastructure. Labour availabilities. Those are the main factors.

3.10 What demands do you have on the ports? There are higher demands on capacity and services in port for regular services, due to the volume and the fact that you need to deal with them daily.

3.11 Who has the strongest position in negotiation? If you have a near monopoly, the port is in the strongest position. The power of ports from a negotiation point of view has become very clear to a lot of investors. That is why you have seen in the last 5 years huge acquisitions have been made in the port industry. They buy ports as a long-term investment and they like the value of the land. You can also have a situation where you are short customers.

3.12 Why do you have a strategy to own and operate port terminals? Because of the flexibility it brings and the control. We have made investments here on short notice that maybe a port owner wouldn't have done. I think we are more flexible than any other operator would have been, because we are part of the same group. This protects your long-term interest as a shipping line. To find another terminal that could take our volumes and the large number of calls would be very difficult for someone else. We need at least 2-3 years to accommodate that. If we would have been owned by an extern stevedore today, they would have charged exceptionally high rates. But we should not own all terminals; only the strategic hubs.

Respondent 2

Route characteristics

Questions are foremost related to Research Question 1

1.1 What are the requirements necessary for an efficient short sea shipping link with good vessel capacity utilisation? Connecting on both ends, reliable service, good capacity, high quality, good solutions for the customers. Of course you need to have a high frequency, but even more important is a reliable service. Regularity is also important. The drivers passing the port should be sure that there is a departure every day at the same time. This is important in order to attract

new markets, which means we need new vessels we can trust. We need to be reliable. But, you need the money first; you need to deliver the result first, then you get something back. We are still in the building up phase.

We are trying to reduce the top three customers and increase the good-paying customers. Here are a lot of possibilities for value adding. This is the only place you have the mixture of the 5 legs: trailers, containers, MAFIS, special cargo and cars.

1.2 What type of customer do you have on the route? We say "no" to customers. Now we discuss the rates for next year, and we don't want the biggest customers to be bigger and we are looking for long-term relations. Today, the three biggest customers represent 60%; 4 years ago the same 3 customers were 80%; 8 years ago one customer represented 70%. My goal strategy-wise is to decrease the 3 important customers below 50%. We are trying to get smaller customers, because they are paying higher rates. We have long-term contracts with car manufacturers. We are responsible for the quality control in port, which is very important for them. We are trying to expand within the North Sea and the Baltic Sea. This port could be a hub for the Baltic Sea with direct service lines. Today we have a limited number of units on road to the Baltics, but I am sure there could be a direct service.

1.3 Do you have demand variations and imbalances in import and export figures? We have seasonal variations but to a small extent. The car manufacturers have peaks. Everybody wants their new cars before Christmas. Car manufacturers want to dictate the lowest rate, but I don't accept that. They need to pay for it. There are big imbalances between exports and imports. We could easily fill up the vessel to X but not back again. But it is not a problem within the company; all other operators have the same problem. From X, 50% of trailers and containers are empty. Normally we are about 100% westbound, due to the double stacking and the MAFI loaded 6-7 metres. We try to find new cargo eastbound.

1.4 What is the competitive situation like? We mainly compete with road. Our hinterland is cities within 300 km. There is a lot of traffic on the roads, which helps shipping. It is even worse in Holland and Belgium. The toll system also makes it expensive to transport on roads, and there will be one in Holland starting in 2011. It is also difficult for German road hauliers to recruit drivers. They have to go to Eastern Europe to get drivers. All this is in favour of RoRo. This is one of the four most important services based on volume, lane meters, and expansion. Here there are so many possibilities to grow.

1.5 Do you measure performance of your operations frequently? Bunker consumption. Turnaround time. Problems with employees and accidents, but we have almost nothing. Cost control. Damages. Claims. For the cars, we are allowed to have 0.3% we have 0.03%. We control each trailer and container, also inside. Delays for the vessels have been a nightmare the last two years because of old vessels. An engine has been blowing up, and we have had other kinds of mechanical and technical problems. This is creating a lot of problems, and there are demands on quality and flexibility of the people involved. We have not been reliable for our customers the last two years. If you don't have reliability it is difficult to discuss further volumes and get the rates up. We have extra time in our sailing schedule but not enough. We don't need to pay if we are late. We have been working together for 10 years, and they know the problems will end one day.

Vessel capacity utilisation strategies
Questions are foremost related to Research Question 2

2.1 What is your business strategy? Our vessels are chartered. We sold the old vessels and charteded them back. The vessels are the right kind of vessels for our service, based on the volumes and type of goods: trailers, containers, mafi, cars and special units. For the cars we need the lower haul and hanging decks, and for the MAFI and double stacked containers we need the main deck to be approximately 6-7 metres. On the weather deck we double or triple stack containers. The vessels are really flexible, and can handle both RoRo and LoLo.

2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation? 82% is our strategy plan for next year. But we need two new vessels and 7 departures/week, which is only possible with new and faster ships. We also need to find the best mixture of cargo and to find customers and convince them. Here volume is not equal to profit.

2.5 What is important to consider when you set the sailing schedule? The sailing schedule is tight, so it is not possible to increase the number of departures with existing vessels. It is possible to go a little bit faster with the vessels. But I am telling the captains: "Don't to go too fast. The time we are saving in port…don't spend it out there." We have one captain that is very proud when he can save bunker.

Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

3.1 What external factors affect the vessel capacity utilisation? Too many cars, so you need to use the main deck. Too many trailers, which you cannot double-stack. Eastbound: too little cargo. We can take all: trailers, cars, containers, etc.

Imbalances.

3.2 What internal factors affect the vessel capacity utilisation? I am working out my own strategy plan for this service.

3.3 How can vessel capacity utilisation be enhanced? A third and a fourth vessel. Extension of vessels. Before, we had individual services, but in the future we will have a network. We are already trying to do that. If they need help, we help. If we need help, they help. Both ways. We are more thinking in networks. We started 3 years ago, but we will do it more in the future. Before, we were really protective: "This is mine and this is yours."

You can't change from large to small customers from one day to another due to the long-term contracts. Our goal is to keep the number of cars where it is today and not get any more so we can use the hanging decks and lower deck only, but not the main deck or weather deck for cars, because that it is a waste of capacity. We don't want more trailers because we are trying to get MAFI loads and double stacked containers so we use the height of the main deck.

3.8 Are the capacities in port in general enough? We have deep waters, no locks, a direct connection to sea and a lot of hinterland possibilities. What we are missing, and it will take 15 more years to finish, is the direct motorway connection. We can also expand the terminal area, which is uncommon. That's why many other car manufacturers are interested in exporting cars

from this port, but there is no capacity. We want cargo in the other direction. We need to fill up two vessels in both directions before we get a third vessel.

The port has more capacity. They are extending the area and are growing. They have it in other ports. When the port is getting bigger we also need to get bigger, otherwise competition will come.

3.9 What criteria do you base the decision upon when selecting terminals for your shipping service? Deep water, no locks, no river calls that take hours. The costs in neighbouring ports compared with this one are doubled. We are saving time and saving money. Enough terminal space, good cooperation with the union in port, a large hinterland, the location, the distance between ports, and the distance to open sea are important issues when selecting terminals. And here we are the number one customer, so we get high priority.

3.10 What demands do you have on the ports? No demands; there is no end when it comes to capacity. Hopefully, there will not be too much capacity in a short time because another shipping company could get the idea of competing. We have demands on quality and flexibility. We are turning the vessels around in a very short time, considering we transport both containers and RoRo units, and with the lowest number of damages or claims. Short turnaround time compared with other ports: it takes 6 h 5 min to load and unload the vessels. I am very proud of the organisation and the whole cooperation. We have a short distance to politicians and the terminal operators.

3.11 Who has the strongest position in negotiation? We do, without a doubt. Nothing is happening in the port without our approval. We are a very important customer of the port so we are getting all the focus. You never ever find one day when they are not working for us. It is open for Christmas, and we don't have any problems with the union. Other ports have problems with unions. People are really identifying themselves with the service due to the fact that we had an unemployment rate of even more than 60% before. We have a lot of people working for the port directly or indirectly. You never hear a "no". Everybody is supportive. If you compare flexibility it is very high, and if you compare with other ports, the rates are very low. We were the first, we are the biggest, and we get all the attention.

3.12 Why do you have a strategy to own and operate port terminals? Reliability and control of our quality. You need to control your service if you want a reliable service. Before, our strategy was not to operate terminals because that was not our core business. We underestimated the importance of this market. At that time, this service was used more to protect another service. Today it is different. We are 75% of the port turnover and we are running the terminal as if it was our own. As long as we can grow with the port we are on the safe side. But with the profit they are making, even with their low rates, we could have saved that for ourselves.

Respondent 3

Route characteristics

Questions are foremost related to Research Question 1

1.1 What are the requirements necessary for an efficient short sea shipping link with good vessel capacity utilisation? It should be an obvious route. In addition, here we are the only actor; the

frequency then becomes important as it becomes a substitute for a bridge. This shipping service is definitely an alternative to a bridge. Frequency is the most important factor and also having a reliable sailing schedule. This shipping service is developed for the market, while shipping service X is adapted to a specific customer and their demands. If you define how shipping services emerge, it is due to the market in general or to single customers.

1.2 What type of customer do you have on the route? This is a RoPax shipping service; hence, we are taking both passengers and freight. Passengers arrive both with and without vehicles and in addition we also need to provide space for the drivers. Something that separates us from other shipping services is that we almost only have self-drivers; it means that drivers take the trucks onboard instead of only leaving the trailers in port. This originates from the culture and tradition in this market. We have around 80-90 drivers each day, which represent 90%. This results in less handling for the stevedoring company. We have several small customers, and no large dominating customer; the largest one is not even 7%.

1.3 Do you have demand variations and imbalances in import and export figures? Based on experience, we know roughly what cargo is coming during a week. We normally know which days we are fully booked and on which days there is less cargo. We are struggling with it every day. Some days we could use two vessels and some days we could cancel the departure. But it doesn't work that way; we need a high frequency. The Monday and Saturday departures always decrease the capacity utilisation. If it weren't for those departures we would reach a capacity utilisation of 100%. The seasonal variations are not significant for goods but for passengers. We have peak demands around Christmas; at that time we are fully booked or over-booked almost every day. After Christmas, everyone goes back to work and travels with us again. The summer period is also very intense. The export is slightly larger than the import. One of the reasons for the imbalances is the triangulation, e.g., round-trips of load units.

1.4 What is the competitive situation like? We are competing with another shipping company, and rail to some extent. At present we have seven departures every week with the ordinary vessels and three per week with the sweeper. That is a new temporary vessel. A competitor recently closed down, so we had to take in an additional vessel to absorb the volume.

1.5 Do you measure performance of your operations frequently? We measure damages but not how long it takes to load and unload. Most drivers drive on and off by themselves. If customs is checking all the trailers the unloading is not faster than customs allows. The turnaround time doesn't matter since we stay in port for a long time. We almost never miss a departure or are late.

Vessel capacity utilisation strategies
Questions are foremost related to Research Question 2

2.1 What is your business strategy? Fartygen ägs av oss. For this service, we own our vessels. We need more capacity, but it is a difficult tonnage to replace as there are no RoPax in the market. Usual RoRo vessels are much easier to get. If we had used RoRo, the capacity could have been increased quite easily. We have a corporate strategy to charter one part and to own the other part. We also have an age strategy of the tonnage. So we have an underlying vessel strategy within the corporate group.

2.2 Do you in general have shortage of vessel capacity or unutilised vessel capacity? The development has been fantastic. We started six years ago with basically nothing. Today we are

close to 100%. We have increased the capacity since one competitor closed down; at present we have an additional vessel that takes the peaks. The curve is the same, but with a higher capacity utilisation level every day. We are fully booked almost every departure; we cannot handle more goods. But, the departures on Monday and Saturday decrease the capacity utilisation because we only have 50-60% these days. Otherwise, we would have had a capacity utilisation of almost 100%. The capacity utilisation is also declining due to the new vessel, so we have decided to only use the vessel until Christmas. The time period in front of us will lower the capacity utilisation for almost a month: Christmas for the Protestants and the Orthodox. We are then reducing the number of vessels and hopefully we will reach a capacity utilisation of X again. There is a lot of money involved.

The dream scenario is to get the same type but larger vessels with 6-7 departures per week. We need to increase the load capacity with about 700 lane meters, and the passenger capacity with 100-150 passengers. But that would have involved a deeper down-turn in passengers during low season. However, the passengers are not the ones that keep this shipping service running. The passengers are more like icing on the cake.

2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation? I do not believe we will reach much higher than we have at present. If we could keep this utilisation level on a yearly basis, it would be a satisfactory result. It is very difficult to reach higher; it is enough if the capacity utilisation falls to 50-60% for 1-2 departures per week. There are no cargo those days; the market does not want a departure. Then it drops towards 75% even if the other departures are around 95-100%. It is not an optimal situation to obtain higher capacity utilisation than 75%. If you are close to the limit, as we were before the third vessel was introduced, you are facing the problem of not always being able to take all the cargo onboard. Not all customers will be satisfied, and they will look for alternatives. This is a very difficult trade-off. The third vessel has definitely been costly, but we have listened to the market and the customers are satisfied.

2.5 What is important to consider when you set the sailing schedule? We spend a long time in port. We would like to leave earlier in the afternoon and cross at nine knots in order to save bunker, but the market doesn't want that. The market wants us to leave at 18:00 and that is what we have adjusted our schedule to. Actually, the customers want us to go as fast as possible, but we have reached a compromise to arrive early in the morning. We don't have a tight schedule at all. It is important that we depart on time; otherwise we spend some extra tonnes of bunker fuel, which involves additional costs and pollution.

The ideal would have been to have a slightly larger vessel absorbing the total increase in volume so we could still reach X% in capacity utilisation. Sometimes it is cheaper to add newer and larger vessels with lower bunker consumption than to add an extra vessel. But we are definitely fulfilling the customers' demand on frequency. Even fewer departures per week would have been sufficient.

Enhancement of vessel capacity utilisation

Questions are foremost related to Research Question 3

3.1 What external factors affect the vessel capacity utilisation? External factors affecting us are to a high extent quite simple parameters, such as seasons, but also politics. The result of the Russian election can affect the sensitive market of Eastern Europe. What will happen with the

volumes to Ukraine after their election? There is more to consider than only the state of the market. The Baltic economies are overstrained. Is that sustainable? Will the inflation and the higher salaries in the Baltic States result in production moving further away? The politics and the inflation rate in each country are affecting us considerably. I claim that it is harder to plan the capacity for this shipping service than others. That we can also see on the development of our service; we started on a small scale and we have since increased every year by 25-30%.

The competition is obviously affecting us. Today the market is rather balanced. If a new actor enters the market, it disrupts the whole in-official balance.

It is disturbing when the customers play with us. They might book 10 trailers with us and another shipping company as well. Then they directwhere they are going. We can be over-booked the whole day and then at the last minute, some trailers don't show up. Today we cannot invoice for unused space. They are playing with the vessel slots. If it would have been possible, we would have invoiced.

Sometimes there are small delays due to weather conditions. Larger delays might occur twice a year; otherwise, the vessels run like clockwork.

3.2 What internal factors affect the vessel capacity utilisation? It is more difficult to reach high capacity utilisation when calling a string of ports. The design of the vessel can affect the vessel capacity utilisation. In some cases, the maximum capacity is based on hanging decks, which may not be used. We would not have used such decks here; hence, we would never have had such a vessel officially fully loaded.

The internal management is important to create an understanding among the employees: why we shouldn't say that we are booked-up, why we should move the goods between the days and why we should focus on capacity utilisation. The leadership is important. Every day we are discussing things like: "How was it yesterday? Was it full? Were we able to move cargo?" To just book like a zombie, without taking into consideration that the customers might go elsewhere, is not an option here. In our case we also have drivers who might influence their booking department: "I do not want to go with X; their food is bad or their cabins are crap; I have to sleep with 14 others in one cabin." It can really affect us. The truck drivers are our customers. If you only ship trailers, the haulier company is the only customer, but here we need to take care of the drivers as well.

The crew itself influences the Chief Officer's stowage plan, and the willingness to plan. It is the human factor. I once worked in a port with two identical vessels; one vessel could always take much more cargo than the other. It is important that the Chief Officer and the crew are flexible.

3.3 How can vessel capacity utilisation be enhanced? To use another vessel, or to have the right type of vessel: right size, speed, and fuel consumption.

In addition, an experienced market organisation is important. It doesn't matter if you have a vessel if you don't have good contact with the market and your customers.

A centralised vessel pool: before, the vessels were only used for one specific route; now the vessels can be moved between services.

We have worked hard to reach a high capacity utilisation level. Before, we could say "no" to customers, but we have a new policy this year; to never turn down a customer. Instead, we look at our planning and try to move cargo on Monday or Saturday if possible. This year the capacity utilisation has increased 5% thanks to that. We are not saying "no" anymore. Before, many knew

that we always rejected customers on Tuesday, Wednesday and Thursday so they didn't even call us those days. They are now calling us and they are aware that we are working with enhancement of capacity utilisation.

3.4 What is difficult in vessel capacity planning? It is the market and demand variations. We have a vessel with 40% of unutilised capacity and we offer half the price, yet customers are not coming.

Something that also could affect the level of capacity utilisation is the day when the salaries are too high for Russian, Lithuanian and Baltic truck drivers and accompanying trucks will come to an end. Then we are talking about something completely different: ordinary trailer traffic. Perhaps we will not need RoPax anymore and can shift to RoRo, but we don't know when that is going to happen. But we can look into the future and believe something. It is the same with 45-foot containers that have affected the development on the continent a lot. The 45-foot container is not common here yet, but it is used to a high degree on the railway and barges on the continent of Europe. This can happen if there is a shortage of drivers.

3.5 Do you use price differentiation? So far we haven't used price differentiation. The cargo we can direct ourselves, we do, and we are also discussing with the customer if it is possible to leave another day. Some goods are stored in the receiving port for some days anyway. We have worked very hard with our capacity utilisation. We have explained things to the customers, and they understand. If the cargo needs to leave a certain day, we are for sure listening, but we are always asking if Saturday or Monday would be possible instead.

3.6 How long does it take to establish a new shipping service? We have opened a service and closed it down after three months. Perhaps the demand for the vessel increases somewhere else: you make a fast decision to move the vessel and close the service. That could happen if you have an extra vessel. But, if you are invested in a particular market, perhaps one can accept a year or so.

3.7 How do you handle the large capacity steps associated with introducing new vessel capacity? We use a so-called "vessel pool". Earlier, the vessels were designated to one shipping service; today they can be used in other routes. The sweeper is not economically viable; it is a pure market decision to show that we are investing in a market and that we take care of the cargo.

3.8 Are the capacities in port in general enough? Yes, and they are investing in the port. They are probably reaching what in general can be asked from a stevedoring company and perhaps a little bit more. Then there are pros and cons as always. Some gangs are always better than others. The infrastructure is sufficient but not satisfactory. Trucks on these roads are not a dream scenario. The railway is working quite well, but not as it should. We have tried to increase rail transportation but the customers didn't want that: they want a truck and a driver, and are not interested in transporting the trailer on a railway wagon. The terminal's land area is sufficient, even though the terminal layout is inferior for a large international terminal.

Since we cannot absorb more goods, one can say that we are hindering the development of the RoRo traffic in port. In addition, with a proper layout, there would be even more capacity. We can switch ports tomorrow, which is a risk to the port. So how much do they want to invest when there are no long-term contracts? I believe that other shipping services are in other situations; they cannot move on short notice because large customers require their presence.

I believe that a smaller number of ports and more specialized ports are necessary, especially for RoRo traffic. I do not believe in multi-purpose ports, where they do a little of everything. It doesn't create specialists and they will never get good money for any segment. The ones that are strong are the ones that have a strategy to become the largest on one coastline within container traffic or within RoRo traffic, and only focus on that segment and adjust the layout and infrastructure to really get efficient. One cannot do everything.

3.9 What criteria do you base the decision upon when selecting terminals for your shipping service? This port is flexible and is willing to create something, which was determinant for the decision. Then the location of the port is important, both the land based infrastructure and the nautical miles.

3.10 What demands do you have on the ports? We stay in port a long time since we arrive in the morning and depart in the evening. If you are going to load and unload within three hours, then your demands on the port are extensive. Here, we don't have that situation. Since we have a high frequency no goods are stored long in the terminal. The port doesn't need large yard space as the cargo is not stored for 2-3 days; most of the goods are leaving the same day. There are several issues to improve when it comes to efficiency and flexibility. This port can allow a higher degree of flexibility compared to a larger port, but it is not always an advantage; it can turn into frustration and be a source of stress. Efficiency can sometimes affect flexibility. The port does everything for us; for example, some cargo that arrives on rail they unload, place on MAFI trailers and store in a warehouse. We have a close collaboration and have outsourced the cargo handling to them. They are not only handling the vessels.

3.11 Who has the strongest position in negotiation? If you would ask the port, I believe they would answer "us", but if you ask me, we say "us". We are the customer. We don't have any long-term contracts, so we can leave tomorrow if some neighbouring port gives us an offer. I don't think that would affect our capacity utilisation; I believe the customers would have followed us.

3.12 Why do you have a strategy to own and operate port terminals? Our strategy is to own ports in strategic locations. We think we can do it better ourselves, both with regard to adjusting to our needs but also with regard to profitability. Today, this port is not strategic; we get quite good service here, and at the same time we have the flexibility to go elsewhere.

Respondent 4

Route characteristics

Questions are foremost related to Research Question 1

1.1 What are the requirements necessary for an efficient short sea shipping link with good vessel capacity utilisation? The most important factor for the customer is departure frequency; the second most important is reliability. If we can offer 100% reliability, they can trust our transport system and our vessels become their warehouses. To be brave enough to increase frequency as soon as possible and offer high reliability are the two most important issues. The third is most likely price. The transport time has decreased in importance compared to reliability. Being situated close to the market is also an advantage. Better infrastructure means better availability, service level and flexibility. The interface between terminal and the inland is a larger problem

than the ship/shore interface. But what is going to happen in a 10-15 year perspective? For how long can the market grow? I believe the development will go towards local production and then the transport demands will decrease, and the transport price will increase; the environment cannot cope with the trends of increasing volumes.

1.2 What type of customer do you have on the route? We have two different customer segments: trailer operators who are volatile and the industry customers who are not. The base with own industry customers is around 30%, but we would like to increase them to 50%.

1.3 Do you have demand variations and imbalances in import and export figures? We have large season variations: in December before the closing of the accounts the warehouses are empty and a lot of goods are transported. There are fewer activities in January. In February it starts again, and it is also intense around Easter, as well as at the end of May and June, while the summer is calmer. At the end of September it starts again.

Every market has its imbalances: you can never reach 100%. Market X has traditional imbalances; we will always export more than we import. Market Y has no large imbalances

1.4 What is the competitive situation like? We are competing with industrial systems for shipping service X. For shipping service Y, the competition is extensive: railway, roads and bridges, etc. I do not believe that you can afford to have oversized vessels to hinder competitors. If you have a well-functioning market, one cannot afford that. It is possible for the five largest deep sea shipping companies that have divided the ocean shipping market between them, but for short sea shipping services that compete with everything that moves, there is no reason for it.

1.5 Do you measure performance of your operations frequently? We are measuring reliability every week and damages as well. We also have a report from operation that describes the reasons for the deviations. We are also measuring the costs divided per lane meter to be aware of where the cost drivers are.

Vessel capacity utilisation strategies
Questions are foremost related to Research Question 2

2.1 What is your business strategy? According to our strategy we should be the natural choice for our customers when it comes to moving cargo from A to B. We are also prepared to shift from the old quay-to-quay approach to offer longer distance transportation including rail and road with a focus on Northern Europe. We believe in high frequency shipping service and we prefer a high density service network rather than starting new adventure routes that cannot offer high services.

We have 50% charter and 50% owned vessels today, but we are now revising this strategy. We charter because we like to have flexibility in vessel capacity, but also because we don't need to invest that much of our own capital. It is good for the balance sheet. But the most important reason is the flexibility. The charter contracts are from a couple of months up to 10 years. The advantages of owning vessels are economies of scale and to gain knowledge of your core business. You can also design each vessel to suit individual shipping services. The charter vessels are not hard to find if you pay high rates; the demand the last three years has been higher than available capacity, which has increased prices a lot. There is no decline of prices yet in sight. We are speculating that it will come during 2010-2011.

2.2 Do you in general have shortage of vessel capacity or unutilised vessel capacity? Vi har brist på kapacitet, helt klart, pga. ökade volymer under tre år.

2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation? In a long-term perspective, 80-85% to maximise the customer service level and to obtain the best price. It is better for our trademark not to go too high, because you can offer the customers the same service every day without the need for moving bookings and we can handle larger variations in demand. We should have more unutilised capacity.

I definitely believe that it is not good when we exceed 90% of vessel capacity utilisation. Prices fall since the customer does not really get what he wants. You get a dissatisfied customer that looks around for new alternatives. With a capacity utilisation of 100%, there are risks of delays and prolonged turnaround time as well as increased bunker consumption. The whole system is more vulnerable, and the last trailer doesn't pay for that.

When you have less cargo you get lower bunker fuel consumption and fewer critical actions in port. With high capacity utilisation, you easily reach the maximum load for the vessel, so accurate planning is crucial. These are the reasons why I don't like 100% of vessel capacity utilisation. I don't believe you are making much profit, and you can't offer the highest service level. So you work harder and are making less money, which is stupid, and in the long run it is *extremely* stupid. The customer dissatisfaction volumes that are too high creates will sooner or later result in some kind of discount that you don't need to offer the customers if you have a capacity utilisation of 80-85%. This separates economists and customer oriented people. To maintain a reasonable and acceptable service level for the customer, you should not be over 80-85% on average. You have an optimal price there both for the customer and for yourselves. It is not good when economists are calculating capacity utilisation as they don't understand customer benefit.

2.5 What is important to consider when you set the sailing schedule? There needs to be a certain time slack in the sailing schedule, and we shouldn't be overambitious or too optimistic because if something goes wrong, we are forced to cancel if we cannot catch up. If you look at optimal conditions for transport between X and Y the vessel is consuming approximately 60 cubic metres of bunkers in 24 hours, but can easily increase to 100 cubic metres if the speed is increased a little bit. It is both bad for the environment and implies higher costs. Therefore, it is important to stick to our sailing schedules because these are optimised to as low of consumptions as possible and maximum usage of the vessels. If you don't have full capacity utilisation you can increase the market that you want to attract. As soon as you reach 80-85% you start looking at which customer segment is making the most money, and there will be some segments that you are not interested in anymore.

Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

3.1 What external factors affect the vessel capacity utilisation? You have the weekends when customers are not producing, which is a major reason for weekly variations. Several customers' receptions are not open on Saturday and Sunday. We have a peak on Mondays and then there are several shipping departments that sleep the whole week and send everything off on Fridays. You

still have this pattern. The customers' production cycle is probably the worst external factor that affects us.

There are of course factors such as weather and wind, which we cannot influence much. If you have bad weather conditions one weekend, you will have an overlapping increase in transport need the forthcoming week and it will take a few days before it attenuates. Now the process is faster as we have daily departures, but of course it affects us.

Holidays and planned production stops affect us. We transport a lot for major customers. If they have quality problems it is enough for generating cargo quickly. First we get a valley when we cannot transport the cargo because it is still in the factory, and then we get a peak when they release all the cargo at the same time. We are very dependent on the industry. The customers are not good at forecasting. We receive information regarding production stops, but we cannot get information that the companies don't have themselves. When it comes to long term changes we are noticed in time.

We are also affected by weekly and seasonal variations, but these are normal and we can plan for them. Vacations, Christmas and Easter don't come as a surprise. We adjust the sailing schedules and maintain our vessels during low seasons.

3.2 What internal factors affect the vessel capacity utilisation? Technology and maintenance. We must ensure that the vessels are in excellent condition. We must also ensure that we absorb the information from the customers and that we have good internal communication between office and vessel; everyone needs to understand the bookings process, cargo weights, etc. It is important that the people onboard are given the correct information from the booking department for their planning. If the Chief Officer doesn't receive the correct cargo information in time, it is hard for him to do a proper stowage plan, which can delay the vessel.

It is also important to have a reasonable sailing schedule.

3.3 How can vessel capacity utilisation be enhanced? In the short term, we can move bookings. We can reduce the price on Sundays, or if no one wants to leave on a Sunday we cancel the departure. We can charter an additional vessel if there is an increase in demand. We have very good contact with colleagues and brokers that have extra vessels we can get on short notice. We don't have slot charter agreements in RoRo shipping and the competition works well.

Long-term planning: we are following tendencies and work with technical development, such as developing new transport units that allow more weight per lane meter. We increase the capacity utilisation by developing the new transport units, and we develop automatic lashing systems. We are trying to understand the market, approaching the right customer segments, work with pricing strategies, and do market research.

The question is if the RoRo vessels should be standardised so that the vessels are rather suitable to all shipping services, or if the vessels should be designed for one shipping service. We are not intelligent enough to answer that question, but what we can do is to build the cargo hold to be as flexible as possible. But we cannot build vessels with too small of a capacity for the large shipping services or too large of a capacity for the small ones.

There are always some adjustments of the vessels; for example, hanging decks can be added or removed. The problems are rather the location of the engine, if there should be 1 or 2 engines, the installation of double ramps, etc. Double ramps in port save a lot of time when loading the vessels but require heavy investments in the terminal. There are different concepts and standards.

We must also think about what type of cargo we are handling. Today trailers constitute a large part, but what will happen in 15 years? Perhaps more containers? In that case we need to be sure that the vessels can take double stacked and triple stacked containers.

3.4 What is difficult in vessel capacity planning? The entrance barriers in this market are enormous. Shipping companies have some economic endurance, but as the fixed costs are so high, the figures are often frightening. The variable costs are actually quite low. Smaller tonnage has been replaced by larger tonnage, but the speed has not been increased to increase the capacity.

3.5 Do you use price differentiation? We do not have price differentiation. We have tried, and it didn't work at all. The only result we obtained was lower prices on cargo we were already shipping. The industry is more interested in short lead time and high frequency than lower transport costs on a Sunday. We often have freight rates based on volumes, but with the same price every day.

3.6 How long does it take to establish a new shipping service? From decision to implementation of a new permanent service, it often takes three years. Now we are chartering capacities, which speed up the process. However, these solutions are often not the best. In order to succeed, you need contracts corresponding to at least 50-60% of the vessel capacity utilisation. We have had services where we started with less and it didn't go well. The shareholders don't have that kind of economic endurance. When you open a new service you need to allow for three years of unprofitability even though it is a successful investment. It is not easy to open up new services; it is better to enlarge the existing services network or try to incorporate a competitor.

We have been too late with the investments during the last years because there has been a large growth in transportation. We have always ordered too small of vessels when investing in new capacity. We should absolutely have chosen larger vessels. The lead time of three years is important; we are filling it within one or two years which isn't the purpose. I prefer something to grow with.

3.8 Are the capacities in port in general enough? Often the port has less capacity and has not enough time to load and unload the vessels as planned, which leads to delays. They have no flexibility. There are no problems with the personnel or the equipment, but with the mentality of the staff. Our ambitions for growth are greater than the port's. I believe the port is profitable so they can afford investments. The infrastructure is a problem: it starts to get congested. The infrastructure is sensitive to disturbances; for example, we have only one railway bridge. The city has its own interests and the port has others; and they are starting to collide. Not everyone that buys an apartment or a house close to the sea for five million SEK enjoys having a German vessel calling the port at 07.00 on Saturday morning.

3.9 What criteria do you base the decision upon when selecting terminals for your shipping service? Service, the port's land based infrastructures, how attractive the port is for the market, costs, attitudes among employees, and potential for expansion and growth. Finally, if it is possible for us to own the terminal.

3.10 What demands do you have on the ports? We have contracts about production guaranties, what they at least should manage in terms of trailers per hour. We have different contracts depending on the sailing schedule, and we have different turnaround times in ports. Opening hours: we require the port to be open 24h, 7 days a week and 365 days per year. If they are not fulfilling our demands, there are penalties. We have a penalty in both directions. We have

demands on the railway as well. These are determined in the principal negotiation. Now we have a very long contract for five years. It is rare to have that long of contracts; they are normally between 2-3 years. Every industrial project also turns into a negotiation with the port, so we have negotiations during the rest of the year as well. The port is very much involved when it comes to larger industrial commitments.

3.11 Who has the strongest position in negotiation? The port; they have a monopoly. We are tied to negotiate with only one part. We cannot move. Once you are established and have started an industrial transport system linked to existing infrastructure and different logistics systems, you cannot just switch ports. The port knows that as well, and we get more dependent on the port. The drawback of being so tightly linked to the port is that their problems turn into our problems and our customers' problems. But at the same time, their possibilities are the possibilities for our customers. I do not believe in port monopoly; the ports need to be exposed for competition

3.12 Why do you have a strategy to own and operate port terminals? We believe that investing in infrastructure is important to attract more cargo to sea. We believe that with our knowledge, we are better at operating and managing the stevedores then a port owned by municipalities often are. We do not want to take over the port and their important work with infrastructure investments, such as railway and roads. We don't have the long-term perspective they have.

Respondent 5

Route characteristics
Questions are foremost related to Research Question 1

1.1 What are the requirements necessary for an efficient short sea shipping link with good vessel capacity utilisation? On-time deliveries. That we keep our schedule is number one, at least for our industrial customers. I believe it is the same for our trailer customers. Our delivery accuracy within 2h exceeds 95%. It is extremely good for operating vessels on the North Sea. With the frequency we have today, speed is not the most important factor, but since we have so few vessels and so many sailings, speed is important for us. For shipping service X, we went from four vessels and six departures/week to three vessels and six departures. That is the same number of departures with fewer vessels.

The drawback is that higher speed is necessary, which increases the bunker consumption. A couple of years ago, some extra tonnes of bunker fuel didn't matter, but today the bunker fuel is very expensive and the consumption is crucial. However, since we removed a vessel with capital and personnel costs there was room for an increase in bunker cost.

It is a sales argument and a competitive advantage for a trailer operator to leave in the evening and arrive in the morning. The industry cargo is not as sensitive, but requires enough capacity. We use four sailings out of six for Customer Y. It is enough for him. The alternative for that customer is to use a full train per week. If the customer uses the railway he needs to have a certain tonnage each week, and the customer doesn't appreciate that all the cargo arrives at the same time. Having four shipping departures per week means shorter lead-times and smaller batches, which is a major improvement.

Every penny is important and hard to reach when we negotiate prices. I wish reliability and on-time delivery would have been more important than price, as we have a very good shipping service. Instead, the customers turn it around and they say that reliability is a pre-requisite for even considering the service. There is always a balance of what we need to get from a business relationship. If we are below the price limit we are not conducting the deal; and of course we like it to be as high as possible. It is the usual game.

For shipping service Z, I believe they have lost customers due to poor reliability. They also have a totally different competitive situation. It is not easy to sell a high quality service level with bad vessels. Instead, you have to lower the price. It is easy to go lower, but it is not easy to increase prices later on.

1.2 What type of customer do you have on the route? If you take the industrial cargo and trailers, the prerequisites are completely different. We also have the so-called special cargo, which is non-standardised cargo. We are good at handling heavy, tall and bulky cargo on RoRo-vessels. We cannot survive on this solely, but it is a good complement and the money is good. It is a lucrative business. Trailers are the dominating load carriers and represent approximately 60% of X and closer to 100% on the way back when we don't have any cars and almost no industrial cargo.

We cannot wait for late customers, because that will delay the vessel. Either the cargo is on the vessel when it departs or the cargo have to wait until the next day. We have departures every day, so it is not that sensitive. On shipping services where we have one departure per week, we can wait around an hour for the cargo, because we have time in the sailing schedule and the customer doesn't need to wait a week for the next sailing.

1.3 Do you have demand variations and imbalances in import and export figures? We have peak days. The industrial cargo has large imbalances. For example, for customer Y all cargo goes in one direction but the boxes back are empty. The boxes are taking as much space back as forth, and we have one price that covers both directions. We could have something else in the boxes on the way back, but it is hard to find goods that fit without soiling them. It is easier to handle imbalances in the flows of cassettes as they can be stacked on each other when they are empty; 5-6 cassettes out are one unit back. The number of trailers is still quite balanced. When it comes to industrial cargo we have very little going south and quite a lot going north. I am working on finding cargo in the south direction.

1.4 What is the competitive situation like? A trailer operator can go with us today and with a competitor tomorrow. It is different with the industrial cargo because we have longer contracts with them. It takes quite a long time for a customer to change from one transport set-up to another, because there are rarely new flows so they need to leave something. For us the railway is the most important competitor. If they can manage their block trains, we have almost no chance. We can compete with wagon loads, because when wagons are going to different directions problems start. But the block train from A to B is unfortunately now working well, not for all but for many.

1.5 Do you measure performance of your operations frequently? We have our key-figures. The shipping company measures lane meter, but for the industrial cargo we are measuring tonnes. The better we are at loading tonnes per metre, the fewer lane meters we need.

Vessel capacity utilisation strategies
Questions are foremost related to Research Question 2

2.1 What is your business strategy? We have a strategy for tonnage within the company; the vessels should be a maximum of 10 years old. That might be the average age, I don't really know. Sometimes when a vessel is too old, we sell the vessel and charter it back for a fixed amount of years. This is a way to get more money when we are selling the vessel since we can guarantee a charter rent to the buyer. If you charter a vessel, you have no more fixed costs at the end of the contract and we are more flexible in our tonnage. However, we have a tendency to make it sound like a very good deal: "We own 50% and charter 50%, which gives us flexibility". To be honest it isn't as easy as that. If you want to charter and you are alone and there are several vessels available, then you have the possibility to negotiate and it can be cheaper. However, during the last several years, there haven't been many RoRo vessels available. Then it is often a more expensive solution, and we have the most modern vessels in Europe.

Traditionally, we work mainly with our own shipping services even though the head office wants us to take a broader perspective. I believe moving capacity between shipping services is only a dream. But there have been situations when we have done so. We have some older and cheaper tonnage that we use first when there is a growing demand for capacity.

The advantage of the industrial cargo is the long term horizon which gives stability. A dissatisfied trailer operator can leave and go to a competitor. He has that flexibility. The success factor is to have a mixture of customers. We don't only want very large customers as they are good at pushing the prices down. The industrial customers are good to have as a base; around 30% is a guideline, but it varies between the routes. Some services have a larger share as these are developed around certain industries. For example, we would have never started a shipping service to B if we didn't have our big customer there.

2.2 Do you in general have shortage of vessel capacity or unutilised vessel capacity? We have lack of capacity today. We need to increase. Perhaps not today, but the day when we will need more capacity is approaching. It is a large step for us.

2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation? If the capacity utilisation is too high, a competitor will enter at once. For profitability and from a short-term perspective it is of course ideal to have as high of capacity utilisation as possible, at least a year or two. But you are no longer in a good situation when customers are searching for new alternatives since you cannot offer enough capacity, and when a competitor enters. In a long-term perspective you cannot have too high of capacity utilisation. I believe 80% on a long-term perspective is a good level. That is a minimum to have some margins left. I do not believe in higher capacity utilisation. The ideal situation for operation is to have 50% of capacity utilisation but you will never reach breakeven. It is also a problem when you have days with 100-110%.

How long do you have the patience to sail with 50% of capacity utilisation? It is the usual problem; you want as high of capacity utilisation as possible, but at the same time if you believe in growth in transportation you need the unutilised capacity to handle it. It is a very difficult equation. At some point you have to guess, but you can support your conclusions with marketing research, economic analysis, trends, our own expectations, and customer's beliefs. You adjust when doing new investments, so you start with vessels that are quite suitable. At the same time there needs to be enough capacity for expansion.

2.5 What is important to consider when you set the sailing schedule? With the sailing schedule we have on service X, I believe we need one larger vessel so we get three vessels with the same size. The schedule is really good. We have 14 departures with three vessels. One more vessel would not be better. On shipping service Y, I am not as sure. I believe adding a fourth vessel could be the best solution in order to increase frequency, and we also have competition.

Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

3.1 What external factors affect the vessel capacity utilisation? The market. For example, we had a large customer three years ago that transported 1000 tonnes in both directions. Then a decision was made to close one production facility and the volumes were all gone. It had nothing to with our service or the customer being dissatisfied with us; it was a strategic decision within that company. It affected us to a very high extent. They said: "The flow will be phased out within 30 days". It was, and the production facility closed down.

There is an internal conflict in the port that affects us. Our industrial customers haven't been complaining, but we believe we have lost trailers. They are worrying about whether the vessel can be unloaded during the weekend or not, which depends on if there will be a boycott. The port is a factor we cannot control. The failure with the sweeper was due to the port. We couldn't unload it since it was out of our regular sailing schedule.

We see an increased demand for the information flows: for example, we have EDI-connections, e-bookings, e-invoices and track-and-trace. We need to have internal resources to handle that. At the same time it ties the customers closer to us and it is harder for them to leave, so we approve of the development of course. But it requires resources and it costs a lot.

There are reasons for that cargo not reaching port on time: congestion or simply lack of time.

3.2 What internal factors affect the vessel capacity utilisation? The level of capacity utilisation differs depending on which Chief Officer is doing the stowage plan; that is the human factor. Some vessels are easier and more flexible to load than others.

Our bottleneck is the main deck. Some chassis and trailers with valuable cargo need to be placed dry and safe from water and rain on the main deck, while dangerous goods need to be on the weather deck. Some industrial cargo is transported on cassettes reaching almost six metres and you cannot take these up on the weather deck. You can cover the weather deck, and sometimes we do, but it means much more steel and a smaller cargo deck. Consequently, the types of cargo in relation to available spaces on the different decks affect the vessel capacity utilisation. We would like to have a bigger main deck.

3.3 How can vessel capacity utilisation be enhanced? In the short term, you can add more sailings with existing vessels if possible. You can increase the speed, but then you have to calculate increased bunker costs versus the benefit of transporting more cargo. You can change to a larger vessel if you have one available, or the other way around; from a larger to a smaller to decrease costs. However, you need something to exchange with and it is not always easy to find.

During Christmas, we don't need all departures and therefore we decrease the frequency. We are determining the schedule with our largest customer. When the vessels are in port we take the opportunity to maintain them; then we need to have people, parts and equipment working on

these vessels. We do not want unnecessary sailings, as it is expensive and we need the time for maintenance; otherwise the vessels are sailing all the time.

Another solution we are working a lot on is to find suitable load carriers. The more load we can have per square metre, the better it is. We can increase profitability and if we can load our industrial cargo more efficiently, we free up some space at the same time. It is important how we load the cargo: we should not accept more cars than we can take on the hanging decks. The daily mix is very important as well as who is responsible for the planning. We have the same vessels every day, and the people working here are very skilled. An inhibiting factor is the different sizes between the vessels. Often the smaller vessel sets the limit. If you're lucky you can have the large vessel on a peak-day, but that isn't as easy as it may sound.

If the customers don't have a confirmed booking, they are on the stand-by list. If there is a lot of cargo and they have few alternatives, the tendency is an increase in stand-by cargo. If the customer has many alternatives and there is unused capacity, he will of course go somewhere else if he cannot have a confirmed booking.

Without stand-by cargo the capacity utilisation might only reach 90-95% even if the vessel is fully-booked, since some trailers didn't show up. Today, if 10 trailers don't show up, we can have 10 trailers from the stand-by list and we get a full vessel. It is the same principle as an overbooked flight. Then we have a discussion with the customers: "You have booked 15 units: 12 confirmed and 3 on stand-by. If we can't take three units, which ones do you want to leave until the next departure?"

The customers are aware of the conditions and not all units are in a hurry, especially as we have daily departures. So here we go again; if we have one departure per week they would say: "Hey, I cannot wait one week, I will have to find another alternative!" Most customers have a certain number of cars to pick up the units and they cannot handle too many per day. Of course it is better for them to have the cargo ready in the receiving port, but we have a frequency that allows the customer to wait with some units. And we always have a full vessel; it is really a positive trend.

If you have the right vessels, the right capacity and appropriate equipment, you can attract more customers in the long run. We are lucky that we can take part in the development of new vessels. At the same time, we need large transport volumes as we have the most expensive vessels. Often, the vessels are introduced to this shipping service and then later to another service. Maersk Line does the same; they always have the largest vessels on the most important trade. If they invest in new vessels they move the old ones to the second most important trade and so forth.

3.4 What is difficult in vessel capacity planning? There are several years between ordering a vessel until the vessel is on service. You have no idea about the market trends far in advance and it is hard to look in the crystal ball; or of course you have some idea since transportation increases a few percentage points every year. Anyway, if it was easy to predict the future one wouldn't be seated here, but would rather be a millionaire out playing golf.

3.7 How do you handle the large capacity steps associated with introducing new vessel capacity? It is very expensive to introduce a new vessel, as you have such small volume from the start. One way to enter, if the goal is to have a larger, more expensive and modern vessel on a shipping service, is to start on a smaller scale and build volume, and slowly take the necessary steps. We have, for example, a small temporary vessel on a shipping service. The idea was to start with the sweeper, increase the demand and then see where the market went. The goal is to add a fourth

permanent vessel later on, which needs to be integrated with the existing three vessels in order to create a sailing schedule more suitable for the market. If we are planning to bring a big, new and expensive vessel into a service, we can start with a smaller vessel and build up volumes. Thus, we divide the development of the service into two steps.

The large fixed cost is a barrier to competition as in most other industries. A base flow is very good to have for profitability. If we are going to earn money, we need to fill the vessels with high capacity utilisation; otherwise there will be no money left. And if we fill the last 10%, it is very good.

3.8 Are the capacities in port in general enough? The port has enough employees, but they need to adjust to our peaks. We know that if they wake up on the right side, they unload the vessels without problems, but if they don't want to it doesn't matter if there are twice as many men working. If we are on time, everything works well, but if we are late we will never get the service if they have a boycott.

There are a lot of possible improvements for the infrastructures. There are available berths today, but the land area can be discussed. The port wants more space. Every port says they want more space, but I believe there are few ports that are actually lacking land area. As you can see, there are many empty containers standing here, which indicates that they don't have this problem. One way to decrease the dwell time for containers is to charge earlier for storing containers in port. If it starts to get expensive, people will come and pick up their cargo. Internal efficiency and strategies are important. Of course, if Maersk comes with their large volumes, they can leave their empty containers for free. What you give away in a negotiation is hard to take back. It is like a tree. It doesn't take long to cut down a tree, but making it grow again takes time. It's the same with prices. It is easy to cut prices, but hard to raise prices.

Railway is a problem. If one bridge breaks, no goods can be delivered to the port. The vulnerability is enormous. The cargo is stuck in queues. The most important thing for the port is the infrastructure and making contracts with the stevedoring company. When the stevedores are in a good mood they can do a fantastic job, but their lowest level is way too low.

We rarely have problems with other vessels being at the berth when we are arriving, which can be a common problem in other ports. When it comes to the port, they have overcapacity, but if you look at the quays it is not certain that they have overcapacity. There are plenty of berths; we can stay in port the whole day.

3.9 What criteria do you base the decision upon when selecting terminals for your shipping service? A port that is well located for our customers and our customers' customer, and has large and excellent roads.

3.10 What demands do you have on the ports? Railway, road and inventory capacity are important. Around the port, there is congestion. Sometimes our customers cannot get their cargo here on time because there are queues with trucks picking up their containers. A port is not only a berth; surrounding hinterland transportation is very important.

When we are making contracts with the port, we agree to deliver a certain volume with a certain frequency. So there are demands on the port, but also demands on us. Of course we have to make sure to arrive as agreed if they provide us with the necessary resources. We are working in close cooperation.

There are clauses regarding productivity in the contracts, that the terminal should load and unload a certain number of units per hour and how long it should take before the vessel is ready to depart. If we are late, there are clauses for how late we can arrive, what will happen if we come after a certain time and how much it will cost.

3.11 Who has the strongest position in negotiation? Of course we think that we as the largest customer have a good bargaining position. But our demands on infrastructures, resources and land areas mean that we cannot easily move. Then the question is who has the strongest position. No one is happy with a dissatisfied customer. If you are pushing him too far there are always alternatives. We are looking for alternatives in the area but with our volumes, no one can accommodate our vessels and load and unload them within a reasonable amount of time. If you also take the infrastructure and the location of the customers into consideration, I am certain that we might not be in the best position.

3.12 Why do you have a strategy to own and operate port terminals? We want to own the strategic ports. It would especially in X have been an advantage with the large cargo volume of goods. It would have been cheaper and more profitable. Then we can influence much more, and make the strategic decision to get more people if we believe we are going to grow, but we loses our ability to negotiate. There are internal companies that are not at all cheaper than external. But of course, in a port where we have both night and day traffic we believe we are cheaper.

Respondent 6

Route characteristics
Questions are foremost related to Research Question 1

1.1 What are the requirements necessary for an efficient short sea shipping link with good vessel capacity utilisation? We have four keystones: frequency, reliability, adaptability and cost efficiency. Frequency is within the sailing schedule, and reliability is important. Adaptability means being able to adapt to the customer's need. A good terminal in terms of berths, fairways and infrastructures is very important, as well as access to railway into the terminal and good possibilities for trucks to leave and enter the port.

1.2 What type of customer do you have on the route? Trailer operator, industrial cargo, project cargo, etc.

1.3 Do you have demand variations and imbalances in import and export figures? In the past there have been imbalances in shipping service X, but it has been evened out lately. Before, there were many export trailers out from the port and empty trailers back.

1.4 What is the competitive situation like? Shipping service X is competing with road and with other shipping companies. For shipping service Y no other RoRo shipping companies are operating. There are some LoLo companies but they have a lower frequency.

Vessel capacity utilisation strategies
Questions are foremost related to Research Question 2

2.1 What is your business strategy? Earlier it was to own and charter 50/50. We are not sure it is so good anymore. We are changing towards own vessels, own flag and own crew.

2.2 Do you in general have shortage of vessel capacity or unutilised vessel capacity? It depends which day it is. For example, the customers only want six departures on one shipping service. The Sunday departure is not interesting, but we use it since we have too large of volumes the other days. Thus Sundays are used to clean the terminal from cargo. What is produced on Friday should leave with the next vessel on Saturday, and Sunday is number two.

2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation? We have large peaks on this shipping service. The customers demand that we be able to handle the peaks, and normally we do. But sometimes we need to move the cargo to another day. I would like to have a capacity utilisation of 85-86% so that we have 14-15% to offer customers when we have peak demands. We need the extra capacity in order to serve our customers when there are peaks in demand, and to serve our on-off customers or customers that show up occasionally. These are also important, since they are paying higher rates. It is dangerous to reach 90-92%. On another shipping service, the utilisation level is very high, but it is not healthy in a long-term perspective. You can have that situation in a shorter period if there are tendencies of decreasing volume.

2.5 What is important to consider when you set the sailing schedule? The sailing schedule for service X is optimal. The vessel calls at the port early in the morning so the trailers can leave and collect cargo in the neighbouring industrial area during the day to catch the evening departure. The utilisation of the trailers is therefore high. On the other end, we have problems with congestion some times of the day. Therefore, we arrive at night so the customers can drive quite a bit before congestion starts in the morning. Consequently, we have a large hinterland, and the customer can use his time for driving instead of queuing.

When it comes to trailers there has always been a growth of 1-2%. It is foremost the industrial cargo that increases. At shipping service Y it is different. We have large base flows and we cross a little slower since the demand on transport time is not higher. The growth on shipping service Z has been fantastic. We had four vessels last year, and then we changed to three. We removed one vessel, but still increased capacity by 30%, which is rather fantastic. We changed the sailing schedule but kept the six departures per week. Now we have three sister vessels so we have the same capacity on all vessels. We increased the capacity and it was filled within three months.

If the sailing schedule allows, it is possible to add a port and call a string of ports. It is not always a good solution but we have done so to increase capacity. I think it disturbs the schedule, but we are still making money on that shipping service. I look at it from an operative perspective and the economists from an economic perspective, and so they should. From an operational point of view there are questions that need answers: how much capacity can we leave to the third port? Where can we place the cargo on the vessel? In a worst case scenario we have to shift the transport units' position onboard to get the required one. We want to avoid that, as it costs a lot of money.

Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

3.1 What external factors affect the vessel capacity utilisation? External factors are the customers' resistance towards using the capacity available on Sundays, that is, customer demand. We cannot affect variations in demand either. It has happened that competitors enter or leave the market. The infrastructure can also influence the railway capacity in the terminal. If we are trying to get a new large account, it can matter if the railway is up to date or not, which can affect our vessel capacity utilisation.

3.2 What internal factors affect the vessel capacity utilisation? The size of the vessel is significant of course. Age has more an impact on reliability; the older, the less reliable. The vessel's characteristics have an impact on capacity utilisation.

3.3 How can vessel capacity utilisation be enhanced? You can remove or add vessels, or extend a vessel to increase capacity. You can also cancel or add a departure. If the schedule allows, you can call an additional port and set up a string. Some customers demand that the cargo leaves on a Saturday, but they let the cargo stay in the receiving port until Wednesday. It means that two more vessels call at the port before the cargo is collected. We and our customers are connected to the information system in the port, so we both know when a trailer arrives at the terminal and when the cargo was loaded or unloaded. Then we can ask our customers to use the Sunday departure instead so we can take new customers on Saturdays. The booking department has these discussions going on all the time.

We can increase our capacity utilisation if we get better information about the cargo. We have booked cargo that doesn't show up before departure. One large customer has a deadline one hour before departure, which is really late. We are not invoicing cargo that is not delivered. We have tried to, but the customers take it as a threat and we are trying to avoid that. As a consequence of this we take some risks and overbook the vessels. We know that every Tuesday, there are 10 units that won't come. If we overbook and all units arrive, then we are really in a tight spot. In that case we have to move bookings to the next departure. It is not good, but it rarely happens. Then we have stand-by cargo that we use quite a lot for some shipping services, which also is a way of overbooking.

Most vessels are custom-made for our shipping services. They were not that from the start, but then we started to build hanging decks for cars and adjust the cargo decks to boxes and cassettes. The cargo mix is very important to us. If there is no cargo we can use for the handling decks, we remove the decks and use the space for other cargo. We have a project to develop a more suitable transport unit in order to utilise the vessel capacity better. Therefore, we need to make some adjustments on the vessels. The vessels are designed for double ramps in the terminal but we are not there yet. One reason is the costs and that we get more locked to certain ports.

3.4 What is difficult in vessel capacity planning? The vessels are designed for the cargo mix we have. We have a strategy for what will happen when we have filled the vessels: if we are going to build new vessels or extend the existing ones. These are important decisions. If you start drawing a vessel now, perhaps it will be in service in 2015. What will the market be like then? For how long will we transport RoRo units? Will containers take over in the future? The container market is increasing; will that affect us? No one can answer these questions.

3.5 Do you use price differentiation? No; we have tried, but it didn't turn out very well. Price is often not the determining factor, but reliability and just-in-time are. Some customers are always interested in price, but on the whole it didn't give any increase in volume.

3.8 Are the capacities in port in general enough? Generally speaking, yes, but not when there is a boycott. The lowest level in the port is really low. If we are 6-7 hours late due to bad weather it is often not possible to make up time in port. I don't know for sure if we have lost contracts due to the situations in port, but the marketing department has indicated that. The port authority needs to solve the situation with the stevedoring company; a flexible and reliable stevedoring is a great advantage. The highest level is really good, and even if we are late they can sometimes do a great job. But the problem is that we don't know in advance so we cannot plan.

I think the port has less capacity then the vessels. The land areas are very limited. They need to remake the terminal layout and be more efficient with existing resources. Where should the trailers be located in the terminal? Should they have a fishbone pattern or should the trailers back towards each other? Some customers are using the port for storage.

3.9 What criteria do you base the decision upon when selecting terminals for your shipping service? Customer demands, that it is feasible to call the port with respect to water depth, berths, fairways, infrastructures, etc. That there is enough cargo and reliable customers.

3.10 What demands do you have on the ports? That the ports take care of our vessels and have enough resources so we can provide reliable shipping services. My shopping list when I see the port includes a sailing schedule, volumes and deadlines; these are the prerequisites for the port to be able to sell a product to me.

3.11 Who has the strongest position in negotiation? The port, since they have a monopoly.

3.12 Why do you have a strategy to own and operate port terminals? We believe we are better at handling it ourselves with higher profitability. We can benchmark other ports and we know from experience that this is an expensive port. The port affects our ability to sign new contracts with the industry as they charge too high of rates.

Respondent 7

Route characteristics
Questions are foremost related to Research Question 1

1.1 What are the requirements necessary for an efficient short sea shipping link with good vessel capacity utilisation? A shipping service should have high frequency and booking offices in both ports. It is important with the frequency of seven departures per week. We don't necessarily need to own the terminals, but we should have our own office so the customer can see one and the same name on both sides of the market. The port should have the capacity to accommodate us and have an information system that is linked to ours, if it's not our own, and a well working EDI solution. In our own ports, we use a system we have developed ourselves. It is also important to have an efficient gate system; when a truck drives through the gate a picture is taken automatically, instead of having someone inspecting the truck, writing down damages on a paper

and signing. With the automatic photographic system, the customers can later get the pictures from our database.

It is important to have an accurate, good and efficient sailing schedule. And to have two ports ready to accommodate us when we want to come, day or night, and land based infrastructures that give us access to the port 24h/7d.

1.2 What type of customer do you have on the route? We have door-to-door, quay-to-door and quay-to-quay transportation. There are many actors in the chain that need to be integrated when it comes to industrial customers: train operators, road hauliers, terminal operators, customers, and so on. The industrial cargo represents 25-30% of the transported cargo service X and Y. Other cargo segments are trailers, containers and automotive.

1.3 Do you have demand variations and imbalances in import and export figures? Yes, traditionally we have always had an enormous imbalance between X and Y, where we export more then we import. But it changed this autumn. We have actually transported more loaded trailers in that direction than in this one. It shows market development. We know how the market will develop before we hear it on the television two months later. Already in September we saw the business cycle was on its way down. On line Z we are importing more than we are exporting, so we have an imbalance. We are very dependent on our industrial customers.

1.4 What is the competitive situation like? You keep your competitors away by having overcapacity.

Vessel capacity utilisation strategies
Questions are foremost related to Research Question 2

2.1 What is your business strategy? We start with a shipping service before we have a customer base. The first service was built around the large trailer operators. It is important with the frequency of seven departures per week. We believe in fast services to rationalize the capital, in order to decrease the number of vessels. In the middle of the nineties, the bunker cost was 15% of the total quay-to-quay cost; now it is 50%.The customer pays for frequency and short transport time. When we started with daily departures, the customers rationalized their resources and removed 20% of their trailers with preserved transport work.

If the capacity utilisation is too high you do not have the possibility to increase the market share and take on new customers.

We have different customer strategies. We have large industrial customers, but few companies are transporting more than 500,000 tonnes. It takes at least three years to get new industrial customers; you need to find them and convince them since they often are leaving an existing transport solution. For our trailer operators, it is better to have 10 customers of a similar size, rather than one large customer and nine small ones. There is a tendency in the transport market that the large operators are getting larger and the small ones are getting smaller. The large customers have better combination possibilities and probably less overhead costs per transported unit, so they have an advantage.

There are enormous possibilities for economies of scale, but there are also small and very skilled companies with good business oriented people. We want the small to survive, but we cannot give

a small actor a lower price just so he can survive. The large customers do not like that. We want our prices to be transparent. I want to have the prices with volume discount on our webpage.

Transport costs have increased, both for us and for the trailer operators, due to the increase costs in bunker fuel and oil. The fuel represents almost 50% of the total cost for a door-to-door transport assignment. It is getting harder and harder.

2.2 Do you in general have shortage of vessel capacity or unutilised vessel capacity? It depends. For service X we have some overcapacity since we have weekly variations. In summer and at Christmas we take the vessels to the shipyard to maintain the vessels since there are some weeks when the market is completely dead. For service Y we have a shortage in capacity. We can almost never take it all; there is always cargo left after every weekend. We had a small temporary vessel for a while but we removed it as we didn't receive the required service in port. The small vessel was instead moved to another shipping service. The extra vessel is an expensive toy. We never make any money during the short time that it is used. It is like pouring balm into a wound. You don't care why you have the wound; instead you are just pouring more balm. You will never earn any money from that.

2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation? It depends on the market. If you take Service X first, we have a responsibility. We have a responsibility to provide a good service, since we are the only option. Therefore, we need to plan for unutilised capacity. Our product is well-paid and we need to provide the capacity. It is a different scenario for Service Y. There are many short sea shipping companies as well as the railway. We are exposed to competition in a very different way. We have many competitors here. When you have a downward pressure on prices, you cannot afford any unutilised capacity. Sometimes you need to cut peaks and let someone else take the cargo. The customers are not prepared to pay for this luxurious overcapacity.

You should always be able to accommodate the last trailer and therefore you need 87-88% in capacity utilisation for shipping service X. You can handle the volumes with this level if they are relatively even without any large peaks. For shipping service Y, the situation is different and we have to go higher in capacity utilisation.

2.4 Under what circumstances can you continue a service with low vessel capacity utilisation? From a pure economic perspective, there are shipping services we should close as the capacity utilisation is low. But we consider it as a package together with another shipping service, so we continue. The shipping services complement each other since it is the same customer segment and type of cargo. If the vessel is full on X we can often through compensation make customers go by Y instead, so in that respect they are complementing each other. Since we are operating the route, we are also occupying a berth and we are present in the market. A competitor cannot just come. If we wouldn't have been there and since we are so strong in Y, a competitor could start there and take market shares from our more important service in Y. I am not worried about the cargo they take from us; I am more concerned about the downward pressure on prices for the remaining cargo competition brings about. Economic endurance is a problem in shipping; you can easily lose money. A lot of money has been thrown into the North Sea through the years.

It is never good from a competitive perspective to have excess capacity in the port, because it means a competitor can come. Sometimes it might be strategically wise to add an extra departure even if there is no need for it, as you occupy a port slot. You cannot leave with empty vessels just

to use the port capacity, but it is not good if there, for example, is a free slot on Saturday morning. It is better if we have an extra departure, rather than someone else.

Actually, the vessel is too large when it is taken into operation. But we know that we have filled our vessels rapidly. For one route, the capacity utilisation increased overnight when we started with a vessel with a utilisation level of 30-40%. That is a lot. We said before, "Now we will have to fight for many years to get these vessels filled", but it only took a year. For another shipping service we said, "Ok, if we increase the total capacity by 30%, it will take five years before we fill these vessels". But the volumes came almost directly. The market is expanding so much faster than the stock exchange or industry index. The transport market is growing almost twice as fast.

We can also continue if the excess capacity keeps competitors away.

2.5 What is important to consider when you set the sailing schedule? You need the time modules when you set your sailing schedule; it should be possible to arrive at the right time for our customers in both ports in order to get the best utilisation of the trailers and avoid congestion. Reliability is also important. One route has a reliability of approximately 96-97%, which is extraordinary for crossing the North Sea.

We try to connect existing ports with new relations rather than to add new ports. If we are calling a new port we have to build up a new relationship with the terminal; we need to have a new office, negotiate prices, convince our customers that it is a well-functioning port, etc.

Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

3.1 What external factors affect the vessel capacity utilisation? We are to a great extent affected by the market conditions and the customers. The slightest deviations from the business cycle, we notice directly.

3.2 What internal factors affect the vessel capacity utilisation? If we notice that a market is going up or down we can make a strategic decision to add or cancel a departure.

3.3 How can vessel capacity utilisation be enhanced? We do not move the vessels in low season because in that case we need to take them far away and it costs a lot of money to only keep them for a short period of time. You can remove a vessel completely from service; the problem is that it doesn't disappear completely just because you remove it. It still costs money and there are still a certain amount of people working.

3.4 What is difficult in vessel capacity planning? The hardest is to understand market tendencies. The large customers have very bad forecasts, which surprise me. They do not have any reliable forecasts themselves, which affects the possibility to reach good capacity utilisation in the long run. So how do we plan for the coming years? We use experiences and interpret the indications from different directions and build our own truth. On that we base our budgets and plans.

3.5 Do you use price differentiation? We can use it, but then we need to do it for everyone. We are lucky right now because we don't have any bad departures; we only have very good departures. They are all full. We have cancelled the Sunday departures at present since the utilisation was too low. We have an obligation since we have sold seven departures, but if there is no cargo we don't need to go.

3.7 How do you handle the large capacity steps associated with introducing new vessel capacity? We have a small vessel to be used for building volumes before we introduce the larger permanent vessel. We cannot just start with the larger vessel; it costs more than twice as much as the smaller one. If you need to avoid large steps, you start on a small scale. The day we add the large vessel we hopefully have 30-40% of its maximum capacity. The difficulty in shipping is the capacity steps.

The most common is to have a belief in a market, to add capacity and slowly grow.

Another way to handle the large capacity steps is to sign a contract with one big new customer. First you get the client, then you get the vessel, then you have a good capacity utilisation from the start.

You can also buy a competitor; we have done that. It is a good way to increase the capacity utilisation of the vessels as well.

You can also attract a new segment of customers, such as container customers. You need to decrease prices as containers are more price sensitive than RoRo cargo. When the capacity utilisation increases, you continuously add better paying customers and start to phase out the container customers. This is the old school. In principal we are borrowing and lending customers from each other.

When we enter a new market we allow ourselves a lower capacity utilisation for a while as we need time to take market shares from our competitors. We start with an attractive service first, then we get the customers.

3.8 Are the capacities in port in general enough? The equipment is probably very good here, as well as the port infrastructures. The port is rather efficient I believe. The problem is the Stevedoring Company; they need to break the stevedore monopoly. I also believe that the competence among employees in general is not very good. Perhaps they are fond of taking things easy and are afraid of conflicts.

The port has the largest capacity; we are still allowed to change our sailing schedules and adjust departure and arrival times if it is bad weather. There is still an overcapacity in the port, but it is not very large.

3.9 What criteria do you base the decision upon when selecting terminals for your shipping service? The larger customers more or less “force” us to call a certain terminal. In one case we signed a long-time contract and had guaranteed volumes for several years. That is one way. The other is to investigate where there is port capacity. We have always been in X since they have had capacity. So location and capacity determine the selection.

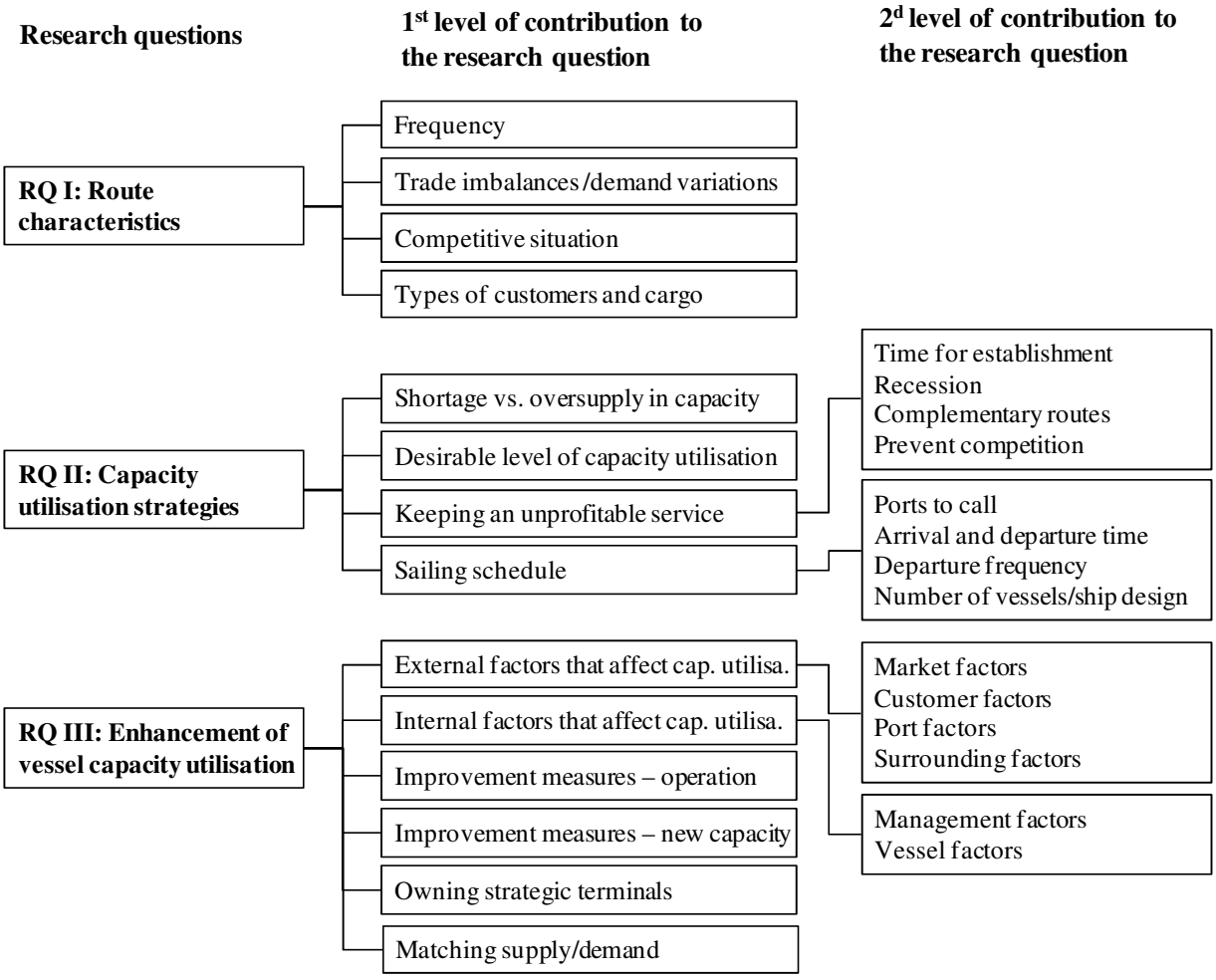
3.10 What demands do you have on the ports? We have demands regarding access to highways. In X we have our own exit; it cannot get any better, as it takes the trucks directly to the vessel and it just takes a minute. The drivers do not even need to stop at the gate; the trailer number is read by a camera when they enter the port. The system finds the booking automatically and gives a parking slot number to the driver.

3.11 Who has the strongest position in negotiation? The port. In ports with unutilised capacity and open competition we can go to any terminal and discuss prices with the stevedoring companies. It doesn’t matter which terminal we call at as long as they have a ramp and tug masters that can handle trailers. It is a question of capacity and monopoly. In this port, we cannot

go somewhere else and ask if they can unload our vessels, and we cannot change ports because the customers do not want that.

3.12 Why do you have a strategy to own and operate port terminals? We want to control our own cost development. X is a great example. We own the terminal and it is really a hub. We can set the sailing schedules in order to use the fixed facilities in the best possible way. There is an economic advantage as well. The terminals should not be profit centres. Our profit should be on the shipping service. The terminals should provide good service and be operated as efficiently as possible.

Appendix D Data analysis of Study II



Appendix E Interview protocol Study III

Interview protocol for ocean shipping company and feeder operator

Name of respondent:
Position:
Company:
Year in the company:

1 Case description

1.1 Do you only sail on a pre-established schedule?
1.2 What are the reasons for calling at the ports?
1.3 What is the competitive situation for the route like?
1.4 Do you have variations in demand and how do you handle them?
1.5 Do you have trade imbalances and how do you handle them?
1.6 Do you have long-term (more than a year) contracts?

2 Enhancement of vessel capacity utilisation

Overall

2.1 What factors affect the vessel capacity utilisation?
2.2 How can vessel capacity utilisation be enhanced in the short run, and in the long run?
2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation?
2.4 What do you do if you are late and need to catch up time?
2.5 Do you use customers' forecasts when you do your capacity planning?
2.6 What is difficult in vessel capacity planning?
2.7 What main factors do you take into consideration before investing in new vessel capacity?
2.8 If new capacity is needed for this route, do you prefer: additional vessels, bigger vessel with the same number, higher speed; route changing; other?
2.9 Are your vessels suitable for the transported cargo?

Port interface

2.10 What demands do you have on the terminals?
2.11 What demands do the terminals have on you?
2.12 Who has the strongest negotiation power, you or the terminals?
2.13 Do you get the required service in port?
2.14 Do you get the same service even if you are late?

2.15 What would a reduced turnaround time in port mean to you?
2.16 Is the port capacity matched with vessel capacity?
2.17 What are the advantages and disadvantages of operating your own terminals? [only asked to Maersk Line]

Sea interface

2.18 What demands does the feeder operator make on the ocean shipping company?
2.19 What demands does the ocean shipping company make on the feeder operator?
2.20 Who has the strongest negotiation power, the ocean shipping or the feeder operator?
2.21 Do you cooperate with other shipping companies? If yes, why?
2.22 Who introduce a new feeder service?
2.23 What are the consequences for the feeder vessel if the deep sea vessel is late?
2.24 What are the advantages and disadvantages of owning your own feeder service? [only asked to Maersk Line]
2.25 Does Maersk inform you before they change routes or invest in new vessels? [only asked to feeder operator]
2.26 How can the cooperation between you and the shipping company be improved?

Customer

2.27 Who are your customers?
2.28 How do you prioritise customers when there is a capacity shortage?
2.29 Do you use price differentiation?
2.30 What demands do the customers have on your shipping service?
2.31 Why is feedering not more common in Japan? [only asked to Japanese shipping companies]

Interview protocol for terminal

Name of respondent:
Position:
Company:
Year in the company:

1 Case description

1.1 Who owns and operates the terminal?
1.2 How many shipping companies call at your terminal?
1.3 What is the modal share? (% truck, % rail, % sea)
1.4 Do you have variations in demands and how do you handle them?
1.5 Do you have trade imbalances and how do you handle them?
1.6 What are your competitive advantages as a port?

2 Enhancement of vessel capacity utilisation

2.1 What factors affect terminal capacity utilisation?
2.2 Are the terminal capacities enough?
2.3 What is needed to increase terminal capacity?
2.4 How do you prioritise vessels when there is a capacity shortage?
2.5 How do you handle delayed liner vessels?
2.6 Do you use customers' forecasts when you do your capacity planning?
2.7 What demands do you make on the shipping companies?
2.8 What demands do the shipping companies make on you?
2.9 Who has the strongest negotiation power, you or the feeder operator?
2.10 Who has the strongest negotiation power, you or the ocean shipping company?
2.11 Do you have long-term contracts with feeder operators or ocean shipping companies? If yes, how long?
2.12 Do shipping companies inform you before they invest in new capacities?
2.13 How can better information from the shipping companies improve your service?
2.14 Is it possible to reduce the turnaround time with existing port capacities? If yes, how?
2.15 How can the cooperation with you and the shipping companies be improved?
2.16 Why is feedering not more common in Japan? [only asked to Japanese terminals]

Appendix F Summary of respondents' answers in Study III

SHIPPING COMPANIES

1 Case description

	Study III - Europe		**Study III - Japan**	
	Feeder operator	Ocean shipping	Feeder operator	Ocean shipping
1.1 Do you only sail on a pre-established schedule?	Yes, but we are flexible and can change quickly.	Yes	Yes, but we are flexible and can change quickly.	Yes
1.2 What are the reasons for calling at the ports?	Demands from ocean shipping companies.	To fill the vessels with cargo.	Demands from ocean shipping companies.	Started initially to cover a major shipper.
1.3 What is the competitive situation for the route like?	Feeder operators, ocean shipping companies, short sea shipping companies, and road to some extent.	We have a unique product.	Road, domestic feeder services, ocean shipping companies. Our advantages are low costs, large service network, large number and size of vessels.	Ocean shipping companies, domestic feeder operators.
1.4 Do you have variations in demand and how do you handle them?	Yes, peak seasons. We change vessel capacity.	Yes, to have the right level of committed cargo.	Yes, both weekly and seasonal variations. We change vessel capacity.	Yes, but not remarkable and they do not affect us specifically.
1.5 Do you have trade imbalances and how do you handle them?	Yes, we add more ports or we sail with low utilisation in one leg.	Yes, we fill up with empties to make sure we max out the vessel on TEU instead of weight.	No, less than 5%.	Basically import acceptance is done to meet export demand.
1.6 Do you have long-term contracts?	Some general agreements with first refusal, but no long-term contracts.		No, one year contract with ocean shipping company only including price per unit.	Yearly contracts.

SHIPPING COMPANIES

2 Enhancement of vessel capacity utilisation (RQ III)

	Study III - Europe		**Study III - Japan**	
	Feeder operator	Ocean shipping	Feeder operator	Ocean shipping
2.1 What factors affect the vessel capacity utilisation?	Imbalances and demand variations; cargo mix; competition; late cancellation; double booking; information exchange; delays of deep sea vessel; port performance; weather conditions; regulations; planning, organising or leading; vessel design; stowage plans.	State of the market; cargo mix; produced output; freight rate; port capacity; port performance; congestion; ship design; customer service level.	Demand variations; cargo mix; delays of the deep sea vessel; port capacity; weather conditions; regulations.	Delays of the deep sea vessel; port capacity.
2.2 How can vessel capacity utilisation be enhanced?	Find cargo in low-volume leg or departure; type of customers and cargo; rescheduling of bookings; cooperate and communicate with ports; change sailing schedule; develop suitable vessel design; change vessel capacity; change vessel speed.	Stand-by cargo; change freight rates; cooperate and communicate with port; change the sailing schedule; suitable vessel design; change speed.	Type of cargo and customers; flexible capacity management; change vessel capacity.	
2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation?	Above 90% of the physical capacity.	95-97%, you don't stretch the operations and you utilise the capacity almost to its full extent.		
2.4 What do you do if you are late and need to catch up?	Overtime in port, cancel a port, change schedule.	Change speed, cancel a port.	Change speed. Alternative transport mode to connecting port.	Alternative transport mode to connecting port.
2.5 Do you use customers' forecasts when you do your capacity planning?	We discuss with customers.	Yes, but we trust more historical data.	No, we don't have the information.	
2.6 What is difficult in vessel capacity planning?	Market fluctuations, demand variations, port congestion.	Lack of proper customer forecasts, imbalances.	The uncertainties: if the feeder vessel service will be permanent or not.	Nothing.
2.7 What main factors do you take into consideration before investing in new vessel capacity?	Need for capacity, type of cargo to be transported, price.	"Show me the money".	Demand, the mother vessel schedule and volumes, licence costs, market condition, need for capacity.	Feeder capacity.
2.8 If new capacity is needed for this route, what do you prefer?	Depends on the situation, but in general larger vessels.	Cannot increase capacity.	We would have preferred bigger vessels with the same number. The frequency is already high.	Either additional vessels or bigger vessels, or both.
2.9 Are your vessels suitable for the transported cargo?	Yes, very short charter agreements that allow a quick change of vessels.	Yes	Yes	Yes

SHIPPING COMPANIES

2 Enhancement of vessel capacity utilisation (RQ III), cont.

	Study III - Europe		**Study III - Japan**	
	Feeder operator	Ocean shipping	Feeder operator	Ocean shipping
2.10 What demands do you have on the terminals?	Flexibility.	Port productivity, customs setup.	Price, safety for cargo and workers, information.	Berth windows and cargo handling
2.11 What demands do the terminals have on you?	Information: stowage plans, cargo information.	Fixed berth windows, information.	Information about sailing schedule.	Accurate container information.
2.12 Who has the strongest negotiation power, you or the terminals?	The port, due to terminal monopoly and customers' demands.	We, because of the extra capacity in port, we can ask for better rates and terms.	The port, due to terminal regulations.	We have, because we are their customer.
2.13 Do you get the required service in port?	Yes in normal cases, but not during peak days.	In most ports.	Yes, we are a small company, but have advantages as we are transporting Maersk's containers.	Yes
2.14 Do you get the same service even if you are late?	In normal cases, but not between 00-07.	It depends on the contract.	Same. The satellite port is very flexible.	Yes
2.15 What would a reduced turnaround time in port mean to you?	We can leave earlier.	It is always possible to reduce turnaround time.	It is possible to reduce time in port, which is good for us.	Cost saving and efficiency.
2.16 Is the port capacity matched with vessel capacity?	Yes, but not during the peak days. The average utilisation of the cranes are very low.	No, depends on the market conditions.	Yes. The satellite port can handle bigger ships or increased frequency. Could be a problem at the hub port due to limited berth windows.	Yes, but there is a berth conflict on the quay side.
2.17 What are the advantages and disadvantages of operating your own terminals?		It doesn't matter for us if we use APMT or other terminal operators.		Advantages: prioritisation and productivity. Disadvantages: costs.
2.18 What demands does the feeder operator make on the ocean shipping company?	Cargo information.	We are the customers.	We cannot make demands.	No demands.
2.19 What demands does the ocean shipping company make on the feeder operator?	Reliability, price, to keep our promises, flexibility.	Price, reliability, type of vessels, number of reefer plugs, equipment, the geographical coverage, frequency, flexibility.	Price, suitable sailing schedule, flexibility, reliability of export cargo.	Reliability, connection to and from the hub port.
2.20 Who has the strongest negotiation power, the ocean shipping or the feeder operator?	The ocean shipping companies.	It depends who has the upper hand, but we are the customer.	Maersk!!! Because it is a very big company.	We have, because we are the customer.
2.21 Do you cooperate with other shipping companies?	Yes, but it is uncommon in feeder shipping.	Yes, with both ocean shipping and feeder operators.	Not for this service, due to tough competition and the fairly new market, but we do in other parts of Japan.	No
2.22 Who introduces a new feeder service?	Mainly the ocean shipping company.	We leave a tender.	Ocean shipping companies.	It depends.

SHIPPING COMPANIES

2 Enhancement of vessel capacity utilisation (RQ III), cont.

	Study III - Europe		**Study III - Japan**	
	Feeder operator	Ocean shipping	Feeder operator	Ocean shipping
2.23 What are the consequences for the feeder vessel if the deep sea vessel is late?	Waiting time, lower capacity utilisation.	If the cargo onboard is enough they leave, otherwise they have to wait.	We have to wait.	The feeder operator needs to adjust.
2.24 What are the advantages and disadvantages of owning your own feeder service?		Advantages: flexibility and influence. Disadvantages: costs if utilisation is low.		Not allowed to own due to cabotage restrictions.
2.25 Does Maersk inform you before they change routes or invest in new vessels?	About a month, but we are very flexible.		Yes, three months ahead, which is not enough for our planning. Earlier is better, but Maersk has a head office policy.	
2.26 How can the cooperation between you and the shipping company be improved?	Enhanced information exchange in both directions, so we all can plan better.	Easier if it is strictly operational.		
2.27 Who are your customers?	Ocean shipping companies.	Key accounts with contracts: app. 70%; the rest spot customers.	Few, large ocean shipping companies, we don't have contact with cargo owners or forwarders.	Manufacturers and traders.
2.28 How do you prioritise customers when there is a capacity shortage?	Due to relations and contracts.	Committed cargo, best paying, reefer containers, military cargo, etc. there are many rules.	The biggest share holder will get the advantage. If we have a shortage we use another vessel from the market. 2-3 days is enough to take a vessel here.	Based on contribution margin.
2.29 Do you use price differentiation?	Yes, depending on volumes and relations.	A product called "priority cargo upgrade".	We have fixed prices agreed on yearly basis, and we have different prices for empty and full containers.	Yes we use price differentiation based on various business factors.
2.30 What demands do the customers have on your shipping service?	It depends on the market conditions. In recession it is foremost price and not frequency or environmental aspects.	Price, space guarantee, transit time, customer service, reliability.	Frequency, but daily frequency is very expensive.	Punctual connections to and from ocean vessels. Transit time.
2.31 Why is feedering not more common in Japan?			1M TEU from Busan to Japan is not included in the domestic statistics. High costs for cabotage, new vessels and licenses.	

Questions 2.17 and 2.24 only asked to Maersk Line; question 2.25 only asked to feeder; question 3.32 only asked in the Japanese case.

TERMINALS
1 Case description

	Study III - Europe		**Study III - Japan**	
	Hub port	Satellite port	Hub port	Satellite port
1.1 Who owns and operates the terminal?	Two shareholders. APMT owns 50%. We operate the terminal.	Local government owns and operates.	Governmental body owns the port, APMT is leasing the berths, we are responsible for terminal operations and we use external stevedores.	Governmental body owns the port, and there are two container terminal operators.
1.2 How many shipping companies call at your terminal?	Maersk has a share of app. 90%. Six other ocean shipping companies; three feeder operators.	Three ocean shipping companies; eight feeder operators and short sea shipping companies.	One domestic feeder operator, five international ocean shipping companies.	Eight shipping companies, both domestic and international calls.
1.3 What is the modal share?	Sea 60%; road 20%; rail 20%.	Sea 5%; road 50%; rail 45%.	Sea 10%; road 90%; rail 0%.	Road 100%.
1.4 Do you have variations in demands and how do you handle them?	Minor seasonal variations, we have a personnel pool if there is a peak.	Weekly variations, everybody wants to arrive on Fridays.	Seasonal variations (reefer peak and volume peak in different periods) and weakly variations. We increase yard stack density.	Weekly variations. We use more people and equipment, and work overtime.
1.5 Do you have trade imbalances and how do you handle them?	No.	No problem until the crisis, since then more export than import.	Some, but not a problem.	
1.6 What are your competitive advantages?	High productivity, state-of-the-art equipment, highly motivated people.	Geographical location, short distance to open sea, unutilised capacity.	High productivity, efficient equipment and stevedoring.	Location, close to very big industrial area.

TERMINALS

2 Enhancement of vessel capacity utilisation (RQ III)

	Study III - Europe		**Study III - Japan**	
	Hub port	Satellite port	Hub port	Satellite port
2.1 What factors affect terminal capacity utilisation?	Port capacity; yard utilisation; information exchange; weather conditions; schedule reliability; dwell times of containers; move count accuracy.	State of the market; imbalances; demand variations; information exchange; weather conditions; regulations; planning, organising and leading; vessel design, size and age; stowage plans; our railway shuttles.	The state of the market; port capacity; port performance; regulations and legislations; planning, organising and leading; vessel design, size and age; cargo owners and forwarders; the storage time of the containers.	State of the market; port capacity; port performance; adjustment to the other terminal operator; the number of empty containers.
2.2 Are the terminal capacities enough?	Yes	Yes, we have unutilised capacity, but also peak days. Bottlenecks are railways and marshalling area for trucks. Rail capacity can be increased with existing infrastructure, and better information and planning.	No. Our bottlenecks are length and number of berths, container cranes, land areas and reefer receptacles.	No, we need more container yard space. There is some congestion on the roads.
2.3 What is needed to increase terminal capacity?	Yard space. Higher yard utilisation means that we need to stack higher, which decrease the productivity; or we can try to reduce the containers' storage time.	Increased productivity with existing resources, by increased motivation among employees, better planning and improved information from customers.	Expand the berths length, increase land area, one more crane, high-density stacking, reduce the storage time, develop a pattern of yard allocation.	Reduce the storage time, more land areas and increase container yard space.
2.4 How do you prioritise vessels when there is a capacity shortage?	In a dialogue with the shipping companies. We prioritise ocean going vessels, but not necessarily Maersk's vessels.	We prioritise deep sea vessels.	We prioritise deep sea vessels.	
2.5 How do you handle delayed liner vessels?	In a dialogue with the shipping companies and the delayed vessel.		Request from shipping companies to give priority to delayed vessels. Reasons for delays: strong wind, typhoons, vessel engine problem, crane trouble in previous ports.	We can help the feeder operator to send their containers by trucks instead. Shipping companies can cancel other ports but not ours.
2.6 Do you use customers' forecasts when you do your capacity planning?	Yes, but only two weeks in advance.	No forecasts, but we talk with them.		No
2.7 What demands do you have on the shipping companies?	Information about the number of containers, vessel schedule and container information.	Berth window, information latest 23.00 one day in advance about arrival time, stowage plans and cargo.	Reduce empty container storage.	Information about what time vessels will arrive and cargo information.
2.8 What demands do the shipping companies have on you?	Price and productivity.	Productivity, turn around time, flexibility, price.	Space, high service level, turnaround time.	Port capacity, port performance, yard space, turnaround time.

TERMINALS

2 Enhancement of vessel capacity utilisation (RQ III), cont.

	Study III - Europe		**Study III - Japan**	
	Hub port	Satellite port	Hub port	Satellite port
2.9 Who has the strongest negotiation power, you or the feeder operator?	The feeder operators because they are customers and they are carrying Maersk's cargo.	We do, because we have a stronger position and have a monopoly.	No such relationship.	The feeder operator.
2.10 Who has the strongest negotiation power, you or the ocean shipping company?	The ocean shipping company.	The ocean shipping company!	The ocean shipping company.	The ocean shipping company.
2.11 Do you have long-term contracts with feeder operators or ocean shipping companies?	One-year contract including price.	No, only one-year contract.	We have only a one-year contract.	One-year contract with the feeder operator.
2.12 Do shipping companies inform you before they are investing in new capacities?	We get the information well in advance so we are able to act.	Sometimes, but not always.	Sometimes we get the information 1-2 months ahead, sometimes through press releases. This is not enough for our planning.	We would like information earlier.
2.13 How can better information from the shipping companies improve your service?	Productivity can be improved if the data quality and the data integrity are better.	Better information means better planning and shorter turnaround time, and also that all shipping companies can be more involved in capacity planning.	If we can get information about the containers one week ahead we can arrange the yard better and don`t need to housekeep so much.	We would like information earlier when the shipping companies are introducing new ships or changing their schedule.
2.14 Is it possible to reduce the turnaround time with existing port capacities?	Yes, by operation strategies; by improved stowage planes with sufficient crane split; by reduced number of hatch covers being handled and reduced number of housekeeping moves.	Yes, if the shipping companies arrive as planned and we have the correct information, then we have time to arrange the yard better.	Our productivity is 45 cont/h/crane. If we invest in one more crane we can increase port productivity. We cannot reduce with existing capacity.	Yes, increase the technical skill of people working in the port and the skill of planners.
2.15 How can the cooperation between you and the shipping companies be improved?	We already have good cooperation with the shipping companies.	Increased understanding for each other's businesses. Agreements that facilitate better relations.	With good communication between actors.	
2.16 Why is feedering not more common in Japan?			Compared to Europe, Japanese domestic feeder capacity is very low. The distance between origin and destination is less than 50 km so it is easy to reach customers. It is very convenient to use the trucks for the JIT-products.	We don't use feeders much because the lead time is longer and the frequency is lower than for trucks so most of the customers take the containers straight to the hub port. But feeder is cheaper, 50-70% of the price.

Question 2.16 only asked in the Japanese case.

Respondent European Feeder operator

1 Case description

1.1 Do you only sail on a pre-established schedule? We have fixed departure days but it is not any more precise than that. Most of the time you have berth windows in ports; if you don't arrive within those windows you often have to pay for overtime and penalties. We are trying not to adjust the schedule too often, but we have to if the demands are changing. We set a master schedule which we usually keep for 3-6 months. We do smaller adjustments if something happens; for example, we can reschedule a vessel if a large temporary customer has cargo to be transported. We are often calling a string of ports and we very seldom only commute between two ports. If we want to have the large transport network the market demand, then we cannot have shuttles only calling two ports; there is not enough cargo for that, so we need to triangulate.

1.2 What are the reasons for calling at the ports? The deep sea shipping companies' demands on which relations they want. The short sea cargo is now growing very fast so in some corridors we are looking at pure short sea links with forwarders and regional industrial customers, which also determines the selection of ports. There are different reasons for the selection of ports among the deep sea shipping companies: transit times, cost or feeder service frequency.

1.3 What is the competitive situation for the route like? We are competing with other feeder operators who have a similar coverage of ports. Then we have the niche feeder operators that commute between two ports, and short sea shipping companies that started feeder services during the financial crisis. The latter is probably something casual while waiting for their original market to wake up.

Additionally, we compete with our customers, such as Maersk Line, both for direct calls and feedering. We know we carry Maersk's cargo when it suits them, but when a certain level is reached then we're out. That's the name of the game! The risk that we have seen a few times is that the volumes grow large enough for the ocean shipping companies to start their own feeder service, and our whole concept falls. I do not believe in a direct call here, but a feeder service owned by the deep sea shipping company can definitely compete. Since the railway shuttles are collecting a lot of cargo here, it is easy for them to reach the critical volumes. Maersk is quick; they make a decision and one month later we're gone. Then it is good to have short-term charter contracts. Their policy is to do things themselves; it is an economic question. The advantage of Maersk is that we get large volumes; the disadvantage is that we can quickly lose them.

Short sea shipping competes with road and rail as there are different types of customers compared with feeder services. Short sea shipping always has problems with transit times. A trailer that leaves from Northern Germany can arrive in Gothenburg the next morning, while a vessel might need three days. When it comes to short sea shipping cargo, we transport bulky cargo without tight time schedules, and we have been the cheaper option.

We are generally not competing with RoRo; perhaps to some extent on the short sea cargo segment. The customer demands are different for short sea cargo compared to what we are used to. There are higher demands on frequency, information, documentation, etc.

I don't think rail can compete with us. You need several high-frequency block trains in order to replace the feeder vessels. It will be a complement to us in the future, but not a competitor.

1.4 Do you have variations in demand and how do you handle them? Yes, we have peak season, but not very large variations. We add an extra vessel or use a larger vessel for some routes during that period. We can also exchange vessels between services. We are trying to solve the capacity issue internally. In normal cases, it is hard to find extra capacity during peak season but since the crisis it has been easy.

1.5 Do you have trade imbalances and how do you handle them? Yes we do and we try to solve imbalances in different ways: either you have cargo with high freight rates in one sea leg, or you have to call additional ports to fill up the vessels. However, it is more difficult to keep a good level of capacity utilisation when calling many ports on a string.

1.6 Do you have long-term contracts? We used to have one-year contracts, but there are no binding contracts anymore. In good times contracts might work, but in bad times a competitor can come up with a better price; either it's "thanks and good by", or we have to negotiate prices. We have, for example, three-year general agreements with "first refusal" when we are their preferred carrier. The shipping companies come to us first and we answer "yes" or "no". If we cannot or do not want to compete with the price level they are offering, they move on. Right now, it's a buyer's market, due to the balance between demand and supply.

We often have one-year or two-year contracts with the ports. Prices, waiting times and charges are in the contract. Traditionally we have had no agreements about arrival and departure times and berth windows, but that is changing.

2 Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

Overall
2.1 What factors affect the vessel capacity utilisation? We are affected by delays of the deep sea vessel. This can mean we need to leave half-empty one week, while the vessel the next week has a huge problem when plenty of cargo has accumulated from the week before. It also happens that they do not fulfil their promises and remove allocation on the feeder vessel if they are not interested in a certain market anymore.

Peaks and demand variations affect us. Except for market conditions, the flows are quite even in normal cases. But if we lose the cargo to the deep sea vessel, then it is gone.

Regulations such as sulphur restrictions in bunker fuel will have a large effect on our business. If you compare with road and rail, which are tax-subsidised, shipping needs to carry its own costs. Fairway dues, port dues, towing assistance, pilotage, etc. cover actual costs and are not negotiable. The high fixed costs imply that we cannot afford to enter a port with few containers.

There are also factors related to the vessel and the cargo such as max loads, stowage restrictions, dangerous goods regulations, and types of container. You have tank containers and bulk containers with strange measurements, e.g., you have the 30 foot container and the 2.55 foot wide container. We can take them all but we lose in capacity utilisation. For example, tank containers have a weaker construction so we cannot stack them high, and you lock two cells if you take the 2.55 foot wide container. 45 foot containers are a problem on some older vessels that do not allow them to be stored in the cargo hold; instead, they need to be placed on deck. This is not a

problem for newer vessels as these are built to carry 45 foot containers. Hence, you have all kinds of cargo restrictions affecting the capacity utilisation.

Management. There is always a conflict within each company. The sales department is responsible for customer relations and they have one view of the business. Operations that handle the cargo and the vessels have a totally different view. The financial department with their cost focus has a third view. And here we stand, stuck between the head office and the customers, trying to solve it in the best possible way. When we know the vessel is full and the sales department urges that we shouldn't say no to cargo, and operations says "we cannot handle more cargo, we have to leave cargo behind", then we need to solve the equation. This is not a rare situation for shipping companies. We sometimes need to leave cargo; there is no other option.

The weather affects us a lot, especially during autumn and winter. The ice situation we had during the winter was really bad.

The shipping industry's dilemma is that we are not well-developed when it comes to information technology; all the shipping companies with self-respect have a self developed system and all the ports have their systems. Now shipping companies have started to buy systems, but then they adjust them so you don't recognise them. We can receive poor information from our customers; this could include incorrect container numbers, incorrect weight figures, etc.

If the customers forget to cancel if they have booked a departure with a competitor or if they are late it affects our capacity utilisation. That might be the case for perhaps 2-10 containers per vessel.

Port performance affects us. Their planning is dependent on their access to information from us; they can use the cranes more efficiently, and load and unload the vessel faster. Rotterdam we have to wait until 24 hours after the departure of the deep sea vessel before we call because they need that time to get all information and bureaucracy together. It works better in German hub ports where they can handle deep sea vessels and feeder vessels at the same time. Their business is traditionally based on transshipment and they are adapted to handle feeders, while Rotterdam always claims that it is a deep-sea hub. However, this attitude is changing, starting with the losses in volumes due to the financial crisis in 2008.

2.2 How can vessel capacity utilisation be enhanced? We are trying to move the cargo between days if possible. We have a certain number of departures per week in a certain corridor. If we are fully booked on a Monday we can move it to a Wednesday. The customers don't get any compensation or discount, but as long as there is no disadvantage for them, they accept it. It is a mutual dialogue and they are trying to help as much as they can. We also move goods forward.

We are trying to find the best combination of ports when we set the sailing schedule to fill the vessels. We lost 25-30% of the volume in the crisis, and we were forced to combine more. We brought three strings together and got two strings with longer transit times. We cancelled 15 vessels in the crisis, so then it was good to have short-term charter contracts. The prices went from approximately 9000 euro per day to 2500 euro per day. And if you have to pay 9000 euro in a year and you cannot fill the vessel, then you will lose a lot of money.

We make sure we have the right vessels in the right trade. The vessels are very different in their design so we have to optimise the vessels.

We are working hard with the imbalances of the flow of empty containers. We are making sure that the port has a competitive empty depot.

We are going at full speed so we cannot increase much, but we can use the night shift in port even if it involves extra costs. We can also cancel a port or change the schedule. The number of vessels is our strength. We have many vessels so we can change vessels between routes when something happens. If you have few vessels you cannot elaborate as much.

The ports can use an additional container crane if we have a cargo handling split suitable for one more crane. The vessel can be loaded in such a way that two cranes interfere with each other. The vessels that are loaded and unloaded with two cranes are planned for that from the start.

We complement the feedering cargo with short sea shipping cargo, partly since short sea shipping is a business where you can make money, and partly since we believe that short sea shipping has a future. There are problems with the road network in Europe and there are several initiatives from the EU to promote sea transportation. In addition, many ports are working intensively on moving goods from road to rail, using railway shuttles, which have attracted more cargo to ports. Short sea shipping is a necessity for our financial results. Today the container constitutes approximately 90% of the volumes, but in the future I believe the balance will change radically. I believe we will be a short sea shipping company transporting feeder containers rather than a feeder shipping company transporting short sea shipping cargo.

2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation? If you have a nominal capacity of 900 TEU, which is a normal capacity of our feeder vessels today, you can load 900 empty containers, but approximately 550 are full in reality. Our capacity utilisation is quite high on our vessels. To be profitable we need to exceed 90% of nominal capacity utilisation. Either you max out on weight or TEU. We often max out on weight first. The load factors for the long legs are near 100% while the short legs are not. We are trying to have high capacity utilisation in the long legs.

You tie up a large amount of money when you call a port and it is not good if you have a period of low vessel capacity utilisation. You bleed very fast. Sometimes you need to invest and take risks of course, but there needs to be sound thinking behind the investment. We have a very short economic endurance because of the big money involved.

2.4 What do you do if you are late and need to catch up? It is hard to make up time as we are often going at full speed. Sometimes we have to change vessels. It is very expensive for us to be late. We have to cancel a port or re-schedule or combine different strings.

2.5 Do you use customers' forecasts when you do your capacity planning? We have contact with the industry, but it is more based on our interest to see what is going on in the market, and not so much on discussing operational issues.

2.6 What is difficult in vessel capacity planning? Fluctuations. In a long-term perspective, capacity utilisation is good, but individual departures can have very low utilisation level due to the deep sea vessels' delays. Delays are the largest problem. Reliability has improved since they started to slow steam because they now have wider margins. Before, they were more often late than on time.

2.7 What main factors do you take into consideration before investing in new vessel capacity? The need for capacity and the possibility to take 45 foot containers and other dimensions such as tanks and bulk containers. Ice certification and other demands on the vessels; for example, there should be a certain environmental and safety classification, etc.

2.8 If new capacity is needed for this route, do you prefer additional vessels, bigger vessels with the same number, higher speed; route changes; other? It depends. Larger vessels, if you can fill them, are better from an economic perspective. Then it is better to use a larger vessel and combine strings. Frequency is not so important, as long as you have a regular schedule that you don't change too often, i.e., a quarter of a year. The reliability is more important. For short sea cargo frequency is much more important than for feeder cargo. A trailer can arrive at any time. Frequency can become more important in the future.

It is a problem to have too high of capacity utilisation. In such a case we need to have high frequency in a port so you can move the cargo between departures. If you have a weekly service and you leave cargo, then it is a week to the next one and you miss the deep sea connection.

2.9 Are your vessels suitable for the transported cargo? We charter all our vessels. We have always had a policy to have short charter contracts be flexible. The market is very volatile. If some vessel suddenly doesn't fit in our concept then you don't have to pay for it in the continuing 12 months. We want to be able to act fast when something happens. We are optimising the vessel's capacity and equipment the whole time. Newer vessels are better and consume less fuel, which is also an important factor.

Port interface

2.10 What demands do you have on the terminals? We have high demands on flexibility. The port wants to treat us as like an ocean shipping company, but that doesn't work for us. We need to have the flexibility and the possibilities to change rapidly. The satellite port believes they are a deep sea hub port and they want us to have a closing for the cargo two days before the containers leave the terminal. It doesn't work for our business.

2.11 What demands do the terminals have on you? Information; that they have correct loading and unloading plans and closing times when the containers need to be in port before departure. They need that for planning and housekeeping activities. It is great for us when they replace the containers closer to our berth to reduce the turnaround time, but the problem is that we need more time for planning.

2.12 Who has the strongest negotiation power, you or the terminals? I wish it was us, but the port has started to dictate conditions and we are struggling intensely. The port is optimising their resources and I understand it to a certain extent. They have demands on profitability, but it should be based on higher costs for us and worsened service. The new information system means that we have been assigned tasks the port was responsible for before, and bookings cannot be changed. We are arguing a lot about minor issues. We quarrel and throw sand at each other and that is not evolving. We all blame the port for everything because they lost their goodwill a long time ago.

In smaller ports we have better possibilities to dictate the conditions. Consequently, they have a better negotiation position. The port also knows we don't have any alternatives. We do not decide to call a certain port; our customers do.

2.13 Do you get the required service in port? Yes, in normal cases. We are measuring capacity and productivity in the port every week to benchmark the ports and to see whether they fulfil their promises or not. The problem is that the satellite port calls itself a deep sea port and they don't realise that they are still a feeder port. The largest volumes are still feeder cargo. They remove capacity, increase the prices radically, and introduce an information system that is

completely. Sometimes they get a lot of complaints for minor issues, but they haven't been acting well for a long time.

There is enough capacity in the port, but not on the days when Maersk is calling. Maersk says: "Jump" and the port answers: "How high?" When Maersk says "We are coming on Fridays instead" the port says: "No, problem". We found that out one week ahead of time. We had two vessels on the Friday before and suddenly we only had one crane operating the vessels. That was not very well communicated.

2.14 Do you get the same service even if you are late? Normally yes in most ports, but not always.

2.15 What would a reduced turnaround time in port mean to you? In order for us to decrease the turnaround time we will probably need to move the closing forward. Thereby the port has more time for housekeeping the containers. Thereby we can save approximately half an hour.

We always depart earlier than scheduled in order to go slower or to reach the next port earlier. It is important to have extra time in the sailing schedule. But you cannot come too early either, or the cargo might not be there yet. What time we sail is completely uninteresting for the export customers as long as they know the day and they catch the departure time of the deep sea vessel.

2.16 Is the port capacity matched with vessel capacity? It was better before; now their peak time is Thursday-Friday. There are just not enough cranes for all the vessels these days. But I don't know what to do about it since there is plenty of excess capacity the rest of the week, and the capacity utilisation of the container cranes is very low on a weekly basis.

Sea interface

2.18 What demands does the feeder operator make on the ocean shipping company? Cargo information is the most important demand. We have small, weight-sensitive vessels. We need to know the number of containers, where they are going, weight and if there are dangerous goods. We get information regarding delays quite early as we are connected to the information system in the port.

2.19 What demands does the ocean shipping company make on the feeder operator? Reliability, punctuality, price and that we keep our promise: that we can handle the volumes every week in some pre-defined corridors. They cannot demand that we should wait when they are late but we'll do that if we can. We can wait if Maersk is a dominating customer on a certain route, but not if we also have cargo for many other ocean shipping companies. But it is a game: how late is the deep sea vessel? How delayed will I be if I wait? What will I lose if I don't wait? What will I gain of I do wait?

2.20 Who has the strongest negotiation power, the ocean shipping or the feeder operator? The shipping companies, obviously.

2.21 Do you cooperate with other shipping companies? Yes, in some relationships. We have one shipping service that we share with two other shipping companies. We operate the vessel and they pay for a number of container slots. The advantage is a reduction in cost. There is not much cooperation within short sea shipping, so this set-up is rather unique. There is more often cooperation between deep sea shipping companies and feeder operators. We make a commitment and we are guaranteed a certain number of container slots. They might always pay for 200 slots

even if they don't use them. I believe those kinds of relationships will increase. It can also be a first step for the deep sea shipping services to start their own feeder service.

2.22 Who introduces a new feeder service? The initiative in opening a new shipping service often comes from the ocean shipping companies that have cargo to be transported between certain ports. We calculate if the volumes are enough as a base flow, and what potential the port has for other cargo. Shipping companies select a transshipment hub based on price, transit times, volumes and operations. Further, many shipping companies own or partly own terminals.

2.23 What are the consequences for the feeder vessel if the deep sea vessel is late? Waiting times, lower capacity utilisation and increased volumes on the next departure. Sometimes it is worth it to lose a berth window; for example, if Maersk's vessel is late. We have to consider lost income versus increased costs.

2.25 Does Maersk inform you before they change routes or invest in new vessels? Yes, at least a month's notice, and I consider that a long time. We can start and close routes in a couple of months and that is our strength. We sometimes communicate changes in our schedule only a week in advance, but in normal cases we try to do it three weeks before.

2.26 How can the cooperation between you and the shipping company be improved? By mutual information exchange, and that is our responsibility as well. The more we know the better we can plan. We are trying to plan further in advance because it is better for us and we save money.

Customer

2.27 Who are your customers? For feeder operations our customers are the approximately 30 ocean shipping companies, and for the short sea cargo we have more relations with end-customers and cargo owners.

2.28 How do you prioritise customers when there is a capacity shortage? The loyal customers. There are ocean shipping companies that very often change feeder operators, and always try to find the cheapest price all the time; we are not prioritising those customers. And we do give preference to the customers we have long-term relationships with and contracts that tell us how to handle their cargo, rather than the best paying customers. Sometimes we would like to leave other customers than we do. You cannot optimise every single vessel all the time; it causes problems and the customers get tired and lose interest in us if we start to move cargo back and forth.

2.29 Do you use price differentiation? Yes, based on volumes and relationships. A larger customer has a lower price.

2.30 What demands do the customers have on your shipping service? Before the crisis almost all shipping companies had contracts with all the feeder operators. We are basically all charging the same freight rates as there is a market price. We compete with customer services and try to have good relationships with the customers. Then we work hard trying to get customers from our competitors. The shipping industry is very person-oriented. If your contact changes companies, many times you'll go with him or her. Since the crisis many things have changed; many companies have consolidated, and others can't afford to keep the same service level for their customers. The price is much more important now compared with, for example, frequency. Of course it is a survival strategy among the shipping companies, just as slow steaming. Unfortunately, it doesn't matter anymore how good we are from an environmental aspect if the price doesn't match that.

Respondent European Ocean shipping

Case description

1.1 Do you only sail on a pre-established schedule? Yes

1.2 What are the reasons for calling at the ports? During the financial crisis we did not have enough cargo and the more ports we added, the better chance we had to fill the vessels. Now when there is no crisis, we want to decrease the number of ports to save costs and we fill the vessel with fewer port calls

1.3 What is the competitive situation for the route like? Since we have a direct connection to Gdansk and Scandinavia, we have a unique product. The direct calls mean you avoid transshipment.

1.4 Do you have variations in demand and how do you handle them? Yes, we have peaks in the third quarter up until Christmas and before Chinese New Year. This year it was in January and it was terrible. Basically, all volumes increase dramatically in these periods.

It is possible to handle if you are sure you have the right level of commitment cargo on the vessel. These are the volumes we have all year round, no matter what. These are around 70% but the commitments also increase in peak seasons, so instead I say around 60%. Do we succeed? No, we never have. We always run out of space so we don't deliver the customer service that we want. It is impossible to handle; in some situations you want to be as tied up as possible and in others as little as possible. We try to find a balance between the two, but right now we are too heavily committed. I try to bring it down. In some peak periods, like this Chinese New Year, it was not possible for the customers to go somewhere else. They had to wait.

1.5 Do you have trade imbalances and how do you handle them? Of course there is a structural imbalance for dry bulk containers between the Far East and the West. But I also have a lot of reefers going from Europe to Asia where they don´t need them. But on a TEU level, I take the same number of TEU in and out. But on the way out 2000 of the containers are empty because the cargo from Europe to the Far East is much heavier than the other way. That is the reason why you fill up with empties to make sure you don't max the vessel out on weight, but you do it on the number of TEU instead. Westbound always maxes out on TEU, and eastbound you always max out on weight if you don't take empties. We have a high utilisation, very close to 100% for the westbound leg. It is almost as high for the eastbound leg as well. I need to balance, to have an equal amount of TEU in and out, so I don't have all the containers standing in one place.

Enhancement of vessel capacity utilisation

Questions are foremost related to Research Question 3

Overall

2.1 What factors affect the vessel capacity utilisation? Market demand, price... If we ask our customers what the most important things for them are, both smaller and larger customers answer price first. On top of that you have on-time delivery, customer service, transit time, and the guarantee we offer for a certain price.

Berth activity becomes important, but we wouldn't build a string if we knew that the port couldn't handle the moves we need. But if you have port congestion, then it is a problem and you risk sailing unutilised. We sometimes get priority but there are ports where the volumes are so big that you lose out on vessel capacity.

We cannot sail fully utilised if we miss a feeder connection. For example, if a feeder connection from Jakarta doesn't come in to Tanjung Pelepas in time, there will be 100-150 containers that cannot leave with the deep sea vessel the day after. As long as you don't have extra containers waiting, we call it rolling pools.

The types of cargo affect utilisation because of the weight. Eastbound from Europe to the Far East is a good example; you move waste paper, fertilisers, scrap metal, metal in general and chemicals. All are very heavy. Going the other way you move electronics, flat screen TV panels, clothes; all these items are much, much lighter. Therefore, you tend to max out on weight instead of TEU on the export.

There could be limitations in the number of 40 ft related to 20 ft containers the vessel can take. There can be vessel specifications that reduce the utilisation. And of course there is the weight of the cargo.

Some rules, like the cabotage in some countries doesn't allow us to transport cargo within the country. But again, we would not start a shipping service that could affect us in that respect. In such a case we haven't done our home-work well enough. We avoid situations that prevent us from doing what we want.

There are also port limitations that only allow a certain number of containers high onboard, 5-6 containers for example. We will always try to solve that before. Several ports can't reach the outer rows of our biggest vessel, but again, we wouldn't go in there. She only calls ports that can take her.

2.2. How can vessel capacity utilisation be enhanced? We are almost 100% utilised if you are looking at the vessel from the Far East, so there is not much more we can do here. Perhaps there are some technical vessel specifications so you can squeeze out a few more TEU.

We have changed the sailing schedule to prolong the transit time: 2 days extra westbound and 5 days extra eastbound. The customers had no choice because everybody did it. Four years back the average number of vessels on the string was 8 vessels; now it is 9, and the expectations are that it will go to 10. By adding a vessel we take out capacity of the market and we save fuel. We have reduced the costs 10% by going slower. Environmental aspects are also advantages of slow steaming. Reliability is another advantage as we can catch up if we are late. Since we are full now there are some lost opportunities. We could speed things up to get some extra capacity but with the costs in bunkers, we will not do that.

2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation? 95-97%. We have tried to calculate this, but it is very difficult. From 97 to 100%, I don't think there is payback on that: so much more coordination, and so many things that can go wrong; you shift things, you tend to roll customers and what are the opportunities with that? I think 97% is the perfect spot on; you don't stretch the operations and you utilise the capacity almost to its full extent.

Our bottleneck is our containers. What we are doing right now is actually bringing down the physical vessel capacity utilisation by pricing. We are pricing too high so we are losing out on

business right now. But we do it on purpose. The point is to make more money with a lower utilisation level.

If you have almost 100% utilisation perhaps you would like to add capacity. But that is always the big trick. We can increase the capacity. We can add a new string. But what is the risk? The risk is that everybody thinks that and starts strings and we have overcapacity. Then the rates drop and the same thing will happen as two years ago. That is the name of the game. That is why it is a cyclical business. You have the top 15 carriers that always want to be the top three. And they do that by buying vessels. That is the reason for overcapacity.

2.4 What do you do if you are late and need to catch up? Go faster, that is all. We can cancel a port but that is a problem as we have weekly departures. But it does happen that we don't call a port if we are so far behind. For example, if we need to catch Suez Canal; Suez has convoys, so if we are late we have to wait 24 hours for the next convoy. In those cases it will cost you more to lose that than to cancel a port. But how do you assess the commercial downside of not calling a certain port? That is very difficult to calculate and it tends to be much more operational: the $250,000 or $500,000 dollars to go through the Suez, the cost of the speed up will cost us x amount of money in fuel and so forth. And then we have all the big customers onboard that need to get off in the port, so we need to have another port they can get off instead.

There could be many reasons for being late; for example, reasons related to weather, fog in China, etc. It could also be due to the port. If there is a vessel in the port we need to wait. We speed up but that costs a lot of money. In my main leg the average speed is 18 knots.

2.5 Do you use customers' forecasts when you do your capacity planning? Customers very rarely know what they need. We look at it, we take it into consideration, but we tend to use historical data to assess what they actually will commit to. We found it is closer to the real world.

2.6 What is difficult in vessel capacity planning? Lack of proper customer forecasts. If you have 70% of the vessel capacity committed the point is to have 70% week after week, but you have downfalls. When I look at south China for example, I consistently have around 25% of downfalls. It goes up or it goes down. So 25% doesn't show up. You can compare it with a restaurant. If you book and don't show up, that is lost money. It is fine if someone standing outside needs the table. Or, in our case, if someone is waiting with cargo in the port. It is a really big problem. In a weak market it is very difficult to sanction the customers. But what tends to happen is that we sanction them when the market is getting stronger; that is what we call rolling cargo: they don't get onboard if we are full.

2.7 What main factors do you take into consideration before investing in new vessel capacity? "Show me the money." That is the easy one and the only one principle. That is based on how we expect the demand to develop and how we expect the market to develop. And what the supply of capacity will be at the market.

We never open a service based on a specific customer. We look at the market. You cannot entertain a vessel only for one customer. It is different for short sea shipping.

You need a minimum of eight vessels to open a string. That is $800-$1000 million, so almost a billion dollars is out only for starting a new string. So you have to be pretty comfortable that there is a demand for them. That is the reason why many of our competitors are in trouble right now, because they need to pay for vessels with low utilisation. Why are we not in trouble? Because we were lucky because we didn't order any vessels.

2.8 If new capacity is needed for this route, do you prefer: additional vessels, bigger vessels with the same number, higher speed; route changes; other? Bigger vessels, but if we have bigger vessels we cannot go to Gdansk. I cannot increase capacity. Well, I can go faster and increase the rotation and take a vessel out. Weekly departure is theoretically the way of doing it. You can increase capacity, but it is nothing you can sell. Remember this, because it is important for capacity utilisation: even if you cut off time in certain ports, the factories in China have a certain day when you need to be there. For example, if you need to be there Friday afternoon we make sure everything is loaded during the weekend and goes out on Sunday or Monday. That will also affect capacity utilisation. That is mainly a problem if you have one string, but we have several. Of course our service will not meet all single windows perfectly, but it will meet 2 out of 3 and then string AE2 will take the other ones. We have a whole group working with this to try to make it work. When you multiply the number of strings, the number of port moves, the number of moves, and populations, there are so many possibilities.

2.9 Are your vessels suitable for the transported cargo? Yes.

Port interface

2.10 What demands do you have on the terminals? The key figure is port productivity. We have specifications for gate movement, how many containers can come in and out of the port. Another thing is the customer setup in a specific port, e.g., customs, inspections, and authorities connected to the port, in order to avoid bureaucracy. In several ports we have more than one terminal and they may not be the same customs. Some ports are more flexible and easier to deal with.

2.11 What demands do the terminals have on you? Fixed berth windows so they can plan their activities. Information.

2.12 Who has the strongest negotiation power, you or the terminals? We do right now because of the extra capacity in port, but it was different three years ago and it will change again in the future. Before there was a lot of cargo to the Baltic States that went through Port X that we now ship directly to Gdansk. We took away a lot of business for them that they would like to get again, so now we can ask for better rates and terms. They would have done the same. It is about finding a partnership where you can rely on each other. You don't want to kill them. If we don't pay them enough they will not be able to live up to our requirements. It is a balance. The power will change again.

2.13 Do you get the required service in port? In some ports we do and in some we don't. It depends. But I think due to our size we get the services we plan for in most ports.

2.14 Do you get the same service even if you are late? It depends on the situation, if there are vessels in port or not. In some ports we have "first right of refusal" so even if we are late we can kick them out. In other ports, we need to sit down and wait.

2.15 What would a reduced turnaround time in port mean to you? It is always possible to reduce the turnaround time. The possibilities to decrease the turnaround time in port are higher with higher productivity, better yard planning, and improved port infrastructures. There are all these factors within the terminal, and if you ask the terminal they will probably give you a list of a hundred things. Better information from our side could probably also reduce the turnaround time. When we are arriving from the Far East they know exactly what is on the vessel, and they know exactly how many moves they have except for the export moves. That is why they have a cut-off time 24 hours before the vessel.

2.16 Is the port capacity matched with vessel capacity? Right now if you look at Europe, the main bottlenecks are the ports, but it will be again.

2.17 What are the advantages and disadvantages of operating your own terminals? APM Terminals owns the terminals and Maersk Line uses them. We use the terminals like any other operator and we treat each other at arm's length. There are certain terminals around the world that we consider cost centres, which mean they are hubs. They opened these terminals to meet our needs. We are the main customer. Other terminals have about 35-40% from other customers.

Sea interface

2.18 What demands does the feeder operator make on the ocean shipping company? We are the customers.

2.19 What demands does the ocean shipping company make on the feeder operator? Price, reliability, type of vessels, number of reefer plugs, equipment, the geographical coverage, frequency, flexibility, how soon they can change routes.

2.20 Who has the strongest negotiation power, the ocean shipping or the feeder operator? How we need to treat them depends on who has the upper hand: we need to pay for a certain number of slots, or we pay for used slots only. We tend to go into agreements with few operators, but we usually have one. But we change if someone else has a better product or a better price. The negotiation power depends on the situation. If an operator has a product going into certain ports and the demand from our side is not big enough for us to open our own service, they know that their price can be close to the cost for us to run our own service, and by that they have the upper hand.

2.21 Do you cooperate with other shipping companies? Yes. Both ocean shipping companies and feeder operators.

2.22 Who introduces a new feeder service? If for example we want a feeder from Gdansk to Finland, we go to the feeder operator in Northern Europe with a tender and ask them who wants to bid on this business.

2.23 What are the consequences for the feeder vessel if the deep sea vessel is late? It depends on how many customers they have. They usually have more than one customer, so they can fill up with cargo. If it is not enough they have to wait.

2.24 What are the advantages and disadvantages of owning your own feeder service? Advantages are flexibility and that we can decide what we want to do by ourselves. If we use a third part feeder, they decide. The disadvantage is that it is expensive if you are not utilising your vessel capacity. So, it can be a very expensive solution.

2.25 Does the deep sea vessel affect the feeder service capacity utilisation? Yes, if we are late.

2.26 How can the cooperation between you and the shipping company be improved? If you look at the feeder operator X we have a close cooperation, but feeder operators are also competitors with their own business portfolio. It is always complicated to cooperate with competitors. You have diverse interests. But it is easier if it is strictly operational.

Customer

2.27 Who are your customers? A mixture. We have a lot of key accounts, but also medium size and smaller clients. Of course the biggest weight onboard is on key accounts. The goal of 70% is a scientific number unfortunately; we don't know. We are trying to figure out for each string: perhaps it should be 85% or 50%? It depends on how much you want to play with at the spot market and how volatile the market is. If you can fill the vessel no matter what, you can have 100% in. The market is very strong, and then you can get a higher rate, but that is also pretty risky. It is about striking that balance. Our target right now is around 70%.

A higher level of base volumes is obviously important if the freight rates are low. Low freight rate is typically a result of a weak market. The more you can lock into the vessel the better it is. The spot rate is lower than the rates you have on the vessel. Likewise, this year we are still carrying a lot of cargo that is significantly under the market price and we have a high level of commitment rate. If I went out on the market now, I could get double the price we have on our vessels today.

2.28 How do you prioritise customers when there is a capacity shortage? If you have committed cargo you have first priority. Second priority is best paying customers, and so forth. We have reefer containers that we have to take onboard, and military cargo, etc.; there are many rules.

2.29 Do you use price differentiation? Not really. But we are looking into introducing a new product call "priority cargo upgrade", where you basically can buy yourself into the vessel for a certain fee.

2.30 What demands do the customers have on your shipping service? Price, space guarantee, transit time, customer service, reliability. It depends on the customers.

Respondent European Hub port

1 Case description

1.1 Who owns and operates the terminal? We have two shareholders that own 50% each. One of them is APM terminals. We operate the terminal.

1.2 How many shipping companies call at your terminal? The major client is Maersk that has a share of approximately 90%. We have approximately six other ocean shipping companies, and three feeder operators.

1.3 What is the modal share? The transship volume is about 60%. 20% is truck, 20% is rail.

1.4 Do you have variations in demands and how do you handle them? Close to the end of the year, the volumes normally increase because every customer wants to have his vessels filled up with cargo. Less cargo is transported over the seas at the beginning of the year. It is not that we have very high peaks or low volumes, so we don't have over-capacity or under-capacity in our personnel. If there is a high peak we can order staff from a pool that provides specialised, trained people, and we have the equipment to handle the peaks.

1.5 Do you have trade imbalances and how do you handle them? No, we don't.

1.6 What are your competitive advantages as a port? The advantage is high productivity. We have sufficient state-of-the-art equipment and highly motivated people.

2 Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

2.1 What factors affect terminal capacity utilisation? Schedule reliability, data integrity and to have an EDI exchange. We sometimes get incorrect information from both ocean shipping companies and feeder operators. Dwell times. Something we call "move count accuracy". For each vessel calling the terminal we get an indication of how many moves we need to handle. That enables us to do the pre-planning. It might cause problems if there are big deviations between the move count and the finally provided load and discharge lists. Therefore, move count accuracy is important. We get the first information a week and a half in advance and the closer it gets to the vessel's arrival the more accurate the figures will be. We adjust them every day. We need to have the most reliable figures the day before arrival, because then we order the personnel.

Are weather conditions a factor? It varies, but not many days per year there can be fog, high winds, etc.

Yard utilisation. If you stack five containers high the yard utilisation is quite high. But high yard utilisation also means that productivity will go down as the straddle carriers drive longer and handle more containers to get the required containers out of the stacking area.

2.2 Are the terminal capacities enough? Yes, both personnel and equipment.

2.3 What is needed to increase terminal capacity? We need more yard space, but it is not possible. We might be able to rent space in the neighbouring facilities, but it is not possible to expand yard space or reclaim land somewhere in the sea. With the straddle carriers we are using now, it is not possible to stack them higher. In that case, we have to exchange equipment, but that involves of course heavy investments. The yard space is enough due to the dwell time we have at the present and the volumes we have in combination with the productivity we provide. But, for example, if cargo is not shipped to a Russian port as they are on strike and not able to handle the cargo, then the cargo is stuck here. This means that the yard utilisation is automatically increased, and we need to stack higher. We are able to stack 4 containers high, but we would like to keep it as low as possible, maximum two high, to decrease the housekeeping activities. It is also possible to reduce the storage time of the containers, but this is something we need to discuss with the shipping lines so they can force their customers to pick the import cargo earlier and not deliver the cargo as early to the terminal as they normally do in order to decrease the dwell time. The average dwell time is four days for full containers and almost the same for empties.

2.4 How do you prioritise vessels when there is a capacity shortage? In a dialogue with the shipping companies. We definitely prioritise ocean going vessels, but we don't necessary prioritise Maersk's vessels. Other global lines also have vessels that belong to certain stings that have certain berth windows which should be kept. The priority of the feeder vessel depends on if there is connecting cargo on the feeder vessel to a main carrier that is already at the quay.

2.5 How do you handle delayed liner vessels? In a dialogue with the shipping lines and the delayed vessel. If we need to have her in now, the late one gets priority. The vessels are not often

late; they are mainly on schedule. Before the crisis and slow steaming we also had quite good schedule reliability. It was worse in the past when we started the operations here, but now it is ok.

2.6 Do you use customers' forecasts when you do your capacity planning? Yes, with regard to vessel schedule, move count forecast for our daily planning and the number of containers to handle. That is the only forecast. Cargo-wise we would like to know the number of empty containers to handle, as there are large empty shipments to take care of. We don't have forecasts a year in advance, only two weeks in advance.

2.7 What demands do you have on the shipping companies? Information about the number of containers, vessel schedule, container information, etc. But no other demands.

2.8 What demands do the shipping companies have on you? Price and productivity.

2.9 Who has the strongest negotiation power, you or the feeder operator? They are the customers. They are mainly carrying Maersk cargo, and we depend on the Maersk Line. It is not the same level as the ocean shipping lines, but due to the fact that they are still the customers the power is more to the feeder operators than to us.

2.10 Who has the strongest negotiation power, you or the ocean shipping company? Definitely the shipping company mainly because we are a dedicated facility that has some major clients.

2.11 Do you have long-term contracts with feeder operators or ocean shipping companies? Normally we review contracts every year. The terminal contract is longer, so it is not reviewed every year. The terminal contract only specifies the service to be provided without any price tag. Price may change every year but not the service.

2.12 Do shipping companies inform you before they invest in new capacities? We get information in advance. I cannot specify if it is one, two, or three months or a year in advance. It is not ad hoc that we cannot handle it and that we are surprised by a new service or a new vessel type. We get the information well in advance so we are able to act. It is enough.

2.13 How can better information from the shipping companies improve your service? We can improve productivity if the data quality and the data integrity are better. The planning for a container starts before the vessel arrives at the facility. We have already decided before the vessel arrives where to drop the container and where the allocation for that container will be in the yard. Any cargo coming into the terminal will be directly located close to the berth of the vessel it will be on. We try to put the container in the right place from the start to avoid housekeeping activities. If there is a high amount of cargo at a certain berth and the vessel is late, we might consider reberthing the vessel. But then we need to consider if it is worth to do so, or if we should go for the original berth as the majority of the cargo is located at that spot. In case we reberth the vessel we need to consider the high amount of housekeeping moves to get the cargo reshuffled. We also need to consider cross traffic of the straddle carriers during operations. The late vessel might also have a conflict with other vessels being handled in port.

If we in 100% of the cases have email contact with the vessel, we can avoid going onboard to provide them with the planning. We can instead send the plans before the vessel arrives and they can look into what we are planning to do. If they disagree and something needs to be changed, we don't need to wait until the vessel arrives and someone from the planning department goes onboard and discusses it with them. If there are changes to be made they can be done before we can start the operations.

2.14 Is it possible to reduce the turnaround time with existing port capacities? We can increase productivity. That can be done by using operation strategies like pooling. This is not always possible due to the crane split being provided by the shipping companies. Normally you have a number of straddle carriers serving a crane and that goes for each crane. If you pool all the straddle carriers it means that straddle carrier number one is not always serving crane A only during that shift, but can also serve crane B. The straddle carriers are not dedicated to one certain crane but to a vessel, which is served by a number of cranes.

The shipping companies' stowage planes affect the turnaround time. If they provide a sufficient crane split the cranes are not too close when they operate the vessel. If you have sufficient space between the cranes, in our case that is 80 ft in between, it definitely increases the productivity of the cranes. The straddle carriers can cycle around one crane and don't need to drive though a lane.

The turnaround time can also be reduced by reducing the amount of hatch covers being handled and reducing the amount of restowes. A restowed container needs to be discharged from the vessel as it prevents original cargo from being designated to the port to be discharged. Afterwards, the container needs to be reloaded again.

Respondent European Satellite port

1 Case description

1.1 Who owns and operates the terminal? It is owned by the local government, but the container terminal will soon be put up for sale.

1.2 How many shipping companies call at your terminal? Thirteen different shipping companies, three of which are ocean shipping companies.

1.3 What is the modal share? Approximately 45% rail, 50% road and less than 5% sea. We are trying to increase the transshipment.

1.4 Do you have variations in demands and how do you handle them? We have weekly variations in demand but no seasonal variations. Everyone wants to come on Friday and since Maersk arrives on Friday, not many other companies can call then. Five container cranes, five gangs and many straddle carriers are working on the big vessel. It doesn't matter which day they arrive since they occupy almost all resources that particular day. However, many want to come on Fridays because that is the way the industry works and it is hard for us to change that. We want the ship calls to be as even as possible.

1.5 Do you have trade imbalances and how do you handle them? Until last year we had a very good balance of exports and imports. In the last year, imports decreased substantially while exports stayed quite even. We need to handle a lot of empty containers as empties are imported.

1.6 What are your competitive advantages as a port? We have a good geographical location close to the Swedish and the Norwegian markets, and we only have 1.5 hours to open sea. We have also unutilised capacity, except on Fridays. We used to say we had available capacity while our competitors were full, but that is not the case anymore.

2 Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

2.1 What factors affect terminal capacity utilisation? How the vessels are loaded affects the capacity utilisation. For example, if the vessels are stowed so that an optimal number of container cranes can work on them throughout the whole operation, and if the larger vessels are loaded so they allow the smaller cranes to reach all the containers to be unloaded in port, that represents good capacity utilisation. Some vessels are stowed in a strange way that prolongs the turnaround time. There could for example be 6-7 rows of containers close to the quay that are stacked really high that we should not touch at all, but the containers on the bottom of the outer rows are to be unloaded. In such case we cannot guarantee the same productivity. There are many other things to take into consideration when planning the vessels, e.g., location of dangerous goods.

Sometimes a lack of correct information causes delays when a container is in a wrong location. Then we need to stop the operation and start searching for it. We should always receive information within a certain time frame before a vessel's arrival, but it can happen that some containers that should be on the vessel haven't arrived in the port in time; there might be congestion or a truck with a flat tire or something else. We are discussing how to improve the information exchange at present. As soon as changes occur, we need to re-plan the small weight-sensitive vessels. Many shippers do not understand how important it is to have the correct weight for the containers.

Fluctuations in demands.

The market condition.

We have railway shuttles that have made it possible to increase our volumes over quay quite a bit as well. Last year when many ports lost much of their cargo volumes, we didn't lose as much. Some are new customers that used to go to another port but today take the train to our port.

New IMO-regulations on sulphur emissions will soon come, which could affect us since it affects sea transportation as a whole.

Management; we have a continuous dialogue with our union. Now things have improved since management has involved the union much more and they have been allowed to participate in the discussions. We have a new management that motivates people and makes them work better.

Weather conditions; we have to stop the cranes if the wind is too strong.

2.2 Are the terminal capacities enough? We have a lot of unused capacity, but we also have uneven utilised capacity; Thursday and Friday full, Saturday-Wednesday free capacity. The gates are open between 5.30 and 23.00, but the berths are open 24 hours if we have customers. Equipment and personnel are sufficient for the volumes we have now; the question is how much we want to grow. We have quite a lot of space compared to other ports, even though our planning division believes we are all full. We are only stacking two full containers high but we have tried three containers high. We can physically handle it but we don't want to because of the additional housekeeping activities. If one container is cancelled, there is so much work to move around the containers. We can stack three containers high if we improve the information exchange.

We bought three large cranes to handle Maersk's vessels and increase the direct calls, which we have not received yet.

The customers demand a high degree of flexibility. We can provide them with staff and equipment whenever they want to come, but are they ready to pay for it? They are not. It is expensive to have the employees doing nothing but waiting for vessels. That is the problem with peaks in the demand.

We are trying to increase the volumes on rail. The railway is a bottleneck but in reality it is more due to lack of planning and information exchange. The physical capacity exists but we receive many half empty trains. I believe we can increase a great deal without new tracks.

2.3 What is needed to increase terminal capacity? We're trying to increase productivity with existing resources. It is much about motivation, that people feel involved. We have always been very flexible and service-minded, which have cost us plenty and the customers have been unsatisfied when we didn't manage. Now we have tried to change that and the customers think we are inflexible. We are discussing time windows between 7-24, and that we want to have correct information at a certain time. This means we can cut the turnaround time, and the vessel can leave earlier. Sometimes the feeder operators want us to wait for a late container. Earnings must be compared with increased costs, and then it is probably better to leave the container to the next departure.

2.4 How do you prioritise vessels when there is a capacity shortage? We prioritise deep sea vessels.

2.6 Do you use customers' forecasts when you do your capacity planning? We are making prognoses for one year ahead and we update them every quarter. We talk to the shipping companies, but we don't receive any forecasts. We must keep in mind that the customers are often competitors, especially the feeder operators, which borrow goods from each other. So if one customer believes he will increase with 15% you know he is calculating that on transferring containers from a competitor. Thus, our total volumes will be unchanged.

2.7 What demands do you have on the shipping companies? We have never before made demands on the feeder operators, but now we have increased our demands, which we neither needed nor wanted before. There will be time windows where we guarantee a certain amount of moves and when we need the information. If this is fulfilled, we can guarantee handling the vessel in a certain time. If we don't fulfil that, there will be consequences for us accordingly. They believe the demands are annoying; we hope that our strategy will make them more satisfied. They don't have fixed sailing schedules. There needs to be a certain level of flexibility in feeder shipping as the competition is really tough.

Information about the vessel: estimated time of arrival, stowage plans, and which containers are to be loaded and unloaded. We make a load plan that needs to be checked with the Chief Officer. At 23.00 the day before the vessel's arrival, the information needs to be available.

2.8 What demands do the shipping companies have on you? The most important for the ocean shipping company is productivity, that we are able to handle the vessel within a certain time. We have individual contracts and the price is most important, especially for common feeders as the ocean shipping companies dictate prices. Flexibility is also central for the feeder operators. Before, we tried so hard to be flexible and help them that we sub optimised our own activities.

2.9 Who has the strongest negotiation power, you or the feeder operator? If you ask the feeder operators they will answer "the port" as we have a monopoly and can dictate prices. We know

that they need to call at this port as their customers want that. Perhaps we have a stronger position.

2.10 Who has the strongest negotiation power, you or the ocean shipping company? When we are negotiating with ocean shipping companies we can only listen to them. By tradition it is very important to have a deep sea call from Asia. We are working to get more direct calls here, because it is important for our industries. They want to avoid transshipment as it costs more money, and they believe one departure per week is too few. The direct calls are important for the industry and also for the marketing of the port.

2.11 Do you have long-term contracts with feeder operators or ocean shipping companies? I believe most contracts have a duration of one year. Some customers might have a two-year contract, but that is very long.

2.12 Do shipping companies inform you before they invest in new capacities? I believe they come to us quite late, so the time is rather short. Sometimes they have already decided, and then there is no dialogue at all.

2.13 How can better information from the shipping companies improve your service? Correct cargo information makes it possible for us to do our work much better. Strategic information is essential as well. It is difficult for us that Maersk Line is so dominating; they can change their strings and call another day if they want to. If they want to come on Wednesdays they will come on Wednesdays. We wish to take part in the discussions, and also to engage our other customers so they feel involved in the planning. We would like to inform them in an early stage because everyone automatically needs to adjust.

2.14 Is it possible to reduce the turnaround time with existing port capacities? Yes, if they arrive when they should and at the time we have agreed on, and if the information is correct and the containers are located where they should be. Perfectly planned vessels with perfect information decreases the turnaround time. Technical issues affect the time; it can, for example, be hard to open old types of twist-locks. We can housekeep containers and get ready before the arrival of the vessels by placing the containers close to the berths in order to reduce the straddle carriers' driving distances and ensure that the cranes are busy the whole time. Then it is annoying when we have worked hard with the preparations and the shipping company cancels half of them or moves them to another vessel that will arrive at another berth. A decreased turnaround time is not only good for the shipping companies, but for us as well because then we can accommodate more vessels.

2.15 How can the cooperation between you and the shipping companies be improved? The feeder operators understand we need to organise ourselves better. But at the same time, they think it works against their business, which needs to be as flexible as possible.

Respondent Japanese Feeder operator

1 Case description

1.1 Do you only sail on a pre-established schedule? Yes, but sometimes we change it on short notice. The schedule is quite similar every week, but if the mother vessel changes her schedule

we also adjust. We can easily change the schedule if requested by Maersk. We can also change if another ocean shipping company asks us to change the route, but we need to check with Maersk first to see if it will be a problem for them or not. We always need to plan for the mother vessels. We have a basic schedule; if we need to put in an extra vessel or a larger vessel we need to know two days in advance. Our route schedule needs to suit their departure time frames. For example, Tuesday is the deadline for cargo to be transported to Europe; therefore, we need to deliver the cargo on Monday. We are increasing capacity every year, we inform before.

1.2 What are the reasons for calling at the ports? Maersk Line's requests. We have vessels that only transport cargo for Maersk but not on this route. Maersk's share is about 80% for this service.

1.3 What is the competitive situation for the route like? We compete with road carriers. There are other domestic feeder services but Maersk is only using us on this route. We have almost 50% of the market share for domestic feeders in Japan. The total number is about 660,000 TEU/year. The feeder competitors only have smaller types of vessels. We also compete with shipping lines transporting cargo between Busan in South Korea and Japan, which Maersk is using. Finally, we compete with the mother vessels. For example, if Maersk Line decides to call at our satellite port with their own vessels, they don't need a feeder service anymore. Therefore, it is very difficult for us to forecast investments.

The rail capacity in Japan is very poor; Japanese Railways (JR) is not in any competitive position. There is mainly passenger transportation on rail. It is possible to transport 40 ft containers but few containers are available.

Our competitive advantages are: 1) low costs (lower than Korean competitors), 2) our service network is much bigger than our competitors' networks, 3) the large number of vessels that allow us to use a vessel from another route if necessary when there is a volume peak, and 4) the large size of the vessels compared with competitors that only have small vessels.

1.4 Do you have variations in demand and how do you handle them? Yes, we have seasonal variations. We cannot control this. In November it is low season for refrigerated containers (5%) while it is higher in July or August (up to 20% for refrigerated containers), but we have enough refrigeration units for the containers. The seasonal variations in refrigerated containers are mainly due to the export of fish. If the volumes decrease we change the number of vessels from 4 to 3, or we can change from a big to a small vessel. If instead there is an increase in volume we can increase the number of vessels. We also have weekly variations. For example, we have two vessels on Saturdays because of the amount of containers. This is because of export deadlines.

1.5 Do you have trade imbalances and how do you handle them? We carry empty containers from the hub port to the satellite port for customers to export. So the balance is ok; I think less than 5%. There is no problem for us with trade imbalances. We are very happy about this market.

1.6 Do you have long-term contracts? No, only one year contracts with Maersk Line. It is only price per unit in the contact, not how much we will transport. All risks are on us. We have contracts where the whole vessel is used by Maersk. It is the same with the terminal, year by year, and only price. No performance targets are mentioned. We have no contract with the cargo owner because that is Maersk's responsibility.

2 Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

Overall
2.1 What factors affect the vessel capacity utilisation? The Japanese feeder market faces some issues regarding regulations that affect feeder operations: 1) cabotage, 2) only Japanese employees are allowed onboard, and 3) it is costly to enter into the Japanese Union. For example, if a new vessel costs 500 million Yen, we need to pay an additional 100 million Yen to enter the Union in order to be allowed to transport domestic cargo. The reason why Japanese feeder operators have small vessels is the regulations. There are two types of vessels, below 500 Japanese gross tons and between 500-750 Japanese gross tons. It is easier for smaller vessels to get a licence and it is cheaper to enter the Japanese Union. It is approximately 100 million Yen for 499 GT and 150 million Yen for 749 GT. 4) We are not allowed to change stevedoring companies once we have registered.

Port capacities are enough. If the ports are busy we can in some cases use public terminals for loading and unloading the containers and transport them by truck to the right terminal. In other cases the vessels need to wait if the port is busy.

Sometimes we wait for the mother vessel in the hub port. Today Maersk Line calls Kobe, Shimizu and Yokohama. If Maersk only goes to Yokohama we have a good chance to transport cargo between these big ports. Then we can increase our capacity utilisation.

Seasonal variations in transport volumes of the mother vessels.

Weather conditions.

We can't use 100% of the vessel capacity if all containers are full. This is our headache! Therefore, we carry 60% empty containers. We have an over-capacity due to heavy weights. The GT is the limitation. If a container weighs 30 tonnes, on a 250 TEU vessel that is 30x250= 7500 GT if all containers are full.

We try to find more containers in order to increase our vessel capacity utilisation. We try to get new domestic local customers to fill up empty capacity. An example of short sea shipping cargo is recycled materials that can be put in containers.

2.2 How can vessel capacity utilisation be enhanced? We can change vessels between our services if necessary when there is a volume peak. We can get in contact with other shipping companies and ask if they have containers to be transported.

2.3 What do you believe is the theoretical optimal level of vessel capacity utilisation? Today we have X% of capacity utilisation of all our 18 vessels. We try to increase it by 5-10%, but our management requests full capacity. The optimal level might be 100% if we use short sea shipping cargo. We are trying to identify new customers that use trucks today and that have non-time-sensitive cargo. This cargo is "second" or "slow" cargo because it can wait if other cargo is more important, like Maersk's cargo. These customers can fill up 5-20%.

2.4 What do you do if you are late and need to catch up? In order to save bunker we don't travel at maximum speed (14 knots), so we can speed up if we are late. It costs more but cost is the second matter; on-time delivery is more important.

Normally we deliver cargo one day before the arrival of the mother vessel, but it is possible to unload the vessel at the same time as the mother vessel is loaded if we are late. This can be done if there is less than half a day delay. If there is a bad weather, we can transport the cargo with trucks. Trucks are only used for exports; we don't do that with import cargo. Cost is a second matter in this case. In the worst case we have to send it with the next vessel.

2.5 Do you use customers' forecasts when you do your capacity planning? No, we don't have the information.

2.6 What is difficult in vessel capacity planning? The uncertainty is if the feeder vessel service will be permanent or not, that is, if the ocean shipping companies will continue to use the feeder service. Ocean shipping companies also force us to minimise the price. And all risks are on our company.

2.7 What main factors do you take into consideration before investing in new vessel capacity? 1) Demand, 2) the mother vessel schedule and volumes, 3) licence costs 4) the market condition, 5) the need for maximum capacity.

2.8 If new capacity is needed for this route, do you prefer additional vessels, bigger vessels with the same number, higher speed; route changes; other? We would have preferred a bigger vessel with the same number because we already have high frequency. However, high frequency is market requirements and then we cannot have one big vessel. We have 18 vessels now, maybe 19 and then 20 next year…. The vessel with 499 GT and 749 GT needs the same number (5) of staff onboard, and if we would have a bigger vessel than 749 we would need more people. The introduction licence is also much higher. We tend to invest in bigger vessels but it is driven by customer and market demand.

2.9 Are your vessels suitable for the transported cargo? Yes, we are thinking about investing in new, bigger vessels, but the demand depends on the mother vessel and available cargo. We only transport containers, not bulk cargo, so our vessels are suitable for the cargo.

Port interface

2.10 What demands do you have on the terminals? We discuss price, but it doesn't change much yearly. We discuss safety for cargo and workers, and if communication is enough.

2.11 What demands do the terminals have on you? We discuss sailing schedules daily.

2.12 Who has the strongest negotiation power, you or the terminals? The terminals; if they refuse to service us, we cannot do anything. Once we have registered a business relation, we cannot easily change it. There are two terminal operators in the satellite ports, and once we have made up a contract we can't change due to Japanese regulations, even if they want to increase prices, because we can only sign up with one company.

2.13 Do you get the required service in port? Yes, both in the hub and satellite port. Even if we are a small company we have some advantages. Since we are transporting Maersk's containers, they prioritise us both in the hub port and in the satellite port. And we have been in the business for 35 years, so we have an advantage compared with other small companies.

2.14 Do you get the same service even if you are late? Same service. In the case of the satellite port, they are very flexible. Even if we are late they will start unloading and loading as soon as we arrive.

2.15 What would a reduced turnaround time in port mean to you? It is better for us to have a short turnaround time. Today only one crane and one gang is loading and unloading the vessel so it would have been possible to reduce time if they increased the number of gangs and cranes. It is, however, difficult for us since our volumes are low and since the Japanese workers are expensive.

2.16 Is the port capacity matched with vessel capacity? Yes. The ports can handle bigger ships. They can also handle higher frequency. Increased frequency could be a problem in the hub port since we need to get a new berth time window. They only have 2 berths and several big mother vessels are calling at the port.

Sea interface

2.18 What demands does the feeder operator make on the ocean shipping company? We can't make demands. We want Maersk to decrease the number of ports they call at in Japan. Thus we can take care of the domestic transportation and we can both decrease costs.

2.19 What demands does the ocean shipping company make on the feeder operator? Good price. Sailing schedules that suit the mother vessels. Flexibility; they want us to work on the New Year, and therefore we will. The demands are different for outbounds and inbounds; especially the timing of the export cargo in order to get the cargo to the mother vessel before the weekly departure. If we are late we can deliver cargo with trucks, but we only do this for export cargo.

2.20 Who has the strongest negotiation power, the ocean shipping or the feeder operator? Maersk! Because it is a very big company.

2.21 Do you cooperate with other shipping companies? Not for this service, but in other parts of Japan we do. We have space charter agreements for containers. We don't do it here because the competition is tough and it is a fairly new market.

2.22 Who introduces a new feeder service? Ocean shipping companies.

2.23 What are the consequences for the feeder vessel if the deep sea vessel is late? We have to wait.

2.25 Does Maersk inform you before they change routes or invest in new vessels? Yes. Maersk informs us if they are investing in new capacity three months ahead of time. This is not enough time for planning. Earlier would have been better, but there is no other way due to Maersk's head office policy. But still it is better than Japanese shipping companies. They can change the mother vessel's schedule without any notice.

Customer

2.27 Who are your customers? Our customers are Maersk and other shipping companies: few and large companies. We don't have contact with cargo owners or forwarders.

2.28 How do you prioritise customers when there is a capacity shortage? Depending on the priority of customers, some cargo will have to go with the next ship. The biggest shareholder will

get priority. If we have a shortage in capacity we use another vessel from the market. 2-3 days is enough to get a vessel here. We can also use a road haulier. It depends on the quantity. If it is 50-60 we try to use the vessel. It also depends on the priority of the customer.

2.29 Do you use price differentiation? We have fixed prices agreed to on a yearly basis, and we have different prices for empty and full containers.

2.30 What demands do the customers have on your shipping service? Frequency. If we have daily departures it is possible to get new customers that use trucks today. The possibilities are very high. But daily frequency is very expensive.

2.31 Why is feedering not more common in Japan? Due to the cabotage the costs are high for feedering in Japan, and we have high costs for investing in new vessels and licenses. Then we have about 1M TEU from Busan to Japan that is not included in the Japanese domestic statistics.

Respondent Japanese Ocean shipping

1 Case description

1.1 Do you only sail on a pre-established schedule? Yes. But sometimes we change the route depending on the customer's requirements and weather conditions.

1.2 What are the reasons for calling at the ports? We initially started to cover the port for a major shipper and subsequently accepted import shipments for container flow balance. We buy slots onboard for this route. 10-15% of the mother vessel's capacity is transported by the feeder operator.

1.3 What is the competitive situation for the route like? There is a competitor that makes a direct call at the port on its Pacific string. Others serve the port by rail, truck and domestic feeder vessels.

1.4 Do you have variations in demand and how do you handle them? Yes, we have seasonal variations but they are not remarkable and they do not affect us specifically. We leave it to the feeder operator to adjust their capacity based on the demand.

1.5 Do you have trade imbalances and how do you handle them? Basically import acceptance is done to meet export demand in terms of container flow.

1.6 Do you have long-term contracts? Basically all contracts are on a yearly basis.

2 Enhancement of vessel capacity utilisation

Questions are foremost related to Research Question 3

Overall

2.1 What factors affect the vessel capacity utilisation? Capacity utilisation is a concern when the contracts with feeder operators are not on space purchase basis but on number of container basis.

There is a berth conflict as there is capacity shortage on the quay side. A late deep sea vessel can affect the capacity utilisation of the feeder.

2.4 What do you do if you are late and need to catch up? Alternative transport mode, road or rail, is applied.

2.6 What is difficult in vessel capacity planning? Nothing.

2.7 What main factors do you take into consideration before investing in new vessel capacity? The capacity of the feeder services.

2.8 If new capacity is needed for this route, do you prefer additional vessels, bigger vessels with the same number, higher speed; route changes; other? Either additional vessels or a bigger vessel, or both.

2.9 Are your vessels suitable for the transported cargo? Yes.

Port interface

2.10 What demands do you have on the terminals? Berth windows and cargo handling productivity.

2.11 What demands do the terminals have on you? Accurate container information.

2.12 Who has the strongest negotiation power, you or the terminals? We do, because we are their customer.

2.13 Do you get the required service in port? Yes.

2.14 Do you get the same service even if you are late? Yes.

2.15 What would a reduced turnaround time in port mean to you? Cost savings and efficiency.

2.16 Is the port capacity matched with vessel capacity? Yes, but there is a berth conflict on the quay side.

2.17 What are the advantages and disadvantages of operating your own terminals? The advantages are prioritization and productivity. The disadvantage is cost.

Sea interface

2.18 What demands does the feeder operator make on the ocean shipping company? No demands.

2.19 What demands does the ocean shipping company make on the feeder operator? On-time connection to and from the mother vessels. The demands for the outbound and inbound are not the same.

2.20 Who has the strongest negotiation power, the ocean shipping or the feeder operator? We do, because we are their customer.

2.21 Do you cooperate with other shipping companies? No.

2.22 Who introduces a new feeder service? It depends.

2.23 What are the consequences for the feeder vessel if the deep sea vessel is late? Adjustment of the feeder services to meet the changes.

2.24 What are the advantages and disadvantages of owning your own feeder service? We should not own; we are not allowed to operate feeders due to cabotage restrictions.

Customer

2.27 Who are your customers? Manufacturers and traders. We have sales activities.

2.28 How do you prioritise customers when there is a capacity shortage? Based on contribution margin.

2.29 Do you use price differentiation? Yes, we use price differentiation based on various business factors.

2.30 What demands do the customers have on your shipping service? Reliable connections to and from ocean vessels. Transit time.

Respondent Japanese Hub port

1 Case description

1.1 Who owns and operates the terminal? A governmental body owns the port and the cranes. APMT is leasing the berths. We are responsible for terminal operation but not vessel control, and we have a contract with APMT. We use an external stevedoring company as a subcontractor.

1.2 How many shipping companies call at your terminal? One domestic feeder operator, and five international ocean shipping companies.

1.3 What is the modal share? Approximately 90% trucks, 0% rail, and 10% short sea shipping. 10% is good for a Japanese port. We don't have railway tracks into the terminal.

1.4 Do you have variations in demands and how do you handle them? Usually we have peak demands from August to October because of Christmas imports. In spring 2009, Maersk Line will start to call a Japanese port in their trans-pacific route to transport fruit, which will change the patterns. We use portable generators for the refrigerated containers. We also have weekly variations. Tuesday, Wednesday and Thursday are the busiest days. The berth windows are very congested on these days, because of the busy schedules of the mother vessels. We increase yard stack density to handle the peaks; we stack higher.

1.5 Do you have trade imbalances and how do you handle them? We have some trade imbalances: we import a little more than we export but the figures are almost equal.

1.6 What are your competitive advantages as a port? High productivity, efficient equipment and lashing gangs. Shipping companies are interested in high productivity.

2 Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

2.1 What factors affect terminal capacity utilisation? Number of cranes, number of equipment, land space, procedure of our operations, management and organisation in terminal, and size and type of vessel. For example, some small vessels have ship cranes onboard that they use at some terminals. As these interfere with our container cranes, they affect the productivity. The market and cargo owners or forwarders also affect utilisation. The storage time of the containers: the rotation is low, 2-3 weeks, and they try to use the terminal as a warehouse. Thereby, we lose capacity in the terminal. We ask the big customers/shippers or the shipping lines' sales departments to remove their containers because we need the extra space. Safety regulations and inspections in port for imported containers reduce productivity: they inspect coffee beans, fruit, hay, etc. Quays and berths are open 24h/day. Truck gate: 8:30-20:00 weekdays. The union doesn't allow it to be open longer. Some road carriers want it to open earlier in the morning.

The ocean vessels and feeder vessels call the same berths in this terminal. Years ago we used to have separate berths for domestic and international vessels. The infrastructures for domestic and international are still separated in some Japanese ports. On such occasions we need to use a road haulier to transfer cargo between the terminals, and we have to pay for it. The government deregulated in the 90's and ever since we have been allowed to use the same berths for ocean vessels and feeders.

2.2 Are the terminal capacities enough? No, the land area is restricted. We can handle maybe up to 1.1 million TEU per year, and we are almost there. We need berths, cranes, land area and reefer receptacles. The capacity utilisation of the cranes is 20-40%. Some other terminals in Japan have less than 15%.

2.3 What is needed to increase terminal capacity? Our bottlenecks are berths and quays. The length of the berths is X metres, which is a bit short so we would like to expand them by 50-100 metres. The k-class requires longer berths, so we will not get an additional berth, but we will be able to accommodate all sizes of vessels.

We only have 5 cranes, so we will get one more at the end of next year. Even though the capacity utilisation is low, the extra crane is necessary to load and unload the vessel quickly with 6 cranes if there is a need for it. When the European vessel arrives on Tuesday, we have the maximum handling volume in our terminal; we handle more than 22,000 TEU. Then we need to apply six cranes.

High-density stacking area and marshalling yard to maximum the number of container slots. In October 2008 we had the maximum number of containers at our terminal, 27,000 TEU, and then we stacked higher, 4 or 5 containers on top of each other. But it affects vessel productivity and reduces safety due to the reduced visibility in the yard. Five containers is the maximum stacking capacity. This is due to handling equipment, and not because of pressure on the ground. Empty containers are stacked 6-7cont/slot.

Increased land space and container handling equipment. The land area is very restricted. We stack five containers, but we also need to relocate many containers. We are planning to expand the port with two new terminals but it will take five years to build as we need to reclaim land.

Today we have in total 24,000 containers in the terminal: 10,000 are full and the remaining 14,000 are empty. There are too many. China doesn't need any more empty containers so that is

why we have so many here. The shipping companies are responsible for the empty containers. If they are owned by Maersk, Maersk has to pay for them. The capacity can be increased if the storage time is reduced. If the import containers are stored for more than one week, the customers have to pay an additional fee for them. Export containers are allowed to arrive a week before departure. But some customers are in contract with Maersk to store their containers longer.

In the long run, it is possible to develop a pattern of yard allocation for vessel/size/type/port. Today we use information from Maersk and their experience.

2.4 How do you prioritise vessels when there is a capacity shortage? We prioritise deep sea ships.

2.5 How do you handle delayed liner vessels? According to requests from shipping companies, we give priority to delayed vessels and they get the same service even if they are late. We adjust and use the maximum number of cranes.

I heard from Maersk Line that around X% is late. This is a confidential figure. The reasons for delays are strong winds, typhoons, vessel engine problems, crane trouble in previous ports, etc. We have more delays between spring and autumn due to weather conditions. This figure is for Maersk deep sea vessels; feeders are impossible to measure. The feeder operator's vessels are not fixed to a schedule. They only have schedules for basic routes and they change based on conditions, e.g., if they suddenly get additional containers from one port. Sometimes they don't come the same day as they should. Our agency division has daily contact with them, and they know when the terminal is not occupied. We don't measure their punctuality. If they are late we can unload the feeder vessel at the same time we load the mother vessel.

2.7 What demands do you have on the shipping companies? Reduce the time of the empty container storage.

2.8 What demands do the shipping companies have on you? More yard space, high service level, and fast turnaround time.

2.9 Who has the strongest negotiation power, you or the feeder operator? The feeder operator has a contract with Maersk Line so we don't negotiate with them directly.

2.10 Who has the strongest negotiation power, you or the ocean shipping company? Maersk!

2.11 Do you have long-term contracts with feeder operators or ocean shipping companies? We have a terminal agreement with APMT. We established a contract this last January. Until last year we had a contract with Maersk. We have only a one-year contract.

2.12 Do shipping companies inform you before they invest in new capacities? We get information through APMT. We have daily contact with the Maersk cluster team. When there are special cases, such as a new capacity or a new schedule, it is important for us to get the information. Sometimes we get the information 1-2 months early, sometimes through press releases. This is not enough for our planning. We want to know earlier, but they have a press release policy at Maersk. We plan months ahead, but the vessel schedules are always changing.

2.13 How can better information from the shipping companies improve your service? We want to know the number of containers for export and of course the destination. If we can get this one week ahead we could easily arrange the yard better and we don`t need to housekeep the containers so much.

2.14 Is it possible to reduce the turnaround time with existing port capacities? The shipping lines require short time in the port, and it is our target to reduce the turnaround time. Our productivity is 45 cont/h/crane. We can increase productivity if we increase with one crane and use six cranes/vessel, but we cannot reduce the turnaround time with existing capacity.

Sometimes the deep sea vessel departs and leaves some containers behind. The first priority of the shipping line is the base cargo, and the export and import cargo. They are highly respected for that and such cargo is very punctual. Transfer cargo is cheaper and not so punctual. Even though the cargo is a target for a ship, it is sometimes left for the next vessel. The shipper doesn't care about arriving time or day. That is also different between a direct call and a transit call. Transit cargo is like economy class and has low priority. Sometimes containers are left behind due to vessel stability, vessel capacity or time problems.

We stack five containers but the housekeeping activities increase the turnaround time of the vessel because it takes longer to get the containers from the yard to the quay. However, if the import container is stacked higher it doesn't affect the vessel productivity so much as if export containers are stacked five containers per slot.

2.15 How can the cooperation between you and the shipping companies be improved? With good communication between actors. We have a contract with APMT, but we have no formal contract with Maersk. APMT and Maersk work closely together. For APMT, Maersk is one of the customers. Both companies have different interests. Their targets may not always match. We are between these companies in a very delicate position.

2.16 Why is feedering not more common in Japan? Compared to Europe, Japanese domestic feeder vessel capacity is very low. Japan is a small country so it is easy to reach customers' doors with trucks. The distance between origin and destination is less than 50 km, so we can stand for 2 h in congestion and still reach the customers in the morning or in the evening. Road congestion is a bigger problem than sea and rail congestion. The hub port is very important for one of the biggest Japanese car manufacturers that ships parts and products related to their just-in-time system. Sometimes one booking covers more than 500 containers. It is very convenient for them to use the trucks for the JIT-products.

Respondent Japanese Satellite port

1 Case description

1.1 Who owns and operates the terminal? The prefecture owns the port. There are many different operators in the port, and we are two container terminal operators. We share the same cranes and equipment, and we do our planning together and decide who can use the cranes. We make adjustments depending on the order of vessels that are calling the terminal. Sometimes we load and unload ships together.

1.2 How many shipping companies call at your terminal? We have only liner services, but both domestic calls and international calls. All together we have around eight shipping companies. Today there are many feeders compared to how it used to be. It is about 50% feeders and 50% deep sea calls.

1.3 What is the modal share? 100% road, 0% rail. We don't have railway tracks.

1.4 Do you have variations in demands and how do you handle them? We don't have so much demand variation, but there are many vessels coming on Monday and Tuesday so there might be more trucks on those days and the deadline for dropping of containers is Wednesday-Thursday so there might be more trucks those days as well. If there is a peak we use more staff and more trucks, and work overtime.

The terminal is not open 24 hours/day, but the demand is not high enough to keep the gate open longer. If a vessel arrives when the gate is closed the terminal will load and unload the ship as normal. This happens around 1-2 times per week. Some of the road hauliers would like the gate to be open longer.

1.6 What are your competitive advantages as a port? There are a lot of factories around this area. The location is close to the central parts. We are pretty big.

2 Enhancement of vessel capacity utilisation
Questions are foremost related to Research Question 3

2.1 What factors affect terminal capacity utilisation? Speed of the service, the restricted land area, that we need to adjust to the other terminal operator, import/export volumes, and if the number of empty containers can be reduced. It is rather the terminal that affects the road hauliers and not the other way around. If the terminal's capacity utilisation was better then perhaps there would be less congestion.

2.2 Are the terminal capacities enough? No, we need more container yard space. The cranes are not a problem. There are enough containers to have feeder vessels 3-4 days per week, but if the cargo volumes increase maybe they can increase to 5-6 departures per week. Frequency is important. I think there is enough cargo in this area to be able to have 7 departures per week. But if they would have it the capacity in the terminal would not be enough. And also, if you could have 7 feeder departures per week then it would be better to just add a big mother vessel instead. But then the frequency would become very low again.

Berths, quays, cranes and equipment are enough for now, but not the land. The prefecture has a plan to expand the land area within five years. There is some road congestion but this is not really a problem.

2.3 What is needed to increase terminal capacity? In the short run, to increase rotation of the containers by getting the goods-owners and shippers to pick up the containers quicker and reduce the storage time. The rotation of empty containers is very low and needs to be improved. We pay a fee to the owner for containers stored in the terminal. This amount is then claimed from the shippers, and the shippers in turn claim this from the goods-owners. In the long run, more land area is needed and increased container yard space is needed.

2.5 How do you handle delayed liner vessels? If the vessel is late and cannot make it to the hub in time, we have to redo the planning of the vessel and the feeder operator has to arrange for the containers to be delivered by truck to the hub port. Sometimes the feeder operator puts this on us. Because this port is important for the feeder operator they do not skip us but they might skip other terminals.

2.6 Do you use customers' forecasts when you do your capacity planning? No. We have six months to one year joint planning, but they don't discuss what they should do about our port in the future. They don't plan five years in the future.

2.7 What demands do you have on the shipping companies? To get information about what time vessels will arrive and cargo information (amount of containers, amount of refrigerated containers, etc.), and the size of the vessel.

2.8What demands do the shipping companies have on you? They have made demands for increased yard space, and increased cargo handling speed, but not any demand printed on paper…We are counting 30 containers per hour, but for the small feeder vessels that are easier to load and unload, it is 35 containers per hour.

2.9 Who has the strongest negotiation power, you or the feeder operator? Basically the feeder operator, but both partners have discussions of what they need from each other.

2.10 How has the strongest negotiation power, you or the ocean shipping companies? The ocean shipping company.

2*.11 Do you have long-term contracts with feeder operators or ocean shipping companies?* A one-year contract with the feeder operator, with automatic renewal. Basically we do not have contacts with cargo owners, only with shipping companies.

2.12 Do shipping companies inform you before they invest in new capacities? Yes, we get information before; otherwise we could not handle the containers. For all shipping companies we get information about two weeks or one month before new vessels are introduced. But we do not get this information several months in advance.

2.13 How can better information from the shipping companies improve your service? We would like the information earlier when the shipping companies are introducing new ships or changing their schedules. Now we get the information about changes in sailing schedules 12 hours to 24 hours before the ships arrive to the terminal.

2.14 Is it possible to reduce the turnaround time with existing port capacities? With increased skill of the staff working in the port and of the planners. Planning is not so critical and they don't spend too much time on planning. They use Excel and special applications for planning but it is up to every single person.

2.16 Why is feedering not more common in Japan? The lead time is longer for short sea shipping than for trucks and that is why the feeder is not used so much in Japan. It takes 6-8 hours with trucks and more than one day by feeder from the satellite port to the hub port. It's much faster to send the containers by direct liner services. It's impossible to send something by feeder if it has to arrive the next day or the day after that.

Basically, feeders are cheaper than trucks. For example it costs $1000 to send a container from Tokyo to here by a truck. By feeder, it is 50-70% of that price. Besides, you can transship it to an ocean liner but some customers dislike it because it takes too long and the feeders don't leave every day so most of the customers prefer to take the containers straight to the hub port.

Appendix G Questionnaires Study III

Questionnaire for ocean shipping company and feeder operator

Company		
Name of respondent		
Position in the company		
Years in the company		
Route characteristics		
Departure frequency		Departures/week
Ports included in the route		Names
How many vessels operate the route?		No.
Time for the vessel to complete a round trip?		days:hours
Average TEU handled in port/s		
Loaded		TEU
Unloaded		TEU
Average turnaround time in port		
Reliability for the route (punctuality)		%
Average capacity utilisation of vessels: *Mark (X) only one box*		
80-100 %		
60-80 %		
40-60 %		
20-40 %		
0-20 %		

Questionnaire for terminal

Company		
Name of respondent		
Position in the company		
Years in the company		
The terminal		
Calls per week		No.
Handled TEU per year		TEU/year
Length of quays		meter
Number of berths		No.
Number of container cranes		No.
Land area		m2
Average storage time for containers		
Open hours in port		
Average capacity utilisation of container cranes: *Mark (X) only one box*		
80-100 %		
60-80 %		
40-60 %		
20-40 %		
0-20 %		
Route characteristics		
Average turnaround time in port		
Reliability for the route (punctuality)		%
Average handled TEU for the sailing route		
Loaded		TEU
Unloaded		TEU

Appendix H Data analysis of Study III