Structuring and modelling decision making in the inland navigation sector

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GRAPHS:

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ABBREVIATIONS

ADN: Accord Européen relatif au Transport International des Marchandises Dangereuses par voie de Navigation intérieures

ADNR: Accord Européen relatif au Transport International des Marchandises Dangereuses par voie de Navigation du Rhin

BE: Belgium

BVB: Bureau Voorlichting Binnenvaart

CBO: Coöperatieve van Binnenvaart Ondernemers

CBRB: Centraal Bureau voor de Rijn- en Binnenvaart

CBS: Centraal Bureau voor de Statistiek

CBV: Coöperatieve Binnenscheepvaart Vereniging

CCR: Central Commission for the Navigation of the Rhine

CEMT: Conférence Européenne des Ministres de Transport

CFNR: Compagnie Française de navigation Rhénane

CH: Switzerland

CZ: Czech republic

CZB: Coöperatieve Zandschippers Bond

DE: Germany

DGSEI: Directorate General Statistics and Economic Information

DRB: Dienst voor Regeling der Binnenvaart

EBIS: European Barge Inspection Scheme

EC: European Commission

ECMT: European Conference of Ministers of Transport

ELV: Europese Logistieke Vervoerders coöperatie

FR: France

GMP: Good Manufacturing Practices

hp: Horsepower

IKT: Industry Knowledge Team

INE: Inland Navigation Europe

ITB: Instituut voor het Transport langs de Binnenwateren

IVR: Internationale Vereniging het Rijnschepenregister

IWT: Inland Waterway Transport

kW: kilowatt

LU: Luxembourg

NL: the Netherlands

NSTR: Nomenclature uniforme des marchandises pour les Statistiques de Transport, Révisée

NPRC: Nederlandse Particuliere Rijnvaart-Centrale

PBT: Profit before taxes

PBV: Promotie Binnenvaart Vlaanderen

P&I: Protection and Indemnity

PTC: Particuliere Transport Coöperatie

Ro/ro: Roll on, roll off

SPB: Stichting Projecten Binnenvaart

TEU: Twenty foot equivalent unit

WS: Weekblad Schuttevaer

GLOSSARY

Bareboat charter. Similar to lease. The vessel is chartered to a third party who to all intents and purposes owns it for the period of the charter, provides the crew, pays operating costs (including maintenance) and voyage costs bunkers, port dues, canal transit dues, etc.), and directs its operations (Stopford, 2009).

Barge. A barge is a type of inland waterway vessel with does not have its own means of mechanical propulsion. It typically has no accommodation and a rectangular form.

Charterer. Person or company who hires a ship from a ship-owner for a period of time (time charter) or who reserves the entire cargo space for a single voyage (voyage charter) (Stopford, 2009).

Container. Large metal box with standard dimensions designed to carry freight.

Construction year. The year of the original construction of the hull of the vessel.

CV-construction. An alternative way of financing a vessel. The equity needed for the vessel comes from several private investors, the rest is provided by a financial institution. The vessel is than rented on the basis of a bareboat charter.

Demurrage. A fee levied by the shipping company upon the post or supplier for not loading or unloading the vessel by a specified date agreed upon by contract. Usually, assessed upon a daily basis after the deadline (Paelinck, 2008).

Freight rate. The charge made for the transportation of freight (Paelinck, 2008), Freight tariff.

Load factor. The percentage of cargo carried.

Leasing. Alternative way of financing goods. The legal owner of the good hands the property over to the lessee in return for regular payments. The lessee uses the goods as though it were his own. At the end of the period, the good returns to the owner, also referred to as lessor (Stopford, 2006).

Owner-operator. In case the vessel is operated by the person that owns it, this person is called an owner-operator. It is common in the sector that the vessel in this case is operated by the family.

P&I club. Mutual society which provides third party insurance to ship-owner members (Stopford, 2009).

Rotation. The rotation is a system of chartering that was used in the sector before the liberalisation. It consists of allocating requests for transport operations from customers on the basis of the order in which boats become available after unloading and are registered by their owners in a charter exchange. Carriers entered on the rota are invited, in the order of their registration, to choose in turn a load from those on offer for which that meet the conditions. Those who do not choose a load nonetheless keep their position in the order. In rotation systems, prices are fixed either by the public authority or by a multisector organization. The conditions attaching to the loads on offer (destination, type of good, price…) are published (EC, 1994).

Self-propelled vessel. This is a powered inland waterways freight vessel.

Self-propelled tanker vessel. A self-propelled vessel for the transport of bulk liquids or gaseous products.

Spot (voyage). A charter for a particular vessel to move a single cargo between specific loading port(s).

Pusher vessel. This is a powered vessel without its own carrying capacity. It is designed to push barges, platforms and so on.

Tug. A tugboat is a powered vessel without its own carrying capacity. It is designed to be used in combination with barges, platforms and so on.

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It takes quite some time to write and finish a PhD. In that time period, the world does not stand still and wait for you. So many things happen, good as well as bad, and so many people come into your life for a shorter or longer period. All these encounters and events leave something behind and that is how you grow as a person. The PhD grows in a similar way, as a result of interesting discussions, new viewpoints, new data that comes available and so on.

Writing this part is somewhat delicate, because there is always the chance of forgetting to mention someone. Therefore, I would like to start by expressing my gratitude to all people who have contributed to this work in any way and in any moment in time. But I also want to thank some people in particular here, although it is difficult to decide on whom to start with.

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One of the main challenges of the PhD was how to get all that knowledge that is gathered over the years on paper and preferably in a way that is understandable for people who were not involved in the whole thinking process. I hope I have succeeded in it. Thanks to all the members of the PhD -commission for reading and commenting on this work.

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Chapter 1: Setting and outline of the research

1. General description of the inland navigation sector

Inland navigation is a transportation mode which combines high mass transport capacity with low operating costs, an average predictability and good traffic safety, although it is very limited in terms of speed, network development potential and frequency of service (ECMT, 1999).

1.1. Introduction

Even though the inland navigation sector has a long history, for several decades, its use was reduced to such an extent that it was forced to the background of the transport market. On the one hand, road transport became a more attractive alternative from the 1960s onwards, because it was relatively cheap, fast, efficient, flexible, etc. Companies increasingly started settling in areas where the connection to roads was better, and so estates close to waterways became abandoned. On the other hand, the share of product categories which traditionally benefited from inland navigation, being mostly bulk transport, diminished as a result of structural economic changes, such as relocation of production sites.

Ever since the 1998 liberalisation, the situation for certain goods and certain routes has changed to a great extent; inland navigation is more often presented as an alternative to road traffic. The ever increasing congestion, especially around the most important economic locations such as cities and seaports, demands an adjusted transport organisation of companies. Inland navigation is also used for short distances, as this transport mode is hardly subject to congestion. Moreover, the trend of just-in-time transport does not necessarily mean fast delivery of goods, but reliable delivery times.

In addition, the increased activity in European seaports – and especially in those ports with a good connection to inland navigation – has led to an increase in the use of inland navigation. In return, inland navigation brings a more extensive hinterland for the ports, which makes them more attractive and on top of that, more shipping is generated. Furthermore, the increased containerization has spurred inland navigation. The use of intermodal loading units has made it easier to organise combined transport, which made the combination of modes more frequent. What's more, containerization has brought a larger freight potential, goods which otherwise would not have been transported using inland navigation.

Governments strongly focus on sustainability, among which sustainable goods transport using alternative modes. For this purpose, among others intermodal goods transport and the use of inland terminals are promoted for container transport. Inland navigation itself also contributed to its improved situation. A decade ago, the sector had to deal with a negative image, being old, slow and not flexible. Modern ships and techniques are now massively invested in and the sector's trump cards are actively played, meaning the environmental friendliness, reliability and the congestion-free character of this transport mode. Introducing labels and certificates in the sector in order to increase the quality of the vessels such as the Green Award[1] for inland navigation (as from 2011), can emphasize the strong points of the mode and therefore encourage shippers to consider using inland waterway transport.

The aspects of sustainability and environmental friendliness as such, however, will not lead to a major breakthrough of inland navigation. The price remains an important factor for shippers, which makes it necessary that freight tariffs in inland navigation transport are competitive compared to those of the other transport modes. This is even more the case for intermodal transport, which entails an important transhipment cost and the costs of pre- and post- haulage.

Moreover, also duration plays a role for shippers. Inland navigation is a relatively slow mode and extra transhipment increases this even more. It is less important for container transport from and to seaports, as the time span is relatively small compared to the duration of maritime transport or door-to-door traffic. For a number of sectors, not the speed of transport is an important factor, but reliability (just-in-time). This offers new opportunities for inland navigation. Furthermore, the sector should respond to the new situation in order to keep and expand its market share. This entails the offer of a decent service, co-operation with other parties in the transport chain and exploration of new markets (e.g. dangerous goods).

1.2. Overview of the sector

In this part, a general description of the sector is given, which starts with the geographical aspect, followed by an outline of the types of waterways and vessels used for inland navigation. Next, the most important goods transported by the sector are represented. It ends with the importance of the sector in the different European countries and the policy level.

The European network of navigable waterways covers around 15,000 kilometres. The major part (around two thirds) is located in Central Europe and the other part in the newly admitted member states of the Union. In Central Europe, waterways in the year 2001 are largely (almost 80%) ECMT class IV[2] or higher. In the new member states that same year, however, 40% of the network still belonged to class I, II or III (PLANCO, 2003a).

Because not all European countries have navigable waterways in their territories, inland navigation only represents around 3% of total European goods transport. Notwithstanding this limited percentage at European level, inland navigation is an important transport mode in a number of countries. European countries in which inland navigation plays a substantial role are the Netherlands, Germany, Belgium and France. Also in other European countries such as Romania, Austria, Luxembourg, Bulgaria, Hungary and Slovakia goods are transported by inland waterways. Taken all together, these last ones only represent a very small share of the total IWT in Europe (see figure 1.1).

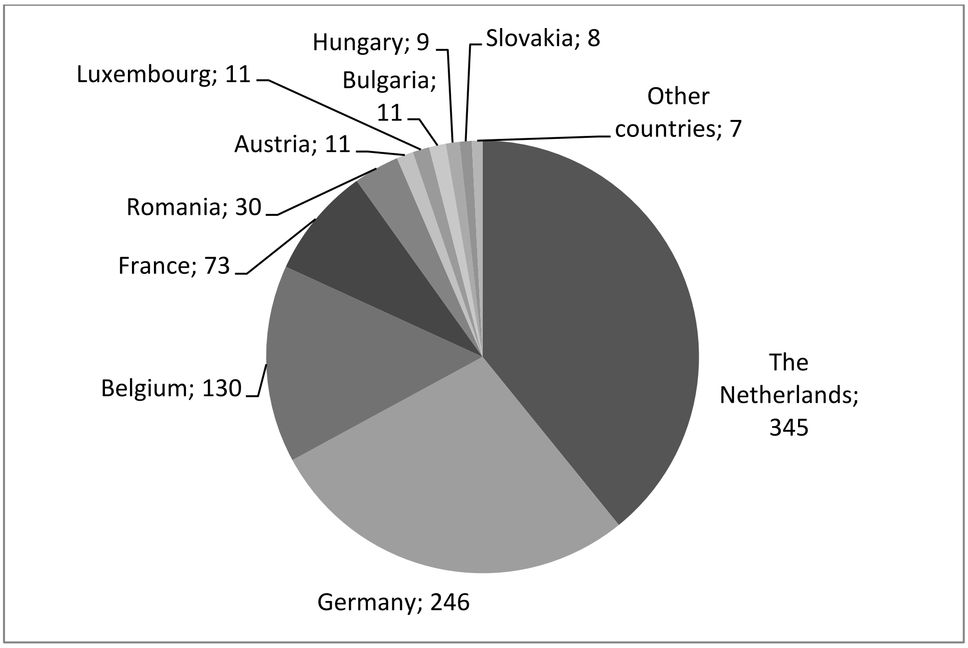
Furthermore, inland navigation is to be found in some other countries, such as in Italy, Sweden, Finland, the Iberian Peninsula and the United Kingdom. In these countries, inland navigation works

[1] This is a certification which should lead to recognition and motivation of clean ships and serve as a tool for charterers to choose clean ships

[2] See Annex 1

on a regional level as these navigation areas are only connected to other networks by means of short sea shipping. Also in China, the USA, Brazil and in some African countries goods are shipped by means of inland waterway transport.

Graph 1.1: Goods freight transport by inland waterways, EU-27 2008 top ten (in million tonnes)



Source: Eurostat (2010)

The connected network of navigable rivers in Europe is subdivided into four shipping areas or corridors. The four European corridors of the network are (Buck Consultants International et al., 2004):

- The Rhine corridor (western Germany, the Netherlands, Switzerland, eastern France and Luxembourg). The Rhine is the most important waterway here.
- The Danube corridor (South-East corridor). This concerns the Main and Danube rivers as the main rivers.
- The East-West axis (northern part of Germany to Poland). This corridor comprises the Elbe, Oder and Wisla basins.
- The North-South axis (France, Belgium and the Netherlands), where the Seine and Rhône rivers are the most important waterways.

This principal network is further supplemented by smaller waterways. This generates an inland navigation network which stretches from the North Sea to the Black Sea. In Annex 3, the four corridors and the entire navigation network are mapped. The Rhine axis is the most important of the four axes and it covers around two thirds of the waterborne transport in Western Europe (CCR, 2007a). Together with goods transport on the Danube, this represents 70% of the inland navigation transport (CCR, 2007b).

The main goods flows in inland navigation are either between seaports, from the seaports to the industry and towards the inland terminals in the hinterland. European seaports often form part of the transport route of goods which are shipped by means of inland navigation. Raw materials are mainly imported from overseas and conversely, a part of the production is destined for export. This each time entails transhipment in the seaports. Therefore, transport by means of inland navigation often has a seaport as origin or destination (ECMT, 1999). Large volumes are also shipped by inland waterway transport between seaports, like for example between the ports of Antwerp and Rotterdam. Next to this, the intra-port barging is becoming more and more important. The environment of seaports is often heavily congested which makes the transport of containers by inland waterways between terminals within a port beneficial if not necessary. The Premium Barge Service in the Port of Antwerp is an example of such intra-port barging3.

Industries dependent on raw materials (bulk goods) have mostly settled in areas which are accessible for this type of transport. Traditionally, these are situated nearby a waterway, such as for example the iron and steel industry and power plants. Evidently, relocation of this industry has significant effects on the transport demand (CEMT, 1999).

The presence of inland terminals for intermodal transport spurs an increase of traffic on certain inland navigation routes. Container transport allows smaller quantities to be transported in a cost-effective way by means of inland navigation. The inland terminals also serve as satellite ports for seaports in order to relieve the latter. Between seaports and inland terminals, e.g. on the river Rhine, more and more container services are organised.

Traditionally, inland navigation was used for transports on a mid to long distance range. The average distance of transport by means of inland vessels has gradually decreased during the last years. This is among others connected to the containerization, the ensuing rise of intermodal transport and the use of inland terminals. The higher transhipment costs of intermodal transport are compensated by the lower transport costs, in this case of inland navigation, which makes it cost-efficient to use inland navigation for shorter distances. Also the use of inland terminals nearby the seaports as supply and conveyance hub contributes to the reduction of average distances.

As already indicated, inland navigation is important in merely a limited number of European countries, as not all countries possess navigable waterways. Inland navigation is, however, not equally important in each of these countries and has moreover a different pattern of development. This importance is connected to the quality of the existing waterway infrastructure, but also to the supply of the competing modes, such as for example railway transport.

In the White paper of the European Commission (2011) ambitious goals are set concerning the reduction of greenhouse gas emissions, the oil dependence and congestion. One of the goals is the shift of 30% of road freight over 300 km to other modes such as rail and IWT. By 2050, more than 50% of these transports should be shifted.

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[3] The Premium Barge Service started in 2010 and is a regular service that calls daily at 6 terminals in the port of Antwerp.

Table 1.1 illustrates the share of the various hinterland transport modes in the main European IWT countries in 2008, expressed in tonne-kilometre. These figures clearly show that inland navigation holds a substantial share in tonne-kilometres especially in the Netherlands (32.3%), Belgium (14.7%) and Germany (12.8%). The rather modest share of inland navigation (around 3%) in Austria and France can be explained by the limited capacity of waterways and the strong position of railway transport in these countries. Also in Germany, railway transport is important, which has a larger share than inland navigation (21.4% compared to 12.8%). In Luxembourg both inland navigation and railway transport have a rather modest share (respectively 4.6% and 4%). Luxembourg and France are the countries where road transport is predominant (a share which is larger than 80%).

Table 1.1: Share of the modal split for hinterland transport 2008, expressed in tonne-km

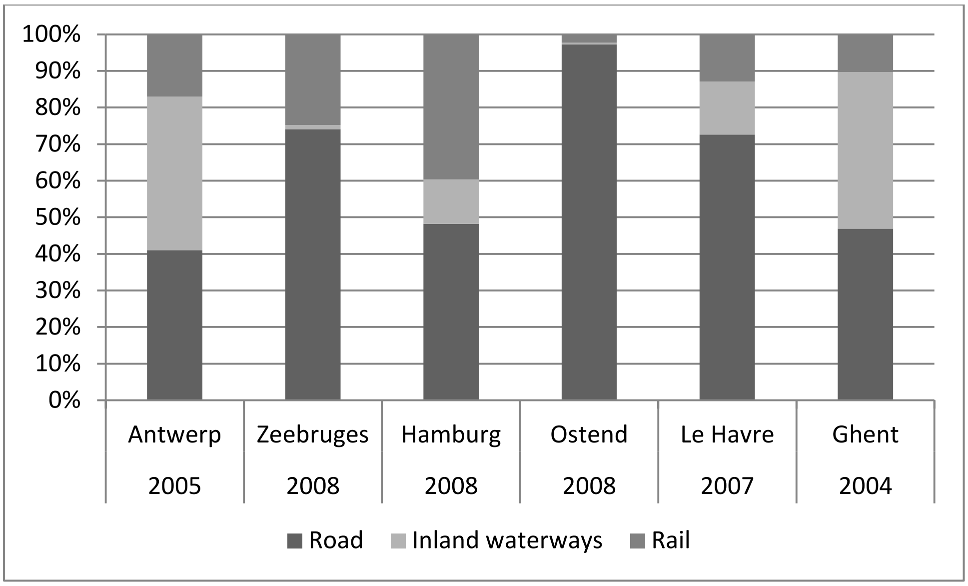
	Road	**Rail**	**IWT**	**total**
Germany	65.5	22.2	12.3	100
The Netherlands	59.9	5.4	34.7	100
France	80.6	15.9	3.5	100
Belgium	69.1	15.1	15.8	100
Luxemburg	94.2	2.5	3.3	100
Austria	58.6	37.4	4	100

Source: Eurostat

About 75% of the shipped tonnage by means of inland navigation concerns international transport including transit traffic. Around 97% of this international transport across inland waterways takes place between Germany, the Netherlands, Belgium and France. Of the domestic goods transport, part is intended for the domestic market, and another part is, among others in seaports, transhipped to a different transport mode (Buck Consultants International et al., 2004).

Also seaports are increasingly focused on the hinterland aspect, amongst others due to congestion in the ports. Graph 1.2 gives the modal split of the hinterland transport of the Flemish seaports in 2006. In their master plans, a number of ports have set the figures of modal split that they want to attain in the future. The Port of Ghent for example announced in its strategic report 2010-2020 that a modal split of 35% road, 50% inland waterway transport and 15% rail is desired by 2020. The strategic plan of the Port of Antwerp holds a modal split of 35% road, 45% inland waterway transport and 20% rail for all transports and the division 42% road, 43% IWT and 15% rail for container transport by 2020. By 2035, the Port of Rotterdam wants to attain a modal split of 35% road, 45% IWT and 20% rail for its containers on the Maasvlaktes.

Graph 1.2: Modal split hinterland transport seaports



Source: Meersman et al. (2010)

2. Setting of the research

When analysing decision making in the inland navigation sector, the research finds itself in the domains of demand, supply and market equilibrium. In this part, the framework of this dissertation is developed. The relevant theories and models in the scientific literature are studied and summarized after which this research is framed within the literature.

Studies on decision making in the transport sector are for a large part concentrated on modal choice for passengers and freight. Winston (1985) makes a survey of the literature in transportation economics. It is found that in the analysis of supply and demand, there is a trend towards analysis on a more disaggregate level. The initial models that were used to estimate transport demand were aggregate modal split models, with little behavioural grounding. In order to address the shortcomings of these models, behavioural models have been developed (Blauwens et al., 2010, Winston, 1985).

Disaggregate analysis offers a number of advantages since they are grounded in a theory of individual behaviour, which is generally consistent with the basic unit of empirical observation. Moreover, the disaggregate approach captures important characteristics of the decision maker (Winston, 1985). When working with these behavioural models, one has to take the data problem into account. Some characteristics of the decision taker as well as of the alternatives are available, while others are unknown (Blauwens, 2010).

- *Research on transport supply and cost models*

Winston states that ”research on transportation supply has been primarily concerned with estimating firms’ cost functions. This research has been motivated by both academic questions and policy questions”. Cost models are being used for several purposes in academic transport research, such as determining whether economies of scale exist or to compare between transport modes. The first important field in which cost models are being used is estimating and comparing costs of competing modes. A second application is the calculation of economies of scale, density and scope in the transport sector. A last domain were cost models are employed is research on productivity growth. With respect to policy questions, cost functions can provide guidance for regulatory bodies, e.g. for pricing and investments (Blauwens et al., 2010; Winston, 1985).

Quinet and Vickerman (2004) and Pels and Rietveld (2000) note that “Knowledge on the costs is necessary for decision making of transport companies. At a micro-economic level, detailed information on the costs and on the factors which influence these costs are the basis for decisions of transport companies on pricing, frequency of service, size of vehicles, investment choice and management. The same authors argue that knowledge about costs and cost functions that show the variations with respect to the parameters is necessary on a more general level to support policy makers.

The use of cost functions is widely spread in the studies on modal shift in freight transport (Blauwens et al., 2006). In transport supply, there are several modes, several possibilities within the transport mode and several types of companies that provide the services. The heterogeneity of transport supply is the result of the heterogeneous demand. The size of the vehicle, the speed, accessibility, variability in capacity and flexibility are important quality aspects in the choice of transport mode. In certain segments, the use of the transport mode is easily defined while in others there is competition between modes. Because of the heterogeneous demand, supply within a transport mode becomes more specialised (Blauwens et al., 2010). Examples of such specialisation in the maritime field can be found in Stopford (2009).

In this respect, the use of a single output measure may be problematic. The unit of output that is used in costs functions in freight transport is generally tonne-kilometres, which implies homogeneous products. In reality transport services are typically heterogeneous, from a demand as well as cost perspective. It is only possible to compare the performance of two modes (or companies within a mode) transporting similar shipments and the quality of the service has to be taken into account (Blauwens et al., 2006, Pels and Rietveld, 2000).

- *Methods of analysis*

In transport economics, research is done on the cost price, the speed and the terms of the transport service. Blauwens (2010) describes the two main methods of analysis that are being used, being the statistical method and the engineering method. The available data determines for the main part the method which is chosen. The engineering method will give good results if the causal relationship is clear and if experiments can be carried out. The statistical approach will be chosen if one has sufficient historical data i.e. time series data or cross sectional data. If it is difficult to identify the costs of a specific transport service, e.g. in the case of multiproduct firms, the use of econometric cost functions can be a solution. In this case, a quantitative relation between costs and output is estimated and a function is defined that corresponds maximally to reality. The engineering method on the other hand uses analytical models such as production functions. These production functions give the link between input and output. Accounting data can be used in this approach because the different cost items can be allocated to different cost units.

The level of transportation supply at a company level can be explained by means of the company's cost data. The information on the costs can be gained by different methods. This data can come from the accounting data of the company or be based on technical information. A more generalised approach can be used to explain the supply for a whole industry. The macro-economic approach says that the supply of a certain good is a function of the price of the good, the price of alternative goods and services, the price of production factors, the state of technology and the intentions of the producer (Blauwens et al., 2011).

The accounting method is one which gives the actual level of the costs, but not the cost functions (Quinet and Vickerman, 2004). In Pels and Rietveld (2000) it is argued that the cost accounting method may be useful for short run extrapolations, but that long term decisions and pricing decisions it may lead to misleading results. In this reasoning, they base themselves on the older cost accounting methods. In these methods there is often no link between costs and prices, no substitution between inputs and no or insufficient distinction between fixed and variable costs. Moreover, the splitting of common costs is not easy and done on an ad-hoc manner.

- *Cost minimisation*

Costs are necessary expenses in order to have production. The cost relation can be derived from the technological production function and the factor prices (Blauwens et al., 2010). The cost function gives the minimal cost to produce a given quantity Q by means of production factors x, y and z, resulting in the following formula: C=C(Q,Px,Py,Pz) (Quinet and Vickerman, 2004). From this function, a set of indicators can be derived, such as economies of scale and marginal costs.

When using cost functions, the underlying assumption is that the strategy of the firm is cost minimisation (Pels en Rietveld, 2000). This approach omits vessel owners having different goals besides making profit, such as enlarging their market position or increasing service levels. In the competition between modes, the service quality is an important aspect. Inrets (2000) indicates that quality is a very important factor of competition in freight transport. Even though quality factors (reliability etc) prove to be important aspects in the modal choice, Park et al. (2009) derive from their research in the airline segment that users pay most attention to economic efficiency i.e. low price charged by carriers. Porter (1998) states that that there are two basic types of competitive advantages, the first being cost leadership, the second differentiation.

- *Freight prices and profitability*

The supply of transport services is dependent on the transport price and profitability is the result of revenues and costs. The revenues are the transported volumes times the freight tariffs. Transport companies will be inclined to focus on the out-of-pocket costs in the short term. These out-of-pocket costs are the real expenses to perform a certain service. Using a short term cost function gives a non-optimal relation, because not all inputs are used optimally. In the long term, all the costs, including the investments should be incorporated. Long term marginal costs are generally considered to be a good measure of profitability (Blauwens et al., 2010).

Both supply and demand curves relate to volume to costs, so the actual volume and price are where the two curves cross, i.e. the equilibrium point. Travel demand always relates to costs explicitly or implicitly. There is the question whether demand should be conceived in number of trips or distance. It is argued by Bates that in micro demand, it is more straightforward to use trips, as this is related to the associated activity. In the transport sector, the market has some special characteristics. Transport is a service and therefore cannot be stocked and furthermore, some activities occur outside of the market and are regulated by governments (Blauwens, 2010). The freight rates are the regulator that motivates decision maker to adjust capacity, finding ways to reduce costs and adjusting the services. This can be for example adjusting the operation speed, adjust the services or layup vessels (Stopford, 2009).

The importance of freight prices and whether they are endogenous with respect to transport activities is studied by amongst others Demirel et al. (2010), Wilson (1987) and Behrens et al. (2009). Behrens et al. starts by saying that the from New Economic Geography it can be found that changes in the costs of shipping goods have an crucial impact on industry location and spatial distribution. Despite the role of transport costs that is assumed in the literature, not much effort is made to modelling them carefully. The reason for this is that transport prices are often considered as being exogenous assuming a perfectly competitive market or a fully regulated one. In a perfect market environment, prices reflect all relevant characteristics of the transport operation (Blauwens et al., 2010). In reality, freight prices are endogenous and influences by trade imbalances (Behrens et al., 2009).

The costs of a vessel are the result of decisions of different actors, being the owners and operators, charterers and policy makers in a direct way and shippers in an indirect way. The costs, together with the revenues and taxes, subsidies and so on determine the profits and profitability of vessels. In the supply, the productivity of the vessel plays a major role (Stopford, 2009). The vessel productivity is determined by different factors, influenced by owners and operators as well as shippers, charterers and policy makers. The revenues are the result of the volumes transported and the freight tariffs (Blauwens et al., 2010). Freight tariffs in inland waterway transport are the outcome of supply and demand, initiated by vessel owners and shippers, and the charterer.

- *Literature on inland waterway transport*

The academic literature that deals with inland waterway transport in Western Europe is rather scarce. Most scientific publications that address the inland navigation sector are looking at it from a modal choice –perspective. Moreover, a large part of the recent academic research that deals with inland navigation is focussed on intermodal transport and climate issues. With respect to intermodal transport, several issues are addressed. Important authors dealing with container transport and networks are Caris et al. (2011), Konings (2003, 2006, 2007, 2009), Theys et al.(2008). The integration in the container segment is addressed by Frémont, Franc and Slack (2009), Franc and Van der Horst (2010) and Platz (2009). Slack and Gouvernal (2011) study the freight rates in the container segment and policy measures to stimulate intermodal transport are dealt with by Macharis and Pekin (2009).

Outside of the container segment, Demirel et al. (2010) developed a model to study backhaul pricing and Kornet (2008) studied the demand for double hull tankers after the new regulation. Imbalances in trade flows in inland waterway transport and their effect on the transport prices are analysed by Jonkeren et al. (2008). Fischman and Lendjel (2010a; 2010b) address the existence of the owner-operators and the efficiency of spot charters in the inland waterway transport sector. Concerning the effects of climate changes, research has be done by Bosschieter (2005), Jonkeren et al.(2007), Jonkeren en Rietveld (2009), Jonkeren (2009), Koetse and Rietveld (2009) and Demirel (2011).

The supply side of the inland navigation market is generally considered as being exogenous. The supply itself is studied in numerous statistical studies, such as number and size of vessels and new constructions in the market (CCR, 2007; CCR, 2008; CCR; 2009, CCR; 2010; FOD Economie, 2007; FOD Economie, 2008), but a thorough analysis of the processes which are behind the establishment of such a supply is often lacking. Some studies do focus on a certain market segment, e.g. agribulk or sand- and gravel (PBV, 2001; PBV, 2000; Bückmann et al., 2008) and study these segments in detail.

Comparing and relating such market segments to each other or bringing together different aspects of the sector such as the actors, the structure of companies, the capital and cost structure often escapes notice. Yet, bringing together the different aspects is crucial to have a better understanding of the supply in the sector. This in its turn is essential in explaining the dynamics in the market of inland waterway transport.

Understanding the dynamics of the inland waterway transport market is necessary if public policies are to be developed consistently with the high goals often put forward for the industry. The fragmentation of supply in inland navigation makes the selection of appropriate policies difficult. Policies must be selected in the light of the criteria used by owners when investing and operating in the industry.

- Decision making in the inland navigation sector

The important difference of the dissertation in comparison to other studies on the inland navigation sector is that the focus is on the supply side of the market. The subject is studied on a micro-economic level, being the individual companies and more specific the vessel owners. The vessel owner in this case can be an individual operator owning one vessel, as well as a company owning several vessels and even a shipping company owning and operating an entire fleet. The most important actors involved whose decisions are entangled with the vessel owners' are the shipyards, shipbrokers, chartering agents and shippers of goods. The actions and decisions of governments and waterway administrators are considered exogenous e.g. it is presumed in this study that individual vessel owners have no influence on these decisions.

In general, vessel owners and operators have only very limited influence on the freight tariffs and are often not able to distinguish themselves compared to others. Therefore, it is reasoned that a vessel that can operate at a lower cost will have a competitive advantage compared to others. This is in line with the theories on cost minimisation that were discussed before. For the modelling, detailed cost functions will be used, which allow to determine the effect of choices and decisions. A strict focus on the costs alone will necessarily result in wrong decisions though. Therefore, the revenues and profitability are also included in the analysis. In this research, the profitability of a vessel will be a measure for the competitiveness of a company.

A number of choices and decisions can be made by vessel owners, -operators en policymakers that affect not only the costs, but also the revenues and profitability of a vessel. The choices of vessel owners are related to the investments as well as to the operations of vessels. Vessel owners for example can opt for an older or more recent vessel, can operate it themselves or with employees, there are several options concerning the financing of the vessel and so on. Furthermore, a vessel can be used in an intensive way or not, e.g. more hours per day or more days per year. More intensive operations in general increase costs as well as revenues. A non-exhaustive list of such choices and decisions is:

- The type and size of vessel to invest in
- The market segment
- The financing of the vessel
- The type of contract
- Whether to cooperate or not
- The intensity of operations
- The speed of the vessel
- The composition of the staff
- …

Apart from the choices made by vessel owners and operators, the profitability of a vessel is also subject to decisions made by governments. This includes legislation and regulation with respect to the vessels, as well as taxation, subsidies and so on. If different legislation exists in different countries, an inland waterway transport company in one country can have some advantage over on in a different country. Decisions related to policymakers that affect the profitability of inland waterway vessel are amongst others:

- The taxation schemes
- The waterway depth
- The waterway dues
- The internalisation of external costs
- The legal waiting time and demurrage
- The speed limitations on the waterways
- Minimum manning rules
- Minimum wages and social contributions
- …

While most studies have concentrated on the decisions concerning the use of different modes, in this research, the other transport modes are not directly incorporated. Comparisons with other modes are beyond the scope of this research. It is kept in mind though that the modal competition is very important for certain segments, e.g. the smaller vessels and intermodal transport. The freight tariffs of the other modes influence the demand and freight tariffs in the inland waterway sector. Moreover, they are often a precondition.

The focus of this research is on the supply and the activities on the connected European network i.e. the traditional Western European inland waterway countries. Data on the Danubian States and Central European states is not always available or comparable, and therefore it will not be included in the comparisons. A a result, mainly data on the traditional inland waterway countries will be used i.e. Belgium, the Netherlands, Germany, France and Luxembourg. The fleets of these countries represent about 90% of the transport capacity and transport performance of the European inland navigation market (CCR, 2010a).

3. Goal and research question

The aim of this dissertation is to understand the dynamics and the cost structure of the industry to assist decision makers, i.e. the public as well as the private sector, in the decisions they take with respect to investment, operations or incentives. The main research question is:

'Can choices made by vessel owners with respect to investments and operations in inland navigation can be explained from a business economics point of view and how do decisions influence the competitiveness of and within the sector?'

This main research question can be divided in three sub-questions:

1. Can choices concerning investments and operations be explained from a business economics point of view?

The decisions taken in the sector with respect to the investments and operations of vessels and companies are multiple. The goal is to determine whether the choices concerning investments and operations made by the vessel owners and operators are taken from a business economic point of view and if not, what are the consequences of such behaviour.

2. How do decisions influence the competitiveness within the sector?

In the dissertation the competitive position of several types and sizes of vessels as well as companies is studied. Decisions of owners and operators on investments and operations, but also decisions made by policy makers affect the profitability of vessels and companies within the sector. Such decisions can result in one vessel type or one company having a clear advantage over the others.

3. How do decisions influence the competitiveness of the sector?

Part of the legislation in inland waterway transport is made at the EU-level or by the River Commissions. This leads to a certain degree of harmonization e.g. on the level of safety standards. On other aspects, the legislation is still on a national or even regional level. As a result, public policies can put a certain fleet in a better competitive position in comparison with other fleets. Therefore, the effect of such differences on the competitiveness of the fleets of different countries is examined.

4. Information sources and methodology

Different information sources have been used in the research. First, the existing literature on inland waterway transport was studied intensively. This contains reports and studies on a European as well as national and regional level. The largest part of the studies and authors stem from the Netherlands, but also in Germany, Belgium and France the topic has gained importance in the last decade. For a general view on the sector, how business is done, which topics are important and so on, specific inland waterway transport magazines and papers[4] were consulted. For several parts of the research, data was necessary in order to support the general ideas that came from the literature study. For the data-analysis, a variety of data sources were used. Some data is published on a regular basis or simply available through the internet. Other data had to be gained through personal contacts and some were provided in combination with the interviews which were held.

In order to get real insight in the functioning of the market, a number of in-depth interviews were held amongst different actors in the sector. These interviews also contributed to understand the cost levels and cost structure of the inland waterway sector. The persons interviewed belong to companies working in the sector, i.e. owner-operators as well as shipping companies and co-operations. Also persons from insurance companies, banks and accounting offices were questioned. They were selected based on their expertise and position in the sector, as well as their availability and willingness to participate. The interviews were of a non-structured type and it was tried to have more than one interview for each type of actor in order to compare the results. In total 16 interviews were carried out, of which 8 mainly related to the cost structure and 8 mainly to the functioning of the market. Apart from the interviews, these and other people in the sector were consulted for ad-hoc questions.

All this together provides an insight into both carriers and owners, it makes it possible to identify patterns of behaviour and develops a better understanding of pricing decisions. This leads to a more objective and scientific approach of the topic. Although a better understanding of the industry is gained through this process, this dissertation does not want to create the illusion to really get to the bottom of the individual actor's decisions. Everyone shares what they want to share, and try to keep for themselves the things that are really crucial.

Based on the information gathered through the previous sources, i.e. the literature, the data and the interviews, a cost simulation model was developed. This cost simulation model starts from the micro economic level because it is assumed that choices made on the level of an individual have a very important effect on the whole sector. Starting from the economic theory that vessel owners try to minimise their costs, this means that from an economic point of view these costs should be the lower limit of the prices in the market. This cost simulation model allows calculating the average costs of several vessel types, as well as the costs for a certain shipment. This way, the effect of different choices with respect to investments and operations on the profitability can be compared with each other and the effect of policy variables can be identified.

Three types of analyses, being the sensitivity, strategic and systems analysis, are carried out for each vessel type in the model.They serve to identify the effect of changes in the variables on the outcome of the simulation. By means of the first analysis, the effect of the data that is used in the model on the outcome is assessed. The strategic analysis determines the effect of a number of real-world events on the costs. These real-world events could be the result of the market situation, policy decisions or decisions made by the owner or operator. Last, the systems analysis evaluates the effect

[4] Inland waterway transport magazines and papers such as 'De Binnenvaartkrant', 'Weekblad Schuttevaer', 'De Binnenvaart' en 'Binnenvaartmagazine'. The topic was also followed in 'de Lloyd' and 'Nieuwsblad Transport'.

of options which are included in the model. From this analysis, the variables that influence most on the costs of vessels are derived.

Afterwards, the model is used to simulate the costs and revenues of a selection of case studies. The cases are selected in a way that they show the usability of the model for the different users. Moreover, each of the case studies represents a typical transport in inland waterway transport (IWT), i.e. a small vessel on small waterways, a larger vessel in domestic transport and a larger vessel in the Rhine segment. For the first three case studies, different alternatives for the investments as well as for the operations are calculated. From the results of the case studies, conclusions can be drawn on the competitive position of different vessel sizes and companies as well as on the operations. Based on these basic case studies, three more simulations are made in which decisions from policy makers are included. Last, calculations are made which show the effect of differences in regulation and policies between countries.

5. Structure of the dissertation

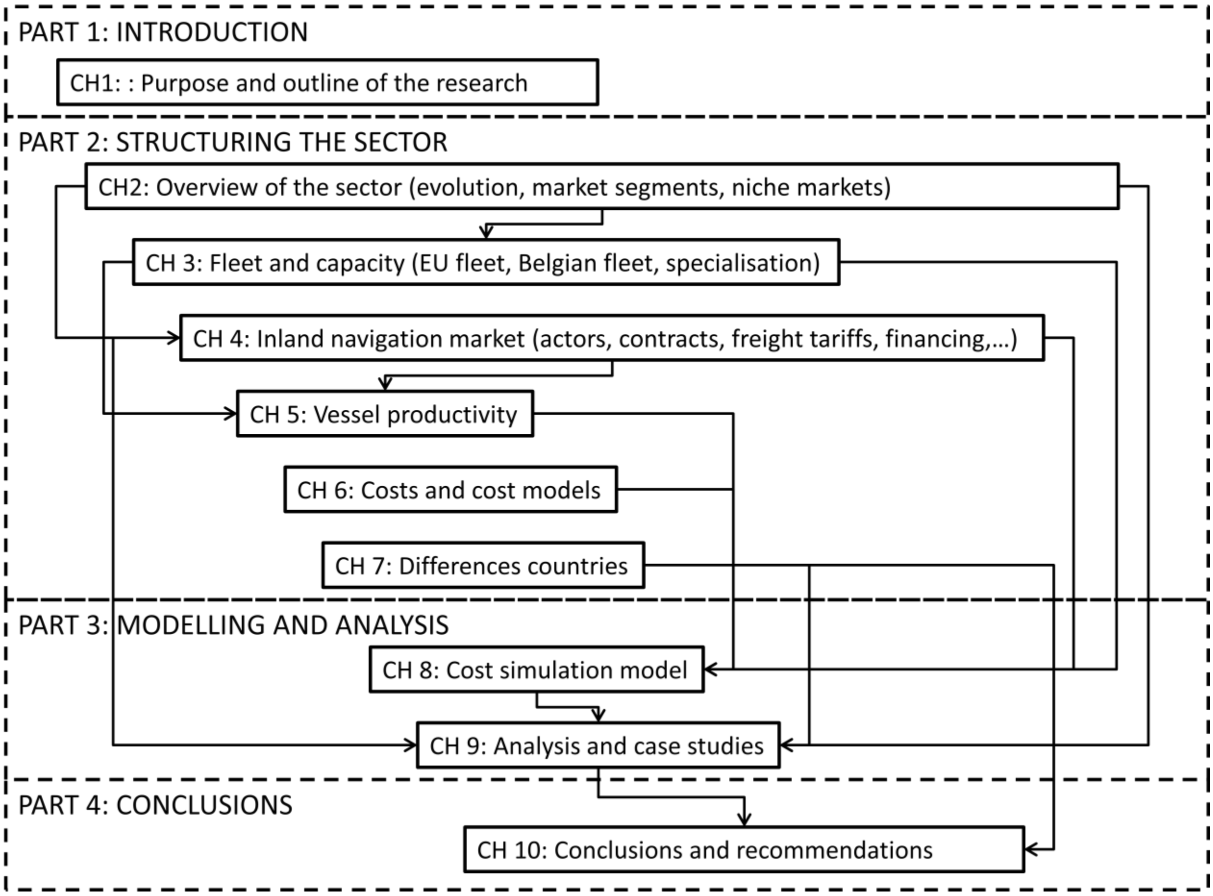
In the first part the purpose and outline of the research are given. In this part, the scientific framework of this study is developed and the research questions are formulated. In the second part, the necessary knowledge on the sector and its functioning is acquired. This part studies a number of aspects which are important in decision making in the sector and it provides the necessary information for the modelling. The third part of the dissertation is where the analysis and modelling takes place. In the last part, the findings from the second part and the results from the analysis are brought together in order to answer the research questions.

The structure of the dissertation is presented in figure 1.1. After this chapter, the dissertation starts with the structure of the inland navigation sector. In order to understand the inland navigation sector, its characteristics and the main aspects are described in the second part of the dissertation. From the different chapters in this part, the main aspects influencing decisions in the sector and the importance of national policies are derived.

Chapter 2 gives a global overview of the inland waterway sector. As the past is the foundation of the current situation, also a detailed description of its evolution is included. Given the long life span of inland waterway vessels and their capital intensity, it is certainly important to understand the current situation. It is important here to state that there is no single inland navigation market. There are several market segments, each having their own characteristics and evolution. Moreover a number of niche markets have emerged in the previous years. The knowledge gained in this chapter is used in chapters 3 and 4 and for the modelling and analysis in part 3.

The third chapter addresses the fleet and transport supply in the traditional European inland waterway countries in a quantitative way. The decisions made by vessel owners and operators concerning investments are reflected in the composition of the fleet. Moreover, advantages existing in one country with respect to e.g. profitability, financing and so on could be derived from their respective fleets. Furthermore, the characteristics of the Belgian vessels registered in the previous ten years are studied and also specialisation in the sector is addressed in this part. By means of descriptive statistics, more detailed information is gained on the choice of vessels for different types of companies. The data from this chapter is used for constructing the cost model in chapter 9 and the findings on the specialisation are an important input for chapter 5 which deals with productivity.

Figure 1.1: Structure of the dissertation



In chapter 4 the functioning of the market is discussed. It identifies the different actors in the sector and their function, the usual contracts, the materialisation of freight tariffs and the working of the second hand market and financing. This market functioning holds necessary information for the modelling and analysis (chapters 8 and 9), but also for chapter 5.

The fifth chapter addresses the productivity of vessels. It is demonstrated that this can have a large influence on the profitability of a company. By means of the concepts of capacity utilisation, load factor and rotation, this part of the dissertation shows the importance of this productivity on the profitability of vessels. The results from this chapter are used for building the cost simulation model in chapter 8. Furthermore, important variables that influence on the profitability are derived from this chapter and used in the analysis and case studies.

In chapter 6 the literature on cost studies in inland waterway transport is reviewed and a typology of cost models is developed. This is followed by a detailed description of the cost items in inland waterway transport. This information is the basis for the cost simulation model (chapter 8).

Chapter 7 then deals with the differences between countries that might affect the costs and their impact on the competitiveness of national fleets. The analysis of the activities on the Belgian network shows the position of the respective fleets and gives an indication of the competitiveness of the Belgian fleet on its domestic network. This chapter shows whether or not a clear competitive advantage can be found.

This then leads to the third part of the dissertation in which the modelling and analysis takes place. In the eighth chapter the characteristics of the cost simulation model which was developed for this research are presented, along with the data which is used for making the calculations. Input for this model stems from about all the preceding chapters.

In the following chapter (chapter 9) first an analysis is made of the data of the model, as well as the options that are in it. In the second part of this chapter, a number of case studies are developed. The case studies are chosen in such a way that they demonstrate the usability of the model for its purpose as defined in chapter 8. The necessary background information for the cases originates from chapters 3, 4 and 7 and the interviews that were carried out.

The dissertation then reaches its conclusion in chapter 10, where the results and findings from the research are used to answer the research questions and to make recommendations.

Chapter 2: Overview of the sector

In order to understand the sector and its functioning, the dissertation starts with an overview of the evolution of the sector. In this evolution, the liberalisation of the sector in 1998 receives the main attention, because it has had a major impact on the functioning of the sector. Afterwards, a segmentation of the sector is made, since the market consists of various segments that each have their own characteristics.

1. Evolution of inland navigation sector in Europe

In order to study the decision process in the inland navigation sector, it is important to have a closer look into the evolution of the sector. The situation in the past and the factors that influenced the changes have to be taken into account in order to understand why the sector today is the way it is. The regulation and following deregulation of the sector is by far the most crucial aspect in its history. In this part, the entire process from a non-regulated market till a regulated one and back is described.

1.1. Before regulation

The supply side in the inland navigation sector consisted traditionally of numerous self-employed bargemen who represented the larger share of cargo space, together with a number of smaller and larger shipping companies. This strong fragmentation was especially manifest in the dry cargo segment, a lot less in the liquid cargo segment where the shipping companies had a more important share.

The market behaviour of self-employed bargemen before the regulation has partly triggered the regulation of the inland navigation sector. In cases of extremely low freight prices, which were among others a result of the economic depression in the 1930s, bargemen increased their working time in order to make up for the loss of income. This included working more hours a day and/or taking fewer days off. As a result, capacity increased and prices fell even more. This behaviour was a result of the large share of fixed costs of inland barges and their long life span.

In addition, bargemen were not readily willing to give up their profession and to sell their ship in case of unfavourable market conditions. Their entire life, meaning their work and living, was connected to their ship, which meant that they were often not capable to start a new life ashore. Bargemen therefore took on short-term cargo against tariffs based on the variable costs, without taking into account investment costs or wages for themselves. In order to resolve this pitiful situation, which came into existence after the Depression in the 1930s, part of the inland navigation market was regulated (Dullaert et al., 1998).

1.2. During regulation

During the time of regulation, from the 1930s to the 1990s, several rotation systems and minimum tariffs in the various inland navigation countries were imposed, which were furthermore not the same for the various categories of goods. These systems were applied during the economic depression of the 1930s, in order to protect bargemen against the extremely low prices as a result of the demand shortage on the market. These measures, on which the governments took a strongly regulating stance, had to ensure all bargemen a minimum income from their activities. This, of course, has partly determined the decision-making process of shippers when it comes to competitiveness and investments. Table 2.1 gives a short illustration of the systems which were active in the various countries during the times of regulation. When it comes to Rhine navigation, which includes the river Rhine and its affluents, as a result of the Convention of Mannheim (1868), there was always a free market.

The rotation system entailed the fact that bargemen who wanted to transport goods belonging to this system, had to subscribe to a list at the shipping exchange of the place where their vessel was located at that moment. A vessel subject to this system had to sail empty from the place of unloading to the exchange before taking on a new load. It was not allowed to take on a new load without passing there, even though there was a shipment available on its route. This resulted amongst others in long waiting times at the exchange and many empty trips.

Shippers who wanted to have goods transported which also fell under these conditions, brought their assignment to this exchange. There, the assignment was supplied to the bargeman who was listed at the top of the list and whose ship met the requirements. Only when an assignment was refused twice by the bargemen (first and second on the list) a free agreement could be established. Fixed agreements, customer loyalty and competition were not possible in this system.

The dry cargo segment was strongly regulated, both for national and international navigation. The situation was different depending on the country and the direction of transport. Transport of dry bulk goods by means of inland navigation was often done by producers themselves using their own vessels. Their seasonal peaks were balanced by the external capacity via the exchange system.

In Belgium, the domestic transport of dry cargo by inland navigation was subject to a legal rotation system, in which the supplied cargo was distributed by the shipping exchange. A number of goods categories were exempted, such as container transport, transport of sand and gravel, hazardous cargo and also own account transport. Domestic transport of liquid cargo by inland waterways was subject to legal minimum tariffs, except for time charter and multiple voyage charter. The tariffs were determined by the Dienst voor Regeling der Binnenvaart (DRB)[6].

Dry cargo shipping in France was also subject to a legal rotation system, called tour-de-rôle. This system did not apply to Rhine and Moselle navigation, nor to liquid cargo shipping, transport on own account and transport based on a charter agreement.

[6] Office for the Regulation of Inland Navigation

Table 2.1: Overview of the regulation in inland navigation in Europe

	To		
From	BE	FR	NL
BE	legal rotation system (except for sand and gravel and transport on own account) and mandatory tariffs	legal rotation system and minimum tariffs	notification requirement, voluntary rotation system and non-official minimum tariffs
FR	legal rotation system (except for Rhine and Moselle, transport on own account and vessels with a contract)	legal rotation system (except for Rhine and Moselle, transport on own account and vessels with a contract)	legal rotation system (except for Rhine and Moselle, transport on own account and vessels with a contract)
NL	legal rotation system (except for Rhine navigation)	legal rotation system (except for Rhine navigation)	legal rotation system (except for regular barge service, transport on own account and sand and gravel)

Source: Own composition (based on Beelen, 2003)

Also in the Netherlands a system of rotation was installed, which was called 'evenredige vrachtverdeling' or freighting in rotation, for the occasional domestic freight transport by inland waterways. Transport by rotation, liquid cargo shipping, transport on own account and transport of certain building materials (e.g. sand and gravel) were not subject to these rules.

In Germany, the free market was maintained for the Rhine and its affluents. For the remainder of domestic transport, minimum tariffs applied, also known as 'Festfrachten'. The tariffs were determined in freight committees.

The system in cross-border transport was dependent on the route, direction and the type of goods. For transports from Belgium to the Netherlands a notification requirement was installed, which in practice led to a 'voluntary' rotation system and non-official minimum prices. For dry cargo shipping to France a legal rotation system and minimum tariffs applied (except for Rhine navigation).

Dry cargo shipping from France to Belgium and the Netherlands was organised by means of a legal rotation system and minimum tariffs, except for Rhine and Moselle navigation. For liquid cargo shipping, transport on own account and transport on the basis of charter agreement were exempt. For dry cargo shipping from the Netherlands to Belgium and France, a rotation system (at first voluntary, then legal) and fixed minimum prices were in force. Again this did not apply to Rhine navigation.

The various systems described above were merely applicable to a part of the transport by means of inland waterways. In the year 1990, around 490 million tonnes were transported by inland navigation in Belgium, Germany, France, Luxembourg and the Netherlands. Of this, only 35 million tonnes (or 8% of the total) was allocated through the rotation system. This share illustrates that the influence of the rotation system was rather limited on a global level (EC, 1994). The free navigation on the Rhine, which represented two thirds of the inland waterway transport in Europe, explains the relatively low importance of the regulated system.

Nevertheless, this system had a major impact on certain market segments, for certain goods and on certain waterways or in certain countries. This impact was diverse, which is presented by the following figures of the countries concerned. Table 2.2 gives an overview of the importance of the 'tour-de-role'- system for domestic transport per country. In Belgium, around 50% of domestic transport was under the regulated system, in France this amounted to 18% and in the Netherlands around 20%. Apart from that, the voluntary rotation system represented around 3% of the total transported tonnage (EC, 1994).

The regulated share for international transport between these countries is quite large. Inland navigation transport from Belgium to France was allocated for 74% through the shipping-exchange and from the Netherlands to France this share amounted to 84%. Conversely, 67% of the international transport from France to Belgium and the Netherlands was allocated through the exchange system. Transport from Belgium to the Netherlands was organised for 41% through a rotation system and in the other direction the share represented 19% (Tijsmans, 1992).

In general, the system of chartering by rotation mainly applied to dry cargo shipping, both for national and international navigation, and concerned for the most part smaller vessels of less than 1,000 tonnes (EC, 1994).

Table 2.2: Overview of European inland navigation market according to regulation system in 1988 (in million tonnes and percentages)

Domestic Transport		**NL**	**D**	**B**	**F**	**Total**
Total		89.70	63.00	22.20	29.50	204.40
Of which free transport		13%	8%	28%	0%	11%
Of which transport for own account		41%	8%	17%	37%	28%
Transport by third parties		46%	84%	55%	63%	61%
Of which:	Tour-de-rôle	20%	0%	49%	18%	17%
	barge service contracts	12%	0%	6%	36%	11%
	exceptional permission	10%	0%	0%	0%	4%
	Festfrachten	0%	84%	0%	0%	26%
	other	3%	0%	0%	9%	3%

Source: Dullaert et al. (1998): Verein für Binnenschiffahrt E.V. (1991), Bedeutung der Binnenschiffahrt in Europa

Bargemen were, however, not obliged to enter into this system of rotation and minimum tariffs, or work in it permanently. As mentioned before, certain categories of goods and types of agreements existed which were exempted from these systems. Also certain waterways were exempted, of which most importantly the Rhine and its affluents. Therefore, one could choose cargo or routes to which the rotation system was not applicable.

The regulated market and Rhine navigation existed next to each other and balanced one another. Bargemen for example had the choice between the free market on the Rhine navigation (international transport) and the domestic regulated dry cargo market. Depending on the market conditions, they could subscribe to the rotation system, or on the contrary they could choose shipping on the international navigation level.

In times of high minimum freight tariffs on the exchange, more bargemen chose for the rotation system. In moments of long waiting times on the exchange, there were always a number of bargemen choosing for Rhine navigation during a certain amount of time. Table 2.3 illustrates the relation between both markets.

When, for example, waiting lists on the shipping exchange were rather long e.g. due to low demand, a number of bargemen chose to change to international shipping, such as Rhine navigation. This made the supply of capacity on the shipping exchange decrease and as a result increased the capacity on Rhine navigation. This had a negative effect on freight prices on Rhine navigation and a positive effect on the length of the waiting lists. When prices on the free market were lower than the minimum tariffs in the regulated market, a number of bargemen opted for inscribing on the exchange. This caused the supply on the Rhine navigation to decrease, which increased the market price here, and at the same time the waiting lists for the rotation system increased (Dullaert et al., 1998).

Table 2.3: Relation between the regulated and free market

	Number of vessels on exchange	Waiting times exchange	Number of vessels in Rhine navigation	Tariffs Rhine
Waiting times low	increasing	increasing	decreasing	increasing
Waiting times high	decreasing	decreasing	increasing	decreasing
Minimum tariffs low	decreasing	decreasing	increasing	decreasing
Minimum tariffs high	increasing	increasing	decreasing	increasing
Tariffs Rhine low	increasing	increasing	decreasing	increasing
Tariffs Rhine high	decreasing	decreasing	increasing	decreasing

Source: Own composition based on Dullaert et al. (1998)

The bargemen's change from one market to the other kept both systems in balance. One condition for this, however, was that the regulated market would be sufficiently large in order to accommodate fluctuations. The waiting time on the exchange was an indicator of the transport market, as this was dependent on free market prices.

In practice, mainly small vessels (<650t and <1,000t) sealed a transport agreement by the system of rotation. Shipping companies which had invested large amounts in more modern vessels and which in addition were confronted with higher employment costs, had to reach a higher rotation speed and always chose to allocate these vessels on the free market. Producers having their own inland vessels for transport of their cargo did not fall under the rotation system. At the peak, when their own fleet capacity was insufficient, they issued an appeal for bargemen via the rotation system.

In the dry cargo segment, mainly minimum tariffs were applied. In Belgium, minimum tariffs were established by the DRB and complemented with numerous freight tariff increases and reductions up to a maximum of 30% above or below the minimum price. Both in the Netherlands and in France, minimum tariffs were adopted with a number of regional variations. Germany worked with fixed tariffs for national transport, which were determined by freight committees and which left no room for deviations. In liquid cargo shipping, also minimum tariffs and adaptations applied. The parties concerned were shipper, bargeman, shipping exchange and possibly a chartering company.

The consequence of this tariff system was an unclear tariff structure because of many increases and reductions, which was highly unattractive for the shippers. The minimum tariffs, moreover, often only covered the direct exploitation costs of the inland vessels, which left no surplus for the necessary investments and renewal of the fleet.

Under normal circumstances, low tariffs make sure the least efficient supplier disappears from the market when direct costs are not recovered by the revenues made. Due to the rotation system and minimum tariffs, freight tariffs were kept high in an artificial way, which ensured each vessel operator of a decent income, despite the waiting time. Even the most inefficient vessels were kept in navigation, which caused a structural overcapacity in the market (Dullaert et al., 1998).

The lack of competition in this system and the limited opportunities for long-term contracts resulted in very few incentives to invest in new ships and modern techniques. As a consequence, the supply of cargo space was often inadequately adjusted to demand. Also the compulsory empty navigation on the way back to the exchange made operators often miss out on income and it limited the incentive for investment and specialisation (Beelen, 2003).

At the European level, a number of measures were adopted in order to control capacity in inland navigation. An essential overcapacity to balance fluctuations, which are a result of e.g. low water levels and seasonal peaks, is typical of the sector. Structural overcapacity, however, keeps freight tariffs permanently low. To tackle this, a capacity regulation was introduced in 1989, which entailed on the one hand a scrapping arrangement, meaning making redundant capacity disappear by granting scrapping premiums, and on the other hand the 'scrap-and-build' regulation which held the conditions for constructing new vessel capacity.

The scrapping arrangement has led to three rounds of scrapping between 1990 and 1998. These scrapping rounds were financed by the sector itself, the concerned member states and the European Community. The three rounds represented in the dry cargo segment a reduction of vessels by 27%, which equals a capacity reduction of 22%. In the liquid cargo segment, the number of vessels decreased by 32%, which amounts to a reduction of the liquid cargo capacity of 30% (Beelen, 2003).

The scrapping regulation was especially successful in the Netherlands, Germany and Belgium. About 92% of the dry cargo vessels and 86% of the tanker vessels which were scrapped in the action from 1996 to 1998 had the nationality of one of these countries (Beelen, 2003).

The 'scrap-and-build' regulation entailed an exchange percentage or contribution for the input of new capacity into the region. When purchasing a new inland navigation vessel, an owner had the choice either to withdraw a certain percentage of tonnage from navigation, or to pay a fine to the scrapping fund. At first, the exchange percentage was 1 to 1, which means equal new capacity and withdrawal from navigation, but this was later on increased to a maximum of 1.5 to 1 in order to faster reduce capacity. In 1999, it was opted for a reduction of the period of this regulation to 4 years. (Beelen, 2003).

1.3. After liberalisation

Liberalisation in inland navigation is a consequence of the European Directive 96/75/EC, which dates back to the end of 1996 and which had to be introduced in all countries before 2000. This liberalisation entails the freedom of the inland navigation parties to establish agreements and the freedom to negotiate freight tariffs and conditions. In Germany, liberalisation was already introduced on 1 January, 1994. the Netherlands and Belgium implemented the liberalisation in 1998, as from 1 December, and France followed in the year 2000.

After the liberalisation freight tariffs and contracts are determined by supply and demand on a free market. Vessel owners, operators, charterers and shippers can make arrangements as they wish now (Fischman and Lendjel, 2010a). This improves efficiency and increases competition in the sector.

After liberalisation, a large part of the dry bulk segment still goes via the spot market. The vessels are predominantly owned by independent vessel owners, and are hired by charterers or shipping companies. The consignee is mostly located close to an inland terminal or near the water, so intermodality is of less importance here than in container transport. The dry bulk cargo mostly originates from seagoing vessels in ports or is shipped between inland terminals. An important effect of the liberalisation on the inland navigation sector is the restructuring of supply by means of discontinuation of companies, mergers and the establishment of co-operations in the sector. In chapter 4, the actors and companies in the sector will be discussed more in detail.

The establishment of agreements in the liquid cargo segment was mainly left to the free market already in the past, apart from one exception. The transport of liquid cargo within Belgium was subject to legal minimum tariffs, except for time chartering and chartering for consecutive journeys. In liquid cargo shipping, as opposed to dry cargo transport, mainly shipping companies have always been active. Reasons which can explain this are among others the concentration of shippers in liquid cargo shipping, the far-reaching specialisation and capital intensity (Branswijck, 1987).

In Rhine navigation, both shipping companies and independent vessel owners were active in the past. Shipping companies mainly stemmed from (family) companies who were involved in production, trade and/or transport of (bulk) goods. These shipping companies were often present in conventions and pools in order to limit the effect of strong freight tariff reductions in times of lower economic activity. These partnerships were mainly focused on transport of a certain goods category, as the transports were demand driven and there was no liner shipping yet (Van Driel, 2000).

A number of such (German) shipping companies sold their vessels to their former employees after the liberalisation in the beginning of 1994. Those employees started exploiting those vessels as self-employed bargemen (PLANCO, 2002). The shipping companies, who had a substantially higher staff cost than the self-employed bargemen, were often not capable of competing on the free market. The remaining shipping companies started expanding their tasks and became forwarding and logistics companies, with a limited fleet in property. In some niche markets, such as chemicals, new shipping companies and self-employed bargemen came up, along with a larger fleet (Aeschlimann, 2006).

Container transport via inland navigation was rather limited before the liberalisation. At the rise of container transport, a partnership (RCL) was started in 1969 between the 15 major ‘Rhine navigation companies'. This was ended in 1975 because the share of container transport was merely limited in the entirety of goods transport via the Rhine. A strong development was noticeable starting from 1995. The structure of the companies in inland container navigation is highly diverse, ranging from small companies focusing mainly on the domestic market, to large multinationals working in all market segments. They can be found mainly in Rhine navigation and Rotterdam-Antwerp navigation (Van Driel, 2000).

The liberalisation of the market and the abolition of minimum tariffs had enabled the prices to go down. Strong price reductions (from 30% to 60%) existed in Germany after the repeal of the Festfrachten in 1994 (NEA, 1995). The resulting drop in revenues was balanced by the inland navigation companies through an increased capital productivity e.g. by operating the vessels in a continuous or semi-continuous way. The price reductions in Belgium after the repeal of the rotation system were less severe than in the other countries, because as a result of a number of exceptions, prices were generally already lower than the official tariffs (Branswijck, 1987).

In the inland navigation sector, there is a need for a certain overcapacity in order to balance among others seasonal peaks and low water levels. This capacity, called spare capacity, self-evidently causes a cost. The rotation system entailed a type of compensation for this capacity, which was supported by all bargemen by means of the waiting times for the rotation system. This system, however, contributed to the establishment of a structural overcapacity, which caused a negative pressure on the freight tariffs (Beyers, 1985).

In the 1960s, inland navigation witnessed an expansion of the fleet, by means of larger vessels and stronger engines and, as a result, a higher rotation speed and an increase in productivity. But the number and the volumes of traditional inland navigation customers declined due to the lower production, such as for example in steel industry, petrol industry and building. Moreover, there was an economic crisis (1970-1980), road transport boomed after World War II and railway transport was modernised. All this made the demand for inland navigation transport decrease. The combination of an increase in supply of capacity and the reduction of demand resulted in a lower income for bargemen.

After the liberalisation, it has become possible to make long-term contracts for all goods and it is also possible to accept return freight. Shippers can choose a vessel which meets their demands and prices are determined mutually. As a consequence, the oldest and least profitable ships are out priced on the market. The other ships can be allocated more efficiently, which improves their rotation speed and which makes it more interesting to invest. Moreover, empty return freight can be reduced to a minimum because companies are free to make contracts. They are allowed to search for return freight or to choose for freight on routes where the possibility of potential return freights exists. They can also take this into account for the freight tariffs. This, in turn, has caused an improved rotation of the ships, which is an incentive to invest in new capacity.

The supply of transport capacity is elastic upwards, which means new vessels are built during boom times, but inelastic downwards. Explanations for this are among others the long life span of the ships and the lack of alternatives for vessels and bargemen (Beyers, 1985).

The liberalisation did not only result in a major restructuring of the market and price decreases, but the sector also became more accessible for new transports and intermodal transport. Price reduction as such will hardly ever lead to an increase in the use of inland navigation. Demand appears to be price inelastic (NEA, 1995). This is connected to the various market segments. A number of market segments or goods categories are captive, which means they almost automatically use inland navigation since there are no real alternatives. Other market segments are more difficult to access for inland navigation, for example highly expensive goods or goods for which the time-critical aspect plays an important role, such as perishables. The different market segments in the inland waterway segment and their characteristics will be addressed in the following part.

2. Segmentation of the inland navigation market

The inland navigation market is a very heterogeneous subject. The existence of numerous types of vessels and transported goods, the different waterways and corridors, the various ways of operating a vessel and so on makes it difficult to get a clear overview of the market. Therefore, in this part, the market is classified in different market segments.

First, an overview of the traditional market segments and their characteristics is given. There are several ways of addressing the existing market segments in inland navigation. This section starts from an overview of the market segments based on the dimensions of vessels and waterways. Afterwards an overview of the categories of goods and their appearance is given and the niche markets are studied in detail.

A second part consists of an analysis of the specialisation in the sector. This begins with a quantitative part based on the fleet data of the European countries and the new builds of the fleet. Then the factors influencing this specialisation are identified followed by a closer look into certain niche markets and their perspectives.

2.1. Existing market segments in inland navigation transport

The importance of segmenting the inland navigation market originates from the nature of the different segments. These segments each are built up differently and have a different way of working. The market of small vessels for example is completely different from the one of larger ones. Companies working on the spot market act in a different way than those having a long-term contract with a shipper or charterer. The tanker market functions in a different way than the dry cargo market and so on.

Sometimes market segments are completely separated from each other, but in other cases they are connected. Dry cargo and container shipping for example are two segments which are strongly connected, certainly since the recent dry cargo vessels are built based on container sizes. It enables vessel owners or operators to choose segments depending on the market conditions.

The present inland navigation sector can be classified in several ways. The principal criteria are size of the vessel, type of goods and vessels and the geographical aspect (routes) and the operational management (type of contracts, intensity of exploitation). When the criteria are combined, it becomes clear that certain combinations appear frequently, while others do not. Small vessels for example are not operated in a continuous way, while the largest vessels cannot be found on the smaller routes. The reasons can be of a technical as well as an economic nature. The market segments will be addressed here based on the size of vessels and the type of goods and vessels.

2.1.1 Size of waterways and vessels

The type of vessel which is used on a specific route depends on a number of factors. Primarily, there is the technical aspect of the waterway and second, the market conditions play an important role. Moreover, there are specific regulations for the different corridors, such as licences for the crew, which limits the use of certain vessels to certain corridors.

When considering the dimensions of a vessel it is clear that the size of the vessel should correspond to the dimensions of the waterway. Waterways for inland navigation are subdivided into ECMT classes based on the maximum beam and length of vessels allowed. A historical classification of inland barges exists (see annex 1), in which class is chiefly determined by beam. This classification is rather broad, which over the years generated more narrow subdivisions for various applications (Wolbers and Stap, 2002). Table 2.4 provides an overview of the general ECMT subdivision of waterways linked to the largest normative vessel or push-tug combinations.

Table 2.4: Classification of inland waterways 1992

class	**type of self-propelled vessel**	**length**	**beam**	**tonnage**
0	Pleasure boating			
I	Spits	38.5	5.05	250-400
II	Kempenaar	50-55	6.60	400-650
III	Dortmund-Ems Canal	67-80	8.20	650-1000
IV	Rhine-Herne Canal	80-85	9.50	1,000-1,500
Va	Large Rhine vessel	95-110	11.40	1,500-3,000

class	**type of push tow**	**length**	**beam**	**tonnage**
IV	1 p. barge	85	9.50	1,250-1,450
Va	1 p. barge	95-110	11.40	1,600-3,000
Vb	2 barges, long combi	172-185	11.40	3,200-6,000
VIa	2 barges, wide combi	95-110	22.80	3,200-6,000
VIb	4 barges	185-195	22.80	6,400-12,000
VIc	6 barges, long combi	270-280	22.80	9,600-18,000
VIc	6 barges, wide combi	193-200	33.0-34.2	9,600-18,000

Source: own composition, based on European Conference of Ministers of Transport (ECMT)

A normative vessel is a vessel having the maximum beam and length that is allowed on a specific waterway. Class 0 is utterly suited for recreational use, class I for the smallest freight vessel (Spits) and class VII for the largest push-tug combinations. Next to this, also the depth of the waterway and the vertical clearance of bridges are determining factors. By the same token, new structural works are adjusted to the desired class of vessels (Ministerie van Verkeer en Waterstaat, 2003).

In the past, the normative vessels sometimes received the name of the waterway(s) they were built for. The vessel type 'Kempenaar' for example was built on the measures of the 'Kempische kanalen' in Belgium and the south of the Netherlands. This was how several vessel sizes were named, although vessels are also named after their tonnage, such as a 1,100 tonnes vessel. The details of the various types of vessels can be found in Annex 4.

In addition to the technical aspect of waterways also market conditions play an important role in the choice of vessels. Bargemen can sometimes adapt to sub-optimal conditions such as insufficient depth or low bridges by for example loading less tonnage or transporting one level of containers less. As this implies less cargo transported each time, these types of transport are economically less profitable. This is why we assume that under normal conditions, meaning no exceptional low water levels or crisis situation, the vessels used on a corridor have the optimal size for it.

Also the characteristics of the cargo, which holds the type of goods as well as the quantity, is of major importance. When the type of goods is chiefly shipped in small quantities, or when the addressee has no capacity to receive large volumes, a small vessel will be chosen. Sometimes it is possible to bundle several shipments, but often no other consignee or addressee on the route is willing to cooperate or the goods have to be stored separately. In such cases, smaller vessels will be used than what is technically possible even though small vessels on major waterways have a competitive cost disadvantage.

In general, the inland navigation sector has been characterised by a remarkable scaling-up during the last decades. Capacity of inland waterway vessels has increased strongly during the past years. Length as well as beam and draught increased in order to maximise economies of scale. On the larger rivers, such as the river Rhine, ever increasing push convoys are brought into action for the transport of containers, ores and coal. When vessels attain the maximum dimensions of waterways, their usability might decrease. This is reflected in several negative aspects such as the fall in carrying capacity in case of low water levels, which leads to smaller revenues. Next, a decrease in maneuverability might result in time losses and increased security risks. Further, very large vessels are more difficult to reposition to other areas, which reduces their flexibility.

The influence of variable water levels on the Rhine is given here as an example. Both low water and high water levels limit the carrying capacity of especially the larger vessels because it creates draught restrictions or problems with the vertical clearance of (container) vessels. In such cases, the fixed costs remain the same while the revenues decrease, which results in a less optimal exploitation.

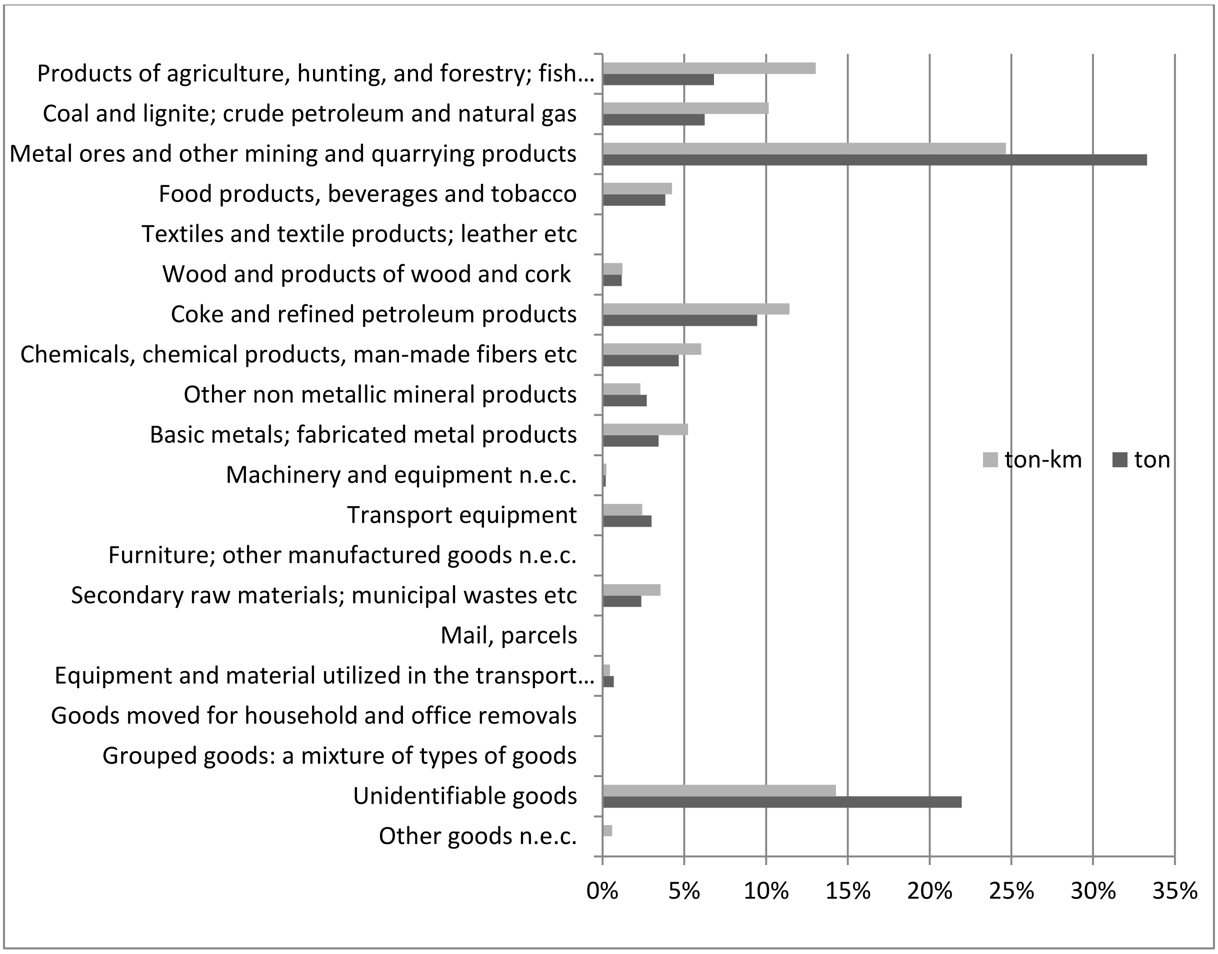
Low water levels frequently appear and therefore low water surcharges are being set as a compensation for the operators. The largest vessels experience the disadvantages of low water levels faster than smaller vessels, while the latter benefit most from those surcharges. High water levels are less frequent and generally this only entails speed limitations (Bosschieter, 2005).

2.1.2 Type of goods and vessels

The major market segments in inland navigation are strongly related to their appearance. Traditionally, these are dry cargo, liquid cargo, container and roll-on roll-off (ro/ro) / heavy goods. When we go into further detail on these segments, we can distinguish for the dry cargo segment amongst others raw materials such as ores, solid mineral fuels, building materials and agricultural products. In the case of liquid cargo, the most important goods are crude oil and oil products and chemicals. Graph 2.2 shows the importance of the goods based on the NST 2007 code.

Of these four major segments mentioned above and their most important sub-segments, a more detailed description is provided here. Emphasis is particularly laid upon the goods transported and the technical characteristics of vessels. Figure 2.2 gives a schematic overview of the segments and how they are interwoven. On the upper side, the goods segments are represented, while the lower side holds the different types of vessels. The arrows show which goods are generally transported in which vessels.

Graph 2.1: Inland waterways goods transport: distribution by NST 2007, EU 27, 2009 (% tonne and %tonne-km)

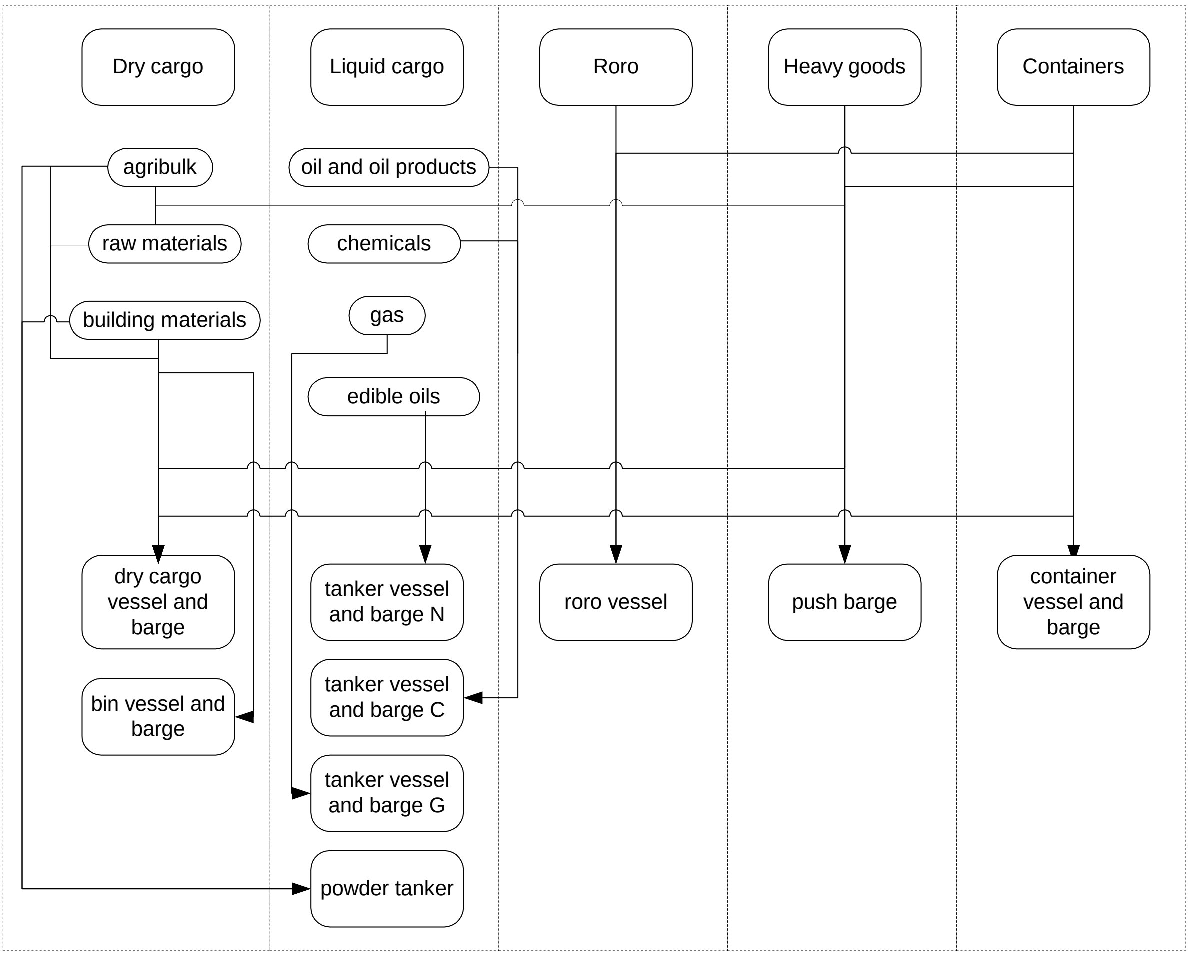


Source: own composition, based on data from Eurostat (extracted 04-04-2011)

Dry cargo is the collective term for all dry goods being transported with inland vessels. This segment holds a variety of products, which have their own characteristics and particularities. Next to technical aspects, also a number of regulations and standards enforced by both governments and the industry itself are applied to the transport of certain goods. Containers are considered as a separate segment and will be discussed later. The two market segments are connected to each other, because normal dry bulk vessels are also used to transport containers.

In the dry cargo segment, we can distinguish amongst others raw materials such as ores, solid mineral fuels, building materials and agricultural products. The main types of vessels in the dry cargo segment are the self-propelled dry cargo motor vessels and the push barges. Most self-propelled vessels that are newly built in the last years are based on container sizes which allows them to take dry bulk as well as containers in an economically more profitable way. Sometimes vessels need extra equipment in order to transport certain goods. For goods which need shelter from water, such as animal fodder and grains, vessels with hatches are used. In case of wet goods such as sand slurry or dredgings, special vessels called 'bin vessels' are used. These vessels have a smaller cargo hold than normal dry cargo vessels and extra floating power, sturdiness and drainage pipes. That way, they can carry the heavy load without problems.

Figure 2.1: Segmentation and vessels



Source: own composition

Next to technical aspects, also a number of regulations and standards enforced by both governments and the industry itself are applied to the transport of certain goods. An example is the Good Manufacturing Practices (GMP) system for agribulk in the Netherlands. One of the important factors in this system is the registration of successive cargo and the inspection of cargo space. Agri-only vessels, for example, are vessels which have been used exclusively for the transportation of agri-products during a period of 6 months.

In tanker trade, four main segments can be distinguished. These are crude oil and oil products, chemicals, gas and special products. The first two segments are responsible for the larger share of the volumes transported (Centrale Commissie voor de Rijnvaart, 2008b). Tanker vessels are much more specialised and therefore more expensive than dry bulk vessels (Bückmann, et al., 2008).

There are three main types of vessels in accordance with ADNR[8] for the transportation of dangerous goods. N (Normal: for crude oil, oil products and certain chemicals), C (chemicals) and G (Gas). Type G is the most specialised followed by type C and type N. Vessels for chemical products have a double hull since safety measures prescribe it so.

The use of single hull vessels has shifted in the past to the segment of oil products and is now shifting further to other products after the latest ADNR regulation of 2007-2008. In theory, goods which are allowed to be transported in a type N tanker vessel are also allowed to be transported in C- and G-barges if all conditions are met. Capacity is in this respect, under certain conditions, exchangeable among segments (Van der Lugt et al., 2002; Bundesamt für Güterverkehr, 2006). In practice, type C tanker vessels often transport type N products when no type C goods are available (Jaegers, 2005). Vessels for LPG and other gaseous products (type G) are not easily exchangeable with other segments in tanker shipping. As a result, they are neither influenced by nor influence the supply in other segments (Kornet 2008).

A number of dry bulk goods can be loaded or unloaded by means of pumps. These products such as fly ash, lime, gypsum and cement are transported by powder tankers. Powder tankers are often converted dry cargo vessels in which separate tanks are placed. For the transportation of edible oils and other non-hazardous goods, normal tanker vessels can be used. Smaller volumes of liquid cargo are also transported by means of tanker containers. In these cases, container vessels or other dry cargo barges are utilised.

The dimensions of most recent dry cargo vessels are based on container sizes, but also older, non-adjusted vessels can be used to transport containers. Apart from this, also specialised container vessels with container guides are being used. In container transport the separate sub-segments do not relate to the goods transported as in the other market segments, but to the geographical aspect. The three major market segments in container transport are domestic transport, Rhine navigation and Rotterdam-Antwerp navigation. When it comes to transport of containers, the Rhine river itself is divided into three areas: the Lower Rhine (Rotterdam-Cologne), The Middle Rhine (Cologne-Karlsruhe) and the Upper Rhine (Karlsruhe-Switzerland) (Zurbach, 2005).

[8] Accord Européen relatif au Transport International des Marchandises Dangereuses par voie de Navigation du Rhin : Regulation on the Transport of Dangerous Goods on the Rhine

For ro/ro transportation, specific self-propelled vessels and pushed barges exist. Ro/ro vessels also transport containers when a vessel is not fully charged for a liner service. Thus, a combination with other forms, such as containers or dry cargo, is possible depending on the characteristics of the vessel.

Transportation of extremely heavy and voluminous loads can take place with regular (dry cargo) freight barges when the cargo fits the hold capacity. If this is not the case, pontoons or ro/ro platforms are used, which are either towed or pushed. Transportation of general cargo for a large part takes place in containers.

In case of very large quantities of goods, transported between the seaports (e.g. containers between Rotterdam and Antwerp) or from the seaports to the Ruhr area (e.g. ores and coal), the use of push convoys is an important segment. The pushed barges can be left behind while the pusher vessel can immediately be used for a different assignment.

During the last years there has been an increase in coupled trains. Coupled trains are self-propelled vessels with one or more push barges. They are generally allocated by placing one barge up front or one barge aside and appear rarely with more than one barge. On smaller canals, often combinations with two vessels of the type 'Spits' are used in order to increase the capacity and therefore increase the profitability.

2.2. Niche markets and their perspectives

In the previous years, the inland navigation sector has become active in several niche markets. For the most part this was spurred by different governments aiming at decreasing the external effects of road transportation by stimulating the use of inland navigation. Next to this also shippers and vessel owners have been working together closely in order for new products to be transported by inland waterways.

2.2.1 What is a niche market?

When a market segment is very small and has quite specific needs, the term market niche or niche market is used. Niche markets concern very particular goods or services and imply higher expenses and/or require specific competences. These niche markets are often characterised by a limited number of suppliers, a higher willingness-to-pay by the shipper and a close relation between both parties.

In the previous years, quite a few studies and projects on niche markets in inland navigation were set up in business, some more successful than others. A brief overview and some examples of the most important new niche markets are given below.

2.2.2 New niche markets in inland waterway transport

One of the new niche markets is the transport of waste and recycling materials such as domestic waste, building and demolition waste, contaminated earth, glass and so on. Normal dry cargo vessels or vessels with limited extra equipment are generally used for these transports since the goods are dumped loosely or packed in containers. Regulation for the transportation of waste differs between countries and depends on the products.

The major problems of these transports are the cost of road transport to and from the terminals and the investments in cranes on the quays. As a result of these extra costs, inland navigation usually cannot compete with road transportation and therefore needs (temporary) government aid. This result emerged from a number of Dutch pilot studies, for example the pilot of Essent in order to test the feasibility of waste transportation by inland navigation between Moerdijk and Maastricht in 2003.

In the Belgian province of Flemish Brabant plans were made to collect the domestic waste of almost all communes in three transhipment centers located at the waterside. From there this waste would be transported in closed containers by inland navigation to the processing plant near Antwerp. This project should have started from 2009 onwards, but is put on hold due to budgetary reasons. Currently, the costs of these transports are too high compared to road transport, mainly as a result of the transhipment costs. A second example can be found in the Netherlands. Here, recycling company Maltha transports glass from Dintelmond to Alkmaar. This is a successful initiative, partly because the transportation by inland waterways renders an extra benefit for the production (less transhipment and therefore less glass break).

The concept of transporting dry bulk products in tanker vessels is not new. However, the adoption of the concept for certain goods, such as flour, is. These vessels are generally equipped with self-loading and unloading equipment or experienced some other technical adjustments. An example is the flour barge of Mercurius Scheepvaart Group in the Netherlands. The flour barge Mercurial-Latistar was built for the transportation of dusty flour between the flour factory of Meneba in the province North-Holland and the processing plant Avebe Latestein B.V. in Nijmegen. After the end of the five-year contract and the move of the processing plant, the vessel was converted to a normal dry cargo vessel.

Pallets can be used for the transportation of consumption goods as well as for building materials. Generally, it concerns goods flows between producer and wholesale store. Several pilots have been tested, generally starting from a standard vessel and later on adjusted to the specific needs of these transports. Examples are the Distrivaart project in the Netherlands and the transport of building materials in Flanders (StoneExpress project). The (small) conversion of these vessels implies that they are less easily exploitable for other transports. Conversion is often realised by means of financial support from governments granted to those projects, e.g. The European Commission, national and regional governments.

The Distrivaart project started in 2002 as an initiative of Nederland Distributieland. In this project, fast moving consumer goods were transported from producer to distribution centres. The project appeared commercially unfeasible when released on the market in 2004. This was due to a number of reasons, such as the lack of new companies willing to join the project. Organizational reasons, the high cost of transporting the goods to and from the companies which were not located near the waterways and the large investment costs for the technical aspects of the system were the major drawbacks. A similar project with building materials on pallets was tested in Flanders in 2007-2008.

In this StoneExpress project, public as well as private actors work together closely. Here too, the high transhipment cost appears to be an important drawback of the system.

Refrigerated and frozen goods are transported by means of reefer containers. These containers can be loaded by normal dry cargo or container vessels and can be connected to the standard electricity supply. Some vessels, however, are equipped with extra facilities for these transports, such as extra generators and connection points, and can consequently take more reefer containers. Within the European funded Agroship project, a pilot started in 2007. It concerns the transportation by inland vessel of frozen goods in reefer containers between Bergen-op-Zoom and the ports of Antwerp and Rotterdam (for Mepavex and Lamb Weston Meijer). At the end of the pilot in 2008, it received a favourable evaluation.

As discussed in chapter 3, during the last years, only a limited number of new small vessels were put into service. These were generally ECMT class III and IV vessels (55 m – 86 m) or special vessels (bunker, crane and pallet barges). To counter this trend and to give an impulse to the use of small waterways, several projects have been set up. The earlier mentioned European funded Waterslag concept (the use of a self-propelled vessel and a pushed barge as a coupled train in order to increase capacity) which started in 2006 and got a positive evaluation at the end of 2008 is one of them. A second example is the Watertruck concept for which a feasibility study was carried out in 2009 and for which a pilot study would start in the year 2011.

Generally, financing new small vessels is less interesting for banks since small vessels are less profitable than larger ones due to higher costs per tonne, lower rotation speed, etc. Therefore, government support is often indispensable to have less profitable projects running. Exceptional cases for which financing is not a problem are vessels which are specially designed for specific goods or routes and have long-term contracts at transportation prices which are sufficiently high.

In order to stimulate container transportation by inland waterways for smaller companies located at the waterside, vessels with a crane on board to load and unload containers at any location were designed. The concept existed already in dry cargo transport (e.g. sand), but in this case the vessel has extra ballast tanks to ensure stability. The AMS Barge concept was established in co-operation with the Port of Amsterdam and started in 2006 with the barge Mercurius Amsterdam. In this project not only the technical aspects of crane and vessel determine the economic feasibility. Also the organisation and positioning of the crane vessel in the broader logistics chain are crucial success factors. Since the end of 2009 a second crane vessel, called Transferium, is deployed in the port regions of Amsterdam and Rotterdam.

2.2.3 Technical adjustments for niche markets

For special vessels, new technical concepts and innovations are available, such as efficient sizes, construction in series and alternative, low maintenance and energy efficient materials. Such concepts are essential for small vessels in order to diminish the difference between the costs of a new small vessel and those of an existing one (Buck Consultants, 2008).

New techniques and materials allow the construction of less heavy vessels, which, as a consequence, have a smaller draught. Further, vessels for specific market niches can be built from composite materials. Yet these materials are more expensive than the usual ones, which limit their application in the normal market segments.

2.2.4 Results and perspectives

From the previous overview and a number of other projects we can learn that new studies and pilot projects can be driven by the sector itself. Examples can be found in tanker shipping where specialised vessels are built for special chemical products e.g. MTS Alain Colas for the transport of iron trichloride for Beltank. But also in dry cargo transport successful cases can be found e.g. transport of glass for recycling company Maltha from Dintelmond to Alkmaar. When using inland navigation creates an extra benefit in the production process, such projects become commercially feasible for companies

But very often new niche markets and pilot studies are initiated by governments, public and semi-public institutions and agencies. In these cases they are merely focused on new goods for inland navigation and the use of small waterways. These segments are seldom interesting markets from a vessel-owners perspective, but they are important in the light of sustainable transport. Government aid, at least temporary, is often indispensable in order for pilot projects to get started. Generally, support for studies, conversion of vessels, (technical) innovations, construction of terminals or handling equipment is granted. A number of these projects appeared commercially unfeasible when in operation in the open market, e.g. Distrivaart.

In the case of small vessels, the use of new materials and techniques are necessary in order to make them more profitable, because there are no economies of scale to be gained. Furthermore, the competition with road transport for those new transports is fierce. Transporting goods by road often remains the most cost-effective means of transportation. Therefore it is crucial to embed these new inland navigation initiatives in a broader logistic concept which creates extra benefits for shippers.

Conclusion concerning the overview of the sector

It is clear from this chapter that there is not such a thing as one inland navigation sector. There are many market segments which each have their own characteristics, in fleet as well as operations, area and evolution. The period of regulation has been an important one for the inland navigation sector. Even though it is by now more than 10 years ago that the sector has been liberalised, it is still important to study its past. The regulated system did not apply to all IWT transport, but in certain areas it had an extensive influence on the market, e.g. in domestic dry cargo transports.

The liberalisation has created opportunities for all actors to play a more active role in the market. Vessel owners are subject to a competitive market which brings uncertainties for some, but also creates opportunities. Vessel owners have responded to the demands of shippers by amongst others modernising the fleet and increasing the scale of vessels. The position of IWT transport in the traditional inland navigation countries is substantial and the role of the sector is emphasized by governments at different levels. Moreover, there are some challenging goals put forward by amongst others the European Commission and port authorities.

In the chapter it is shown that some market segments are clearly separated, while others know more or less overlap. It is important for the vessel owner to decide whether he wants to direct himself toward a very specialised segment or towards a broader one. The first option might include extra expenses for the vessel and certificates. Moreover a higher risk is included, because of a smaller market. If the company for which one has built a vessel would relocate or shut down, it might be hard to find new cargo. It is possible that the vessel even has to be reconverted to a different type. On the other hand, in such segments competition can be less severe and freight tariffs are often higher. Moreover, if shippers want to be sure of the capacity, they engage themselves in long-term contracts. This is certainly the case if a vessel is specially built for a certain shipper, since both the vessel owner and the financial institution will want to reduce the risk.

The second option might seem a safer way, because there are more opportunities available and one does not depend on a limited number of shippers or products. The competition in a less specialised environment, such as dry cargo transport could be much higher though, since there are no special features for the vessel involved and there are more competitors in the market. It is therefore likely that freight tariffs will be lower and/or waiting times for shipments longer. This will have an influence on the productivity and revenues of the vessels. This will be further addressed in chapter 5.

Chapter 3: Fleet and capacity

The fleet in a certain year consists of the existing vessels in the market, plus the new ones which have been built, minus the ones being scrapped. The average lifetime of an inland vessel is rather high and depends to a great extent on the market situation. In this respect, also government regulation and self-regulation of the market influences the lifetime of vessels. In this chapter the current fleet of the major European IWT countries and its evolution is analysed. This is followed by an in-depth view on the vessels registered in Belgium in the previous 10 years. Afterwards, the specialisation in the sector is addressed based on the new builds in the sector. Furthermore the effect of such specialisation on the capacity is addressed.

1. European fleet

The inland navigation fleet can be subdivided in dry cargo vessels on the one hand and tanker vessels on the other hand. There is also a different classification being on the one hand the self-propelled vessels and on the other hand the pushed barges in combination with push-and tugboats. In the following analysis, these different vessel types are represented separately.

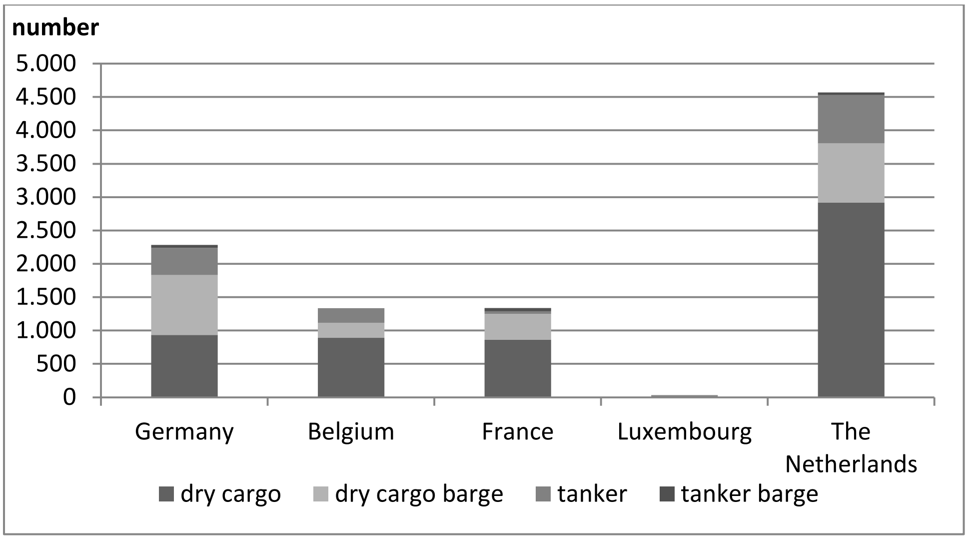
The national inland navigation fleets of the different countries have gone through a different evolution as a result of numerous national actions and initiatives such as the investment support, the scrapping regulations and so on. The establishment or abolition and timing of such measures can have a significant influence on the composition of the fleet. Such effects are expected to be found in the data in the year(s) just before the abolishment of a measure of just after the installation of a new one.

1.1. Current European fleet

Graph 3.1 and graph 3.2 give an overview of the fleet in number of vessels and fleet capacity per country. The Dutch fleet is manifestly the largest one, followed by the German, Belgian en French fleet. In number of vessels the French and the Belgian fleet are almost equal, but in capacity there is a large difference. The graphs show that the French vessels are on average much smaller than the Belgian ones. It is clear from both graphs that the dry cargo fleet, consisting of both self-propelled vessels and pushed barges, is the largest in all countries. The proportion of both is very different though. Whereas the pushed barges only take about a third or a quarter of the dry cargo fleet in Belgium, France and the Netherlands, it is almost half in Germany.

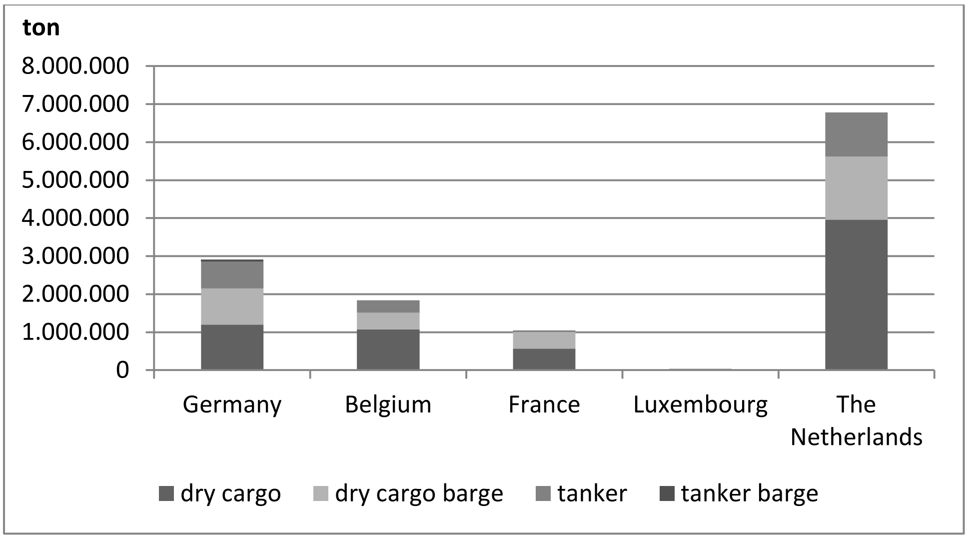
Self-propelled tanker vessels are mainly found in the Dutch, German and Belgian fleets. The fleet registered in Luxembourg is very limited compared to the other countries, but consists almost entirely of tanker vessels. When comparing the share of tankers in both graphs, it can be concluded that the tanker vessels in the Netherlands and Germany are generally larger than the dry cargo vessels. Overall, the number of tanker barges and the total fleet capacity of these pushed barges are very small.

Graph 3.1: Number of inland waterway vessels in 2009 per country



Source: own composition based on data CCR Market Observations

Graph 3.2: Capacity of the fleet in 2009 per country (in tonne)



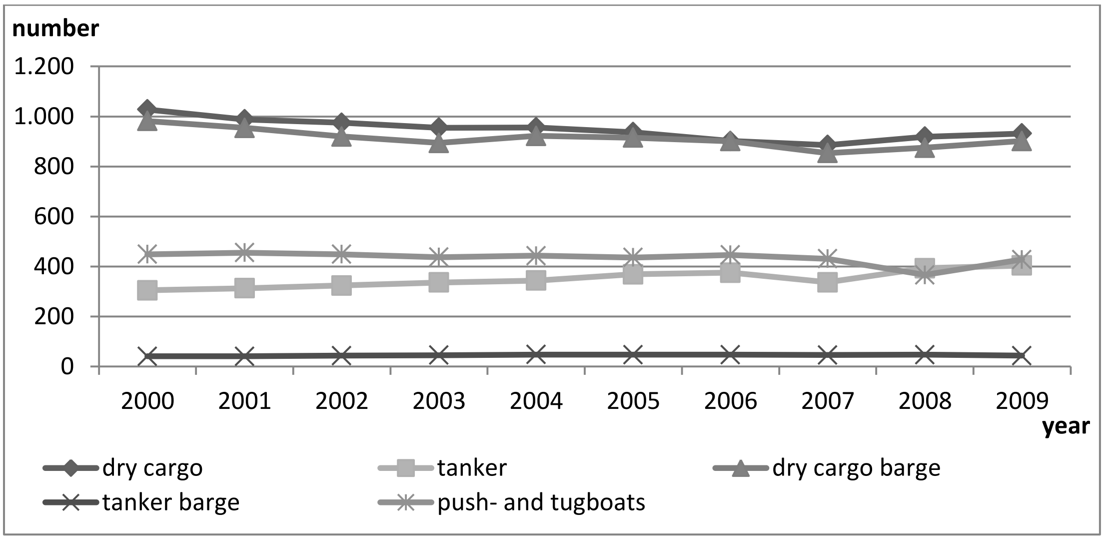
Source: own composition based on data CCR Market Observations

1.2. Evolution of the national fleets

Not only is the situation as it is today important. In chapter 1 it was reasoned already that history and the major events in the past have made the sector to how it is today. Therefore, it is equally important to have a closer look at the evolution of the fleet than only considering the current situation. In this part, the evolution of the fleet as from the year 2000 onwards is examined based on the data assembled by the CCR. Since the different IWT countries each have known their own evolution because of different policy measures and legislation, the analysis is carried out for the major IWT countries separately. Because the number of vessels is as important as the size of them, both the size and the capacity of the fleet is studied.

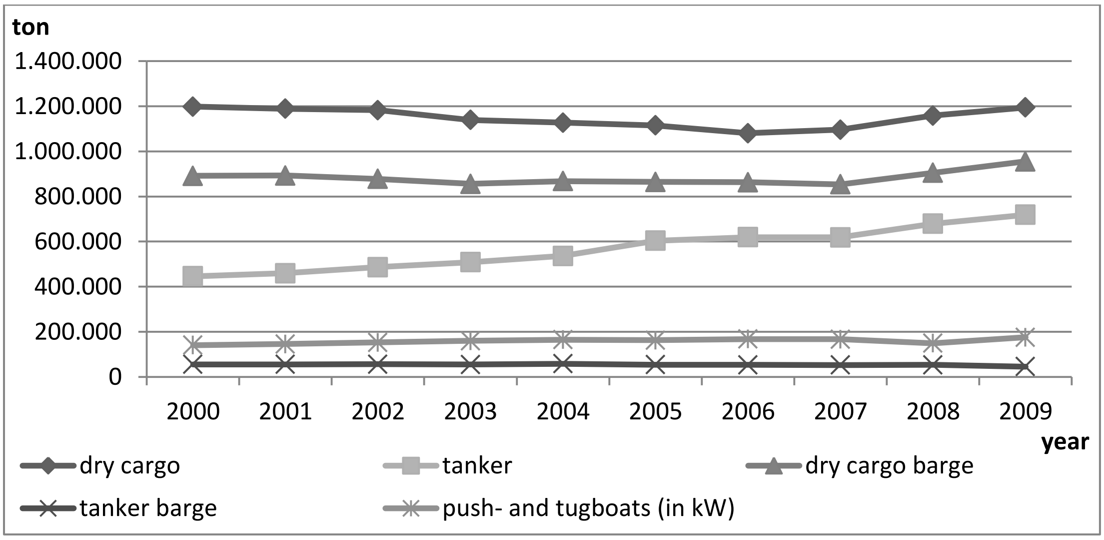
As mentioned before, the German fleets consist mainly of both self-propelled vessels and barges in the dry cargo segment. Their number and total capacity has decreased slowly throughout the years until it started growing after the year 2007, which can be found in graph 3.3 and graph 3.4. In the tanker segment on the other hand a clear increase can be found almost over the whole time period. The number and capacity of push- and tugboats and tanker barges has remained stable all over the period studied.

Graph 3.3 Evolution of the German fleet (number of vessels)



Source: own composition based on data CCR Market Observations

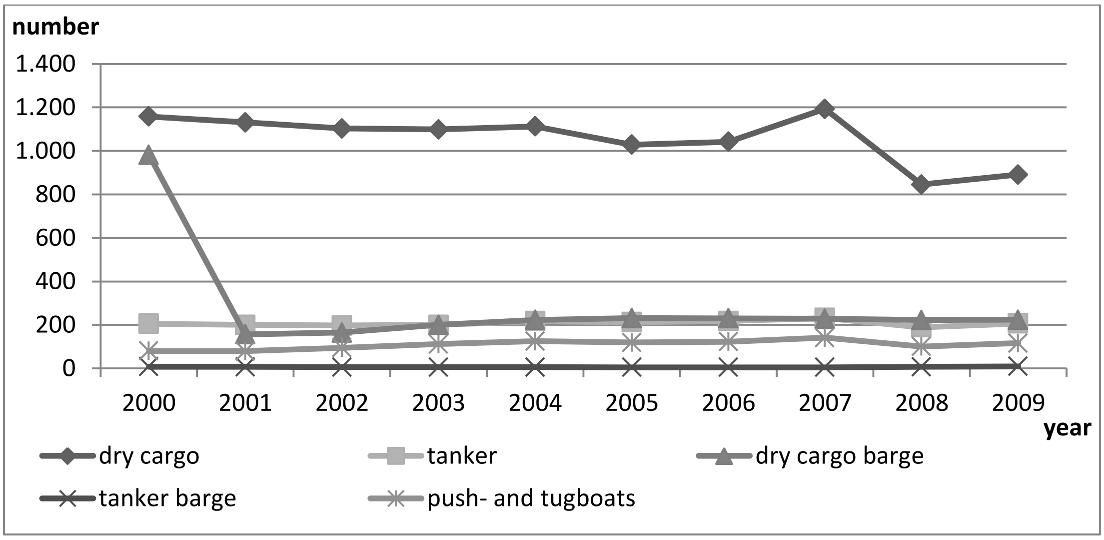
Graph 3.4: Evolution of the German fleet (fleet capacity)



Source: own composition based on data Market Observations

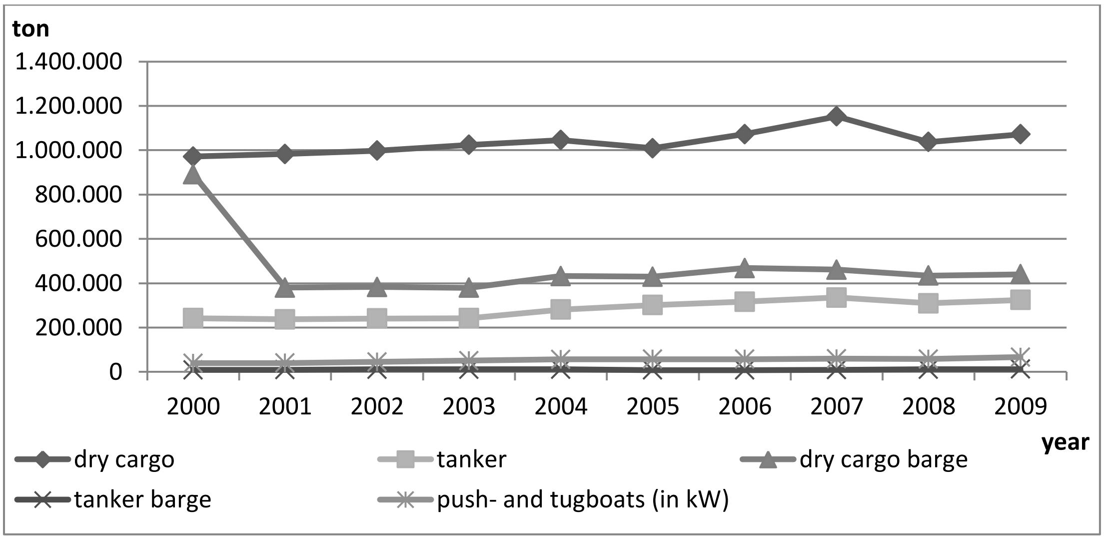
The evolution of the Belgian fleet shows a clearly different picture compared to the previous one (see graph 3.5 and graph 3.6). The number of dry cargo vessels has slowly decreased over time, but the fleet capacity has slightly increased in this time frame. This indicates a scale increase of the fleet. In the years 2006 and 2007 a major increase in fleet and capacity is found, followed by a sharp decline in the year 2008, being the crisis period. The number of dry cargo barges has known a steep decline in the year 2001 after which it has slightly increased in number and capacity. For tanker vessels and push- and tugboats, a slight increase is found over the years which stopped in the crisis period.

Graph 3.5: Evolution of the Belgian fleet (number of vessels)



Source: own composition based on data CCR Market Observations

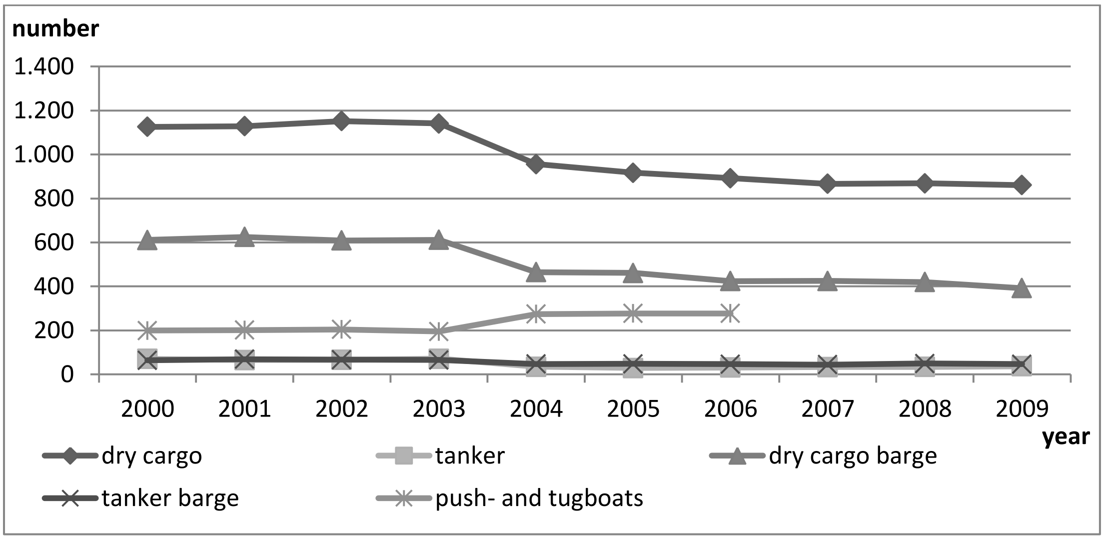
Graph 3.6: Evolution of the Belgian fleet (fleet capacity)



Source: own composition based on data CCR Market Observations

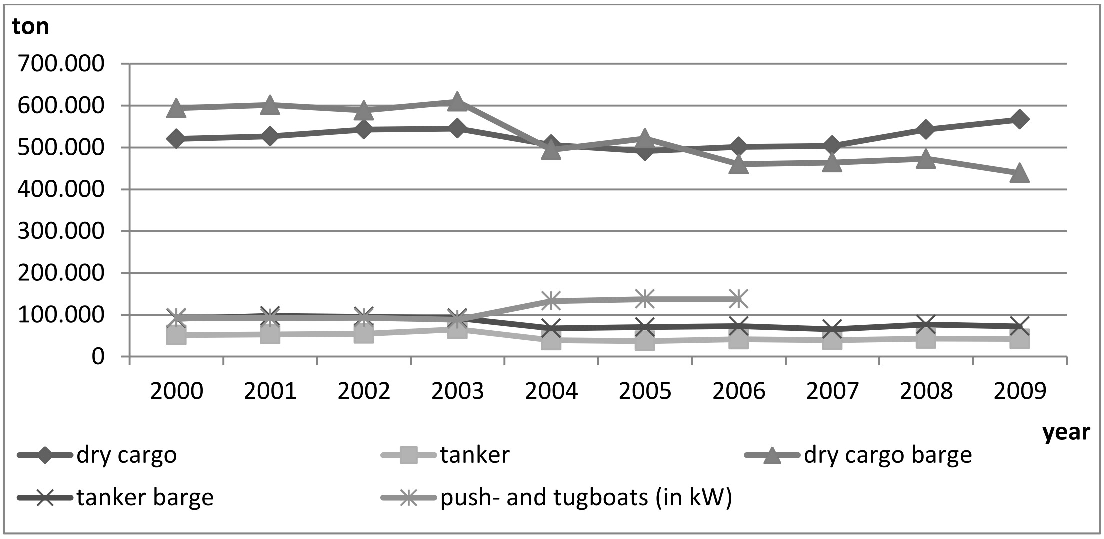
The dry cargo barges of the French fleet are on average much larger than the self-propelled vessels. The number of self-propelled vessels is almost double the one of barges, but their total fleet capacity is much closer to each other. The evolution of both vessel types has a similar course (see graph 3.7), slightly declining over the years with a large decline in the year 2004. The same downward trend is found for both the self-propelled tankers and tanker barges. The number of push- and tugboats on the other hand has increased in the year 2004. The fleet capacity (graph 3.8) has quite a similar development as the number of vessels, except for the self-propelled dry cargo vessels of which the fleet capacity has increased as from 2006, which indicates a scale increase of such vessels.

Graph 3.7: Evolution of the French fleet (number of vessels)



Source: own composition based on data CCR Market Observations

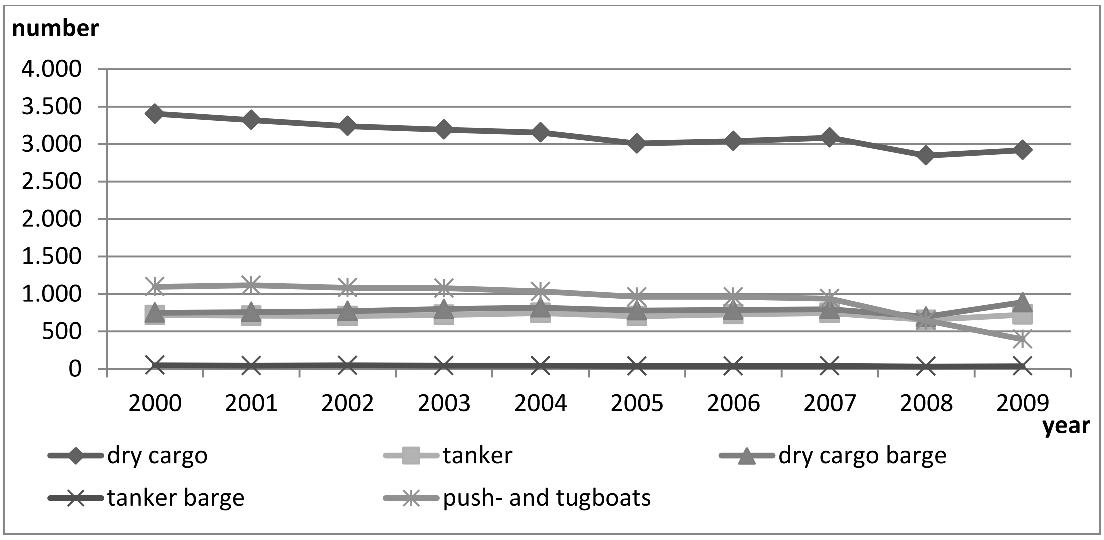
Graph 3.8: Evolution of the French fleet (fleet capacity)



Source: own composition based on data CCR Market Observations

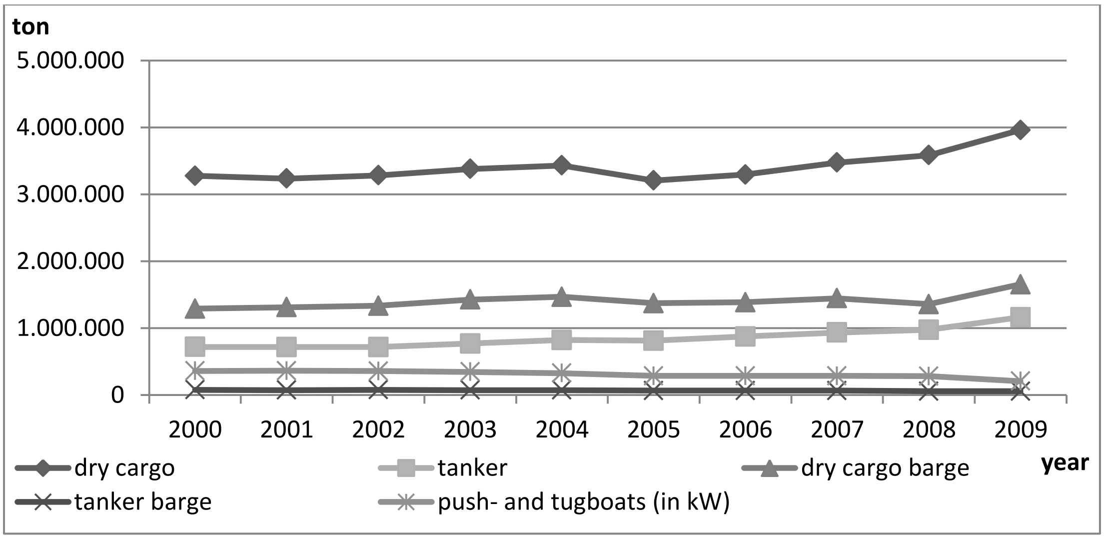
As shown in graph 3.2, the Dutch fleet is clearly the largest one in Europe and therefore changes in this fleet will have the highest impact on the sector. From graph 3.9 it is clear that not only the self-propelled dry cargo vessels are far most the largest part of the fleet, but also that the number of these vessels has diminished over the years. The corresponding capacity (see graph 3.10) on the other hand has seriously increased over the years, demonstrating the scale increase of the vessels. The number of self-propelled tankers and dry cargo barges has remained rather stable over the years, but their capacity has also increased. The number of push- and tugboats on the other hand has slowly decreased in the time period and has seriously dropped after the year 2007.

Graph 3.9: Evolution of the Dutch fleet (number of vessels)



Source: own composition based on data CCR Market Observations

Graph 3.10: Evolution of the Dutch fleet (fleet capacity)



Source: own composition based on data VVR Market Observations

Conclusion on the European fleet

The fleets of the major European countries have a different composition, but all mainly consist of vessels for dry cargo goods. In general a scale increase is found for most vessel types throughout the years, even though the magnitude and the starting point of this increase are different amongst the fleets. This increase in vessel size is the result of important scale advantages in the sector.

2. Inland navigation vessels registered in Belgium

Apart from the new construction of vessels, also the mutations of existing vessels are important in order to get a good view on the sector. In this case, we want to see whether Belgian owners are buying new or second hand vessels, where these vessels are coming from and whether most vessels are bought by independent owner-operators or shipping companies.

2.1. Data

In order to retrieve data on the vessels belonging to the Belgian fleet, the Belgian Ships register is consulted. It holds all inland navigation vessels registered in Belgium, which are:

- Active in commercial shipping/inland navigation
- Registered on demand of their owner.

There is no obligation in Belgium, normally only those inland navigation vessels for which a mortgage is necessary are registered. The registration therefore is optional and not all Belgian inland navigation vessels are on this list.

The register holds newly built vessels (first registration) as well as existing vessels coming from a different European register. The technical data is based upon the certificate of tonnage. The data analysed ranges from 1998 until 2008, holds all types of inland navigation vessels and consists of 848 observations of which the larger part has a mortgage. Vessels of which the year of construction only differs one year with the year of registration are considered as new builds. Most vessels have a Belgian owner (92%) which is alike for independent bargemen and partnerships.

2.2. Analysis

This analysis shows that more than 56% of the vessels registered are self-propelled vessels, almost 14% are tankers and 14% are pushed barges of which a minor part are tank barges (see table 3.1). Furthermore a number of push- and tugboats (9%) and work- and other vessels (together 7%) are in the list.

Table 3.1: Type of vessel

Type of vessel	number	%
Self-propelled dry cargo vessel	476	56
Self-propelled tanker vessel	117	14
Dry cargo barge	114	13
Tanker barge	7	1
Push- and tugboats	76	9
Work vessels	25	3
Other	33	4
Total	**848**	**100**

Source: own composition, based on data from Belgian Ships register

More than 80% of the vessels in the register have a mortgage, probably as a security for a loan. In the case of container vessels, pushed barges, tanker vessels and dry cargo vessels the share is higher than 80%. For work- and other vessels, the share of vessels with a mortgage is lower. Since these vessels are often smaller, less expensive and/or owned by larger companies, there is less need for mortgages in order to be acquired.

About 45% of the vessels registered are bought by partnerships and 55% by owner-operators. From the owner-operators 90% of the registered vessels have a mortgage, while this is not even 70% for the partnerships. Again, this shows that larger companies have less need for a mortgage when buying a vessel since sufficient other certainties can be available. The vessels which are more often bought by these partnerships are mainly work- and other vessels (77.4%), tanker vessels (73.5%) and pushed barges (64.5%). Dry cargo vessels on the other hand are bought more often by owner-operators (70.5%). For push- and tugboats there is no real difference to be found. The larger the vessels, the higher the share of vessels with a mortgage, except for the smallest vessels which are push- and tugboats.

Table 3.2: Year of construction

Year of construction	number	%
before 1960	225	27
1960-1970	159	19
1970-1980	101	12
1980-1990	99	12
1990-2000	61	7
2000-2008	203	24
Total	**848**	**100**

Source: own composition, based on data from Belgian Ships register

The year of construction of vessels which are registered between 1998 and 2008 is represented in table 3.2. It shows that 24% of the vessels are built between 2000 and 2008. Of this number, more than 85% (189 vessels) are considered new at the time of registration in this register. These are the vessels of which the year of construction and the year of registration differ only one year (more as well as less). Furthermore, it shows that a rather large share of vessels is somewhat older. Vessels from before 1980 make up 58% of the vessels registered. The vessels of 10-20 years old only have a small share of 7%.

Table 3.3 shows that most second hand vessels have their origin in the Netherlands (59%). The other countries represent only a small share. Since only vessels coming from a different register or having no previous register are in this list, there is no indication on how many vessels are being bought and sold within Belgium.

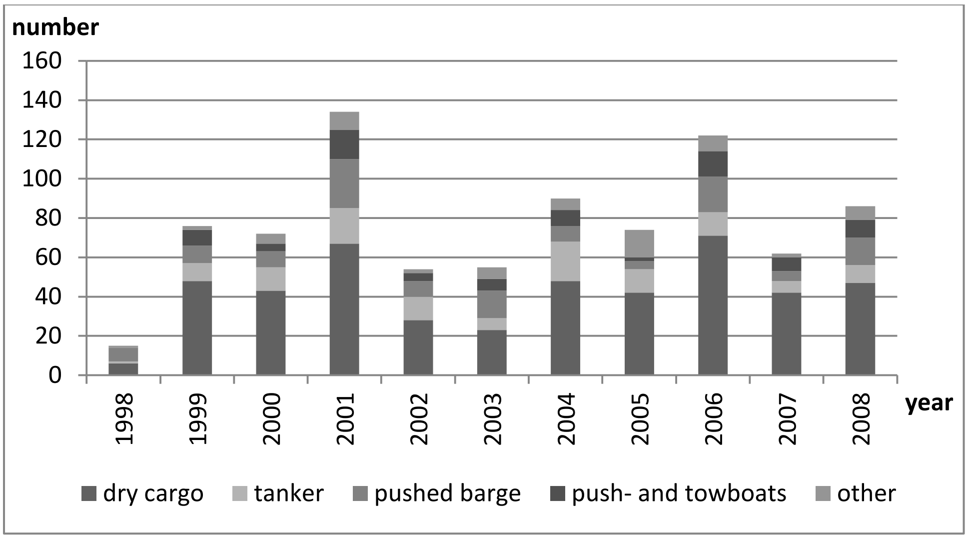
The number of vessels registered per year and by vessel type are represented in graph 3.11. The data of 1998 is not complete which explains the low number of observations there. The graph shows that in the years 2001 and 2006 most vessels were registered, mainly as a result of the high number of self-propelled dry cargo vessels. Tanker vessels were mostly registered in the years 2001 and 2004, pushed barges and push-and towboats mostly in 2001 and 2006.

Table 3.3: Country of previous registration

country	number	%
CH	11	1
DE	34	4
CZ	31	4
FR	39	5
LU	11	1
NL	503	59
other	13	2
none	206	24
total	**848**	**100**

Source: own composition, based on data from Belgian Ships register

Graph 3.11: Number of vessels by type and per year of registration (1998-2008)



Source: own composition, based on data from Belgian Ships register

When only focusing on the self-propelled vessels and barges which are assumed to be used for carrying goods on the inland waterways vessels, 778 observations remain in the dataset. The moment of registration is here supposed to be the moment of purchase of the vessels, since most vessels have a registration because they are involved in a mortgage. When looking at the age at the time of registration, or as assumed here at the time of purchase, we can see a clear difference according to vessel type (table 3.4).

Table 3.4: Age at time of registration by type of vessel

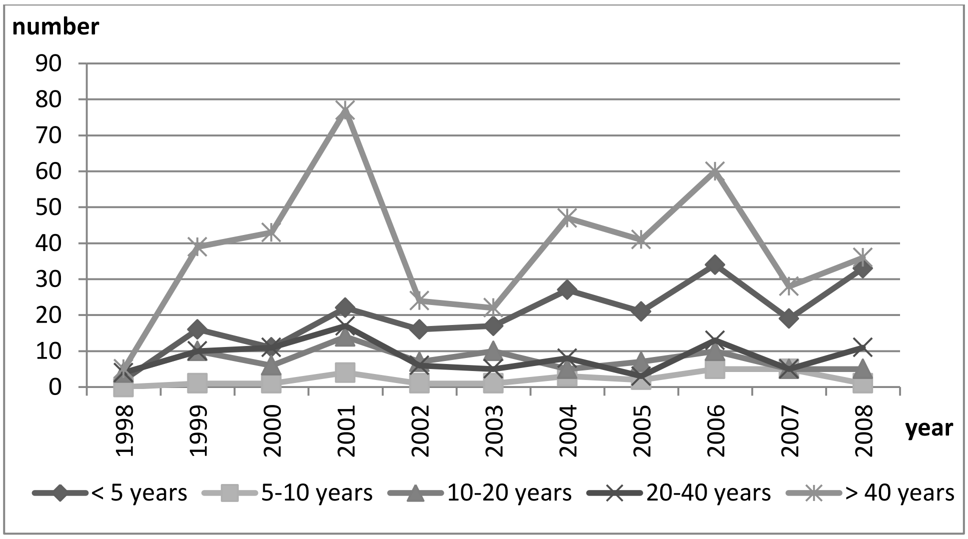
age at time of registration	dry cargo vessels		tanker vessels		push and tugboats		pushed barges		total	
	count	%	count	%	count	%	count	%	count	%
< 5 years	104	22	52	44	35	29	10	13	201	26
5-10 years	12	3	5	4	2	2	1	1	20	3
10-20 years	31	7	5	4	42	35	1	1	79	10
20-40 years	35	8	16	14	22	18	18	24	91	12
> 40 years	283	61	39	33	19	16	46	61	387	50
total	**465**	**100**	**117**	**100**	**120**	**100**	**76**	**100**	**778**	**100**

Source: own composition, based on data from Belgian Ships register

For the self-propelled dry cargo vessels and tanker vessels there is a clear distinction between on the one hand a large share of recent vessels which were less than 5 years old at the time of purchase and on the other hand a large share of vessels older than 40 years. As mentioned before, in the first category most of those vessels were newly built. The share of vessels which were between 5 and 10 years old is a lot smaller. Generally push- and tugboats are either younger than 5 at the time of purchase or older than 10. Pushed barges are generally older than 20 years, although a small number of new pushed barges are in the list.

In order to see whether the age of vessels at the time of purchase has changed throughout the years and whether a difference can be found according to the type of vessels, a time-series analysis is made for the main categories of vessels (graph 3.12).

Graph 3.12: Number of vessels by age and per year of registration (1998-2008)



Source: own composition, based on data from Belgian Ships register

Graph 3.12 shows that the amount of vessels of less than 5 years old has seriously increased during the years. The number of vessels aged 5-10 years is rather stable and very low, while the number of those aged 10-20 years is somewhat higher but generally decreasing after the year 2001. The number of vessels aged 20-40 years is fluctuating and had the same course as the oldest group but on a much lower level.

Conclusion on the Belgian registrations

What can be concluded from this analysis of the vessels registered in Belgium between 1998 and 2008? First, that mainly self-propelled dry cargo vessels have been registered and that most registrations are to be found in the years 2001 and 2006. Next, that almost one quarter of the vessels are built as from 2000 and that most of them were new at the time of registration. The number of vessels of less than 5 years old at the time of purchase is increasing over the years. Furthermore that more than half of the vessels being registered are older than 30 years and that most of them were registered in the Netherlands before. Also that the number of vessels aged 5 until 20 years at the time of purchase is very low and is decreasing after 2001. About 55% of the vessels are owned by owner-operators, being mainly dry cargo vessels. Partnerships on the other hand have a higher share of self-propelled tanker vessels and pushed barges. The share of vessels with a mortgage is higher when the owner is an owner-operator compared to a partnership. This shows the importance of size for the underlying securities in order to get a financing.

3. Specialisation in inland navigation and its effect on the capacity

An important trend in the last 10 years is the increased investments in vessels for inland waterway transport. Not only did this result in a more modern fleet and an increase in capacity, it also had other effects on the supply. Whereas only a limited number of vessel types existed in the past, during the last years several specialised vessels have been taken in operation. This specialisation relates both to vessel-size and vessel-type.

As a result, one cannot look at the sector as a whole when analysing capacity in inland navigation. Available capacity strongly differs in size and type depending on the corridors and goods categories. The increasing demands of shippers, the ever-increasing regulation and safety measures and a growing competitive environment have stimulated vessel owners to focus on specific market segments or search for niche markets in order to increase their profits. It is clear that vessels built for certain niche markets are less flexible in use than others. Furthermore, the increasing regulation and safety measures diminish the opportunities for barges to shift markets. Thus, the more specialised vessels become, the less employable they are in other segments and therefore the larger the effect on the capacity.

3.1. Determining factors

Several factors can have an influence on possible specialisation. Six of them are described here in detail. These factors can relate to the vessels as well as to their operations and the regulation involved.

Fleet and capacity

3.1.1 Investments

Specialised vessels require larger investments than standard vessels. Whether or not these extra costs can be recovered depends on the situation. As a result of these larger investments, especially in the cases of tankers and very large vessels, other ways of operations such as (semi-) continuous operations are necessary.

Since vessels have a long lifespan they are often adjusted to new market conditions or goods categories. Extending the length e.g. new front or middle part, reconversion from dry cargo vessel to powder tanker, from tanker to dry cargo vessel, from single hull to double hull and so on are daily activities on shipyards. All depends on opportunities for these vessels in combination with the expenses for the conversion.

3.1.2 Long-term contracts

Sometimes vessels are designed and built exclusively for one customer or for a very limited number of products. Both the vessel owner and the financial institution require in these cases long-term contracts before taking the risk of investing. Examples of such projects are the flour barge of Mercurius Scheepvaart Group and the first Jowi-container barge.

3.1.3 Certificates and regulation

European and national governments, the sector itself and the shippers impose a number of rules and quality standards upon both vessel owners and chartering agents. Quality guarantee systems, such as the Hygiene code for inland navigation transportation of animal fodder, and security standards, such as ADNR for dangerous goods, lead up to a segmentation of the fleet. Due to increased regulation, vessels often no longer take return cargo and more empty trips are made. This has a negative influence on the capacity of the fleet and the profitability of vessels (Buck Consultants, 2008).

Furthermore, there are separate certificates for inland navigation on different corridors such as for navigation on the river Rhine. This also limits vessels to shift markets. Stimulated by European regulation, these differences are being removed gradually e.g. uniform certificate for Rhine and Danube in 2009.

3.1.4 Cleaning and dedication

Both in tanker and in dry cargo shipping, requirements on purity of products and safety are ever increasing. Therefore certain products should be stored and treated separately, which makes an (expensive) cleaning of the hold or tanks between different cargoes necessary. Sometimes the hold even has to be repainted before certain products can be taken. Operating vessels in dedication, often linked to long-term contracts, is a way to prevent the extra costs of cleaning and a lower rotation speed. As a consequence, the vessels are less flexible towards other market segments and return cargo.

In practice, it will depend on the market conditions whether shipments for which cleaning or repainting is necessary will be accepted. If a vessel has no shipment in the near future, except for one that requires the vessel to be repainted, the vessel owner will be more inclined to accept the shipment and do the works than when he has several options available. Furthermore, it also depends on the freight tariffs.

3.1.5 Market conditions

In allocating vessels, the market conditions and cargo (type and volume of goods) play an important role. When it comes to goods which are shipped in small quantities, e.g. edible oils, or when capacity at the receiver is restricted, smaller vessels than allowed on the waterway are used.

Container shipping services are using large container vessels and inland waterway convoys for the transportation of containers between seaports and the hinterland terminals in order to increase economies of scale. When demand of container transportation drops, these large container vessels, e.g. with a length of 135 m, are not easily used in other segments since they are either not suited for the waterways or the vessels are too large to transport the available quantities on the dry cargo market in a profitable way. In tanker trade, although more expensive, type C tankers often transport type N products when no type C goods are available.

A number of inland navigation companies such as Mercurius Scheepvaart Group[13] and FTS/Hofftrans consciously opt for medium-sized barges of about 86 m because of their multifunctional usability. Moreover, nearly all recent dry cargo vessels are based on container sizes, which give them the opportunity to shift from the dry cargo to the container segment or inversely depending on the market situation.

3.1.6 Support measures

In order to stimulate the inland navigation sector in general, a number of support schemes have been elaborated in the last years. Some of these support plans focused on improving the utilisation of small waterways as an alternative for road transportation e.g. Waterslag concept[14], Watertruck[15] and Inlanav[16]. Other projects aimed at the realisation of a modal shift for certain goods e.g. Agroship[17]. Usually these projects are linked to innovative concepts such as the use of alternative materials, energy-saving propulsion mechanisms or capacity-increasing concepts. Especially for projects focusing on small waterways and new market niches, (temporary) government aid is often indispensable.

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[13] The Smart Barge of Mercurius Scheepvaartgroup has the measures 86 x 11,45 x 3,75m.

[14] WATERSLAG (ECSWA = Enhancement of Containerised freight flows over Small Waterways) organised by a number of Flemish and Dutch organisations and private companies with support of the European Interreg IIIB North West Europe program.

[15] The Watertruck concept consists of a small pusher vessel in combination with a number of small pushed barges and developed by the Flemish Institute for Mobility (VIM).

[16] The INLANAV project is a spin-off of the ECSWA project which ended in 2008. INLANAV covers the entire freight market by developing a craning solution for coupled barges with a view of autonomously loading and unloading unitised cargo.

[17] Agroship is a co-operation of several Flemish and Dutch organisations which want to promote the use of inland navigation of non-bulk agricultural products and foodstuffs.

3.2. Analysis

Quite some data on the number of vessels and the equivalent capacity of the West-European fleet is available. Unfortunately, this data does not always provide detailed information on the characteristics of these vessels. In order to gain an insight into the specialisation of the fleet, various sources had to be consulted.

3.2.1 Data

The data from the 'Inland Navigation in Europe – Market Observation' (see table 3.5) gives an overview of the inland navigation fleet in the most important Western European countries. These countries are the Netherlands, Germany, Belgium, Luxembourg and France. Next to this, also the Swiss fleet is included in the dataset.

In the period 1990-1999 in total 643 new vessels were registered in these countries. This fleet is composed of 25% dry cargo vessels, 20% tankers, 49% pushed dry cargo barges, 3% pushed tanker barges and 5% pusher vessels. From 2000 until 2007 (the data of 2007 is not complete), in total 750 vessels were registered of which 42% dry cargo vessels, 26% tankers, 30% pushed dry cargo barges, 1% pushed tanker barges and 1% pusher vessels.

The increase in the number of dry cargo vessels stems mainly from the emergence of container traffic on the one hand and the effect of the liberalisation on the other hand. In the case of tanker vessels, the growth is sparked by all kinds of new regulations such as ADNR 2007-2008. These regulations imply among others a substitution of single hull vessels by double hull vessels for quite some products.

Table 3.5: Number of vessels and fleet capacity by type and year

type of vessel	before 1990 and unknown		1990-1999		2000-2007		total	
	number	tonne	number	tonne	number	tonne	number	tonne
dry cargo vessel	5,467	4,946,728	158	363,878	316	802,352	5,906	6,001,303
pushed dry cargo barge	1,840	2,246,473	312	598,007	223	393,228	2,346	3,183,372
tanker vessel	1,104	1,259,556	127	232,412	196	528,977	1,404	1,970,612
pushed tanker barge	115	161,891	17	33,825	8	17,353	140	213,069
pusher vessel	1,151	-	29	-	7	-	1,186	-
total	**9,677**	**8,614,648**	**643**	**1,228,122**	**750**	**1,741,910**	**10,982**	**11,368,356**

Source: own composition, based on data from CCR, 2008b

When analysing the equivalent capacity, it is clear that there has been a remarkable increase in scale. This scale effect is striking for self-propelled tanker vessels, but also the average volumes of self-propelled dry cargo vessels and pushed tanker barges have risen substantially. For pushed dry cargo barges on the contrary the average volumes have decreased, a results of the barges in the dataset being part of coupled trains.

This data from the Market Observation gives a good overview of the current fleet, but unfortunately it does not provide any more information concerning the technical aspects of these vessels. In order to discover more detailed characteristics, various sources had to be consulted. For the period of 1991 until the first half of 1998, data from the IVR[18] has been used. The data spanning the period of 1999 until 2008 is composed out of data available on new vessels in the 'Binnenvaartkrant'[19] and data provided by shipping companies. This way, more detailed information on newly built vessels was assembled for this period. The data for this second period contains more details than for the first.

Unfortunately, it was not possible to receive all data on all newly built vessels. Since the sector in the Netherlands is both the largest and the most organised, the larger part of the data for 1999-2008 relates to Dutch vessels. Next to this, the share of self-propelled vessels, dry cargo as well as tankers, compared to pushed barges is overrepresented in the second period. Despite these deficiencies, the database gives an in-depth view on the newly built vessels of the last decades.

3.2.2 Type of vessels

Table 3.6 shows that the number and share of new self-propelled dry cargo vessels have increased strongly after the liberalisation of the market in 1998. The abolition of all kinds of systems which limited competition increased opportunities for investments. Investments in the number of bin vessels on the other hand have not changed significantly, since this market segment was already largely exempted from the existing regulation before 1998.

Table 3.6: Vessels by type

type of vessel	**IVR data 1991-1998**		**Vlootschouw 1999-2008**	
	number	**%**	**number**	**%**
dry cargo vessel	77	19	404	51
bin vessel	12	3	32	4
container vessel	8	2	3	0
tanker vessel	84	20	280	35
pushed dry cargo barge	122	30	25	3
pushed tanker barge	11	3	1	0
pusher vessel	6	1	16	2
tug and other vessels in tow	17	4	0	0
special vessel	10	2	38	5
other/unknown	63	15	0	0
total	**410**	**100**	**799**	**100**

Source: own composition, based on data from IVR and Vlootschouw (December 2008)

[18] International Association for the representation of the mutual interests of the inland shipping and the insurance and for keeping the register of inland vessels in Europe.

[19] Available on www.vlootschouw.nl

Based on the data in table 3.6, it seems as if less container vessels were built starting from 1999. This is only due to the name-giving in the different sources and the evolution of container transportation. In the period 1991-1998, eight vessels specially adjusted for containers have been built. They were called container vessels in the database, but they could also transport dry bulk cargoes. Later on, almost all dry cargo vessels were built based on container sizes, but were catalogued as dry cargo vessels. The container vessels which appear in this second period are those vessels that are specially equipped with container ways and are therefore exclusively used for containers.

Table 3.7 gives an overview of the total fleet of tanker vessels in 2007 and the tanker fleet built between 1999 and February 2009. A distinction is made by type of tanker vessel and by type of hull. When looking at both datasets, it shows clearly that the majority of newly built vessels have a double hull. Furthermore, the share of newly built chemical vessels in these years is much higher than their share in the overall tanker fleet. The increasing regulation and safety measures add greatly to this trend.

New construction of pushed (dry cargo) barges is often linked to new constructions of new self-propelled vessels, which form a coupled train together. In this second database all pushed barges (dry cargo as well as tanker) are part of such coupled trains. Investments in new pusher vessels have increased while the use of all types of vessels in tow has become obsolete.

Apart from these general types of vessels, the inland navigation fleet also consists of special vessels. In the period 1991-1998, 10 vessels were listed as special. Amongst them were two crane vessels, one bunker boat, two cement vessels and five working vessels. Starting from 1999, in total 37 barges were classified as special vessels. Six powder tankers, nine crane vessels, of which eight for sand and dredging and one for containers, and two vessels for the transportation of goods on pallets could be distinguished. Further, there was one ro/ro vessel, one vessel adapted to reefers, one vessel with special grain partitions and several other vessels, such as a cement transhipment vessel, anti-pollution vessels and an instruction vessel.

Table 3.7: Total tanker fleet (2007) and newly built tanker vessels (1999-2009)

	European fleet on 26/04/2007				**New vessels 1999-2009**			
	double hull	**single hull**	**total**	**%**	**double hull**	**unknown**	**total**	**%**
Type N	155	673	828	69	33	9	42	12
Type C	317	-	317	26	182	6	188	54
Type G	62	-	62	5	16	0	16	5
unknown	-	-	-		24	80	104	30
total	**534**	**673**	**1,207**	**100**	**255**	**95**	**350**	**100**
%	44	56			73	27	100	

Source: own composition, based on data from EBIS[20] (26/04/2007) and IVR (February 2009)

[20] European Barge Inspection Scheme

3.2.3 Size of vessels

Table 3.8 illustrates the increase in scale and its dimensions for the different segments. Since length is one of the determining factors concerning access to waterways at locks, three classes of lengths are being used. Vessels smaller than 86 m (ECMT class IV), from 86 m until 110 m (ECMT class Va) and larger than 110 m can be distinguished.

When comparing the two data periods, the share of newly built bin barges in these three groups is fairly constant. In the case of container vessels, the share of vessels larger than 110 m has increased strongly. For dry cargo and tanker vessels, the share of the smallest vessels decreased in favour of the largest ones. The share of middle-size vessels remains constant for both vessel types.

Newly built pushed barges also have a constant share over the two periods. Their length in this database remains limited because they are all part of a coupled train with a maximum length. Vessels which are special mainly belong to the smallest sizes although they also appear in the middle and largest size after 1999.

When studying into more detail the group of vessels smaller than 86 m, which is not represented in this table, it shows that the number of bin vessels is equally divided among ECMT classes III (67-80 m) and IV (80-85 m) in both time periods. The fleet of dry cargo vessels on the contrary only consists of 10% vessels of ECMT class III in the first period. In the second period, the share of class III vessels reaches 15%. The shares of tanker vessels give opposite results. While in the first period 13% of these smaller vessels belonged to class III, from 1999 to 2008 this was less than 4%.

Vessels classified as special are remarkably smaller than the other types of vessels. This obviously relates to their application. About half of these smaller vessels belong to ECMT class II (less than 55 m) and are merely bunker vessels. Class III vessels represent 20% of this group of smaller vessels and consist amongst others of crane- and pallet vessels. The remaining 30% are part of ECMT class IV which holds for the greater part powder tankers.

Table 3.8: Share of vessels by type, year and length

year	length	dry cargo vessel	bin vessel	container vessel	tanker vessel	special vessel	pushed dry cargo barge	pushed tanker barge
1991-1998	< 86	35	92	0	36	80	80	91
	86-110	56	8	88	52	0	11	9
	110-135	3	0	13	0	0	0	0
	unknown	6	0	0	12	20	10	0
	Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**
1999-2008	< 86	14	94	0	20	92	80	100
	86-110	59	6	33	59	5	20	0
	110-135	26	0	67	21	3	0	0
	Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: own composition, based on data from IVR and Vlootschouw (December 2008)

3.2.4 Handling equipment

Some IWT vessels and certain cargoes need special transhipment equipment in order to load and unload the goods. This equipment has to be available at the premises of shippers and recipients or at the inland terminals. In order to stimulate container transportation by IWT on small inland waterways or by small companies located at the waterside, specific vessels were designed. One of them is the crane barge of Mercurius Scheepvaart Group which limits transhipment costs for companies located at waterways and shipping small volumes. This vessel has a crane on board which allows it to load and unload containers without the need of extra equipment.

The possibilities of transhipment can also play a role in vessel design and determine amongst others the scale of vessels. The scale increase of tanker vessels requires for example fewer adjustments to loading and unloading equipments than in the dry cargo segment. As a result we can see a faster scale increase in the tanker trade than in dry bulk trade (BVB, 2006).

3.3 Effect on capacity

The capacity of a fleet in a certain market segment is determined by the characteristics of the fleet on the one hand (number, size and type of vessels) and its productivity on the other hand. Productivity is subject to a number of factors such as rate of circulation, infrastructure and social regulation. The available capacity has to be allocated to the different market segments. Since specialisation decreases the possibilities for inland waterway vessels to shift markets, it influences productivity and capacity of the fleet.

3.3.1 Fleet flexibility

Vessels which are flexible, such as dry cargo vessels based on container sizes and medium-sized vessels can be used for different products and on several corridors. If there is a high demand for container transportation by inland navigation, a part of the dry cargo fleet will shift markets to the container market since tariffs there are higher at those moments. When demand of container transportation falls, the largest container vessels (135 m) are not easily used in other segments, since they are either not suited for the cargo or the vessels are too large for the quantities available on the dry bulk market.

Vessels being built in function of a certain shipper, product or corridor incur extra costs when changing their purpose or area. As a consequence of this specialisation, the capacity becomes less flexible. In the case of tankers, the larger dry cargo and container vessels, higher revenues are gained from more intensive operations. For niche markets, willingness-to-pay by shippers is higher and compensate for the lower flexibility.

Tanker trade goes through a modernising phase set by adaptation of regulations. A number of products will only be allowed to be transported by means of double hull vessels. The older single hull vessels will be sold to other countries with a different regulation, scrapped, reconverted into dry cargo barges (if there is a market for it) or used for other liquid products which are still allowed. In the two latter cases they enlarge the supply in those segments enormously which will result in overcapacity.

3.3.2 Productivity

The scale increase of vessels in certain market segments, such as tanker trade, container transport and inland waterway convoys, has led to a higher profitability as a result of scale advantages. The largest vessels are generally exploited in a (semi-) continuous way which increases productivity resulting from the higher rate of circulation.

Cleaning of vessels between two different products on the contrary increases costs and lowers the rotation speed. By means of long-term contracts and dedication these costs can be avoided. As a consequence of this specialisation, the number of empty returns increases which has a negative impact on productivity and capacity.

Operation hours on smaller waterways are often too restricted to exploit new small vessels in an economic way. Besides this also the fact that there are few shippers on these waterways results in a limited chance on return cargo.

When comparing double hull to single hull tanker vessels, the difference in draught amounts to 20 to 30 centimetres. This obviously leads to a decrease in loading capacity in case of low water levels. Increasing substitution of single hull by double hull tanker vessels will increase the market volatility in tanker trade (Jaegers, 2005).

These low water levels also limit the carrying capacity of other vessels, especially the larger ones, which results in a less optimal exploitation. For the largest vessels the disadvantages of low water levels are experienced faster than by smaller vessels. The latter benefit most from low water surcharges which compensate for the loss in carrying capacity.

Conclusion concerning the specialisation in the sector

The inland navigation sector has gone through major changes in the last ten years. A marked scale increase of vessels and a trend towards horizontal and vertical integration of companies, especially in the container segment, is the result. Nevertheless, new smaller vessels are still being constructed and smaller shipping companies and chartering offices remain important in certain segments. Furthermore, the share of independent vessel owners in the available capacity remains dominant.

A closer look at the West-European fleet shows that in the examined period a number of specialised vessels have been built. This specialisation is influenced by a number of factors. The most important ones are the larger number of products transported by IWT and the increasing regulation (e.g. in tanker trade) on the one hand and the search for more profitable segments on the other hand. As a consequence of this specialisation, vessels become less flexible and sail more in dedication. Vessels that are adjusted to or designed upon the demands of a specific shipper require long-term contracts in order to cover the risks for both banks and vessel owners.

And yet there is a market for multifunctional vessels. Almost all new dry cargo vessels are based on container measurements and there are shipping companies and independent vessel owners who intentionally choose middle-sized vessels which can be used on several corridors.

Conclusion on the fleet and capacity in the sector

The analysis of the European fleets shows that the fleets of the different IWT countries are clearly different with respect to their size and composition. Apart from the differences, the fleets also have clear resemblances. Although there is a difference in the importance of the different vessel types, the dry cargo fleet is clearly the largest one in all countries. Generally, the number of vessels gradually decreases after the year 2000, while the total fleet capacity increases. The magnitude of the scale increase between countries is quite different though.

The vessels registered in Belgium are mainly self-propelled dry cargo vessels and the ones built after the year 2000 were for the major part new at the time of registration. Second hand vessels mainly originate from the Netherlands. The number of young second hand vessels which were registered increased during the years, as a result of the booming freight market and positive forecasts which encouraged investments in the sector.

The scale of the vessel is one aspect of the specialisation, next to the type of vessel and other characteristics related to the vessel. Some vessel owners prefer a size and type of vessel which is more flexible, while others opt for one that is more specialised. Specialised vessels are often operated in a different way as a result of the regulation that applies to them and the contracts they have with shippers. Specialised vessels are more restricted to certain goods categories and therefore sail more often in dedication compared to other vessels. This is found more in the tanker than in the dry cargo segment. In the dry cargo segment, the specialisation is more related to the size of the vessels.

Chapter 4: The inland navigation market

As discussed before there are several market segments within the inland navigation sector. Apart from that, there are also different markets, being the freight market, the construction market, the second hand market and the scrapping market. The actors which are operating differ according to the market. In the freight market, shippers, ship-owners and charterers will be the main actors, while in the vessel construction market, the vessel owner, shipyard and shipbroker will play the main role. First, an in-depth view on the actors in the market is given. This is followed by two main aspects of the freight market, being the contracts and the freight tariffs. Afterwards, the other three markets are covered.

1. Actors

The supply side of the inland navigation sector is known for its fragmentation. It traditionally consists of a large number of small and medium sized actors. Even though there are a number of very large shipping companies and logistics groups, the owner-operators remain responsible for the largest part of the capacity in the sector, especially in the dry cargo segment.

Decisions in the inland navigation sector with regard to the choice of navigation area, investments and possible co-operation, take place in a different way depending on the company. Inland bargemen who are self-employed and have their own vessel, have a different decision making process from a major shipping company having its own and chartered vessels. Owner-operators sailing on their own account are different from those who work in a partnership and those who make long-term contracts with a shipping company or enterprise. An overview is given here of the types of companies in the sector and their way of operating.

1.1. Independent owner operator

The owner-operators in general run their business in family relation. The smallest vessels (less than 70 meters) are usually man-woman companies. For vessels which are somewhat larger, members of the family or other relatives often belong to the crew. The exploitation of new and larger vessels requires often external personnel because of the more intensive way of operation. This also has effects on the tradition of living and working on the vessel.

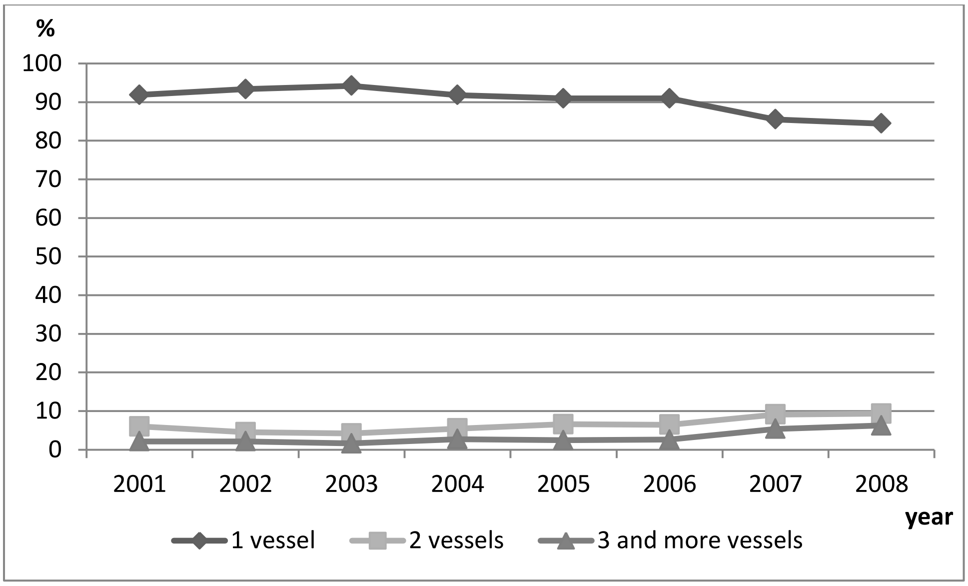
The transport capacity in inland waterway transport is for the major part in the hands of owner-operators with one or two vessels. Table 4.1 shows the figures for Belgium and the Netherlands in 2002. It is clear that the majority of the companies in the sector only have one vessel. The evolution of the share of Belgian companies by number of vessels is represented in graph 4.1. It is clear that the share of owner-operators with only one vessel is predominant, but slightly declining whereas the share of the companies with 2, 3 and more vessels is slowly increasing. These ones with 2 vessels are often coupled trains. Overall, the ones with only one vessel in 2008 still account for almost 85% of the companies in Belgium.

Table 4.1: Number of IWT companies by number of vessels

	Enterprises			
	The Netherlands		Belgium	
number of vessels	**number**	**%**	**number**	**%**
1 vessel	2,930	87%	1,058	93%
2 vessels	230	7%	51	5%
3 vessels	73	2%	11	1%
4-5 vessels	56	2%	7	1%
6-10 vessels	39	1%	5	0%
10-20 vessels	28	1%	1	0%
20+ vessels	9	0%	0	0%
Total	**3,365**	**100%**	**1,133**	**100%**

Source: own composition, based on data from BVB (2009) and FOD Economie (2008)

Graph 4.1: Evolution of the share of Belgian inland waterway transport companies by number of vessels (2001-2008)



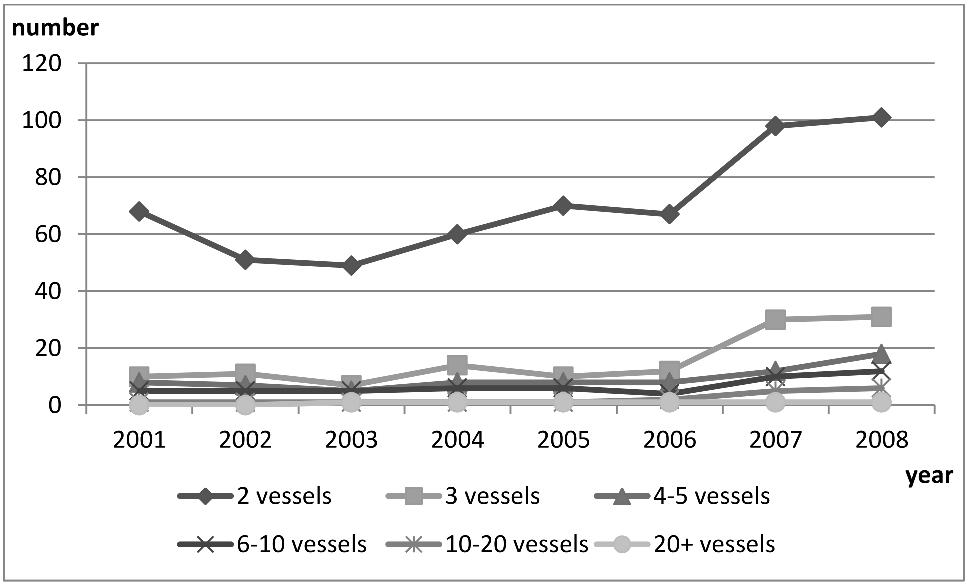
Source: own composition, based on data from ADSEI (2010)

When looking more into detail at the evolution of companies with more than one vessel (graph 4.2), it clearly shows that as from the year 2004 an increase is found for almost all categories. The number of companies with 2 and 3 vessels almost doubled in five years' time. The largest increase can be found in the year 2007, just before the crisis. Only in the group of companies with 4-5 vessels, an important relative increase can be found in 2008. Generally, companies with less than 5 vessels are still considered individual operators. Starting from 5 vessels, the companies are considered shipping companies.

For their operations, the owner-operators have several options. First they can choose to work on the basis of contracts for particular transports (on the spot market), without attaching themselves to one client or engaging themselves in long-term contracts. In order to get assignments, they make use of the services of charterers. This way of working implies a large degree of freedom for the owner operator, regarding transported goods as well as working area. A disadvantage is the uncertainty about both assignments and freight tariffs.

Another option is engaging themselves into a long-term contract with a shipper, shipping company or charterer. This often implies the vessel sails exclusively for this contract partner. A third way of working is within a commercial co-operation.

Graph 4.2: Evolution of Belgian inland waterway transport companies with more than 1 vessel (2001-2008)



Source: own composition, based on data from ADSEI (2010)

1.2. Charterer

A charterer is an intermediate party which intervenes in the establishment of a transport agreement between the shipper and transport operator. Charterers mostly confine themselves to certain types of goods or even specific products. For their intermediation they receive a provision when the parties enter into contract. This provision usually is a percentage of the freightage and it is legally limited to 10% at maximum. In practice it generally comes down to 5% of the gross freight tariff, but in certain segments it can be higher e.g. 7.5-8.5% for France (Fischman and Lendjel, 2010a). The commissions are a percentage of the gross freight tariffs, so the charterer always has a positive income for a transport order. This is even the case when the price is too low for the vessel operator to cover his costs.

There are two types of charterers, one that is only an intermediate party and one that actually takes part in the agreement. The charterer himself in theory does not take a part in the agreement, nor does he have a permanent agreement with the principal. He can therefore not represent or commit the principal, which is the shipper of the goods. The charterer does not guarantee the materialisation of the transport in any way. In this case the charterer is just an intermediate person, bringing the shipper and the vessel operator together. The assignment of the charterer can be enlarged though, so that he can lead the negotiations and conclude contracts. The charterer could however also act as a broker (commission agent), in which case he commits himself to a certain result, being the performance of the transport concerned. In this case, the charterer acts on behalf of the principal.

Basically, charterers do not have own transport equipment. In practice, many charterers start from being vessel owners or shipping companies and have extended their activities such as Steja Transport International NV. They can have a number of own vessels and have next to this a mix of vessels chartered. Therefore, they can work with contracts for a single transport on the spot market, but can also contract vessels on a longer term. The different options in chartering, for charterers as well as for shippers and shipping companies are described in detail later in this chapter.

Under the regulated system, the position of the charterer was limited. For freight which was subject to the regulated system, the charterer could not select the best vessel for the shipper and freight tariffs were fixed (Fischman and Lendjel, 2010a). Therefore, price negotiations were not possible, which reduced his tasks to submitting the transport request. After the liberalisation, a more active role could be played by the charterers. What is more, charterers have been able to extend their function and now also provide capital for vessels owners at the purchase or modernisation or conversion of vessels. They can also engage themselves in providing staff for the vessels. Most vessels that work for charterers are owned by independent vessel owners. Shipping companies for the larger part take care themselves of the affreightment of their vessels.

The emergence of commercial co-operations and the in-house chartering or large shipping companies and logistics groups takes away part of the market of independent charterers though. Sometimes charterers join forces with commercial co-operations, but mostly it is found that they are taken over by a shipping company or logistics group. In this case, they often keep on working under the original name as a separate division.

When vessel owners want to buy a new vessel and lack sufficient own funds, they can sometimes turn to their charterer. The charterer can in this case provide a part of the capital in the form of a loan. In return, apart from the repayment of the loan and the interests, the vessel owner signs an exclusive contract with the charterer. The time of this contract approximates the period of the loan e.g. for five years. This way the charterer obtains the capacity he needs at favorable conditions and the vessel owners obtains the necessary funds. In the sector, this way of financing and contracting is often judged in a negative way. It is seen as a way for the charterer to enforce low tariffs to the vessel owner. After this contract period the vessel owner is free to work for other parties. It happens though that these vessel owners remain working for the charterer after the end of the contract. This indicates that this way of working is not always that bad after all.

Not only shipping companies and vessel owners focus on certain market segments. This is also the case for chartering offices such as Maaskade Bevrachters (non-hazardous liquids), ProLog (the transportation of containers on small waterways on the one hand and container transports with the ports as origin/destination on the other hand) and Minolta B.V. (liquid mineral and semi- chemical products). The importance of independent charterers is very different depending on the market segment. In container transport, the independent charterers have a rather limited role, as a result of the role of the shipping companies. The same applies to chemical transports in the tanker market. In the sand- and gravel market on the other hand, many shippers take care of the inland waterway transport themselves (Hubens, 1999; Bückmann et al., 2008).

Charterers who have a contract with a shipper for a certain period use several vessels for such transport. This way, they prevent the shipper and vessel operator to get to close and setup a contract bypassing the charterer. Furthermore, not all contracts are profitable enough for a vessel to work for exclusively. It would often imply quite some empty return trips. In such case, vessel operators will prefer doing other, more remunerative transports as well. Last, many vessel operators prefer some kind of variation in the transport orders and areas.

1.3. Commercial co-operations

Commercial co-operations of independent vessel owners are established in order to attain a certain size which offers transport certainty to shippers. They often do the chartering themselves, but sometimes use the services of charterers. Co-operations search and accept cargo for the associated vessels and engage themselves in long- and medium term contracts with shippers. These corporations of vessel owners exploit a fleet of vessels which are either exploited in ownership by the co-operation, with a captain on the pay-roll, or the company can have individual vessel owners working for them. These vessel owners can be the members of the co-operation, but this is not always the case. If the co-operation is also active in chartering, it can use other vessels which are active on the spot market. In contrast to an individual vessel owner, a co-operation can guarantee the transport of the cargo, irrespective of holidays, illness or technical problems. They can even organise the transport by other transport modes in case it is necessary, which is not an option for an individual. Moreover, shippers will more likely enter into contracts because these co-operations are more professional and have the necessary certificates e.g. ISO norm.

Generally, the new members of a co-operation pay an amount of money related to the capacity of the vessel. This way, they take part in the company’s capital. In return, in case profits are made at the end of the year, they come back to the vessel owners. The advantages for the associated vessel owners are the certainty of the transport assignments and the reduction of administrative tasks such as invoicing and payment of port dues. In return, the vessel owner pays a provision of about 5% for the services and mediation. Furthermore, depending on the co-operation, the vessel owner has to give up part of his freedom. He sometimes has to work exclusively for the co-operation and could be confined to a certain sailing area.

Amongst commercial co-operations, there can be large differences though. Some co-operations, e.g. in the Netherlands, request an exclusivity from their members. This means that the vessels can only be used for transports which go through the co-operation. In this case, the contracts between the co-operation and vessel owners are generally for a period of one year, which is automatically renewed and the vessel owners are shareholders of the co-operation. In other cases, there is no exclusivity which means the vessel owners can take any transport they like. The vessel owners are not obliged to work for the co-operation, since there are only contacts on the spot market. A vessel owner can have several reasons for joining a co-operation without necessarily working for it. The membership can be seen as a capital investment, it could be an extra security for a bank or it could be a backup for the vessel owner in case to market goes down. When accepting new members, co-operations working with yearly contracts usually start from their existing freight contracts. Only if there is enough cargo or a new contract, new entrants will be allowed to join. Other co-operations have a trial period of e.g. 6 months after which the general assembly decides on the membership. Generally, in bad times when little cargo is available, it becomes interesting for vessel owners to join a co-operation. At this moment, this is usually blocked by the existing members. Adding members in a declining market would mean that they have to share the same revenues with more vessels, which will decrease the individual profits. When the market is flourishing on the other hand, many operators want to leave the co-operation, since they can earn more by operating on the spot market. By the contract and its conditions in which operators engage themselves when joining the co-operation, the co-operations try to maintain a certain capacity in order to fulfill their obligations towards the shippers.

In the Rhine navigation, commercial co-operations exist already a long time. The NPRC for example was established in 1935. After the liberalisation, these co-operations also appeared in other markets. This is explained by the fact that due to the free market, freight tariffs decreased and consequently the profit of vessel operators also went down. On top of this, most vessels operating in the regulated market were smaller vessels in domestic transport, which even increased the effect of deregulation on the profits. Working together in co-operations and sharing risks was for some of them a way to survive (Dullaert, 1998b).

Also governments spurred the establishment of new co-operations, in order to bring stability into the market (EC, 1996). One of the examples is the support for commercial co-operations granted by the Flemish Government[21]. It is also claimed that the use of co-operations makes the freighting more efficient and reduces empty trips (Van Toor, 2010). The majority of the commercial co-operations can be found in the dry cargo market.

The existing co-operations were mainly established in the 1990s as a result of the liberalisation or before, e.g. ELV and General Bulk which were founded in 1994 and PTC in 1995. They have been promoted afterwards mainly with the view on stability and strengthening the position of the individual vessel owners. This was not a real success, because the only one established afterwards is Sabon Shipping BV at the end of 2005. This brings the number of commercial co-operations in Belgium and the Netherlands to about 12. This is mainly due to mentality of people in the sector and the good market conditions, meaning sufficient demand, which did not necessitate working together. Since the crisis the aspect of co-operation of owner-operators has become an important issue again (Verberk, 2010). End of 2010, a new commercial co-operation Rent-a-barge, was established in the Netherlands. After many difficulties in finding enough participants, they soon afterward ran into problems with charterers. All in all, not even 5% of the vessel owners in the Netherlands are part of a co-operation.

Co-operations mostly group vessels of a certain size or type and are focused on certain goods or areas (market segments). Examples are the Coöperatieve Zandschippers Bond (CZB) which is active in sand and dredging, Coöperatieve Binnenscheepvaart Vereniging (C.B.V) which focuses on dry cargo,

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[21] http://www.binnenvaart.be/nl/nieuws/persberichten_archief_artikel.asp?article_id=77

Spitsenverband ELV which consists of small vessels and Particuliere Transport Coöperatie (PTC) working in the domestic transport in the Netherlands and Belgium.

One could expect that vessel owners working together in a co-operation would also gain other benefits from the capacity they represent. Collective purchases of amongst others fuel, insurances and equipment could result in substantial discounts. Nevertheless, it appears that such collective purchases are almost nonexistent. Vessel owners which are working together in a co-operation are already giving up a major part of their freedom. Therefore, the decisions they can still make on their own become even more valuable and are not given up for a relatively small discount. Furthermore, the personal aspect, tradition and experience are very important in this respect. Some vessel owners prefer using certain materials because their ancestors used them. The choice of the bunker place can be influenced by the manager of the place and the services it renders. Sometimes co-operations work together with large logistics companies in a joint venture, e.g. C.B.O with Manuport.

1.4. Own account operators

Own account operators are mainly industrial companies which own and operate a fleet of inland vessels in order to transport their own goods. These companies are active in the manufacturing and building industry. Because of the nature of the products, being large volumes and having relatively low value, inland waterway transport has always been the evident choice. These companies are therefore located next to a waterway, which prevents expensive transshipment.

One segment which is known for its important share of own account transport is the transport of sand and building materials. Sand and gravel exploitation companies often have their own vessels or barges such as B.V. Zand- en grindhandel Raaijmakers and Cotrano B.V. Their own fleet is filled up with chartered vessels when demand is high. Sibelco for example had its own fleet until 2004, now it uses long-term charter contracts with owner-operators and charterers. Heidelberg group has a share in Rederij Cement Tankvaart. But also examples in manufacturing can be found, such as ArcelorMittal which has a share in SOMEF S.A., a shipping company with own and chartered vessels. Other such companies can be found in the oil, steel, energy and chemical sectors. These sectors are characterised by high quantities of low value products (ECMT, 1999).

1.5. Shipping company

In this part a very brief overview of the most important aspects concerning the shipping companies in the different segments is given. A major trend in the sector is a horizontal and vertical integration of these shipping companies, especially in the tanker and container segment. But next to this, also smaller shipping companies and charterers play a role in certain segments, and the share of independent vessel owners in the available capacity remains dominant.

Inland waterway shipping companies carry out transport for third parties. They in general work with a mix of self-owned and chartered vessels and often have their in-house chartering division. It is also possible that a charterer started operating an own fleet and this way becoming a shipping company. It is difficult to clearly separate both actors, since their activities are often intertwined. An example of such a company is RKE, which is active as a charterer as well as IWT operator, forwarding agent and so on.

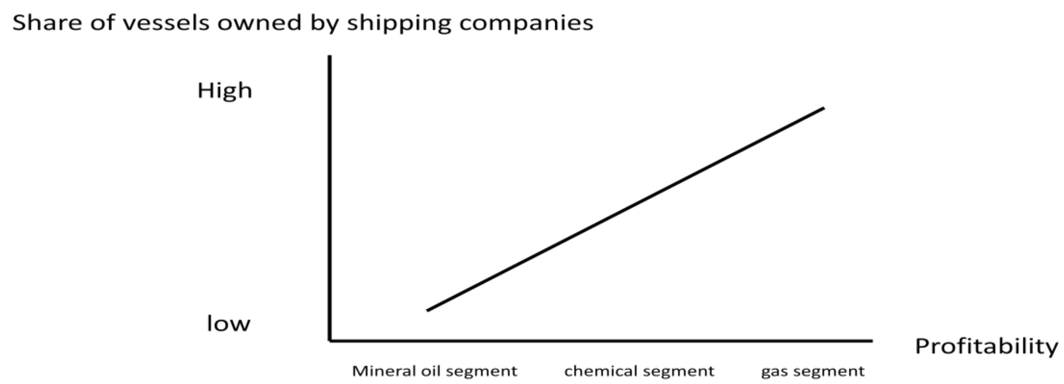
As shown in table 4.1 the sector holds only a limited number of larger shipping companies. These large companies consist of several divisions or subsidiaries which all have their own product range or corridors. The divisions are often smaller shipping companies taken over by a larger one in order to expand its product range, e.g. Chemgas Shipping B.V., or region. A shipping company can be a part of a logistics company which is active in the whole logistics chain and which holds also inland terminals, road transport, forwarding activities, warehousing etc.

The larger shipping companies in tanker shipping are active in a whole range of products, vessels and routes. They usually work in the larger market segments such as mineral oil and chemicals e.g. Interstream Barging, Somtrans and Oeltrans. Some of them also have a division which focuses on the gas segment e.g. Reederei Jaegers and Gefo Shipping Group, or on the transportation of edible oils e.g. Fluvia. These shipping companies consist of several divisions or subsidiaries which all have their own product range or corridors. These subsidiaries or divisions are often existing companies taken over by a larger company in order to expand its product range, e.g. Chemgas Shipping B.V., or region.

Other, usually smaller shipping companies concentrate on specific market segments. This can be a geographical specialisation as well as a product specialisation e.g. Unibarge in fuel oil, Koole in edible oils and Victrol mainly in bunkering. Powder tankers are serviced by certain shipping companies or chartering offices that are specialised in these transports e.g. Rederij Cement Tankvaart and Binnenlloyd.

Transportation of oil products fluctuates strongly and therefore the tanker shipping market relies heavily on spot charters. Vessels of private owners are being chartered by agencies for these transports (Bückmann, et al., 2008). Vessels for the transportation of gaseous products or chemicals are more often owned by shipping companies. Owner-operators and charterers play a less important role in this segment (Van der Lugt, et al., 2002). The increasing investment cost of specialised tanker vessels requires more intensive operations. Both the high investment and the intensive operations are often not always an option for owner-operators. Moreover, the segments of more specialised products are more profitable for shipping companies to invest in. Figure 4.1 presents the relationship between ownership by shipping companies and the profitability of the segment.

Figure 4.1: Share of vessels owned by shipping companies in relation to the profitability of the segment



Source: Bundesamt für Güterverkehr (2006)

Companies transporting heavy goods and special cargo are often specialised, since they also need specialised loading and unloading equipment such as mobile cranes and floating sheerlegs. Apart from that, they also co-operate constructing bridges and locks and carry out salvage and other hoisting operations. Well-known companies are BTS (Mammoet), Lekstroom Transport, Van der Wees Watertransporten and Muller Dordrecht. Furthermore, there are Bonn en Mees, Multraship Towage & Salvage, GPS Marine and Smit Internationale[22].

The main actors in ro/ro transport are Rhine Roro and Interrijn RoRo and they both belong to the Interrijn Holding B.V, which is also active in container, bulk and neo-bulk transport. Cobelfret Waterways operates ro/ro services between the seaports and the Ruhr area and the Albert Canal.

When it comes to inland waterway convoys, a limited number of large companies serve the market. The major transporters in the segment of push towing are ThyssenKrupp-Veerhaven and Imperial Reederei-Gruppe, who both own the larger share of their push tows and barges. Push tows, and especially the larger ones, are operated on a continuous basis, which means they sail day and night, and the staff works in shifts. Push tows are mainly used for dry cargo and containers.

In the container segment, shipping companies are generally part of a logistics group which is active in multimodal transport and the whole door-to-door transport. Around 70% of the supply of inland container navigation on the Rhine is owned by three major logistics groups, being Wincanton, Rhenus Group and Imperial Holdings Logistics (Zurbach, 2005; Rabobank, 2004). Apart from container transportation, they can also be active in dry bulk and ro/ro, e.g. Interrijn Holding. These groups are very often composed of several subsidiaries which have been established or taken over through the years, e.g. Rhinecontainer. As a result of mergers, takeovers and participations, a remarkably smaller amount of larger inland navigation companies is left on the market. As in tanker trade, these subsidiaries each have their own specialisation both in products and in corridors. Some logistic groups are even active in tanker trade as well as in dry bulk and containers, e.g. Imperial Reederei Gruppe and Lehnkering Logistics and Services.

For the door-to-door delivery of goods transported by inland waterways often a part of the distance is covered by road transport. This is the case when either the shipper or consignee of the goods is not located at a waterway. The number of inland terminal operators has grown, since many new terminals were started in the last ten years. Now that inland waterway operators are increasingly becoming part of more consolidated groups, we can also find integrations with the terminals. The container operators on the river Rhine for example often have their own terminals there.

The sector study of Rabobank (2004) gives an overview of the actors in container inland waterway transport. It distinguishes three actors, vessel operators/charterers, terminal operators and vessel owners. The positions they can take are represented in figure 4.2. The basic functions for the vessel owners are transporting goods with one or more vessels (A). Vessel operators charter one or more vessels and offer liner services (B). Terminal operators manage one or several terminals (Rabobank, 2004).

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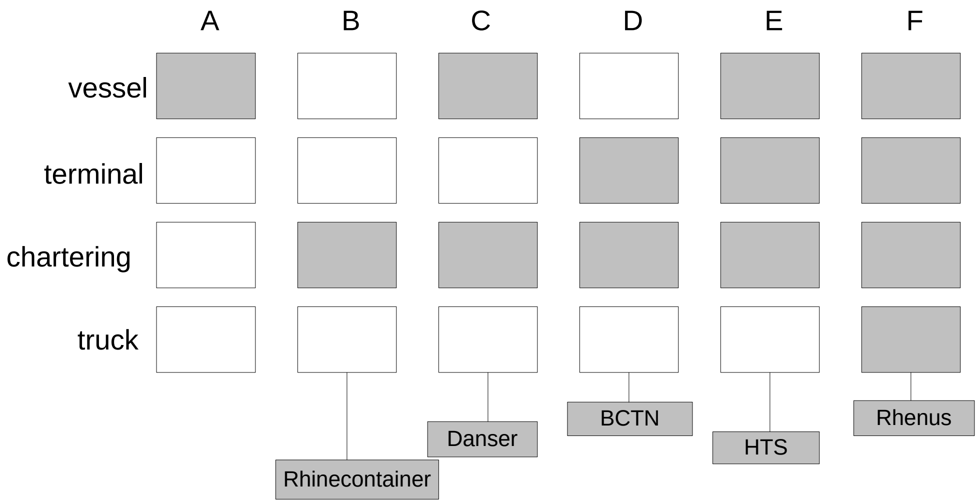
[22] http://www.cbrb.nl/organisatie/ledengroepen/ledengroep-sleep-en-bijzondere-transporten

The functions of these actors are not clearly separated from each other, which means vessels owners can charter not only their own, but also vessels from others or charterers can have their own vessels (C), vessel operators can own terminals, terminal operators can charter vessels themselves (D), have their own vessels in property (E) and offer additional services (F) (Rabobank, 2004). This overview shows that there is an important trend of horizontal and vertical integration in the sector. The logistics groups are active in several segments in order to diversify their activities. They try to control the hinterland transport in view of creating an integrated door-to-door logistics chain.

Figure 4.2: Positions in container transport by IWT



Source: Rabobank (2004)

Furthermore, sea-shipping companies participate in container hinterland transport, inland navigation as well as rail, often by taking shares in inland terminals or by starting inland waterway services via co-operations e.g. CMA-CGM and Maersk in the ports of Le Havre and Marseille. Also seaports and seaport terminal operators are getting active in the hinterland transport. A first example is the Europort Group, a port operator focused on bulk and general cargo, which has diversified greatly since 2006 by means of acquisitions in (inland) terminals all over Europe and extending its logistics services. Lately, the Port of Antwerp and DP-World have decided to take part in Beverdonk Container Terminal in Belgium.

1.6. Shipyard

Generally, vessels are constructed by order of a client, being the future vessel owner. Especially in the Netherlands, quite a number of shipyards are still active. The hull, which is the most standard part of the vessel, is more and more built in countries with lower labour costs because of cost savings. Many recent hulls are for example constructed in China or Romania. Afterwards, they are transported to the shipyards in Western-Europe where they are completed.

The situation in the freight market determines the order book of the shipyards and therefore also the delivery times of the vessels. When freight tariffs are high or expected to increase in the future, new vessels will be ordered. Waiting times for a vessel of several years were no exception in the booming period of 2006-2007, just before the crisis. During the construction process that takes several months, the vessels were frequently passed on from one buyer to another. This way, buyers could get a new vessel faster, but it led to increasing vessel prices. In periods when forecasts are not so positive, it can go two ways. A number of owners will stop investing in new capacity which will immediately reflect in the order books. Others will try to find a niche market for which a specialised vessel is necessary, or will try to be ready for a future rise of the market by investing beforehand when construction prices are lower.

In a market with positive forecasts, shipyards also construct sister vessels at their own order, since the cost of the construction of two identical vessels is lower than the cost of two different ones. The function of shipyards has expanded during the years, leading to companies which are also active in ship brokerage and shipping.

1.7. Ship broker

A ship broker is an intermediate party which on the one hand assists the future vessel owner in buying or constructing a vessel and on the other hand helps selling vessels. A vessel owner who wishes to switch to a new vessel can go to a ship broker who will assist him in selling his old vessel and in buying the new one at the same time. They offer buyers advice on the purchase, they can help with the purchase e.g. inspections and insurance, and with the financing of the vessel e.g. drawing up the business plan. The ship broker receives a financial compensation for this intermediation, which is called a commission of brokerage and is stipulated in the mediation contract.

Ship brokers can also extend their services and bring shipping companies and investors together in the so-called CV-constructions (see part E: capital structure and financing), for example offered by Ship Investment Werkendam B.V. which is part of VEKA. Ship brokers can be connected with either shipyards, e.g. VEKA Group, or with shipping companies, e.g. GSK Brokers & Shipping, since their activities are complementary.

2. Chartering contracts and conditions

Chartering is very important in inland waterway transport. Only a small number of industrial companies keep their own fleet running. Many shippers themselves turn to charterers or shipping companies in order to find transport capacity. Most shipping companies have an own fleet, which they fill up with vessels chartered for a certain period. On top of that, vessels can be chartered on the spot market in order to cover peak demands.

Vessels can be chartered for a certain voyage (voyage charter), multiple voyages or a certain period (time charter). Furthermore, these can be bareboat charters, semi-bareboat or fully equipped, which means provided with fuel and manned by the vessel owner. Depending on the type of contract, different conditions and tariffs apply.

There are four types which are common in inland waterway transport. The first type is the bareboat charter, where only the vessel (hull) is put at the disposal of the charterer. In this case, a certain rent per day is paid for the vessel. This is found mainly for pushed barges, which are chartered either for one year, or for 2 or 3 years. It is also possible for self-propelled vessels, but this is not common.

The second type is chartering for one particular voyage, called single voyage charter. Vessels which are chartered in this way operate on the spot market. This means the owner puts his vessel at the disposal of several charterers and shippers, at the current market prices at the moment of contracting. A third option is chartering for multiple journeys. In this case, the number of transport orders and the tariff per order is fixed in the contract. Both in single voyage and multiple voyage charter, the vessel is fully equipped by the owner which means the crew and fuel costs are included in the freight tariff.

The last option is time chartering, where the vessel owner receives a certain amount for the period that the vessel is at the disposal of the charterer. The vessel is in this case generally semi-bareboat chartered. This implies that the vessel as well as the crew is hired, but the specific costs of the trip, such as fuel costs and port dues, are at the charterer's expense. The reason for this is that it is impossible for the vessel owner to predict the variable costs in this situation, since it depends on the number or orders, the sailing area and so on. This is called "engine room free" sailing and is generally used in container transport and for push boats.

Long-term chartering of vessels gives a capacity guarantee for shipping companies and charterers, without doing the investments themselves. For the vessel owner on the other hand, a long-term agreement assures work and income. Long-term contracts could therefore create stability in the market. But in case the difference between the tariff in the contract and the spot market becomes too large, such contracts can be renegotiated. This happened frequently during the last crisis period.

3. Demand and freight tariffs

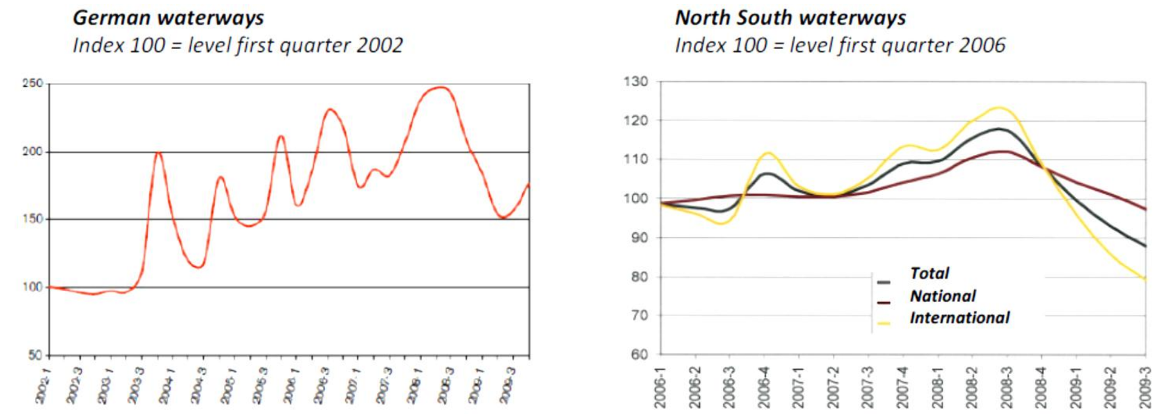
Freight tariffs are the result of on the one hand the demand and on the other hand the available supply. At the intersection of the curves of demand and supply, prices and volumes are set (Blauwens, 2010). The freight rates can motivate decision maker to take certain actions such as adjusting capacity, finding ways to reduce costs and adjusting the services. This can be for example reducing the operation speed, reduce the services or layup vessels (Stopford, 2009).

The balance of supply and demand is a very important aspect in the freight tariffs. If demand is higher than supply, freight tariffs will go up. In the opposite case, the freight tariffs will fall. Since the supply in the inland navigation sector is strongly fragmented and certain market segments are characterised by a high degree of overcapacity, the competition is severe. Carriers which operate in a highly competitive market have only limited influence on the price-fixing (Blauwens, 2010). In periods of low demand, they can often only decide on whether or not to accept an order.

The long life span of vessels in the inland navigation sector, combined with the fact that many owner-operators live on their vessel and do not incorporate all costs in their tariffs, leads to prices going down heavily when there is less demand, which for example occurred during the last crisis period (2008-2009). When on the other hand demand is high and little capacity is available, vessel owners can determine the tariffs to a larger extent. This process leads to very large price fluctuations in the inland navigation sector. Graph 4.3 shows an example of the evolution of freight tariffs for the German waterways as well as the North-South corridor. It has to be mentioned here that the freight prices of the other modes are often the boundaries. When freight tariffs for example on the Rhine are very high because of low water levels, part of the shipments will be shifted to rail.

The freight tariff is based on the type and tonnage of the goods transported but also on the distance and the area to which the goods have to go and the possibility of return freight. Research on the effect of imbalances in transport flows on the price of transport has been done by amongst others Demirel et al. (2010) and Behrens et al. (2009). For the transport of gravel from the upper-Rhine for example, generally very low tariffs are paid. This is because these transports are return cargo for vessels taking for example grain on their way up. In this case the vessels have the choice either to go back empty or to take back the gravel at a low tariff. It also counts for small French vessels which bring goods to Belgium. This is often the farthest point they want to go, amongst others for language reasons. So in case a return load for France is available, it is generally accepted at a low tariff. The freight tariff in these cases only has to cover for the extra costs of taking the cargo, e.g. fuel. This will be discussed more in detail in chapter 5, which deals with the productivity of inland vessels.

Graph 4.3: Evolution of freight tariffs in the dry cargo segment, long-term contracts included (NEA)



Source: Verberk (2010)

The operator of a vessel, under normal conditions, uses the costs of the vessel as a lower limit for the negotiations on the freight tariff. To this end, he can either consider the costs on a long-term basis, including replacement of the vessel, or only take the operational (short-term) costs into account. In the past, they often based themselves on the variable costs of the vessel. However, from a business economic point of view, this is not a good situation. This is why also within the sector it is tried to encourage inland waterway operators to use their long-term costs (see chapter 6). In times of crisis, it is clear that many vessel owners turn back to their old customs in order to survive. This behavior only encourages the prices to decrease further. This is why during the crisis period of 2008-2009, several inland waterway associations voiced to officially prohibit freight tariffs which are below the cost price of the vessel, e.g. La Glissoire in France (van Oers, 2010).

It is important in inland navigation to distinguish between the freight tariff paid by the shipper for the transport of the goods and the tariff received by the vessel owner or operator. The more intermediary parties, the larger the difference between both. As mentioned before, a normal commission for charterers is 5% of the freight tariff. The freight tariff can be a tariff per tonne, a tariff for a certain shipment or a tariff per day, depending on the contract and the type of goods. A tariff per tonne is commonly used for dry bulk transports. For project cargo on the other hand, usually a certain price for the whole transport is fixed. Such goods have a large volume, but low weight which makes a price per tonne unprofitable for the operator. Therefore a lump sum tariff is determined. This is also used when the shipper is not sure on how large the shipment will be. In this case, he asks for a vessel of a certain size and pays a fixed price for it, irrespective of the tonnenage that is transported.

Furthermore, the type of contract and its contents such as loading and unloading times and demurrage. In case a vessel is rented for a certain period (time charter), the number of hours it has to sail (14h, 18h, 24h) also determines the tariff. The freight tariff also depends on the type of contract. Freight tariffs applying to long-term contracts are based on the freight tariffs on the spot market at the moment one enters into the contract. In case a vessel is chartered by a shipping company or charterer in time charter it is important for such companies that the vessel capacity is used in an efficient way. If the vessel on the other hand has a spot contract and therefore has a fixed price for the transport, it does not matter for the charterer whether or not the vessel has a return freight. They could however try to find return cargo for the vessels in order to decrease the freight tariffs.

The freight tariffs and conditions of the contract are each time negotiated between the shipper, shipping company or charterer and vessel owner. The charterer has a number of vessel owners to whom he presents a certain offer. The vessel owners on their part have offers from several charterers. Both the vessel owner and the charterer can prove their experience and commercial talent in this game. For vessels mainly operating on the spot market, such talents are indispensable.

This marketplace, which consisted for a major part of repetitive phone calls in the past, has now also found its place on the internet. A lot of communication is done by via e-mail, but also other ways of bringing supply and demand together have been established, such as Bargelink[25]. On this electronic platform, vessel operators can register themselves if they are looking for cargo. On the other hand, shippers, shipping companies and charterers who are looking for a vessel can offer cargo there. This way both parties find each other easier and it creates a more transparent market. The actual negotiations are still done by personal communication between operator and shipper though.

In order to give more insight into the freight market for vessel owners and operators, the Vaart!Vrachtindicator was established in 2002. Operators can register the freight tariffs they obtain via the website, where they can be consulted by other operators. By means of daily and quarterly freight indexes for different vessel sizes and areas, the vessel operator should get an idea of the freight tariffs which are in line with the market. This should support him in the freight tariff negotiations since the difference between the costs and the index is the margin. Of course the quality of the data in the indicator depends on the accuracy of what is communicated by the operators. The other actors moreover are not so keen on operators making the freight prices public.

[25] www.bargelink.com

On top of the freight tariff per tonne or rent per day or per transport, a number of surcharges can be added, such as demurrage[26], low water surcharges and fuel surcharges. These surcharges are normally charged if the conditions for which they are created occur and if they have been included in the chartering contract. Events which are beyond the fault of the operator and which delay the vessel after it sails from the loading place can give rise to demurrage. This could for example be obstruction because of ice or low water levels (CBRB conditions of carriage). The exact amount of the surcharges depends on the conditions stipulated in the contract. Also a fuel surcharge can be included in the contract, e.g. in a contract for a period of one year. It can for example start from a minimum fuel price, e.g. 400 euro per 1,000 tonnes in 2006, and graduated surcharge, e.g. for each price increase of 25 euro above the minimum. The surcharge can also depend on the freight tariff (WS, 2006). The starting point for the calculation of the fuel surcharges are generally the gas oil prices published by the CBRB.

Whether or not such surcharges are paid to the operator, mainly depends on the market segment and the market situation. In general, it can be said that if demand for vessels is high, e.g. in case of low water levels, these surcharges are easily paid. In case demand is low, it is very likely that there is no room for such surcharges, contrary to the deep-sea situation (Slack and Gouvernal, 2011). Shipping companies, e.g. in container transport, and charterers in general have covered fuel surcharges in their contracts with shippers. If the total freight tariff becomes too high because of such surcharges, there is a chance though that shippers will switch to other transport modes e.g. rail. Owner-operators working on the spot market often do not include such clauses in their contracts, this way taking more risk. Some vessel operators already include a potential increase of fuel or decrease of water level in the freight tariff they negotiate with charterers. This depends on the capabilities of the operator and his specific situation.

Because of the uncertainty of freight tariffs due to the system of surcharges, a fixed tariff is sometimes requested in order for the shipper to know in advance what a certain transport will cost. Fuel price increases and low water periods are difficult to predict though and they can have quite some impact on the costs of a vessel. In case something unexpected happens, such as long waiting times due to for example a lock break, such a tariff could prove to be a very bad choice for the vessel operator.

Judging whether a certain transport offer, taking all conditions into account, is a ‘good’ one is often very unpredictable. An offer that seems to be a good one in the beginning could turn out to be loss-making because of incidents which were unforeseen such as an obstruction of the waterway. The same counts for an offer that seemed less interesting at the start e.g. because of a low freight tariff. If in this case an unexpected well paid return freight is found, the trip can prove to be more profitable than expected. The stipulations in the contract concerning surcharges can reduce this uncertainty to a certain extent.

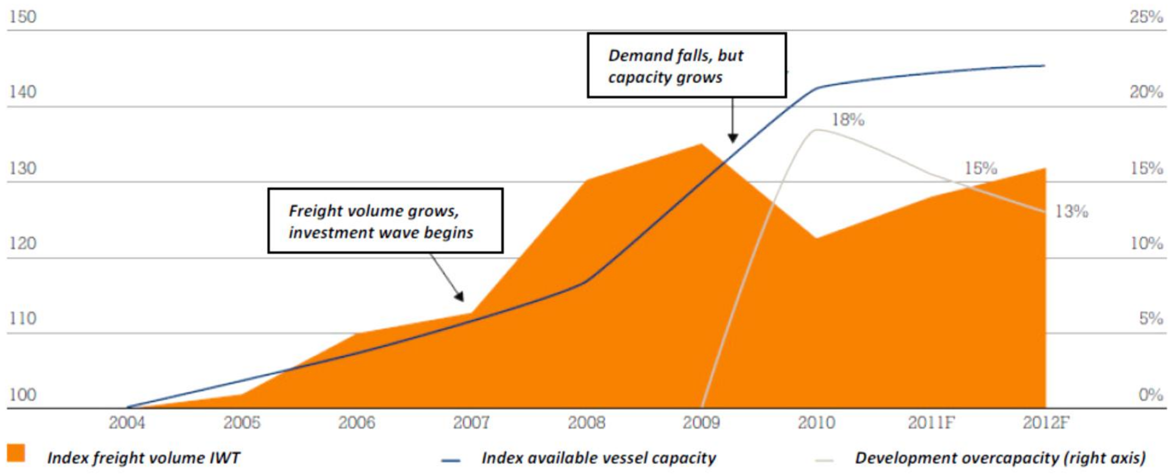
[26] See glossary

4. Construction market, second hand market and scrapping market

The construction market and second hand market in the inland navigation sector are closely connected. If the business goes well in the new building market, in other words, when the order books of the shipyards are filled, this means that freight tariffs are good and that there is sufficient demand in the sector. This entails that prices on the second hand vessel market are high, certainly of the more recent vessels. Conversely, this means that when demand of inland waterway transport is low and freight tariffs are low, there are no financial means to build new vessels. In this case, also the prices of second hand vessels are much lower.

At the moment that the demand and therefore the freight tariffs in the sector are high, many companies are interested in buying extra vessels, replacing smaller vessels by larger ones or older ones by newer ones. At that moment the prospects are good and financing is easily available. The prices of the materials and components play a role in the vessel price, just like the capacity of the shipyards. In times of high demand, it can take up to two years to have a vessel delivered. If waiting times for new vessels are high, second hand vessels will become more interesting for certain buyers. This situation was found in the years 2006-2008, when the demand for vessels was booming. In this period, also speculation in vessel construction occurred. Some traders or companies ordered one or two (extra) vessels, which were then sold multiple times before actually being delivered. Such actions resulted in an increase of vessel prices. When the crisis struck and no new orders were made, a very high vessel capacity came into the market for another two years (see chapter 3). Because demand fell and more capacity came on the market, this resulted in serious decreases in freight tariffs and vessel prices (see graph 4.4).

Graph 4.4: Evolution of freight volume in relation to the fleet



Source: ING (2011)

Both markets, the construction and second hand, need each other. A good second hand market implies that vessel owners will order new vessels sooner since they get a good price for their old vessel. The older vessels are popular among starters in the sector. At this moment, the relationship between both markets is very clear in the tanker segment. Because of the new demands for double hulls for tankers, for heating oil by the year 2012 and for diesel and gas oil by the years 2018, and the individual demands of certain shippers such as a maximum age of tankers, the value of older and single hull tankers has seriously decreased. This implies that owners of such tankers can get insufficient money for the vessel to buy a new, double hull tanker. Such single hull vessels can hardly be shifted to the dry cargo segment since there is already overcapacity. This means that once the dates are reached, for a number of them scrapping will prove to be the best solution.

Certain support mechanisms of governments, such as the European scrapping regulations, can encourage vessel owners to invest in new vessels. Sometimes the end of a certain measure has an influence on the construction of vessels in the period just before the abolition. This was found for example in the Netherlands just before the investment premium was stopped in 1987 (see chapter 2). In the tanker trade, a new scrapping round is asked for as a result of the new regulation. Because both single and double hull vessels can be used for the same products during the transition period, there is a fierce competition. This is on the one hand due to the overcapacity of both fleets coexisting and on the other hand because the older single hull vessels have much lower costs. The new double hull tankers can therefore not compete with the older fleet and this slows down the construction of tankers. Since there is hardly any alternative market for the single hull tankers, they will be used as long as legally allowed. Therefore, a new scrapping round would diminish the single hull fleet which would lead to higher freight tariffs and give financial means to invest in new vessels.

The vessels built in the last years are generally larger vessels which are used in intensive operations. In the previous years, vessel owners were often encouraged to buy a new and large vessel instead of a small and older one. Newly built vessels are depreciated on 20 years or more, while second hand vessels have a depreciation period of 10 to 15 years. For financing reasons it makes new vessels more interesting. It also reduces the difference in capital costs between new and second hand vessels. Increasing vessel prices are reflected in the capital and insurance costs of a vessel. Because of the higher capital, the interest costs are higher and also the insurance costs increase because of the higher insurance values (CCR, 2007b).

Besides the construction and second hand market, there is also a scrapping market. If vessels are in such a state that they require high expenses in order to meet the legal standards e.g. as a result of insufficient maintenance or an accident, or if there is not much interest from buyers, it can be sent to the scrap yard. In this case the second hand value and the scrap value are weighted up against each other. Because of the long lifetime of inland waterway vessels and the possibilities of using it for other purposes e.g. as a houseboat or as a warehouse, relatively few vessels are being scrapped. Furthermore, many older vessels are being sold to companies operating in Eastern European countries. Since differences in standards will be smoothed out in Europe, this market will likely disappear in the future.

The vessels being scrapped are generally the smaller ones. Table 4.2 shows the vessels being scrapped between 1991 and 2010 in the Netherlands. The dataset holds 355 vessels in total of which the major part (220 vessels) was scrapped before the year 2001. This is mainly as a result of the scrapping- and ‘old for new’-regulations which were running in the eighties and nineties (see chapter 2). Amongst those, the vessels smaller than 650 tonnes had a large share of almost 47%. In the period after, this share seriously decreased. Over the two periods, only few vessels larger than 1,350 tonnes were destructed.

Table 4.2: Scrapped fleet by tonnage (period 1991-2010)

	tonnage vessel			
destruction year	**<650t**	**650<= t <1,350**	**<=1,350t**	**total**
1991-2001	103	108	9	220
2001-2010	41	82	12	135
Total	**144**	**190**	**21**	**355**

Source: own composition, based on data from Van Heck and Van Zanten, 2010

When studying the scrapped fleet in more detail by its size and age, table 4.3 shows that only one vessel of maximum 20 years old has been scrapped. The major part of the vessels is 40 to 80 years old.

Table 4.3: Scrapped fleet by tonnage and age

	age vessel				
tonnage vessel	**0 - 20 years**	**20 - 40 years**	**40 - 60 years**	**60- 80 years**	**> 80 years**
< 650 t	1	12	43	50	38
650<= t <1,350	0	32	82	56	20
> 1,350 t	0	6	5	4	6
total	**1**	**50**	**130**	**110**	**64**

Source: own composition, based on data from Van Heck and Van Zanten, 2010

5. Capital structure and financing in inland navigation

5.1. Common practice

Financing an inland vessel is mainly done by on the one hand the financial institution which provides a (mortgage) credit and on the other hand by the owner of the vessel. The share of personal capital and borrowed capital can be different for each vessel. The financial institution normally requires a certain percentage of personal capital investment when the financing of a vessel is requested.

A mortgage loan from a financial institution is the usual way of financing, both for independents and for shipping companies. This mortgage is valid for 15 years, but in case the duration of the loan is longer, it can be booked again. For this, however, extra costs will be added. The duration of a loan mostly coincides with the mortgage. In certain cases, the initial duration can be longer, but paying back will be started after 15 years. In most cases though, a vessel will be kept a lot shorter and may be sold in the meantime.

The chosen percentage of personal capital has evolved over time and it also differs according to the country. In the past, a larger share of personal capital was required than in the period just before the crisis. In case of state guarantees, financial institutions could be inclined to allow a higher percentage of borrowed capital. Of course, in the event that the inland navigation company owns sufficient personal capital, it could borrow a smaller share from the financial institution. In the literature, a ratio of 80% debts and 20% equity is presumed. In practice however, ratios of 70-30 and 90-10 are mentioned. In the literature, the interest percentage of debts generally equals the interest percentage of a vessel mortgage, generally the average taken over a number of years.

The part of the investment for which the ship owner is responsible varies among others according to the age of the vessel. The capital used for this, i.e. the invested personal capital, is often the selling value of the previous vessel in the case of family businesses. This indicates that the market situation, and the accompanying second hand prices and new construction prices, are an important factor when investing. A favorable second hand market for vessels is therefore crucial for financing new vessels. Especially in the case of second hand vessels, personal capital of the barge owner is of utmost importance, as often a higher share of personal capital is required in this case.

When a vessel owner does not have the required personal capital, in certain cases he can appeal to family members, shipper or related logistic group, vessel brokers or even the seller of the vessel. They could provide a part of the required personal capital under certain conditions. In such case, this is called co-financing. Equal to financial institutions, the capital needs to be paid back with interest and a mortgage is taken on the vessel. When co-financing is started up with a shipper, also a transport contract is linked to this.

In push-towing, it is often the case that there are several co-owners of a push tug and who are not active on the vessel themselves. They are often (retired) barge owners who consider these vessels an investment and who often spread their investments over several vessels. In general, the major part of the vessels is financed by a combination of the owner and the bank. Investments in larger and new vessels, which require a major capital investment, can be made jointly with several investors or barge owners. In order to make the exploitation of the vessels profitable, semi-continuous navigation is often required.

Alternative ways of financing are not common in inland navigation. There are some shipping companies such as Mercurius Shipping Group, however, which have vessels built and have them sailing on the basis of hire-purchase. In the next part, some of those financing schemes are discussed in detail.

5.2. Alternative ways of financing in inland navigation

5.2.1 Limited partnerships

A finance company is a business which gives financing to private persons and enterprises. Examples are commercial banks, mortgage-, lease- and factoring companies. One of the finance companies active in vessels for inland navigation is Ludwig Harms Finanzdienstleistungen e.K. in Elsfleth (Germany)[27]. This company works with limited partnerships, more detailed CV-constructions, for inland navigation. This means the finance company searches for private investors for the construction of inland waterway vessels. The sum of this capital is considered the equity capital, which is the basis for the loans. A captain, who is a leaseholder, runs the vessel. The investors get a payment, for example half yearly, based on the exploitation results and a share of the profits when the vessel is sold afterwards.

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[27] http://www.harms-finanzdienstleistungen.de

In sea shipping, such limited partnerships are quite common. In inland navigation, a number of them have been set up in the previous years, mainly for tanker vessels. Chemical Transportation Unity CV, a limited liability company of 6 years with 23 participants for the MTS Unity, is one of them. The company 'VNC Zeevaert & Anker verzekert' has started the first one in 2008 for the vessel MTS Rhody and another one in 2009 for the MTS Kruiskade. The vessels have a five-year bareboat charter, which means the exploitation costs are at the account of the tenant. Normally, these constructions are set up for a fixed period e.g. for 5 years, and afterwards the vessels is sold and the project ends. If the market situation is not good, meaning low selling prices for the vessel, one can opt for an extension.

5.2.2 Franchising

Franchising is mainly found in retail trade, such as in supermarkets of clothing stores. This is because the scale of large companies is often too big, which creates inefficiencies. Therefore, a collection of smaller companies in a network can be a better way to go (Zimmerman, Ouwerkerk, 2010). This also applies to the inland navigation sector. In the past a number of large shipping companies, with an own extensive fleet existed. These companies could not compete with the owner-operators having one vessel and sailing in family relation. This was mainly due to higher staff costs. Therefore, these shipping companies sold their vessels to the captains and hired them back by means of time-charter contracts (Zimmerman, Ouwerkerk, 2010).

Mercurius Shipping Group uses a hire purchase system, called MER-franchising. Mercurius is involved in financing the vessel, contract negotiations, bookkeeping and operational management. The guidance of the barge owner therefore does not necessarily end at the moment that the vessel is bought. In the first phase, the vessel is owned by Mercurius and the employee rents and exploits the vessel. He has the right to buy that vessel at a price that is predefined and a long-term commitment is agreed with a shipper. During the period of franchise, a fee is paid to Mercurius. In a second phase, after 4-7 years (generally 5 years) of renting, the buyer has the opportunity to finance the rest of the purchase price at a financial institution (and Mercurius). As from the moment of purchase, the vessel owner is independent and can choose whether or not to keep on using the services of Mercurius (Zimmerman, Ouwerkerk, 2010).

The main advantages of the system of franchising are the possibility of collective purchases which lowers the costs, the use of the network, experience and support of the company. The main aspect in these systems is the mentality of the buyers. Not all operators are willing to give up part of their freedom, and therefore this system appears to be mainly successful in certain niche markets (Zimmerman, Ouwerkerk, 2010).

5.2.3 Leasing

Leasing of a vessel is a kind of hire purchase of a vessel in which the lessor gives the vessel in disposal of the lessee. This last one pays a fixed compensation for the usage of the vessel and in this way prevents doing the actual investment himself. This is done by special leasing companies. They can be active in several segments such as cars and machinery, such as UniCredit Leasing. Leasing of inland vessels is generally done by large French leasing companies. They can also be focused on only inland waterway transport such as Touax Leasing Corp., active in pushed barges, which is part of the larger

TOUAX River Barges Group. The Touax group is working in leasing and trading of river barges as well as in transport of bulk cargo by barges.

There are three different types of leasing and each type is described briefly.

1. Operational lease
2. Financial lease
3. Sale and lease back

Operational lease resembles renting and is a form of leasing which is rather short compared to the lifetime of the good. It is commonly used to gain equipment for a relatively short-term period. The lessor remains the owner of the good. The lessee pays a monthly amount which covers part of the amount of purchase and interest and on top of this also an amount for maintenance, insurance and so on.

Financial lease is more like hire purchase and the period comes close to the economic lifetime of the good. The lessee pays a monthly amount which holds an amount for the purchase and interest. At the end of the period, the lessee had the right (or duty) to buy the good at the booking value.

In the case of sale and lease back the lessee was first the owner of the good. Afterward they are sold to the lessor and hired back by the lessee. This way, liquid assets become free for the lessee.

The main advantage of leasing is the decrease in investments, which gives more flexibility to the company. Furthermore, there are possibilities to transfer certain aspects such as the maintenance of the barge and the insurance. From these leasing systems also fiscal advantages can be gained. On the other hand extra costs can be included such as taxes on the sale of the good in case of sale and lease back.

Real leasing in inland navigation is until now mainly used for pushed barges, but it is also an option for self-propelled vessels. One of the reasons why it could not become common for self-propelled vessels is the reticence of lease companies with respect to these vessels. The aspect mentioned most is the uncertainty and risk in case of major damages. Moreover, it is hard to fix a residual value for a vessel, since it depends to a great extension the economic situation. In a short period, the value of a vessel can seriously in- or decrease. It sometimes is argued that leasing vessels have no real residual value and that one can assume that the vessel will have to be scrapped after the leasing period because of a lack of maintenance. The lessor will not further invest in the vessel since he does not operate it. The lessee in turn generally does not have the funds to do the maintenance and cannot get financing for it from a financial institution, since the vessel is not his property.

On the other hand, there is a reserve from the side of vessel owners who still see the vessel as their property. The value of the vessel is seen as a way of saving, which in reality is not always true. They therefore want to decide for themselves on when and how to sell their vessel. Moreover, the idea prevails that a good entrepreneur can get a financing for his vessel in the ‘normal’ way and that only the bad entrepreneurs have to make appeal to leasing options. The experiences with failures of companies with vessels in leasing and the shadowy nature of some of the leasing companies add to this perception.

Conclusion concerning the inland navigation market

There are four main markets in the sector, the freight market, the construction market, the second hand market and the scrap market. They are all closely related and changes in one of them therefore are reflected in the others. The tariffs on the scrap market are the lower bound for the second hand market. The second hand market and scrap market provide part of the financial means for vessel owners when new vessels are ordered. The freight market and prospects determine whether there are opportunities for new vessels and whether financial means will be found for a project.

Traditionally, the financing of a vessel is done by the vessel owner and a financial institution. The prices of vessels have increased seriously in the years before the last crisis, amongst others because of the high demand and the increasing size. Therefore, there is a higher capital demand in the sector and also other actors, such as shipyards, shipbrokers and charterers might render loans to the vessel owners. Also alternative ways of financing have come up, such as partnerships and franchising, but this is on a rather limited scale.

Even though there is a large scale increase in shipping companies, by far most of the vessel capacity is owned by companies with only one or two vessels. The owner-operators can either work in an independent way or become part of a commercial co-operation. Such co-operations have been promoted after the liberalisation in order to create stability in the market, but their success is limited. During the last crisis period they were again on the agenda.

Vessels can work on the spot market or by means of time charters. Working on the spot market gives a lot of freedom to the operator, but also includes a lot of uncertainty. There are several types of contracts with different conditions, depending on the customs in the market segment. Apart from the freight tariffs, also the loading and unloading days, demurrage and surcharges are part of the contract. Such conditions often prove to be as important for the profitability of a shipment as the actual freight tariff.

Chapter 5: Vessel productivity

The capacity of a fleet is not just the number of vessels and the corresponding tonnage which is available. The capacity which is really available is also determined by the utilisation of the vessels. This is on the one hand the share of the capacity which is actually used when a vessel is transporting goods i.e. the load factor and share of empty kilometres and on the other hand how intensively this vessel is operated. The latter is determined by the intensity of operations as well as the rotation. Each of these topics together with their effect on the vessel productivity are discussed in this chapter.

1. Capacity utilisation

In the past, the regulated system accounted for low capacity utilisation in inland waterway transport. This was for a large part due to the high number of empty trips which were the result of the exchange and rotation system in the dry cargo segment. Furthermore, the vessels that were ranked first on the exchange were not always particularly suited for the goods that had to be transported. There was also no possibility to attune the goods to the capacity of a certain vessel. This resulted in sub-optimal vessel loads. More recently, several other reasons for those empty trips have come up such as product specialisation, safety and quality requirements. Since the capacity utilisation influences amongst others the profitability of vessels and the average freight tariffs in the market, it is important to have a closer look into this subject.

The inland navigation sector got a strong impulse of change and modernisation through the liberalisation, which led amongst other things to an increase in fleet capacity. The capacity of a fleet is determined by a number of factors, such as the number of vessels, the vessel size, rotation times and the capacity utilisation of vessels. The number of vessels and vessel size are the two factors which are mentioned most when studying fleet capacity. The other aspects are mentioned less, although they are increasingly important in the light of the increasing capital investments.

Some of the purposes of the abolishment of the 'tour-de-role'- system were reducing the waiting times (i.e. increasing the rotation time), increasing the load factors and reducing the number (and distance) of empty trips. In other words, increasing the capacity utilisation of vessels which in the end should lead to a higher profitability of vessels and lower freight tariffs.

As mentioned before (see chapter 2), after the liberalisation and the abolishment of the rotation systems, vessel owners, operators and shippers can make transport arrangements as they wish. This improves efficiency and increases competition in the sector. Also the charterers have more possibilities now to organise the shipments and available vessels in order to prevent empty trips. Therefore the degree of empty trips is expected to have decreased in the last decade.

But next to the liberalisation, also other changes took place in the sector. Increased regulation and self-regulation of the sector on safety and quality of goods increases the number of vessels sailing in dedication, which entails more empty trips (Ecorys, 2008; SPB, 2002). Furthermore, the large investments in capacity require a high rotation speed and a different way of operating vessels. The use of liner services in the container segment for example prevents these vessels from taking return cargo because of the strict sailing schedule they are working in.

The resulting focus of vessel owners on certain market segments in order to increase profits leads to a specialisation in inland navigation. As a result, the vessels are not easily usable for other cargoes, which decreases their flexibility. This may increase the number of empty trips and as a consequence increases the volume of unused capacity.

From a welfare point of view in general low capacity utilisation is considered undesirable. It generates emissions without having a useful purpose, increases average freight tariffs, affects the profitability of transport companies and increases traffic on the network. Therefore, better capacity utilisation is seen as beneficial for the sector and the environment alike.

In several studies and research projects the concepts of load factors and empty trips of inland vessels are used. Depending on the objective of the study, the concept is defined in a different way. Studies calculating traffic and transport forecasts for inland navigation for a certain lock may use only the number of empty vessels passing through the lock (Ecorys, 2009; Wolbers and Stap, 2002). In these studies the distances covered are not included and therefore there is no distinction made between long and short trips. Studies calculating capacity utilisation ratios also include the distance travelled by the empty vessel (Blauwens et al., 2010).

The purpose of this part is to show the effects of liberalisation and later evolutions on the capacity utilisation in the inland navigation sector. The analysis is made by means of an analysis of the empty trips, based upon the main factors influencing them, being the type and the size of the vessel. By means of statistical time series data of inland waterway transport on the Belgian waterways, the evolution of the empty trips over a 10-year period is studied.

1.1. Factors influencing capacity utilisation

Two important aspects of the capacity utilisation of a vessel are load factors and empty trips. In this section, they are both studied into more detail.

1.1.1 Load factors

The load factor of a vessel is determined by the maximum capacity of a vessel and the weight of the goods loaded. A good match between the size of the load and the size of the vessel therefore increases the load factor. Here we find that the draught plays an important role. If the vessel cannot load fully because of insufficient depth of a waterway, the transport will be less profitable.

An important aspect which is sometimes overlooked when calculating load factors is the weight/volume of goods. The capacity of vessels is mostly expressed in tonnes, but it can also be measured in volume (cubic meter). This is mostly the case with bin vessels. If the cargo is very voluminous, but the weight is rather low, the vessel could be fully filled in volume, but still have a low load factor when calculating the ratio based on the tonnes. This applies for example to containers.

<u>*1.1.2 Empty trips*</u>

Empty trips are generated due to a number of reasons. The possibilities of finding return cargo is one, the profitability of these transports is another. Whether or not finding return cargo depends on several factors such as the characteristics of vessels, the type of goods and the area in which the vessels are located. The choice of taking return cargo on the other hand depends on the contracts and attractiveness of the return load.

The technical aspect of vessels is a first factor that can prevent vessels from finding return cargo. A dry cargo vessel for example is not equipped to take liquid products, a small vessel cannot take a large shipment and so on. Furthermore, not all vessels are allowed to take any cargo due to regulation (e.g. ADN[28] regulation in tanker trade). A vessel transporting products which are subject to certain procedures or regulations cannot switch to other products easily, or at least not without extra costs of cleaning. Therefore, in tanker trade and for special products a higher degree of empty trips is expected. For tanker trade, most products go from the refineries or seaports to the hinterland. These vessels are often loaded one way and empty on the return, which gives a degree of empty trips as high as 50% (Ecorys, 2008).

Vessels do not only sail from A to B and back, certainly not when they are equipped for taking different cargoes. They can make a detour in order to find return load. Empty trips in this case are often the result of geographical imbalances in traffic flows (Fischman and Lendjel, 2010a). In certain areas return cargo is easily found, but in others it is far more difficult and vessels have to cross a larger distance before finding cargo. Therefore, it sometimes can be more profitable to go back to the initial loading place where more shipments are available, e.g. the seaports, instead of making a big detour.

Next to the possibilities of finding return loads, also the choice whether to search for them is important. One of the conditions is that the benefits of taking return cargo should be higher than the costs it brings along. When cleaning of the hold is prescribed between the transports of certain goods, e.g. GMP[29]-certified products, the cleaning costs and the accompanying time losses should be compensated by the freight. Also the conditions of the assignment play a role. Sometimes, it is more profitable to return empty very fast to take another load for which more is paid, than to take the return load which is available.

In this respect, contracts have an influence on whether return cargo is taken. Vessels operating on the spot market are free to take return loads if they want. Vessels sailing under a contract are tied to a certain shipping or chartering company. The size of these companies and the variety of cargo they transport (types of goods as well as origin-destination) determine the empty trips of the vessels committed to them. Larger groups are also expected to operate their vessels in a more efficient way. One could assume that more empty trips are made by vessels operating on the spot market because they do not have an overview of the market and have to look for cargo more often. On the other hand, more dedicated transports are done by vessels with contracts, e.g. in the tanker trade.

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[28] Accord Européen relatif au Transport International des Marchandises Dangereuses par voie de Navigation
[29] Good Manufacturing Practices (GMP)

In the case of a vessel used in a liner service (container transport), generally no non-containerised return cargo will be taken because of the strict timing of the schedule and the high costs if the service is disrupted. Furthermore, adding an extra stop for these vessels could necessitate an additional vessel to be put on the service in order to meet the schedule.

1.2. The economic impact of capacity utilisation

The capacity utilisation has an influence on several aspects of the sector. It affects the profitability of inland vessels, the freight tariffs in the sector and the capacity of the network. First of all, the capacity utilisation affects the profitability of inland waterway vessels. The costs of the empty trips have to be compensated by the revenues of the loaded ones (Rabobank, 2009). Furthermore, the freight tariff per tonne of cargo loaded has to cover the transport costs of the journey in case the vessel is not fully loaded.

We assume vessel owners want to maximise their profits. This means maximizing revenues minus costs, as equation (1) shows. Revenues are determined as the price per tonne-kilometre for transport performance i (P_i) times the tonne-kilometres sailed for this transport performance (X_i).

$$\text{Max } W = \text{Max}[\sum P_i X_i - \sum C_i] \quad (1)$$

The effects of empty trips and low load factors can be found on the three factors in the equation. First, the capacity utilisation influences on the production, i.e. the tonne-kilometres (tonne-km) performed by a vessel. When a vessel of 1,500 tonnes sails over a distance of 200 kilometres and is fully loaded one way and empty on the way back, it means 300,000 tonne-km (1,500 tonnes x 200 km + 0 tonnes x 200 km) is performed by the vessel. In case this vessel would have a return load of 1,000 tonnes on the way back at 20 km from the place of unloading, the production for the same distance travelled would be 480,000 tonne-km (1,500 tonnes x 200 km + 0 tonnes x 20 km + 1,000 tonnes x 180 km).

Next, the price which is paid per tonne transported is based on the cost per tonne-km. In the cost of the loaded trip, also the probability of not finding a return load is included. If not, the loaded trip could turn out to be non-profitable after all. In this respect, also the load factor is incorporated in the freight price.

Lastly, the capacity utilisation has an effect on some parts of the costs. The fixed costs such as capital costs and staff costs will remain equal whether or not a vessel is fully loaded. Some variable costs, of which the fuel costs are the most important, on the other hand will differ clearly depending on the load factor. When sailing empty, a vessel is expected to consume about 25 to 35% less than when it is loaded (Oonk et al., 2003; NEA, 2003). The previous reasoning shows that the less empty trips, the shorter these trips and the higher the average load factor, the better for the vessel owner or operator.

As discussed before, capacity utilisation has a large impact on the average freight tariffs. Low water levels on the river Rhine for example result in lower average capacity utilisation and as such in higher freight tariffs. This is due to low water surcharges which are charged for in order to compensate for the lower load factors, because of limited draught. Moreover, if the probability for the vessel to get a return load is fairly limited, the risk and costs of an empty trip will be reflected in the freight tariff of the initial trip. Jonkeren et al. (2010) found in their research that imbalances in trade flows have substantial effects on transport prices in inland navigation.

Low capacity utilisation also influences the vessel capacity needed in the market and the capacity of the waterway network. If load factors are low or many empty trips are made, more vessels are necessary in order to transport the same amount of cargo. This way, it also increases the traffic on the network. Most waterways used for inland navigation still have sufficient capacity, but certain locks already face congestion. Therefore, an efficient use of capacity is recommended.

1.3. Methodology

When calculating utilisation rates of a vehicle, there are two possible approaches to determine the units in which it is expressed. One can only look at the amounts transported (tonnes) or one can also take into account the distances, in which case the units are tonne-kilometres (Blauwens et al., 2010).

Capacity utilisation ratios are determined by transport output and traffic output. In freight transport, transport output is the number of tonnes of goods transported multiplied by the distance travelled. Traffic output is the maximum capacity of the good, times the distance travelled, empty and loaded (Blauwens et al., 2010). In order to be complete a third factor, being the weight/volume coefficient, should be included. The previous definition shows that the capacity utilisation ratios are very much affected by the number and distance of empty moves. An empty trip or empty move refers to the trip made by a vessel without load from the last place of unloading to the next loading point.

The quantitative analysis used in this study consists of descriptive statistics and graphics analysis of time series data. A straightforward way of detecting a trend in time series data is to take averages over a certain period. If the averages change with time, it indicates the existence of a trend. As the effect of the liberalisation and further evolutions on the empty moves is to be studied, a dataset which goes back long enough in time is required. Moreover, the dataset should be composed in a consistent way, allowing a solid comparison in time.

From the preceding reasoning, it is deduced that the amount and development of empty moves are expected to be dissimilar according to type of goods or cargo, due to technical aspects or legislation, and size of vessels, as a result of the chances of finding return cargo. Therefore, the further analysis is focused on these two factors.

Ideally, data on all inland waterway countries should be used in order to make correct statements for the whole sector. Furthermore, the distances travelled should be included in the analysis. Due to data restrictions, this study focuses on the trips on the Belgian network, including domestic transport, imports, exports and transit flows.

A special aspect of capacity utilisation in inland navigation is the transport of empty containers. From an overall position, these transports are considered as unproductive as the empty trips itself. But for the vessel transporting the empty containers, it is considered as a load for which it is paid. Therefore, the transport of empty containers is considered as a loaded trip in this study.

Regulations on the disposal of residues can oblige vessels to sail a certain distance in order to clean the vessel. As a result there is a trend in the sector towards transporting goods which are compatible or sailing in dedication. In these cases the cargo holds will not be fully cleaned, which leaves more residues and therefore results in a higher number of trips with small quantities. These trips have to be classified in a correct way before further analysing the data.

Since the regulated system mainly applied to the dry cargo market, a clear impact on capacity utilisation in this segment is likely to be found. In the tanker segment, due to further specialisation an increasing share of empty return trips could be expected. Furthermore, the number of shippers on the smaller waterways decreases, which should diminish the possibilities of return cargo for the smaller vessels and as a result increase their share of empty trips.

1.4. Data

The Directorate General Statistics and Economic Information (DGSEI) gathers yearly statistics on the transport of goods on the Belgian inland waterway network. These datasets originate from the data collected by the waterway administrators[30] on their part of the network. The datasets comprise domestic transport, imports and exports of which the starting or ending point is located in Belgium and the transit passing through Belgian territory.

The data only relates to vessels having part of their route on the Belgian waterway network. Furthermore, the distances and tonne-kilometres calculated only covers the part of the trip on the Belgian network. In the cases of import, export and transit trips, there is a part of the trip abroad which is not included in the calculations. Unfortunately, no data is available in the dataset on the distance travelled by empty vessels, nor on the distances outside the country.

In transport statistics, as from 2008 a completely new goods classification NST 2007 is being introduced on the European level. From 2007 onwards, the new NST 2007- code is used on the data of the DGSEI. As a result, data from before 2007 cannot be compared to the one of 2007 and later. Therefore, the paper will represent data until 2006 and use the former NST/R[31] classification, based on 10 chapters (see annex 2). The data used for the initial analysis is the data from the year 2006. For the evolution the datasets of 10 years, from 1997 until 2006, are used. This way, the situation before the liberalisation as well as afterwards is represented.

In the dataset, each barge of a combination, such as push convoys and coupled trains, is registered separately and there is no link between them. A self-propelled vessel with a barge in front or aside is registered in two separate observations, without a field connecting both. By including these vessels and barges in the analysis, trips would be counted double or even more if push convoys were included. Furthermore, statements about empty trips could not be made correctly, since a loaded self-propelled vessel can take an empty barge along. In this case, for the vessel and the barge together, it cannot be considered an empty trip. Therefore, only the observations of vessels sailing alone are used in this study. Nevertheless, it is important to keep in mind that empty units can be taken along with loaded ones.

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[30] Waterwegen en Zeekanaal NV, nv De Scheepvaart, MET

[31] Nomenclature uniforme des marchandises pour les Statistiques des Transport, Revisée

As stated above, only the observations of the trips of self-propelled vessels sailing alone will be used. They represent more than 77% of the total amount of trips in this dataset of 2006 (table 5.1). Container vessels mainly take containers, dry cargo vessels take either containers or other dry cargo. Tankers for solid cargo, also called powder tankers, are used to transport dry cargo products which can be loaded and unloaded by means of pumps, such as gypsum and cement. Bunker vessels are vessels mainly delivering fuel to other vessels (bunkering).

Table 5.1: Trips on the Belgian network by type of vessel (year 2006)

type of vessel	**number**	**share**
dry cargo vessel	205,548	57.1
tanker vessel for liquid cargo	44,942	12.5
tanker vessel for solid cargo	3,085	0.9
container vessel	23,748	6.6
bunker vessel	519	0.1
total sailing alone	**277,842**	**77.1**
other	82,319	22.9
Total all vessel types	**360,161**	**100**

Source: own composition, based on data from data DGSEI (2009)

In table 5.2 the empty and loaded trips on the Belgian network are represented. When taking a closer look into the loaded trips, it is found that a rather high amount of loaded vessel trips (8.6% of the loaded trips in 2006) has a load of only one tonne. Considering the large capacity of an inland vessel and the size of the usual quantities it is unlikely that these are real shipments or parts of a shipment.

Table 5.2: Share of vessels empty - loaded - small quantities (year 2006)

tonnes	**number**	**%**
empty	90,668	32.6
loaded	187,174	67.4
of which 1 tonne	*16,145*	*8.6%*
of which >1 tonne	*171,029*	*91.4%*
total	**277,842**	**100**

Source: own composition, based on data from data DGSEI (2009)

It is more reasonable to believe that at least part of these transports actually consists of residue. These residues are part of the shipment which stays behind in the hold or tanks after the vessel has been unloaded (Wolbers and Stap, 2002). Given that all figures in the dataset are rounded off to a tonne, it is assumed that the figures of these small quantities are even lower and rounded up to one tonne. Based on the report of the Ministerie Verkeer en Waterstaat (2003), the amount of residues left after unloading a vessel can go up to one tonne. It is expected though that this amount will decrease in the future as a result of new regulation concerning residues in the tanker segment. Since these trips are registered as loaded ones, they increase the share of loaded trips in the dataset.

When trying to make statements on the empty and loaded trips it is important to identify the transports of residues. Therefore a distinction is made between empty trips, loaded trips and transport of residues.

Following this reasoning, for dry bulk goods and tank cargo, meaning NSTR codes 0 until 4 and 6 until 8, the transport of one tonne is considered as residues. For NSTR classes 5 and 9 on the other hand this assumption seems not acceptable. Class 5 is metal products of which it is assumed that there are no residues left after unloading. For class 9, consisting of all types of goods such as machinery, manufactured goods and wrapping materials including empty containers, it seems not acceptable to consider one tonne as residues. This class also holds a higher number of trips of two and three tonnes. This could be the transport of one container since the weight of an empty 20' container is 2,200 kg, but there is no certainty about it. It could also be products with a small weight, but a large volume. Therefore, in the further calculations the small quantities of these two goods categories are considered as loaded trips. This gives the following classification of small quantities in table 5.3.

Table 5.3: Classification of trips (year 2006)

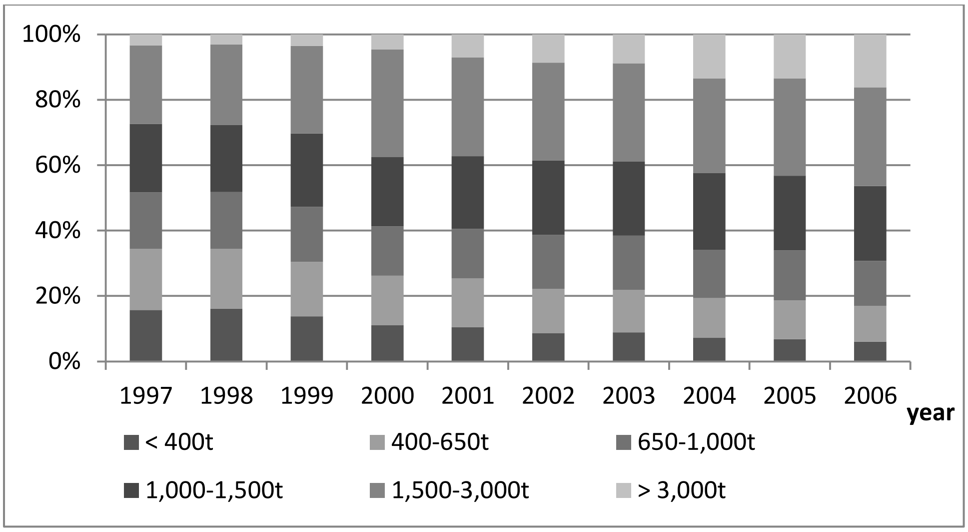
type of vessel	**empty**	**residues**	**loaded**	**total**
	%	**%**	**%**	**%**
dry cargo vessel	37.1	2.6	60.3	100
tanker vessel for liquid cargo	21.4	19.0	59.6	100
tanker vessel for solid cargo	46.6	0.1	53.3	100
container vessel	13.5	2.6	83.9	100
bunker vessel	17.7	0.2	82.1	100
total	**32.6**	**5.2**	**62.1**	**100**

Source: own composition, based on data from data DGSEI (2009)

Table 5.3 shows that the share of empty trips of tanker vessels in 2006 is rather low, while the share of trips with residues is very high (19%). This is probably the result of sailing in dedication without cleaning the hold. The share of empty trips of container vessels is small, because these vessels often take empty containers back which is considered a loaded trip. Further in the analysis, the trips with residues will be taken together with the empty ones.

Graph 5.1 represents the evolution of the shares of vessel sizes in the total number of trips. It is clear that the share of smaller vessels is decreasing rapidly. Whereas the three smallest vessel types accounted for more than 51% of the trips in the period of regulation, they hardly attain 31% in 2006. The share of the middle sized vessels (1,000-1,500 ton) remains fairly constant. The share of the largest vessels increases as from 1999 and attains more than 45% of the number of trips (empty and loaded) in 2006. This graph already indicated that changes of empty and loaded trips in certain vessel sizes will have a larger impact on the total than others.

Graph 5.1: Evolution of share of vessel type in number of trips (1997-2006)



Source: own composition, based on data from data DGSEI (2009)

1.5. Results

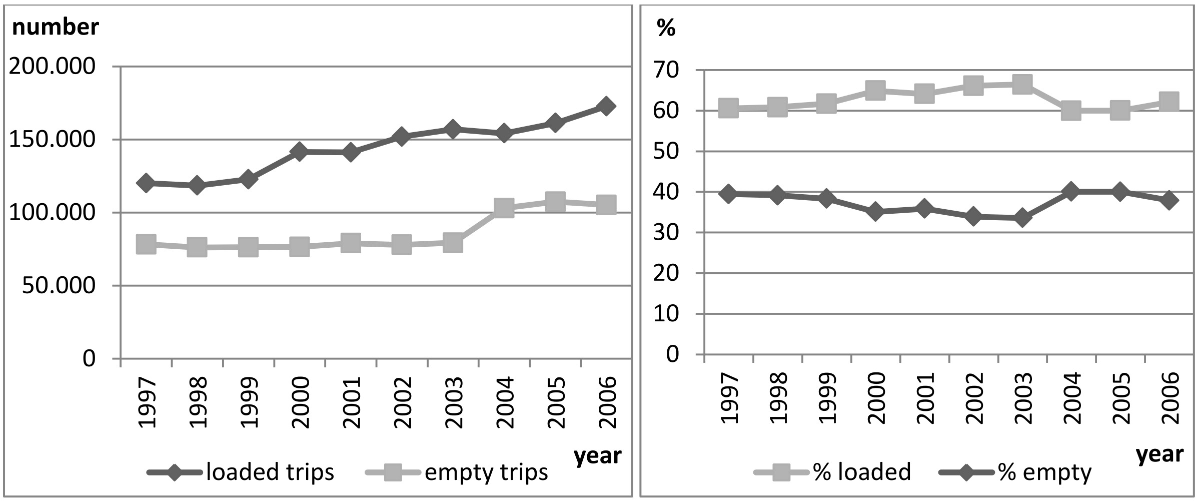
1.5.1 Empty trips

The evolution of the number of trips over a time period of ten years is represented in graph 5.2. It shows a constant course of the number of empty trips with a large increase in the year 2004, followed by stabilisation in the following years. This evolution could be the result of methodological changes in the dataset itself. But it could also stem from a serious change in the sector of a combination of both.

In general, for 2006 more than 105,000 empty moves are found compared to almost 175,000 loaded ones. This means that almost 38% of the moves are empty. Ten years before, the share of empty moves reached 39.5%.

The evolution of the share of empty and loaded trips shows that there is a slow but steady decease of the share of empty moves until the year 2003 where the lowest share of empty moves (33.6%) is attained. In 2004, we see a serious increase, bringing the share to the highest value in this time series (40%).

Graph 5.2: Evolution of empty and loaded trips in number and share (1997-2006)



Source: own composition, based on data from data DGSEI (2009)

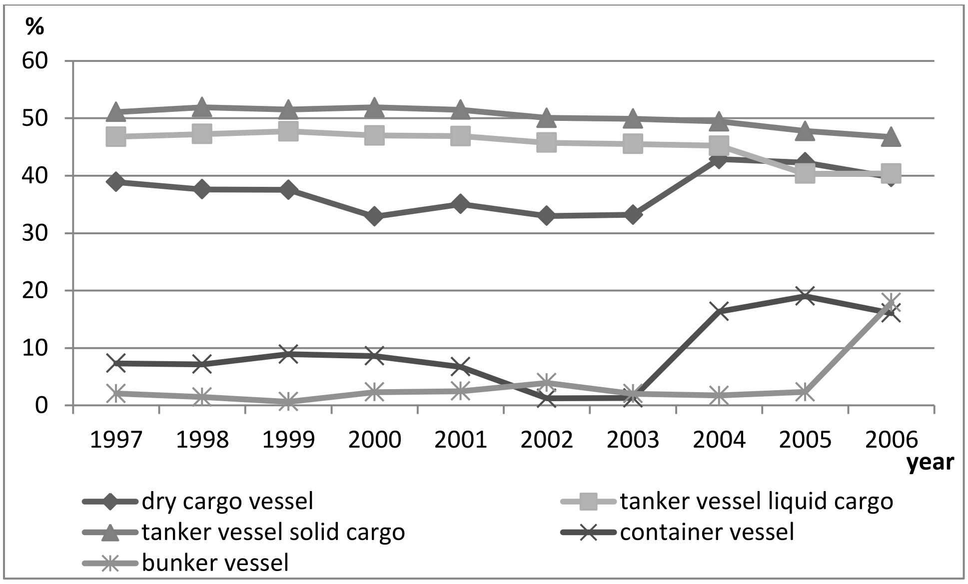
These figures only give the general trend for the whole sector on the Belgian network. As mentioned before, this is expected to be different for the individual segments of the market. In the rest of the paper, the share of empty trips will be used as a basis for the analysis. Of course it is important to keep the numbers in table 2 and graph 1 into account when valuing the importance of these individual evolutions on the sector as a whole.

When taking a closer look into the evolution by type of vessel (graph 5.3), it can be seen that tankers for solid cargo have the highest share of empty trips (between 52 and 48%), followed by liquid cargo and dry cargo vessels. Tanker vessels, liquid as well as solid cargo, have a steady course, followed by a slight decrease starting from 2002. Factors influencing this evolution are the cleaning systems on board of tanker vessels and the use of several separate reservoirs and pipelines which allow for the vessels to take different products.

Dry cargo vessels have a decreasing share of empty trips until 2002-2003 where it attains 33%. In 2004 a large increase is found until almost 43%, followed by a small decrease in the years after. For container vessels a very low share of just above 1% can be found in the years 2002 and 2003. In 2004 on the other hand, the share increases greatly and it reaches 19% in the year 2005. The strong rise found for bunker vessels in 2006 stems merely from the large incline in loaded trips. Overall, these two vessel types have a much lower share of empty trips than the other types.

Since dry cargo vessels and container vessels together make up about 82.5% (229,296 trips on a total of 227,842 see table 5.1) of the total number of trips of vessels sailing alone, the increase in empty trips of both types as from 2004 account for the increase of the total share shown in graph 5.2. A possible explanation of this evolution in the dry cargo and container segment is the increase in freight tariffs in the dry cargo segment in the Rhine area in this period. This makes it profitable to return empty very fast to get a load for which high freight tariffs are offered.

Graph 5.3: Evolution of share of empty trips by vessel type (1997-2006).



Source: own composition, based on data from data DGSEI (2009)

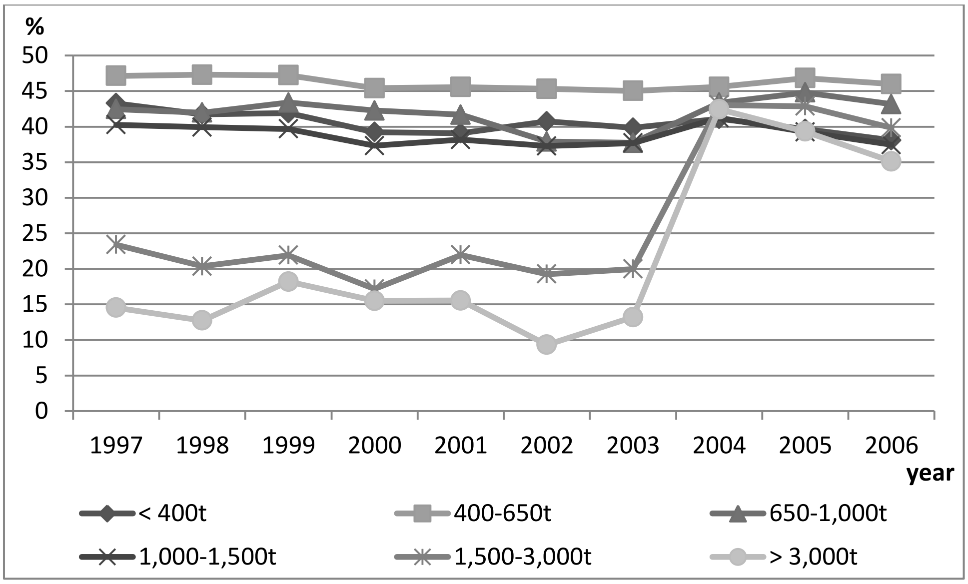
Because the empty trips are also expected to differ according to the size of the vessel, the share of empty trips is calculated for each vessel size. Graph 5.4 shows the results for the dry cargo segment. The vessel size is determined based on the tonnage of the vessel and the ECMT[32] classification is used to distinguish between categories. In the tanker segment the slope of the curves is rather similar for all tanker sizes.

It is clear from this graph that smaller vessels have a higher share of empty trips compared to the larger ones. The smaller traffic volume on the smaller waterways is an important reason why small vessels have more one-way trips than larger ones. Amongst these smaller vessels, the smallest size (<400 tonnes) performs better in this respect than the class '400-650t'. A reason could be a longer trip (to France) which makes waiting for return cargo more interesting. Overall, the curves of smaller vessels have a slight decreasing slope as from the year 2000, followed by small increase in 2004.

For larger vessels, the course is far less stable. After 1999, one can see a kind of decreasing trend for the largest vessels. This decrease continues until a minimum of less than 10% empty trips is reached in 2002. Also the share of empty trips for the Rhine vessels remains at a low level. After a slight increase in 2003, for both vessel sizes a huge increase is found in 2004 where their share almost reaches the same level as the smaller vessels. Afterwards, a small decrease can be found again. The sharp increase can be explained by amongst others the increasing use of larger vessels on the network (see graph 5.1) and the increasing freight tariffs.

[32] European Conference of Ministers of Transport

Graph 5.4: Evolution of share of empty trips of dry cargo vessels by vessel size (1997-2006)



Source: own composition, based on data from data DGSEI (2009)

To summarise, we can say that the total number of loaded trips increased, while the number of empty ones remained almost the same for years in a row. This results in a downwards slope of the share of empty trips. This decrease only lasted until 2004, when a considerable rise of the number of empty trips took place. As a result of this a high increase in the share of empty trips in 2006 almost reaches the level of before the liberalisation of the sector.

A more detailed look per type of vessel shows that the share of empty trips is generally much higher for tankers than for dry cargo vessels. The pronounced increase in empty trips in 2004 originates almost entirely from the dry cargo segment, merely from dry cargo vessels and for a smaller part from containers vessels. In the tanker segment on the other hand, it is found that both for dry and liquid cargo the share of empty trips decreases. As from 2004, both dry cargo vessels and liquid tankers attain a share of empty trips of about 40%.

Concerning the size of vessels, it is clear that in the dry cargo segment smaller vessel sizes have a higher share of empty trips than the larger vessels, although the difference has clearly diminished in the last years. In comparison to the dry cargo vessels, the differences between vessel sizes in the tanker segment are much smaller. The trend which is found in the dry cargo segment is merely determined by the evolution of the smaller vessels in the beginning, while the evolution of the largest vessel sizes gets the upper hand later on.

1.5.2 Load factor

The load factors are calculated as an average per vessel type over the years 2004-2006. In order to prevent data problems concerning registration of residues to bias the results, a number of observations have to be excluded from the dataset. Otherwise, the presence of vessels with residues in the dataset might have a serious negative effect on the averages calculated. All vessels which are registered as being loaded, but with a weight which is less than 1%[33] of the maximum capacity are therefore not considered as being loaded and are removed from the dataset.

For container vessels, the load factor will be much lower than for vessels carrying dry or liquid bulk. It is known that containers generally have a relatively low weight (about 11 tonne per TEU). A vessel of the type Kempenaar for example, which can take about 600 tonnes, will have a load factor of about 50% when transporting containers (max. 24 TEU). Therefore, the load factor of container vessels is calculated separately.

In this respect, the registration of the shipments is important. If a ship carries a load of the same good for two or more recipients, the shipments are considered as separate observations. Moreover, if a vessel carries goods from different goods categories at the same time, they are also registered as separate observations. Unfortunately in the dataset, no link between these trips can be made. Therefore, it is tried to identify these transports based on the data of the waterway administrators which contain more detail.

The dataset used for this purpose comes from De Scheepvaart and holds 148,075 observations for self-propelled vessels sailing alone in the years 2006 until 2008 (see table 5.4). This dataset holds only part of the Belgian network, but is assumed that the results will be similar in the other areas in Belgium.

Based on the registration number and the date, the number of multiple shipments is identified. Table 5.5 shows that only 5.3% of the observations of loaded vessels are multiple shipments. Furthermore, in table 5.5 the results are shown for the different goods categories. The multiple shipments are mainly found in NSTR category 9, which holds the container transports. The transport of several, generally two types, of goods also appears in other goods categories, mostly in building materials and chemical products.

Table 5.4: Multiple shipments per vessel type (year 2006-2008)

type of vessel	**loaded vessels**	**dupes**	**share**
self-propelled dry cargo vessel	60,073	934	1.6
self-propelled tanker vessel for liquid cargo	16,119	670	4.2
self-propelled tanker vessel for solid cargo	1,837	140	7.6
self-propelled container vessel	6,643	2,708	40.8
self-propelled bunker vessel	21	4	19.0
total	**84,693**	**4,456**	**5.3**

Source: own composition, based on data from De Scheepvaart

Tankers often have separate tanks in which they can transport different goods such as gasoline and diesel or different types of chemical products. In the dry cargo, it is often sand and gravel or one type of goods for several recipients. Overall, this is only a limited amount of the total observations in the

[33] Based on the experience of Mr. H. Paelinck

dataset. Therefore, for the dry cargo and tanker vessels, the load factors will be determined based on the data of the DGSEI.

Table 5.5: Multiple shipments per goods category (year 2006-2008)

type of goods	loaded vessels	dupes	share
0	4,911	12	0.2
1	3,198	59	1.8
2	3,636	4	0.1
3	8,846	184	2.1
4	2,535	2	0.1
5	4,501	59	1.3
6	37,689	399	1.1
7	2,212	12	0.5
8	7,350	359	4.9
9	9,815	3,366	34.3
total	**84,693**	**4,456**	**5.3**

Source: own composition, based on data from De Scheepvaart

The results in table 5.6 show that the load factors are generally somewhat higher for dry cargo vessels than for tanker vessels. The load factor for tanker vessels is rather similar over the different vessel sizes. In the dry cargo segment on the other hand, quite some differences are found. The medium size vessels have the highest load factor (91%) whereas the largest vessel types have the lowest (58%).

Table 5.6: Load factor dry cargo and tanker vessel (year 2004-2006)

	load factor	
vessel type	**dry cargo**	**tanker**
Spits	74%	72%
Kempenaar	82%	88%
Enlarged Kempenaar	87%	72%
Canal du Nord	85%	77%
Dortmunder	91%	71%
Rhine Herne	86%	75%
Large Rhine vessel	75%	71%
Large container vessel	58%	71%

Source: own composition, based on data from data DGSEI (2009)

Since the transport of goods belonging to separate goods categories in one vessel appears mostly in container transport, where empty and loaded containers have a separate code, the actual load (loaded tonnage) of vessels transporting containers has to be determined in a different way. The different observations which are part of one shipment have to be brought together again, before calculating the actual load. The procedure which is followed here is based on the dataset that is used for calculating the load factors for bulk vessels. The calculations are made with the data of De Scheepvaart for the year 2006 and the results are compared the one of the complete dataset for the same year.

Table 5.7: Actual load container vessel (year 2006)

	% loaded (in tonnes)	
vessel type	**De Scheepvaart 2006**	**DGSEI 2006**
Spits	-	-
Kempenaar	16.42%	26.36%
Enlarged Kempenaar	29.91%	22.89%
Canal du Nord	27.13%	24.23%
Dortmunder	26.78%	17.79%
Rhine Herne	25.06%	12.42%
Large Rhine vessel	31.84%	23.36%
Large container vessel	13.10%	47.51%

Source: own composition, based on data from data DGSEI (2009) and De Scheepvaart

Because of very few observations for the smallest vessel in both datasets, it is difficult to pronounce upon the actual load of these vessels. The shares of the dataset from De Scheepvaart are generally higher than the one of DGSEI (table 5.7). This is a result of bringing together multiple shipments in this dataset, instead of taking the observations separately. In the case of vessel types 2 and 8, the load based on the larger dataset is higher. For the vessel types 6 and 8 large differences can be found between the results of both datasets. For the vessel type 6 (1,500 tonnes on average), the much lower load in the dataset from DGSEI is probably the result of many multiple shipments in that vessel category. For the vessel type 8 (> 3,000 tonnes), the load in the dataset from DGSEI is more than 3 times as high as the other one.

It is important to remember that this actual tonnage carried by container vessels or vessels transporting containers does not say anything about the number of containers or space which is left on the vessel. It only calculates how much tonnage is loaded compared to the maximum tonnage the vessel can take. This is e.g. important for calculating the draught of the vessel and the corresponding fuel consumption. As mentioned before, the weight of containers is generally smaller than the one of bulk products and on top of that empty containers take the same space as loaded ones. It is therefore very likely that a container vessel is fully loaded, but has a load factor of less than 50%.

In order to make a right calculation of the load factor for container vessels, it is necessary to include data on the number of containers that are being transported and the container capacity of the vessels. Ideally, this would be done with data which contains the exact container counts. Unfortunately, this data was not at the disposal of the author at the moment of this research. In absence of such data, an estimate could be made by using for example 11 tonnes as an average value for a container.

Conclusion on the capacity utilisation in the sector

Capacity utilisation is an important aspect in inland waterway transport because it affects the profitability of vessels and average freight rates as well as the capacity of the fleet and the network. In that respect, empty trips strongly influence the capacity utilisation of vessels. In the past, an important part of the market was subject to a regulated system, which led to a high number of empty trips. Now, taking return cargo or not depends both on the availability of cargo and the attractiveness of the load, and differs according to type and size of a vessel. New regulations on quality of products, new cleaning systems and other ways of operating vessels can have quite an impact on the empty return trips. In this respect, it is often stated that working in larger groups can lead to more efficiency in capacity utilisation. On the other hand, contracts can prevent vessel owners from accepting an available load, leading again to more empty trips.

The analysis shows that the liberalisation initially has had a positive effect on the capacity utilisation of dry cargo vessels operating on the Belgian network. On the other hand, new regulations and new ways of operating vessels have come up which could increase the number of empty trips again. A clear increase of empty tips is found in the dry cargo segment in 2004, mainly amongst the larger vessels. As a result, the share of empty trips in 2006 turns out to be only slightly lower than ten years before. In the tanker segment, it is found that both for dry and liquid cargo the share of empty trips decrease. Given that some important new regulations were only established in the previous years, the possibility of a reverse trend which cannot be derived from this dataset should be kept in mind.

Even though this research only reports on the number of trips and not on the distances, it gives an indication of the effect of empty moves on the capacity utilisation in the sector. In order to get a full view on this capacity utilisation and draw conclusions for the sector as a whole, there is a need of reliable and coherent statistics, preferably at a European level.

The calculation of the load factors, which are determined as an average over three subsequent years, shows that they are generally somewhat higher for dry cargo vessels than for tanker vessels. For the latter, the load factor is rather stable over the different vessel sizes, while in the dry cargo segment the medium size vessels have a much higher load factor than the largest vessel types. For container vessels, a different approach has to be taken and no conclusions can be drawn from this analysis due to insufficient data.

2. Intensity of operations and rotation

In this part, both the intensity of the operations and the rotation of a vessel are considered. The intensity of operations indicates how many hours a day and how many days a year a vessel is operational. The rotation is defined here as the time needed to execute a certain transport, including the time needed for the charter.

2.1. Intensity of operations

The intensity with which a vessel is used certainly has an effect on the productivity and on the costs of a vessel. On the one hand, a more intensive way of operating the vessel raises certain costs, such as the labour costs. On the other hand, by increasing the operating hours, more trips and more revenues can be made and the fixed costs are being spread over a larger whole which in its turn decreases the hourly costs.

2.1.1 Type of operations

For Belgian companies one has to follow the manning regulation which exists in Belgium by the Royal Decree of March 9th 2007[34], concerning the regulation on the crew of inland waterway vessels on the Belgian waterways. This KB harmonised the Belgian law with the Rhine regulations. It elaborates amongst others on the three types of operations and the rest moments for the personnel. Also administrative rules concerning working hours such as the sailing times of personnel and the use of the tachograph are part of this KB.

The type of operations determines the block hours in which a vessel can sail and the maximum sailing time. In the A1 regime, a vessel can only sail between 6h and 22h for maximum 14h. In the A2 regime a vessel can sail 18h at maximum and the working hours are between 5h and 23h. From these block hours, it can be deviated if a tachograph is used to register the sailing hours of the vessel. For the B regime (continuous operations), the vessel is allowed to work 24h a day. For each regime, a different minimum staff is required. The more intensive the operations, the more people are needed on board.

The choice for a more intensive type of operations is often more related to the flexibility than to the actual working hours per day. The same goes for the number and qualifications of the people on board. In case the vessel sails in places where it is difficult to find a place to moor overnight, this might be a reason to shift for example from A1 to A2 operations. This way, the vessel can stay in line with the regulation on sailing- and working hours. For small vessels (dry cargo <55m and tanker <35m) on certain waterways an exception is made to the standard regulation which allows for bargemen to sail alone under certain conditions, e.g. max 12h per day and 50 hours per week.

[34] Belgisch Staatsblad 16 Maart 2007

2.1.2 Effective days

The number of days a vessel is operated is the total days in a year minus the days the vessel is out of business. This can be for a number of reasons, of which holidays, special occasions and repair of the vessel are the most important ones. The effective days are the ones that the vessel is immediately ready to take on a shipment. This is calculated by the following formula: Number of exploitation days per year = 365 - holidays - special occasions - repair - …

In this respect it is important to mention that generally larger and more expensive vessels have a more intensive type of operations than smaller ones. They are often only one or two weeks out of service per year for the necessary maintenance. This is not only the case for vessels operated by employees, but also for owner-operators. They can have a temporary crew on board during their holidays. But larger vessels which are run by the owner-operators sometimes just stop working during the holidays. Given that the vessel is also their home, they are not always very keen on having 'strangers' operating the vessel while they are not on board. Having family members or friends taking over can solve this problem.

The effective days do not only consist of the days that cargo is transported. It also comprises the days travelled empty, the time needed to load and unload the cargo, the waiting times for loading and unloading and the waiting times for chartering. By multiplying the effective days by the number of hours per day the vessel is operated, one gets the effective hours per year. The maximum number of hours the vessel can operate per day depends on the regime which is chosen (see type of operations). This mainly affects the minimum requirement of staff on board.

2.2. Rotation

The rotation speed of a vessel is an important part of the productivity. The rotation speed depends on the speed at which the vessel is sailing, the time needed to find and prepare for a new transport order and the waiting times and delays which are encountered during the transport. It is obvious that the higher the rotation, the more trips can be made and the more revenue can be made.

2.2.1 Vessel speed

The speed of the vessels differs according to the waterway the vessel is sailing on or the action it is taking. When approaching a lock or terminal, the speed will be low in order to avoid collision. When sailing on a large waterway, such as the river Rhine, the vessel will generally sail at a much higher speed.

The vessel speed is not only related to the vessel itself, meaning its shape and engine power, but also subject to the instructions of the waterway administrators of the waterways they use. In order to ensure the safety of the vessels and the preservation of the infrastructure (e.g. the river banks), speed limitations are applied on many waterways. The maximum speeds on the waterways are generally related to the draught of the vessel. In Belgium, most waterways or parts of waterways have speed limits and they are often different from each other. An overview of these speed limitations on the Belgian waterway network can be found in annex 6.

2.2.2 Waiting times and delays

The waiting times and delays are very important in the sector. A vessel can wait for a number of reasons which can be for example waiting for a new shipment, waiting before being loaded or unloaded, waiting at locks because of congestion or technical problems and so on. Part of this waiting time is normal and expected, but in case of accidents or breakdowns, also unexpected delays can come up. An unexpected delay can interfere with for example the sailing schedule of a container vessel and this way causing extra costs for terminals and clients.

The waiting time for a vessel between two shipments is influenced by a number of factors. The waiting times depend amongst others on the demand in the market, but also on the contacts that the vessel owners have with charterers and shippers. In this respect it is beneficial for a vessel that is not chartered on a time basis, to reduce this waiting periods to the minimum. During these periods, the fixed costs of the vessel keep on running, but no revenues are made. The assistance of a charterer therefore is often asked in order to get assignments. For vessels which receive a daily rent for a certain period, the risk of the waiting times is for the party that chartered the vessel.

Furthermore, there are the waiting times at the terminals before starting to load or discharge the vessel. These waiting times are generally included in the contract and can give right to demurrage if exceeded. In case the waiting times are as such that the vessel cannot take a foreseen next shipment because of these waiting times, this could prove to be an unbeneficial situation. If the vessel is already charged, it can do nothing else than waiting for unloading. Demurrage could in some cases prove more interesting than a new shipment at a low freight tariff though.

In Belgium, the number of loading and unloading days of a charter contract was in the past regulated by means of the Royal Decree of 4 Mai 1999[35]. In June 2011, a new Royal Decree[36] was enacted that replaces the one of 1999. This Royal Decree is valid only if no other terms are fixed in the contract. Also the compensations for extra waiting times for loading and unloading are established in this Decree. The number of waiting days and the compensation is different depending on the country. In case nothing is fixed in the contract, the regulation of the country in which the vessel is loading or unloading applies. The Belgian legal loading and unloading days and compensations of both the old and new Decree can be found in table 4.2.

The parties can decide on having shorter periods in their contracts. For vessel owners, this means that the vessel is free earlier which could increase the rotation time of the vessel. The number of loading and unloading days also depends on the type of goods. A small vessel carrying containers for example can be loaded or discharged in a few hours. In case the loading and unloading has to be done during the night (between 22h00 and 6h00) or on Sundays or legal holidays, extra compensations have to be paid to the people working on board. In Belgium, these compensations are stated in the same Royal Decree.

[35] KB 4 mei 1999 betreffende de ligtijd en het bedrag van de overliggelden inzake binnenbevrachting

[36] KB 17 juni 2011 betreffende de ligtijd en het bedrag van de overliggelden op het gebied van de binnen-bevrachting

Table 5.8: Belgian legal number of loading and unloading days and compensations

number of days:					
Royal Decree 1999			**Royal Decree 2011**		
Tonnage vessel	**loading**	**unloading**		**loading**	**unloading**
tonnage <= 750 t	2	2	tonnage <= 1,750	2 half	2 half
750 < tonnage <= 1,600	3	3	1,750 < tonnage <= 3,500	3 half	3 half
1,600 < tonnage	4	4	3,500 < tonnage	4 half	4 half
compensation for extra waiting time:					
Royal Decree 1999			**Royal Decree 2011**		
Tonnage vessel	**self-propelled**	**pushed barges**		**self-propelled**	**pushed barges**
tonnage <= 750 t	0.30 euro	0.20 euro	tonnage <= 1,750	0.41 euro	0.49 euro
750 < tonnage <= 1,600	0.27 euro	0.17 euro	1,750 < tonnage <= 3,500	0.36 euro	0.44 euro
1,600 < tonnage	0.25 euro	0.15 euro	3,500 < tonnage	0.31 euro	0.39 euro

Source: own composition, based on data from AGEBO CVBA (2011) and Belgisch Staatsblad (2011)

In general, for loading and unloading of the goods, each time 2 days are common practice in the sector. For larger vessels which are going to places where loading and unloading can be done during the night, the time is expressed in hours instead of days. If a vessel would start unloading during the day (day 1), continuing at night (day 2) and ending on the following day (day 3), this could otherwise be seen as 3 days in which case demurrage has to be paid. By using 48 hours instead of 2 days, this can be prevented.

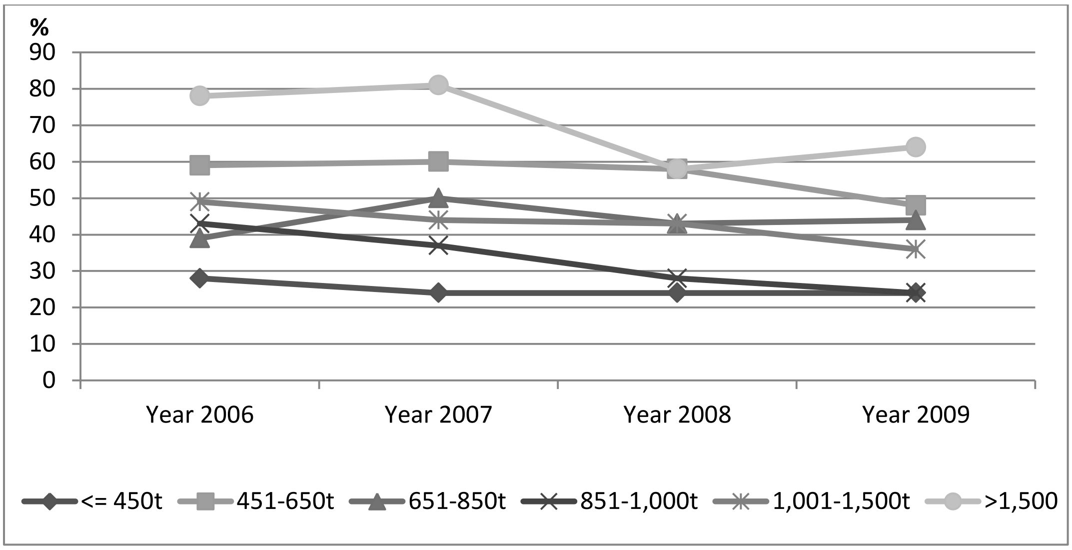
By reducing the number of loading and unloading days in the new Royal Decree, the vessels have right to a demurrage much faster than before. Apart from the shorter loading and discharging times, the compensations for waiting have increased. For the vessel-operator, this is a good thing, because the previous demurrage did not compensate sufficiently for the increased costs of the vessels. Furthermore, the shorter times and increased demurrage will encourage shorter loading and discharging times, which increases the vessel productivity.

2.3 Number of trips

The ITB gathers quarterly economic information on the Belgian inland navigation companies by means of inquiries. One of the indicators emerging from this exercise is the average number of loaded journeys. Graph 5.5 gives this average per vessel type for the dry cargo segment. This graph shows clearly a decrease in the average number of trips in the crisis years of 2008 and 2009 for all vessel sizes. For the vessels larger than 1,500 tonnes a decrease of about 25% is found.

Furthermore the graph shows that the smallest vessel type (Spits) clearly has a much lower number of trips per year than the other types. This is mainly due to its longer distance over smaller waterways (France). The type Kempenaar on the other hand has a very high number of trips per year, compared to the other vessel sizes. These vessels are in Belgium often used for transports between the ports and on the smaller waterways. These are in general relatively small distances and therefore many trips can be made.

Graph 5.5: Average number of loaded trips per year by vessel size (dry cargo only)



Source: own composition, based on ITB Trimestriële Conjunctuurenquête

Conclusion on the vessel productivity

In this chapter the vessel productivity is addressed, which is one of the factors influencing costs and revenues. On the one hand, there are the load factor and the empty trips which influence the capacity of a vessel or fleet as it is. That is, given a certain way of working, the load factor and empty trips determine what capacity can be transported. On the other hand, there is the intensity of operations which might in- or decrease the available capacity. The capacity of a vessel can be increased by increasing the size, but also by using the vessel in a more intensive way. In that respect, the type of operations and the effective days that the vessel works per year determine the total hours that a vessel can be deployed. And not to forget, the vessel speed and waiting times have an impact on the number of shipments that can be taken. All these aspects of the vessel productivity are to a greater or lesser extent included by the vessel owner in his negotiations on the freight tariffs. In the next chapter, the main cost items and cost aspects are discussed in detail and the most important cost models that are used in the inland navigation sector are addressed.

Chapter 6: Cost models in inland waterway transport

In the long run the total costs of a vessel should be the lower limit of the freight tariffs. Therefore the costs play an important role in the operations of a vessel. If new investments are being done, this inevitably will alter the costs of the operations. A new vessel for example will have a higher capital cost than an older one. The costs compared to the freight tariffs, i.e. the profit margins, in turn also influence on the investments. In this chapter, the existing cost models and cost studies in the sector are studied in order to see whether one of these models could be used for this research. Besides, the main cost components and the main factors influencing them are identified and described in detail.

1. Literature cost models for inland navigation

The literature review on cost models in inland navigation starts with an overview of the most important cost models and studies. They mainly originate from the traditional IWT countries in Europe. The main cost models and their evolution are first described and afterwards, a typology of them is made.

1.1. Overview of existing cost models in inland navigation

This literature overview only concerns the economic costs involved in the operations of an inland vessel. The costs are calculated per hour (sailing time, waiting time etc.), per tonne-kilometre or per journey for a certain type of inland vessel or several types of vessels. In these studies, the main focus is on the inland vessel itself. The overhead costs are generally not taken into account, amongst others because most models are based on vessels either operated by an owner-operator or shipping company or use average data.

Most cost studies start from a division between fixed costs and variable costs. Both types of costs can be converted to hour-coefficients. The yearly fixed costs are divided by the amount of effective hours per year and the variable costs are represented per active (engine) hour. In order to convert into costs per tonne-kilometre, average speed and transported tonnage will be taken into account. In order to calculate the costs of a certain route, additional specific costs are added.

A first analysis of the existing cost studies shows a division between on the one hand overall models, and on the other hand partial studies. The overall cost calculation models strive to give an approximation of an exact cost calculation in which as many cost factors as possible are taken into account. Apart from this also studies exist which focus on one single cost item, e.g. fuel consumption in the light of studies on the ecological aspects of inland navigation. In the following part, a classification and a brief overview is given of the existing studies and models.

1.1.1. Models for overall cost calculation

Within the existing models providing an overall cost calculation, three types of models can be distinguished. First there are the theoretical or general cost models, which are developed and afterwards used for more elaborate studies. Further there are the specific or ad hoc cost calculations which are used by companies in the sector. To conclude, also studies exist which are specific for a certain case. These studies are often conducted for new types of vessels or new concepts.

- General cost models

The most important sources in the area of inland navigation cost calculations are the cost studies of research groups NEA in the Netherlands, ITB in Belgium and PLANCO in Germany. They each have developed their own cost model and they regularly publish cost studies related to inland navigation. Depending on the study, these publications are specific to a greater or lesser extent. It often concerns cost evolutions, in which indices are used. In this category of general cost models also freight models are listed which use cost data for the various modes such as the Freight Model Flanders. All of these models generate a cost calculation for an 'average' vessel in the sector.

One of the most important sources in terms of inland navigation cost calculations are the cost studies of research group NEA, which date back to the 1980s (EWB, 1977; NVI 1978; EWB 1980). The purpose of developing this inland navigation model was to support the freight tariffs, i.e. fixing the rates, in the regulated market. This basic model was refined, adjusted and expanded over the years. In the past years, a variety of studies of this research group was published with regard to inland navigation costs (NEA, 2002; 2003a; 2003b; 2004; 2006; 2008; 2009a). A number of studies are rather general (NEA, 2004), while others go into more detail on a certain market segment (NEA, 2006) or certain cost items (NEA, 2003a). The NEA inland navigation cost calculation model mostly uses data on the Dutch fleet. A number of research reports were commissioned by an external party such as the 'Centraal Bureau voor de Rijn- en Binnenvaart' (NEA, 2002; NEA, 2003; NEA, 2009a; NEA, 2010) or for the 'Ministerie van Verkeer en Waterstaat' (NEA, 2004).

The initial ITB model was developed late 1970s, early 1980s for smaller vessels. The structure resembles the NEA cost model, as the ITB used to provide Belgian data for the Dutch model. More recently, the first publication dating end of 2009, the ITB has changed its way of cost calculation (ITB, 2009). Calculations are now based on real costs provided by accounting companies instead of using theoretical cost approximations. This adjustment emerged from the demand of the sector to have a more transparent view on the costs. The results should serve among others as a preparation for discussion on a fiscal level, such as establishing minimum fees and value added taxes. This system of calculating cost evolutions should equal the system used in road transportation in Belgium[37]. At present, only cost data and cost evolutions are determined for smaller vessels in the dry cargo segment. A second step in this system would be determining the profitability of the different vessel types.

[37] Instituut wegtransport en logistiek België (ITLB)

By means of the PLANCO- cost model for inland navigation that was developed for the German Federal Government (Bundesverkehrswegeplanung), calculations can be made for different types and sizes of IWT vessels (PLANCO, 2007). The study is not only focussed on the economics but also on the environmental aspects. Therefore, the costs of fuel consumption are calculated in a more precise way than in the previous models. Moreover, it includes aspects such as speed and load factor in the cost calculation and also external costs are included.

- *Cost models created by companies in the sector*

Entrepreneurs in the inland navigation sector have the choice between various existing cost calculation programs in order to gain an insight into their costs. This information can be used to determine the costs that are linked to a certain journey, whether they are break-even at a certain freight tariff and therefore it can be used in negotiating freight tariffs. These programs exist both online and on pc (to download) and both for free or to pay. The cost calculation program of 'Kantoor Binnenvaart'[38] and the online freight tariff - journey calculator Logos[39] are two of such examples.

The cost calculation program of 'Kantoor Binnenvaart' is structured in a way that each entrepreneur can enter his/her own specific cost pattern. The costs are divided into on the one hand fixed costs, being the depreciation, interest, insurance, wages, maintenance costs, and other costs such as communication, and on the other hand variable costs such as the fuel costs, canal and port fees and other specific costs related to the journey. Costs related to a journey should be known beforehand in this case and be entered by the inland navigation entrepreneur him/herself. This means one should know the expected fuel costs, port fees, etc. It is generally assumed that the inland navigation entrepreneurs can determine this easily based on their experience. By determining the number of effective days and the number of sailing days of a journey, the cost per journey and per day is calculated. Calculations are based on a standard journey, with accompanying variable costs and sailing days. This cost calculation model gives an approximation of the cost of a journey. The more accurate the initial data are, the more accurate the cost calculation will be.

The online freight tariff - journey calculation model Logos (2009) combines a cost calculation program with a market overview which is an index derived from turnover and journey data. The purpose is to gain insight into the market and to create transparency. This way, inland navigation entrepreneurs can be assisted in negotiations concerning freight tariffs. By using the individual cost calculation models, the cost of a journey can be determined and moreover, this result can be compared to the market on the basis of the index available in the model. This programme also uses on the one hand fixed costs, holding the depreciations, financing costs, insurance, maintenance costs, personnel costs and other costs, and on the other hand variable costs which are directly related to the journey. In this model, only the costs of fuel and lubricants are taken into account. In this cost calculation program, equally like the previous one discussed, the hours and days per journey should be entered. On the basis of these data, the costs for the journey are calculated. By using the costs and the freight tariff per tonne, the revenues can be determines.

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[38] Available on http://www.kantoorbinnenvaart.org/diensten/kostprijsprogramma

[39] www.aandereis.nl

These and other similar cost calculation programs offer the opportunity to quickly and easily calculate the freight price for a certain vessel covering the most common costs. These programs are not general cost calculators, they are made in a way that each entrepreneur can enter his/her own specific cost pattern. Evidently, all depends on the accuracy of the data entered. These programs are mainly suitable for individual cost calculations, however sometimes also used by consulting companies (Buck Consultants, 2008).

Also other parties use their own composed cost calculation programs. There are for example cost calculation programs which are used by shipping companies or charterers in order to determine whether it is more interesting to invest in vessels, or to charter them instead. These programs start from a cost estimate, based on the costs of the company's own vessels or experience.

- *Cost calculations for case studies*

Apart from the previous types of models, there are studies which use cost calculations or cost models for a certain case study (Jaegers, 2007; Groothedde et al., 2003; Van der Lugt et al., 2002). This could be for example a business model for a certain type of (new) vessel, or it could be an example to demonstrate the effect of a certain policy measure on a certain type of vessel. In this case, all or at least the major part of the costs is taken into account. However, these models are only used for one or a limited number of vessels i.e. a certain vessel types or vessel size.

1.1.2. Models for partial cost calculations

In the past years, a number of studies were conducted which concentrated on one cost item, that is the fuel cost. These studies are conducted to determine fuel consumption of engines in inland navigation, mainly with respect to having an insight in emissions of transport modes (Schilperoord, 2004; TNO, 2003; Bolt, 2003a; Vanherle et al., 2007). The data and results generated from these studies can however be used to verify the outcome from other cost models.

1.2. Typology of cost calculation models in inland navigation

The complete cost calculation models can be subdivided according to their characteristics. Apart from the general division which emerged from the type of cost model in the previous part (general model, cost calculation program and case study), a further division is made according to the type of cost function, the purpose of the cost calculation model, the users of the model and the scope of the study.

A. Type of cost function

Certain cost calculation models exist which include as many variables as possible and use exact vessel data for this. These models are usually to be found in the sector itself, used by the inland navigation companies. These entrepreneurs know the costs of their vessels and usually know from experience which costs are typically related to a certain journey. Consequently, they can generate a rather accurate cost calculation with the use of these cost calculation programs. Further, there are also cost models which include again as many variables as possible, but which use average figures. In these cases researchers want to determine the costs of an 'average' vessel in the sector. To conclude, there are models which comprise a limited number of variables and use econometric models in order to make estimates. This is often done to compensate a shortage of available data.

B. Users of the model

Further, a division can be made according to the (potential) users of the cost models. Some models are focused on and used by inland navigation companies. Others are mainly utilised by researchers in the sector and/or by interest groups in the sector and policy makers.

C. Goal of the model

Also the purposes of the various cost models are different. The purpose of a model can be to document cost differences and to compare them, both within the mode and between transport modes. The model could also aim at forming a basis for pricing, both on an individual company base as for the sector as a whole. Last, a cost model could also be part of a broader model. In such case, apart from economic costs, also other costs such as external costs are calculated.

D. Scope of the model/study

To conclude, the scope indicates which part of the inland navigation market the study relates to. Some studies are focused on a certain type of vessel, such as small vessels or container vessels for intermodal transport (Gauderis et al., 2002; Recordit, 2001), while others have a geographical focus, targeting for example Belgium, the Netherlands or the Rhine navigation.

An overview and structure of a number of cost models which were found in the literature study is presented in table 6.1.

Table 6.1: Typology of cost models

Source	Year	Type of cost model	Purpose of cost function	Type of cost function: methodology	Users	Area
Beuthe and Jourquin	1994	General cost model	Sector profitability	Calculation based on average values	Researchers	Domestic goods transport BE
Bollaerts R.	1983	General cost model	Sector profitability	Calculation based on average values	Researchers	BE
De Grave-Antverpia	2008	Cost calculation program	Cost overview/comparison	Calculation based on exact vessel data	Companies/policy	Smaller vessels
Freight model Flanders	2010	General cost model	Part of a broader cost model	Calculation based on average values	Researchers/policy	Flanders
Groothedde et al.	2003	Case study	Cost overview/comparison	Calculation based on exact vessel data	Researchers/companies	Distrivaart project
ITB new	2009	General cost model	Cost overview/comparison	Calculation based on average values	Researchers/policy/ companies	BE (smaller than 1000 tonnes)
ITB old	1980	General cost model	Pricing	Calculation based on average values	Policy	BE (vessels up to 1,000 tonnes)
Jaegers	2007	Case study	Cost overview/comparison	Calculation based on exact vessel data	Researchers/policy	Tanker trade
Kantoor Binnenvaart	2000	Cost calculation program	Pricing	Calculation based on exact vessel data	Companies	N/A
La Glissoire	2010	General cost model	Pricing	Calculation based on average values	Companies/policy	FR
Logos	2009	Cost calculation program	Pricing	Calculation based on exact vessel data	Companies	N/A
NEA	1977-2010	General cost model	Pricing Cost overview/comparison	Calculation based on average values	Policy/researchers/ companies	NL
PINE	2004	General cost model	Cost overview/comparison	Calculation based on average values	Researchers/policy	Vessels important for intermodal transport

PLANCO	2003	General cost model	Cost overview/comparison	Calculation based on average values	Researchers/policy	DE and international comparison
PLANCO	2007	General cost model	Part of a broader cost model	Calculation based on average values	Researchers/policy	DE and Rhine navigation, larger vessels
RECORDIT	2001	General cost model	Part of a broader cost model	Calculation based on average values	Researchers	Vessels important for intermodal transport
Gauderis et al.	2002	General cost model	Cost overview/comparison	Calculation based on average values	Researchers	Flanders, waterways of ECMT classes I and II
RWS - DVS	2009	General cost model	Part of a broader cost model	Calculation based on average values	Communes and provinces	NL
SORT-IT	1998	General cost model	Sector profitability	Calculation based on average values	Researchers	BE
Van de Voorde	1985	General cost model	Part of a broader cost model	Estimates	Researchers	Domestic goods transport BE
Van der Lugt et al.	2002	Case study	Cost overview/comparison	Calculation based on average values	Researchers	Tanker trade, the Netherlands
Van Dorsser	2005	Case study	Part of a broader cost model	Calculation based on exact vessel data	Companies	AMS Barge
Van Dorsser	2004	Case study	Part of a broader cost model	Calculation based on exact vessel data	Companies	Palletvaart Nederland
Van Mol	2001	General cost model	Cost overview/comparison	Calculation based on average values	Researchers	BE

Source: own composition

2. Cost items

In this part the main cost items, their composition and the aspects which are important will be discussed in detail. These main cost items are the capital cost, labour cost, insurance cost, overhead cost, cost of repair and maintenance, the fuel cost and the other costs.

2.1. Capital costs

Capital costs entail on the one hand depreciations and on the other hand interest costs on the invested capital.

2.1.1. Depreciation

In order to include the decreasing value of vessels into the costs, depreciations are used. For the depreciations, the value and the residual value of the vessel and the engine and the depreciation period are important factors. There are various ways to depreciate capital assets, such as linear and degressive methods.

- *Value of the vessel*

All vessels differ from each other, hence it is difficult to determine the value of a vessel. The value of a vessel is strongly linked to its technical characteristics. One can estimate the value of a vessel as the sum of the purchase price of the various parts, such as purchase price of steel, engines, nautical equipment, facilities and so on. For a second hand vessel apart from the characteristics, also the condition of the vessel matters, such as maintenance and age of the engines.

Apart from the technical aspects, also the market conditions in which the vessel will be allocated play a crucial role. In case there is no cargo for a certain type of vessel and as a result no adequate revenues are to be expected, the market value will be very low. This is the case for single hull tankers at this moment. At moments where the demand for vessels is extremely high, even older and badly maintained vessels can be traded for high amounts of money. The demand driven market therefore has an important influence on the market value of vessels. This process is already discussed in detail in chapter 4.

The value of a vessel serves as the basis for the depreciation. To this end, various valuations are possible. First, the purchase price of the asset could be the starting point. This method, however, does not take the market conditions into account as only the price at the moment of purchase is considered. It is also possible to start from the current market value, in other words the current selling value. Disadvantages are on the one hand that it is difficult to determine the market value of a vessel, and on the other hand that it is often subject to fluctuations as a result of market developments. In inland navigation, a third valuation type is often used, i.e. the insured value. The insured value approaches in principle the market value at the moment of purchase and can be adjusted afterwards as a result of renewals or changes in the market (see further).

- *Lifetime of a vessel*

Due to usage, age, wear etc. the value of a vessel decreases with time. The technical lifespan is the period in which the vessel is technically able to perform as requested. The economic life span on the other hand, is the period in which it is economically justified to use the vessel. An inland vessel has both technically and economically a rather long life span.

When the overview of the fleet of the major European IWT countries is considered according to the construction year, then it becomes clear that a large share of the active vessels have an age of 30 to 40 years and a fair share is even older (see table 6.2). Evidently, over time a number of adjustments will be made to the vessel and in some cases not much is left of the original vessel for example after a new bow, stern, conversion etc.

Table 6.2: Fleet of the major European IWT countries by construction year

	dry cargo vessels		**tanker vessels**	
construction year	**number**	**share**	**number**	**share**
before 1930	861	15	27	2
1930 - 1949	589	10	42	3
1950 - 1959	1,516	26	245	18
1960 - 1969	1,639	28	325	24
1970 - 1979	409	7	283	21
1980 - 1989	302	5	122	9
1990 - 1999	157	3	115	9
2000 - 2006	278	5	169	13
total	**5,751**	**100**	**1,328**	**100**

Source: own composition, based on data from CCR, 2008a

New regulations can limit the life span of inland vessels to a great extent, such as in the case of the single hull tanker vessels. Generally it is assumed that the life span of the more recent vessels will be shorter than that of older vessels as a result of a number of regulations implemented in the previous decades and the increased requirements of shippers.

The depreciation period is the period during which a capital asset, in this case a vessel, is depreciated. This period is different for new vessels compared to second hand vessels. Considering the rather long economic life span, the depreciation period is proportional. For new vessels, a depreciation period of 20 to 35 years is generally used in the literature. The minimal depreciation span of a vessel is 10 years for the purchase and large investments. For smaller investments, for example purchasing a generator, a shorter depreciation period of for example 5 years could be used.

The engine is a crucial part of the vessel, of which the life span is in principle shorter than the life span of the hull. That is why a different, shorter, depreciation period is used for the engine. New engines are mostly depreciated during a period of 10-15 years.

- Residual value

In the literature, the residual value of engines is determined as a percentage of the purchase value. Mostly, a residual value of 5-10% of the purchase value is assumed. At the end of the depreciation period, the vessel still has a certain (selling) value. This value is called the residual value. Evidently, the residual value is closely related to the condition of the vessel at the end of the depreciation period, but also to the market conditions. In good times, second hand prices of old vessels are rather high, in bad times very low. After their depreciation period, certain types of vessels are worth more than other. Also regulations can strongly influence the value of vessels, which is currently noticed in the second hand market for single hull tankers. In the literature, the residual value is mostly represented as a fixed percentage of the purchase value. Various percentages exist, but in general the residual value amounts to 15-20% of the purchase value or replacement value.

- *Methods of depreciation*

Depreciations can be carried out in various ways. In the literature, mostly a linear depreciation method (fixed percentages) is used, but also other systems are possible such as progressive or degressive percentages.

2.1.2 Interest costs

Apart from depreciations, also interest costs are an important capital cost. Two types of interest costs are used for the calculation of inland navigation costs. On the one hand there are the interest costs of borrowed capital and on the other hand the opportunity costs for the investment of personal capital.

Interest costs can, like depreciation costs, be calculated in various ways. Two possible interest cost calculations are on the one hand interest cost over the book value at the start of the year and on the other hand interest cost over the average invested capital or over the average book value during the planned period. The book value equals the purchase value or insured value of which the yearly depreciations are deducted. Interest over the average invested capital is calculated in the following way: (purchase value + residual value)/2 * interest percentage.

2.2. Labour costs

Labour costs inherent to the operation of vessels consist on the one hand of crew costs and on the other hand of labour costs of people working ashore. As a major part of the vessels are managed by self-employed vessel owners, generally only the labour costs on board are included in the cost calculations. The remaining labour costs which we find for example in shipping companies, should be taken into account in the overhead costs.

Labour costs make up a major part of the operational costs of an inland vessel. The share of labour costs in the total cost amount is larger for small vessels than for larger ones. The smallest vessels, i.e. the types Spits and Kempenaar, are mainly managed by the owner-operator together with his/her partner. In this case, they can reduce their costs to a great extent in economically difficult times, by reserving few payments for themselves. However, fewer and fewer youngsters are willing to start working self-employed on a small vessel, as it is often not very profitable. Yet small vessels are still considered important to secure transport on small waterways. In order to improve profitability of small vessels, various ways of reducing personnel costs are investigated, such as single-handed sailing. Crew costs also play an important role for larger vessels. Not only the cost as such, but also finding suitable personnel seems to be a difficult topic.

2.2.1 Employees

In order to determine the labour costs, generally the minimum crew instructions, as established for Belgium in the Royal Decree of March 9, 2007, and minimum wages in the sector, according to Collective Agreement of November 26, 2007, are taken into account. This results in the minimum labour cost, depending on the type of equipment and the type of operations of the vessel. Evidently, these labour costs could be higher when higher wages are paid than the minimum ones, or when more people are working on board the vessel.

The total labour cost can be influenced strongly by the amount of overtime work. This overtime work is paid at 150% and 200% of the normal hourly wage. In the sector, often a labour cost of 40% higher than the minimum cost is assumed to cover for overtime work. Apart from this, there are a number of additional compensations, such as for cleaning the cargo tanks and preheating the cargo, which influence the labour costs of certain vessel types in certain situations. In reality, all of course depends on the agreements on the terms and conditions of the contract and payments between the employer and employee. On top of the gross wage, also social contributions are added which should be paid by the employer.

2.2.2 Owner-operators

When the owner-operator and his/her partner work on the vessel, the labour cost is strictly seen a lot lower than if they hired personnel instead. Next to the fact that less social contributions have to be paid, hours are generally not calculated as it should be the case for employees. Furthermore, the owner-operator could reduce his personal remuneration to a great extent, up until his livelihood, in order to reduce the costs in economically difficult times (Blauwens, 2010). As from a business economics perspective this is not ideal since it creates as economically bad situation in the long run. Therefore, in studies and cost models often an opportunity cost will be charged for the entrepreneur.

This opportunity cost can for example be the (net) wage that the entrepreneur would earn if he was himself on the payroll in another company, but it could also be considered a ‘normal entrepreneur’s wage’. The normal entrepreneur’s wage is the amount the entrepreneur can earn by investing his effort and money in a different way than in his vessel. This could be an investment in a more profitable sector, risk investments etc.

2.3. Insurance cost

Foremost, it is important to make a distinction between the various types of insurances which one can take out for inland vessels. There is the insurance of the vessel as such, which is called casco insurance, the liability insurance, which covers amongst others damage to others and pollution, the insurance of the cargo, the liability of the charterer, etc. Every vessel owner or charterer decides for himself which insurances to take, and which accompanying warranty to choose. This often depends on the type of vessel, the cargo and the sailing area, but also on the personal choice and experience of the owner, and evidently the related costs. In order to close insurance contracts, often an insurance agent, who has a thorough insight into the market, will be asked as an intermediary.

The two most important insurances concerning inland vessels are on the one hand the casco insurance, which is related to the vessel, and on the other hand the Protection and Indemnity (P&I)

which is related to the cargo, cargo shortage, pollution and coverage of persons on board (physical risk). Both types of insurances are explained into more detail in the following paragraphs. Important factors which apply to both insurances are the damage statistics of the underwriter, i.e. the damages in the past, and the level of personal risk, the franchise. Further, it is necessary to keep in mind that several insurance companies have different ways of determining the premium rates. One company could take into account different factors for calculating the premium rates than other companies or attach different importance to a certain factor.

Before going deeper into the insurances and factors, attention is first given to the companies where these insurances can be contracted. Insurances in inland navigation can be taken with an insurance company, but also a variety of mutual insurances exist, especially in the Netherlands. For both casco insurance and the P&I insurances there is a choice between the commercial insurance market and mutual insurances.

In case of a mutual insurance, instead of a premium per year, a contribution or call will be paid at the beginning of the year. Members who sustain damage during the year will be refunded by the yearly contribution of all members. If the yearly contribution is insufficient in a certain year, members will be asked to pay an additional contribution in order to remedy the shortage. Premium amounts for mutual insurances are often lower than for the other insurance companies, but in the end, additional premiums called ‘back calls’ can be requested which causes insecurity with regard to this cost. These back calls can increase to a high amount for P&I insurances, up to 50 to 60% of the initial premium.

Some P&I clubs adjust their premiums after years with damages, which makes back calls rare e.g. Standard London, with increases of 5% to 15% during the last years. Other P&I clubs do not do this and request an additional premium afterwards in case of damages, e.g. West of England. The previous three years are always open to back calls, which results in a potential future cost increase. This principle is based on the concept of solidarity. In practice, members are rarely asked for an additional contribution as often reserves are built up and the P&I clubs assess the risks fairly well.

In practice, the P&I insurance is often taken as a mutual insurance. The reason is that the warranties of the mutual insurances are higher and cover more risks. P&I clubs in inland navigation are based on the principles used in sea shipping, where P&I already exists far longer. There are 13 P&I clubs which are part of the International Group of P&I clubs[40]. Their joint re-insurance represents around 85% of the world trade fleet, consisting of the maritime and inland navigation sector. Each club is an independent nonprofit organisation which offers insurances to its members.

2.3.1 Casco insurance

Casco insurances are often traded on the commercial insurance market, however, also mutual insurances exist which offer this insurance policy, e.g. Alliance Batelière and Schepen Onderlinge Nederland. The main Belgian insurance companies which are active in the inland navigation sector are Nateus Verzekeringen, Amlin, B.D.M. nv, Axa-Verheyen and Avero Insurance Belgium. The premium rates for the casco insurance are based on a number of factors, among which the type of

[40] www.igpandi.org

vessel, the insured value, the vessel tonnage, the construction year of the vessel and the engine power are the most important. Further, the number of revolutions and the construction year of the engine, the specifications of auxiliary engines such as bow thrusters and transfer pumps, the operator of the vessel, i.e. an owner-operator or employee, and the scope of the subscribed warranties can play a role.

- *Insured value*

The insured value is based upon the economic value, i.e. the selling value, and can be determined by the owner of the vessel himself. In this case, the owner determines the amount of money he would like to have the vessel insured for. Of course, the risk of under- or over-insurance of the vessel exists. Further, the insured value can be determined based on the assessed value. In this case, the value of a vessel is based on an expert report. The insured value can also be determined by the construction price, in case of a new vessel, or by the market value. The latter can prove to be quite variable though.

The basis for the insured value is often the purchase value. Of course, the purchase value can differ from the true value of the vessel. Given that the insured value of a vessel is often the amount which is stated by the vessel owner, there is a possibility that the vessel is under- or over-insured. If the insurance company is doubtful about the given value, they can appoint an expert who will estimate the value of the vessel. However, as an expert report i.e. a valuation report requested by the mortgage provider, is often necessary when taking a loan at a financial institution, the purchase value of the vessel is presumed to approximate to the real value or the market value. When taking a mortgage, banks normally require such a valuation of the vessel by an expert, to be sure that the vessel is worth sufficient as collateral for the borrowed amount. That is why insurance companies in general take the purchase value of a vessel as the insured value.

Of course, the value of a vessel can change over the years. Vessels are subject to damage and wear, renovations are made, new equipment is installed, etc. On the one hand, the value can decrease as a consequence of ageing or damage. On the other hand the value can increase when old parts are replaced or renovations are done. A revision or replacement of the propulsion system for example increases the value of a vessel to a great extent. Apart from that, also the market has a large impact on the value of vessels, as well as regulations. If the market conditions improve strongly, the value of the vessel may increase.

As a consequence of these and other developments, the insured value of a vessel can differ greatly from the market value after some time. Vessel owners can have the insured value adapted according to the circumstances (upwards or downwards) if they wish to do so. Generally such adjustments are made when the value of the vessel increases. The opposite effect is rather rare in practice, it is uncommon to adjust the insured value downwards. Under-insurance could be a way to lower (insurance) costs though. In this case, the vessel owner chooses to run a higher risk. The insurance costs can also be limited by not taking a number of warranties, such as damage to the contents of the vessel, the nautical equipment, etc. Also the liability insurance can be limited to a great extent and the amount of personal risk can be increased.

- Tonnage

The tonnage of the vessel is used to determine the size of the vessel in calculating the premium. A standard premium can be used, which holds a fixed amount per tonne until a certain tonnage e.g. 2,000 tonnes and a gradual discount for larger vessels (2,500 tonnes, 3,000 tonnes, 4,000 tonnes etc.). Other companies use a fixed premium per tonne which only differs according to the type of vessel i.e. dry cargo or tanker vessel.

- Construction year

For newly built vessels, significant discounts can be obtained on the premium amounts. These discounts for newly built vessels are the consequence of a strategy in order to have a mix of old and new vessels in the insurance companies' portfolios. Often, in order to calculate the premiums for these vessels, which became operational in the last 8 to 10 years, other calculation methods are used, which makes them not suitable for comparison to the premiums for older vessels. This way, large new vessels are sometimes paying the same amount or less than vessels of 15 years old which are only half the size of the new one.

- Characteristics of the engine

Important parameters of the engine, which can play a role in determining the premiums, are the age of the engine, the power i.e. the amount of hp or kW, and number of revolutions. This applies both to the main engine and to the auxiliary engines, e.g. the engine of the bow thruster and potential transfer pumps. The age of the engine determines among others the possible warranties. For some insurance companies old engines i.e. for example older than 13 years, are not allowed to be included into the extensive engine warranty. The number of revolutions is important to distinguish the (semi-) slow speed engines, capable of up to 1,250 rotations per minute, from the high speed engines, with more than 1,250 rotations per minute. Slow speed engines have generally a longer lifespan and reliability, which makes the premium for these engines lower.

- Discounts

Shipping companies which have several vessels insured with the same company can have discounts on the premium amounts. These discounts can be rather considerable when a shipping company owns a number of vessels. Conversely, often more is charged as they work with employees on board, which are considered less trustworthy and less careful than owner-operators. Individual owner-operators who unite in a corporation can obtain similar discounts as shipping companies. While this occurs often in the Netherlands, in Belgium it is rare. Also the insurance agent working as an intermediary can obtain discounts on the premiums for his/her customers if his portfolio has a certain volume.

- Subscribed warranties

Within casco insurance various warranties are possible, both for the casco and for the engines. Apart from the basic coverage, additional coverage can be taken, such as a warranty for hidden casco flaws, an extensive engine warranty for engine damage from inside, insurance for the contents of the vessel or for the salvage costs. As for the cargo, also for the engine various warranties can be chosen. For example, in the basic coverage for engines, no coverage is included for omission and negligence, neither for hidden flaws. Around 80% of bargemen, however, take an extensive engine warranty, which does comprise these warranties.

- *Insurance for mooring/sailing*

Some insurances automatically include a clause for mooring, for which at the end of the year the number of days are determined that the vessel did not sail and the vessel is empty. For this period, a part of the casco premium is repaid. Other companies have a separate insurance for mooring and sailing.

2.3.2 Protection and Indemnity (P&I)

The larger the size of vessels becomes and the more (dangerous) products are transported, the higher the importance of the limitation of liability of vessel owners. The P&I insurance policy covers damage not applying to the casco, such as damage to third parties, damage to the cargo, cargo shortages and pollution. Also the risks for passengers and crew are covered. The extent of the P&I depends strongly on among others the vessel type, the vessel size and the cargo transported. In practice, inland vessels in tanker trade and passenger transport always have a P&I insurance policy on top of the casco insurance policy, due to the considerable risk of damage, such as pollution or personal losses. In dry cargo navigation fewer vessels take the P&I insurance policy as it is rather expensive. Especially smaller, older vessels in dry cargo navigation stick to the casco insurance only.

For the cargo, pollution and damage to third party and personnel, also a separate liability insurance can be chosen with normal insurance companies, without including P&I. In practice, P&I is often opted for, among others as the warranties of the underlying insurances are larger and entail more risk coverage than those of the commercial companies. Vessel owners can have certain risks excluded from the P&I insurance policy, when they already have coverage for a certain liability, for example for cargo or crew. It is, however, common for vessel owners to underwrite a complete P&I insurance. The mutual i.e. co-operative insurance is contracted with a so-called P&I club.

For determining the P&I premium, various factors play an important role. The various P&I clubs may take different aspects into account in their premium calculation. First, the vessel type is important i.e. in this case dry cargo, container or tanker vessel. Further, the tonnage, the engine power, the nationality of the crew and the value of the transported cargo can be crucial. Not to forget is the insured value of the vessel, the personal risk of the vessel owner, his/her damage statistics of the previous years and the other warranties covering the vessel such as the casco insurance.

In the case of chartering, the charterer can take out a charterer's liability insurance in which his/her liability is insured in case the vessel owner's insurance turns out to be insufficient. The factors that come into play here are the number of journeys (in the case of a time charter), the number of TEU (the tonnage of the vessel is not important) and the type of vessel (tanker or dry cargo vessel). This liability insurance will not be addressed in further detail since it is of lesser importance in the scope of this research.

- Type of vessel and cargo

For the P&I premium for dry cargo navigation, the age of the vessel is not important. For the transport of certain dry cargo products, such as high-grade steel, some P&I clubs do ask an extra premium, a higher personal risk or the presence of an expert when loading for transport, since it is often subject to corrosion. Container vessels entail an additional risk compared to dry cargo vessels as they transport also ADNR goods and refrigerated containers may be aboard the vessel. The risk of damage to the cargo of reefers is larger when for example something goes wrong with the electricity supply. Some P&I clubs take into account higher tariffs, others do not.

Cement vessels are often considered as dry cargo vessels with built-in tanks. As the products contained by the tanks are under pressure, more severe pollution is possible in case of defects. Due to the higher risk of these products, sometimes an extra premium on top of the normal one for a dry cargo vessel is taken into account. For tanker shipping the premium could among others depend on the age of the vessel and the transported cargo. For tankers which transport edible oils, the risk of pollution is smaller than for tankers transporting petroleum or chemical products. This is why they pay smaller premiums. For bunker vessels often an increased premium is counted, as there is an extra risk of pollution due to the more frequent loading and unloading.

- Tonnage

The P&I premium may consist of a basic amount per vessel which is supplemented by an amount per tonne per type of vessel. It may be a fixed amount up until for example 500 tonnes and starting from then an extra amount per additional tonne. Due to this basic amount or minimum premium the cost for P&I for a small vessel is relatively higher than for a larger vessel. The minimum premium differs between clubs, likewise the amount per gross tonnage. Some P&I clubs base the premiums solely on the tonnage, without taking into account the minimum premiums.

- Engine power

The engine power is important for establishing the P&I premium for cargo vessels and push- and tug vessels. A certain amount per hp or kW is taken into account, possibly linked to a minimum premium.

- Value of the cargo

Also the value of the cargo is important as the P&I also insures cargo shortages and damage to the cargo. This risk is for example higher for a single hull tanker vessel, but the value of the cargo transported by this vessel could be lower than the value of the cargo in a double hull tanker vessel.

- Previous damages

Previous damages caused by the vessel owner may result in a higher personal risk or a higher premium. On average only 20 to 25% of the vessels belonging to a club causes damage. The central idea is the concept of solidarity, which means all members contribute to the damage compensation. As this is often considered as being not fair to accident-free vessels, the vessels which cause accidents may be charged separately in their premium contributions.

- Personal risk

The personal risk, as for the casco insurance, plays a role in determining the contribution. The personal risk is for example higher in tanker trade than in dry cargo navigation and is higher for vessels which transport dangerous cargo. Increasing the personal risk can be a way of limiting the increase of insurance premiums for vessel owners who have experienced a number of damages in the past.

- Other guarantees

As the P&I insurance will intervene in amounts higher than the insured values of the casco insurance, called excess collision, also the underlying casco insurance and the insured values for damages to third parties and wreck removal also have an influence on the P&I contribution.

- Other factors

The amount of insured value only has a limited influence on the premium. The limits of the insured values can be determined by the vessel owner or the broker. The nationality of the crew only plays a role in determining the premium when a broader liability is required than the legal liability. Further, it is important to note that shipping companies can obtain a volume discount.

2.4. Cost of repair and maintenance

An inland vessel requires timely maintenance and the necessary repair in order to remain in good condition. A number of these works can be carried out when it suits the vessel owner, for example in times of low demand. Other works and costs should take place at specific moments, such as for the periodical inspections in order to preserve the necessary certificates.

2.4.1 Types of costs

First, there are the normal maintenance costs which occur on a regular basis. A major part of these maintenance works are not crucial for the good operation of the vessel and can therefore be postponed for a number of years. Evidently, this maintenance pattern does have an effect in the long run on the state of the vessel and its market value. It is assumed that the costs of repair and maintenance in the long run are less high for a well maintained vessel and therefore it has a higher market value.

Next, there are a number of costs which have to be made in a certain year and which are necessary for the operations of the vessel. This entails for example costs related to the five yearly inspections to retain the required certificates. These costs are, apart from the inspection itself which is performed by the classification society such as Bureau Veritas and for which the costs are booked under 'other costs', renting the dry dock or the slipway, the costs for possible necessary adjustments or repairs, etc. Of course as many maintenance works as possible will be executed at the same time in order to save money and time.

To conclude, there are repair costs which only take place sporadically, but which represent far larger amounts than the 'normal' yearly or five yearly costs. These costs comprise the major repairs which are a consequence of the normal wear of the material, such as a revision of the engine. Apart from that, there are also repair costs which are the result of collision, accidents and flaws. When the insurance intervenes, these cannot be counted as costs. As these costs cannot be predicted, they are generally not taken into account as maintenance and repair costs.

2.4.2 Influencing factors

It is known that the age of a vessel plays an important role in the maintenance costs. A new vessel will have low costs of repair and maintenance during the first years if the vessel is treated carefully. An older vessel will have costs more often, as some parts will start to wear. Of course, the maintenance cost depends strongly on the state of the vessel and the maintenance in the previous years. An older vessel which has been maintained meticulously will not necessarily have more costs than a younger one. Moreover, in case of an older vessel which is out of guarantee the operator can do part of the maintenance himself. For more recent vessels, more is done by subcontracting, which increases the costs.

Evidently, it is also possible that when a vessel is very old or it presumably cannot be sold anymore and will be demolished in the near future, less money will be spent on the repair and maintenance. Also the quality of the used products and materials are important. When higher quality and sometimes more expensive materials are used, a longer life span is expected. Of course, this is not guaranteed as when it comes to maintenance and repair costs, one also sometimes needs to be lucky.

2.4.3 Method of calculation

In most studies, among others the ITB & NEA cost models, maintenance and repair costs are counted for 50% as fixed and for 50% as variable costs. The maintenance cost of a vessel depends on the age, the size and the type of the vessel and the engine and evidently on the maintenance in the past. Some studies choose to calculate the maintenance and repair costs as a percentage of the value of the vessel and the engine. Other studies choose for the accounting method. A lot depends really on the available data. In the literature, the following percentages are taken for maintenance and repair: for a second hand vessel the percentage amounts to 2.5% of the casco purchase value and 1.5% of the engine value. For a new vessel a percentage of 1% of the casco purchase value and 1.5% on the engine value is used (Gauderis et al., 2002).

When using accounting data, it is possible that costs in a certain year are much higher than in another year. This is for example in case of service at a wharf or after a collision. When only the data of one year is available, this can result in incorrect results when the dataset for a certain vessel type only has a limited amount of observations. In case the vessel incurred damage in a certain year, this will lead to a higher cost in the accounting. As in this case the insurance company will intervene, the difference between the damage costs and the intervention of the insurance should be taken out.

2.5. Other fixed costs

The group of other fixed costs entails a number of costs which are made during a year and which are not specifically linked to a journey. Of course, a certain journey can increase costs e.g. telephone costs, but in general these costs can be considered fixed. In this group we find among others costs of communication, administration and the cost of licenses and certificates.

Communication costs comprise telephone, fax and internet costs and fluctuate in a limited way over time. Costs can increase in case of more intensive use, however, when a more favorable subscription is taken, costs can be reduced. In inland navigation mainly international calls and internet is a major cost. The phone costs can easily reach 1 to 1.5% of the turnover (Fischman and Lendjel, 2010a). Administration costs are yearly recurring costs and comprise among others the accounting expenses. This cost will be higher for vessels with employees than for smaller vessels where the crew consists of family members.

Not all licenses have to be renewed yearly. The exploitation license should be renewed every year, but other certificates are valid for 10 years or longer. When renewing these certificates, in certain years costs could be slightly higher. The costs of inspections and certificates may vary according to the vessel length or tonnage. The costs for large vessels are higher than those for small vessels, although this is not always in proportion to their tonnage or length.

2.6. Overhead costs

The main costs difference between working alone as an owner-operator and working in larger entities is the overhead cost. Owner-operators carry out the administrative work themselves on the vessel, or can hire someone to do it for them, which means all the costs are directly related to the vessel. When working in a co-operation, a part of these tasks are taken care of by the co-operation, which has an office on the shore. In case the owner of the vessel is a shipping company or a larger entity, the overhead costs related to the vessels have to be added.

The overhead costs which have to be divided over all the affiliated vessels of a co-operation consist of the costs of the facilities at the shore (office, furniture etc.), the staff at the shore and other expenses. The same counts for the shipping companies, but here one has to add the reimbursement of the company owner(s) since this company wants to make profits. In the case of a shipping company, all administrative costs of the different vessels are done together which reduces the costs. For vessels working in a co-operation, part of the administration costs, e.g. accounting, remain at the individual vessel.

Operating in larger entities gives the possibility of reducing costs because discounts can be obtained by purchasing in larger amounts. Such discounts are in general possible for each company if working together with others, so not only for shipping companies owning several vessels. In practice, it appears very difficult for owner-operators to make such agreements, even when being part of a commercial co-operation. Therefore, higher reductions are gained by a shipping company than a co-operation in practice.

Typically, most studies do not take this overhead cost into account, nor do they include the potential cost reductions of larger entities, since they are generally focused on an individual vessel. Even when calculating the costs for a vessel generally working for a shipping company, the overhead costs are not included in the cost calculation.

2.7. Costs of consumption

Fuel costs for inland vessels are calculated on the one hand by the fuel consumption and on the other hand by the fuel price at the moment of purchase. Apart from that, there are also lubricating oil costs, of which the used amount is much lower than the fuel costs, but of which the unit price is much higher.

2.7.1 Fuel prices

Fuel prices are determined by demand and supply and can, even in the short run, fluctuate strongly. Graph 6.1 gives the course of the fuel price in the inland navigation sector. In general, there is an increasing trend. When large quantities are purchased, discounts can be offered. Large vessels can therefore profit more from these discounts than smaller ones, as they have larger fuel tanks on board. Also, shipping companies or charterers who buy at the same suppliers for several vessels can obtain larger discounts than individual vessels.

Graph 6.1: Quarterly index gasoil price (index 100 = average year 2004)

Source: CCR (2010b)

An important trend, especially in container trade and for large vessels sailing under time charter, is sailing engine room-free. This means that the engine room cost e.g. fuel, lubricants and engine maintenance, is met by the charterer or the shipping company. The cost can still be allocated to the vessel in a theoretical model, but cost reductions have to be taken into account as the charterer or shipping company can obtain better prices with fuel suppliers. Furthermore, not all costs are allocated separately. Lubricants and drinking water are sometimes supplied for free together with fuel orders.

As from 2011, inland vessels in Europe are obliged to use sulphur-free fuel (EN 590). The cost for EN 590 is higher than the previous gasoil. The surcharge is on average between 2 and 5 euro cent per litre[41]. The use of EN 590 would on the other hand lengthen the life span of the engine and cause less maintenance costs, e.g. for the filters.

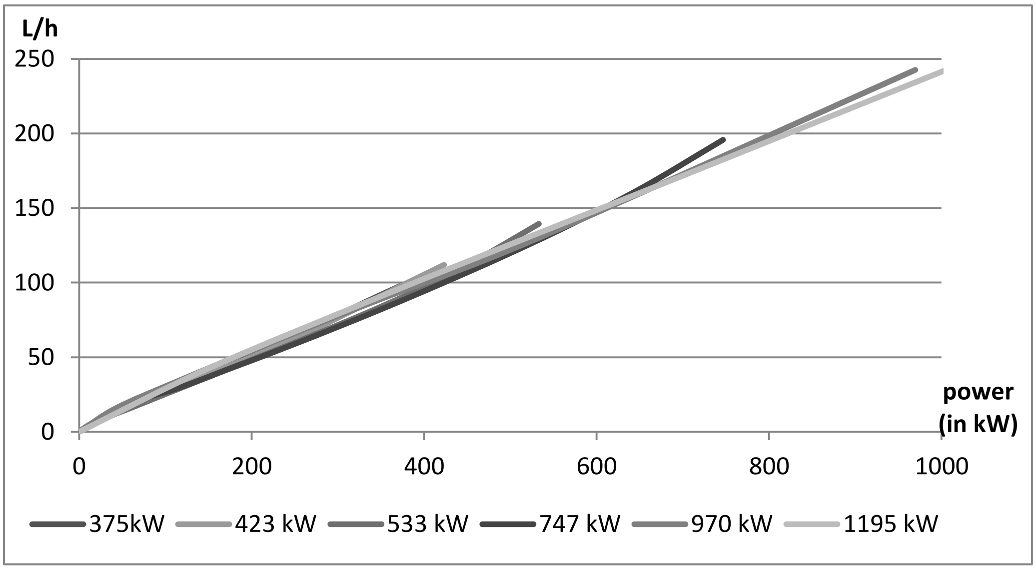
2.7.2 Fuel consumption

The fuel consumption depends on a number of factors, such as the resistance of the vessel, the type of the engines and their consumption, the size of the waterway, the speed, the wind and the current.

- Energy consumption of the engine

In order to calculate fuel consumption it is necessary to determine first the energy consumption of the propulsion system. This energy consumption differs according to the type of engine, but also according to the number of revolutions or the speed and the resistance. There are a number of engine types which are used in inland navigation. Vessels have a certain engine power according to their size and tonnage. On the basis of the sailing area or the personal preference of the owner, a stronger or lighter type of propulsion system can be opted for. An important trend in this respect is the use of very strong engines in the newly built vessels in the last few years.

Graph 6.2: Fuel consumption (in litres/hour) for several types of engines at different power requirements



Source: own composition based on fuel consumption model (see annex 11)

The difference in consumption between large and small engines for the same power requirement is not so large (see graph 6.2). It can be assumed that a certain number of hp has a certain fuel demand, whether it is in a large engine or in a small one. However, some smaller differences exist. In case of a low power requirement, the consumption of the large engines is slightly higher than that of small engines. In case of a higher power requirement, consumption of the large engines will be lower. The consumption of engines is related to their optimal number of revolutions. When they are far lower or far higher than this optimal, this will lead to a large increase in energy consumption.

[41] source: http://www.informatie.binnenvaart.nl/en590.php

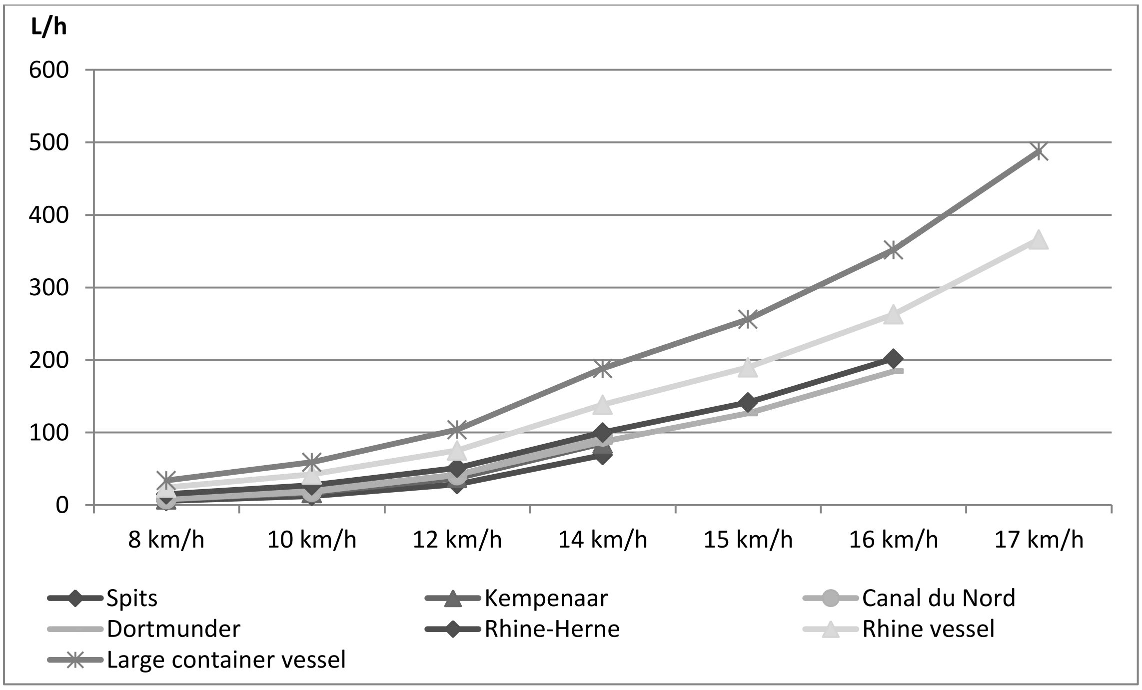
- Resistance

When calculating energy consumption, the resistance of the vessel is important. The design of the vessel is an important factor here, as well as water depth, speed and size of the waterway. The shape of vessels is traditionally streamlined in order to cruise through the water efficiently and so to limit the resistance. And yet we can witness the last few years that more vessels are built which are less streamlined. They lean towards the shape of pushed barges, for example those vessels which are used in coupled trains.

The speed of an inland vessel depends on the size of the vessel, the sailing area, the current, the assignments etc. When we consider the average speed, we find that they are often lower for smaller vessels. One of the reasons for this is that they usually sail on smaller canals where speed limits are in place and where a number of constructions such as locks limit their speed. Furthermore, they generally sail less intensively. Larger vessels which approach the maximum measurements of a waterway have to sail less fast than slightly smaller vessels as they experience more resistance and are able to manoeuvre less easily. The speed of a vessel can be calculated in relation to the ground or to water. This is an important difference for waterways with a strong current, such as the river Rhine and the river Scheldt.

Smaller vessels reach the maximum power of their engine faster than larger ones, which causes the consumption to increase relatively faster at higher speeds (see graph 6.3). In addition, an engine always consumes a certain minimum amount, so also at very low speeds, a certain energy consumption is necessary. This minimum consumption is a lot smaller for small engines than for larger ones.

Graph 6.3: Fuel consumption (in litres/hour) for several vessel types at different speeds



Source: own composition based on fuel consumption model (see annex 11)

- Fuel consumption empty sailing

When a vessel is sailing empty, the fuel consumption is lower than when a vessel sails with cargo under the same circumstances and at the same speed. After all, the vessel will be less deep in the water and will experience less resistance. In the literature, the fuel consumption in case of an empty load is calculated as a percentage of the consumption of a loaded cargo, e.g. 67% (NEA 2003). This percentage is generally based on interviews with people in the sector and an approximation to the actual consumption.

2.7.3 Cost of lubricants

It is difficult to determine costs of lubricants. As for fuel, the consumption depends on the type of engine, the age of the engine, the resistance of the vessel, speed, etc. Apart from that, the cost depends on the price of lubricants, which can vary in time and can differ according to the type or brand of the lubricating oil.

The consumption of lubricants is often determined in the literature as a percentage of fuel consumption. The percentage often used varies between 1% to 5% of the total fuel consumption (Van Mol, 2001; PLANCO, 2007). When we consider the cost calculations in the sector (Logos, 2009) it appears that the consumption of lubricating oil amounts to around 1/1,000 of the fuel consumption. Given that the price of lubricating oil is around 10 times as high as that of fuel, lubricating oil cost amounts to 1/100 of the fuel cost. The relation between the cost of lubricants and fuel cost is of course subject to the product prices. Furthermore, the consumption of lubricants, equally like for the fuel consumption, depends on the way of sailing.

The main aspects of the cost items which are immediately related to the operations of vessels are discussed in rather general terms in this chapter. This means that it gives a general idea of which aspects are important and how they are dealt with in the literature. Of course, depending on the company, some aspects are considered more or less important, but in general they are valid for the whole sector. Apart from these cost items, there are also aspects that are related to the country in which the company is registered. Differences in legislation might result in differences in costs and therefore influence on the competitive position of fleets. In the following chapter, a closer look is taken upon some of those differences between countries.

Conclusion on the cost models in inland waterway transport

In this chapter an overview was made of the main cost models and cost studies that are used in the sector. A typology was made according to the type of cost model, its purpose, the methodology, the users and the area. It is found that most studies make calculation based on the fleet average. Unfortunately, important aspects disappear because of the generalisations made. Others are developed for a specific type of vessel and therefore not comparable to others. As a result, the existing models are either too specific or too broad and therefore not suitable for the current purpose. The structure of the existing cost models and the main cost items are the basis for the new cost model that will be created. The new model however will need more detail on a number of cost items and on different types of companes in order to determine the effect of choices in investments and operations and the effect of measures on the costs of the vessel.

Chapter 7: Competitiveness between countries

Transport in general is an international phenomenon. Transport companies belonging to one country perform activities in other countries. As a result, they interact and go into competition with companies belonging to other countries and maybe acting under different conditions. The competitiveness of a company or fleet within a market segment is determined by internal as well as external factors. Internal factors are amongst others the cost structure and age of the vessel(s). When addressing the costs of vessels in the previous chapter, it is mainly focused on the Belgian situation and the factors that are directly related to the operations.

There are factors though that influence the costs of a company that are connected to the country. These external factors are amongst others government policies such as taxation, education and infrastructure. As a result, the fleet of one country might have an advantage over other fleets. Therefore, it is necessary to have a deeper look into the main factors influencing the profitability that are related to the countries. In this chapter the competitiveness of IWT companies in different countries is analysed. It starts by exploring the activities on the Belgian network. Then the differences between the countries with regard to the activities and mainly profitability of IWT companies are studied. The main focus is here on Belgium and the Netherlands.

1. Activities on the Belgian waterway network

1.1. Data

The dataset used in this part, is the one from the The Directorate General Statistics and Economic Information (DGSEI) that was already used in chapter 5. The traffic on the Belgian waterway network consists of domestic transport as well as imports, exports and transit transport. The imports are the transports which come from abroad and have Belgium as a destination of the goods. The exports are these transports that have Belgium as an origin and a different country as destination. The transits have an origin and destination outside of Belgium, but take place partly on the Belgian waterway network.

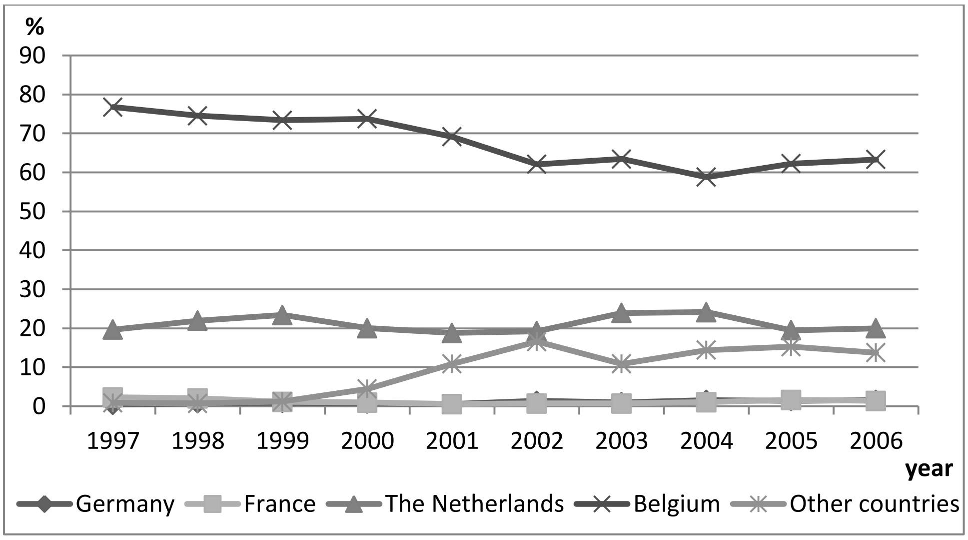
1.2. Analysis

For each of the types of transport i.e. domestic, imports, exports and transit, the importance of the different fleets on the Belgian waterways is given in the following graphs (7.1-7.5). For the domestic transport, the analysis is given both in tonne and tonne-km. For the transports which take place partly abroad the graphs only show the results on the tonnages since no data on the distance travelled outside the Belgian network is available.

The importance of a fleet on its domestic market gives an indication on the competitiveness of the sector. On their home market, the national vessels/vessel owners are expected to have more benefits because of their local knowledge, the contacts and so on. The nationality of the vessel gives no information on the operator of the vessel though. A vessel from outside Belgium can be chartered by a Belgian operator for example.

Graph 7.1 shows that the share of goods carried by Belgian vessels is clearly declining over time. As from 2004 a small increase is found. The share of the German and French fleets in the domestic transport is very low but stable. The share of the Netherlands fluctuates between 20 and 25% during this 10-year period. The vessels from other countries have gained quite a share. From about nothing before the year 2000 it attains almost 15% of the goods transported within Belgium in 2006.

Graph 7.1: Evolution of domestic transport by vessel nationality in tonne (in %)



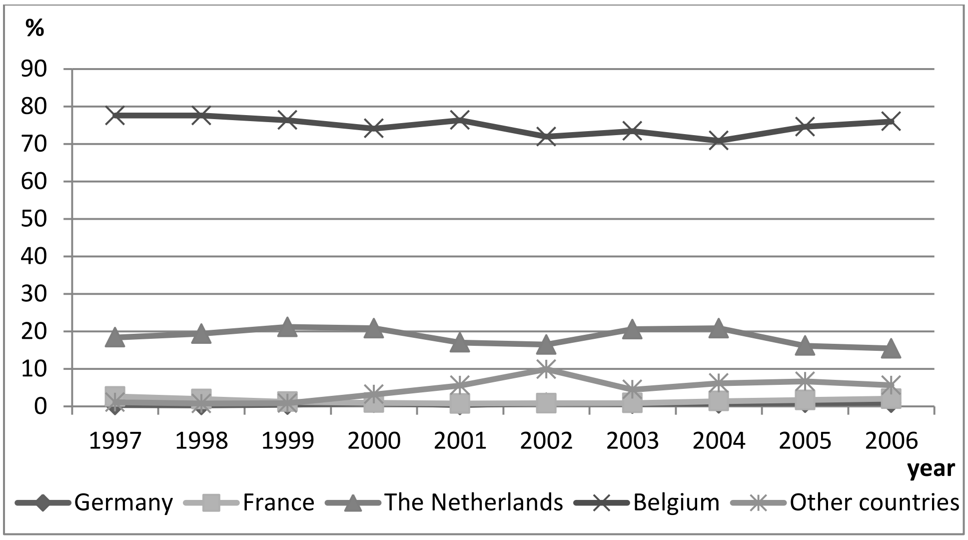
Source: Own composition based on DSGEI

When taking the distance travelled into consideration, it is clear from graph 7.2 that the decline of the share of Belgian vessels is less strong. After a gradual decrease as from 1998 the share in 2006 almost equals the share of the beginning of the data period studied. In tonne-km, the share of the Netherlands in the domestic transport in tonne-km is somewhat lower than in tonne. The same counts for the other countries.

When doing the same exercise for the imports and exports, the results prove to be very different from the domestic transport. The results for imports and exports are rather similar though (see graph 7.3 and graph 7.4). More than half of the goods which are imported of exported are carried by Dutch vessels. For the imports this is even around 60%, which shows a clear dominance of the Dutch fleet. The position of the Belgian fleet in imports and well as exports is much lower and has moreover decreased heavily as from the year 2001. After a decrease of almost 10% of the share in the year 2001, the position has known a further decline throughout the following years.

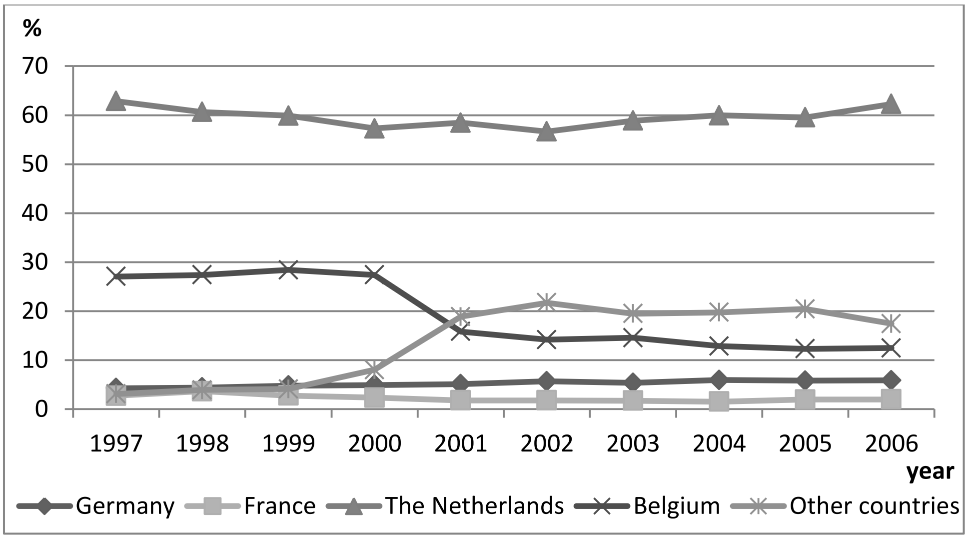
The share of French vessels is very low and slowly declining, both for imports and exports and little changes have occurred during the period under study. The share of German vessels in the exports is almost double as for the imports and both are increasing slowly. Remarkable is the position of vessels from other countries. After a sharp increase in the years 2000 and 2001, its share attains about 20% both for the imports and exports.

Graph 7.2: Evolution of domestic transport by vessel nationality in tonne-km (in %)



Source: Own composition based on DSGEI

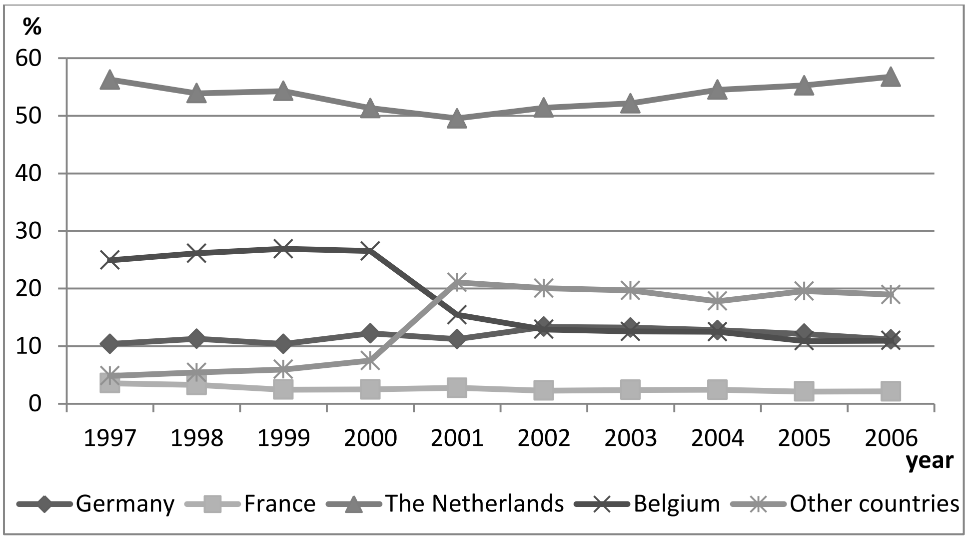
Graph 7.3: Evolution of imports by vessel nationality in tonne (in %)



Source: Own composition based on DSGEI

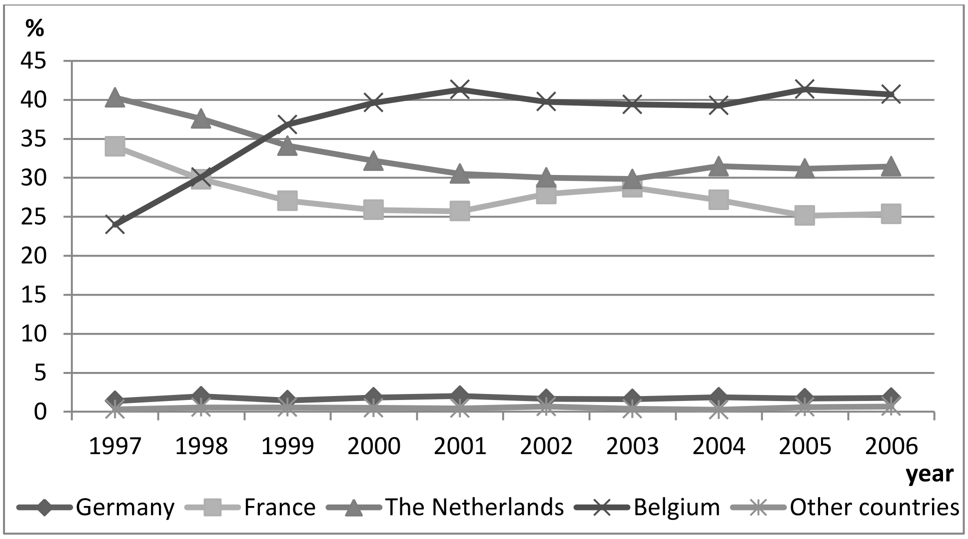
The transit through Belgium again shows a very different picture (graph 7.5). Whereas the share of the Netherlands and France was very high in the past, being more than 40% and almost 35%, it has gradually declined over the years. Over the last 10 years, both their share declined with about 10%. The share of Belgian vessels on the other hand has sharply risen as from 1998 and preserves its share of about 40% since the year 2000. The sharp rise/fall in the year 1998 and following is no doubt related to the liberalisation of the sector (see chapter 2). The vessels with German or other nationality play only a minor role in the transit traffic in Belgium.

Graph 7.4: Evolution of exports by vessel nationality in tonne (in %)



Source: Own composition based on DSGEI

Graph 7.5: Evolution of transit by vessel nationality in tonne (in %)



Source: Own composition based on DSGEI

Conclusion on the activities of foreign fleets on the Belgian network

The share of the Belgian fleet in the domestic transport is still dominant, but slowly declining. Mainly vessels from other European countries gain importance here. In the exports and imports there is a clear preponderance of the Dutch fleet. The Belgian vessels are losing market share mainly if favor of vessels from other countries. In the transit flows on the other hand, the share of Belgian vessels has seriously increased in the time period and remains stable at a high level. Overall, the French and German fleets have a limited importance on the Belgian network. The German fleet does have a considerable share in the exports and the French fleet in the transit flows.

2. Differences between countries

Not only the choices vessel owners can make related to their investments and the operations of their vessel(s) determine their position in the market. Also the country they have their company registered in has quite some influence on their business and therefore on the sector in general.

In theory, nationality should not be a real barrier, since companies can establish themselves in another country in case there are large benefits to be gained. Of course, changing countries also involves a number of administrative efforts and knowledge. Therefore, this is more often found for larger companies. In this respect, it is important to distinguish between the country the company is registered in and the country where the vessel is registered (flag of the vessel).

There are several differences to be found between countries with regard to IWT companies. In this part, it will only be elaborated on the most important ones. The main attention goes to the systems which apply to Belgium, after which the differences with other countries, mainly the Netherlands, are worked out. Some of the systems are not specifically focused to the inland navigation, but do apply to them. Examples of those are support mechanisms for small en medium sizes enterprises and the social contributions.

2.1. Accounting & taxation

The first main difference between countries is the accounting and taxation. The most important aspects in the accounting domain are the tax regimes which apply to inland navigation and the taxation of excess value. Furthermore, the subsidies and grants which are accorded by different governments can hold important differences for vessel owners.

2.1.1 Tax regimes

In Belgium, two systems are possible depending on the choice of the vessel owner and the type of vessel and operations. The first system is a special system, called ‘forfaitair systeem’ in Dutch, in which a certain semi-gross profit is determined. This is established in order to embed the inland waterway transport companies. In the rest of the text, it will be referred to as ‘fixed system’. The second one is the normal taxation, in which case a complete accounting has to be kept.

- Belgium fixed system

In Belgium the possibility exists for professional associations to make an agreement with the tax administration to calculate the VAT based on the purchases instead of on the real turnover. This is the case when it is difficult to keep track of all sales and purchases. There are about 40 of such exemptions in Belgium, amongst others for bakeries and butchers. It is also used in inland navigation, mainly for smaller companies and in dry cargo because of the accompanying regulations. This system cannot be chosen for amongst others[42]:

[42] The complete list can be found on: http://ccff02.minfin.fgov.be/KMWeb/document.do?method=view&id=bbfaa29d-a2d2-44e2-8cc2-1d4cc00f8921

- Tanker vessels for liquid cargo
- Companies operating more than 5 vessels
- Managers who are also charterers
- Partnerships and legal entities
- Vessels specially equipped for container transport
- …

Therefore, this is generally used by owner-operators in the dry cargo segment. Moreover, it is generally assumed that about 90% of the owner-operators that are allowed to use this system make use of it. The main advantages are first the fact that these companies are not liable to VAT in Belgium for transactions that are related to the vessel, e.g. the maintenance costs, and second the exemption of using a complete accounting system. When not liable to VAT, a simplified type of accounting suffices. This system therefore does not only limit the advanced VAT payments, but also reduces the administrative costs.

In this system, the tonnage of the vessel is taken as the basis for the revenues. Therefore, four categories are defined (see table 7.1). For the smallest vessels (<86m) the tonnage is calculated on a draught of 1.90 instead of the actual draught, because these vessels mainly sail on the smaller waterways where the draught is often confined to 1.80m. For the larger vessels on the other hand one calculates with the whole tonnage. For each category a scale is determined each year by the professional groups e.g. Bond van Eigenschippers, and the taxation office together. The fixed amounts are based on the results of a sample of companies in that year.

Table 7.1: Fixed amounts

Categories	income 2007	income 2008	income 2009
<= 850t (on 1.90m)	162	170	145
>850t but <86m (on 1.90m)	173	180	130
> 86m	166	170	82
vessels in tug etc	60	75	75

Source: Bond Van Eigenschippers

These fixed amounts are used to determine the semi gross profit, which is calculated with the following formula:

$$semi\ gross\ profit = \ fixed\ amount \times tonnage\ vessel$$

An example is given here with the figures of the year of taxation of 2009 (revenues 2008):

Vessel of 1,250 tonnes: Semi-gross profit = 180.00 euro x 1,250 tonnes = 225,000 euro

The fixed amount holds the revenues minus the direct costs such as commissions of charterers, fuel costs, port fees and so on. To this amount, one as to add compensations, subsidies, remunerations etc. which are received. For the small vessels, the French taxes can be deducted separately. Since these costs are rather high and for the larger vessels the navigation on the Rhine is always free of charges, they remain separately tax-deductible.

From the semi-gross profit a vessel owner can deduct amongst others the interest costs, the remunerations for self-employed assistants, the wages of employees, the depreciations, insurance premiums, costs of certificates and so on. The complete list can be found in annex 8.

In the fixed amount, one has already included the normal number of non-productive days. They are calculated based on the normal waiting times for loading and unloading the goods. Vessels generally carry out 3 to 4 trips per month, which brings the normal non-productive days per month to 13-14 days on average. In case of extraordinary non-productive days such as repair and maintenance, sickness and so on, one has to account for them by means of the required documents.

An example is given here with the figures of the year of taxation of 2009 (revenues 2008):

> Vessel of 1,250 tonnes, 12 days extraordinary non-productive days
>
> Yearly semi-gross profit: 1,250 tonnes x 180.00 euro = 225,000 euro
>
> Extraordinary non-productive days: $\frac{12 \text{ days}}{366} \times 180.00 \times 1{,}250 \text{ tonnes} = 7{,}377 \text{ euro}$
>
> Applied semi-gross profit: 225,000 euro – 7,377 euro = 217,623 euro

In this system, it is not possible to carry forward the losses which are made during a certain year. In the normal taxation system this is possible though. An advantage of this fixed system is that no VAT is due by these companies, which means less financial means are necessary for the operations of the vessel.

- *Normal taxation*

If the owner-operator in Belgium does not want to make use of the previous system, he can opt for a real declaration under the normal system of taxation. In this case the company is liable to VAT and therefore a complete accounting has to be done. The vessel owner has to prove all his revenues and expenses, which entails quite some administration and increases the costs for the accounting.

Table 7.2: Income tax Belgium

taxable income	tax tariff
0 until 7,900 euro	25%
7,900 until 11,240 euro	30%
11,240 euro until 18,730 euro	40%
18,730 until 34,330 euro	45%
more than 34,330 euro	50%

Source:http://www.belgium.be/nl/belastingen/inkomstenbelastingen/particulieren_en_zelfstandigen/aangifte/vestiging_van_de_aanslag/index.jsp

The vessel owner can switch between the two taxation systems. A change from the fixed system to the real one can be done at any time. For a change in the opposite direction, a notification has to be done in advance. The tax rates in both systems are the same (progressive income tax). The income tax is a progressive one, with five tax brackets. This means the higher the income, the higher the tax tariff one has to pay. The taxable incomes and corresponding tariffs for incomes of 2009 and 2010, taxation years 2010 en 2011 are given in table 7.2. In the Netherlands, a similar system with different tax brackets and tariffs applies. The respective tax tariffs are presented in table 7.3.

For smaller companies in Belgium, when only taking the taxation into account, the fixed system is often disadvantageous to the real declaration. This depends on the revenues that are made. On the other hand, less administration has to be done and the costs of accounting are lower. In case one would lose certain documents during the year, the real system could turn out to be less advantageous after all. In the latter system, the losses made in a certain year can be carried forward to the next years.

Table 7.3: Income tax the Netherlands

Tax bracket	Wage on yearly basis	Tax/premium national insurance	
		younger than 65 years	65 years old, born in 1946
1	€ 0 until € 18,628	33.00%	15.10%
2	€ 18,629 until € 33,436	41.95%	24.05%
3	€ 33,437 until € 55,694	42.00%	42.00%
4	€ 55,695 or more	52.00%	52.00%

Source: http://www.belastingdienst.nl/zakelijk/loonheffingen/overig2011/overig2011-10.html#P773_12629

- Corporations

A company can also be established as a partnership, in which case the company is VAT liable and has to a full accounting. Companies active in tanker trade are generally registered as partnerships, because the costs of the vessels are so high, that several companies or persons take part in it. In this case, in Belgium a corporation tax is imposed on the real declaration. The tariff amounts to 33.99% (additional crisis tax of 3% included). For partnerships with a taxable income of less than 322.500, a lower progressive tariff applies (see table 7.4), but there are some conditions that come along. One of the conditions is for example a minimum reimbursement for entrepreneurship of 30.000 euro. This reimbursement is taxed twice, one time by the corporation tax and once as income tax of the entrepreneur.

Table 7.4: Corporation tax Belgium

taxable income	tax tariff
1 until 25,000 euro	24.98%
25,000 until 90,000 euro	31.93%
90,000 until 322,500 euro	35.54%

Source:http://www.belgium.be/nl/belastingen/inkomstenbelastingen/vennootschappen/aangifte/vestiging_van_de_aanslag/index.jsp

In the Netherlands, inland waterway companies have to work with a complete accounting system. The corporation tax in the Netherlands for the year 2010 is given in table 7.5.

Table 7.5: Corporation tax the Netherlands

taxable income	tax tariff year 2010
<= 200,000 euro	20.0%
> 200,000 euro	25.5%

Source: http://www.belastingdienst.nl/zakelijk/vennootschapsbelasting/vennootschapsbelasting-16.html#P151_10429

2.1.2 Private costs

An owner-operator (and partner) who lives on the vessel he/she operates has a number of benefits which are not taken into account in the taxation of the company. Part of the expenses of the operations of the vessel is for personal use. It is very difficult though to distinguish between the expenditures for professional and personal use. The heating costs of the accommodation for example are part of the total fuel costs. The vessel provides accommodation for which no rent is paid and which costs are completely at the expense of the company.

In the Netherlands an agreement has been made in 2009 between the Inland waterway organisations 'Kantoor Binnenvaart' and Vereniging van Sleep- en Duwbooteigenaren 'Rijn & IJssel' and the tax department on the fiscal legislation and rules of inland waterway companies for a period of 5 years[43]. They agreed on a private communication cost of 100 euro per month and a correction for living on board of the vessel if the owner operator does not have a house. The yearly corrections for 2009 are presented in table 7.6.

Table 7.6: Correction living on board (the Netherlands)

1. For an owner operator living with his family on board
- Of a vessel of more than 2,000 tonnes: 1,692 euro - Of a vessel of more than 500, but less than 2,000 tonnes: 1,269 euro - Of a different type of inland vessel: 846 euro
2. For an owner operator that lives on board and has no family: 684 euro.

Source: Binnenvaartconvenant

2.1.3 Taxation on excess value

When a vessel is sold, a vessel owner could make an excess value on the sale of the vessel. This excess value is the difference between the sale value and the book value. For a vessel which is sold for 1,000,000 euro and has a book value of 600,000 euro an excess value of 400,000 euro is made. On this excess value a tax can be imposed, depending on the country.

The Netherlands are the first country with attractive fiscal regulation for investments in inland navigation vessels. The exemption of taxes on book profits of selling an inland vessel is one of them. Until 2006, it was the only country with such a system and this reflected in the structure and the new

[43] Binnenvaartconvenant

vessels of the fleet[44]. Because of the advantages of this system for the Dutch vessel owners, also other countries applied the system later on.

As from January 2006, the German vessel owners can reinvest their book profits on the sale of a vessel completely in a new one without paying taxes on this amount. This makes financing new vessels easier and encourages German vessel owners to invest in a modernisation of the fleet. Before, they first had to pay taxes on the book profits after selling their vessel. Now, the taxation can be delayed until the termination of the company.

In Belgium, for self-employed people, normally a tax of 16.5% (+ local taxes) is raised on the excess values obtained by selling company assets which were in the company for more than 5 years. There is an exemption for company vehicles (such as trucks) if the sale value is reinvested in new ones and if the conditions are met (De Meyer et al., 2010). For inland waterway vessels, this taxation is exempted since 2007 in case the complete sale value or compensation (in case of damage) is reinvested is a more recent and/or larger vessel for commercial exploitation in Belgium. This investment has to be done within 5 years and a number of conditions and ecological standards have to be met[45]. This exemption is made with the purpose of stimulating the modernisation of the fleet[46].

The preconditions to the vessels in which this capital is reinvested are:

1. Being of a more recent construction year (at least 5 years younger).
2. Having 25% more carrying capacity (or 25% more engine power for push boats).
3. Being 20 years old at maximum.

Vessels larger than 1,500 tonnes have to meet at least two of these conditions. For vessels of maximum 1,500 tonnes, it was very difficult to meet the third condition, since they have not been built in the last 20 years. Therefore, they only have to meet one of the remaining two conditions.

The new regulation in Belgium and Germany brings the vessel owners of these countries on the same competitive position as the Dutch vessel owners[47].

2.2. Labour costs

The crew requirements (see annex 13) is to a great extent harmonised in Europe. This leaves three main factors in the difference of the labour costs between countries. The first one is the minimum wage scales, which are different in for example Belgium and the Netherlands. The minimum wages are compulsory, but higher wages can always be paid, which is in general the case in the sector. The official wage scales of Belgium and the Netherlands in 2009 can be found in annex 13 and 14.

In practice, companies pay their employees more than these minimum scales. The lack of people who want to work in the sector certainly plays a role in this. It also happens that they are paid in a

[44] http://www.informatie.binnenvaart.nl/schepen/nieuwbouw-schaalvergroting.html.
[45] See Article 44ter, WIB 92 (aj. 2010), the complete text can be found in annex 8.
[46] Wetsontwerp 29 januari 2007, DOC 51 2873/001
[47]http://www.vaart.nl/log/pivot/entry.php?id=397 and http://www.informatie.binnenvaart.nl/binnenvaartvloot.html

different way e.g. not counting the overtime hours but increasing the monthly wage with a fixed amount. Moreover, there are numerous premiums and compensations which are not included in the minimum scales discussed here. When comparing a few examples of these minimum wage scales, it is clear that the official wages in the Netherlands are somewhat lower compared to the Belgium ones (see table 7.7). The size of the difference differs according to the type of vessel (dry cargo – tanker) and the type of crew member.

Table 7.7: Comparison minimum wage scales Belgium – the Netherlands

	Belgium	the Netherlands	difference
seaman 23y	1.660,4	1.613,8	-2,8
able seaman 23y	1.698,7	1.638,3	-3,6
skipper dry cargo < 750t	1.979,9	1.913,6	-3,3
skipper dry cargo > 2500t	2.327,1	2.033,7	-12,6
skipper tanker < 750t	2.042,4	2.017,8	-1,2
skipper tanker > 2500t	2.431,2	2.265,1	-6,8

Source: Loontabel motorvrachtschepen en motortankschepen (NL), loonbarema's in de binnen- Rijn en tankvaart (BE)

A second difference related to the labour costs is the social contribution which has to be paid for the employees. An overview of the contributions in the Belgium system can be found in annex 16. A third difference is found in the contributions which are paid by self-employed people in the sector. The table of social contributions for Belgium can be found in annex 17.

The differences in labour costs are a subject that is often mentioned in discussions on the competitiveness of vessels of different countries. The idea lives for example that the labour cost in the Netherlands is much lower than in Belgium due to among others lower social contributions. This would contribute to the dominant position of the Dutch vessels on certain routes. Research conducted by order of the 'Fonds voor Rijn- en Binnenvaart' in 2010 (WS, 2011c) concludes after a thorough study on the differences between Dutch and Belgian IWT companies that the differences in labour costs between these are of minor importance. The same is found for the contributions of self-employed people.

It is often stated that the inland waterway sector has a high labour cost combined with a staff shortage. The use of interim labour is believed by many to be a solution to both problems. In Belgium, interim labour is not allowed in all sectors and the inland navigation sector is one of them. Companies in inland waterway transport are not allowed to use labour forces on an interim basis as from the year 2000, stated in the Royal Decree of 13 December 1999. In the Netherlands interim labour is allowed though. This means that Dutch companies have an advantage over the Belgian ones.

The major benefit of interim labour is having flexible solutions for temporary staff shortages e.g. as a result of sickness, holidays etc. This allows the vessel to be operational in a short term when part of the usual crew is missing or when additional people are needed. It could also be a way for entrants to get to know the sector and for older people to remain working in the sector in a less intensive way. Allowing interim labour in inland waterway transport will not solve the problems of staff shortage though. The people working on a vessel need certain qualifications and therefore the number of people that qualify is limited. Moreover, there is a serious chance that certain vessel owners will prefer this flexible and less expensive staff and therefore will be less inclined to invest in people working for their company on a permanent basis.

2.3. Subsidies & grants

In the different inland waterway transport countries different systems of subsidies and grants apply. This might even be different according to the region e.g. in Belgium. The Naiades program of the European Community made an overview of the available funding programs, on a European as well as national level. These programs are generally about intermodal/combined transport, transhipment facilities, modernisation of the fleet (environmental as well as ICT related) and training. Next to the specific subsidies and grants for inland waterway transport, these companies can also benefit from more general programs, such as for investments and establishments of new companies (example of the Netherlands: see Annex 7).

Overall, the support measures in Belgium and the Netherlands are rather equivalent (WS, 2011c). A major difference is often the application procedure which seems to be easier in the Netherlands. As a result, Dutch vessel owners make more use of the available subsidy programs than Belgian ones. There are not only differences between countries, but also within a country. In Belgium for example, in the Walloon region a modernisation grant of 30% exists, which is not included in the taxation. In Flanders on the other hand, there are a number of subsidies for environmental investments which have to be included in the tax declaration.

Because of the call-system which is often used for the subsidies, the investor does not know in advance whether he will get a subsidy or not. Moreover, it can take some years before the subsidy is actually granted. Therefore, the subsidies are a nice benefit if one is planning the investments anyway, but not a reason to make the investments. The system of subsidies can be a reason to relocate the company to a different region because of higher chances of getting one. Relocation to another country for subsidies generally is a bridge too far. Relocation mainly goes together with social aspects and personnel.

Conclusion on the differences between countries

Even though there are many differences between countries on the level of accounting and taxation, labour costs and subsidies, this does not always result in a clear advantage or disadvantage for a certain fleet. The taxation regime can have an important effect on the profit of a vessel. The advantage or disadvantage of the different Belgian systems is not so clear cut though. For smaller vessels, the fixed tax can be more beneficial, mainly because it requires much less administration since no full accounting is required.

Chapter 8: Cost simulation model

In this part, the various sections of the new simulation model will be considered in detail. First a general description of the cost simulation model is given. Afterwards, the structure of the model, the variables used in it and the formulas of which it is composed are drawn up. In order to keep track of the structure, it is visualised by means of a schematic presentation of the model. This is preceded by a classification of the vessels, as this will serve as the basis for the model and for the processing of a number of data. The data which is used in the model is discussed equally as the way in which it is processed.

1. General

Vessels exist in all kinds of sizes and shapes. It is virtually impossible to find two identical vessels, even amongst sister vessels. Each owner has his/her own preference, family situation, experience and contacts. This is a challenge when composing a model which has to define the costs of certain vessel types. Therefore, in many cases assumptions, approximations and averages have to be used.

1.1. Theoretical cost calculation compared to actual cost calculation

When creating a simulation model it is important to find the balance between on the one hand a very general model based on averages and on the other hand a very specific model, such as the cost models used in the sector (see chapter 6). In the former case, formulas are used to determine the average costs of the various vessel types and ways of operations. As certain differences are levelled out by using averages, few possibilities are left to take specific situations into account. In the latter case quite some details about the vessels is required and so for each vessel there will be a different result.

The actual cost calculation e.g. the new model of ITB, starts off from accounting data. This method is mainly suited to determine the composition of the costs for the sector itself. In this calculation, which is based on actual data, costs are spread over the entire year and grouped according to certain cost items. This data can then be compared between consecutive years, which makes it possible to determine the evolution of various cost items. When using this method though, it is not easy to derive costs per hour or per kilometre. More detailed costs per journey could be estimated or derived if, apart from accounting data, more data were available on the number of journeys or in case the number of journeys could be estimated.

It is furthermore not possible to simulate the effects of certain measures on costs by using the accounting data. When certain measures are introduced, the effect can become apparent in the data of the following accounting year. On the other hand the effect could also be veiled by other effects taking place at the same time. After all, the different cost items are rather general. A reduction in labour costs by hiring a person who has been long-term unemployed can for example be compensated by an increase in the number of sailing hours. This way no difference in the total of yearly personnel costs is found.

The theoretical cost calculation however, starts from a number cost functions in which the variables are determined for the different types of vessels. The various cost items each have their own cost function and the data are gathered from a number of available datasets. With the use of this model, the influence of a change in one of the variables of the cost function can be simulated.

The disadvantage of this theoretical model is that it is a general model which has to be applicable to all inland vessels, which sometimes entails an abstraction of a number of details. The models use for example averages per vessel category. The categories are yet more detailed than those used in the actual cost model. For a number of cost items, no functions are available which makes it necessary to rely on averages from data which is available in the sector.

1.2. Purpose & choice of the model

The purpose is not to create a business economic cost model which requires for each vessel a long list of detailed data. The purpose is rather to use a theoretical model in order to compare the costs of various vessel types and vessel sizes and to calculate the influences on the different cost items. To determine the differences in a realistic way, sufficient detailed data is required related to the main factors with regard to the various options and choices e.g. the type of operations and vessel speed. When averages are used for large categories or when an abstraction is made from factors which can lead to important differences in costs, no realistic results can be obtained and the model will not be able to answer specific questions concerning the sector.

In chapter 6 an overview of the existing cost models and their characteristics is given. The econometric models are used when little information is available and when researchers want to draw conclusions on a macro-economic level. These models are used to calculate general effects of for instance a scale increase. The models for general cost calculation do so for average vessels, which in itself would be usable. But because of the generalisations made, important aspects disappear. When calculating costs for a certain vessel type, the way this vessel is generally operated is already taken into account. There is e.g. no data available on the difference between operating this vessel with staff or by the owner himself. Individual cost calculations on the other hand are very detailed and therefore contain very useful information, but it is impossible to gather this information on a whole fleet or make comparisons. Moreover, it is not enough to only deal with the cost side to answer the research questions. In chapter 5 the importance of the productivity of a vessel on the revenues was already indicated. Therefore, the demand side has to be incorporated in the model in order to determine the revenues and the profitability of vessels.

Therefore, a new cost simulation model is constructed, which enables answering questions related to the choices and decisions in the inland navigation sector. These could stem from individual decisions of vessel owners as well as from decisions taken by governments and sector organizations. In this research, the cost simulation model should help formulating an answer to the research questions (see chapter 1). Nevertheless, this model is not only meant to be used by researchers but also by vessel owners, financial institutions, government and so on, i.e. all actors involved in the sector. They can use such a model to support their decision making and give it a scientific basis.

What will this simulation model allow to calculate?

1. The difference in costs between equal vessel types as a result of choices made by the vessel owner or operator,
2. The difference in costs between vessel sizes (technical scale advantages),
3. The difference in costs between owner-operators and shipping companies (economic scale advantages),
4. The differences in costs and profits between countries,
5. The effect of external decisions, e.g. policy measures, on the costs and profits of the different vessel types and companies.

1.3. Description of the cost simulation model

The cost model is composed of various sub-cost models which entail a certain cost, for example labour costs. This way, adjustments and additions can easily be integrated. Apart from this, there is a model with operational data of the vessels and a journey model which holds the specific costs of a certain route. Last, the cost model is linked to a dataset of freight tariffs on different routes. This is used for calculating the revenues. Together, they form the entire simulation model.

The cost simulation model consists of one main Excel file and four accompanying files. The main file holds the general calculation sheet and the data and calculations of the depreciation, repair and maintenance and administrative costs. The separate files are the calculation of fuel consumption, the calculation of the insurance cost, the calculation of labour costs and the details on the operations. It is decided to keep those calculations in a separate file because they consist of rather extensive calculations which would otherwise make the main file very large and complex. The main file and the accompanying files are linked to each other both ways. The choices made in the main file are used as input in the accompanying files, while the output of the calculations in these files is transmitted back to the main file. This way, the complete theoretical cost (per hour/ per km/ per tonne-km) for a certain type of vessel can be calculated as well as the cost for a specific trip.

The model is focused on self-propelled vessels, but can be elaborated for push-towing[48]. It includes eight vessel sizes for dry cargo as well as for tankers.

code	Name vessel type
1	Spits
2	Kempenaar
3	Enlarged kempenaar
4	Canal du Nord
5	Dortmunder
6	Rhine-Herne
7	Large Rhine vessel
8	Large container vessel

[48] The same methodology can be followed for push-towing, but additional data is needed.

There are a number of options included in the model related to the type of vessel and company. Some variables can be chosen freely, while others are automatically connected to a certain vessel or company type. Before running the model, one first has to decide on the characteristics of the vessel. These are the type of goods (g = dry cargo, tanker) and size of the vessel (s = 8 vessel sizes, see above), the type of equipment (u = S1, S2)[49]. The year of construction and purchase of the vessel and the age of the engine can be chosen freely. If the vessel is older than 15 years and no explicit age of the engine is entered into the model, the age of the engine is automatically assumed to be higher than 15 years. This can be adjusted if one assumes a new investment is done. The tonnage of the vessel and the engine power are related to the vessel size (see chapter 6).

Furthermore, there is the choice of the type of company and the details on the operations. In the model, there are four types of companies (co) included. One can opt for either an owner operator working on the vessel with or without partner, an owner having several vessels (max 5), an owner-operator being part of a commercial co-operation and a shipping company. Furthermore, three types of operations (e) can be chosen, being A1, A2 and B[50]. Within each option, a standard number of hours and crews are included, based on sector information. These standard assumptions can be adapted if necessary.

1.4. Advantages and limitations of the model

Like every model, also this one has its advantages and drawbacks. The importance of certain disadvantages always depends on the purpose of the model. The most important ones of this model are covered in the following paragraphs.

The model only holds data on self-propelled IWT vessels. No other modes are included, because it is built from the perspective of the vessel owner. If desired, it can be linked to other (intermodal) models though.

The cost simulation model does not hold origin-destination and route information. Calculations can be made for certain routes, but in this case, the time, distance etc have to be entered into the model for each specific case.

The model is not able to calculate the effects of e.g. scale increases for the (Belgian) IWT sector as a whole, because it holds no data on the composition of the fleet or the trips made. Simulations could be made though if such data was linked to the model.

The model is easily usable for the simulation of existing cases since it is based on data of the current fleet. A calculation for a new type or size of vessel on which no cost information, e.g. price of the vessel, is available is therefore difficult. The exercise can therefore only be made for new types of vessels if at least some kind of estimate is available. The calculation of the costs of a crane vessel for example can be done if there is an idea on the extra cost of this crane compared to one that is in the model already.

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[49] See chapter 6

[50] See chapter 5

The calculation of the fuel consumption is based on a pushed barge model which has different resistance characteristics from many of the existing self-propelled vessels used in IWT transport. The advantage of using this model on the other hand is that the consumption by the various vessel sizes can be compared to each other.

The model incorporates the demand in the inland navigation sector by means of the freight tariffs. In this model, the actual freight tariffs are based on quotations of charterers and operators[51]. Consequently, the demand and possible trade imbalances are already included. By means of the tariffs and the volumes transported, the revenues which can be made are calculated. This way, the profitability of a vessel can be determined. Moreover, simulations can be made where freight tariffs or volumes are adjusted in order to assess the effect on the profitability.

The main drawback of the model is its data requirement. Collecting this data was quite intensive and time-consuming and the results depended on the collaboration of many people and companies. The outcome also depends on the quality of the data received. In order to prevent working with data of the vessel owners, which might be biased because of lack of co-operation or ignorance, the data was collected with suppliers, service providers and directly from the accounting. For the dry cargo segment, sufficient data was available for most cost items. For the tanker trade, much less data was available, which means that not for all vessel types calculations could be made. This was solved by using outcomes from other studies and additional assumptions.

The main advantage compared to other cost models is that it includes different options for each vessel type instead of just the fleet average. Therefore, it comprises variations within this fleet average. This allows the users to see the effect of choices in investments and operations and the effect of measures on the costs of the vessel. This way, the model can support vessel owners and operators in their decision making. Furthermore, it also allows researchers and policy makers to assess the effect of potential measures.

Summarised, based on the typology made in chapter 6, this cost simulation model:

A. Uses cost functions with average figures as well as exact calculations
B. Is meant to be used by several types of companies, as well as researchers and policy makers
C. Is able to compare costs and revenues and simulate the effect of choices and measures
D. Focuses on self-propelled vessels and the Belgian situation

1.5. Definition of standard types of vessels

In this model, cost calculations are made for a number of inland vessel types. Only self-propelled vessels will be studied, both for dry cargo and tanker shipping. The first classification will be based on size and tonnage of the vessels. This is an important classification as some cost items will be

[51] The freight tariffs that are used are the tariffs that are published on a regular basis in 'Weekblad Schuttevaer'.

determined by the averages from a dataset and as a result it is necessary to classify the vessels in the correct group.

The vessel length will be chosen as the most distinctive parameter, as the length of a vessel often determines the access to a certain waterway i.e. among others due the sizes of locks. An average tonnage will then be linked to this parameter. The average tonnage is necessary for a number of other cost calculations, for example the insurance and labour cost. Furthermore, it is used to determine the costs per tonne.

A number of 'standard types' of vessels have emerged over time. Their sizes are often determined by the sizes of the waterways on which they traditionally sail (see chapter 2). The vessels belonging to a certain type, however, do not all have exactly the same size. Some vessels are slightly longer, shorter, smaller or wider. Furthermore, draught is a crucial variable for calculating tonnage. The deeper loading is possible, the larger the capacity. These sizes (LxWxD) determine the amount of tonnage which can be transported. This causes small and sometimes larger differences in tonnage between the vessels belonging to the same class. Inland vessels could also be named after their tonnage e.g. 1,150 tonnes vessel. This is certainly the case for larger vessels, as only two classes are still used for all vessels larger than 85m, i.e. Large Rhine vessel and Large container vessel.

The table in annex 1 gives an overview of the various inland vessel types and accompanying sizes, as determined by the European Conference of Ministers of Transport (ECMT). This table displays the maximum size for vessels to be allowed to sail on a certain waterway. As mentioned before, the lock sizes are crucial in this respect. Vessel type 'Kempenaar' can pass a lock of 51m, an enlarged 'Kempenaar' vessel however, which may have the same tonnage but measures 55m, does not have access to this waterway. This table evidently only provides a rough classification. Vessels exist for example which are smaller than 80m and which can load more than 1,000 tonnes, but there are also vessel which are larger than 80m but are loading less.

Table 8.1: Dimensions of the vessel types

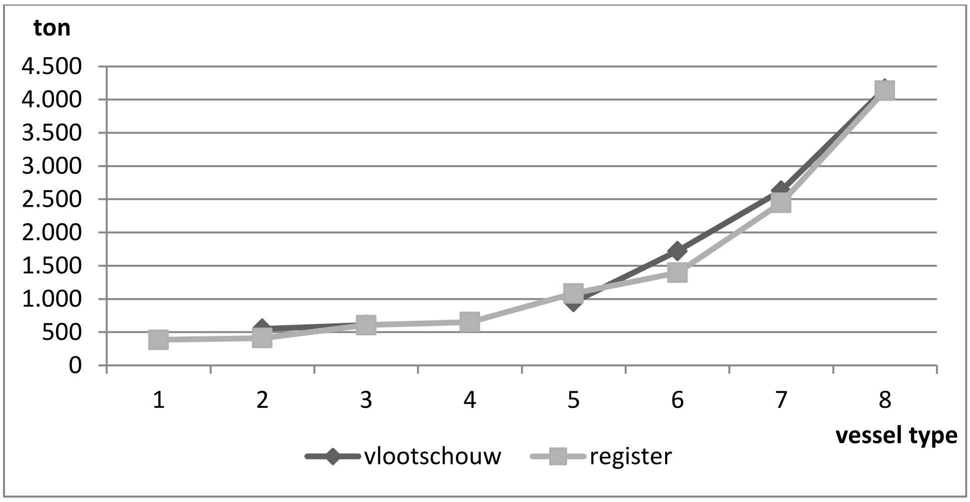
type	Minimum size	Maximum size
Spits	>35	<=38.5
Kempenaar	>38.5	<=50
Enlarged Kempenaar	>50	<=55
Canal du Nord	>55	<=60
Dortmunder	>60	<=80
Rhine-Herne	>80	<=85
Large Rhine vessel	>85	<=110
Large container vessel	>110	<=135

Source: own composition

Based on the ECMT classification and the lock sizes, the following delineation for determining categories is used (table 8.1). The accompanying tonnage for these categories is determined by the characteristics of two datasets used, on the one hand the Register and on the other hand data from ‘the Vlootschouw’ and the IVR database. For the Rhine vessel class, the median is each time slightly above average. For the largest vessels though, the average is each time higher than the median. As the average value and the median do not differ strongly, average tonnage will be used further.

When a comparison is made between the average tonnages in both datasets, we only find a small difference for both dry cargo and tanker vessels (graph 8.1 and graph 8.2). In the dataset from the 'Vlootschouw' only data is taken up of inland vessels built after 1999, which means fewer small vessels are present in the list except for special vessels, and in the medium segment the number of observations is spread less well. That is why the data of the Register are valued more.

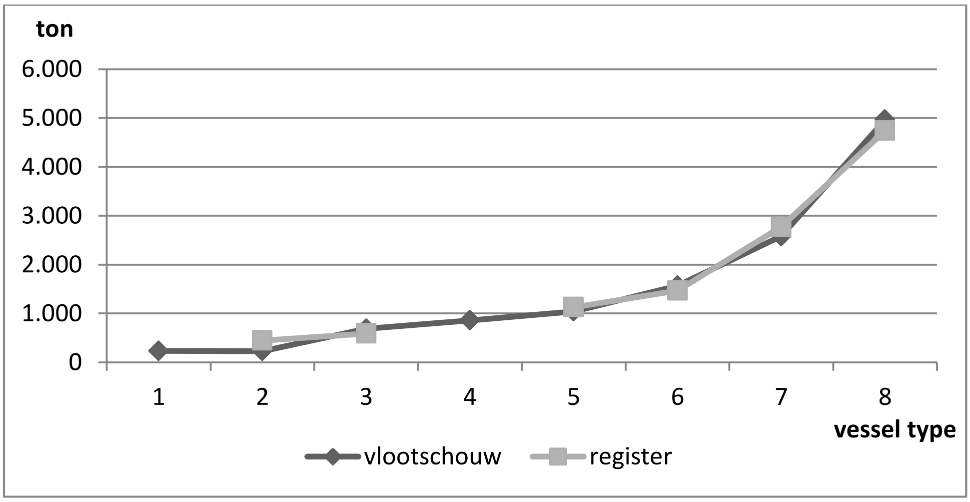
Graph 8.1: Comparison dry cargo vessels



Source: own composition, based on data from ECMT and Vlootschouw

The ECMT classification (see table 8.2 and annex 1) also shows tonnages which match the classification. As this classification contains less classes e.g. for the type 'Kempenaar', the average values for these categories are by definition higher or lower than in the more detailed classification.

Graph 8.2: Comparison tanker vessels



Source: own composition, based on data from ECMT and Vlootschouw

The following tonnages (table 8.3) were determined for the various vessel types, based on the averages from the datasets and the ECMT classification. These are evidently approximations, which means that they are not applicable to all vessels.

Table 8.2: Tonnage according to ECMT classification

type	min tonnage	max tonnage	Average
Spits	250	400	325
Kempenaar	400	650	525
Dortmunder	650	1000	825
Rhine-Herne	1,000	1,500	1,250
Large Rhine vessel	1,500	3,000	2,250

Source: own compostion based on data from ECMT

Table 8.3: Average tonnage of vessel types

type	tonnage
Spits	350
Kempenaar	500
Enlarged Kempenaar	600
Canal du Nord	750
Dortmunder	1,000
Rhine-Herne	1,500
Large Rhine vessel	2,500
Large container vessel	4,000

Source: own composition

2. Structure, functions and data of the cost simulation model

In this section the composition of the costs of a vessel in inland waterway transport is reproduced. Therefore a schematic presentation of the model and the individual cost items is given. Furthermore, the functions from which the model is composed are given. A list of the variables can be found in annexes 10 and 11, just like the functions of the fuel consumption model, which is quite extensive (see annex 12). The indices are only used in the initial formulas for reasons of clarity[52].

The model can be used in two ways, on the one hand for determining yearly costs for a certain type of vessel and on the other hand for computing the costs of a certain shipment or trip in detail. For the general model, a number of assumptions are made and less detail is included than when

[52] The costs are function of the goods category (g), the vessel type (s), the year of construction (c), the year of purchase (b), the type of operations (e), the length of the vessel (le), the equipment of the vessel (u), the tonnage of the vessel (t), the income of the owner-operator (r), the type of company (co) and the number of vessels in the company (n). Some of these variables can be correlated to a certain extent e.g. vessel type and tonnage.

calculating the costs based on a certain shipment e.g. for the costs of waterway and port dues. From the costs that are calculated per year or per trip, the hourly cost can always be deducted based on the effective hours.

The costs of the cost model are subdivided into fixed and variable costs. Among the fixed costs we find the capital costs i.e. depreciations and interest costs, the insurance costs, the labour costs, the costs of repair and maintenance which are related to time, and the other costs i.e. administrative and communication costs. Variable costs entail fuel and lubrication costs and maintenance and repair costs which are related to the vessel activity. Apart from these, we also find other costs which are linked to a specific journey e.g. waterway and port dues and commissions.

In order to have the model running, a lot of data is needed for the different cost items. Collecting cost data from inland navigation companies is considered a laborious process of which only a limited result can be expected. Previous studies such as the SORT-IT study indicate that collecting cost data is not very efficient this way (Dullaert et al., 1998). That is why the choice was made to reproduce cost data for a number of vessel types. A number of costs will be calculated on the basis of simplified data e.g. insurance, fuel consumption and labour costs, while for other costs averages are used from data provided by accounting companies e.g. maintenance and repair. The latter are necessary to determine the costs which are difficult to obtain individually.

The necessary data is collected at the suppliers or service providers as much as possible in order to understand how the costs are composed. For a number of cost items, it was not possible to work this way because the costs are spread over several suppliers. Maintenance and repair costs can for example be made at various companies and suppliers and they can differ to a great extent according to the circumstances. The maintenance of an engine can be done by an engine repair company, purchasing filters can be done at a petrol station, the maintenance of the hull at a shipyard, repair of a propeller at a specialised company, and so on. In this case, appeal was made to accounting data. This also applies to the administration and communication cost. Also for these cost items, data from accounting offices are used. The latter costs are assumed not to vary too much every year. For maintenance and repair costs it is however necessary to use averages over around five years. In the following part, for each part of the cost model the data source and processing will be discussed in detail.

2.1. Total vessel cost

The total cost consists of fixed costs and variable costs. The fixed costs, also called time costs, are the costs that are not related to the use of the material, in this case the vessel. These are the costs that are there, no matter whether the vessel sails or not. They are the result of the passing of time (Blauwens, 2010). Depreciation is an example of such a cost. The variable costs on the other hand are the costs that are related to the activities. A typical cost which is part of this group is the fuel cost. If the vessel does not sail, there is no fuel consumption. If it sails more, the fuel expenses are higher and if it sails less hours, they are lower.

$$TC = CF + CV$$

Where:

TC	=	Total cost
CF	=	Fixed costs
CV	=	Variable costs

The fixed costs hold the capital costs, labour costs, insurance costs, the fixed costs of repair and maintenance, the costs of communication and administration and the overhead costs. Depreciation is considered a fixed cost in most cost studies (see chapter 6). This is not entirely correct as these costs also vary according to sailing time. As this only has a limited influence, these costs are considered a fixed cost in this model.

$$CF = Ccap + Clab + Cins + CFrep + Ccal + Cov$$

Where:

CF	=	Fixed costs
Ccap	=	Capital cost
Clab	=	Labour cost
Cins	=	Insurance cost
CFrep	=	Fixed cost of repair and maintenance
Ccal	=	Cost of communication, administration and licenses
Cov	=	Overhead cost

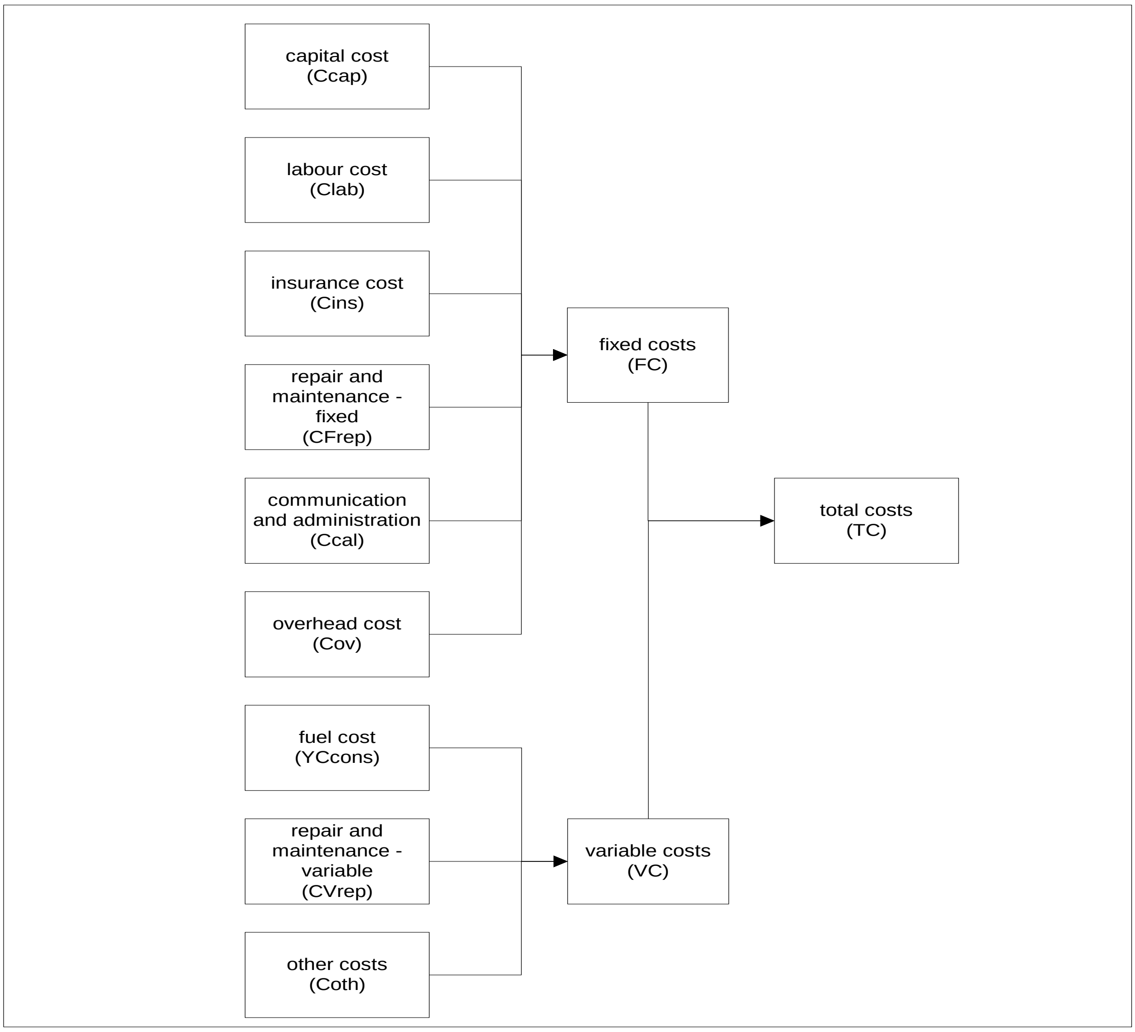
The variables costs are made up of the cost of fuel and lubricants, the variable cost of repair and maintenance and the other variable costs.

$$CV = YCcons + CVrep + Coth$$

Where:

CV	=	Variable costs
YCcons	=	Yearly cost of consumption (engine)
CVrep	=	Variable cost of repair and maintenance
Coth	=	Other variable costs

Figure 8.1: Schematic overview of the cost simulation model



Source: own composition

2.2. Capital cost

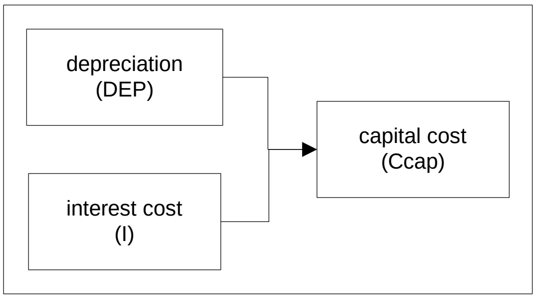
Capital costs consist of the depreciation of the vessel and the interest cost of the capital. In theory also the capital gains, e.g. financial gains after selling a vessel, could be included, but this is not incorporated in the cost model.

$$Ccap = DEP + I$$

Where:

Ccap	=	Capital cost
DEP	=	Depreciation
I	=	Interest cost

Figure 8.2: Schematic overview of the capital cost



Source: own composition

In order to determine the value of a vessel, the purchase value is used which is derived from a dataset of the Belgian ship registry. As the insured value is assumed to approximate the market value at the acquisition of a vessel, the purchase prices of the previous years should approximate the market value (see chapter 6). Of course there are exceptions, such as single hull vessels of which the market value decreased strongly ever since the latest regulation adjustments.

The average value is determined for eight vessel types in the dry cargo and tanker segment and four age categories i.e. 0 until under 10 years, 10 until under 20 years, 20 until under 40 years and 40 years or older. Since the dataset consists of data on vessels being bought and sold, only data is available of existing vessels. Furthermore, for a number of categories, no or insufficient observations exist. The smaller vessels have not been newly built in the last 20 years, so no prices are available for this category. Conversely, the largest vessels are not listed in the oldest category.

There are four ways of calculating the depreciation in this model. First, there are two options for the depreciation period, one on 25 years and one on 50 years for the casco. Besides this, two ways of depreciation can be chosen, the linear and the annuity method. In practice, the linear method on 25 years is generally used in the inland navigation sector.

The first method is depreciation on 25 years for new vessels. Second hand inland vessels older than 15 years (without age specification) are depreciated during 10 years. For vessels between 1 and 15 years, a gradual depreciation period is used. This means that the depreciation period is calculated by deducting the age from the maximum period. A vessel of 8 years old and a depreciation period of 25 years for example will be depreciated on 17 years (25-8=17 years). The residual value of the vessel after depreciation is fixed on 20% of its initial value.

- Method 1: Linear depreciation

$$DEP = \frac{AV_{g,s,c} - RV_{g,s,c}}{N_{c,b}}$$

Where:

DEP	=	Depreciation
AV	=	Value of acquisition of a vessel built in year c of type s for goods of type g

RV	=	Residual value of a vessel built in year c of type s for goods of type g
c	=	Year of construction
b	=	Year of purchase
N	=	Number of depreciation years for a vessel built in year c and bought in year b
g	=	Type of goods (dry cargo/tanker)
s	=	Vessel type

$$I = \frac{AV_{g,s,c} + RV_{g,s,c}}{2} * iw$$

Where:

I	=	Interest cost
AV	=	Value of acquisition of a vessel built in year c of type s for goods of type g
RV	=	Residual value of a vessel built in year c of type s for goods of type g
iw	=	Weighted interest rate

In the capital cost calculation, different possibilities of personal capital, bank loans and other loans can be used in the calculation at different interest rates. The interest rate used is the weighted interest rate. For the interest charged by the financial institution for a bank loan, the rate is based on the average of the 5 years OLO rate taken over 3 years. To this rate, the surcharge for the bank is added, which is derived from interviews in the sector. As is justified by economic theory, an opportunity cost will be charged for the invested equity. For the personal capital, the average interest rate of a risk-free investment is taken, which is in this model the OLO rate on 10 years.

$$iw = ((Shyp_s * ihyp) + (Sof_s * iof) + (Soth_s * ioth))$$

Where:

iw	=	Weighted interest rate
Shyp	=	Share of bank loan in AV for a vessel of type s
Sof	=	Share of own funds in AV for a vessel of type s
Soth	=	Share of other loans in AV for a vessel of type s
ihyp	=	Interest rate bank loan
iof	=	Interest rate own funds (opportunity costs)
ioth	=	Interest rate other loans

- Method 2: Annuity method

$$Ccap = \frac{AV_{g,s,c} - REST}{\left(iw_s + \frac{iw_s}{(1+iw_s)^{N_{c,b}} - 1} \right)}$$

Where:

Ccap	=	Capital cost
AV	=	Value of acquisition of a vessel built in year c of type s for goods of type g
iw	=	Weighted interest rate for a vessel of type s
REST	=	Discounted residual value
N	=	Number of depreciation years for a vessel built in year c and bought in year b

$$REST = \frac{RV_{g,s,c}}{(1+iw_s)^{N_{c,b}}}$$

Where:

REST	=	Discounted residual value
RV	=	Residual value of a vessel built in year c of type s for goods of type g
iw	=	Weighted interest rate for a vessel of type s
N	=	Number of depreciation years for a vessel built in year c and bought in year b

- Method 3 and 4: Depreciation on 50 years (linear and annuity)

In the second option for the depreciation period, the value of the different parts of the vessel is based on the percentages fixed in the 'binnenvaartconvenant' (see annex 18) and the value of the vessel. In this method of depreciation, the value of the vessel is divided into several parts, that each have a separate period of depreciation. The casco itself has a depreciation period of 50 years, while the other parts have lower depreciation periods. Only for the casco a residual value of 5% is included. The rest of the calculation is consistent with the depreciation on 25 years. The calculations can be made using the linear method or by means of annuities.

$$DEP = DEPc_g + DEPe_g + DEPo_g + DEPp_g + DEPt_g$$

Where:

DEP	=	Depreciation
DEPc	=	Depreciation casco of a vessel for type of goods g
DEPe	=	Depreciation engine room of a vessel for type of goods g
DEPo	=	Depreciation other of a vessel for type of goods g
DEPp	=	Depreciation pumps of a vessel for type of goods g
DEPt	=	Depreciation tubes of a vessel for type of goods g

$$DEPc = (AVc - RVc) * Zc_{g,N}$$

Where:

DEPc	=	Depreciation casco
AVc	=	Value of acquisition casco
RVc	=	Residual value casco
Zc	=	Depreciation rate casco of a vessel for type of goods g and depreciation period N

$$AVc \quad = Xc_g * AV_{g,s,c}$$

Where:

AVc	=	Value of acquisition casco
Xc	=	Percentage value casco of value of acquisition of a vessel for type of goods g
AV	=	Value of acquisition of a vessel built in year c of type s for goods of type g

$$RVc \quad = Yc * AV_{g,s,c}$$

Where:

RVc	=	Residual value casco
Yc	=	Percentage residual value casco of value of acquisition of a vessel
AV	=	Value of acquisition of a vessel built in year c of type s for goods of type g

$$DEPe = Xe_g * AV_{g,s,c} * Ze_{g,N}$$

Where:

DEPe	=	Depreciation engine room
Xe	=	Percentage value engine room of value of acquisition of a vessel for type of goods g
AV	=	Value of acquisition of a vessel built in year c of type s for goods of type g
Ze	=	Depreciation rate engine room of a vessel for type of goods g and depreciation period N

$$DEPo = Xo_g * AV_{g,s,c} * Zo_{g,N}$$

Where:

DEPo	=	Depreciation other
Xo	=	Percentage value other of value of acquisition of a vessel for type of goods g
AV	=	Value of acquisition of a vessel built in year c of type s for goods of type g
Zo	=	Depreciation rate other of a vessel for type of goods g and depreciation period N

$$DEPp = Xp_g * AV_{g,s,c} * Zp_{g,N}$$

Where:

DEPp	=	Depreciation pumps
Xp	=	Percentage value pumps of value of acquisition of a vessel for type of goods g
AV	=	Value of acquisition of vessel of a vessel built in year c of type s for goods of type g
Zp	=	Depreciation rate pumps of a vessel for type of goods g and depreciation period N

$$DEPt = Xt_g * AV_{g,s,c} * Zt_{g,N}$$

Where:

DEPt	=	Depreciation tubes
Xt	=	Percentage value tubes of value of acquisition of a vessel for type of goods g
AV	=	Value of acquisition of vessel of a vessel built in year c of type s for goods of type g
Zt	=	Depreciation rate tubes of a vessel for type of goods g and depreciation period N

2.3. Labour cost

Labour costs are assumed to be a fixed cost in this model and only the cost of the crew on board in included here. The labour costs of people working on the shore e.g. in the case of shipping companies, are included in the overhead costs. Evidently, labour costs fluctuate in reality according to the operations of the vessels. When there is no cargo, employees can take holidays, which makes it possible to reduce personnel costs. In this model we presume monthly wage costs, which entails a fixed personnel cost. The labour cost is made up of the costs of employees on the one hand and the remuneration of the self-employed people on board on the other hand. A schematic overview of the labour costs can be found in figure 8.3.

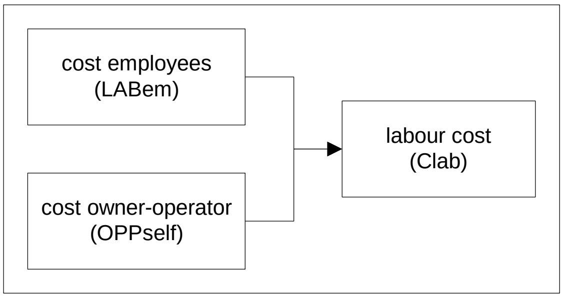
$$Clab = LABem * CS_e + OPPself$$

Where:

Clab	=	Labour cost
LABem	=	Labour cost employees
CS	=	Number of crews for type of operations e

OPPself= Opportunity cost self-employed people
e = Type of operations

Figure 8.3: Schematic overview of the labour cost



Source: own composition

As usual in the literature, the labour cost for employees is based on the minimum of crew regulations[54] and the minimum wages[55] in the sector. The minimum crew depends on the size of the vessel, the equipment of the vessel and the operations. The minimum wages depend on the size of the vessel and are based on an operation of 8h per day and 5 days per week. A cost for overtime work is included in the model. Depending on the type of operations, a certain percentage of overtime is accounted based on the interviews. In this model, 80% of the overtime hours are remunerated at the normal hourly wage, while the rest is paid 50% extra than normal hours e.g. for work on Saturdays. It is important to point out that the wages and the crew regulations used in this model apply to Belgium. The labour costs in other (neighbouring) countries can be higher or lower than in Belgium. Further, foreign crews could be called upon, which lowers the personnel costs. In this model, the standard legal contributions are used. For certain categories of employees e.g. long-term unemployed, older employees, etc., these social contributions could (temporarily) be lower in practice.

$$LABem = \sum_{p} (WN_{p,le,e,u} * (GIem + ECem))$$

Where:

LABem = Labour cost employees
WN = Number of employees of type p for a vessel for goods of type u, length le and equipment u
GIem = Gross income employees
ECem = Employer contribution employees
p = Type staff member
le = Length of vessel
u = Equipment vessel
g = Type of goods (dry cargo/tank)

[54] KB 9 maart 2007 (see annex 13)
[55] CAO 26 november 2007 (see annex 14)

$$GIem = MWage_{p,g,t} + OH * 20\% * HOwage_{p,g,t} + OH * 80\% * HNwage_{p,g,t}$$

Where:

GIem	=	Gross income employees
MWage	=	Yearly minimum wage for employees of type p for a vessel for goods of type g and tonnage t
OH	=	Overtime hours
HOwage	=	Hourly wage for overtime for employees of type p for a vessel for goods of type g and tonnage t
HNwage	=	Hourly wage for normal time for employees of type p for a vessel for goods of type g and tonnage t

$$OH = Ro_e - MH$$

Where:

OH	=	Overtime hours
Ro	=	Share of overtime hours for type of operations e
MH	=	Minimum working hours[56]
e	=	Type of operations

$$ECem = GIem * 1.08 * WGby$$

Where:

ECem	=	Employer contribution employees
GIem	=	Gross income employees
WGby	=	Percentage of employer contribution

In order to calculate the opportunity cost for the owner-operator, there are two options included in this model: on the one hand using the net wage of the employee and on the other hand using a fixed amount for the compensation for entrepreneurship. The model also contains the choice whether or not to include the partner of the owner-operator and whether or not to count overtime hours and -costs for self-employed people.

In the first option, i.e. net wages, self-employed people are allowed the normal net wage they can earn when working as an employee instead. When the owner-operator (and partner) is considered as

[56] The minimum working hours are the hours related to the minimum wage. In the model it is taken 5 days, 9 hours and 48 weeks.

a self-employed person, no employer contributions will be taken into account. Nevertheless, the mandatory social contributions for self-employed people[57] are counted in the model. For this reason, the minimum quarterly contributions paid to the social insurance fund are used in the model (see annex 17).

$$OPPself = OPPow + OPPpar$$

Where:

OPPself	=	Opportunity cost self-employed people
OPPow	=	Opportunity cost owner-operator
OPPpar	=	Opportunity cost partner

$$OPPow = NIem_{p,g,t} + overtime + SOCow_r$$

Where:

OPPow	=	Opportunity cost owner-operator
NIem	=	Net income wage for employees of type p for a vessel for goods of type g and tonnage t
Overtime	=	Cost of overtime self-employed people
SOCowr	=	Social contributions of owner operator for income r
r	=	Income

$$OPPpar = NIem_{p,g,t} + overtime + SOCpar_r$$

Where:

OPPpar	=	Opportunity cost partner
NIem	=	Net income wage for employees of type p for a vessel for goods of type g and tonnage t
Overtime	=	Cost of overtime self-employed people
SOCparr	=	Social contributions of partner for income r

$$NIem = GIem * (1 - 1.08 * WNby)$$

Where:

NIem	=	Net income employee
GIem	=	Gross income employees

[57] National Institute for the Social Security of the Self-employed (NISSE)

WNby = Social contributions employee

$$Overtime = OH * 20\% * HONIem_{p,g,t} + OH * 80\% * HNNIem_{p,g,t}$$

Where:

Overtime	=	Cost of overtime self-employed people
OH	=	Overtime hours
HONIem	=	Hourly net income overtime employee of type p for a vessel for goods of type g and tonnage t
HNNIem	=	Hourly net income normal time employee of type p for a vessel for goods of type g and tonnage t

The second option is using a fixed profit which should be gained after taxes and which is the compensation for entrepreneurship. In the literature on inland waterway transport, no indication is found on the amount which should be considered as a proper compensation. This is neither found in other sectors. Based on interviews with experts in the sector, one could consider a 60,000 euro profit before taxes as the amount a vessel owner in inland navigation should earn per year.

$$OPPself = RE$$

Where:

OPPself	=	Opportunity cost self-employed people
RE	=	Remuneration entrepreneurship

2.4. Insurance cost

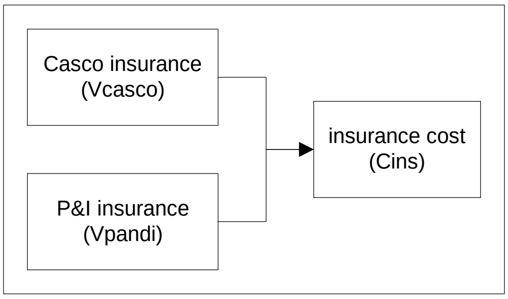
The insurance cost is the sum of the premium for casco insurance and P&I insurance (see figure 8.4). The insurance costs are a fixed yearly premium based on a number of characteristics of the vessel. For larger groups, a premium discount can be given. In some cases, discounts can be obtained for times of inactivity (e.g. crises), which is not included in this model.

$$Cins = (Vcasco + Vpandi) * (1 + Rg_{co})$$

Where:

Cins	=	Insurance cost
Vcasco	=	Insurance casco
Vpandi	=	Insurance P&I
Rg	=	Premium adjustment for groups for type of company co
co	=	Company

Figure 8.4: Schematic overview of the insurance cost



Source: own composition

In order to determine the insurance cost of the casco, two sources were consulted. On the one hand there is a simple formula provided by an insurance company, which is based on tonnage, engine power and the value of the vessel, lifting, contents and equipment. On the other hand a dataset of 40 simulations of casco insurance premiums of self-propelled vessels is used. Several simulations were carried out for type of vessel, type of operator, insurance value of the vessel, year of construction of the casco and engine power. The vessels included in the dataset range from the smallest vessel (350 tonnes) until the largest (5,800 tonnes). The navigation area and loss statistics were not taken into account. For older engines (> 10 years) the guarantees are reduced (no cover of hidden flaws).

When going through the cases of the dataset by means of the simple formula, this results in systematically higher premiums. That is acceptable, because the simple formula does not contain a number of important reductions. A linear regression with several variables of the dataset gives unrealistic 'relations' such as negative results for the variable engine power. A linear regression of the same dataset for each vessel type separately gives better results for the dry cargo segment, but still unrealistic ones for the tanker segment. Therefore, the simple formula is used as a basis and two extra coefficients are incorporated in the formula, being the construction year and the type of operator.

In this cost model the casco insurance is determined based on tonnage, power, age of the engine and insurance value of the vessel, lifting, contents and equipment. Also the operator and the age of the vessel play an important role when setting the premium.

$$Vcasco = (Pbasic_g * t + Pen * PK + Pli * IVli + Pcon * IVcon + Pneq * IVneq + Ptl * IV) * (1 + OPER - NEW)$$

Where:

Vcasco	=	Insurance casco
Pbasic	=	Basic premium casco insurance for a vessel for goods of type g
t	=	Tonnage of vessel
Pen	=	Premium main engine
PK	=	Power main engine
Pli	=	Premium lifting vessel
IVli	=	Insurance value lifting
Pcon	=	Premium contents

IVcon	=	Insurance value contents
Pneq	=	Premium nautical equipment
IVneq	=	Insurance value nautical equipment
Ptl	=	Premium total loss
IV	=	Insurance value vessel
OPER	=	Premium adjustment for operator
NEW	=	Premium reduction for new vessels

The insurance value is assumed in the model to equal the purchase value. The values for the extra guarantees for the contents of the vessel can be chosen freely in the model. For vessels older than 15 years, standard there is no engine insurance included. Newly built vessels receive a premium reduction and if the operator is not an owner-operator but an employee, there is a premium surcharge.

The insurance premium for the P&I is based on a formula provided by a P&I company. It consists of an estimated total premium and a cover for unlimited risk. Possible back calls (see chapter 6) are not included in the model, because the company that provided the information generally has no back calls. The possible extra costs are already included in the premium.

$$Vpandi = ETP_{g,t} + UR_t$$

Where:

Vpandi	=	Insurance P&I
ETP	=	Estimated total premium for a vessel for goods of type g and tonnage t
UR	=	Unlimited risk for vessel of tonnage t

2.5. Fixed cost of repair and maintenance

Maintenance and repair costs are considered partly a fixed cost and partly a variable cost. Part of the costs are caused by time elapsing and should be counted both when the ship is sailing and when it is inactive. A fixed service at a shipyard every five years for the renewal of certificates is an example. Another share of the maintenance and repair costs is related to the usage of the vessel. The more the engine works, the sooner maintenance is needed, or the more the vessel is sailing, the larger the chance small damages occur. This part is counted with the variable costs.

$$TCrep = CFrep + CVrep$$

Where:

TCrep	=	Total cost of repair and maintenance
CFrep	=	Fixed cost of repair and maintenance
CVrep	=	Variable cost of repair and maintenance

As discussed before (see chapter 6), it is common to count the maintenance costs for 50% as a fixed cost and for 50% as a variable cost. This is also the method applied in this model.

$$CFrep = \frac{TCrep}{2}$$

Where:

TCrep = Total cost of repair and maintenance
CFrep = Fixed cost of repair and maintenance

The cost of repair and maintenance in this model originates from the accounting data of inland waterway transport companies. These costs are made with several parties such as the shipyard, an engine revision company, shops for vessel requirements and so on. Therefore, they are very difficult to retrieve in another way than via the companies' accounting.

For the determination of this cost item two datasets have been used, one containing Belgian and the other one containing Dutch inland waterway vessels. The dataset with Belgian vessels does not cover the whole market because it consists mainly of smaller vessels. No other data on Belgian vessels was available at the moment of designing this model. Therefore, appeal was made to data from the Dutch fleet. The data of both datasets are not entirely comparable, given that the classification of the cost items is somewhat different. The cost of products for maintenance for example is combined with the cost of fuel and lubricants in the Belgian dataset, while they are considered vessel requirements in the Dutch dataset.

The available dataset on Belgian vessels consists of 22 vessels from the Belgian inland waterway fleet. It holds only dry cargo vessels which are mainly smaller and older vessels. The year of construction of the vessels in the dataset is between 1911 and 1980, with an average age of 59 years. The loading capacity is smaller than 1,000 tonnes. The main part of the vessels is of the type 'Kempenaar', followed by the type 'Spits'. Of each of the vessels in the dataset, the cost of repair and maintenance is available for four consecutive years, being 2005 until 2008. Table 8.4 gives the overview of the dataset by vessel type.

Table 8.4: Overview dataset Belgian vessels

vessel type	**Spits**	**Kempenaar**	**Enlarged Kempenaar**	**Dortmunder**
number of vessels	5	10	3	4
average age	62	57	53	64
average tonnage	354	400	618	841
average engine power	259	279	474	713

Source: own composition

The available Dutch dataset holds 49 vessels, again mainly dry cargo vessels (3 tanker vessels). The year of construction is between 1925 and 2007, with an average age of 38 years. The loading capacity goes from 350 until 3,925 tonnes and the cases are fairly spread over the different vessel sizes. The smallest vessels are mainly older, the largest mainly younger. For the vessel sizes in between, data is available both for older and more recent vessels. For 40 vessels from the dataset, the cost of repair and maintenance is available for five consecutive years (2005-2009). For the other vessels data for less than five years is available. This is generally the case for the newest vessels, which do not exist that long, e.g. vessels constructed after 2005. Given that in the period before the crisis many vessels have been bought and sold, it is not evident to find sufficient vessels of which the accounting data of the same company is available for five consecutive years. In table 8.5 a brief summary of the dataset is given by vessel type.

Table 8.5: Overview dataset Dutch vessels

vessel type	Kempenaar	Canal du Nord	Dortmunder	Rhine-Herne	Large Rhine vessel	Large Container vessel
number of vessels	3	3	16	6	15	3
average age	74	49	52	33	23	11
average tonnage	459	669	883	1,389	2,516	3,590
average engine power	261	454	591	875	1,360	1,776

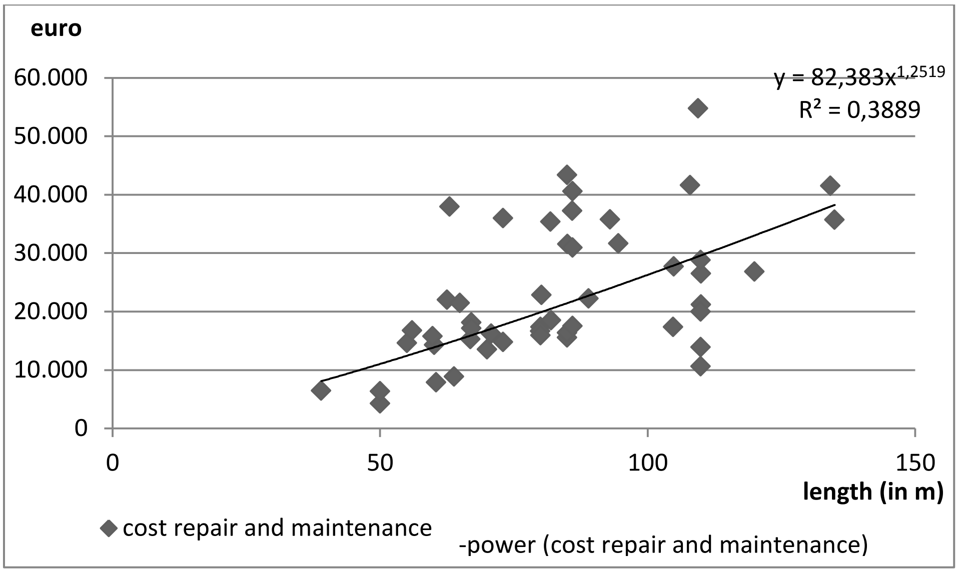
Source: own composition

When studying the yearly data in detail, it is clear that for each case there is one year with exceptional high costs, while the other four years are rather stable. Given that the cost of repair and maintenance is much higher in the year of the inspection and that this cost has to be spread over the 5-year period, an average figure is determined over the available years. The datasets also contain some extreme figures which might disturb the average values. These figures stem from exceptional repairs which lead to extremely high average costs. Therefore, they are removed from the dataset.

The cost of repair and maintenance is often assumed to depend upon size and age of the vessel. There is a possibility that this is indeed the case and therefore the existence of such a relationship is examined by means of a regression analysis. For the length as well as for the tonnage and the construction year of the vessel, the relationship with the cost of repair and maintenance is checked. The results for the length and construction year are presented in graphs 8.3 and 8.4. The results of a simple regression for each of the variables give only very small explanatory values ($R^2 <= 39\%$). The regressions which give the best results are represented in both graphs. Also the multiple regression gives unsatisfactory results (see annex 19).

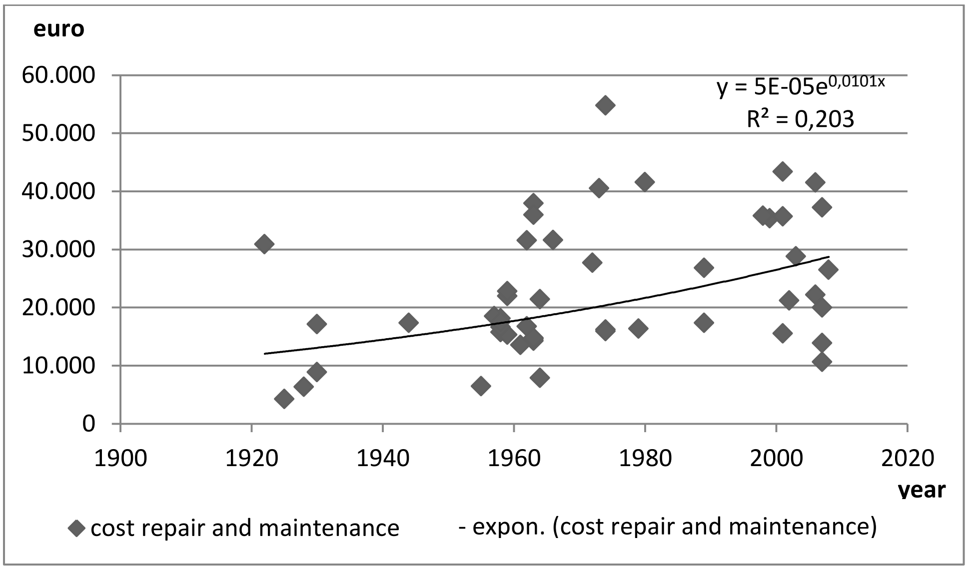
From the previous results, it is concluded that from this dataset no relationship can be derived which can be used in the model. Therefore, it is decided to bring the cost of repair and maintenance into the model by means of average costs per vessel size. In order to deal with the loss of detail caused by working with averages, also median, minimum and maximum values are included in the model as an option.

Graph 8.3: Relationship cost of repair and maintenance and length



Source: own composition

Graph 8.4: Relationship cost of repair and maintenance and construction year



Source: own composition

As discussed in chapter 6, there are potential cost reductions when going with several vessels to one shipyard or when buying goods in larger quantities. Therefore, a cost reduction for larger entities is included in the model.

$$TCrep = Crep_{g,s,c} * (1 + Rn_{co})$$

Where:

TCrep = Total cost of repair and maintenance

Crep	=	Cost of repair and maintenance
Rn	=	Cost adjustment for vessel quantity

2.6. Cost of communication, administration and licenses

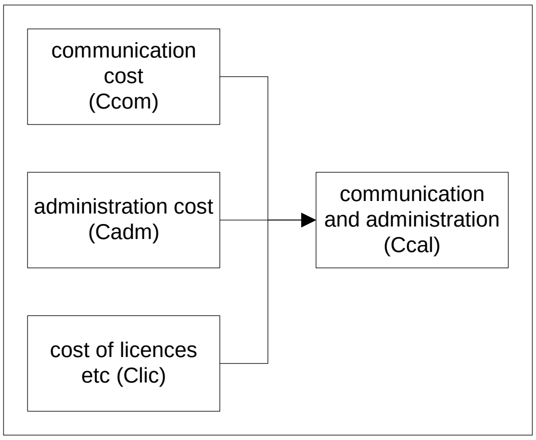
The total costs of communication and administration are the sum of the communication costs, administration costs and costs of licenses, permits and so on (see figure 8.5). These are miscellaneous costs which occur on a fixed basis. Of course, these costs fluctuate over time e.g. because of higher telephone costs, a cheaper internet subscription and so on. However, as these fluctuations are rather limited and average costs over several years are used, these costs are considered fixed in the model.

$$Ccal = Ccom_s + Cadm_{s,co} + Clic_s$$

Where:

Ccal	=	Cost of communication, administration and licenses
Ccom	=	Costs of communication, telephone, fax…
Cadm	=	Costs of administration, bookkeeping…
Clic	=	Costs of licenses, permits, inspections,…

Figure 8.5: Schematic overview of the cost of communication, administration and licenses



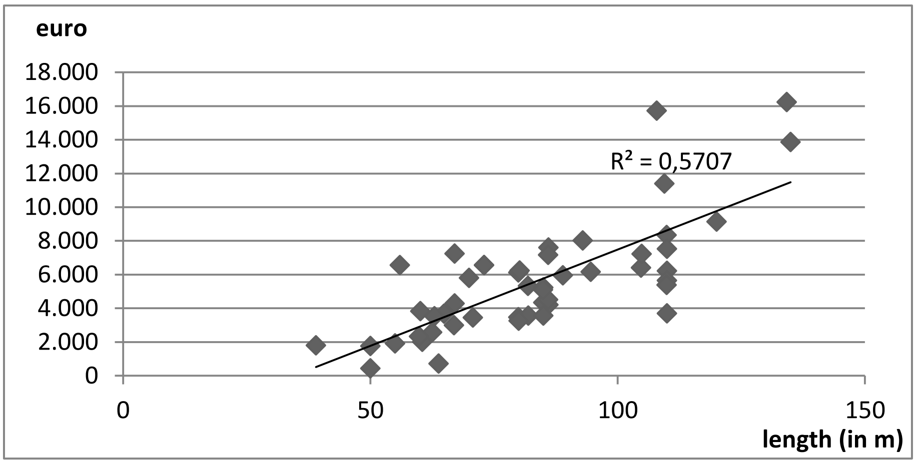
Source: own composition

The cost of communication, administration and licenses is derived from the dataset of Dutch vessels which is also used to derive the costs of repair and maintenance. The three cost items are separately registered in the accounting. A simple linear regression analysis indicates a connection between the length of a vessel and the communication costs (graph 8.5). A larger vessel is often operated more intensively, which makes it necessary to have more contacts with shippers, staff, etc.

The administration cost from the Dutch dataset has to be reduced because in the Netherlands inland waterway transport companies have to do a full accounting, while this is not necessarily the case in

Belgium (see chapter 7). The costs of communication and administration of a vessel are fairly similar for the years available in the dataset. For the different vessel sizes an average cost is determined based on the available data over five years. In order to grasp differences which might have been leveled out because of working with average values, also the median, minimum and maximum values are incorporated in the model as an option.

Graph 8.5: Linear regression cost of communication



Source: own composition

2.7 Overhead cost

The overhead costs are the costs related to larger entities e.g. shipping companies. They are discussed in detail in chapter 6 and the composition is represented in figure 8.6.

$$Cov = COeq_n + COlab_n + COoth_n + COentr_n$$

Where:

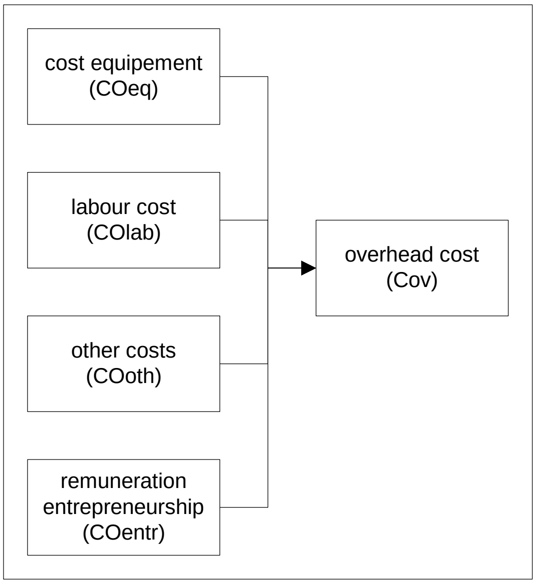
Cov	=	Overhead cost
COeq	=	Overhead cost equipment
COlab	=	Overhead cost labour
COoth	=	Overhead cost other
COentr	=	Overhead cost entrepreneur
n	=	Number of vessels

It is not possible to derive the overhead costs of shipping companies from the annual reports, because these companies generally do more than just operating their own vessels. They often have a chartered fleet besides their own fleet and are active in freight acquisition, chartering, cargo handling, terminal operations and so on. Based on the annual reports it is not possible to distinguish the costs of operating the own vessels from the other activities.

When looking at the activities shipping companies perform which are strictly related to the operation of their vessels, one could compare the overhead costs of a shipping company to the ones of a commercial co-operation or a charterer. The main difference is the profit making of a charterer and shipping company where a commercial co-operation redistributes the profit over the members.

Therefore the overhead cost is derived from the annual reports of five companies, being commercial co-operations, charterers and shipping companies. A separate estimation was made for the costs of equipment, the labour costs and the other costs. Furthermore, for shipping companies the head of the company is supposed to be a self-employed person, for whom the same remuneration for entrepreneurship as for the owner-operator is used.

Figure 8.6: Schematic overview of the overhead cost

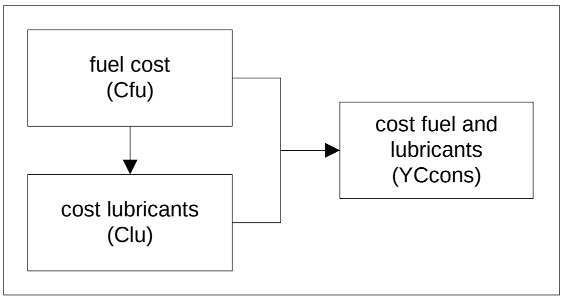


Source: own composition

2.8 Cost of fuel and lubricants

Only the consumption of the main engine(s) is taken into account, as it is difficult to determine the activity of the bow thrusters. It is further assumed that the engines are only working when actually sailing. The possible use of generators for the power supply when the ship is moored is not taken into account. The composition of the fuel cost can be found in figure 8.7.

Figure 8.7: Schematic overview of the cost of fuel and lubricants



Source: own composition

The cost of fuel and lubricants consists on the one hand of the fuel costs and on the other hand of the costs of lubricants which are necessary to run the engine. The cost of lubricants in this model is considered a function of the fuel cost. This is based on the literature and interviews with people from the sector.

$$Ccons = Cfu + Clu$$

Where:

Ccons = Cost of consumption (fuel and lubricants)
Cfu = Fuel cost
Clu = Cost of lubricants

$$Clu = Cfu * lu_t$$

Where:

Clu = Cost of lubricants
Cfu = Fuel cost
lu = Percentage of cost of lubricants

For the fuel price in the model, the average yearly fuel price published by the CCR is used. As discussed in chapter 6, larger entities can obtain price reductions because they purchase in larger quantities. Therefore, a price reduction is included in the model.

Table 8.6: Average yearly gasoil price

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
price for 100l gasoil	28.5	30.07	35.88	46.67	52.12	53.16	67.95	46.30	58.41

Source: CCR (2010b)

$$Cfu = CONSfu * (FP * (1 + Rq_{co}))$$

Where:

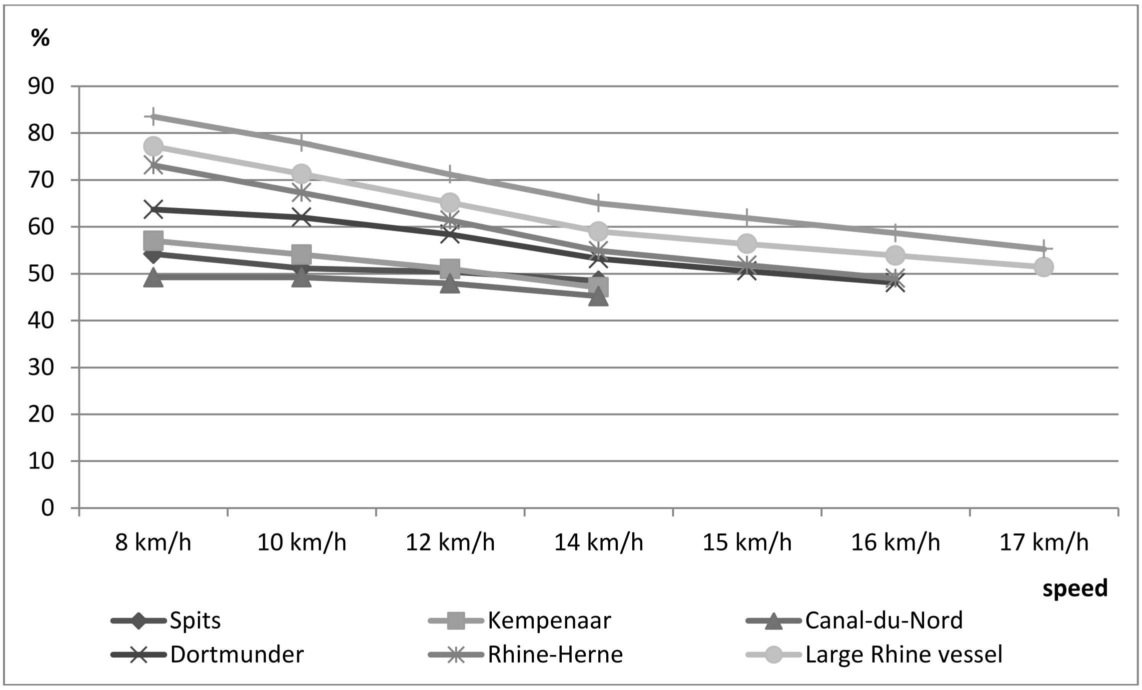
Cfu = Fuel cost
CONSfu= Fuel consumption main engine (calculation see annex 12)
FP = Price of fuel
Rq = Price adjustment for quantities

In order to determine the fuel consumption in this model, the specifications of a number of recent Caterpillar engines are used. The choice of the type of engine for a certain type of vessel is based on the observations of vessels being constructed in the last 10 years (see database Vlootschouw[58] and details on selling websites of vessels[59]) and interviews with people from the sector.

The design of the vessel used in this model in order to determine the resistance is based on the design of a pushed barge (Van Terwisga, Mennen and Holtrop, 1991). This design is used for the different vessel sizes. Obviously, this design does not correspond to the design of many existing self-propelled vessels. Because of its shape, a pushed barge experiences more resistance from the water than a rounded form, since it pushes the water in front away instead of going through it. The design and resistance calculation for this vessel design and the low water corrections can be found in annex 12.

The effects of the width of the waterway are not included in the model. The width of the waterway has only a minor effect on the resistance though. The vessel speed and the water depth on the other hand are included. For smaller vessels, the maximum speed is lower than for the larger vessels, which is a result of the engine power of the corresponding engines. The model holds only the vessel speed towards the ground. In the case studies (see chapter 9) the effect of the current is incorporated.

Graph 8.6: Share of fuel consumption (empty/loaded) for the different vessel sizes



Source: own composition

In the model, the calculation of the fuel consumption in case of empty sailing is done based on the lower displacement of empty vessels and the accompanying resistance. There is no linear relation between the fuel consumption of loaded and empty vessels. Graph 8.6 shows the evolution of the share of fuel consumption (empty/loaded) at an increasing speed for the different vessel sizes.

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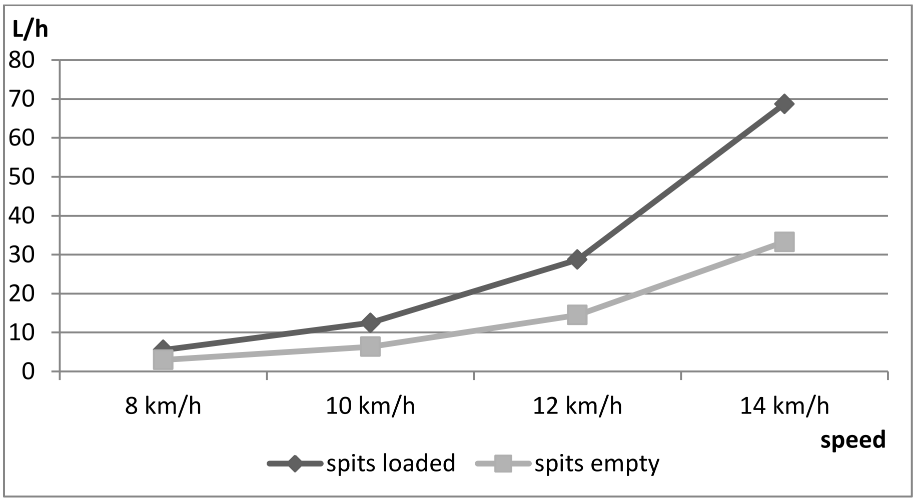
[58] See chapter 3

[59] e.g. www.gtsschepen.nl

The higher the speed, the lower the share of fuel consumption of an empty vessel compared to a loaded one. For large vessels at very low speeds, the fuel consumption of an empty vessel is about as high as for a loaded one. At higher speeds, this drops to 55%. For smaller vessels, the difference between speeds is less pronounced. Going from 8 km/h to 14 km/h for example (see graph 8.7) results in a 5 to 10% higher share of fuel consumption for an empty vessel.

Graph 8.7: Fuel consumption (empty and loaded) for the vessel size 'Spits' (in l/h)



Source: own composition

The model can also determine the fuel consumption for different load factors. The load factors are determined for each vessel type, based on a dataset of trips on the Belgian waterway network (see chapter 5). The average share of empty hours is based on the same dataset, but adjusted to the experience of people active in the sector. The previous functions allow calculating the fuel consumption of a specific trip. This means that each variable (water depth, speed, load factor and empty sailing) can be chosen freely depending on the characteristics of the case. In order to determine average yearly costs, the average depth of the waterways sailed on and the average speed are needed. Also the average capacity utilisation of the vessel, being the load factor and empty hours, and the yearly sailing hours are necessary in this case (see chapter 5).

$$YCcons = SH * (1 - MT_s) * LCcons + SH * (MT_s) * MTCcons$$

Where:

YCcons	=	Yearly cost of consumption (engine)
SH	=	Sailing hours per year
MT	=	Share of empty sailing hours
LCcons	=	Cost of consumption loaded
MTCcons	=	Cost of consumption empty

2.9. Variable cost of repair and maintenance

$$CVrep = \frac{\frac{TCrep}{2}}{SH}$$

Where:

CVrep = Variable cost of repair and maintenance
TCrep = Total cost of repair and maintenance
SH = Sailing hours per year

2.10. Other variable costs

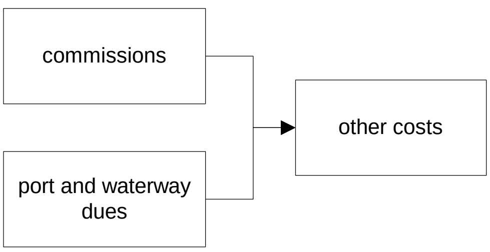
The other variable costs hold the costs that are not related to time elapsing, but are neither directly dependent on the sailing hours. These are costs related to a specific journey or route. The other costs in the model are the commissions paid to charterers and the port and waterways dues (see figure 8.8). If a vessel owner uses a charterer in order to get assignments, the charterer is paid for this intermediation by the vessel owner. Commonly, this compensation amounts to 5-10% of the freight tariff, which means that the yearly cost of commissions depends on the annual turnover. This cost can be avoided if an operator takes care of his own chartering. In this case, it is of course important to have the right contacts in order to get enough assignments for the vessel. A commercial co-operation and shipping company generally take care of the chartering of their vessels themselves (see chapter 4). Therefore, they use their own chartering people, of which the cost is part of the overhead costs.

$$Coth = Ccomm_s + Cnav_s$$

Where:

Coth = Other variable costs
Ccomm = Costs of commissions
Cnav = Costs of navigation and port dues

Figure 8.8: Schematic overview of the other cost



Source: own composition

The port and waterway dues depend on the individual ports and waterways. In the model an estimate is made for the yearly amount of these costs. In the case studies, exact calculations are made for the other variable costs, based on the trip characteristics.

$$Ccomm = comm * YREV$$

Where:

Ccomm	=	Costs of commissions
comm	=	Share of commissions
YREV	=	Yearly revenues

For the case studies, the exact cost of the trip is calculated. The cost of commissions is based on the freight tariff, the tonnage transported and share of commissions. For the calculation of the port and waterway dues, the tariffs of the specific waterways and ports are needed. They can be found at the ports and waterway administrators.

$$Ccomm = \text{FT} * \text{comm} * \text{TON}$$

Where:

Ccomm	=	Costs of commissions
FT	=	Freight tariff
comm	=	Share of commissions
TON	=	Tonnage loaded

$$Cnav = TON * DIST * WAD + WADmt + t * PD$$

Where:

Cnav	=	Costs of navigation and port dues
TON	=	Tonnage loaded
DIST	=	Distance loaded
WAD	=	Waterway dues loaded
WADmt	=	Waterway dues empty
t	=	Tonnage vessel
PD	=	Port dues

2.11. Operations

Apart from the actual cost data, a model on the operations is necessary from the various types of vessels. It is important to determine the effective days that a vessel is operational per year, because this will be the basis for the calculation of the hourly cost. The number of effective days is calculated by means of the following equation: effective days per year = 365 - holidays - special occasions - repair - other days off. For smaller vessels an average of 300 operational days is frequently used (Buck Consultants International et al., 2004, interviews with people in the sector). For larger vessels this is generally somewhat higher (Buck Consultants International et al., 2004) and amounts to 320 or more days per year. Large vessels in continuous operations in general are less than 10 days per year out of service.

$$HEFF = (365 - NWD_e) * WH_e$$

Where:

HEFF	=	Effective hours per year
NWD	=	Non-working days
WH	=	Working hours per day

The effective hours per year are the effective days times the number of hours per day, which are dependent on the type of operations. The number of sailing hours is fixed as a percentage of the effective hours. For dry cargo, a percentage of 43% is assumed, while for tanker trade it is 75% (NEA, 2003).

$$SH = HEFF_e * Hs_g$$

Where:

SH	=	Sailing hours per year
HEFF	=	Effective hours per year
Hs	=	Percentage of sailing hours

All formulas used in the model are summarised in table 8.6. In case several options and therefore several formulas are included in the model, it is also indicated for which method the formula is used. The same is done for formulas that are used to calculate the cost for a certain shipment or when it is used for calculations on a yearly basis.

The cost simulation model that was constructed in this chapter will be used in the following chapter to give an insight into the effect of decisions and measures on the costs. The analysis will show to what extent the vessel owner can influence the costs and how different the effect of exogenous influences is for the different vessel types. Not only the effects on the costs, but also the effects on the revenues and profits will be included in the case studies. This will allow us to draw conclusions on the competitiveness of different vessel types, different companies and different fleets.

Table 8.7: Summary formulas cost model

Variable	**choice**	**formula**
total cost		TC = CF + CV
fixed cost		CF = Ccap + Clab + Cins + CFrep + Ccal + Cov
variable cost		CV = YCcons + CVrep + Coth
capital cost		Ccap = DEP + I
depreciation	Linear	DEP = (AV - RV)/N
interest cost	Linear	I = (AV + RV)/2 * iw
weighted interest rate		iw = ((Shyp * ihyp) + (Sof * iof) + (Soth * ioth))
capital cost	Annuity	Ccap = (AV - REST)/(iw + (iw /(1+iw)^N -1))
residual value	Annuity	REST = RV / (1+iw)^N
depreciation	50y	DEP = DEPc + DEPe + DEPo + DEPp + DEPt
depreciation casco	50y	DEPc = (AVc - RVc) * Zc
value of acquisition casco	50y	AVc = Xc * AV
residual value casco	50y	RVc = Yc * AV
depreciation engine room	50y	DEPe = Xe* AV * Ze
depreciation other	50y	DEPo = Xo * AV * Zo
depreciation pumps	50y	DEPp = Xp * AV * Zp
depreciation tubes	50y	DEPt = Xt * AV * Zt
labour costs		Clab = LABem * CS + OPPself
labour costs employees		LABem = ∑ (WN * (GIem + ECem)
gross income employees		GIem = MWage + OH *20% * HOwage + OH * 80% * HNwage
overtime hours		OH = Ro * MH
employer contribution employees		GIem * 1.08 * WGby
opportunity cost self-employed people	Net wages	OPPself = OPPow + OPPpar
opportunity cost owner operator	Net wages	OPPow = NIem + overtime + SOCow
opportunity cost partner	Net wages	OPPpar = NIem + overtime + SOCpar

Variable	choice	formula
net income employees	Net wages	NIem = GIem * (1 - 1.08 * Wnby)
overtime cost self-employed people	Net wages	Overtime = OH * 20% * HONIem + OH * 80% * HNNIem
opportunity cost self-employed people	Remuneration	OPPself = RE
insurance cost		Cins = (Vcasco + Vpandi) * (1 + Rg)
insurance cost casco		Vcasco = (Pbasic * t + Pen * PK + Pli * IVli + Pcon * IVcon + Pneq * Ivneq + Ptl * IV) * (1 + OPER - NEW)
insurance cost pandi		Vpandi = ETP + UR
total cost repair and maintenance		TCrep = CFrep + CVrep
fixed cost repair and maintenance		CFrep = TCrep / 2
total cost repair and maintenance		TCrep = Crep * (1 + Rn)
cost of communication, administration etc		Ccal = Ccom + Cadm + Clic
overhead cost		Cov = COeq + COlab + COoth + COentr
yearly consumption cost (engine)	Yearly	YCcons = SH * (1 - MT) * LCcons + SH * (MT) * MTcons
cost of consumption and lubricants	Shipment	Ccons = Cfu + Clu
fuel cost		Cfu = CONSfu * (FP * (1 + Rq))
cost of lubricants		Clu = Cfu * lu
variable cost repair and maintenance		Cvrep = ((Tcrep/2)/SH)
other costs		Coth = Ccomm + Cnav
costs of commissions	Shipment	Ccomm = com * REV
costs of navigation and port dues	Shipment	Cnav = t*PORT + TON * DIST
Sailing hours per year		SH = HEFF * Hs
Effective hours per year		HEFF = (365 - NWD) * WH

Source: own composition

Chapter 9: Analysis and case studies

The cost simulation model which is developed in the previous chapter will be used in this chapter for analysis. The parameter values, coefficients and methods which are included in the model are analysed in three ways, by means of a sensitivity analysis, a strategic analysis and a systems analysis. Then, a number of case studies are selected and the costs and revenues are determined for different options.

1. Analysis of parameter values, coefficients and methods

In this cost simulation model choices have been made in order to determine specific parameter values and coefficients (see chapter 8). Moreover, for specific parameters, different methods of calculation are incorporated in the model. If other choices had been made or other data had been used, a different outcome would have been possible. Therefore, the effect on the costs of possible changes in the parameter values and coefficients and the use of the different methods in the model is studied. This analysis tests the sensitivity of the model for changes in the parameter values, coefficients and the methods that are used.

Table 9.1 provides an overview of all parameter values and coefficients which can be adapted in the model. First, it is indicated whether the variables are exogenous or endogenous in the model. This is done for the general model as well as for the case studies, because some variables are calculated into more detail in the case studies compared to the general model (see chapter 8). Differences between the two are found for the load factor and the other costs.

The next column shows whether the variable can be calculated in the model by means of different methods. For the type and time of depreciation, as well as for the remuneration of ownership, the calculation of repair and maintenance and communication and administration costs, two different methods of calculation are included in the model. Then the table demonstrates the parameters of the model that can be influenced either by the companies, governments or not at all. In case it can be influenced by the governments, it can be done in a direct or indirect way. For making this typology, the current situation is started from. This means that when there is no legislation or interference of the government at this moment, it is assumed the government does not influence the variable. In future, this could of course be different.

The last column of the table then presents the way the variable is analysed. The effect of changes with respect to the variables in the model is addressed in three ways. A sensitivity analysis is carried out for the parameter values in the model which are based on assumptions. Afterwards, a strategic analysis based on real-world events is made. For the options which are built into the model, a separate analysis, called systems analysis, is made in which the effect of choosing the alternative instead of the basic scenario on the costs is determined.

1.1. Sensitivity analysis

All models contain a number of assumptions and parameter values which are estimated or uncertain. Even when there is consensus on the actual parameter values, their future values can only be estimated. In order to determine the effect of changes in the current parameter values and coefficients on the outcome of the model, a sensitivity analysis can be carried out. This is commonly done by varying the values of the numerical parameters. The values of the variables are each time adjusted with for example -1% and +1% and the effect on the costs is determined. This way, the robustness of an optimal solution can be tested and important variables and critical values can be identified.

The sensitivity analysis looks into the effects of the variables which can be considered as being exogenous in the short run i.e. not immediately controlled by the vessel owner. These are for example the value of the vessel, the interest rate and the maintenance cost. In the analysis, the effect of a change of one of those variables, e.g. an increase in interest rate of 1%, is determined.

The effects of changes in the parameters of the capital cost, labour cost, insurance cost, repair and maintenance cost, communication and administration cost, fuel cost and other costs on the total costs for each case are calculated. Afterwards, the effects of each alternative on the total costs are represented together in a table. However, not all sensitivities can be calculated on each basic scenario. In order to make a sensitivity analysis of the overhead cost for example, a case in which a co-operation or shipping company is introduced has to be drawn.

1.2. Strategic analysis

After the sensitivity analysis, a strategic analysis of a number of variables is carried out. Some variables were already used in the sensitivity analysis, but are adjusted in this analysis with values based on real-world events. An adjustment of the value of a vessel as a result of market conditions, such as a decrease in market value of a vessel due to an economic crisis, is an example of such an event. The other variables which are analysed here are those which cannot be realistically adjusted by 1%, e.g. number of vessels for overhead costs, or which contain a choice in the model, e.g. including P&I insurance or not, that can be made by the companies. It is important to note that certain options are only realistic for a specific vessel type e.g. leaving out the P&I insurance for small vessels.

The strategic analysis is each time carried out for the fixed costs and the variable costs separately and the results are represented in indices and visualised by means of graphs (see annex 20). The results are separately shown for the fixed and variable costs because companies often do not include the fixed costs in their daily decisions. The results are every time grouped per cost item and the effect on the total costs is also included.

1.3. Systems analysis

In the model a number of options or alternatives are included for the calculation of certain cost items. These are choices concerning the method which is used for these costs e.g. the method of calculation of the communication costs or doing the calculation of the depreciation by means of annuities instead of in a linear way. The values of certain parameters are fixed as average values of a dataset such as the cost of repair and maintenance and the cost of communication and administration. It would in this case be possible to opt for the median, minimum or maximum values when making the calculation. Because such choices cannot be expressed in terms of percentages, they cannot be compared to the results of the sensitivity analysis and therefore have to be treated separately.

1.4. Results

The three types of analysis, i.e. the sensitivity analysis, strategic analysis and the systems analysis, are carried out for the eight vessel types available in the model. The analysis starts from a basic scenario, which is a typical situation in the sector and depends upon the size and type of vessel. First a short description of the basic case is given. Then the composition and importance of the costs of this case is represented in the first graph of the analysis. This immediately shows the importance of each cost item and the volume of the total costs. The following two graphs show the importance of each cost item on the fixed and variable costs. Then the results of the sensitivity analysis are given, followed by the results of the strategic analysis. Afterwards, the effect of the systems analysis, i.e. using alternative methods for the calculation of certain costs, is analysed. The basis scenario is fixed at 100 and the result of each alternative is represented by indices. At the end of the analysis conclusions are drawn for the vessel type.

In the analysis, the year of purchase of a vessel is chosen in such a way that there is always a depreciation included in the cost calculation. In reality, older vessels which are already owned for a long period could already be without depreciation, which results in lower fixed costs. Furthermore, in this model always a remuneration for the owner-operator is included. In reality, the owner-operator and his/her partner can deprive themselves from a decent remuneration when freight prices are low. If an owner operator did this, he could in fact calculate with a cost which is only about 50% of the total costs in the case of a Spits (graph 9.1). For larger vessels, the effect is much less, since the remuneration of the owner-operator has a much lower share of the total costs.

Table 9.1: Model parameters for analysis

Cost items	Parameters	General model	Case studies	Choice of method	Can be influenced by company	Can be influenced by governments*	Type of analysis
Capital cost	value vessel	exogenous	exogenous	n	y	i	sensitivity & strategic analysis
	period depreciation	-	-	y	-	i	systems analysis
	method depreciation	-	-	y	y	i	systems analysis
	intrest rate	exogenous	exogenous	n	n	i	sensitivity analysis
	composition capital	exogenous	exogenous	n	y	i	sensitivity & strategic analysis
	share rest value	exogenous	exogenous	n	y	i	sensitivity & strategic analysis
Labour cost	wages	exogenous	exogenous	n	y	d	sensitivity analysis
	remuneration entrepreneurship	-	-	y	y	n	systems analysis
	overtime owner-operator	-	-	n	y	n	strategic analysis
Insurance cost	insured value vessel	exogenous	exogenous	n	y	i	sensitivity & strategic analysis
	other insured values	exogenous	exogenous	n	y	n	sensitivity & strategic analysis
	pandi	-	-	n	y	-	strategic analysis
Comm & adm	calculation comm & adm	-	-	y	-	-	systems analysis
Rep & maint	calculation rep & maint	-	-	y	-	-	systems analysis
Overhead cost	labour cost	exogenous	exogenous	n	y	d	sensitivity analysis
	office cost	exogenous	exogenous	n	y	n	sensitivity analysis
	other costs	exogenous	exogenous	n	y	n	sensitivity analysis
	ownership cost	exogenous	exogenous	n	y	n	sensitivity analysis
	number of vessels	exogenous	exogenous	n	y	n	strategic analysis
Fuel cost	fuel price	exogenous	exogenous	n	n	d	sensitivity & strategic analysis
	water depth	exogenous	exogenous	n	n	d	sensitivity analysis
	fuel consumption	endogenous	endogenous	n	y	i	sensitivity & strategic analysis
	load factor	exogenous	endogenous	n	y	i	sensitivity & strategic analysis
	share empty	exogenous	-	n	y	i	sensitivity & strategic analysis
	cost of lubricants	exogenous	exogenous	n	-	-	sensitivity analysis
	average speed	exogenous	exogenous	n	y	d	sensitivity & strategic analysis
Other costs	commissions	exogenous	endogenous	n	n	d	sensitivity & strategic analysis
	waterway dues	exogenous	endogenous	n	n	d	sensitivity & strategic analysis
Operations	non-working days	exogenous	exogenous	n	y	n	sensitivity analysis
	share sailing days	exogenous	-	n	y	n	sensitivity analysis
	working hours	exogenous	exogenous	n	y	n	sensitivity analysis

n = not   y = yes   i = indirect   * in the current situation
n = no   d = direct   - = not applicable

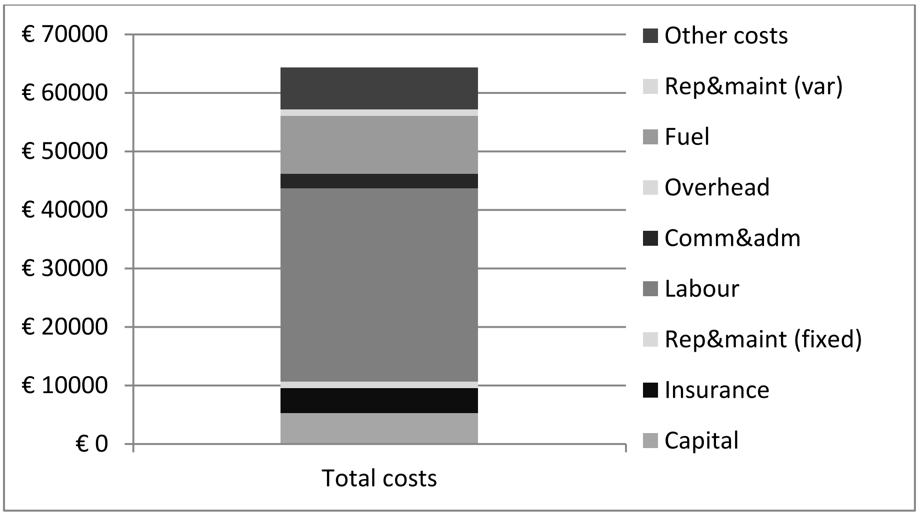
1.4.1 Analysis of the vessel type Spits

-Case description and results basic scenario Spits

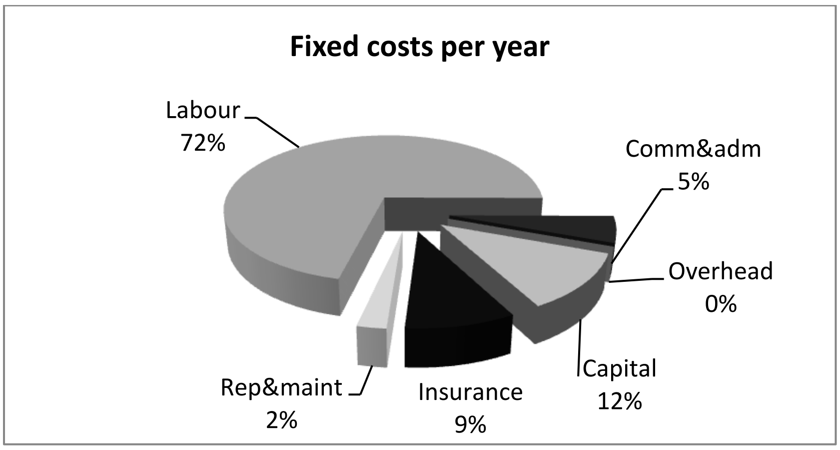
This analysis starts from a basic scenario with an owner-operator and his/her partner operating the vessel at net wages, A1 - 12 hours operations, with a linear depreciation on 25 years, 90% personal capital and mean costs of repair and maintenance and communication and administration.

Graph 1 gives the volume of each of the cost items and the total yearly costs of the vessel. It shows that the fixed costs account for about 75% of the total costs. Furthermore, it is apparent that the main cost factors for this type of vessel are the labour cost, the fuel cost and other costs related to the transports. Graphs 2 and 3 give a more detailed view of the composition of fixed and variable costs for this case. The labour costs are 72% of the fixed costs, followed by the capital costs (12%) and the insurance costs (9%). In this case no overhead cost is included since it is the vessel owner himself who operates the vessel. The fuel costs are just above half of the variable costs (54%). The other costs take the main part of the other half.

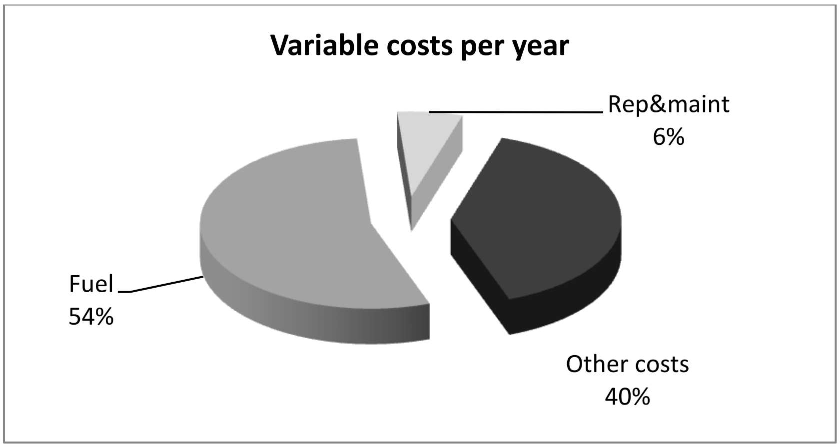
Graph 9.1: Total costs Spits



Graph 9.2: Fixed costs Spits



Graph 9.3: Variable costs Spits



-Sensitivity analysis Spits

The effect of the sensitivity analysis for each cost item on the total costs is represented in table 9.2. The basic scenario is fixed at 100 and the result of each alternative is represented by indices. The sensitivity analysis for this vessel type shows that the main factor influencing the total costs is the commissions (1.65), followed by the speed of the vessel (0.76), the interest rate (0.48), the wages (0.43) and the share of sailing days (0.36).

Table 9.2: Results sensitivity analysis Spits

parameter	0%	1%
value vessel	100	100.08
interest rate	100	100.48
composition capital	100	100.00
rest value	100	99.94
wages	100	100.43
insured value	100	100.00
other insured values	100	100.00
fuel price	100	100.15
water depth	100	99.93
fuel consumption	100	100.15
load factor	100	100.06
share empty	100	99.89
cost of lubricants	100	100.14
speed	100	100.76
commissions	100	101.65
waterway dues	100	100.03
non working days	100	99.97
sailing days	100	100.36
working hours	100	100.15

The effect of the speed is higher for an increase than for a decrease (0.71), because the fuel consumption is not a linear function (see chapter 8). Variables with less effect on the total costs (0.11-0.15) are the fuel price and fuel consumption, the number of working hours per day, the cost of lubricants and share of empty trips. All of these are mainly related to the fuel cost. All other variables have an effect of less than 0.1% when changing the variable with 1%.

-Strategic analysis Spits

In the first alternative the value of the vessel is increased for example with 5% as a result of increasing costs of materials such as steel. In the second alternative the value is reduced by 20%, which can be for example due to the crisis or being the result of not meeting the newest legal standards. Alternative 3 does the same for a different capital structure. In the alternative a share of personal capital of 80% is assumed, where in the basic scenario it is 90%. The last alternative shows the effect of a lower coefficient (10%) for the residual value, which is 20% in the basic scenario. The alternative for the labour costs includes the costs for overtime work for the owner-operator, which is not included in the basic scenario.

The effects of changes in the insurance value of the vessels are calculated in alternative 1 and 2. The same percentages as for the value of the vessel are used. The third alternative shows the effect of an increase in other insured values from 10,000 to 25,000 euro[60] and the last alternative gives the effect of whether or not taking P&I cover for this type of vessel. In chapter 6 it was mentioned that vessel owners of smaller vessel often do not take a P&I insurance because of the high costs.

The fuel price is very likely to increase in future, not only because of scarcity and demand, but also because of more environmental friendly fuel which has a higher cost. Alternative 1 calculates the effects of a price increase of 15%, which is about the price difference between the EN 590 fuel which is due as from 2011 and the fuel which was used before in inland waterway transport. The second alternative looks into a reduction in fuel consumption of 2% due to for example a more efficient engine. In the following two alternatives, the effect of a different capacity utilisation (10% higher load factor and 10% less empty hours) on the variable costs is calculated. To end with, the average speed is adapted.

In alternative 1, a decrease of 5% of commissions paid to charterers is used. This is the result if a vessel does not work via a charterer. The second alternative gives the effect of 5% higher port dues and waterway dues on the variable cost. The last analysis studies the effects of changes in the working days on the hourly costs. The effect of 10 more and 10 less non-working days are determined. Less non-working days occur when the vessel owners for example take fewer holidays. More non-working days can be the result of breakdown of the vessel, problems at the waterways and locks and so on.

The results of the strategic analysis on the total costs are presented in table 9.3. The effects on the fixed costs, variable costs and hourly costs can be found in annex 20. The effect on the fixed and variable costs separately is always more pronounced, because the effect is measured on a smaller amount.

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[60] This amount can be determined by the vessel owner and reflects the value of the contents and navigation equipment of the vessel.

Table 9.3: Results strategic analysis Spits

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	value vessel + 5%	100.41
	alt 2	value vessel - 20%	98.34
	alt 3	-10% own capital	100.05
	alt 4	10% residual value	100.63
Labour cost	alt 1	overtime included	115.38
Insurance cost	alt 1	insured value vessel + 5%	100.01
	alt 2	insured value vessel - 20%	99.96
	alt 3	higher insured values	100.23
	alt 4	include P&I	97.59
Fuel cost	alt 1	fuel price + 15%	102.26
	alt 2	fuel consumption - 2%	99.69
	alt 3	load factor + 10%	100.63
	alt 4	empty hours - 10%	101.10
	alt 5	av. speed - 1km/h	91.38
	alt 6	av. speed + 1 km/h	128.33
Other costs	alt 1	no commissions	92.23
	alt 2	port and waterway dues + 5%	100.17
Operations	alt 1	non working days - 10	97.29
	alt 2	non working days + 10	102.89

The results of the analysis show that the use of the different alternatives for the capital costs have rather limited effects on the total costs. Only a large decrease in value of the vessel has more than 1% effect on the total costs. Including the overtime for the owner-operator does influence the total costs to a large extent (+15%). A change in insured value of the vessel or in the other insured values has only a very minor effect on the premium and the fixed costs. Leaving the P&I out of the insurance cost on the other hand decreases the fixed costs with more than 2% for this type of vessel.

The results show that changes in the average speed have by far the greatest impact on the variable costs (-9% for 1km/h less and +28% for 1km/h more). Also considerable changes in fuel price can have quite some impact on the total costs (+2%). Adaptations of the capacity utilisation with 10% have a small effect on the costs, just like a small reduction of fuel consumption. The strategic analysis of the other cost items shows that small changes of the port and waterway dues have a very limited effect on the total costs. The influence of not including the commission is much higher, reaching almost 8%. The analysis for the operations shows that an in- or decrease of the non-working days by 10 days results in a 2.8% higher hourly cost.

-Systems analysis Spits

The analysis of the different methods which can be used in the model gives the results in table 9.4. Choosing the annuity method (alt 1) instead of the linear depreciation method (basic scenario) has only very little effect (0.22%) on the total costs for this vessel type. The use of a remuneration for entrepreneurship (alt 1) instead of opting for net wages (basic scenario) increases the total costs by almost 42%.

The way of calculating the costs of repair and maintenance and communication and administration based on the dataset (see chapter 6) can also have some influence on the outcome of the cost simulation. Using the median (alt 1) instead of the mean values (basic scenario) has a moderate effect of respectively 1.6 and 0.6%. When using minimum (alt 2) or maximum (alt 3) values, the effect increases (-2.9 to 4.9% and -2.5 to 3.7%).

Table 9.4: Results systems analysis Spits

Cost item	**alternative**	**description alternative**	**index**
	basic scenario		100
Capital cost	alt 1	annuity method depreciation	100.22
Labour cost	alt 1	remuneration entrepreneurship	141.89
rep & maint	alt 1	mean	98.34
	alt 2	min	97.07
	alt 3	max	104.91
comm & adm	alt 1	mean	99.35
	alt 2	min	97.42
	alt 3	max	103.70

-Conclusion of the analysis of the vessel type Spits

The sensitivity analysis shows that changes in the values of 1% in general have less than 1% effect on the total costs. The main effects are found in the commissions, the average speed, the interest rate, the wages and the share of sailing days. From the strategic analysis, it can be concluded that including overtime hours for the owner-operator has a large effect on the total costs. In- or decreasing the average speed of the vessel and not working via a charterer also has extensive effects on the total costs. From the systems analysis, it is clear that using a remuneration for entrepreneurship instead of net wages increases the total costs by more than 40%. Using minimum and maximum instead of mean values can also have a considerable influence. The other options in the model result in moderate effects on the total costs.

1.4.2 Analysis of the vessel type Rhine-Herne

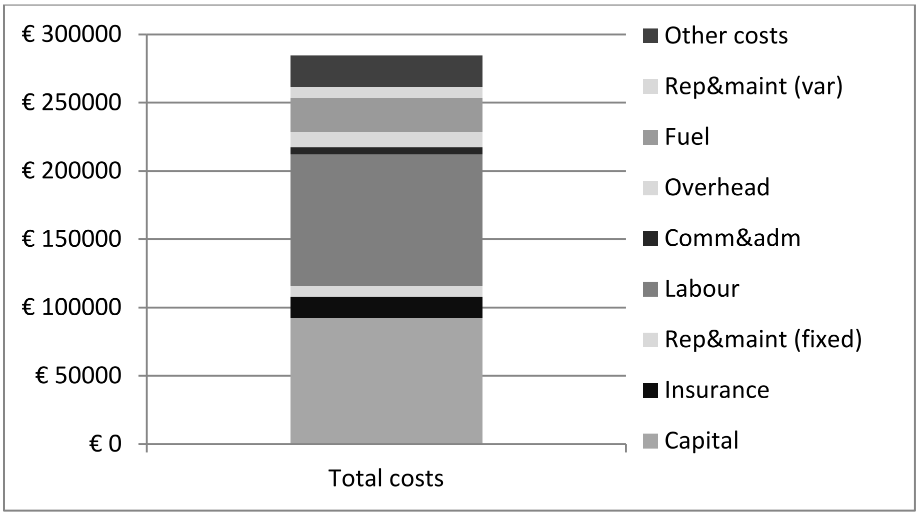
- Case description and results basic scenario Rhine-Herne

The basic scenario in this analysis holds an owner operator and his/her partner operating the vessel at a fixed remuneration for entrepreneurship, A2 - 16 hours operations, with a linear depreciation on

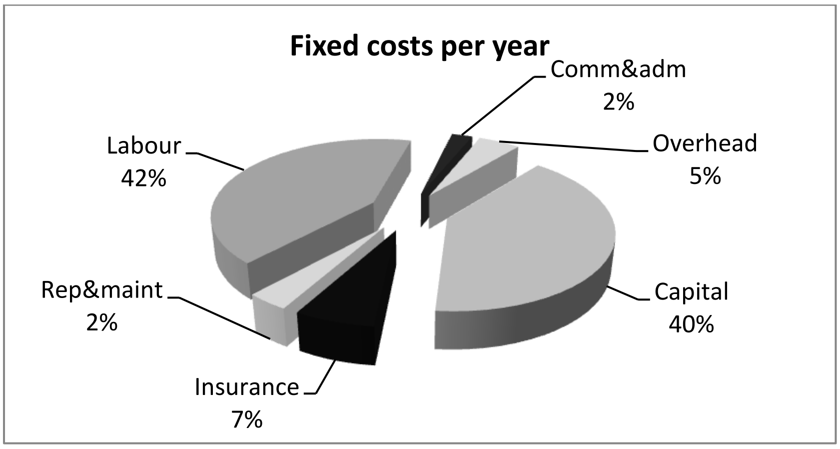
25 years, 60% personal capital, mean costs and being member of a commercial co-operation. In the basic scenario, the water depth is fixed on 4m.

If we compare the results for this vessel type to the one before (Spits), there is a clear difference in the composition of the total costs (see graph 9.4). The fixed costs have a higher share in the total costs (85%) compared to the previous case. The labour cost is still the most important part of the fixed costs (42%), but it is far less pronounced than for the Spits. The capital costs are much higher for this vessel type (40%) and take the second place in importance. The other costs taken together represent only 18% of the total fixed costs. Compared to the previous case, the cost of repair and maintenance takes a more important share of the variable costs (20%). Also the share of the fuel cost (60%) is somewhat higher for this vessel type. Furthermore, there is an overhead cost included in this case, because the vessel in this case is part of a co-operation. The division of the fixed costs (graph 9.4) shows that the overhead cost is only a small part (5%) of the fixed costs.

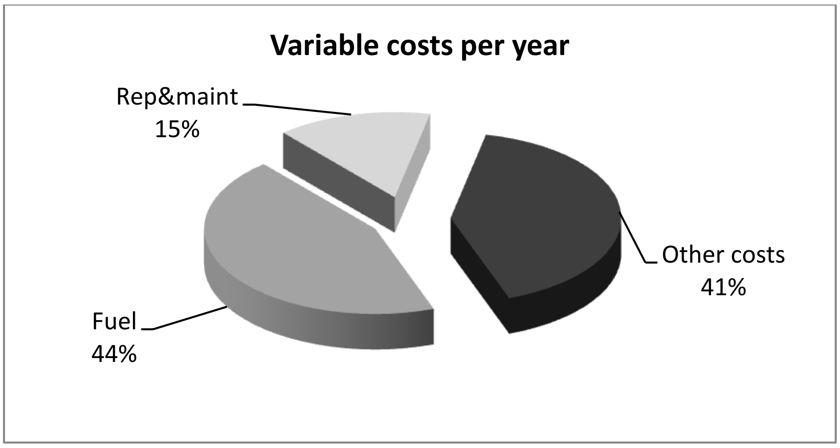
Graph 9.4: Total costs Rhine-Herne



Graph 9.5: Fixed costs Rhine-Herne



Graph 9.6: Variable costs Rhine-Herne



- *Sensitivity analysis Rhine-Herne*

The results of the sensitivity analysis of the vessel type Rhine-Herne can be found in table 9.5. The main effects that are found are the result of a change in interest rate (1.83) and commissions (1.05). Other variables with important effects on the total costs are the value of the vessel (0.32), the rest value of the vessel (-0.24), the speed (0.22) and the sailing days (0.20). It is found that an increase in the wages does not affect the fixed costs strongly (0.13), because it does not affect the remuneration for the owner-operator and his/her partner. It only applies to their employees, hence the effect is limited in this case.

Table 9.5: Results sensitivity analysis Rhine-Herne

parameter	0%	1%
value vessel	100	100.32
interest rate	100	101.83
composition capital	100	99.98
rest value	100	99.76
wages	100	100.13
insured value	100	100.01
other insured values	100	100.00
overhead labour	100	100.01
overhead office	100	100.03
overhead other	100	100.00
fuel price	100	100.09
water depth	100	99.99
fuel consumption	100	100.09
load factor	100	100.02
share empty	100	99.97
cost of lubricants	100	100.08
speed	100	100.22
commissions	100	101.05
waterway dues	100	100.03
non working days	100	99.98
sailing days	100	100.20
working hours	100	100.09

- Strategic analysis Rhine-Herne

For this vessel type, the value of the vessel is adjusted with the same percentages as in the previous case. It is also in this case assumed that part of the capital is provided by a financial institution as a loan. In the basic scenario, 60% of personal capital is assumed. In alternative 3 the effect of a higher share of equity (70%) on the fixed costs is calculated. Furthermore, the impact of the distribution of the overhead costs over a smaller number of vessels is calculated in alternative 1. The results of the strategic analysis of this vessel type are presented in table 9.6.

A large decrease in the value of the vessel has an important impact on the total costs (-6.5), just like a decrease of the residual value (2.49). The main reason for the higher effects in this case compared to the previous one is the higher value of the vessel. It is also found that a higher share of equity only has a limited influence on the total costs. As was found in the previous case, also here the effects of changes in the insurance values on the fixed costs are very small.

The total costs are increased by 1.31 as a result of five vessels less in the co-operation. The same effect is found for a 15% increase of the fuel price. Other important effects are the result of a speed adjustment of 1km/h more or less (1.81 and 2.72) and not paying commissions (-5.27). The results of the analysis also show that 10 more non-working days increase the total costs per hour with about 3%.

Table 9.6: Results strategic analysis Rhine-Herne

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	value vessel + 5%	101.62
	alt 2	value vessel - 20%	93.50
	alt 3	+10% own capital	99.82
	alt 4	10% residual value	102.39
Insurance cost	alt 1	insured value vessel + 5%	100.04
	alt 2	insured value vessel - 20%	99.85
	alt 3	higher insured values	100.04
Overhead cost	alt 1	5 vessels less in the co-operation	101.31
Fuel cost	alt 1	fuel price + 15%	101.31
	alt 2	fuel consumption - 2%	99.83
	alt 3	load factor + 10%	100.20
	alt 4	empty hours - 10%	100.34
	alt 5	av. speed - 1km/h	98.19
	alt 6	av. speed + 1 km/h	102.72
Other costs	alt 1	no commissions	94.73
	alt 2	port and waterway dues + 5%	100.14
Operations	alt 1	non working days - 10	97.08
	alt 2	non working days + 10	103.12

-Systems analysis Rhine-Herne

The basic scenario starts from a fixed remuneration per year, called the remuneration for entrepreneurship. In the second alternative the calculation is made for the net wage. The other alternatives are similar to the ones of the previous case (Spits).

Table 9.7 shows the results of the systems analysis. Using the Dutch system of depreciation over 50 years reduces the total costs by more than 8%. If using net wages for the owner-operator and his/her partner instead of the remuneration for entrepreneurship, the total costs would decrease by almost 7%. Using other ways of calculating the cost of repair and maintenance has a somewhat more important effect when opting for minimum or maximum values. All other options give an effect of around 1% on the fixed costs.

Table 9.7: Results systems analysis Rhine-Herne

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	longer period of depreciation	91.82
	alt 2	annuity method depreciation	100.91
Labour cost	alt 1	net wages for owner-operator	92.75
rep & maint	alt 1	mean	98.25
	alt 2	min	97.51
	alt 3	max	104.99
comm & adm	alt 1	mean	99.91
	alt 2	min	99.01
	alt 3	max	101.81

- Conclusion of the analysis of the vessel type Rhine-Herne

The results of the previous analysis show that the main effects in the sensitivity analysis come from the commissions and interest rate. From the strategic analysis, it can be concluded that important changes in the value and the residual value of the vessel, the commissions paid, the speed of the vessel and the number of working days per year can change the results significantly. The systems analysis of this vessel type shows an important effect of a longer depreciation period and a different remuneration for the owner-operator.

1.4.3 Analysis of the vessel type Kempenaar

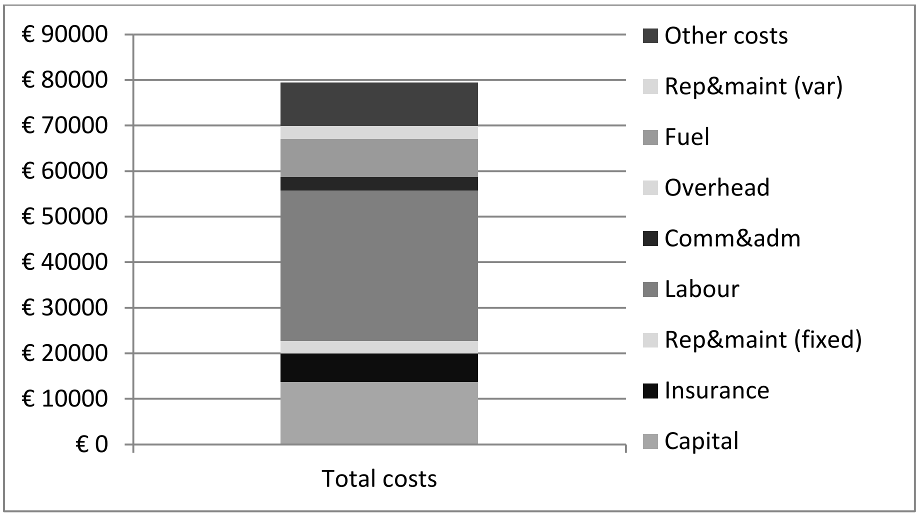
- Case description and results basic scenario Kempenaar

This analysis starts from a basic scenario with an owner-operator and his/her partner operating the vessel at a net wage, A1 and 8h operations, with a linear depreciation on 25 years, 80% personal capital and mean costs for repair and maintenance and communication and administration.

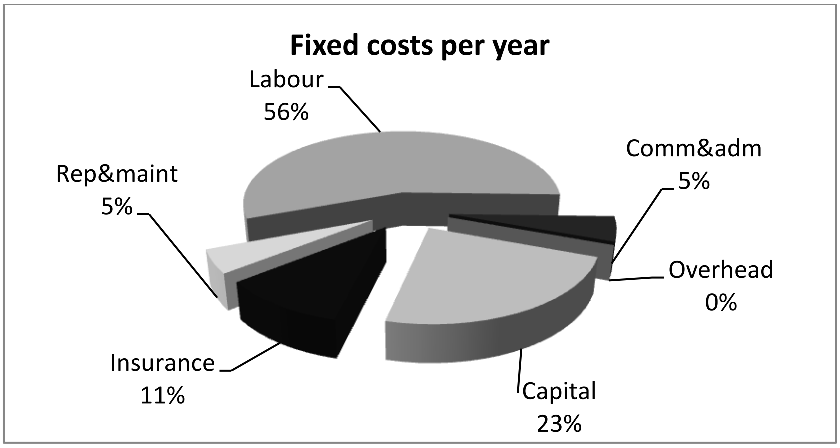
The share of fixed costs for this vessel type is about the same as for the Spits (74%). The labour cost makes up about 42% of the total costs, followed by the capital cost of 17%. The composition of the fixed costs is quite different as a result of the higher capital cost in this case. As can be found in graph

9.8, the labour cost also takes the largest part of the fixed costs (56%). Within the variable costs (graph 9.9), the cost of fuel is rather small because of a non-intensive way of operation, i.e. 8 hours per day.

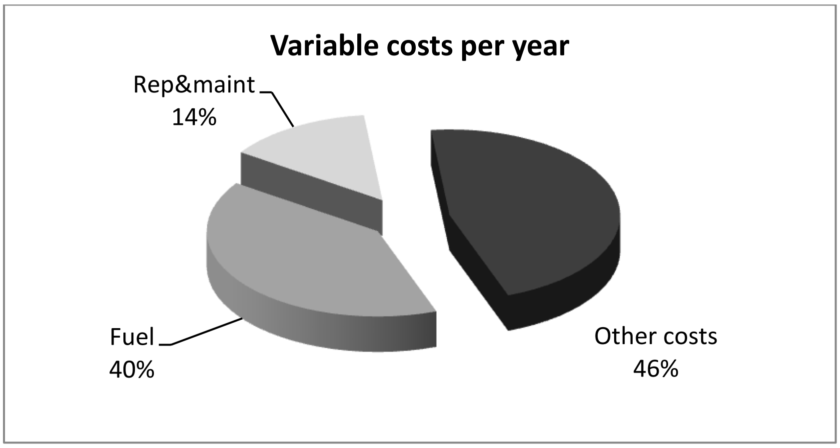
Graph 9.7: Total costs Kempenaar



Graph 9.8: Fixed costs Kempenaar



Graph 9.9: Variable costs Kempenaar



- Sensitivity analysis Kempenaar

An increase of 1% in the share of commissions and the interest rate has the largest effect in the total costs for this vessel type (see table 9.8). The total cost increases respectively by 1.51 and 0.98%. Other variables with somewhat more effect on the costs are the speed (0.44), the wages (0.35) and the share of sailing days (0.24).

Table 9.8: Results sensitivity analysis Kempenaar

parameter	0%	1%
value vessel	100	100.17
interest rate	100	100.98
composition capital	100	99.99
rest value	100	99.87
wages	100	100.35
insured value	100	100.00
other insured values	100	100.00
fuel price	100	100.10
water depth	100	99.96
fuel consumption	100	100.10
load factor	100	100.04
share empty	100	99.92
cost of lubricants	100	100.10
speed	100	100.44
commissions	100	101.51
waterway dues	100	100.04
non working days	100	99.98
sailing days	100	100.24
working hours	100	100.16

- Strategic analysis Kempenaar

In this analysis, the effect of having a partner on board as an independent person is compared to having an employee instead (alternative 1 of the labour costs). Also the option of sailing alone, which is allowed on certain waterways and under certain conditions, is analysed. The other parameter changes are similar to the ones from the previous cases. The results of the strategic analysis are presented in table 9.9.

The share of the labour cost already gives an indication of the effect of the different alternatives related to this cost. The different alternatives for the owner-operator related to his/her partner have an effect of 15 to almost 20% on the total costs. Sailing alone would in this case reduce the total costs with about 20% compared to the basic scenario.

Other important effects are found for the other costs, in alternative 1 were no commissions are included. Furthermore, larger effects are found for an adjustment of the average speed (-3.31 and 5.68), a large decrease in the value of the vessel (-3.44) and leaving out the P&I insurance (-2.19). An increase in the number of non-working days on the one hand reduces the fuel cost, but on the other hand also diminishes the number of effective days, which increases the hourly costs. In this case, 10 more non-working days per year result in a 3% increase of the total hourly costs, while 10 fewer non-working days reduce the total hourly cost by 2.86%.

Table 9.9: Results strategic analysis Kempenaar

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	value vessel + 5%	100.86
	alt 2	value vessel - 20%	96.56
	alt 3	+20% own capital	99.81
	alt 4	10% residual value	101.30
Labour cost	alt 1	employee instead of partner	115.74
	alt 2	sailing alone	80.83
Insurance cost	alt 1	insured value vessel + 5%	100.02
	alt 2	insured value vessel - 20%	99.92
	alt 3	higher insured values	100.19
	alt 4	include P&I	97.81
Fuel cost	alt 1	fuel price + 15%	101.53
	alt 2	fuel consumption - 2%	99.79
	alt 3	load factor + 10%	100.36
	alt 4	empty hours - 10%	100.77
	alt 5	av. speed - 1km/h	96.69
	alt 6	av. speed + 1 km/h	105.68
Other costs	alt 1	no commissions	92.44
	alt 2	port and waterway dues + 5%	100.22
Operations	alt 1	non working days - 10	97.14
	alt 2	non working days + 10	103.06

- Systems analysis Kempenaar

Table 9.10 shows that the main effect of the systems analysis for this vessel type is also found to be the remuneration for entrepreneurship. Using the fixed amount instead of net wages increases the total costs by more than 33%. Using minimum and maximum values instead of mean values could adjust the costs with -6% to +10% for the costs of repair and maintenance. The effect of the same analysis for the costs of communication and administration is much less (2.7%). Also the median values of this parameter are closer to the mean values.

Table 9.10: Results systems analysis Kempenaar

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	annuity method depreciation	100.46
Labour cost	alt 1	remuneration entrepreneurship	133.97
rep & maint	alt 1	mean	96.60
	alt 2	min	93.99
	alt 3	max	110.24
comm & adm	alt 1	mean	99.62
	alt 2	min	97.29
	alt 3	max	102.70

- Conclusion of the analysis of the vessel type Kempenaar

The results of the analysis for the vessel type Kempenaar are similar to those of the vessel type Spits because there are only small differences between both. The main differences found are a result of different characteristics of the basic scenario. The main effects coming out of the sensitivity analysis stem from changes in the commissions, interest, speed, wages and share of sailing days. From the strategic analysis, it can be concluded that sailing alone and sailing with an employee instead of a partner have a considerable influence on the total costs. Using the fixed remuneration has also in this case an extensive effect on the total costs.

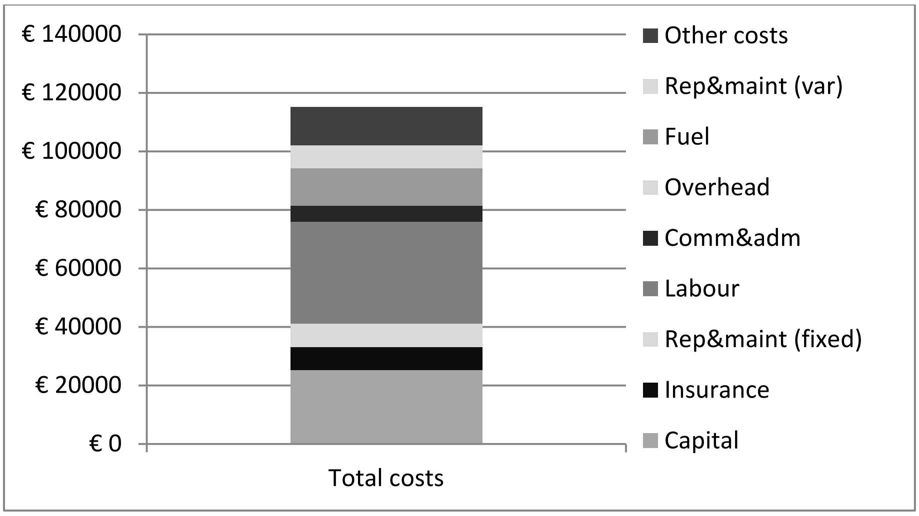
1.4.4 Analysis of the vessel type Canal du Nord

- Case description and results basic scenario Canal du Nord

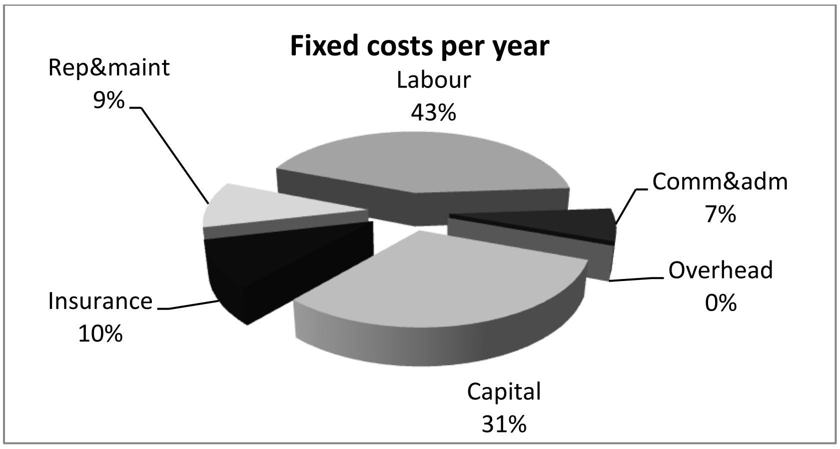
The basic scenario of this analysis has an owner operator and his/her partner operating the vessel at a net wage, A1 - 12 hours operations, with a linear depreciation on 25 years, 80% personal capital and mean costs for repair and maintenance and communication and administration.

Compared to the two types of smaller vessel (Spits and Kempenaar), the share of labour cost in the total is much smaller (graph 9.10). It has only about 30%, followed by the capital cost (22%). Moreover, the cost of repair and maintenance is far more important in this case. The fixed costs are just above 70% of the total costs, which is comparable to the other small vessels.

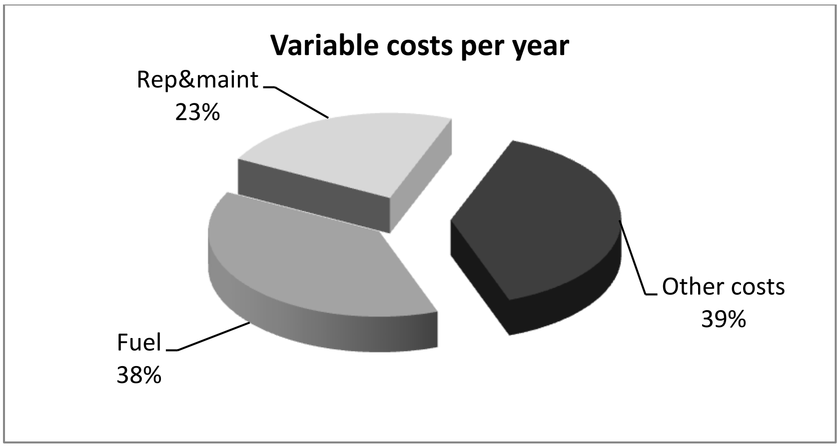
Graph 9.10: Total costs Canal du Nord



Graph 9.11: Fixed costs Canal du Nord



Graph 9.12: Variable costs Canal du Nord



- Sensitivity analysis Canal du Nord

Table 9.11 shows that the most important effects that emerge from the sensitivity analysis are coming from adjustments to the commissions (1.39), the interest rate (1.25), the speed (0.48), the wages (0.26), the share of sailing days (0.26) and the value of the vessel (0.22).

Table 9.11: Results sensitivity analysis Canal du Nord

parameter	0%	1%
value vessel	100	100.22
interest rate	100	101.25
composition capital	100	99.99
rest value	100	99.83
wages	100	100.26
insured value	100	100.01
other insured values	100	100.00
fuel price	100	100.11
water depth	100	99.96
fuel consumption	100	100.11
load factor	100	100.04
share empty	100	99.92
cost of lubricants	100	100.11
speed	100	100.48
commissions	100	101.39
waterway dues	100	100.04
non working days	100	99.98
sailing days	100	100.26
working hours	100	100.11

- Strategic analysis Canal du Nord

In the strategic analysis, we start off from the same adjustments as in the previous cases. For the labour costs, the effect of counting overtime hours and the effect of replacing the partner by an employee is studied. The effect of the alternatives concerning the labour costs is clearly the largest in the analysis (see table 9.12). Including the overtime increases the total costs by more than 9% and replacing the partner increases the costs by more than 19%. Other major effects are the result of not including commissions (-6.95), a large decrease of the value of the vessel (4.38) and changes in the average speed (-3.77 en +6.13%). A change in the working days again has an effect of about 3% on the total costs. All other alternatives influence the total costs by less than 2%.

Table 9.12: Results strategic analysis Canal du Nord

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	value vessel + 5%	101.10
	alt 2	value vessel - 20%	95.62
	alt 3	+20% own capital	99.76
	alt 4	10% residual value	101.65
Labour cost	alt 1	overtime	109.32
	alt 2	employee instead of partner	119.22
Insurance cost	alt 1	insured value vessel + 5%	100.03
	alt 2	insured value vessel - 20%	99.90
	alt 3	higher insured values	100.13
	alt 4	include P&I	98.36
Fuel cost	alt 1	fuel price + 15%	101.65
	alt 2	fuel consumption - 2%	99.78
	alt 3	load factor + 10%	100.44
	alt 4	empty hours - 10%	100.84
	alt 5	av. speed - 1km/h	96.33
	alt 6	av. speed + 1 km/h	106.13
Other costs	alt 1	no commissions	93.05
	alt 2	port and waterway dues + 5%	100.22
Operations	alt 1	non working days - 10	97.16
	alt 2	non working days + 10	103.03

- Systems analysis Canal du Nord

For the vessel type Canal du Nord, the major effect that comes out of the systems analysis is the remuneration of the owner-operator (+21.8%). This was also the case for the other small vessel types. Opting for minimum and maximum values for the cost of repair and maintenance has an effect of around 10% on the total costs (see table 9.13). The deviations for the costs of communication and administration on the other hand are less pronounced (-2.62 and +4.83).

Table 9.13: Results systems analysis Canal du Nord

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	annuity method depreciation	100.58
Labour cost	alt 1	remuneration entrepreneurship	121.80
rep & maint	alt 1	mean	101.16
	alt 2	min	89.78
	alt 3	max	109.42
comm & adm	alt 1	mean	98.89
	alt 2	min	97.38
	alt 3	max	104.83

- Conclusion of the analysis of the vessel type Canal du Nord

The major effects that are found using the sensitivity analysis are similar to the ones from the other small vessel types (Spits and Kempenaar). The commissions, interest rate, speed and wages are the variables which have the highest effect on the total costs. The alternatives which were found to have a serious effect (>13%) on the total costs in the strategic analysis of this case are the overtime hours and hiring an employee instead of a partner. The other results are also similar to the other small vessel types. This means that reducing the effective hours per day, adapting the average speed, decreasing the value of the vessel considerably and not using a charterer have the largest effects on the total costs. From the systems analysis, it shows that the remuneration of the owner-operator has the main effect. Furthermore, using minimum and maximum values for the cost of repair and maintenance and using maximum values for the cost of communication and administration have an important effect (more than 4%) on the total costs.

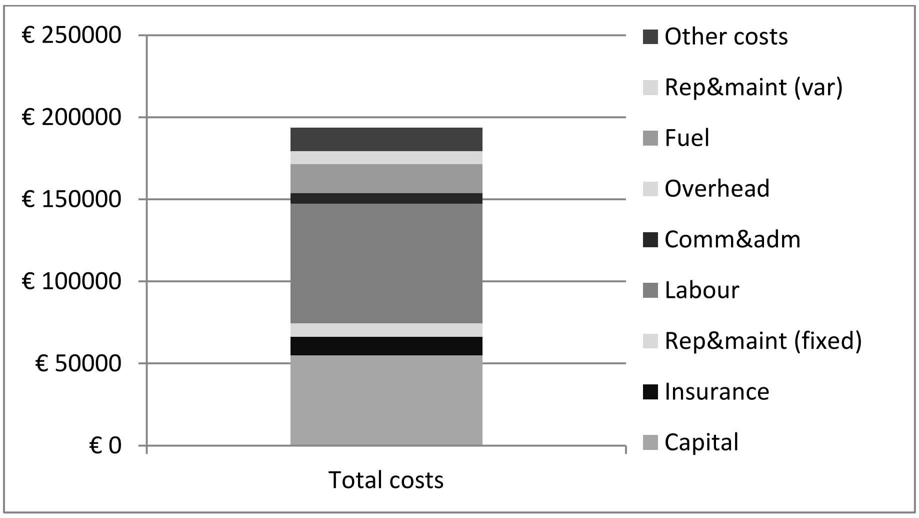
1.4.5 Analysis of the vessel type Dortmunder

- Case description and results basic scenario Dortmunder

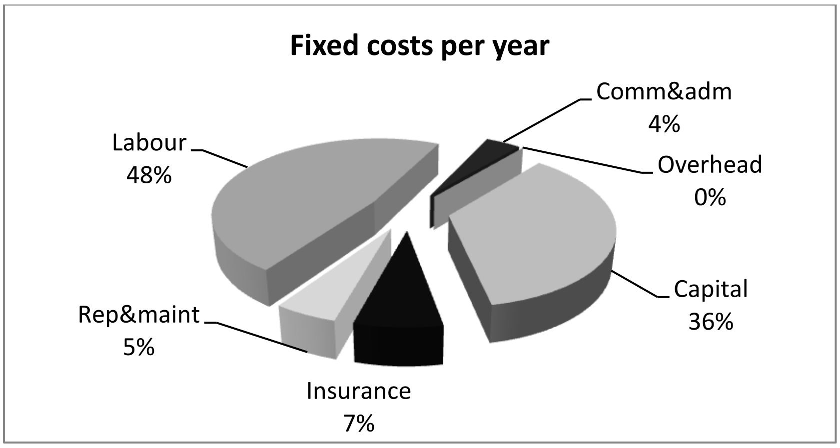
The sensitivity analysis starts with an owner-operator and his/her partner operating the vessel with a remuneration for entrepreneurship, A2 - 14h operations, with a linear depreciation on 25 years, 60% personal capital and mean costs for repair and maintenance and communication and administration.

The labour cost is the main cost item, represent about 38% of the total costs and almost half of the fixed costs (graph 9.13 and graph 9.14). The share of the capital cost reaches almost 30% of the total costs in this case. The three components of the variable costs each have a substantial share (see graph 9.15).

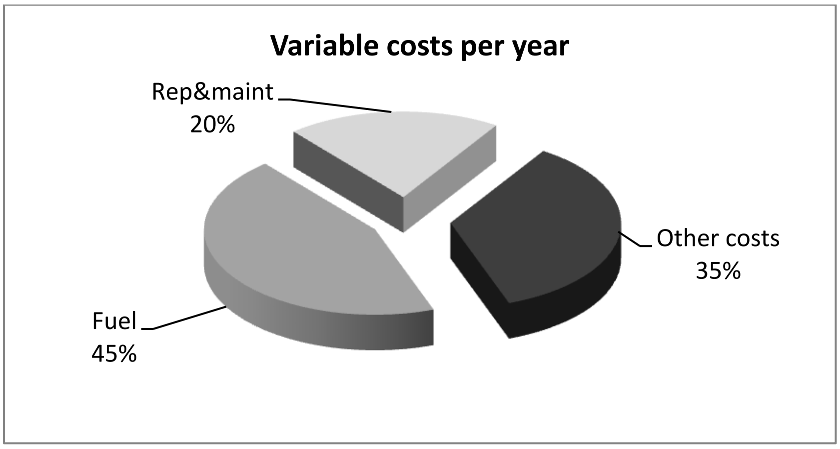
Graph 9.13: Total costs Dortmunder



Graph 9.14: Fixed costs Dortmunder



Graph 9.15: Variable costs Dortmunder



- *Sensitivity analysis Dortmunder*

The main effects which come out of the sensitivity analysis of this vessel type (see table 9.14) are caused by adjustments to the interest rate (1.61), the commissions (0.83), followed by the wages (0.35), the speed (0.33), the value of the vessel (0.29) and the share of sailing days (0.21). Compared to the smaller vessel types, changes related to the capital costs become more important. This is the result of a higher capital intensity of the larger vessels.

Table 9.14: Results sensitivity analysis Dortmunder

parameter	0%	1%
value vessel	100	100.29
interest rate	100	101.61
composition capital	100	99.98
rest value	100	99.79
wages	100	100.35
insured value	100	100.01
other insured values	100	100.00
fuel price	100	100.09
water depth	100	99.97
fuel consumption	100	100.09
load factor	100	100.02
share empty	100	99.94
cost of lubricants	100	100.09
speed	100	100.33
commissions	100	100.83
waterway dues	100	100.03
non working days	100	99.98
sailing days	100	100.21
working hours	100	100.09

- *Strategic analysis Dortmunder*

In the strategic analysis (table 9.15), a load factor of 10% less is used in alternative 3 of the fuel costs, because the load factor in the basic scenario is already quite high for this type of vessel (91%). Results show that this adjustment only has a minor effect on the total costs (0.24). Again, the alternatives related to the labour costs have the largest effects on the total costs i.e. overtime: +8.08 and an employee instead of a partner: +18.89%. Also the other results are similar to the previous cases. Strong changes in the value of the vessel (-20%) has a large impact on the total costs (-6.71%). Also changes in average speed, in the commission and the operations have effects of 3% and more.

Table 9.15: Results strategic analysis Dortmunder

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	value vessel + 5%	101.43
	alt 2	value vessel - 20%	94.29
	alt 3	+20% own capital	99.85
	alt 4	10% residual value	102.10
Labour cost	alt 1	overtime	108.08
	alt 2	employee instead of partner	118.89
Insurance cost	alt 1	insured value vessel + 5%	100.03
	alt 2	insured value vessel - 20%	99.87
	alt 3	higher insured values	100.05
	alt 4	include P&I	98.81
Fuel cost	alt 1	fuel price + 15%	101.37
	alt 2	fuel consumption - 2%	99.82
	alt 3	load factor - 10%	99.76
	alt 4	empty hours - 10%	100.56
	alt 5	av. speed - 1km/h	97.44
	alt 6	av. speed + 1 km/h	104.02
Other costs	alt 1	no commissions	95.86
	alt 2	port and waterway dues + 5%	100.16
Operations	alt 1	non working days - 10	97.10
	alt 2	non working days + 10	103.10

- Systems analysis Dortmunder

Again for this vessel type, the remuneration of the owner-operator has a major impact on the costs (+10.66%). The effect is decreasing with the vessel size because the share of labour costs in the total costs is also decreasing (see table 9.16). Where the share of the labour costs for the Spits is more than half of the total costs, it is less than 40% in this case. As a result of the longer depreciation period, the total costs decrease by more than 7%. Using median values gives about the same result as the basic scenario for both the costs of repair and maintenance and communication and administration.

Table 9.16: Results systems analysis Dortmunder

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	longer period of depreciation	92.80
	alt 2	annuity method depreciation	100.80
Labour cost	alt 1	remuneration entrepreneurship	110.66
rep & maint	alt 1	mean	99.47
	alt 2	min	94.68
	alt 3	max	106.57
comm & adm	alt 1	mean	99.72
	alt 2	min	97.04
	alt 3	max	104.39

- Conclusion of the analysis of the vessel type Dortmunder

When summarising the sensitivity analysis for the Dortmunder, it is clear that the interest rate and commissions are the main factors influencing the costs. Also the wages, speed and value of the vessel are important. The strategic analysis shows that mainly the alternatives related to the labour costs, the values and speed of the vessel and the commissions are important when determining the effect on the total costs. The systems analysis shows that mainly the remuneration for the ownership influences the total costs. Also the longer depreciation period and using extreme values for the costs of repair and maintenance have considerable effects.

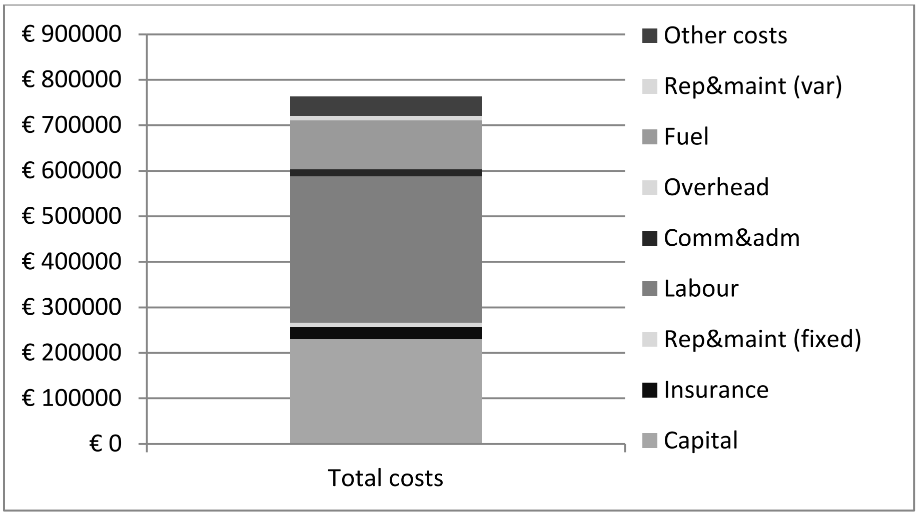
1.4.6 Analysis of the vessel type Large Rhine vessel

- Case description and results basic scenario Large Rhine vessel

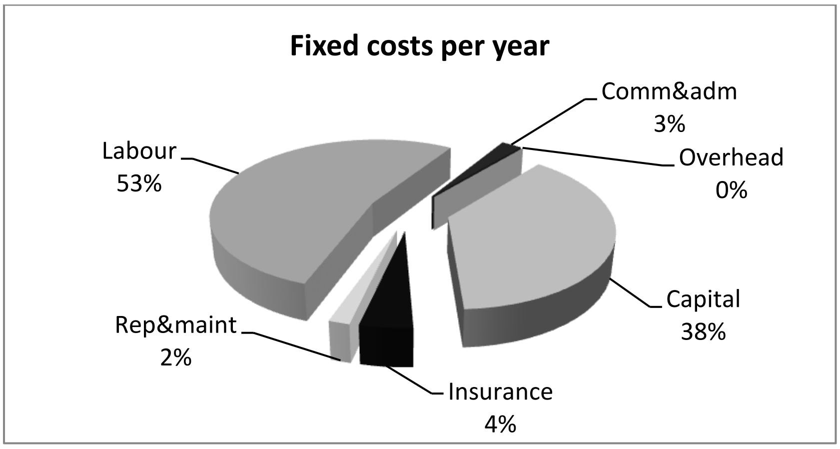
The basic scenario of the analysis of the Rhine vessel has two owner-operators and their partners operating a vessel of less than 10 years old, at a remuneration for entrepreneurship, in continuous operations, with a linear depreciation on 25 years, 30% personal capital and mean costs.

The labour and capital costs are the main cost items, taking respectively 42% and 30% of the total costs. The higher capital intensity compared to other vessel types and the intensive operations bring along extensive expenses in these areas. Also the fuel costs have a rather large share in the total costs (14%). Moreover they make up 67% of the variable costs.

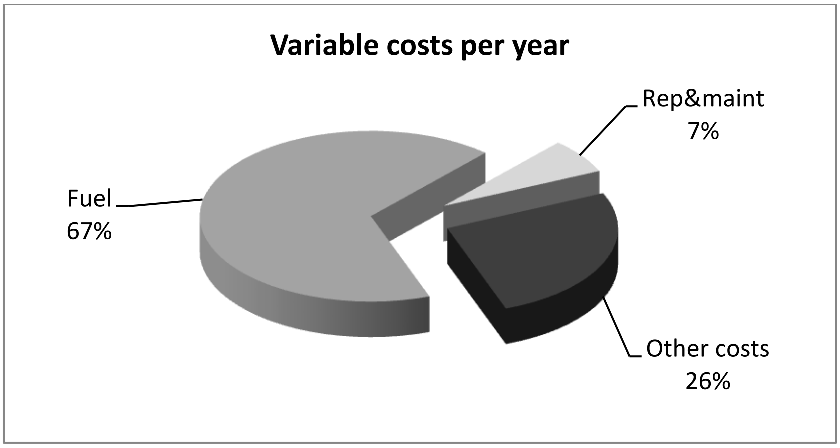
Graph 9.16: Total costs Large Rhine vessel



Graph 9.17: Fixed costs Large Rhine vessel



Graph 9.18: Variable costs Large Rhine vessel



- Sensitivity analysis Large Rhine vessel

The results of the sensitivity analysis in table 9.17 shows that an increase of 1% of the interest rate has the main effect on the total costs (2.52), followed by an increase of the share of commissions (0.85). This is followed by the speed (0.43), the share of sailing days (0.36), the value of the vessel (0.33) and the wages (0.29). The effect of an increase of the wages is also not that high in this case. This results from the assumption that the vessel is operated by two couples of independent people at a fixed remuneration. The share of labour costs for employees is therefore limited.

Table 9.17: Results sensitivity analysis Large Rhine vessel

parameter	0%	1%
value vessel	100	100.33
interest rate	100	102.52
composition capital	100	99.98
rest value	100	99.84
wages	100	100.29
insured value	100	100.01
other insured values	100	100.00
fuel price	100	100.16
water depth	100	99.96
fuel consumption	100	100.15
load factor	100	100.03
share empty	100	99.92
cost of lubricants	100	100.15
speed	100	100.43
commissions	100	100.85
waterway dues	100	100.02
non working days	100	99.99
sailing days	100	100.36
working hours	100	100.15

- Strategic analysis Large Rhine vessel

In case the two owner-operators did not have their partner working on board as an independent person and hired an employee instead, the staff costs would go up by 12.2% (see table 9.18). A large decrease in the value of the vessel can influence the fixed costs to a large extent (-6.03). Changes in the characteristics of the insurance hardly have any effect on the costs. Not using a charterer and adjusting the speed have an influence of 3-4% on the total costs. The effect of in- or decreasing the speed is not very large compared to the other vessel types. Increases in fuel price of 15% have an important effect on the total costs (2.17). This is the result of a moderate speed assumed in the basic scenario (see chapter 6). An in- or decrease in the number of non-working days influence the total hourly costs by about 2.5%.

Table 9.18: Results strategic analysis Large Rhine vessel

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	value vessel + 5%	101.51
	alt 2	value vessel - 20%	93.97
	alt 3	-10% own capital	100.22
	alt 4	10% residual value	101.51
Labour cost	alt 1	employee instead of partner	112.22
Insurance cost	alt 1	insured value vessel + 5%	100.03
	alt 2	insured value vessel - 20%	99.86
	alt 3	higher insured values	100.02
Fuel cost	alt 1	fuel price + 15%	102.17
	alt 2	fuel consumption - 2%	99.72
	alt 3	load factor + 10%	100.25
	alt 4	empty hours - 10%	99.22
	alt 5	av. speed - 1km/h	97.33
	alt 6	av. speed + 1 km/h	103.97
Other costs	alt 1	no commissions	96.07
	alt 2	port and waterway dues + 5%	100.08
Operations	alt 1	non working days - 10	97.55
	alt 2	non working days + 10	102.60

- Systems analysis Large Rhine vessel

Using net wages instead of a fixed remuneration for the owner-operator reduces the costs by about 5% (see table 9.18), which is far less than the effect of the same alternative for the smallest vessels where it attains about 30 to 40%. As was found for the Rhine-Herne vessel type, the longer period of depreciation results in a decrease of the costs. In this case the total costs are reduced by more than 2%. The use of maximum values for the cost of repair and maintenance and communication and administration have a certain impact on the costs (-2.3 to +5%), but only very small effects are found when using median values.

Table 9.19: Results systems analysis Large Rhine vessel

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	longer period of depreciation	97.83
	alt 2	annuity method depreciation	101.32
Labour cost	alt 1	net wages for owner-operator	95.02
rep & maint	alt 1	mean	100.00
	alt 2	min	97.66
	alt 3	max	105.09
comm & adm	alt 1	mean	99.92
	alt 2	min	98.88
	alt 3	max	103.00

- Conclusion of the analysis of the vessel type Rhine vessel

The sensitivity analysis of the cost items for the total costs (table 9.19) show that the interest costs and costs of commissions are the variables that have the main effect on the total costs. Also the speed, the sailing days and value of the vessel are important variables. From the strategic analysis, it is clear that including a partner in the crew results in much lower costs than using an employee instead. By using net wages instead of the fixed remuneration for entrepreneurship, the costs coming out of the model are reduced by 5% for this vessel type, which is a large difference with the smaller vessels.

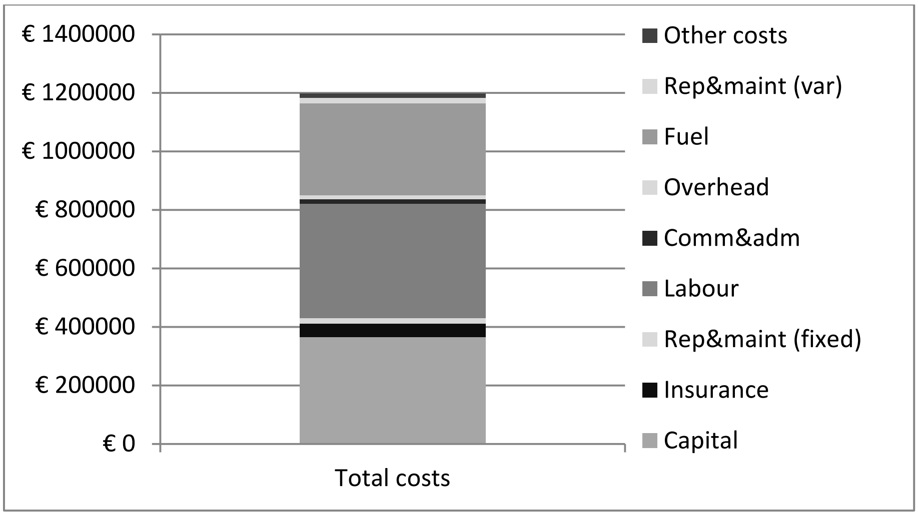
1.4.7 Analysis of the vessel type Large container vessel

- Case description and results basic scenario Large container vessel

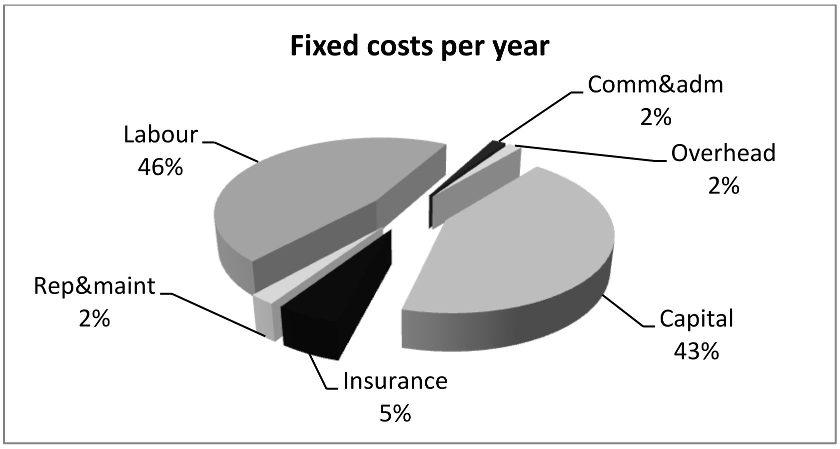
In this analysis the vessel is owned and operated by a shipping company, owning and operating a fleet of 20 vessels. The vessel is used in continuous operations with only employees on board. A linear depreciation on 25 years, 30% personal capital and mean values for the costs or repair and maintenance and communication and administration are assumed for this analysis.

As was found for the other vessel types, here again the labour cost is the main cost item. Its share is almost 33% of the total costs (see graph 9.19). Furthermore, the capital and fuel costs have an important share, respectively 30 and 29%. Because the owner is a shipping company, overhead costs are included in this case, but they prove to be only a very small part of the total costs. The variable costs are made up almost entirely of the fuel costs (90%).

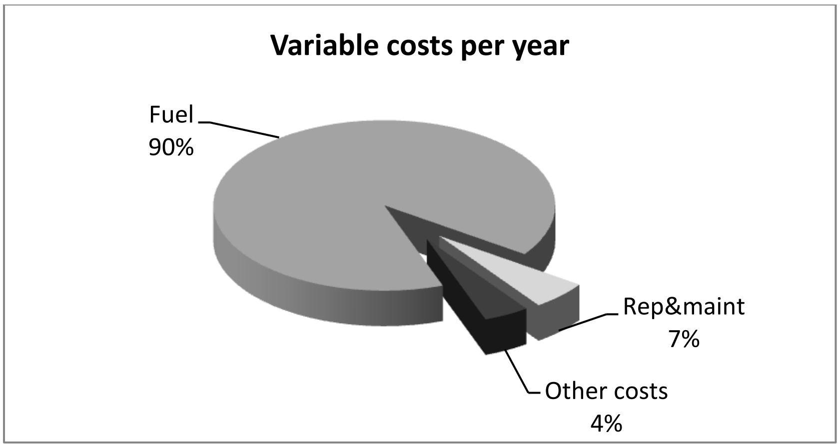
Graph 9.19: Total costs Large container vessel



Graph 9.20: Fixed costs Large container vessel



Graph 9.21: Variable costs Large container vessel



- Sensitivity analysis Large container vessel

The results of the sensitivity analysis for the Large container vessel are presented in table 9.20. The largest effect is due to an increase of the interest rate (2.35), followed by the speed (0.83). The effect of a 1% increase in the share of sailing hours has an important effect on the total costs because on the one hand, the number of effective hours is large and on the other hand, the fuel consumption per hour is also high. Other important effects come from an increase in the wages (0.33) and an increase in the value of the vessel (0.31).

Table 9.20: Results sensitivity analysis Large container vessel

parameter	0%	1%
value vessel	100	100.31
interest rate	100	102.35
composition capital	100	99.98
rest value	100	99.85
wages	100	100.33
insured value	100	100.01
other insured values	100	100.00
share rep & maint variable	100	100.00
fuel price	100	100.27
water depth	100	99.90
fuel consumption	100	100.26
load factor	100	100.03
share empty	100	99.88
cost of lubricants	100	100.25
speed	100	100.83
waterway dues	100	100.01
non working days	100	99.98
sailing days	100	100.61
working hours	100	100.26

- Strategic analysis Large container vessel

The results of the strategic analysis for the container vessel can be found in table 9.21. It shows that a large decrease in the value of the vessel (-20%) reduces the total costs by more than 6%. The downward adjustment of the speed with 1km/h has an effect of 4.56 on the total costs while an increase of 1km/h results in 6.5% higher costs. In this case, also an increase of the fuel price by 15% increases the total costs to a large extent (+4.11%). If the fleet of the co-operation was reduced by five vessels, this would only have a very small effect on the total costs (0.56%).

Table 9.21: Results strategic analysis Large container vessel

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	value vessel + 5%	101.53
	alt 2	value vessel - 20%	93.89
	alt 3	-10% own capital	100.23
	alt 4	10% residual value	101.53
Insurance cost	alt 1	insured value vessel + 5%	100.04
	alt 2	insured value vessel - 20%	99.85
	alt 3	higher insured values	100.02
Overhead cost	alt 1	5 vessels less in the co-operation	100.56
Fuel cost	alt 1	fuel price + 15%	104.11
	alt 2	fuel consumption - 2%	99.48
	alt 3	load factor + 10%	100.29
	alt 4	empty hours - 10%	101.17
	alt 5	av. speed - 1km/h	95.44
	alt 6	av. speed + 1 km/h	106.50
Other costs	alt 1	port and waterway dues + 5%	100.06
Operations	alt 1	non working days - 10	97.89
	alt 2	non working days + 10	102.24

- Systems analysis Large container vessel

It is found from the systems analysis that a longer depreciation reduces the total costs with 2.2%. Using annuity instead of linear depreciation increases the costs by 1.33%. The effect of the other methods of calculating the costs of repair and maintenance and communication and administration are rather small compared to the results of the other vessel types (<2%).

Table 9.22: Results systems analysis Large container vessel

Cost item	alternative	description alternative	index
	basic scenario		100
Capital cost	alt 1	longer period of depreciation	97.80
	alt 2	annuity method depreciation	101.33
rep & maint	alt 1	mean	100.15
	alt 2	min	98.23
	alt 3	max	101.31
comm & adm	alt 1	mean	100.04
	alt 2	min	99.52
	alt 3	max	101.16

- Conclusion of the analysis of the vessel type Large container vessel

From this last analysis it is found that like for the other larger vessels, changes in the interest rate have important effects on the total costs. Also the speed, the share of sailing hours, the wages and the value of the vessel are main factors. The strategic analysis shows the importance of substantial changes in the fuel costs for this vessel type. Also speed adjustments and large changes in the value of the vessel can have quite some effect on the costs. The period of depreciation emerges from the systems analysis as an important aspect for this vessel type.

Conclusion concerning the analysis of parameter values, coefficients and methods

The effect of changes in parameter values, coefficients and methods on the fixed and variable costs individually are higher than on the total costs. Since vessel owners sometimes only take their variable costs into account, it is important to have a view on the effect of both the total and the fixed and variable costs separately. The previous analysis presents a detailed description of the main findings for each vessel type. The main conclusions for the model as a whole are summarised here.

The variables which come out of the sensitivity analysis as having the largest effect on the total costs are rather stable for all vessel types. The commissions, interest costs, speed, wages and share of sailing days are the main factors that emerge from each sensitivity analysis. Their order and the magnitude of the effect are different according to the vessel types. For the larger vessels, the interest costs are much more important than for the smaller ones because a larger amount of capital is involved. The same is true for adjustments to the value of the vessel. The effect of a small change in the value of the vessel is much larger for the largest vessel types than for the smaller ones. Large changes in the values of the vessels, which could be a result of changing market conditions, have a serious influence on the total costs.

For companies that have no or little employees or use a fixed remuneration for entrepreneurship, the effect of changes in wages does not affect their costs. For companies that would count with net wages or that have employees, changes in the wages prove to be an important factor. Overall, the composition of the capital has only very small effects on the total costs. If the gap between the interest rate used for the loans and the one for the equity were enlarged, this could become more important. Also changes in the residual value and in the variables connected to the insurance costs have little effect on the total costs. Changes in the overhead costs have almost no effect on the costs, because their share in the total costs is very small.

Moderate adjustments to the waterway dues have only small effects on the total costs in the cases calculated here. If a vessel sailed intensively on a waterway or had frequent calls in a port and the rates increased substantially, this could have a larger effect though. The share of the commissions paid to charterers is one of the major variables that come out of the sensitivity analysis. When assuming the vessel does not work with a charterer, this results in a large effect on the costs. With respect to the fuel costs, the speed is the main factor. Besides the speed, also the price of the fuel and the fuel consumption of the engine are important. The capacity utilisation i.e. load factors and share of empty trips only has a certain effect if larger changes are made.

The effect of the operations on the costs cannot be forgotten, because they influence the total cost to a great extent. Adjustments to the share of sailing days results in one of the major effects on the costs and also the working hours per day are important. Moreover, a number of days per year more or less in operations has quite some influence on the hourly costs of a vessel.

From the systems analysis it can be concluded that the method of depreciation has only minor effect on the costs. The period of depreciation is only important for the more recent vessel types and proves to be quite important. Using median values for the costs of repair and maintenance and communication and administration overall does not change the results to a large extent. The minimum and maximum values on the other hand are quite different for some vessel types.

It is important to emphasise that the analysis is performed for each cost item separately. It has to be stated though that combining certain changes, which each have only minor effect on the total costs, can lead to significant changes in the outcome. Based on the previous analysis, it is clear which parameters can have a substantial effect on the cost of a vessel and as a result on the profitability of the vessels. Therefore, in further analyses and case studies, the conclusions made here should be kept in mind.

2. Case studies

In the beginning of chapter 8, the purpose of the cost simulation is described. The model should enable to determine:

- the differences between equal vessel types as a result of choices of the owner or operator
- the differences between vessel sizes
- the differences between types of companies
- the differences between countries
- the effect of policy measures

There are a number of short-term decisions which can be taken by the vessel owner, some with a higher and some with a lower impact on the profitability of the vessel. Some of the options are related to the type of company. A self-employed vessel owner for example can operate a vessel together with his/her partner or can choose to have more employees on board instead. This option is not available for shipping companies. From the strategic and systems analysis in the first part of this chapter it results that the choices concerning the remuneration of the vessel-owner and the composition of the staff have important effects on the costs, certainly for smaller vessels. Furthermore, the intensity of operations influences costs to a great extent. But more intensive operations also increase the vessel productivity (see chapter 5) and therefore might result in higher revenues and higher profits. The analysis also shows that fuel costs are the main aspect of the variable costs for the vessels in intensive operations. Changes in the vessel speed prove to have the largest effect on the costs.

In order to demonstrate the usability of the model for questions in the first three domains, three basic case studies are developed. The basic case studies are all situated in the dry cargo segment. For each case a shipment and route is specified on which the yearly costs are based. For each case a short-term decision as well as a long-term (strategic) one is investigated.

The short-term decisions which can be taken by the vessel owner and which are studied in these cases are:

- The partner/employee(s) (in case of owner-operator)
- The remuneration for entrepreneurship
- The intensity of the operations
- The vessel speed

Next to these short-term decisions, choices can be made by vessel owners on the long-term. These decisions are more of a strategic nature and equally have their influence on costs and revenues. The long-term decisions studied here are:

- Size of the vessel
- Type of company (incl. membership of a co-operation)
- New or older vessel

The three case studies each present a typical case from the sector in the dry cargo segment. First, there is a domestic case in which a small vessel operates on a small waterway. Second, there is a case in which the Port of Antwerp is connected to an inland terminal via a large waterway. Last, an international case on the river Rhine is developed. This way, the different navigation areas are covered.

Based on these three basic cases, 3 more case studies being developed. Two of these cases address the effects of external decisions taken by policy makers such as governments or ports on the costs and profitability of vessels. It is chosen to determine the effect of internalising the external costs for inland waterways transport on long distances in the first case and evaluating the effect of more efficiency in the port in the second case. The other case investigates the use of a new technology. Afterwards, the effect of differences between countries is simulated.

The cost difference between vessels in the case studies gives an idea on the competitiveness of the vessels for each specific case. For one shipment, vessel owners do not always include the entire cost into the calculations of the freight tariff. They can only look at the out-of-pocket costs for this transport, which are the variable costs in this model. Since this is not an economically viable situation, the profitability in the long term has to be included in the analysis. In the case studies, this is done by calculating the costs for a regular transport on a yearly basis and including the yearly revenues which can be gained. The difference between both gives the yearly profitability. This way, all the costs which may be disregarded for a certain period, such as capital costs, are included in the calculation.

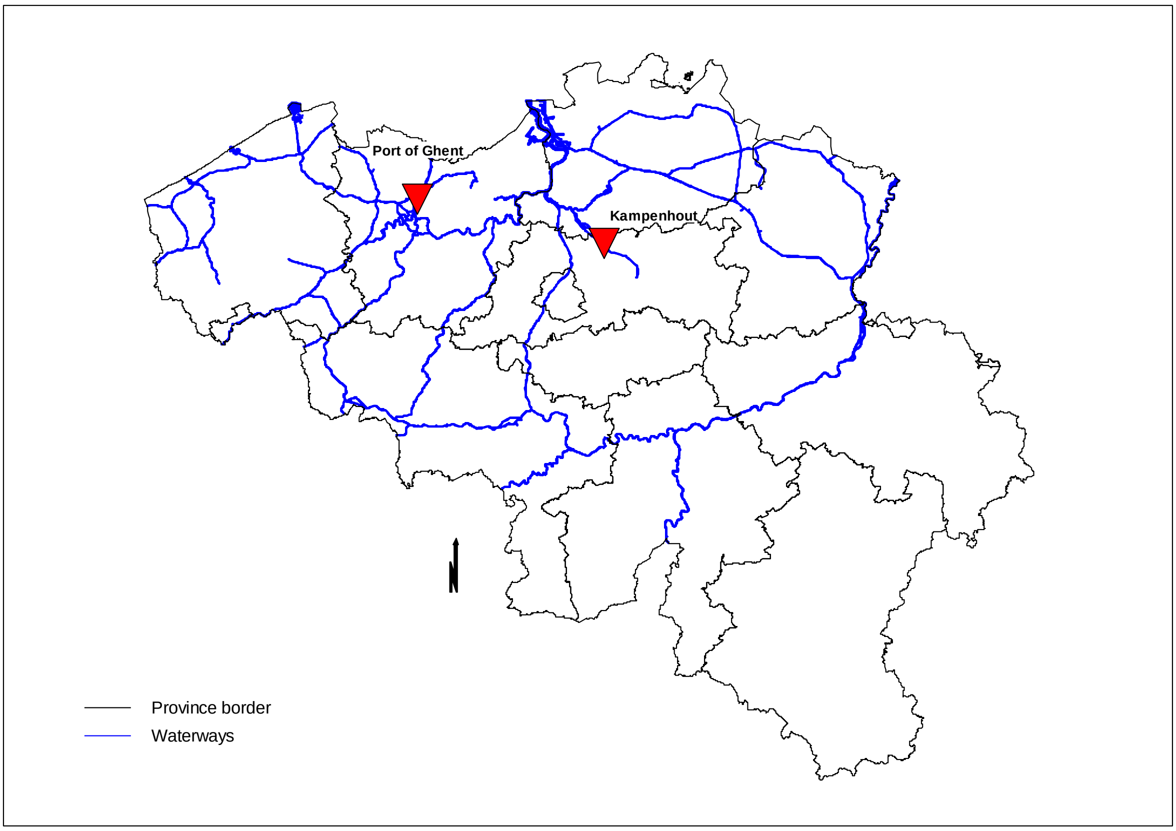
If the profitability of the vessel is taken into account, it becomes clear why certain vessels or certain types of operations are common or not in such a case. It is important to emphasise again the fact that this calculation is made for a single case for a whole year, while in reality vessels which are operating on the spot market have very diversified trips of which some are more and some are less profitable. As said before, operators can in the short- term accept less profitable orders as long as the costs of the trip are covered. In the long- term, a total cost coverage is necessary.

2.1. Basic case studies

2.1.1 Description and results case study 1

The first case is the transport of dry bulk goods from the port of Ghent to a destination about halfway on the small canal Leuven-Dijle (Kampenhout) by a vessel type Kempenaar. Both locations on the Belgian territory are indicated on figure 9.1. This is a distance of about 130 km with 6 locks (of which 2 tidal ones). Based on the average speed of the vessel such a trip would take 5 days. These days entail the time to load in the port of Ghent, the time to sail from Ghent to Kampenhout, the time to unload the goods there and the sailing time back to the port. For loading and unloading, each time one day is assumed. Since two of the locks that have to be passed are tidal ones, 3 days[61] in total are counted for the time needed to get there and back. It is assumed that the vessels are sailing in A1 operations, allowing them to sail from 6h00-22h00.

Figure 9.1: Illustration of case study 1



Source: own composition

For the calculation of the fixed costs, 61 of such journeys per year are taken into account in the first simulation of the case. Furthermore in this part, the calculations are made for an owner-operator on the one hand and for a shipping company on the other hand. In the case of the shipping company it is assumed that no intermediary party is involved, resulting in no commission fees. The second

[61] 3 days of 12h/day

simulation of the case study is equal to the first simulation, except for the number of people working on board. In this case, the operator sails alone, which is allowed on certain waterways and under certain conditions (see chapter 4). Therefore the labour regulation is stricter and a trip to Kampenhout and back would take 6 days. In this case 51 of such trips can be made per year.

Table 9.23 gives the result of both simulations for case 1. The results are given in indices, relative to the first option, being the vessel operated by an owner-operator. The results show that for the same vessel and number of trips, the shipping company has a fixed cost which is almost 39% higher in the first simulation. The variable cost in this simulation is however about 32% lower. The difference is mainly in the fact that for shipping companies, no commission on the freight tariff (variable cost) is taken, since it is already included in the overhead costs (fixed cost). This leads to a total cost of the shipping company which is 27% higher than the one of the owner-operator for this simulation.

In the second simulation, two similar calculations are made, but this time for a vessel operated by only one person. The results in table 9.23 show that this leads to a situation where the shipping company operates the vessel at almost 20% lower costs than the owner operator. This is the result of the choice of using the 'remuneration for entrepreneurship', in which case a fixed sum is used per vessel (see chapter 8). In this simulation, the shipping company can work with one person less, but for the owner-operator the same labour cost is used compared to the previous situation.

Table 9.23: Results of case study 1

	Normal crew composition		**Sailing alone**	
	owner-operator	**shipping company**	**owner-operator**	**shipping company**
Fixed costs	100.0	138.5	100.0	82.3
Variable costs	100.0	67.7	100.0	67.7
Total costs	100.0	127.1	100.0	80.3

Since using a remuneration for entrepreneurship for small vessels is, although reasonable from an economic point-of-view, not close to reality, the same exercise is done based on net wages. Table 9.24 presents the results of this simulation. It is clear that using a net wage for the owner-operator, which is lower than the remuneration for entrepreneurship, increases the difference between both types of companies and makes the shipping company more expensive compared to the owner-operator. In the normal crew composition, the shipping company operates at costs which are about 72% higher than for the owner operator. When operating the vessel alone, the owner-operator still has 38% higher costs.

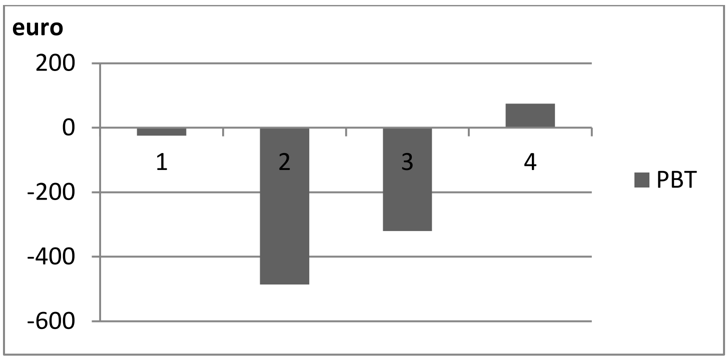
Table 9.24: Results of case study 1 (net wages owner-operator)

	Normal crew composition		Sailing alone	
	owner-operator	**shipping company**	**owner-operator**	**shipping company**
Fixed costs	100.0	200.9	100.0	160.1
Variable costs	100.0	67.7	100.0	67.7
Total costs	100.0	171.9	100.0	138.1

When we go one step further and make the link to the freight tariffs and the competitive position, it is clear that a vessel operating at lower costs can accept lower freight tariffs and therefore rule out companies which operate at higher costs. From this case, it can be derived that given the current situation, a shipping company cannot compete with the owner-operator unless the latter counts a remuneration for entrepreneurship for himself and the vessel can be sailed by only one person (see graph 9.24). If the owner-operator 'only' uses net wages and the vessel needs a complete crew, the shipping company has a very large cost disadvantage. In any case, the owner operator can always adjust his own remuneration in such a way that he can operate at a lower cost than the shipping company.

The first case proves to be profitable only in the case of an owner-operator, in case he does not calculate the remuneration for entrepreneurship (1), or a shipping company in case the operator can work alone (4) (see graph 9.22). The operations of the vessel with full staff by a shipping company in this case would make the company work at a loss (3). It is already mentioned that operators, in the short-term, can use only the variable costs in their calculations. When only the variable costs are taken into account, the shipping company can go lower than the owner-operator, since its variable costs are lower. An important factor is the labour cost though. The self-employed operators can deprive themselves from a decent remuneration for a while, while the labour costs for employees have to be paid monthly. When working with employees, a trade-off has to be made between doing a transport that does not cover the labour costs or move the employees to another vessel or even reduce the number of employees. When taking the normal situation of the owner-operator and only counting the variable costs and the net wages, the freight tariff could already be reduced by half. At such freight rate, it is impossible for a shipping company to compete.

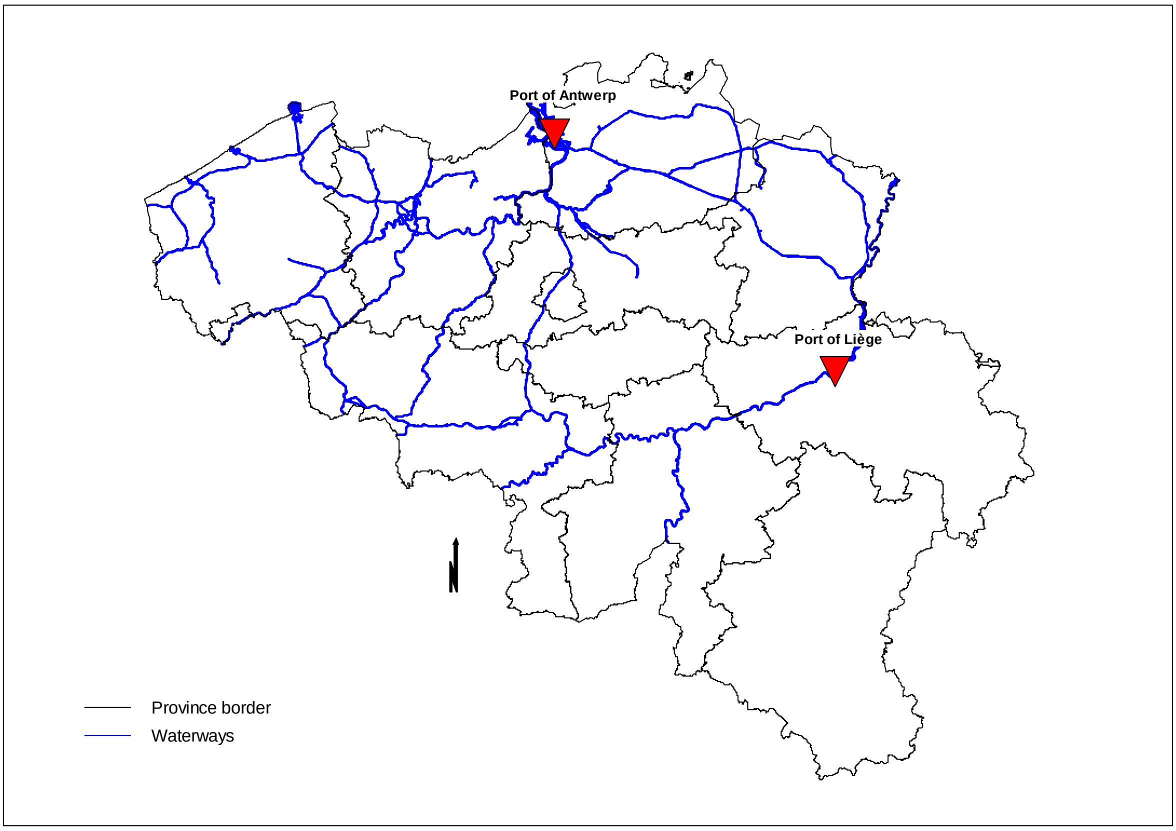
Graph 9.22: Profit case study 1 for one single trip (in euro)



2.1.2. Description and results case study 2

In the second case, the transport of shipments of 1,500 tonnes from the port of Antwerp to the port of Liège is studied (see figure 9.2). The distance of the trip is about 150 kilometres one way, of which 130 kilometres take place on the Albert Canal. This route also holds 6 locks which are normally operated from Sunday 22h until Saturday 22h, i.e. 6 days out of 7. In this case, the cost of the transport is calculated for two different vessel types, a vessel type Rhine-Herne Canal and a Large Rhine vessel, both rather recent vessels of the same age (<10 years). A semi-continuous exploitation is assumed, which means each time a day of 18h is assumed.

Figure 9.2: Illustration of case study 2



Since the speed limitations on the Albert Canal are related to the draught of the vessel, the average speed used for the Large Rhine vessel is smaller than the one used for the Rhine-Herne vessel. The time needed to cover the distance twice is two days for the Rhine-Herne vessel at an average speed of 12km/h and again two days for the Large Rhine vessel at an average speed of 10km/h. The larger vessel needs some hours more for the trip, but can still cover the distance in a day in semi-continuous operations.

In the first simulation the costs are determined for both vessel types operated by an owner-operator and working on the spot market. The time needed for loading and unloading the goods is set on two days for loading and two days for unloading for the Rhine-Herne and the same for the Large Rhine vessel. For both vessel types one extra day is calculated which covers the waiting time for chartering on the spot market. As a result, the fixed costs are based on an average of 48 such trips per year for both the Rhine-Herne Canal vessel and for the Large Rhine vessel.

The second simulation gives the results for a similar transport, but this time the vessel is in time charter for a shipping company or terminal operator. Since the vessel has a fixed cost per day for the charterer, he will make sure the vessel is operated as efficiently as possible. Therefore, it is assumed that the loading and unloading times are only one day instead of two and that there is no extra waiting time between shipments. The main advantage in this case is the fact that more trips are made per year because of less waiting times. The fixed costs in this simulation are therefore based on an average of 83 such trips per year for the Rhine-Herne and the Large Rhine vessel.

The results of both simulations are represented in table 9.25. The results show clearly that the costs of the Large Rhine vessel are much higher (50%) than for the smaller vessel type. The main difference is in the fixed costs and more in detail in the capital costs, which are much higher for this vessel type. Another important factor is the labour cost, since more staff is needed on the larger vessel. For this transport, the Rhine-Herne vessel therefore clearly has an advantage over the Large Rhine vessel, mainly because of the small shipment and the short distance with speed limitations.

When doing the same exercise but for vessels with a time charter, the costs for both vessel types are much lower (see table 9.25). The reason for this is the higher rotation of the vessels because of less loading and unloading days and waiting times. For the Rhine-Herne vessel, the total costs are 35% lower and for the Large Rhine vessel a cost reduction of around 60% is found.

Table 9.25: Results of case study 2

	Spot charter		**Time charter**	
	Rhine-Herne	**Large Rhine vessel**	**Rhine-Herne**	**Large Rhine vessel**
Fixed costs	100.0	161.0	57.1	92.0
Variable costs	100.0	94.8	100.0	94.8
Total costs	100.0	150.0	64.3	92.5

In the previous simulations, the calculations are made for the transport of a fixed tonnage. For the Rhine-Herne, this results in a 100% load factor, while for the Large Rhine vessel the load factor is only 54%. As discussed in the first part of this chapter, the load factor in itself has only little influence on the total costs. In chapter 4 it is argued that it does have an important effect on the revenues though. Therefore, the profitability of a transport is to a large extent affected by the load factor. The last simulation will recalculate both simulations with a different load factor for the Large Rhine vessel. Instead of a shipment of 1,500 tonnes, it is assumed that the shipper or receiver of the goods will take advantage of the larger capacity of the vessel by transporting goods in larger quantities. In this new calculation, the load factor of the Large Rhine vessel will be 90%, corresponding to about 2,500 tonnes.

Table 9.26 shows the results of the existing and new simulation for the Large Rhine vessel. It demonstrates that the variable costs of the Large Rhine vessel are indeed about 29% higher in this simulation compared to the previous one. This has only little effect on the total costs though (less than 5% for both cases). Unlike the costs, the yearly revenues for the Large Rhine vessel could be much higher by increasing the load factor (+67%). This shows that increasing the load factor can be an important aspect in improving the profitability of a vessel.

Table 9.26: Results of case study 2 (different quantity of the shipment)

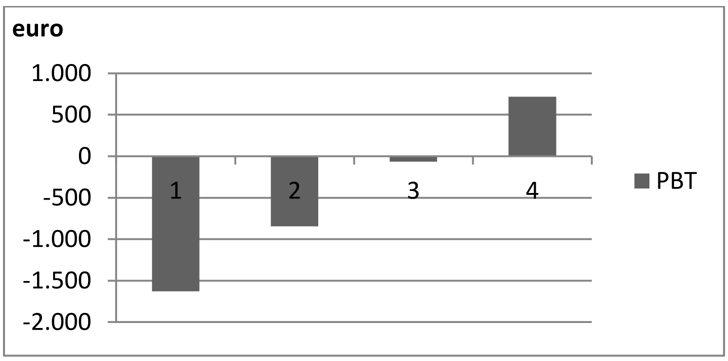
	Spot charter		Time charter	
	Large Rhine vessel	Large Rhine vessel Load factor 90%	Large Rhine vessel	Large Rhine vessel Load factor 90%
Fixed costs	100.0	100.0	100.0	100.0
Variable costs	100.0	129.0	100.0	129.0
Total costs	100.0	103.1	100.0	104.9
Yearly revenues	100.0	166.7	100.0	166.7

In the second case, the operations of both vessel types prove to be unbeneficial for operations on the spot market, under the assumptions made. For vessels in time charter on the other hand it proves to be profitable for the Rhine-Herne vessel in both simulations and for the large Rhine vessel only in the simulation with the increased load factor. This shows that at the presupposed freight tariffs, it is impossible to operate such types of vessels on this route in non-intensive operations or at low load factors. The load factor for the Rhine vessel in the case of time charter should be at least 75% in order for the revenues to equal the costs (see table 9.27 and graph 9.23). In case an empty return trip could be prevented, this could also be beneficial for the profitability. But as mentioned before, a return trip could also be an incentive for the freight tariff of the initial stretch to drop.

Table 9.27: Result case study 2 Large Rhine vessel with adjustments of the load factor (time charter)

	55% (1)	65% (2)	75% (3)	85% (4)
total costs	97	99	100	101
total revenues	73	87	100	113
profit	--	-	+/- 0	+

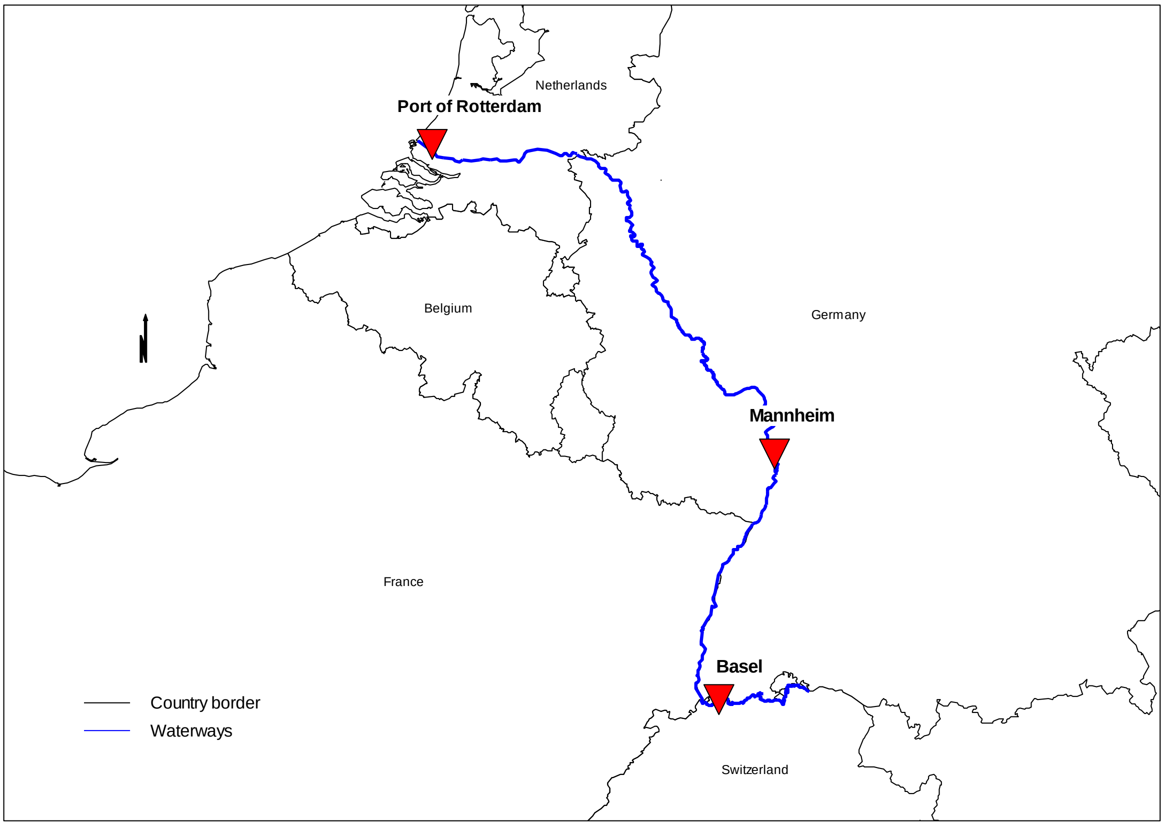
Graph 9.23: Profit case study 2 for one single trip at different load factors (in euro)



2.1.3. Description and results case study 3

The third case is the transport of dry bulk goods from the Port of Rotterdam to Basel, a destination at the High Rhine in Switzerland (see figure 9.3). The distance between origin and destination is about 840 kilometres with a current on the River Rhine of 5km/h on average. The vessel used in this case study is a dry cargo Large Rhine vessel of which the load factor is based on an average of Kaub 180[62]. On the return, the vessel takes goods in Mannheim, which is about 270km downstream and it delivers them in Rotterdam.

Figure 9.3: Illustration of case study 3



In the first simulation of this case the vessel has a very recent year of construction (< 5 years), is operated by the owner and his/her partner and is working in semi-continuous operations. For going upstream, an average speed of 11km/h is used in the model. For the transport downstream the calculations are made with an average speed of 19km/h. Based on the distance and average speed, the transport would take 4.5 days to go from Rotterdam to Basel, 1 day to go from Basel to Mannheim and 2 days to sail from Mannheim to Rotterdam. On top of that, 2 days for loading in Rotterdam, 1 day for unloading in Basel, 1 day for loading in Mannheim and 2 days for unloading in Rotterdam are counted. This amounts to 13.5 days for the trip back and forth. The same calculation is made for an older vessel of the same type (more than 20 years old). In this case the fuel

[62] Which means the draught of the vessel is maximum 2.90m without and 2.70m with safety margin.

consumption is assumed to be 5% higher because the engine is somewhat older. The rest of the parameters of the vessel, the operations and the trip are kept constant.

Table 9.28 (normal speed) shows the results of this simulation in which the use of an old and a new vessel for this case are compared. Because of the older engine, the variable costs are 4.6% higher for the older vessel, but the fixed costs are much lower (-18%), mainly due to the lower capital costs. This means that for this case the older vessel operates at about 5% lower costs than the new one. It is clear that the older vessel can therefore accept lower freight tariffs than the more recent one and therefore has a competitive advantage.

Table 9.28: Results of case study 3 (semi-continuous operations)

	Normal speed		**Reduced speed**	
	new vessel	**older vessel**	**new vessel**	**older vessel**
Fixed costs	100.0	82.1	107.4	88.2
Variabele costs	100.0	104.6	59.3	61.9
Total costs	100.0	95.2	79.4	72.8
Yearly revenues	100.0	100.0	91.3	91.3

In the second part of this simulation the average speed of both vessels is decreased by 2km/h which means the vessel will sail at a speed of 9km/h upstream and 17km/h downstream. A speed reduction implies that the vessel consumes less fuel for the trip, which is reducing the variable costs of the vessel. But by sailing slower, it takes longer to cover a certain distance. In this case the trip would take one day longer, being 14.5 days instead of 13.5. This might result in fewer trips per year, depending on the demand. If this occurs, the hourly costs will again rise because the fixed costs have to be divided over fewer trips. Moreover, if fewer trips are being made, revenues might be lower. Whether or not to sail slower and/or take fewer trips depends on the revenues which are gained from a trip and for which costs have to be made.

In this case, a speed reduction results in only 2 trips less per year, which reduces the revenues by less than 9% (see table 9.27, reduces speed). Sailing at a slower speed has quite some impact on the fuel costs though, it reduces them by 40 to 45%. This is mainly because in the case without the speed reduction, the engine is working at a very high share of its capacity. A reduction of 2km/h therefore results in a large decrease in fuel consumption (see chapter 6).

In the second simulation a similar exercise is done, but this time for both vessels working in continuous operations. Operating in continuous operations increases the turnaround time of a vessel, because the vessel can work 24h per day. This results in a higher number of effective hours and therefore in lower costs per hour and per trip. Furthermore, it means the vessel is more flexible regarding when to sail and when to stop (see chapter 5). The main disadvantage is the higher labour cost because more people are needed on board.

Based on the distance and average speed, the transport would take 3.5 days to go from Rotterdam to Basel, one half day to go from Basel to Mannheim and 1.5 days to sail from Mannheim to Rotterdam. Here again, 2 days for loading in Rotterdam, 1 day for unloading in Basel, 1 day for loading in

Mannheim and 2 days for unloading in Rotterdam are added, which brings the whole trip on 11.5 days. The same simulation, but with a speed reduction, results in a total of 12.5 days for this situation.

Table 9.29: Results of case study 3 (normal speed)

	New vessel semi-continuous	new vessel continuous	older vessel semi continuous	older vessel continuous
Fixed costs	100	113	100	119
Variabele costs	100	100	100	100
Total costs	100	105	100	107
Yearly revenues	100	117	100	117

The results from the simulation without a speed reduction are given in table 9.29. It shows that the costs for the trip which is calculated here is 5 to 7% higher for the vessels working in continuous operations. A look at the yearly revenues which are based on this trip on the other hand indicates that working in continuous operations can prove to be beneficial. All of course depends on the number of trips that can be made.

The simulations in case 3 for the vessels at the normal speed all prove to be unprofitable, the ones at a lower speed on the other hand give positive results. Sailing at a higher speed only appears to be profitable for the new vessel in case the freight tariffs increase by 13%. The semi-continuous operations moreover is the most profitable type of operations. This is mainly due to the waiting times which are assumed. A vessel working for example in continuous operations in a liner service could have less waiting times.

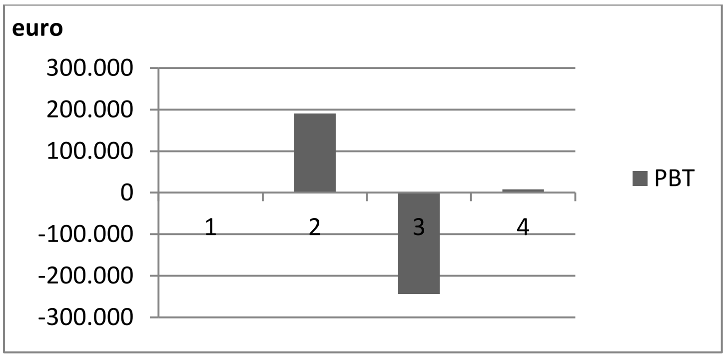
When redoing the calculation in case 3 for the new vessel working in continuous operations, but without taking a return cargo, the transport would turn out not to be profitable (see table 9.30). Sailing at the reduced speed, in order to cut back on the fuel costs, it would take the vessel 9.5 days to perform the transport. This consists of 2 days loading in Rotterdam, 4 days sailing from Rotterdam to Basel, 1 day unloading in Basel and 2.5 days sailing back to Rotterdam. This way, 36 of such trips per year could be made. Whereas in the previous situation, this transport was profitable, without return freight it becomes a loss-making operation (see table 9.30). The results of the cost simulation prove that this transport cannot be done in a profitable way without return cargo, given the freight tariff which is assumed here. In order to make such trips profitable with a paid cargo on only one stretch, the price would have to increase with about 12%.

When doing so, the profit of the vessel sailing at normal speed and the one with empty return at a lower speed proves to be almost equal (simulations 1 and 4 in graph 9.24). Most profitable is sailing at a reduced speed, but having return cargo (2). Sailing at the normal speed without having return cargo on the other hand is highly loss-making in this case (3).

Table 9.30: Results case study 3 with empty return

	return cargo		empty return	
	normal speed	**reduced speed**	**normal speed**	**reduced speed**
Fixed costs	100.0	108.7	73.9	82.6
Variabele costs	100.0	59.3	93.8	56.5
Total costs	100.0	81.4	84.9	68.2
Yearly revenues	100.0	93.1	94.8	85.3
Profit	-	+	---	-

Graph 9.24: Profit case study 3 per year with higher freight tariff and empty return (in euro)



Conclusion of the basic case studies

From the case studies, it can be concluded that the type of company plays an important role. Based on the assumptions made in the first case study, the shipping company can only have profitable operations when reducing the number on people on board. The scale of shipping companies does not compensate for the extra costs (labour) that are added. Therefore, if there is sufficient capacity on the market, shipping companies are better off by renting vessels, either on a long-term basis or on the spot market. The rental price for the shipping company in this case is often lower than owning and operating the vessel by the company itself. In this respect, the remuneration that the owner-operator included and the number of employees on board are important factors.

Next to the type of company, also the scale of the vessel matters. Larger vessels generally result in higher costs, but also generate more revenues because of higher loading capacity. In this respect, the load factor of a vessel is important. A large vessel with a low load factor will be faced with lower profits than a smaller one with a higher load factor. In the second case, the use of the Large Rhine vessel is only justified if the load factor is above 75%. Apart from the scale, also the age of the vessel has an influence on the costs. The lower costs of amongst others repair and maintenance are not entirely compensated by the higher capital costs. If there are no further differences between vessels, the older one will be able to operate at lower cost.

Furthermore, the intensity of operations has an important effect on costs as well as revenues. In case the rotation speed could be increased e.g. by less waiting times, this could improve the results. By sailing in continuous operations, the labor costs increase to a large extent, but on the other hand, more revenues can be made because of more effective hours and more trips.

Also the speed at which the vessel sails influences the number of trips that can be made. Moreover, the effect of an empty return trip on the profit of a company proves to be quite extensive. The profit of the last case study shows that it can be more beneficial to sail at a reduced speed and having an empty return, compared to sailing with return cargo at a normal speed. Because of the high effect of speed reductions on the total costs, it is important to compare such cost reductions with the revenues that are gained from a trip.

Based on the basic case studies that were developed in the preceding part and that mainly focussed on the effect of choices from companies in the sector, three extra cases have been developed. The first case includes the external costs that are caused by IWT transport. The second case introduces as new type of fuel that reduces costs as well as emissions. In the third case, the effect of organisational efficiency is studied.

2.2. Internalisation of external costs

In the first case the external costs of inland waterway vessels is incorporated in the cost calculation. External costs are costs which are caused by a transport user to a third party and for which he does not pay. Noise pollution, air pollution and congestion are a few examples of such externalities which are not reflected in market prices. External costs are not only caused by transport, but the transport sector in general causes high external costs (Blauwens, 2010).

Inland navigation causes relatively low external costs compared to for example road transport. Large volumes are transported by one vessel, which spreads the costs of a vessel over a large quantity of goods. Moreover, there are very limited noise and congestions costs and the effect on infrastructure costs is minor. Several studies make calculations on the external costs of transport modes such as PLANCO (2007) and Oonk et al. (2003). The external costs in most studies show a considerable spread which means there is a large amount of uncertainty concerning the level and structure of external costs.

In this case, the external costs for air pollution are incorporated in the costs of the vessel based on the 'Handbook on estimation of external costs in the transport sector' (Bak et al., 2008). This study is a meta-study of existing third-party studies such as UNITE[63], GRACE[64] and INFRAS/IWW[65]. The transport emission factors for Germany from the TREMOVE[66] database are used for inland waterway transport in this study. The costs of up- and downstream processes are calculated i.e. fuel production, air pollution and climate change costs. The climate change valuation is based on costs factors (€/t CO_2) for 2010. Marginal noise costs due to inland waterway transport are assumed to be negligible, because emission factors are comparably low and most of the activities occur outside densely populated areas. For that reason, noise costs of inland waterway transport are not taken into

[63] Unification of accounts and marginal costs for transport efficiency (UNITE)

[64] Generalisation of Research on Accounts and Cost Estimation (GRACE)

[65] INFRAS/IWW: External costs of transport

[66] http://ec.europa.eu/environment/air/pollutants/models/tremove.htm

account. Information on inland waterways accident costs is almost entirely lacking and is therefore not incorporated in the costs (Bak et al., 2008). The values for an average vessel, differentiated by weight -class, are presented in annex 21.

The effect of incorporating these external costs in the overall costs is studied for the third case study, being the transport from Rotterdam to Basel with a Large Rhine vessel. For this vessel, the external cost amounts to 5.45 euro per kilometre (Bak et al., 2008). The simulation gives the effect on the profitability of the transport in the case of a new vessel in continuous operations with return cargo at a reduced speed. Table 9.31 shows that including the external costs will increase the variable costs by 68% and the total costs by 26%. In case the operator does not give in on his profits, or in this case would not make a loss, this would have to lead to an increase of freight tariffs. For this transport, the freight tariff should increase by 27% in order to cover these extra costs.

In a second simulation, the effect of internalising the external costs is determined for the first case study (owner-operator with a fixed remuneration for entrepreneurship). The results are presented in the right hand part of table 9.31. For the smaller vessel, the effect on the variable costs is much higher than for the larger one. The variable costs are almost doubled. Because of the small share of the variable cost in the total amount, the effect on the total costs is relatively small compared to the larger vessel (+ 18%). In this case, the freight tariff should go up by almost 19% in order to compensate these extra costs.

Table 9.31: Results simulation internalisation external costs

	Large Rhine vessel - international		Kempenaar - domestic	
	without external costs	with external costs	without external costs	with external costs
Fixed costs	100	100	100	100
Variabele costs	100	168	100	197
Total costs	100	126	100	118

The results of this case show that incorporating external costs will have a higher effect on the costs of the larger vessels in intensive operations. The external costs that are used were calculated on average emissions from the sector though. The emission level of vessels can be reduced to a great extent by the installation of more recent engines (e.g. CCRII), catalyst, particle filter etc.

2.3 LNG as alternative fuel

As discussed in the previous case, the inland navigation sector causes limited external costs and is a relatively environmental friendly mode. But vessels and engines in inland navigation have a much longer lifespan than trucks for example. As a result, inland navigation might lose some of its crucial advantages in future. Apart from the environmental issues, also economic aspects are related to these external costs, as was shown in the previous case. Earlier in this chapter it was shown that fuel costs are important for the sector. The importance is higher for vessels sailing in more intensive operations, on larger waterways and at higher speeds. The fuel price is an important component of this fuel cost. As stated in chapter 6, the fuel price is fluctuating in time, but in general it follows a rising trend (see table 8.6). In this case study, a simulation is made for the use of a new type of fuel for inland waterway vessels.

In order to meet both challenges, on the one hand the environmental friendliness of the sector and on the other hand the fuel price, research is being done on new types of engines and propulsion systems, new types of fuels, systems to reduce the resistance and so on. Examples of such innovations are air lubricated hulls and propulsions[67] and LNG dual fuel engines.

The first vessel on the European waterways sailing on dual fuel, a mixture of 80% natural gas and 20% diesel, will be deployed in the second half of 2011 (MTS Argonon[68]). The use of natural gas is not only much better for the environment, but will also decrease operational costs to a great extent. The use of LNG should reduce CO_2-emissions by 20-25%, produce almost no particles and reduce the emission of NO_X considerably. When using dual-fuel engines, 10 to 20% of normal diesel is still needed. On the exact effect of using dual fuel engines on the different emissions such as NO_X, there is still quite some uncertainty (Verbeek, 2011). For the MTS Argonon this is still under research[69].

Apart from the advantages for the environment, the use of LNG will also result in a decrease of the fuel costs. The price of LNG itself is about 50% cheaper than normal fuel, which has a large impact for vessels with a high fuel consumption.

On the other hand, the engine and system bring along a much higher investment cost than a normal engine. Not only the engine is more expensive, the vessel also needs special tanks to store the LNG. LNG is stored in liquid form at -162°C in special tank containers. The time in which the investment can be earned back depends on the fuel intensity of the operations. Vessels which have continuous operations and sailing on the larger waterways at higher speeds, will gain the investment back much sooner than vessels with less fuel consumption. Therefore, owners of vessels with high fuel costs will be more inclined to invest in such new systems.

In this case, the installation of a LNG- installation on a large tanker vessel sailing in intensive operations on the Rhine is investigated. The tanker goes loaded from the port of Antwerp to Krefeld and returns empty. This is done at moderate speed (12km/h) and twice per week. The engine that is presumed in this case is not a dual fuel engine, but one that runs on LNG only. The LNG- system consists of a special engine, a tank for LNG and the necessary additional equipment. The investment for the installation is about 1,000,000 euro higher than a normal system. Because of the lower energy density of LNG compared to gasoil and the extra energy which is needed for the system, this results in expected savings of fuel costs of about 28 %.

In this simulation the additional investment cost is first depreciated over the whole life span of the vessel, being 25 years. Afterwards, this investment is depreciated over only 12 years, which is closer to the normal depreciation of an engine. When using a depreciation on 25 years, the total cost of the vessel is about 5% lower compared to a vessel with a normal fuel system (see table 9.32). When using the depreciation on 12 years, the total yearly cost is almost equal during the time of depreciation. When the installation is depreciated though, the vessels sails at variable costs which are about 25% less compared to the vessel with the normal fuel system.

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[67] Project Energiebesparende Luchtgesmeerde Schepen (PELS)
[68] This project is supported by the European Regional Development Fund
[69] The reduction of emissions will be determined when the vessel is brought in operation.

Table 9.32: Results simulation LNG tanker vessel

	normal fuel	LNG depreciation on 25y	LNG depreciation on 12y
Fixed costs	100	108,3	115,9
Variabele costs	100	75,5	75,5
Total costs	100	95,2	99,8
Total yearly revenues	100	100	100

The second simulation includes the external costs (see table 9.33). Because for LNG in inland navigation only the reduction of CO_2-emission is clear (20-25%), the external costs for the vessel running on LNG will be reduced by 25%. This is a quite simplified reasoning, but it shows the extra benefits which can be gained by using LNG in case there would be an internalisation of external costs.

Table 9.33: Results simulation LNG tanker vessel with external costs

	With external costs		
	normal fuel	LNG depreciation on 25y	LNG depreciation on 12y
Fixed costs	100	108,3	115,9
Variabele costs	100	75,3	75,3
Total costs	100	91,6	95,4
Total yearly revenues	100	100	100

In this case, the simulation was made for a large vessel in continuous operations, resulting in a high yearly fuel cost. The system which is chosen here is a very expensive one, but less expensive systems are available which also give good results e.g. dual fuel systems. For smaller vessel with lower fuel costs, even such innovations which are less expensive are still difficult to earn back.

2.4 Improvement of organisational efficiency

The third case deals with the organisational efficiency in ports. An increased efficiency in the port system could decrease the time the vessels stays in the port and therefore increase the rotation speed of vessels. The vessel port stay depends on a number of factors, such as:

- The amount of goods (tonnage of TEU) that has to be loaded/discharged
- The number of terminals that is called upon
- The waiting times at locks
- The waiting times at terminals and quays
- The time needed for other activities e.g. bunkering
- …

Some of these activities might be organised in a better way e.g. by using information technology systems. The organisation of lock passages can be done in a better way when information on the location of the vessels is available. The Automatic Identification System will certainly add to this. Furthermore, better planning systems on the seaport terminals for inland waterway vessels can reduce the waiting times and increase the time of loading and discharging.

In general, consigners and consignees are not located in the vicinity of an inland terminal or waterway and so inland navigation is part of a multimodal transport chain. Timing and speed are often more important for containers than for dry bulk shipping since the containers mostly contain high-quality products and the competition with other transport modes is severe. Therefore, smooth handling at seaports is crucial. For container transportation on short distances, also organisation and efficiency of the inland terminals are important factors.

The use of a hub in the port or the use of an intra port barging system can reduce the number of terminals a vessel has to call upon. These and other operational improvements will result in shorter port stays for inland vessels. A reduced port stay is amongst others an important aspect for container vessels which are operating in a liner service. Shorter dwell times in the port, can lead to opportunities to call at more inland terminals, to increase the number of port calls per week or it might even lead to less vessels necessary in a certain liner service.

In this case, the case Antwerp-Liège is started from, but the calculation is made for a container vessel sailing in continuous operations. The time necessary to load and unload the containers in the port of Antwerp is based on the CBRB-Port stay index for inland navigation[70]. This index gives the average time in the port per container move. The calculations are made for the two vessel types, the Rhine-Herne and Large Rhine vessel. Both vessels are assumed to carry 3 layers of containers and are fully loaded and unloaded at each port call. For the Large container vessel, this results in a port stay of 42 hours, for the Rhine-Herne vessel this is about 24 hours. The time in the inland terminal is based on a crane capacity of 25 moves per hour. In this simulation, the effect of halving the time that the vessel stays in the port is determined. On the one hand, it reduces the fixed costs to a great extent, because of the increased productivity or more in detail the increased rotation of the vessel (see chapter 5). This increased rotation on the other hand leads to higher revenues, under the condition of sufficient demand.

The simulation gives the results for one trip in table 9.34. A shorter port stay results for the smaller vessel in a decrease of the fixed costs of about 20%. For the larger vessel, a reduction of 25% is found. This leads to a total cost reduction for this trip of 14% for the smaller and almost 20% for the larger vessel. It is clear from this case that improved efficiency in ports can lead to a better productivity of vessels, which might lead to either a better profitability of vessels or a decrease of the freight tariffs.

Table 9.34: Results simulation shorter port stay

	Rhine-Herne		Large Rhine vessel	
	basic situation	**shorter port stay**	**basic situation**	**shorter port stay**
Fixed costs	100	80.8	100	75.0
Variabele costs	100	100.0	100	100.0
Total costs	100	85.7	100	80.3

[70] This index is weekly published for inland container shipping in the ports of Antwerp and Rotterdam. The index is an average for the different terminals and is based on data from CBRB members.

2.5. Differences between countries

As the taxation is mentioned to be of great importance in the competitiveness of IWT companies of different countries (WS, 2011c), this will looked upon closer. Based on the basic case studies, a number of examples are calculated for different types of vessels, companies and countries.

2.5.1. Depreciation

The effect of choosing a different type of depreciation on the total costs is already calculated in the systems analysis. This gives the effect of the difference in the Belgian and Dutch systems, because the alternative type of depreciation used in the systems analysis is the one agreed upon by the accounting companies in the Netherlands (see chapter 6). The results of the systems analysis of the larger vessel types is represented in table 9.35, along with some new runs of the model. The calculation for the Large Rhine vessel and Large container vessel is made both for an older and a more recent vessel. The results show that the total costs decrease when using the Dutch type of depreciation. The difference is much higher though for older than for more recent vessels.

Table 9.35: Effect depreciation on total costs

	Effect depreciation 50y on total cost	
	older vessel (>20y)	**recent vessel (<10y)**
Dortmunder	-7.2	n.a.
Rhine-Herne	-8.6	-2.6
Large Rhine vessel	-6.5	-2.4
Large container vessel	-5.8	-2.2

2.5.2. Taxation

The effect of different taxation schemes, within Belgium as well as between Belgium and the Netherlands, on the profit of the companies is determined in this part. It is a rough estimate, only based on the costs which are incorporated in the cost simulation model and the income tax. The results give a good idea on how important the effect is of the different schemes and how it influences the profitability of companies in the sector.

For the two examples which are given here, the taxation of the year 2008 is used. This year was opted for, because the one of 2009 is affected by the economic crisis. In the first calculation it is assumed that the owner-operator will opt for the fixed system. In the second case, the owner-operator chooses the normal taxation and in the third case the calculation is made for a shipping company. First a calculation for a small vessel is made, followed by an example for a larger vessel.

- Example 1: Kempenaar

The characteristics of the second simulation of case study 1 (sailing alone) is used as the basis of the profit calculation. The costs for the owner-operator as well as for the shipping company are represented in table 9.36.

Table 9.36: Costs example 1 (Kempenaar)

	owner-operator fixed system	owner-operator normal system	shipping company
Fixed costs	**30,021**	**31,837**	**71,713**
Capital cost depreciation	10,400	10,400	10,400
capital cost interest	773[71]	773	773
Insurance cost	7,345	7,345	5,719
Repair&maint	5,678	5,678	5,394
Labour cost	2,813[72]	2,813[73]	33,044
Comm&adm	3,012	4,828[74]	2,233
Overhead cost	0	0	14,150
Variabele costs	**13,443**	**13,443**	**8,974**
Fuel cost	6,142	6,142	6,021
Other costs	7,301	7,301	2,953
Total costs	**43,463**	**45,279**	**80,687**

The calculations of the profit and taxes are represented in table 9.37. For the fixed system, the loading capacity of the vessel is taken on 1.90m[75], which in this case gives a tonnage of 402t[76]. The semi-gross profit of this vessel therefore comes down to 68,340 euro (402 tonnes x 170 euro/tonne[77]). From this amount, a number of costs can be deducted (see chapter 7). Roughly speaking, these are the costs which are not directly related to the journey and are therefore fixed costs in this calculation (see table 9.36). The compensations for the owner-operator i.e. his own remuneration and interest on the capital he invested which were calculated in the case study cannot be deducted though. Therefore, only the costs which can be deducted are included in table 9.37.

A total amount of 30,021 euro can be deducted, which leaves a taxable income of 38,319 euro (see table 9.37). This is then taxed according to the income tax, represented in table 9.38. This means that a vessel owner of this vessel type that chooses the fixed system will have to pay 14.988 euro in taxes and will have a profit after taxes of 42,813 euro (= 87,822 - 30,021 - 14,988) is gained. From this amount, the variable costs still have to be deducted, which leaves 29,371 euro.

When calculating the profit in the system of normal taxation, all costs which are made can be deducted from the revenues. Again in this calculation, the compensations for the owner-operator cannot be taken into account. Compared to the previous system, the total amount of costs which can be deducted is much higher because also the costs of fuel and other costs related to the trips are

[71] No opportunity cost for the owner is included in the interest cost
[72] Only the social contribution of the owner-operator
[73] Only the social contribution of the owner-operator
[74] Includes a complete accounting
[75] For vessels < 850t, the payload is calculated at 1.90m (see chapter 6)
[76] The total loading capacity of the vessel is 600 ton at 2.50m draught. Based on the vessel design, 402 ton can be loaded at a draught of 1.90m.
[77] See table 7.1

included. But the taxable income is also higher because of the higher revenues from which this calculation starts (87,822 euro instead of 68,340 euro). As a result, not only the taxes that have to be are higher (17,100 euro instead of 14,988 euro), but the actual profit is about 14% lower than the profit when choosing the fixed system (25,443 euro instead of 29,371 euro).

In the last column of table 9.37, the calculation is done for the shipping company. Here, also the labour costs calculated in case 1 can be deducted from the revenues, because the operator is an employee. The normal tax of 33.99% is applied. Because of the higher costs, only a small profit before taxes is made and the taxes themselves are very low.

Table 9.37: Calculation profit example 1 (Kempenaar) Belgium

	owner-operator fixed system	**owner-operator normal system**	**shipping company**
revenues	87,822	87,822	87,822
semi-gross profit	68,340	-	-
costs	-30,021	-45,279	-80,687
profit before taxes	**38,319**	**42,543**	**7,135**
taxes	-14,988	-17,100	-2,425
profit after taxes	**42,813**	**25,443**	**4,710**
fuel & other costs	-13,443	**-**	**-**
profit	**29,371**	**25,443**	**4,710**

Table 9.38: Calculation taxes example 1 (Kempenaar) Belgium

		owner-operator fixed system	**owner-operator normal system**
taxable income	**tax tariff**	**taxes**	**taxes**
0 until 7,900 euro	25%	1,975	1,975
7,900 until 11,240 euro	30%	1,002	1,002
11,240 euro until 18,730 euro	40%	2,996	2,996
18,730 until 34,330 euro	45%	7,020	7,020
more than 34,330 euro	50%	1,995	4,107
total		**14,988**	**17,100**

When looking at the actual profit, it shows that the profit made by the owner-operator in the first calculation is only half the remuneration for entrepreneurship which was used as a compensation for the owner-operator in case 1 (table 9.37). The difference in profit with the second calculation (normal taxation) is rather important. In this case, the owner-operator has only just above 25,000 euro on a yearly basis as a compensation for his work, as well as the capital he invested.

The results of the same calculation under the Dutch system can be found in table 9.39. When comparing them to the calculation based on the Belgian tax systems, it is clear that the taxes in the Netherlands are lower and therefore a higher profit remains.

Table 9.39: Comparison tax & profit example 1 (Kempenaar) Belgium - the Netherlands

	Owner-operator normal system		Shipping company	
	BE	**NL**	**BE**	**NL**
revenues	87,822	87,822	87,822	87,822
costs	-45,279	-45,279	-80,687	-80,687
profit before taxes	**42,543**	**42,543**	**7,135**	**7,135**
taxes	-17,100	-16,184	-2,425	-1,427
profit	**25,443**	**26,359**	**4,710**	**5,708**

Table 9.40: Calculation taxes example 1 (Kempenaar) the Netherlands

Tax bracket	Wage on yearly basis	Tax/premium national insurance	
1	€ 0 until € 18,628	33.00%	6,147
2	€ 18,629 until € 33,436	41.95%	6,212
3	€ 33,437 until € 55,694	42.00%	3,825
4	€ 55,695 or more	52.00%	-
total			**16,184**

- Example 2: Large Rhine vessel

The calculations made for this example are based on the third case study, for a new large Rhine vessel sailing at reduced speed. The costs of this case are presented in table 9.41. The taxes are again calculated for the two systems applicable for the owner-operator and for the shipping company.

Table 9.41: Costs example 2 (Large Rhine vessel)

	owner-operator fixed system	owner-operator normal system	shipping company
Fixed costs	**310,805**	**315,435**	**436,729**
Capital cost depreciation	112,381	112,381	112,381
capital cost intrest	70,142	70,142	70,142
Insurance cost	19,711	19,711	15,589
Repair&maint	21,143	21,143	20,086
Labour cost	72,107	72,107	196,671
social contr owner-op	5,627	5,627	0
Comm&adm	9,694	14,324	7,709
Overhead cost	0	0	14,150
Variabele costs	**287,512**	**287,512**	**253,374**
Fuel cost	240,732	240,732	247,587
Other costs	46,781	46,781	5,787
Total costs	**598,317**	**602,948**	**690,103**

The same reasoning is followed as in the previous example. The semi-gross profit of the large Rhine vessel is 476,000 euro (2,800 tonnes x 170 euro/tonne[78]). An amount of 310,805 euro can be deducted from the semi-gross profit, which leaves a taxable income of 165,195 euro (see table 9.42). The tax which applies to this amount is calculated in table 8 and amounts to 78,426 euro. After deducting the taxes and the fuel- and other costs, a profit of 143,126 euro is made.

Table 9.42: Calculation profit example 2 (Large Rhine vessel) Belgium

	owner-operator fixed system	owner-operator normal system	shipping company
revenues	819,869	819,869	819,869
semi-gross profit	476,000		
costs	-310,805	-602,948	-690,103
profit before taxes	**165,195**	**216,921**	**129,766**
taxes	-78,426	-104,289	-44,108
profit after taxes	**430,638**	**112,632**	**85,659**
fuel & other costs	-287,512		
profit	**143,126**	**112,632**	**85,659**

If opting for the normal taxation system in Belgium, the vessel owner would pay 104,289 euro in taxes (table 9.42) on a profit before taxes of 216,921 euro. This then leaves a profit of 112,632 euro on a yearly basis, which is 21% lower than in the fixed system. The shipping company would have to pay 44,108 euro taxes, which is by far the lowest amount of the three systems. The higher costs which can be deducted combined with the lower tax rate are the reasons for this lower amount of tax.

The actual profit made by the vessel owners is much higher for the owner-operator compared to the shipping company. But one may not forget that the profit of the owner-operator still holds the remuneration for his work and his capital, while the labour costs and overhead costs of the shipping company is already included in the costs.

Table 9.43: Calculation taxes example 2 (Large Rhine vessel) Belgium

		owner-operator fixed system	owner-operator normal system
taxable income	**tax tariff**		
0 until 7.900 euro	25%	1,975	1,975
7.900 until 11.240 euro	30%	1,002	1,002
11.240 euro until 18.730 euro	40%	2,996	2,996
18.730 until 34.330 euro	45%	7,020	7,020
more than 34.330 euro	50%	65,433	91,296
total		**78,426**	**104,289**

[78] See table 7.1

In table 9.44 the difference between the taxation in Belgium and in the Netherlands is calculated for this example. Unlike the previous example, where the tax for the owner-operator was lower in the Netherlands, in this example the taxes are slightly higher. For the shipping company again the Dutch system is the most advantageous one (taxation at 20% instead of 33.99%).

Table 9.44: Comparison tax & profit example 2 (Large Rhine vessel) Belgium - the Netherlands

	Owner-operator normal system		**Shipping company**	
	BE	**NL**	**BE**	**NL**
revenues	819,869	819,869	819,869	819,869
costs	-602,948	-602,948	-690,103	-690,103
profit before taxes	**216,921**	**216,921**	**129,766**	**129,766**
taxes	-104,289	-105,545	-44,108	-25,953
profit	**112,632**	**111,376**	**85,659**	**103,813**

Table 9.45: Calculation taxes example 2 (Large Rhine vessel) the Netherlands

Tax bracket	**Wage on yearly basis**	**Tax/premium national insurance**	
1	€ 0 until € 18,628	33.00%	6,147
2	€ 18,629 until € 33,436	41.95%	6,212
3	€ 33,437 until € 55,694	42.00%	9,348
4	€ 55,695 or more	52.00%	83,838
total			**105,545**

The differences that exist between countries with respect to depreciations and taxes do have an influence on the costs of the vessels and therefore on their competitive position. The effect depends on the size of the vessel (capital intensity), the type of company and the revenues made. Shipping companies registered in Belgium have a clear tax- disadvantage. This could be a reason to relocate, although it will not be to the Netherlands, but to a more tax friendly country. For the owner-operators, the fixed system in Belgium has a clear cost advantage given the revenues assumed in this study. The difference in tax tariff between the tax on partnerships and the income tax is rather high. For some owner-operators, it will therefore be more beneficial to register the company as a partnership.

Chapter 10: Conclusion, trends and recommendations

1. Conclusion

After the exhaustive research in the previous chapters, an answer can be formulated to the three research questions which were formulated in the first chapter. Therefore, both the findings from the second part of the dissertation and the results from the analysis and case studies are needed.

1. Can choices concerning investments and operations be explained from a business economics point of view?

Decision making differs according to the type of company. Of shipping companies it is assumed that they include all the costs in their offers and act in a more economic way than owner-operators. For shipping companies, which are often part of a broader logistics company, vessels are only part of their activities. For many owner-operators, the decisions with regard to the vessel and their business are closely related to their personal life, which could lead to less rational decisions from a business economics perspective compared to shipping companies.

Based on chapter 2, it can be stated that the choice of the vessel owner concerning the type of vessel therefore is an important one, since it limits the market segments in which he can work. A second choice is the size of the vessel, because the size determines the area in which the vessel can operate. The size can also determine the type of goods that will be transported, since there is a normal quantity for certain goods, based on amongst others the receivers' capacity. The size of the vessel also has an effect on the costs, which is found in chapter 9. The larger the vessel, the higher the total cost, but on the other hand, the smaller the vessel, the higher the cost per tonne.

Moreover, the size of the vessel determines the number of staff which is needed on board. Therefore, it is beneficial to build a vessel which is just below the maximum size of a category. In practice, many vessels have dimensions of just below 70 or 86m. Half a meter more often offers limited extra capacity, while the labour costs rise substantially because extra people are needed on board. The capacity of a vessel can be increased by making the vessel wider or increasing the draught, but keeping the same length. This can influence the navigable area though, e.g. because of the width of locks or the load factors in shallow water.

Concerning investments in the sector, the analysis of the newbuilding of vessels in chapter 3 has shown that many new vessels have been built in the previous years and that there is quite an increase in scale. From chapter 4, we can learn that investments in the inland navigation sector follow a cyclical pattern and that the four markets in inland waterway transport are very closely related. When the freight market is picking up, many new orders are placed at the shipyards. This results in price increases of vessels due to high demand and overestimation of their value. When the market goes down, no more orders are placed and vessel prices can drop very fast. This hog cycle shows that many owners are following the freight market when deciding on their investments, but often do not take possible downturns into account.

When a future owner decides on buying a vessel of a certain type and size, he has to choose between buying an existing vessel or having a new one constructed. Some vessel owners prefer to have a new vessel which they can build according to their own preferences or like to increase the size of their vessel in a short period. Others prefer a more relaxed life and therefore opt for a second-hand vessel or remain with their existing vessel for a long period in order to cut capital costs. Apart from the personal preferences of the future vessel owner, the available supply on the second hand market and the construction prices of the shipyards play a major role (see chapter 4). The analysis of the Belgian registrations in chapter 3 show that the number of recent vessels is increasing, but also that many Belgian owners still opt for older vessels. The prices of the vessels and the construction time certainly play a role in this choice.

In chapter 4 it is confirmed that the major part of the vessels and capacity of the fleets in the traditional inland waterway transport countries within Western Europe is owned by owner-operators, being companies owning one or two vessels. The analysis shows that, compared to the time before the liberalisation, the number of companies with more than one vessel is increasing. This is partly due to the increased use of pushed trains in the smaller segments because of scale advantages.

In certain segments, where it is crucial to have sufficient vessel capacity, in which there are certain technical conditions and in which the expected profitability is higher, shipping companies could be more inclined to have their own fleet in property. They could however opt for chartering vessels in the long term, which is more common in the tanker than in the dry cargo segment. This gives shipping companies the safety of sufficient capacity, without making the investments themselves. Also strategies in between can be followed, meaning the shipping company providing temporary loans to owner-operators or taking participations in a vessel. This depends on the situation in the market and the available supply in the specific market segment.

From the analysis of the fleet in chapter 3 it is found that the smallest vessels have not been built in the last 30-40 years, at least not in the traditional way. The profitability of a small vessel is often stated to be limited, which is mainly the result of the low operational intensity at which it is used. Moreover, when sailing on smaller distances, they are generally faced with long loading and unloading times compared to the sailing time.

From chapter 3, we can learn that specialisation often goes hand in hand with less flexibility towards types of goods that can be shipped and therefore often results in sailing in dedication. This means that vessels cannot take return cargo and have more empty trips, which is for example found in chapter 4 for tanker vessels, but it is also found in the dry cargo segment. In the third case study, the difference between a vessel with and without return cargo is calculated. From this example we learn that vessels have shorter turnaround times when sailing back empty, but they miss out on revenues. The freight tariffs in this case study should increase in order for the vessel to run dedicated in a profitable way.

The size of the fleet in a certain market segment is a main factor which determines the competition between companies and the resulting freight tariffs. Since inland navigation vessels have a long life span, overcapacity can remain in the market segment for a long period, making it hard for the most recent, and therefore most expensive, vessels to keep up. In this respect, vessels which are able to be used in several market segments have higher chances on finding cargo. Vessels which are really bound to one segment on the other hand, e.g. because of their size, take a higher risk. This risk will be incorporated in the freight tariffs. If a special vessel is required for the goods, it is not easy to replace the vessel. Therefore shippers and/or charterers will be more inclined to work with long-term contracts for such vessels (see chapter 2). Long-term contracts can encourage vessel owners and financial institutions to invest in specialised vessels, because it takes away part of the uncertainty related to such a project.

Because most vessels are owned by owner-operators, the phase in which the family finds itself, can lead to significant changes in the operations. A vessel can be operated by an owner-operator and his/her partner for some years. When the children of this couple get to the age to go to school, it could be that one of the parents stays on shore. This immediately has consequences for the vessel staff and labour costs. Some owner-operators prefer sailing in a family relation, which means they will choose a vessel and a type of operation for which they do not need too many employees. Others see it more in a business-type of way and invest together with other people in a large vessel which is continuously operated. In this case, their personal lives are more located on shore than on the vessel. This is a way of working that became more important in the period before the last crisis, amongst others the result of the more intensive operations which were needed because of the high investments. Due to the bad situation during the crisis period, many vessel-owners had to cut down on staff and started working in family relation again.

A number of vessel owners prefer stability over freedom and therefore prefer sailing on the basis of long-term contracts, e.g. in tanker trade, or becoming part of a co-operation. It is found in chapter 4 that the number of co-operations and their members is limited. This means that most of the owner-operators put their freedom first and choose to work on the spot market, which is more often the case in the dry cargo segment. The sense of freedom is very different according to the person. Many forms of co-operation do not affect the freedom in itself. People working in co-operations even claim that they have more freedom, since they can plan their personal lives more easily.

From the analysis in chapter 9, it appeared that for many costs items, it is difficult to cut them down. However, by purchasing in larger quantities, some cost advantages can be gained. This is mainly an advantage for the shipping companies, because owner-operators are not easily inclined to co-operate in such a way. The individualism of many owner-operators does not allow for such initiatives to take place and prevents gaining potential benefits. But, when sailing under an engine room free-contract for a shipping company, the vessel owners do get their fuel with the same provider. In this case, it is the shipping company that has the benefits of the cost reduction.

Decisions taken by self-employed people are not always rational from a business economics point of view. Self-employed people in all sectors spend many hours on their business, for which they are not always compensated in a financial way. This is understandable, because they have financial responsibilities that require money coming into the company in order to pay back loans etc. The huge financial obligations which go together with the most recent vessels have even increased the need of cash. But when operators are accepting tariffs which are below the cost, the freight tariffs will probably go down even further.

By using long-term contracts with the shippers instead of the contracts on the spot market, one can avoid the costs of commissions for charterers. It is found in the strategic analysis in chapter 9 that this would have quite some effect on the total costs. On the other hand, these intermediate parties can make sure the vessel has regular orders, which in its turn can increase the rotation of the vessel and therefore increase the revenues and profits of the vessel owner. For the individual vessel owner, it is generally difficult to get directly in touch with shippers. For the shippers, it takes too much effort and time to contact individual vessel owners themselves. That is why they prefer working via charterers or with shipping companies, which can provide them with a fleet and transport security.

2. How do decisions influence the competitiveness within the sector?

The analysis of the costs of different vessel types in chapter 9 showed that the main cost items are the labour costs, the capital costs and the fuel costs. In the other cost items, large differences can be found and if added, they can influence on the total costs and therefore the competitive position of a vessel compared to others in the segment to quite some extent.

In chapters 6 and 8 it is discussed that the size of the investment will necessarily be reflected in the (long-term) costs of the vessel. As a result, new vessels of which the purchase price is higher than second hand vessels have a cost disadvantage in this cost item. On the other hand, it is reasoned in chapter 6 that it could be expected that new vessels will have a lower maintenance cost and the insurance cost could equally be lower. Moreover, if the second hand vessel does not have a recent engine, the fuel costs of the new vessel will probably be lower in equal circumstances.

In the third case study, it was demonstrated though that the older vessel can operate at considerably lower costs. Reason for this is that the extra capital cost is not compensated by the lower costs of repair and maintenance. If the vessel is operated in a segment with few opportunities for owners and operators to distinguish themselves based on the characteristics of the vessel, this will lead to a competitive disadvantage for the more recent vessel. This is for example the case in the dry cargo segment and also in the mineral oil segment where double hull tankers have difficulties competing with older single hull tankers.

The overall scale increase of vessels is clearly visible from the analysis in chapter 3, although the magnitude is different according to the country as well as the type of vessel. The analysis shows that the share of vessels of 86 to 110m remains stable, while the share of small vessels decreases in favour of the largest ones. In chapter 4 which deals with the productivity of vessels, it was reasoned that the capacity utilisation of a vessel, being the load factor as well as the empty trips, have a large influence on the costs of a vessel.

In chapter 5 the vessel productivity is addressed. It is reasoned that the productivity of a vessel depends on the capacity utilisation as well as on the rotation of the vessel. The effect of the scale and the productivity on the profitability of vessels is shown in the second case study. This case study explains for a large part the fact that middle-sized vessels remain important in the sector, despite the economies of scale that exist in the sector. In case the quantities that are being shipped are in general smaller, it will be more profitable to transport them by a smaller vessel that is fully loaded than by a larger one with a low load factor. The smaller vessel therefore will be more competitive in this case.

In chapter 5 it is argued that the productivity has important effects on the profitability of vessels. Amongst others, the importance of empty trips on the productivity of vessels is discussed. The third case study demonstrates that it is necessary at the current freight tariffs to take a return trip. Sailing in dedication requires higher freight tariffs in order to compensate the costs for the empty return trip.

Furthermore, the type of operations has an influence on the productivity of vessels. The intensity of the operations often goes hand in hand with the vessels' capital-intensity. The simulations in the third case study show that vessels sailing in continuous operations have higher costs, mainly because of labour costs, but can make more revenues because of the higher rotation. The productivity of a vessel depends also on the speed of rotation. In the analysis in chapter 9, it is found that the number of working days has an important effect on the hourly costs. The effect of the waiting times on the competitiveness of vessels is demonstrated in the second case study.

Apart from the waiting times, also the average speed of the vessel is important (see chapter 5). The analysis in chapter 9 shows that small reductions in the average speed can have major effects on the fuel costs. As demonstrated in the third case study, the vessel speed proves to have a high influence on the costs. Therefore, it can be more profitable to sail at a slower speed, even if fewer trips can be made. All depends on the freight tariffs offered. Last, the load factor and empty trips have an influence, mainly on the revenues of a vessel. The productivity of a vessel proves to have an important effect on the costs as well as the revenues and profitability of the vessel and is therefore an important aspect of the competitiveness of a company.

The type of company is necessarily reflected in the costs related to the operations. In this respect, the position of the owner-operator is dominant, mainly because the labour costs are much more flexible than the costs of shipping companies working with employees. The overhead costs add to the costs of larger entities, but it is found in chapter 9 that their importance in the total costs is rather limited.

Furthermore, it is found that cost reductions of larger entities can be substantial, but they are not always used in practice. Vessel owners generally decide separately on their purchases and prefer the suppliers they are used to working with. Moreover, the cost reductions do not always benefit the actual vessel owners e.g. in case of engine room free contracts. The main cost difference between a shipping company and a commercial co-operation are also the labour costs on board of the vessel. Shipping companies have employees working on the vessels, while the members of commercial co-operations generally are owner-operators.

With respect to the competitive position of the owner-operator compared to the shipping company, it is clear from the first case study that certainly in the smaller segments, the owner-operator has a dominant position. This is the result of lower labour costs in a family-operated company. At this moment, when most small vessels are very old, have a low capital cost and are operated by independent vessel owners, their operations are still profitable.

For a shipping company working with employees only, it is difficult to compete, even when the manning conditions are altered. This indicates that, as long as there is a sufficient amount of vessels operating in the traditional way, there will be little probability that new vessels with a much higher capital cost will be competitive in the same segments. In the larger segments, both company types are more on an equal level, because the owner-operator also has to use employees on board and they cannot always be found within the family. The shipping company moreover can rationalise on certain costs and is often better organised, which can lead to a higher productivity of the vessels.

3. How do decisions influence the competitiveness of the sector?

It is found in chapter 3 that the fleets of the different Western European inland waterway transport countries each have their own evolution and are clearly different with respect to their size and composition. The inland navigation sector is definitely an international one. This means that events in a certain country not only influence on the fleet of that country, but also have an effect on its competitive position compared to the other countries.

Identical vessels of different nationalities are expected to have a similar cost pattern and also on the level of the freight tariffs, no real differences should exist. Otherwise, vessel owners would establish their companies in a different country on a large scale. There are some differences in regulations though, which could encourage companies in certain segments to establish themselves in a ‘cheaper’ country, e.g. shipping companies in the tanker segments relocating to Luxembourg.

There are several ways in which countries can have an effect on the inland navigation sector. The main influences are found in the domains of taxation, subsidies and social regulations (see chapter 7). They each have an effect on the profitability of the vessels and as a consequence on competitiveness of the fleet of a country. By means of the analysis in chapter 8 the effect of a different way of depreciation on the costs is investigated. The system which is used in the Netherlands results in capital costs which are lower for both older and recent vessels, but the difference is larger for the older ones. This way a Dutch company can have a cost-advantage over a Belgian one.

In the research it is found that there are clear differences between countries concerning labour costs and social regulation, when looking at the official minimum wages and manning requirements. In a study based on the accounting costs, no clear differences were found though. When including taxation, the fixed system which exists in Belgium for the owner-operators proves to be the most beneficial based in the case study that was developed in chapter 9. When comparing the normal taxation in both countries, the taxation brackets in the Netherlands give an advantage in case the revenues are rather limited. For higher revenues, the Belgian tax system in more beneficial. Concerning taxation, shipping companies are always better off in the Netherlands.

2: Future perspectives and trends

It is discussed before that the vessels operated by an owner-operator have a clear cost advantage over vessels operated by employees only. In chapter 4 the predominance of the owner-operator is clearly shown. But it also shows an increase in smaller shipping companies. In case the sector goes to a structure where such companies gain a larger share of the capacity, such a change would inevitably lead to an increase in the costs of the vessels and therefore of the freight tariffs.

Financial institutions include more and more a decent remuneration for the owner-operator and his/her family in the business plans which are drawn up when applying for a loan. Moreover, accounting companies advise their clients to calculate in their costs a remuneration which is sufficiently high. This way, they want to make sure their clients have a kind of saving at the end of their professional life, also when the selling price of the vessel would fall short. Moreover, the different interest groups encourage the use of cost models in order to take the real costs into account when negotiating freight tariffs. If both principles would be applied on a wide scale, this certainly would lead to higher freight tariffs in certain market segments.

A professionalisation of the sector, which is one of the topics under discussion since the crisis period of 2008-2009, is slowly emerging. The co-operation of several sector organisations in the Netherlands creates opportunities in this matter. In Belgium the establischment of a common secretariat is an important step forward in the professionalisation of the representation of the inland navigation sector. On the other hand, the number of operators that are member of these organisations has strongly declined during the years.

While a lot of attention is given to the CO_2- emissions of vessels, this will become less important in the future as a result of the new regulation for the engine manufacturers. The future engines will have considerable lower CO_2 emissions compared to the existing ones. The other pollutants such as NO_X remain an important challenge for the sector.

Future investments will be made by young people working in the sector. Because of the lack of skilled people to man the vessel and because of the high labour costs, vessel owners often opt for foreign crews. There is no agreement on the employment of these people, but the proponents argue that they are hard working, well skilled etc. The opponents on the other hand speak about unfair competition. Either way, the fleets of the future not only have to be manned, but also operated by a new generation. Foreign crew members are often only interested in working on the vessel for some time, but not in investing in one themselves. If no investments, in money as well as in time, are made by the current vessel owners in young people who want to become an entrepreneur, only few people will remain in the future to carry the torch.

3: Recommendations

Based on the research that has been done on this subject and the conclusions that were drawn from it, a number of recommendations can be made. Part of the recommendations are addressed to the companies in the sector, while others are meant for other actors in the sector or for policy makers.

1. Recommendations for vessel owners and operators

The owner-operators are the main strength of the sector but at the same time they are one of the largest weaknesses. The strength is that they run a family business in which they invest their time and money. In periods of high demand, they either save or invest in new equipment. In times of low demand, they work even harder and cut back on expenses. This way, most of them have been able to run their businesses for years. It also has made sure that freight tariffs in inland navigation are relatively low. But there are serious weaknesses related to this way of working.

The accounting of the vessel and the family is not always well separated. This means that the companies do not have a good view on their expenses. Moreover, still too many vessel owners work in the short term and do not incorporate all the costs related to their business when negotiating freight tariffs. They for example do not take the fixed costs of the vessel into account, such as depreciations or their own remuneration. As a result, freight tariffs are accepted that do not cover the actual costs and overall freight tariffs go down. A correct view on the company as well as on the personal costs, combined with a decent remuneration is necessary for doing proper business and for a profitable sector in the long run.

Furthermore, it is important to choose the right taxation system. In Belgium, the fixed system is often chosen because it is simple and it does not require much effort concerning the accounting and registration of costs. But this system is not always the most profitable for the companies. Depending on the revenues, the normal accounting system or starting a partnership could prove to be more beneficial.

When deciding on the type and size of the vessel one wants to acquire, a good analysis of the opportunities and risks that come along with the choice is necessary. In other words, well-funded business plans should be developed before investing. The vessels that are very large or very specialised have the disadvantage of being more vulnerable, because they are less flexible. On the other hand, the vessel-owners might establish a long-term relationship with the shippers or charterers that depend on these specific vessels, this way providing more stability.

The main capacity of the inland navigation fleet is still owned by small companies, having one or two vessels. Some of them work individually on the spot market, but others work on a more permanent basis for larger entities such as shipping companies and commercial co-operations. The services that can be offered by these larger groups are important for many shippers, e.g. transhipment, storage, pre- and post haulage. An individual vessel owner and even a small co-operation or charterer are in general not able to meet the shippers' needs.

Larger co-operations could address some of the problems that owner-operators are faced with, such as the lack of scale. The formation of larger entities, being shipping companies/logistics groups, as well as commercial co-operations and the use of new methods of bringing supply and demand together, can decrease the number of empty trips in the sector. Therefore, if individual vessel owners were able to co-operate more on a stable basis, they could not only reduce costs, but also create more stability in their contracts and freight tariffs.

In this dissertation the main focus is on the costs, which of course does not take the quality of the service into account. For shippers the cost price is not always equal to the freight tariff. This of course depends on the type of goods. For more high value goods, next to the price also the reliability and flexibility play an important role. Therefore, the inland navigation sector can gain clients by anticipating these demands. Moreover, in markets where companies can distinguish themselves, the quality of the service is an aspect that can increase the competitiveness of a certain inland waterway transport company compared to another one.

2. Recommendations for other actors in the sector

Investments in inland navigation vessels require very large financial means. There has been a booming period in newbuilding of vessels in the years 2006-2008 and as a result the capacity of the fleets has grown immensely (see chapter 3). The downturn at the economic crisis proved that many of these investors ran into problems once the demand declined. Of course, many businesses in several sectors felt the effect of the crisis, but in the inland navigation sector the overcapacity inevitably led to very low freight tariffs. A good observation system of the European market and prudence from financial institutions could prevent such hog cycles from happening again in future.

Concerning investments, it could be an option for new concepts e.g. small vessels, to not only have the shippers engaging themselves to long-term contracts, but even to involve them in the investment of the vessel. This way, the necessary funds are available and all parties are encouraged to make the system as efficient as possible. The new ways of investing which are being explored in the last years and that are discussed in chapter 4 could certainly be useful. Moreover, such alternative ways of financing and clear engagements from shippers or charterers could meet the needs of new entrants in the business. Given the policy goals concerning the use of inland navigation, combined with the aging of the owner-operators and the shortage of young people in the sector, there will most likely be a need for new ways of operating vessels in future.

A major weakness is the fragmentation of the sector. Despite serious problems during the last crisis period (2008-2009), not only no new co-operations have been established, it also proved to be impossible to take a coherent action for the sector during periods of crisis. This is for the main part due to the mentality of vessel owners, but also to the existence of different market segments which each have their own problems making it difficult to reach solutions which are acceptable for all. These segments can be according to size as well as type of vessel, country or region. Each of these segments have their own representatives and bringing those together would be a first step towards strengthening the position of the sector.

3. Recommendations for policy makers

The productivity of the fleet is one of the aspects of the capacity of fleet. Factors that influence the productivity and that can be influenced by policy makers are amongst others the waiting times and the water depth which has an impact on the load factors. The waiting times can be reduced by more efficient operations at the locks and in the ports, but also by extending the working hours of locks and bridges on certain waterways. Moreover, ICT applications can improve the efficiency of the operations and can lead to a reduction in waiting times and delays.

The high fuel prices encourage vessel owners to take action in order to reduce fuel costs. Owner-operators often lack the expertise and financial means to install new systems or installations such as the LNG systems. In general, most innovations and pilot studies are developed by shipping companies or larger entities. There are several existing subsidies and support systems which are open to companies in inland waterway transport. Some of them specially created for the sector, others are broader. In general, it is found that in Belgium, compared to the Netherlands, it is difficult to convince owner-operators to use these systems. The sometimes difficult administrative procedures certainly add to this. Therefore, simple procedures, combined with a good communication on the best practices could encourage owners to make use of the support systems.

Labour costs are an important aspect in the costs of a vessel, but also finding people who want to work on board is one. When looking some years ahead, there is a serious threat that insufficient new entrepreneurs and employees in the sector will take over from the current generation. In a time where inland waterway transport is so much encouraged, it is crucial to have sufficient capacity in future. Finding decent local employees for a vessel can be a challenge and foreign crews or interim labour might seem a solution to it, but this is only in the short term. Therefore, the intake of not only young people, but also of experienced people from other sectors such as sea trade has to be encouraged. In this respect, the difference in certificates which makes intensive retraining necessary should be tackled.

Newbuilding in smaller vessel sizes has not convinced vessel owners yet. It is argued in chapter 2 that in order to get new vessels in the smallest categories, long-term contracts are necessary with a number of shippers. The incentives of governments, waterway administrations etc. in order to increase the use of small waterways and small vessels has led to a number of cases which have been investigated and pilots studies that were carried out. Many of these cases do not prove to be profitable in the long run, mainly because of the high costs compared to the other modes such as road transport. In this cost, the transhipment costs play an important role. Furthermore, the share of labour costs are high for smaller vessels. Adjusting the minimum manning regulations for smaller vessels will make them more profitable and more attractive, also for shipping companies.

In order to get a good view on the sector and the problems it deals with, there is a need for reliable, coherent and accessible statistics on the fleets as well as the activities performed on the network. Such statistics should preferably be gathered on a European level and hold sufficient detail in order to study the different market segments. Moreover, not only the most recent data is relevant. Also data from the past can provide very useful information for future policies.

Nederlandstalige samenvatting

Het onderzoek is getiteld 'structuring and modelling decision making in the inland navigation sector'. Het doel van het onderzoek is inzicht te verwerven in de beslissingen van de actoren en de kostenstructuur van de binnenvaartsector. Op deze manier kan ondersteuning geboden worden aan beslissingen van zowel private als publieke beslissingsnemers met betrekking tot investeringen, operaties en steunmaatregelen.

De centrale onderzoeksvraag bestaat uit drie delen. Eerst wordt nagegaan of de beslissingen die in de binnenvaartsector genomen worden verklaard kunnen worden vanuit bedrijfseconomisch standpunt. Verder wordt bestudeerd hoe en in welke mate beslissingen van scheepseigenaars evenals beleidsmaatregelen een invloed uitoefenen op de competitiviteit van verschillende scheeptypes onderling. Tot slot worden de verschillen tussen landen en het effect hiervan op de competitiviteit van schepen onderzocht.

De focus in dit onderzoek ligt op de aanbodzijde van de binnenvaartsector, waarbij vertrokken wordt van het standpunt van de scheepseigenaar. De groep scheepseigenaars omvat alle bedrijven, groot en klein, die schepen in hun bezit hebben. De belangrijkste actoren uit de sector zijn, naast de scheepseigenaar, de verladers, bevrachters, scheepsagenten en scheepswerven. De acties en beslissingen van overheden worden exogeen beschouwd in dit onderzoek. Verder worden enkel de voornaamste traditionele Europese binnenvaartlanden bestudeerd, welke goed zijn voor ongeveer 90% van de binnenvaarttransporten.

Belangrijke aspecten die in dit onderzoek behandeld worden zijn de specialisatie in de sector, de productiviteit van de schepen en de marktwerking. Teneinde een degelijk inzicht in de marktwerking te verwerven werden een aantal diepte interviews uitgevoerd met verschillende actoren, zoals rederijen, banken en boekhoudkantoren. Naast deze interviews werden andere mensen binnen de sector gecontacteerd voor ad hoc vragen.

Voor het onderzoek werd een gedetailleerd micro-economisch kostensimulatiemodel opgebouwd, waarin het effect van aanpassingen in de parameterwaarden, net zoals verschillende keuzes en beleidsmaatregelen, op de kosten en opbrengsten kan worden nagegaan. Het model laat toe om de gemiddelde jaarlijkse kosten van verschillende scheepstypes en ondernemingen te berekenen, evenals de kosten van een bepaalde reis. Door het inbrengen van vrachttarieven in het model is het mogelijk om opbrengsten en winstgevendheid van de operaties te bepalen. Op deze manier kunnen de verschillende keuzes met betrekking tot investeringen en inzet van schepen vergeleken worden en de invloed ervan op de competitiviteit van schepen bepaald worden. Bovendien kan het effect van een bepaald beleid doorgerekend worden voor verschillende scheepstypes en bedrijven.

Aan de hand van drie types van analyse wordt het effect van aanpassingen van de variabelen op de resultaten van de simulatie bepaald. Op deze manier wordt eerst door middel van sensitiviteitsanalyse het effect van aanpassingen in de parameterwaarden van het model bepaald. Verder worden ook de effecten van de keuzes in het model bepaald en het gevolg van bepaalde beslissingen en keuze met betrekking tot de investeringen en operaties. In het onderzoek worden daarna enkele case studies ontwikkeld die elk een typische situatie in het binnenvaarttransport vertegenwoordigen. In deze case studies wordt het effect nagegaan van keuzes met betrekking tot investeringen en operaties op de kosten, maar ook op de opbrengsten en winstgevendheid van schepen. Hieruit kunnen bijgevolg conclusies getrokken worden met betrekking tot de competitieve positie van verschillende scheepstypes en ondernemingen onder verschillende omstandigheden. Deze basis case studies worden verder uitgebreid naar toepassingen met een meer beleidsrelevant en innovatief karakter, zijnde de internalisering van externe kosten, een nieuwe type van brandstof voor de binnenvaart en een grotere efficiëntie in de havens. Tot slot worden de verschillen tussen landen op het gebied van belastingen door middel van een simulatie bestudeerd.

Inzake de nieuwbouw van schepen is er een duidelijke schaalvergroting opgetreden in de voorbije jaren. Investeringen in kleine schepen zijn bijna onbestaande, de middelgrote daarentegen behouden hun aandeel. De verwachte opbrengsten, de flexibiliteit en de gebruikelijke partijgroottes zijn belangrijke elementen in deze keuze. Uit de case studies blijkt dat indien er geen kwalitatief onderscheid gemaakt kan worden, bijvoorbeeld op het gebied van service, het niet loont om een recenter schip aan te schaffen. Voor eenzelfde zending kan een ouder schip bijna steeds aan lagere kosten, en bijgevolg aan lagere prijzen, varen. De recentere schepen dragen een hoge kapitaalkost, die zij bijgevolg vaak niet kunnen doorrekenen in de tarieven.

Veruit het grootste aandeel van de schepen is in handen van individuele scheepseigenaars die dit vaak in gezins- of familieverband uitbaten. Bij beslissingen met betrekking tot investeringen en inzet van schepen speelt het persoonlijke leven bijgevolg een grote rol. Zij werken rechtstreeks voor verladers, voor bevrachters of voor rederijen, zowel via de spotmarkt als op basis van langere contracten. De binnenvaartondernemers werken grotendeels alleen, waardoor ze nog al te vaak afhankelijk zijn van tussenpersonen en zelf geen uitgebreide service kunnen opzetten voor de verladers.

Ondanks de extra kost blijven bevrachters een sterke positie behouden in de markt. Rederijen en logistieke groepen hebben veelal hun eigen bevrachtingsafdeling, maar daarnaast zijn er talrijke kleinere bevrachters actief. Het aandeel van deze kost in het totale kostenplaatje is relatief beperkt en voor individuele schippers is het in het algemeen moeilijk om rechtstreeks met verladers zaken te doen. Verladers verkiezen veelal zaken te doen met een enkele partij die niet enkel het binnenvaarttransport, maar het hele deur-tot-deur transport kan organiseren.

Hoewel het aandeel lege reizen op het Belgisch waterwegennet afgenomen is na de liberalisering van de sector, is deze in de laatste jaren opnieuw toegenomen. Ondermeer de nieuwe manier van inzet van schepen, waarbij vaak in dedicatie gevaren wordt en het onevenwicht in stromen zorgen ervoor dat het aandeel leegvaart opnieuw toeneemt. De specialisatie die ervoor zorgt dat het aantal goederensoorten voor schepen beperkt wordt, heeft eveneens invloed op de leegvaart. Uit de analyse blijkt verder dat de beladingsgraden van de grootste schepen lager zijn dan die van kleinere schepen.

Het onderzoek geeft aan dat inzake investeringen lange termijn contracten noodzakelijk zijn vooraleer scheepseigenaars het risico nemen om te investeren in zeer gespecialiseerde schepen. Niet enkel de hogere kosten die veelal met gespecialiseerde schepen gepaard gaan, maar eveneens de beperkingen van inzetbaarheid voor andere trafieken maken dat lange termijn engagementen van verladers en bevrachter noodzakelijk zijn. Voor nieuwbouw van kleine schepen of nieuwe concepten zijn veelal (tijdelijke) steunmaatregelen noodzakelijk.

Uit de analyse en de case studies kan afgeleid worden dat de ondernemersvergoeding, dewelke vaak niet in de kostenberekening wordt opgenomen, een belangrijk aspect is. Het kostprijsbesef in de sector is ondermeer door de inspanningen van de beroepsorganisaties sterk verbeterd. Toch wordt nog te vaak op korte termijn gewerkt, zeker in periodes van weinig vraag. Zelfstandige ondernemers kunnen hierdoor aan veel lagere kostprijs werken dan rederijen die uitsluitend met personeel varen. Voor rederijen is het dan ook vaak interessanter om schepen in reis of tijdsbevrachting te charteren dan er zelf in te investeren.

Rederijen hebben veelal een mix van eigen en gehuurde schepen. Afhankelijk van de beschikbare capaciteit op de markt voelen zij de behoefte om zelf te investeren of te charteren. De rederijen behoren vaak tot grotere logistieke groepen die door deelnemingen en overnames zowel horizontaal als verticaal gegroeid zijn. Door hun schaalgrootte kunnen zijn niet enkel een uitgebreide service bieden aan verladers, maar eveneens aanzienlijke kostenbesparingen met betrekking tot hun schepen halen, ondermeer door een efficiënte inzet ervan.

De productiviteit van de schepen heeft een belangrijke invloed op de vaste kosten, maar eveneens op de opbrengsten. De productiviteit van schepen wordt bepaald door enerzijds de beladinggraden en leegvaart en anderzijds door de rotatie van het schip. Uit de case studies blijkt dat een vermindering van wachttijden belangrijke effecten heeft op de winstgevendheid van ondernemingen. Afhankelijk van de vraag en de prijzen die op de markt heersen kan het aantrekkelijker zijn om een schip intensiever, of net minder intensief uit te baten. Naast de personeelskost, is ook de kapitaalkost hier een belangrijk aspect.

Verder speelt de brandstofkost een grote rol. Deze kunnen de ondernemers grotendeels zelf in de hand houden door verschillende maatregelen, zoals brandstofclausules in de contracten, trager varen, efficiëntere motoren en het gebruik van nieuwe brandstoffen. Uit de analyse en case studies blijkt dat vooral trager varen en innovatieve brandstoffen voor grote kostenbesparingen kunnen zorgen. Dergelijke grote investeringen zijn echter vooral interessant voor grote schepen die intensief varen en hierdoor een groot verbruik hebben. Het brandstofverbruik zorgt niet enkel voor kosten voor de onderneming, maar ook voor externe kosten voor de gemeenschap. Het internaliseren van de externe kosten zou relatief gezien een zeer sterk effect hebben op de totale kostprijs.

Tot slot van het onderzoek worden een aantal aanbevingen gedaan, zowel voor scheepseigenaars en -operatoren als voor de sector in het algemeen en het beleidsniveau. Voor de eigenaars en operatoren zijn het kostprijsbesef en een voldoende vergoeding voor het geïnvesteerde kapitaal en werk cruciaal voor een goede zaakvoering. Verder kan de keuze van het juiste belastingregime belangrijke voordelen bieden. Tot slot kunnen samenwerking en het bestaan van grotere entiteiten niet enkel tot kostenvoordelen, maar ook tot belangrijke productiviteitswinsten leiden.

Voor de sector zijn een goed marktobservatie -systeem, nieuwe financieringsvormen en vermindering van de fragmentatie binnen de sector belangrijke aspecten. Overheden kunnen door een goede infrastructuur bijdragen tot een optimale inzet van de vlootcapaciteit. Verder dienen subsidies en stimulansen eenvoudig en toegankelijk te zijn voor schippers en zijn er maatregelen nodig om jongeren en zij-instromers aan te trekken. Tot slot zijn toegankelijke, vergelijkbare en gedetailleerde statistieken van de vloot en de activiteiten op Europees niveau een noodzaak voor een gedegen wetenschappelijke onderbouwing.

English summary

The research is entitled 'structuring and modelling decision making in the inland navigation sector'. The purpose of the research is to gain an insight into the decisions of the actors and the cost structure of the inland navigation sector. This can support both private and public decision makers in deciding on investments, operations and support measures.

The main research question consists of three aspects. First decisions taken in the inland navigation sector are analysed from a business economic point of view. Further, the research studies how and to which extent decisions of vessel owners and policy measures have an influence on the competitiveness of different vessel types compared to each other. To conclude the differences between countries and the resulting effect on the competitiveness of vessels is researched.

The main focus of this research is on the supply side of the inland navigation sector, and it is started from the vessel owner's point of view. The group of vessel owners comprises all companies, large and small, which own vessels. The most important actors in the sector are, apart from the vessel owners, the shippers, the charterers, the shipbrokers and the shipyards. The actions and decisions of governments are considered exogenous in this research. Furthermore, only the main traditional European inland navigation countries are studied, which represent around 90% of the inland navigation transports.

Important aspects which are dealt with in this research are specialisation in the sector, productivity of vessels and the market mechanism. In order to gain a thorough insight into market mechanisms a number of in-depth interviews were held with several actors, such as shipping companies, banks and accounting agencies. Apart from these interviews also other people in the sector were contacted for ad hoc questions.

A detailed micro-economic cost simulation model was built up for this research. By means of this model the effects can be analysed of adjustments in the parameter values and different choices and policy measures on costs and revenues. This model allows for calculating the average yearly costs of different vessel types and companies, as well as the costs of a certain journey. By adding freight tariffs to the model it is possible to determine the revenues and profitability of the operations. This way, the various choices with regard to investments and the allocation of vessels can be compared and their influence on the competitiveness of vessels can be determined. Moreover, the effect of a certain policy can be calculated for the various vessel types and companies.

By means of three types of analyses, the effects of adjustments in variables on the results of the simulation are determined. This way, by means of a sensitivity analysis first the effects of adjustments in the parameter values of the model are determined. Further, also the effects of the choices that are made in the model are determined and the consequences of certain decisions and choices with regard to the investments and operations. Afterwards in the research a number of case studies are developed each representing a typical situation in inland waterway transport. In these case studies the effect of choices is studied with regard to investments and operations on costs, revenues and profitability of vessels. Conclusions can be drawn from this with regard to the competitive position of different vessel types and companies under different circumstances. These basic case studies are further developed into applications with characteristics more relevant to

policy and innovation. Examples are internalising external costs, a new type of fuel for inland navigation and a higher efficiency in ports. To conclude, the differences between countries in terms of taxes are studied.

With regard to newbuilding of vessels, a clear increase in scale has emerged during the past years. Investments in small vessels are nearly non-existent while the medium-size vessels retain their share. The expected revenues, flexibility and the usual quantities of shipments are important elements in this choice. The case studies demonstrate that in case no qualitative difference can be found, for example in terms of service, the purchase of a more recent vessel is not beneficial. For the same shipment an older vessel can almost always sail for lower costs and thus for lower prices. The more recent vessels have a high capital cost, which often cannot be taken into account in the tariffs.

The majority of vessels are owned by individual vessel owners who exploit the vessels as a family. When decisions are made concerning investments and allocation of the vessels, the personal life plays an important role. They work directly for shippers, charterers or shipping companies, both on the spot market and on the basis of long-term contracts. Inland navigation entrepreneurs mostly work on their own which makes them all too often dependent on intermediaries and which prevents them from establishing an elaborate service for shippers themselves.

Despite the additional cost, charterers retain a strong position in the market. Shipping companies and logistic groups often have their own chartering department, but apart from this, various smaller charterers exist. The share of this cost in the total amount is relatively limited and for individual vessel owners it is generally difficult to do business with shippers directly. Shippers often prefer doing business with a single party which can organise not only the inland navigation transport, but also the entire door-to-door transport.

Even though the share of empty journeys on the Belgian waterway network has decreased after the liberalisation of the sector, it increased again during the last years. Among others the new way of allocating vessels, often sailing in dedication, and the geographical imbalances in flows increase the share of empty sailing again. Specialisation which limits the number of goods types for vessels also has an influence on empty sailing. The analysis furthermore demonstrates that the load factors of the largest vessels are lower than those of smaller vessels.

The research demonstrates that in terms of investments, long-term contracts are necessary before vessel owners take the risk to invest in highly specialised vessels. Not only the higher costs often involved in specialised vessels, but also the limited allocation possibilities for other goods make long-term agreements with shippers and charterers indispensable. For the new-building of small vessels or new concepts often (temporary) support measures are necessary.

From the analysis and case studies it appears that the remuneration for entrepreneurship, which is often not included in the cost calculation, is an important aspect. Cost awareness in the sector has improved greatly as a result of actions by the sector associations. And yet short-term views still occur all too often, especially in times of a low demand. Independent entrepreneurs can then work for a far lower cost price than shipping companies which only sail with staff. Therefore it is often more interesting for shipping companies to use vessels in spot- or time charter than to invest themselves.

Shipping companies often have a combination of own and rented vessels. Depending on the available capacity on the market they feel the need to invest themselves or to charter vessels. Shipping companies often belong to larger logistic groups which have grown both horizontally and vertically due to participations and takeovers. Because of their scale, they cannot only offer an elaborate service to shippers, but also gain substantial cost reductions with regard to their vessels, among others because of the efficient allocation.

The productivity of vessels has an important influence on the fixed costs, but as well on the revenues. The productivity of vessels is determined by on the one hand the loading levels and empty sailing and on the other hand by the rotation of vessels. The case studies demonstrate that a decrease in waiting times has important effects on the profitability of companies. Depending on demand and freight tariffs on the market, it can be appealing to operate a vessel more intensively, or exactly the opposite. Apart from staff costs, also capital costs are an important aspect in this respect.

Further, fuel costs play an important role. Entrepreneurs can restrain these themselves to a great extent, for example by measures such as fuel clauses in contracts, slower sailing, more efficient engines and the use of new types of fuel. The analysis and case studies show that foremost sailing slower and using innovative fuels allow for large cost reductions. Such large investments are mostly interesting for larger vessels which sail intensively and therefore have a large consumption. Fuel consumption not only causes costs for the company, but also external costs for the community. Internalising the external costs would have a relatively strong effect on the total cost price.

To conclude the research a number of recommendations are made, both for vessel owners and operators and for the sector and policy makers. For vessel owners and operators cost price awareness and a sufficient compensation for the invested capital and work are crucial for good management. Further, the choice of the most suitable tax regime can offer important advantages. Last, co-operation and the existence of larger entities can lead to not only cost advantages, but also to important productivity profits.

Important aspects for the sector are a good market observation system, new ways of financing and a lower fragmentation within the sector. Policy makers can contribute to the optimal allocation of fleet capacity by supplying a good infrastructure. Furthermore, subsidies and incentives should be straightforward and accessible to vessel owners and measures are required in order to attract youngsters and people from other sectors. To end with, statistics of the fleet and operations that are easily accessible, comparable, sufficiently detailed and collected on a European level are needed for doing thorough research.

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Annex 1: ECMT classification waterways and vessels (1992)

Class	Standard barge on which the classification is done					Push convoys				
	type	Length	Width	Draught	Tonnage	Length	Width	Draught	Tonnage	Height
		m	m	m	T	m	m	m	T	m
0	Small vessels and leisure	variable	variabl e	variable	< 250					variable
I	Spits	38.5	5.05	1.80 - 2.20	250 - 400					4.00
II	Kempenaar	50 - 55	6.60	2.50	400 - 650					4.00 - 5.00
III	Dortmund-Eemskanaal	67 - 80	8.20	2.50	650 - 1,000					4.00 - 5.00
IV	Rijn-Herne kanaalschip	80 - 85	9.50	2.50	1,000 - 1,500	85	9.50	2.50 - 2.80	1,250 – 1,450	5.25 - 7.00
Va	Large Rhine vessel	95 - 110	11.4	2.50 - 2.80	1,500 - 3,000	95 - 110	11.40	2.50 - 4.50	1,600 – 3,000	5.25 - 7.00 or 9.10
Vb						172 - 185	11.40	2.50 - 4.50	3,200 – 6,000	5.25 - 7.00 or 9.10
VIa						95 - 110	22.80	2.50 - 4.50	3,200 – 6,000	7.00 or 9.10
VIb		140	15.00	3.90		185 - 195	22.80	2.50 - 4.50	6,400 – 12,000	7.00 or 9.10
VIc						270 - 280	22.80	2.50 - 4.50	9,600 – 18,000	9.10
						193 - 200	33.00 - 34.20	2.50 - 4.50	9,600 – 18,000	9.10
VIIb						285	33.00	2.50 - 4.50	14,500 – 27,000	9.10
						195	34.20	2.50 - 4.50	14,500 – 27,000	9.10

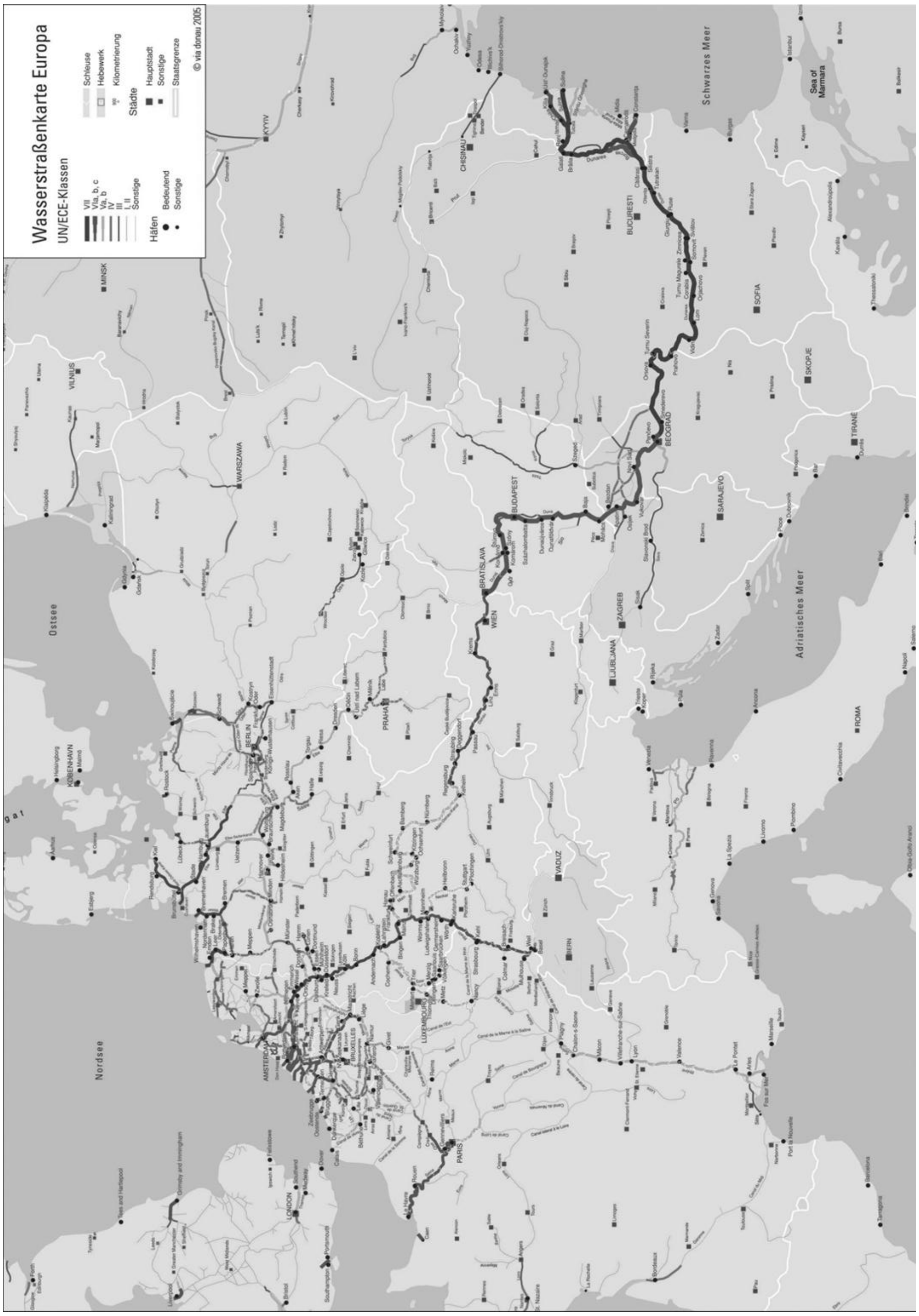
Source: European Conference of Ministers of Transport (ECMT)

Annex 2: NST/R- classification

NST/R-code	Description
0	Agricultural products
1	Foodstuffs and animal fodder
2	Solid mineral fuels
3	Petroleum products
4	Ores and metal waste
5	Metal products
6	Crude and manufactured minerals
7	Fertilizers
8	Chemicals
9	Machinery

Annex 3: European IWT network and major corridors

1. European IWT network



Source: Via Donau (2005)

2. Rhine-Corridor:

Navigable rivers and canals in Germany, Switzerland, Eastern France and Luxembourg.

- rivers: Rhine between Basel and Emmerich, Moselle (strech from French border to the estuary), Neckar and Main (between Frankfurt and the estuary)
- canals: Rhine-Herne-Canal, Wesel-Datteln-Kanal and Dortmund-Ems-Canal

Source:Via Donau (2005)

3. South-East Corridor:

- rivers: Danube (the whole course downstream Kelheim) and Main (between Frankfurt and junction of the Main-Danube Canal)
- canals: Main-Danube Canal and Danube-Black Sea Canal (Cernevoda-Constanta)

Source: Via Donau (2005)

4. East-West Corridor:

Eastern and northern parts of Germany and Czech Republic

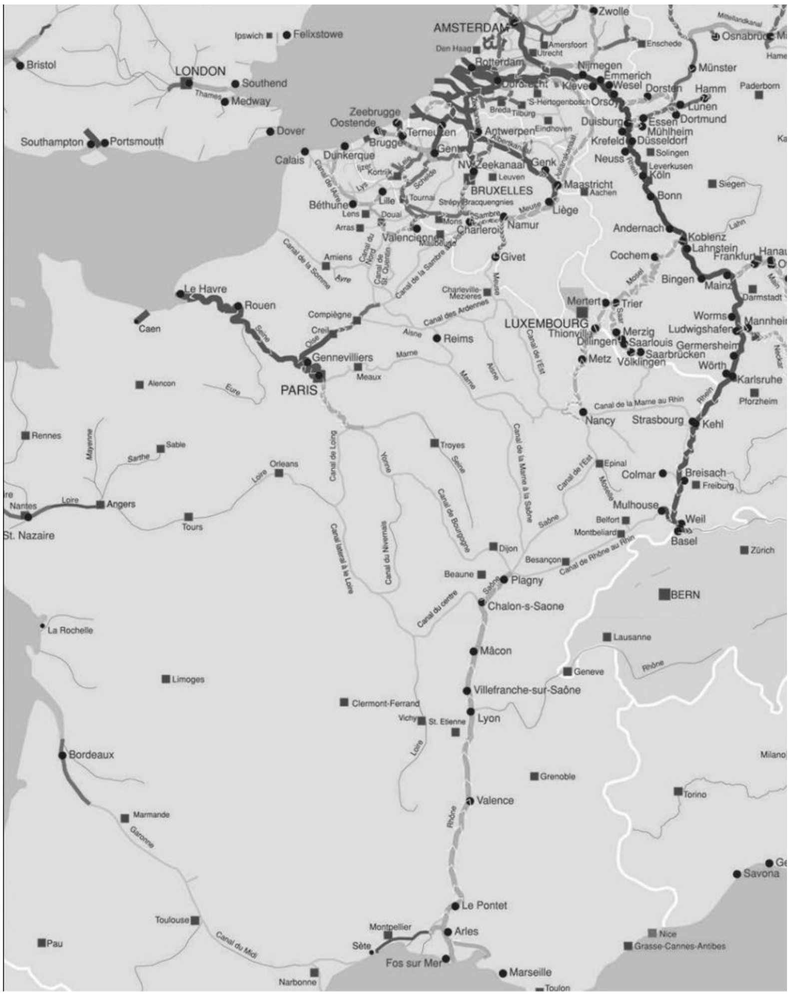
- river: Elbe from Melnik (CZ) to Hamburg
- canals: Mittellandkanal, Elbe-Seitenkanal, Elbe-Lübeck-Kanal, Niegripper Verbindungskanal, Elbe-Havel-Kanal, Untere Havel-Wasserstrasse and Spree-Oder-Wasserstrasse

Source: Via Donau (2005)

5. North-South Corridor:

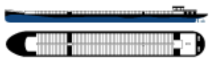
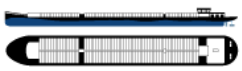
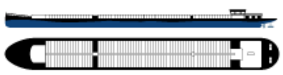
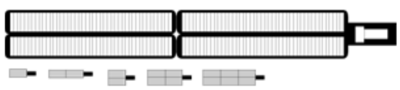
Navigable rivers and canals in the Netherlands, Belgium and Northern France

- rivers: Seine, Meuse, Moselle (French section), Maas and Rhine downstream German-Dutch border (Boven Rijn, Waal, Boven Merwede, Beneden Merwede, Oude Maas)
- canals: Canal du Nord, Dunkerque-Escaut, Albert Canal, Charleroi-Bruxelles, Bruxelles-Rupel-Antwerp, Ghent-Terneuzen and Amsterdam-Rhine Canal.



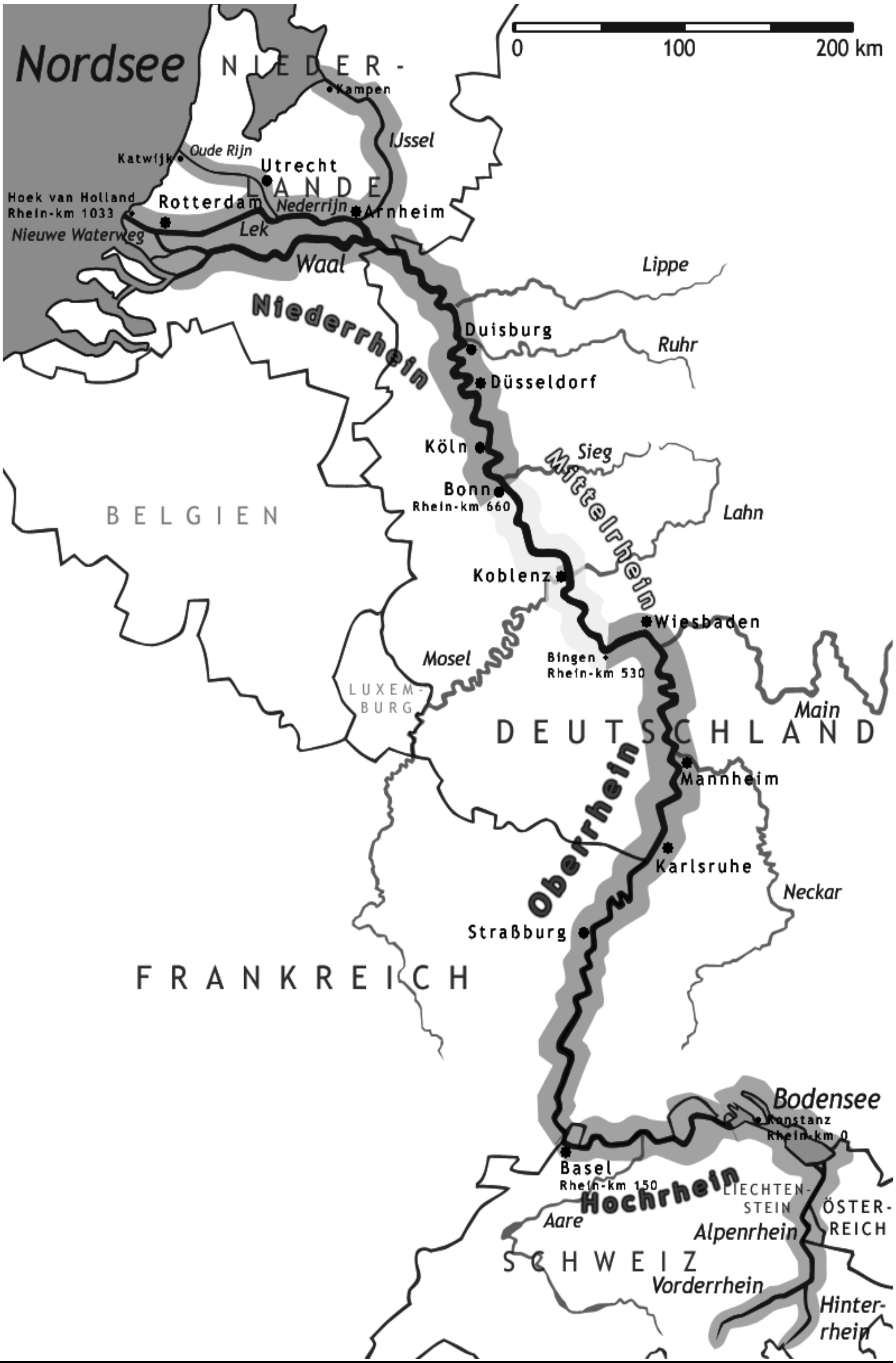
Source: Via Donau (2005)

Annex 4: Vessel types

Spits 	ECMT Class I. Measurements: 38,70m x 5,05m x 2,20m. Average tonnage: 364 ton Average volume: 433 m^3.
Kempenaar 	ECMT Class II. Measurements: 50m x 6,60m x 2,50m. Average tonnage: 600 ton. Average volume: 700 m^3.
Enlarged Kempenaar (Nieuw type Kempenaar) 	ECMT Class II. Measurements: 50m x 7,20m x 2,50m Average tonnage: 683 ton. Average volume: 950 m^3.
Canal du Nord (U.N. Norm: Gustav Koenigs) 	ECMT Class II. Measurements: 60m x 5,75m x 3,20m. Average tonnage: 800 ton. Average volume: 880 m^3.
D.E.K. (Dortmund-Ems-Kanaal), (U.N. Norm: Johan Welker) 	ECMT Class III. Measurements: 67-80m x 8,20m x 2,50m. Average tonnage: 968 ton. Average volume: 1413 m^3.
R.H.K. (Rijn-Herne-Kanaal) 	ECMT Class IV. Measurements: 80-85m x 9,50m x 2,50m. Average tonnage: 1378 ton. Average volume: 1937 m^3.
Large Rhine vessel 	ECMT Class V. Measurements: from 95m x 11,40m x 2,70m. until 110m x 11,40m x 3,50m. Average tonnage: 2160 ton. Average volume: 2708 m^3.
Large container vessel 	Measurements: 135m x 17,00m x 3,00m. Capacity: 470 TEU.
Push-convoy 	ECMT Class V and VI. Measurements: until 190m long and 11,40 (single convoy) or 22,80m (double convoy) large. Capacity: 800 until 12,000 ton

Source: Promotie Binnenvaart Vlaanderen

Annex 5: River Rhine



Source: Daniel Ullrich

Annex 6: Speed limitations Belgian waterways

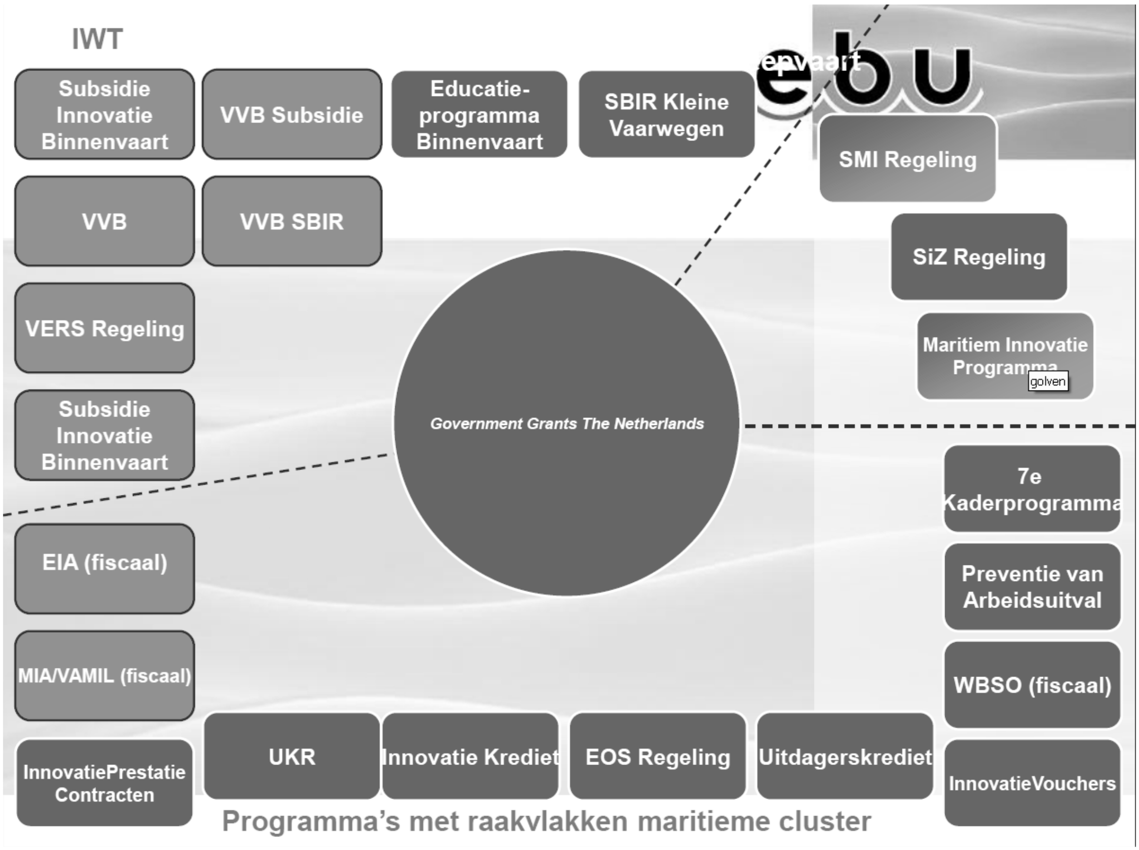
CEMT-klasse en Maximum snelheid op kanalen

Waterweg	CEMT	Max V	B	B	B	B	B	B	B	B	B	OB	OB	OB	OB	OB	OB	OB	OB	OB
			A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O	A/O
			M0	M1	M2	M3	M4	M5	M6	M7	M8	M0	M1	M2	M3	M4	M5	M6	M7	M8
Vertakking van Zulte	1	8	11	11	10	10	9	9				15	15	15	8	8	8			
Spierekanaal	1	8	11	11	10	10	9	9				15	15	15	8	8	8			
Ijzer	1	8	11	11	10	10	9	9				15	15	15	8	8	8			
Kanaal van Ieper naar de IJzer	1	8	11	11	10	10	9	9				15	15	15	8	8	8			
Kanaal van Plassendale naar Duinkerke	1	8	11	11	10	10	9	9				15	15	15	8	8	8			
Lokanaal	1	8	11	11	10	10	9	9				15	15	15	8	8	8			
Kanaal van Brugge naar Sluis	1	8	11	11	10	10	9	9				15	15	15	8	8	8			
Moervaart + Bovendurme	1	8	11	11	10	10	9	9				15	15	15	8	8	8			
Kanaal van Eeklo	1	8	11	11	10	10	9	9				15	15	15	8	8	8			
Dender	2	8	11	11	10	10	9	9				15	15	15	8	8	8			
Kanaal van Briegden naar Neerharen	2	10	11	11	10	10	9	9				15	15	15	8	8	8			
Zuid-Willemsvaart (Zuid)	2	10	11	11	10	10	9	9				15	15	15	8	8	8			
Kanaal van Bocholt naar Herentals	2	10	11	11	10	10	9	9				15	15	15	8	8	8			
Kanaal van Dessel naar Schoten	2	10	11	11	10	10	9	9				15	15	15	8	8	8			
Kanaal naar Beverlo	2	10	11	11	10	10	9	9				15	15	15	8	8	8			
Zuid-Willemsvaart (Noord)	2	10	11	11	10	10	9	9				15	15	15	8	8	8			
Kanaal Leuven - Dijle	2	12	11	11	10	10	9	9				15	15	15	8	8	8			
Leie	4	12	12	12	12	12	12	13	13	12	7	15	15	15	15	15	15	16	12	8
Verbindingskanaal te Nieuwpoort	2	10	11	11	10	10	9	9				15	15	15	8	8	8			
Dijle	4	12	12	12	12	12	12	13	13	12	7	15	15	15	15	15	15	16	12	8
Kanaal van Dessel naar Kwaadmechelen	5	15	12	12	13	13	13	14	14	13	13	15	15	15	15	15	15	16	16	16
Kanaal van Charleroi naar Brussel	4	8	12	12	12	12	12	13	13	12	7	15	15	15	15	15	15	15	12	8
Grensleie	4	12	12	12	12	12	12	13	13	12	7	15	15	15	15	15	15	15	12	8
Netekanaal	5	15	12	12	13	13	13	14	14	13	13	15	15	15	15	15	15	16	16	16
Kanaal van Gent naar Brugge	4	15	12	12	12	12	12	13	13	12	7	15	15	15	15	15	15	15	12	8
Afleidingskanaal der Leie	5	15	12	12	13	13	13	14	14	13	13	15	15	15	15	15	15	16	16	16
Kanaal Roeselare-Leie	5	15	12	12	13	13	13	14	14	13	13	15	15	15	15	15	15	16	16	16
Kanaal Bossuit-Kortrijk	5	15	12	12	13	13	13	14	14	13	13	15	15	15	15	15	15	16	16	16
Ringvaart om Gent	5	15	12	12	13	13	13	14	14	13	13	15	15	15	15	15	15	16	16	16
Kanaal van Brugge naar Oostende	5	15	12	12	13	13	13	14	14	13	13	15	15	15	15	15	15	16	16	16
Kanaal van Brugge naar Zeebrugge	6	7,2	12	12	13	15	15	15	16	15	16	15	15	15	15	15	15	17	17	17
Albertkanaal	6	16	12	12	13	15	15	15	16	15	16	15	15	15	15	15	15	17	17	17
Zeekanaal Brussel - Schelde	6	16	12	12	13	15	15	15	16	15	16	15	15	15	15	15	15	17	17	17
Aftakking zeekanaal naar oude sluis Wintam	6	16	12	12	13	15	15	15	16	15	16	15	15	15	15	16	16	17	17	17
Aftakking zeekanaal oude arm Klein-Willebroek	2	16	11	11	10	10	9	9				15	15	15	8	8	8			
Kanaal Gent - Terneuzen	6	16	12	12	13	15	15	15	16	15	16	15	15	15	15	16	16	17	17	17
schelde-Rijn + ANT	6	16	12	12	13	15	15	15	16	15	16	15	15	15	15	16	16	17	17	17
Benedendurme	1	8	11	11	10	10	9	9				15	15	15	8	8	8			

De aangehouden snelheid is het minimum van Vmax (de maximaal gereglementeerde snelheid) en de oorspronkelijk gemodelleerde snelheid bij B (=Beladen) en OB(=Onbeladen) toestand.

Source: Vanherle K., Van Zeebroeck B., Hulskotte J. (2007)

Annex 7: Government grants for inland waterway transport (the Netherlands)



Source: Presentation Robert Tieman B.Sc. Environmental Coördinator European Barge Union Rotterdam the Netherlands - Flanders Inland Shipping Network Expert Meeting 2010 - November 25th 2010, Antwerp.

Annex 8: Deductable expenses fixed tax system (Belgium)

II. AFTREKBARE BEROEPSKOSTEN

Van de bovenvermelde semi-brutowinst mogen worden afgetrokken (binnen de regels van het gewone stelsel) :

a) interesten :

- alle interesten en kosten van tot bedrijfsdoeleinden aangewende leningen die bij banken, kredietinstellingen of andere financiële instellingen zijn aangegaan of die bij notariële akte of die bij onderhandse akte met vermelding van vaste datum, zijn vastgesteld;
- de eigenlijke interesten en kosten die begrepen zijn in de kosten van financieringshuur (leasing) voor uitsluitend tot beroepsdoeleinden aangewend materieel;
- de interesten en kosten van leningen die gediend hebben om de in artikelen 157 tot 168 WIB 92 bedoelde belastingvermeerdering te vermijden en/of om, op de normale vervaldag, het gedeelte van de personenbelasting te betalen dat proportioneel overeenkomt met de beroepsinkomsten.

b) alle vergoedingen aan zelfstandige helpers en derden die verantwoord worden door de vereiste bewijskrachtige bescheiden (lijsten 325.50, facturen);

c) bezoldigingen van de personeelsleden, met inbegrip van de ermede verbandhoudende kosten bestaande uit artikelen 52, 57 en 59 WIB 92 :

- wettelijk verschuldigde sociale lasten en contractueel verplichte bijdragen inzake sociale verzekering of voorzorg;
- werkgeversbijdragen voor aanvullende verzekering tegen ouderdom en vroegtijdige dood voor het vestigen van een rente of van een kapitaal bij leven of overlijden.

d) afschrijvingen (artikel 61 WIB 92) :

voor binnenschepen waarvan de investeringen of verrichtingen zijn gedaan met ingang van **8.10.1993** geldt een afschrijvingspercentage van maximum 10 % op de aanschaffings- of beleggingswaarde; het bedrag van de afschrijvingen wordt bepaald bij het indienen van de aangifte in de personenbelasting en kan nadien niet meer worden aangepast ;

Belangrijk : in het jaar van aanschaffing van een afschrijfbaar activa is een afschrijvingsplan bij de aangifte te voegen. **Afwijkingen van dit afschrijvingsplan moeten verantwoord worden.**

e) de bijdragen die ingevolge de wetgeving houdende inrichting van het sociaal statuut van de zelfstandigen werden gestort; die sociale lasten omvatten eveneens de mutualiteitsbijdragen voor "kleine risico's" en de vrijwillig betaalde premies die een vergoeding waarborgen voor een arbeidsongeschiktheid tengevolge van ziekte en invaliditeit;

f) de premies voor verzekering in verband met de uitbating van het schip met dien verstande dat de opgetrokken schadevergoedingen bij de belastbare inkomsten gevoegd moeten worden;

g) de bijdragen betaald aan erkende beroepsgroeperingen;

h) de aan belastingconsulenten betaalde honoraria en kosten voor bedrijfsadvies;

i) de belastingen in de mate dat zij aftrekbaar zijn volgens de bepalingen van de artikelen 52 en 53 WIB 92;

j) de Franse belastingen ("loi Morice" - betaling ingesteld door de financiewet voor 1991 en voor de bijdragen Chambre nationale de la batellerie artisanale -CNBA- door de financiewet voor 1985), uitgesloten de vaartrechten ten belope van 20 % van deze taksen ("Loi Morice") en de betalingen aan de Voies navigables de France (VNF) als "Droit de Traction" ("Passage special de Riqueval");

k) kosten in verband met de aflevering van de bewijzen van deugdelijkheid van het schip;

l) kosten van herstellingen aan en onderhoud van het schip of de motor en normaal onderhoud;

m) telefoon- en gebruikskosten, te beperken tot het beroepsmatig gebruik;

n) kosten van afgeleverde certificaten.

Source: http://ccff02.minfin.fgov.be/KMWeb/document.do?method=view&nav=1&id=50c421d6-707f-4526-88a6-5e3c6c51f396&disableHighlightning=50c421d6-707f-4526-88a6-5e3c6c51f396/#findHighlighted

Annex 9: Excess value of IWT vessels - Art 44ter WIB 92 (Belgium)

Artikel 44ter, WIB 92 (aj. 2010)

§ 1. De meerwaarden die in de in het tweede lid bedoelde omstandigheden op voor de commerciële vaart bestemde binnenschepen zijn verwezenlijkt, worden volledig vrijgesteld wanneer een bedrag dat gelijk is aan de verkregen schadevergoeding of de verkoopwaarde wordt herbelegd op de wijze en binnen de termijn als hierna gesteld.

De meerwaarden moeten zijn verwezenlijkt:

1° naar aanleiding van een schadegeval, een opeising in eigendom of een andere gelijkaardige gebeurtenis, of

2° bij een niet in het 1° vermelde vervreemding van binnenschepen die bestemd zijn voor de commerciële vaart, voorzover deze sedert meer dan vijf jaar vóór de vervreemding ervan de aard van vaste activa hadden.

Onder binnenschepen die bestemd zijn voor de commerciële vaart moet worden verstaan:

1° vaartuigen die worden aangewend voor goederen- of personenvervoer, zowel voor eigen rekening als voor rekening van derden;

2° vaartuigen die worden aangewend voor het duwen van binnenvaartuigen, zowel voor eigen rekening als voor rekening van derden.

§ 2. De herbelegging moet gebeuren in binnenschepen die:

1° beantwoorden aan de ecologische normen die door de Koning zijn bepaald, bij een besluit vastgesteld na overleg in de Ministerraad;

2° bestemd zijn voor de commerciële vaart;

3° in België voor het uitoefenen van de beroepswerkzaamheid worden gebruikt;

4° gelijktijdig beantwoorden aan minstens twee van de volgende voorwaarden, met uitzondering van de binnenschepen met een maximum tonnenmaat van 1 500 ton die uitsluitend aan de in a) hierna bedoelde voorwaarde moeten voldoen:

a) van een recenter bouwjaar zijn - minstens 5 jaar - dan het vaartuig waarop de meerwaarde betrekking heeft;

b) minstens 25 % meer laadvermogen of, in het geval van een duwboot, 25 % meer motorvermogen hebben dan het vaartuig waarop de meerwaarde betrekking heeft;

c) maximum twintig jaar in gebruik zijn.

§ 3. De herbelegging moet uiterlijk bij de stopzetting van de beroepswerkzaamheid gebeuren en binnen een termijn:

1° die verstrijkt vijf jaar na het einde van het belastbare tijdperk waarin de schadeloosstelling is ontvangen, voor in § 1, tweede lid, 1°, bedoelde meerwaarden;

2° van vijf jaar te rekenen van de eerste dag van het belastbaar tijdperk waarin de meerwaarde is verwezenlijkt of van de eerste dag van het voorlaatste belastbaar tijdperk dat het belastbaar tijdperk voorafgaat tijdens hetwelk de meerwaarde is verwezenlijkt, voor in § 1, tweede lid, 2°, bedoelde meerwaarden.

§ 4. Om de in § 1, eerste lid, vermelde vrijstelling te kunnen genieten, moet de belastingplichtige bij zijn aangifte in de inkomstenbelastingen vanaf het aanslagjaar dat is verbonden aan het belastbare tijdperk tijdens hetwelk de meerwaarde is verwezenlijkt en tot het aanslagjaar dat is verbonden aan het belastbare tijdperk waarin de herbeleggingtermijn is verstreken, een opgave voegen waarvan het model door de minister van Financiën of zijn afgevaardigde wordt vastgesteld.

§ 5. Indien niet wordt herbelegd op de wijze en binnen de termijnen die bij §§ 2 en 3, zijn bepaald, wordt de verwezenlijkte meerwaarde aangemerkt als een inkomen van het belastbare tijdperk waarin de herbeleggingstermijn verstreken is. In dat geval is artikel 47 niet van toepassing.

Art. 44ter:

- art. 44ter, § 2, 4°, is van toepassing op de meerwaarden gerealiseerd vanaf 1 januari 2009 en voor zover de datum van verwezenlijking ten vroegste betrekking heeft op het belastbaar tijdperk dat verbonden is aan het aanslagjaar 2010 (art. 50, W 06.05.2009 - BS 19.05.2009)

- art. 44ter is van toepassing op de meerwaarden die zijn verwezenlijkt vanaf 01.01.2007 en voor zover de datum van de verwezenlijking ten vroegste behoort tot het belastbare tijdperk dat aan aanslagjaar 2008 verbonden is (art. 108, W 25.04.2007 - BS 08.05.2007) en (art. 2, KB 11.05.2007 - BS 24.05.2007)

Source: Fisconetplus op 15/11/2010

http://ccff02.minfin.fgov.be/KMWeb/document.do?method=view&id=b0ce4ed8-543f-400e-9ebb-95878d97f1d6#findHighlighted

Annex 10: Variables cost simulation model (general model)

Variable	Description	Unit
AV	Value of acquisition of vessel	euro
AVc	Value of acquisition casco	euro
b	Year of purchase	year
c	Construction year	year
Ccap	Capital cost	euro/year
Ccomm	Cost of commissions	euro
Ccons	Cost of consumption (fuel and lubricants)	euro/engine hour
CF	Fixed costs	euro/year
CFrep	Cost of repair and maintenance (fixed)	euro/year
Cfu	Fuel Cost	euro/engine hour
Cins	Insurance cost	euro/year
Clab	Labour cost	euro/year
Clu	Cost of lubricants	euro/engine hour
Cnav	Costs of navigation and port dues	euro
co	Company	co = 1,…,4
COentr	Overhead costs remuneration owner	euro/year
COeq	Overhead cost equipment	euro/year
COlab	Overhead cost labour	euro/year
comm	Share of commissions	%
CONSfu	Fuel consumption main engine	l/engine hour
COoth	Overhead cost other	euro/year
Coth	Other variable costs	euro/year
Cov	Overhead cost	euro/year
Crep	Costs of repair and maintenance	euro/year
CS	Number of crews	number
CV	Variable costs	euro/year
CVrep	Cost of repair and maintenance (variable)	euro/year
DEP	Depreciation	euro/year
DEPc	Depreciation casco	euro/year
DEPe	Depreciation engine room	euro/year
DEPo	Depreciation other	euro/year
DEPp	Depreciation pumps	euro/year
DEPt	Depreciation tubes	euro/year
DIST	Distance travelled loaded	km
e	Operations	e = 1,…,3

ECem	Employers contribution	euro/year
ETP	Estimated total premium	euro/year
FP	Price of fuel	euro/l
FT	Freight tariff	euro/ton
g	Type of goods (dry cargo/tank)	g = 1,2
GIem	Gross income employee	euro/year
HEFF	Effective hours per year	number
Hs	Percentage of sailing hours	%
I	Total interest cost	euro/year
ihyp	Interest rate bank loan	%
iof	Interest rate own funds (opportunity cost)	%
ioth	Interest rate other loans	%
IV	Insurance value vessel	euro
IVcon	Insurance value contents	euro
IVli	Insurance value lifting	euro
IVneq	Insurance value nautical equipment	euro
iw	Weighted interest rate	%
LABem	Labour cost employees	euro/year
LCcons	Cost of consumption loaded	euro/year
le	Length of vessel	number
lu	Percentage of cost of lubricants	%
MT	Share of empty sailing hours	%
MTCcons	Cost of consumption empty	euro/year
MWage	Yearly minimum wage	euro/year
N	Number of depreciation years	years
n	Number of vessels	number
NEW	Premium reduction for new vessels	%
NI par	Net income partner	euro/year
NIow	Net income owner-operator	euro/year
NWD	Non-working days	number
OH	Overtime hours	number
ONIem	Net income overtime employee	euro
OPER	Premium adjustment for operator	%
OPPow	Opportunity cost owner-operator	euro/year
OPPpar	Opportunity cost partner	euro/year
OPPself	Opportunity cost of self-employed people	euro/year
overtime	Cost overtime self-employed people	euro/year
HNNIem	Hourly net income normal time employee	euro/hour
HNwage	Hourly wage for normal time	euro/year
HONIem	Hourly net income overtime employee	euro/hour

HOwage	Hourly wage for overtime	euro/year
p	Type staff member	p = 1,…,5
PANDI	Premium P&I	euro/year
Pbasic	Basic premium casco insurance	euro/ton
Pcon	Premium contents	%
PD	Port dues	euro/ton
Pen	Premium main engine	euro/pk
PK	Power main engine	number
Pneq	Premium nautical equipment	%
Ptl	Premium total loss	%
r	Income	number
RE	Remuneration entrepreneurship	euro/year
REST	Discounted residual value	euro
Rg	Premium adjustment for groups	%
Rn	Cost adjustment for vessel quantity	%
Ro	Share of overtime hours	%
Rq	Price adjustment for quantities	%
RV	Residual value of vessel	euro
RVc	Residual value casco	euro
s	Type of vessel	s = 1,…,8
SH	Sailing hours per year	number
Shyp	Share of bank loan in AV	%
Sli	Share premium lifting vessel	%
SOCow	Social contributions of owner-operator	euro/year
SOCpar	Social contributions of partner	euro/year
Sof	Share of own funds in AV	%
Soth	Share of other loans in AV	%
t	Tonnage vessel	number
TC	Total costs	euro/year
TCrep	Total costs of repair and maintenance	euro/year
TON	Tonnage loaded	number
u	Equipment	u = 1,2
UR	Unlimited risk	euro/year
Vcasco	Insurance casco	euro/year
Vpandi	Insurance P&I	euro/year
WAD	Waterway dues loaded	euro/ton
WATmt	Waterways dues empty	euro
WGby	Employers contribution	%
WH	Working hours per day	number
WN	Number of employees	number

Xc	Percentage value casco	%
Xe	Percentage value engine room	%
Xo	Percentage value other	%
Xp	Percentage value pumps	%
Xt	Percentage value tubes	%
Yc	Percentage restvalue casco	%
YCcons	Yearly cost of consumption (fuel and lubricants)	euro/year
YREV	Yearly revenues	euro
Zc	Depreciation rate casco	%
Ze	Depreciation rate engine room	%
Zo	Depreciation rate other	%
Zp	Depreciation rate pumps	%
Zt	Depreciation rate tubes	%

Annex 11: Variables cost simulation (Fuel consumption)

Variable	Description	Unit
Am	Main frame area	m^2
Atr	Submerged transom area	m^2
B	Beam	m
Cb	Blockcoefficient	-
Cd-tr	Constant of resistance calculation	-
Cp	Prismatic coefficient	-
CpST	Prismatic coefficient of aft ship	-
Displ_design	Displacement design	m^3
Displ_empty	Displacement empty	m^3
Displ_X	Displacement load factor X	m^3
Etha_total	Total efficiency	%
FnB	Froude width number	-
Fnh	Froude depth number	-
Fuel_rate	Fuel consumption engine per hour	l/h
g	Gravity constant	m/s^2
H	Water depth	m
Htr	Height of the transom area	m
Hva	Pressure loss at aft ship	-
L	Length barge	m
Lenter_design	Length of the for ship (design)	m
Lenter_empty	Length of the for ship (empty)	m
Lenter_X	Length of the for ship (load factor X)	m
Loading_X	Load factor	%
Lst_design	Length of the aft ship (design)	m
Lst_empty	Length of the aft ship (empty)	m
Lst_X	Length of the aft ship (at load factor X)	m
N_prop	Number of propellers	-
Nhu	Kin. viscosity of water	m^2/s
P	Constant of resistance calculation	-
P_req	Required power	kW
Pb	Absorbed power	kW
Pb	Absorbed power	kW
Peff	Effective power	kW
Q	Constant of resistance calculation	-
Rall_D	Extra component for correlation deep water	N
Rall_S	Extra component for correlation shallow water	N
Re	Reynolds number	-

Rf_D	Frictional resistance deep water	N
Rf_S	Frictional resistance shallow water	N
Rho	Density water	kg/m³
Rshallow	Total resistance shallow water	kN
Rst	Curvature radius aft ship	m
Rtotal	Total resistance deep water	kN
Rtr_D	Resistance of the submerged transom of the vessel deep water	N
Rtr_S	Resistance of the submerged transom of the vessel shallow water	N
Rvp_D	Viscous pressure resistance deep water	N
Rvp_S	Viscous pressure resistance shallow water	N
Rw_D	Wave making resistance of the vessel deep water	N
Rw_S	Wave making resistance of the vessel shallow water	N
S	Wetted surface	m²
t	Payload	tonne
T_design	Draught design	m
T_empty	Draught empty	m
T_X	Draught load factor X	m
V	Speed of the vessel	km/h
V1	Speed for calculating frictional resistance	m/s
V2	Speed for calculating rest resistance	m/s
α_c	Constant of resistance calculation	rad
α_st	Angle aft ship	rad

Annex 12: Functions Fuel consumption model (based on Van Terwisga, Mennen and Holtrop , 1991)

$$T_{empty} = \frac{Displ_{empty}}{0.9} * \left(L - \left(Lst_{design} - Lst_{empty}\right) - \left(Lenter_{design} - Lenter_{empty}\right)\right) * B$$

Where:

T_empty	=	Draught empty
Displ_empty	=	Displacement empty
L	=	Length vessel
Lst_design	=	Length of the aft ship (design)
Lst_empty	=	Length of the aft ship (empty)
Lenter_design	=	Length of the for ship (design)
Lenter_empty	=	Length of the for ship (empty)
B	=	Beam

$$T_X = \frac{Loading\_x * \left(Displ_{design} - Displ_{empty}\right) + Displ_{empty}}{0,9 * \left(Lst_X + Lenter_X + \left(L - Lenter_{design} - Lst_{design}\right)\right) * B}$$

Where:

T_X	=	Draught load factor X
Loading_X	=	Load factor
Displ_design	=	Displacement design
Displ_empty	=	Displacement empty
Lst_X	=	Length of the aft ship (load factor X)
Lenter_X	=	Length of the for ship (load factor X)
L	=	Length vessel
Lenter_design	=	Length of the for ship (design)
Lst_design	=	Length of the aft ship (design)

$$Displ_{design} = T_{design} * B * L * Cb$$

Where:

Displ_design	=	Displacement design
T_design	=	Draught design
B	=	Beam
L	=	Length vessel
Cb	=	Blockcoefficient

$$Displ_{empty} = Displ_{design} - t$$

Where:

Displ_empty	=	Displacement empty
Displ_design	=	Displacement design
t	=	Payload

$$Displ_X = Displ_{design} - Displ_{empty} * (Loading\_x + Displ_{empty})$$

Where:

Displ_X	=	Displacement load factor X
Displ_design	=	Displacement design
Displ_empty	=	Displacement empty
Loading_X	=	Load factor

$$Lenter_{design} = 4\% * L$$

Where:

Lenter_design	=	Length of the for ship (design)
L	=	Length vessel

$$Lenter_{empty} = \frac{T_{empty}}{T_{design}} * Lenter_{design}$$

Where:

Lenter_empty	=	Length of the for ship (empty)
T_empty	=	Draught empty
T_design	=	Draught design
Lenter_design	=	Length of the for ship (design)

$$Lst_{design} = 0.3 * L/4.7$$

Where:

Lst_design	=	Length of the aft ship (design)
L	=	Length vessel

$$Lst_{empty} = \frac{t_{empty}}{t_{design} - Htr} * Lst_{design}$$

Where:

Lst_empty	=	Length of the aft ship (empty)
T_empty	=	Draught empty
T_design	=	Draught design
Htr	=	Height of the transom area
Lst_design	=	Length of the aft ship (design)

$$T_X = \frac{Loading\_x \ \left(Displ_{design} - \ Displ_{empty}\right) + \ Displ_{empty}}{0.9 * \left(Lst_X + Lenter_X + \left(L - Lenter_{design} - Lst_{design}\right)\right)} * B$$

Where:

T_X	=	Draught load factor X
Loading_X	=	Load factor
Displ_design	=	Displacement design
Displ_empty	=	Displacement empty
Lst_X	=	Length of the aft ship (at load factor X)
Lenter_X	=	Length of the aft ship (at load factor X)
L	=	Length vessel
Lenter_design	=	Length of the for ship (design)
Lst_design	=	Length of the aft ship (design)
B	=	Beam

$$Atr = Htr * B$$

Where:

Atr	=	Submerged transom area
Htr	=	Height of the transom area
B	=	Beam

$$S = L * B * 2L * T_x$$

Where:

S	=	Wetted surface
L	=	Length vessel
B	=	Beam
T_X	=	Draught load factor X

$$Am = B * T_x$$

Where:

Am	=	Main frame area
B	=	Beam
T_X	=	Draught load factor X

$$Lenter_X = Lenter_{empty} + \left(Lenter_{design} - Lenter_{empty}\right) * Loading_X$$

Where:

Lenter_X	=	Length of the aft ship (at load factor X)
Lenter_empty	=	Length of the for ship (empty)
Lenter_design	=	Length of the for ship (design)
Loading_X	=	Load factor

$$Lst_X = Lst_{empty} + \left(Lst_{design} - Lst_{empty}\right) * Loading_x$$

Where:

Lst_X	=	Length of the aft ship (at load factor X)
Lst_empty	=	Length of the aft ship (empty)
Lst_design	=	Length of the aft ship (design)
Loading_X	=	Load factor

$$C_{d-tr} = 0.213 * COS(\alpha_{st})$$

Where:

Cd-tr	=	Constant of resistance calculation
α_st	=	Angle aft ship

$$\alpha_c = 14 * \sqrt{\frac{Rst}{T_x}} * \frac{\pi}{180}$$

Where:

α_c	=	Constant of resistance calculation
Rst	=	Curvature radius aft ship
T_X	=	Draught load factor X

$$Cp = \frac{Displ_x}{(L * Am)}$$

Where:

Cp	=	Prismatic coefficient
Displ_X	=	Displacement load factor X
L	=	Length vessel
Am	=	Main frame area

$$Hva = T_x - Htr - Rst * (1 - COS(\alpha_C) - (Lst_x - Rst * SIN(\alpha_C) * TAN(\alpha_C)$$

Where:

Hva	=	Pressure loss at aft ship
T_X	=	Draught load factor X
Htr	=	Height of the transom area
Rst	=	Curvature radius aft ship
α_c	=	Constant of resistance calculation
Lst_X	=	Length of the aft ship (at load factor X)

$$Q = 0.18357 * (1 - Cp^{-0.32144}) * (\frac{B}{L})^{0.562} * (\frac{B}{T_x})^{0.22314} * (\frac{L}{Lenter_x})^{0.673}$$

Where:

Q	=	Constant of resistance calculation
Cp	=	Prismatic coefficient
B	=	Beam
L	=	Length vessel
T_X	=	Draught load factor X
Lenter_X	=	Length of the aft ship (at load factor X)

$$P = 0.11712 * (\frac{T_x}{L})^{0.78203} * (1.05 - CpST)^{-1.0366} * (0.02 + 0.95 * \frac{Hva}{T_x})^{0.21336}$$

Where:

P	=	Constant of resistance calculation
T_X	=	Draught load factor X
L	=	Length vessel
CpST	=	Prismatic coefficient of aft ship
Hva	=	Pressure loss at aft ship

$$Re = \frac{V}{3.6} * \frac{L}{Nhu}$$

Where:

Re	=	Reynolds number
V	=	Speed of the vessel
L	=	Length vessel
Nhu	=	Kin. viscosity of water

$$FnB = \frac{\frac{V}{3.6}}{\sqrt{g * B}}$$

Where:

FnB	=	Froude number
V	=	Speed of the vessel
g	=	Gravity constant
B	=	Beam

$$Fnh = \frac{\frac{V}{3.6}}{\sqrt{g * H}}$$

Where:

Fnh	=	Froude depth number
V	=	Speed of the vessel
g	=	Gravity constant
H	=	Water depth

Deep water:

$$Rf_D = \frac{0.5 * Rho * S * 0.075 * (\frac{V}{3.6})^2}{(LOG(Re) - 2)^2}$$

Where:

Rf_D	=	Frictional resistance deep water
Rho	=	Density water
S	=	Wetted surface
V	=	Speed of the vessel
Re	=	Reynolds number

$$Rtr_D = C_{d-tr} * \text{ Atr} * 0.5 * \text{Rho} * (\frac{\text{V}}{3.6})^2$$

Where:

Rtr_D	=	Resistance of the submerged transom of the vessel deep water
Cd-tr	=	Constant of resistance calculation
Atr	=	Submerged transom area
V	=	Speed of the vessel

$$Rw_D = Q * FnB^6 * Rho * g * B^2 * T_x$$

Where:

Rw_D	=	Wave making resistance of the vessel deep water
Q	=	Constant of resistance calculation
FnB	=	Froude number
Rho	=	Density water
g	=	Gravity constant
B	=	Beam
T_X	=	Draught load factor X

$$Rvp_D = P * Rho * (\frac{V}{3.6})^2 * B * T_x$$

Where:

Rvp_D	=	Viscous pressure resistance deep water
P	=	Constant of resistance calculation
Rho	=	Density water
V	=	Speed of the vessel
B	=	Beam
T_X	=	Draught load factor X

$$Rall_D = 0.5 * Rho * (\frac{V}{3.6})^2 * S * 0{,}0004$$

Where:

Rall_D	=	Extra component for correlation deep water
Rho	=	Density water
V	=	Speed of the vessel
S	=	Wetted surface

$$Rdeep = Rf_D + Rtr_D + Rw_D + Rvp_D + Rall_D$$

Where:

Rdeep	=	Total resistance deep water
Rf_D	=	Frictional resistance
Rtr_D	=	Resistance of the submerged transom of the vessel
Rw_D	=	Wave making resistance of the vessel
Rvp_D	=	Viscous pressure resistance
Rall_D	=	Extra component for correlation deep water

Shallow water:

$$Rf_S = \frac{0.5 * Rho * S * 0.075 * V1^2}{(LOG(Re) - 2)^2}$$

Where:

Rf_S	=	Frictional resistance shallow water
Rho	=	Density water
S	=	Wetted surface
V1	=	Speed for calculating frictional resistance
Re	=	Reynolds number

$$V1 = \frac{(\frac{V}{3.6})}{\alpha^*}$$

Where:

V1	=	Speed for calculating frictional resistance
V	=	Speed of the vessel
α*	=	(see later)

$$Rtr_S = Cdtr * Atr * 0.5 * Rho * V1^2$$

Where:

Rtr_S	=	Resistance of the submerged transom of the vessel shallow water
Cd-tr	=	Constant of resistance calculation
Atr	=	Submerged transom area
Rho	=	Density water
V1	=	Speed for calculating frictional resistance

$$Rw_S = \frac{Rw_D}{\left(\frac{V}{3.6}\right)^2} * V2^2$$

Where:

Rw_S	=	Wave making resistance of the vessel shallow water
Rw_D	=	Wave making resistance of the vessel deep water
V	=	Speed of the vessel
V2	=	Speed for calculating rest resistance

$$V2 = \frac{(\frac{V}{3.6})}{\alpha^{**}}$$

Where:

V2	=	Speed for calculating rest resistance
V	=	Speed of the vessel
α**	=	(see later)

$$Rvp_S = \frac{Lst\_X}{(\frac{V}{3.6})^2} * V2^2$$

Where:

Rvp_S	=	Viscous pressure resistance
Lst_X	=	Length of the aft ship (at load factor X)
V	=	Speed of the vessel
V2	=	Speed for calculating rest resistance

$$Rall_S = \frac{Rall_D}{(\frac{V}{3.6})^2} * V2^2$$

Where:

Rall_S	=	Extra component for correlation shallow water
Rall_D	=	Extra component for correlation deep water
V	=	Speed of the vessel
V2	=	Speed for calculating rest resistance

$$Rshallow = Rf_S + Rtr_S + Rw_S + Rvp_S + Rall_S$$

Where:

Rshallow	=	Resistance shallow water
Rf_S	=	Frictional resistance shallow water
Rtr_S	=	Resistance of the submerged transom of the vessel
Rw_S	=	Wave making resistance of the vessel shallow water
Rvp_S	=	Viscous pressure resistance shallow water
Rall_S	=	Extra component for correlation shallow water

$$Peff = Rshallow * \frac{V}{3.6}$$

Where:

Peff	=	Effective power
Rshallow	=	Resistance shallow water
V	=	Speed of the vessel

$$Pb = \frac{Peff}{Etha\_total}$$

Where:

Pb	=	Absorbed power
Peff	=	Effective power
Etha_total	=	Total efficiency (estimation)

$$P_{req} = \frac{Pb}{N_{prop}}$$

Where:

P_req	=	Required power
Pb	=	Absorbed power
N_prop	=	Number of propellers

$$CONSfu = Fuel\_rate * N\_prop$$

Where:

CONSfu	=	Fuel consumption main engine
Fuel_rate	=	Fuel consumption engine per hour

N_prop = Number of propellers

$$Fuel_{rate} = M * P_{req} + N$$

Where:

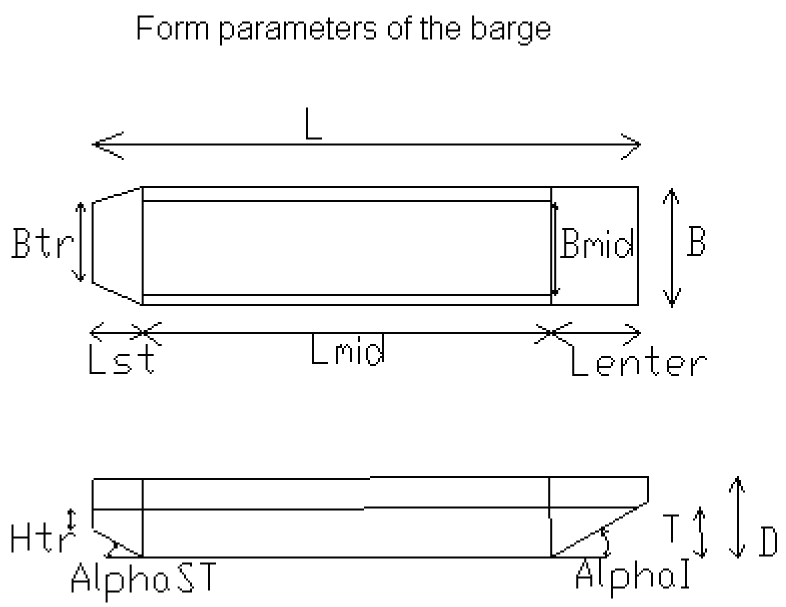
Fuel_rate = Fuel consumption engine per hour
M = see table A
N = see table A

Table A:

Power_engine	**M**	**N**
Power_engine <= 375kW	0.2569	0.7191
375< Power_engine <= 423	0.2573	0.5596
423< Power_engine <= 533	0.2496	-0.1495
533< Power_engine <= 747	0.2488	-0.3972
747< Power_engine <= 970	0.245	3.5328
970< Power_engine <= 1195	0.2376	4.9445

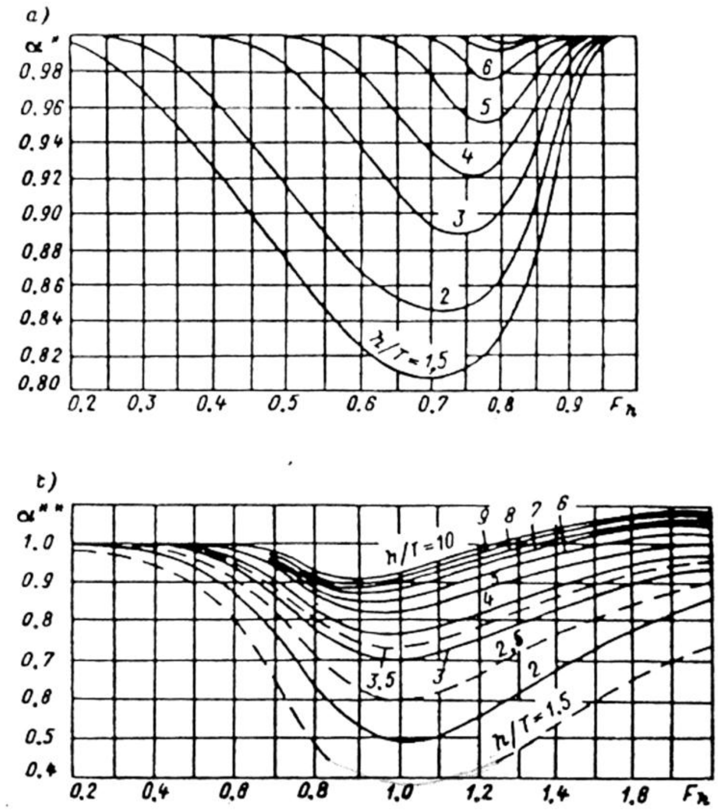
Htr=0.1, Xst=35°, Cb=0.9

Figure A: Local and global form parameters of the barge (Van Terwisga, Mennen and Holtrop, 1991)



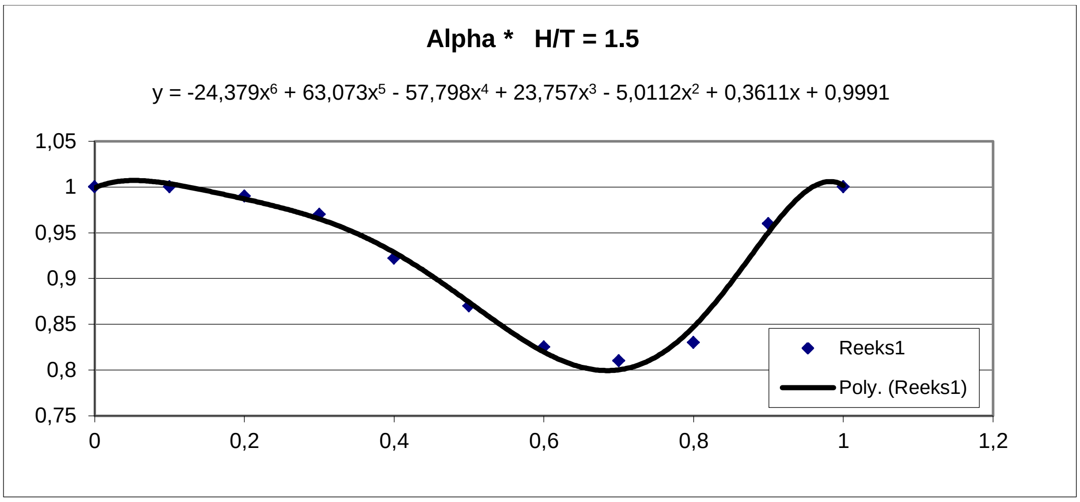
α* and α** are determined with the help of the lines in the figure.

Figure B: Correction line for the calculation of the shallow water resistance of the barge (Karpov /Basin et al., 1976)



In order to use the information that is given in the graphs above (figure B) in the model the different H/T (water depth/barge draught) lines are estimated with a 6th power polynomial function. Where H/T ratio is the ratio of the water depth of the waterway and the draught of the ship. One of the lines to determine Alpha* with an H/T of 1.5 can be seen in figure 3.

Figure C: Polynomial for the determination of Alpha*(Karpov /Basin et al., 1976)



Annex 13: Minimum staff requirements inland navigation (Belgium)

14748 MONITEUR BELGE — 16.03.2007 – Ed. 2 — BELGISCH STAATSBLAD

BIJLAGE IV

Minimum bemanning van motorschepen en duwboten

Groep		Bemanningsleden	Aantal bemanningsleden bij de exploitatiewijze A1, A2 of B en voor de uitrustingsstandaard S1, S2					
			A1		A2		B	
			S1	S2	S1	S2	S1	S2
1	L ≤ 70 m	schipper..................	1		2		2	2
		stuurman	-		-		-	-
		volmatroos	-		-		-	-
		matroos	1		-		1	-
		lichtmatroos	-		-		1[1]	2[1] [3]
2	70 m < L ≤ 86 m	schipper..................	1 of 1	1	2		2	2
		stuurman	- -	-	-		-	-
		volmatroos	1 -	-	-		-	-
		matroos	- 1	1	-		2	1
		lichtmatroos	- 1	1	1[1]		-	1
3	L > 86 m	schipper..................	1 of 1	1	2	2	2 of 2	2
		stuurman	1 1	1	-	-	1 1[2]	1
		volmatroos	- -	-	-	-	- -	-
		matroos	1 -	-	1	-	2 1	1
		lichtmatroos	- 2	1	1[1]	2[1]	- -	1

[1] De lichtmatroos of een van de lichtmatrozen mag worden vervangen door een deksman.
[2] De stuurman moet voldoen aan de bekwaamheidseisen van schipper.
[3] Een van de lichtmatrozen moet ouder zijn dan 18 jaar.

Gezien om gevoegd te worden bij Ons besluit van 9 maart 2007.

Source: BELGISCH STAATSBLAD VRIJDAG 16 MAART 2007: 9 MAART 2007. — Koninklijk Besluit houdende de bemanningsvoorschriften op de scheepvaartwegen van het Koninkrijk, bl.14711.

Annex 14: Minimum wages inland navigation (Belgium)

LONEN BINNEN-,RIJN- EN TANKVAART

geldig vanaf 1 JUNI 2008 - indexsnede 109,34 - 111,53

MET INGANG VANAF 1 JULI 2009 BASISLOON MATROZEN: + 25,00 €

SCHIPPERS

	BINNENVAART EN RIJNVAART				TANKVAART			
	Maandloon	*100%*	*150%*	*200%*	*Maandloon*	*100%*	*150%*	*200%*
Tonnage								
-750	1.941,10 €	11,20 €	17,68 €	23,58 €	2.002,33 €	11,55 €	18,24 €	24,32 €
750 - 1500	2.182,70 €	12,59 €	19,88 €	26,51 €	2.284,86 €	13,18 €	20,81 €	27,75 €
1500 - 2250	2.230,40 €	12,87 €	20,32 €	27,09 €	2.315,51 €	13,36 €	21,09 €	28,12 €
2250	2.281,43 €	13,16 €	20,78 €	27,71 €	2.383,53 €	13,75 €	21,71 €	28,95 €

STUURLIEDEN op ieder schip in binnen-, rijn- en tankvaart

	Maandloon	*100%*	*150%*	*200%*
met patent	1.764,09 €	10,18 €	16,07 €	21,43 €
zonder patent	1.713,02 €	9,88 €	15,60 €	20,81 €

MATROZEN op ieder schip in binnen-, rijn- en tankvaart

	minder dan 2 jaar dienst				meer dan 2 jaar dienst			
	Maandloon	*100%*	*150%*	*200%*	*Maandloon*	*100%*	*150%*	*200%*
Matrozen	1.627,83 €	9,39 €	14,83 €	19,77 €	1.665,36 €	9,61 €	15,17 €	20,23 €
mat. motor.	1.658,53 €	9,57 €	15,11 €	20,14 €	1.695,95 €	9,78 €	15,45 €	20,60 €

SCHEEPSJONGENS (vakantiewerk)

	minder dan 1 jaar dienst				meer dan 1 jaar dienst			
	Maandloon	*100%*	*150%*	*200%*	*Maandloon*	*100%*	*150%*	*200%*
15 jaar	1.147,98 €	6,62 €	10,46 €	13,94 €	-	-	-	-
16 jaar	1.287,57 €	7,43 €	11,73 €	15,64 €	1.342,06 €	7,74 €	12,23 €	16,30 €
17 jaar en meer	1.427,13 €	8,23 €	13,00 €	17,33 €	1.491,75 €	8,61 €	13,59 €	18,12 €

Minimum maandinkomen voor 21jarigen (zowel mannen als vrouwen): 1.512,20 €

Indien het loon van de functie die men uitoefent, dit bedrag niet bereikt, dient de 21-jarige toch het loon te bekomen van 1.512,20 €

Om het dagloon te bekomen wordt het maandloon gedeeld door 173,33*8. Om het uurloon te bekomen wordt het maandloon gedeeld door 173,33.

NIEUW!!! Om de overuren (150% en 200%) te bekomen wordt het maandloon gedeeld door 164,67

En vermenigvuldigd met respectievelijk 150% en 200%

VERGOEDINGEN

Opkuisen tanks

Gasolie & cement	5,21 €
Dieselolie & chemicaliën	6,55 €
Stookolie	6,89 €

Voorverwarmen lading

Zomermaanden	48,64 €
Wintermaanden	57,32 €

Mondingsvaart

Kapitein	371,52
Stuurman	267,35
Matr.Motor.	215,27
Matroos	163,22

Radarticket	39,23

Source: Bijzondere verrekenkas voor gezinsvergoedingen ten bate van arbeiders der ondernemingen voor binnenscheepvaart, Dienst der maatschappelijke zekerheid.

Annex 15: Minimum wages inland navigation (the Netherlands)

LOONTABEL MOTORVRACHTSCHEPEN DATUM VAN INGANG: 1 januari 2009	Maandloon	Weekloon	Vergoeding niet genoten vrije dag	5-DAAGSE WERKWEEK / GEMIDDELDE DIENSTTIJD: Toeslag per uur: Zaterdag	Toeslag per uur: Zondag en verg. reisuur	Overwerk per uur: Normaal	Overwerk per uur: Zaterdag	Overwerk per uur: Zondag	5-DAAGSE WERKWEEK: Continutoeslag per dag: Normaal	Continutoeslag per dag: Zaterdag	Continutoeslag per dag: Zondag	SYSTEEMVAART: Overwerk per uur	SYSTEEMVAART: Continu-toeslag per dag
KAPITEIN													
laadverm. meer dan 2500 ton	2.033,69	467,73	93,55	5,85	11,69	13,62	17,54	21,04	78,32	100,86	120,98	15,78	58,45
lengte meer dan 86 m	1.994,86	458,80	91,76	5,74	11,47	13,36	17,21	20,65	76,82	98,96	118,74	15,48	57,35
lengte 70-86 m	1.953,30	449,24	89,85	5,62	11,23	13,08	16,85	20,21	75,21	96,89	116,21	15,16	56,15
lengte minder dan 70 m	1.913,60	440,11	88,02	5,50	11,00	12,82	16,50	19,80	73,72	94,88	113,85	14,85	55,00
SCHIPPER	1.837,07	422,51	84,50	5,28	10,56	12,30	15,84	19,01	70,73	91,08	109,31	14,26	52,80
MACHINIST	1.701,98	391,44	78,29	4,90	9,79	11,41	14,69	17,62	65,61	84,47	101,32	13,22	48,95
STUURMAN	1.669,94	384,07	76,81	4,80	9,60	11,18	14,40	17,28	64,29	82,80	99,36	12,96	48,00
VOLMATROOS/ MATROOS-MOTORDRIJVER													
leeftijd 23 jr. of ouder	1.638,28	376,79	75,36	4,71	9,42	10,97	14,13	16,96	63,08	81,25	97,52	12,72	47,10
leeftijd onder 23 jr.													
3 functiejaren	1.565,45	360,04	72,01	4,50	9,00	10,49	13,50	16,20	60,32	77,63	93,15	12,15	45,00
2 functiejaren	1.421,80	327,00	65,40	4,09	8,18	9,53	12,27	14,72	54,80	70,55	84,64	11,04	40,90
1 functiejaar	1.278,09	293,95	58,79	3,68	7,35	8,56	11,03	13,23	49,22	63,42	76,07	9,92	36,75
geen functiejaren	1.134,61	260,95	52,19	3,26	6,52	7,60	9,78	11,74	43,70	56,24	67,51	8,80	32,60
MATROOS													
leeftijd 23 jr. of ouder	1.613,76	371,15	74,23	4,64	9,28	10,81	13,92	16,70	62,16	80,04	96,03	12,53	46,40
leeftijd onder 23 jr:													
3 functiejaren	1.406,53	323,49	64,70	4,05	8,09	9,42	12,14	14,56	54,17	69,81	83,72	10,92	40,45
2 functiejaren	1.262,44	290,35	58,07	3,63	7,26	8,46	10,89	13,07	48,65	62,62	75,15	9,80	36,30
1 functiejaar	1.118,78	257,31	51,46	3,22	6,43	7,49	9,65	11,57	43,07	55,49	66,53	8,68	32,15
geen functiejaren	975,26	224,30	44,86	2,81	5,61	6,54	8,42	10,10	37,61	48,42	58,08	7,57	28,05
LICHTMATROOS													
leeftijd 23 jr. of ouder	1.381,20	318,75	63,75	3,99	7,97	9,29	11,96	14,35	53,42	68,77	82,51	10,76	39,85
leeftijd 22 jr.	1.174,00	270,95	54,18	3,39	6,77	7,89	10,16	12,19	45,37	58,42	70,09	9,14	33,85
leeftijd 21 jr.	1.001,35	231,10	46,22	2,89	5,78	6,73	8,67	10,40	38,70	49,85	59,80	7,80	28,90
leeftijd 20 jr.	849,45	196,05	39,21	2,45	4,90	5,71	7,35	8,82	32,83	42,26	50,72	6,62	24,50
leeftijd 19 jr.	725,15	167,35	33,47	2,09	4,18	4,87	6,27	7,52	28,00	36,05	43,24	5,64	20,90
leeftijd 18 jr.	628,45	145,05	29,01	1,82	3,63	4,23	5,45	6,53	24,32	31,34	37,55	4,90	18,15
leeftijd 17 jr.	545,55	125,90	25,18	1,58	3,15	3,67	4,73	5,67	21,10	27,20	32,60	4,25	15,75
leeftijd 16 jr.	476,50	109,95	21,99	1,38	2,75	3,20	4,13	4,95	18,40	23,75	28,46	3,71	13,75

LOONTABEL MOTORTANKSCHEPEN DATUM VAN INGANG: 1 januari 2009	Maandloon	Weekloon	Vergoeding niet genoten vrije dag	5-DAAGSE WERKWEEK / GEMIDDELDE DIENSTTIJD: Toeslag per uur: Zaterdag	Toeslag per uur: Zondag en verg. reisuur	Overwerk per uur: Normaal	Overwerk per uur: Zaterdag	Overwerk per uur: Zondag	5-DAAGSE WERKWEEK: Continutoeslag per dag: Normaal	Continutoeslag per dag: Zaterdag	Continutoeslag per dag: Zondag	SYSTEEMVAART: Overwerk per uur	SYSTEEMVAART: Continu-toeslag per dag
KAPITEIN													
laadverm. meer dan 2500 ton	2.265,09	520,95	104,19	6,51	13,02	15,17	19,53	23,44	87,23	112,30	134,78	17,58	65,10
lengte meer dan 86 m	2.210,00	508,28	101,66	6,36	12,71	14,81	19,07	22,88	85,16	109,65	131,56	17,16	63,55
lengte 70-86 m	2.145,78	493,51	98,70	6,17	12,34	14,38	18,51	22,21	82,69	106,43	127,71	16,66	61,70
lengte 56-70 m	2.081,56	478,74	95,75	5,99	11,97	13,95	17,96	21,55	80,21	103,27	123,91	16,16	59,85
lengte minder dan 56 m	2.017,78	464,07	92,81	5,80	11,60	13,51	17,40	20,88	77,68	100,05	120,06	15,66	58,00
SCHIPPER	1.935,25	445,09	89,02	5,57	11,13	12,97	16,70	20,03	74,58	96,03	115,17	15,03	55,65
MACHINIST	1.701,98	391,44	78,29	4,90	9,79	11,41	14,69	17,62	65,61	84,47	101,32	13,22	48,95
STUURMAN													
lengte meer dan 86 m	1.757,94	404,31	80,86	5,06	10,11	11,78	15,17	18,20	67,74	87,23	104,65	13,65	50,55
lengte minder dan 86 m	1.693,24	389,43	77,89	4,87	9,74	11,35	14,61	17,53	65,26	84,01	100,80	13,15	48,70
VOLMATROOS/ MATROOS-MOTORDRIJVER													
leeftijd 23 jr. of ouder	1.669,94	384,07	76,81	4,80	9,60	11,18	14,40	17,28	64,29	82,80	99,36	12,96	48,00
leeftijd onder 23 jr.:													
3 functiejaren	1.565,45	360,04	72,01	4,50	9,00	10,49	13,50	16,20	60,32	77,63	93,15	12,15	45,00
2 functiejaren	1.421,80	327,00	65,40	4,09	8,18	9,53	12,27	14,72	54,80	70,55	84,64	11,04	40,90
1 functiejaar	1.278,09	293,95	58,79	3,68	7,35	8,56	11,03	13,23	49,22	63,42	76,07	9,92	36,75
geen functiejaren	1.134,61	260,95	52,19	3,26	6,52	7,60	9,78	11,74	43,70	56,24	67,51	8,80	32,60
MATROOS													
leeftijd 23 jr. of ouder	1.646,28	378,63	75,73	4,74	9,47	11,03	14,21	17,05	63,42	81,71	98,04	12,78	47,35
leeftijd onder 23 jr.:													
3 functiejaren	1.406,53	323,49	64,70	4,05	8,09	9,42	12,14	14,56	54,17	69,81	83,72	10,92	40,45
2 functiejaren	1.262,44	290,35	58,07	3,63	7,26	8,46	10,89	13,07	48,65	62,62	75,15	9,80	36,30
1 functiejaar	1.118,78	257,31	51,46	3,22	6,43	7,49	9,65	11,57	43,07	55,49	66,53	8,68	32,15
geen functiejaren	975,26	224,30	44,86	2,81	5,61	6,54	8,42	10,10	37,61	48,42	58,08	7,57	28,05
LICHTMATROOS													
leeftijd 23 jr. of ouder	1.381,20	318,75	63,75	3,99	7,97	9,29	11,96	14,35	53,42	68,77	82,51	10,76	39,85
leeftijd 22 jr.	1.174,00	270,95	54,19	3,39	6,77	7,89	10,16	12,19	45,37	58,42	70,09	9,14	33,85
leeftijd 21 jr.	1.001,35	231,10	46,22	2,89	5,78	6,73	8,67	10,40	38,70	49,85	59,80	7,80	28,90
leeftijd 20 jr.	849,45	196,05	39,21	2,45	4,90	5,71	7,35	8,82	32,83	42,26	50,72	6,62	24,50
leeftijd 19 jr.	725,15	167,35	33,47	2,09	4,18	4,87	6,27	7,52	28,00	36,05	43,24	5,64	20,90
leeftijd 18 jr.	628,45	145,05	29,01	1,82	3,63	4,23	5,45	6,53	24,32	31,34	37,55	4,90	18,15
leeftijd 17 jr.	545,55	125,90	25,18	1,58	3,15	3,67	4,73	5,67	21,10	27,20	32,60	4,25	15,75
leeftijd 16 jr.	476,50	109,95	21,99	1,38	2,75	3,20	4,13	4,95	18,40	23,75	28,46	3,71	13,75

Source: CBRB

Annex 16: Social contributions (Belgium)

Regelingen	Arbeiders in % van het brutoloon tegen 108%			Bedienden in % van het brutoloon tegen 100%		
	werknemer	werkgever	totaal	werknemer	werkgever	totaal
Globale bijdrage (1)						
Pensioenen	7,50	8,86	16,36	7,50	8,86	16,36
Ziekte en invaliditeit						
• Geneeskundige verzorging	3,55	3,80	7,35	3,55	3,80	7,35
• Uitkeringen	1,15	2,35	3,50	1,15	2,35	3,50
Werkloosheid	0,87	1,46	2,33	0,87	1,46	2,33
Kinderbijslag		7,00	7,00		7,00	7,00
Arbeidsongevallen		0,30	0,30		0,30	0,30
Beroepsziekten		1,00	1,00		1,00	1,00
	13,07	**24,77**	**37,84**	**13,07**	**24,77**	**37,84**
Overige algemene bijdragen						
Jaarlijkse vakantie (2)		6,00	6,00			
Asbestfonds		0,01	0,01		0,01	0,01
Betaald educatief verlof		0,05	0,05		0,05	0,05
Begeleidingsplan		0,05	0,05		0,05	0,05
Kinderopvang		0,05	0,05		0,05	0,05
Tijdelijke werkloosheid, anciënniteit		0,10	0,10		0,10	0,10
Loonmatiging		7,48	7,48		7,48	7,48
Bijdrage werkloosheid						
10 of meer werknemers		1,60	1,60		1,60	1,60
loonmatiging		*0,09*	*0,09*		*0,09*	*0,09*
Sluiting ondernemingen						
Klassieke opdrachten						
1 tot 19 werknemers		0,09	0,09		0,09	0,09
loonmatiging		*0,01*	*0,01*		*0,01*	*0,01*
20 of meer werknemers		0,10	0,10		0,10	0,10
loonmatiging		*0,01*	*0,01*		*0,01*	*0,01*
Tijdelijke werkloosheid		0,14	0,14		0,14	0,14
loonmatiging		*0,01*	*0,01*		*0,01*	*0,01*
Algemeen totaal						
1 tot 9 werknemers	**13,07**	**38,76**	**51,83**	**13,07**	**32,76**	**45,83**
10 tot 19 werknemers	**13,07**	**40,45**	**53,52**	**13,07**	**34,45**	**47,52**
20 of meer werknemers	**13,07**	**40,46**	**53,53**	**13,07**	**34,46**	**47,53**

(1) Voor de werkgevers en werknemers die onderworpen zijn aan alle sectoren van de sociale zekerheid, werden de bijdragevoeten per sector vervangen door de globale bijdrage.
(2) Niet inbegrepen de bijdrage van 10,27%, berekend op het brutoloon van het vorige jaar aan 108%, die uiterlijk op 30 april moet worden betaald.

Source: Annex at INFOR VBO nr. 36 – 30 October 2009

Annex 17: Social contributions self-employed people (Belgium)

Definitieve kwartaalbijdragen 2009

In onderstaande tabel kan u de definitieve sociale bijdragen voor 2009 aflezen. Deze worden berekend op uw geïndexeerde inkomsten van 2006 (volgens de breuk 460,41/421,24).

Inkomsten 2006	Hoofdberoep	Bijberoep	Gelijkstelling met bijberoep (Art. 37)	Na pensioenleeftijd zonder pensioen te ontvangen	Na pensioenleeftijd met ontvangst van pensioen	Meewerkende echtgenoot, verplicht mini-statuut	Meewerkende echtgenoot, verplicht maxi-statuut
	reeks A	reeks D	reeks H	reeks Y	reeks O8	reeks Q	reeks L
in EUR	*in EUR*	*in EUR*	*in EUR*	*in EUR*	*in EUR*	*in EUR*	*in EUR*
0,00	676,36	0,00	0,00	0,00	0,00	24,29	297,12
1.196,88	676,36	0,00	0,00	0,00	0,00	24,29	297,12
1.196,89	676,36	74,83	74,83	0,00	0,00	24,29	297,12
2.393,75	676,36	149,65	149,65	0,00	0,00	24,29	297,12
2.393,76	676,36	149,66	149,66	149,66	100,00	24,29	297,12
4.752,54	676,36	297,12	297,12	297,12	198,53	24,29	297,12
5.667,12	676,36	354,30	354,30	354,30	236,74	24,29	354,30
5.667,13	676,36	354,30	676,36	354,30	236,74	24,29	354,30
10.818,42	676,36	676,36	676,36	676,36	451,93	24,29	676,36
12.500,00	781,49	781,49	781,49	781,49	522,17	28,06	781,49
15.000,00	937,78	937,78	937,78	937,78	626,61	33,67	937,78
17.500,00	1.094,08	1.094,08	1.094,08	1.094,08	731,04	39,29	1.094,08
19.085,43	1.193,20	1.193,20	1.193,20	1.193,20	797,27	42,85	1.193,20
20.000,00	1.250,38	1.250,38	1.250,38	1.250,38	voor de toege-	44,90	1.250,38
22.500,00	1.406,67	1.406,67	1.406,67	1.406,67	laten bezigheid	50,51	1.406,67
25.000,00	1.562,97	1.562,97	1.562,97	1.562,97	in uw geval:	56,12	1.562,97
27.500,00	1.719,27	1.719,27	1.719,27	1.719,27	raadpleeg ons	61,74	1.719,27
30.000,00	1.875,57	1.875,57	1.875,57	1.875,57		67,35	1.875,57
32.500,00	2.031,86	2.031,86	2.031,86	2.031,86		72,96	2.031,86
35.000,00	2.188,16	2.188,16	2.188,16	2.188,16		78,57	2.188,16
37.500,00	2.344,46	2.344,46	2.344,46	2.344,46		84,19	2.344,46
40.000,00	2.500,75	2.500,75	2.500,75	2.500,75		89,80	2.500,75
42.500,00	2.657,05	2.657,05	2.657,05	2.657,05		95,41	2.657,05
45.000,00	2.813,35	2.813,35	2.813,35	2.813,35		101,02	2.813,35
47.500,00	2.969,65	2.969,65	2.969,65	2.969,65		106,64	2.969,65
50.000,00	3.052,78	3.052,78	3.052,78	3.052,78		109,64	3.052,78
68.844,54	3.811,07	3.811,07	3.811,07	3.811,07		136,95	3.811,07
en meer	3.811,07	3.811,07	3.811,07	3.811,07		136,95	3.811,07

Indien het inkomen zich tussen twee van hierboven vermelde bedragen bevindt, zal de kwartaalbijdrage evenredig variëren.

Source: Multipen Sociaal verzekeringsfonds voor zelfstandigen

Annex 18: Extract depreciations vessel from the 'Binnenvaartconvenant' (the Netherlands)

Motorvrachtschip

Onderdeel	% aanschafwaarde schip	Afschrijvingspercentage (% van de aanschafwaarde onderdeel)	Restwaarde
Casco	55%	2%	5%
Machinekamer	15%	10%	
Overig	30%	6,66%	

Motortankschip

Onderdeel	% aanschafwaarde schip	Afschrijvingspercentage (% van de aanschafwaarde onderdeel)	Restwaarde
Casco	60%	2,5%	5%
Machinekamer	15%	10%	
Overig	15%	6,66%	
Pompinstallatie	4%	6,66%	
Leidingwerk	6%	5%	

Droge lading duwbak in koppelverband

Onderdeel(1)	% aanschafwaarde duwbak	Afschrijvingspercentage (% van de aanschafwaarde onderdeel)	Restwaarde
Casco	70%	2%	5%
Boegschroef	5%	10%	
Overig	25%	6,66%	

Tankduwbak in koppelverband

Onderdeel (1)	% aanschafwaarde duwbak	Afschrijvingspercentage (% van de aanschafwaarde onderdeel)	Restwaarde
Casco	68%	2,5%	5%
Boegschroef	5%	10%	
Overig	15%	6,66%	
Pompinstallatie	10%	6,66%	
Leidingwerk	2%	5%	

(1) Voor zover de betreffende onderdelen in de bak aanwezig zijn

Losse (verhuurde) duwbakken

De onderverdeling alsmede de afschrijvingspercentages van de bakken in verhuurde staat volgen de hiervoor genoemde uitgangspunten met dien verstande dat voor het onderdeel casco een afschrijvingspercentage van 3% wordt gehanteerd. De overige afschrijvingspercentages blijven gelijk.

Source: Binnenvaartconvenant of November 19th 2009

Annex 19: Output regression analysis cost of repair and maintenance

Regression Statistics	
Multiple R	0,488006684
R Square	0,238150523
Adjusted R Square	0,205026633
Standard Error	10157,12426
Observations	49

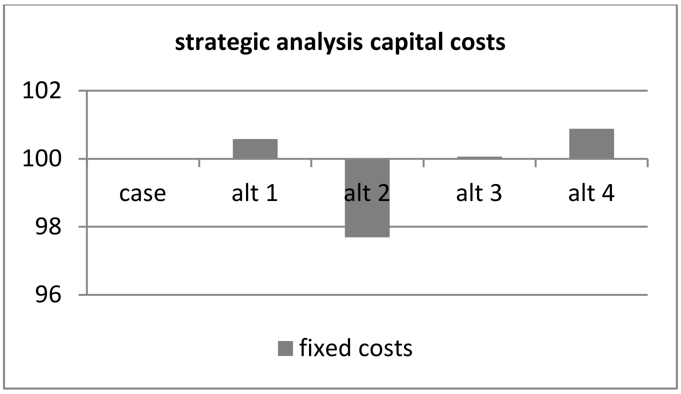
ANOVA

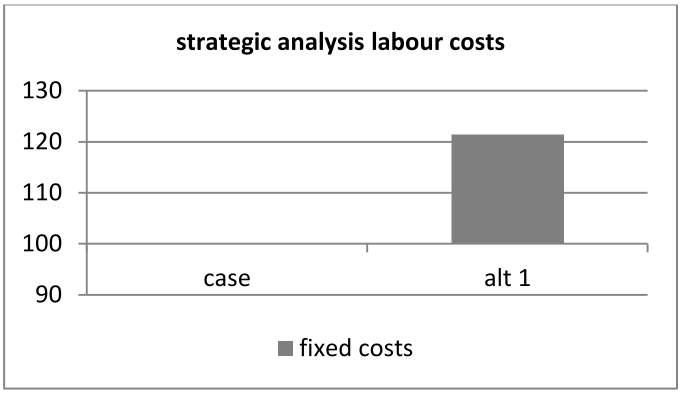
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1483480116	741740057,8	7,189690625	0,001918629
Residual	46	4745689966	103167173,2		
Total	48	6229170082			

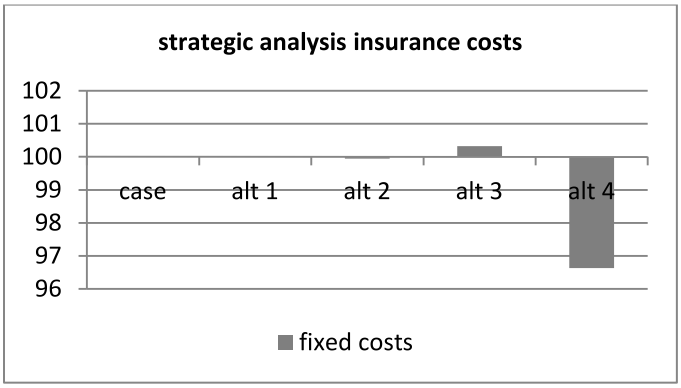
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-41072,21908	174036,4869	-0,235997749	0,814482059	-391389,4922	309245,054	-391389,4922	309245,054
Vessel size (ton)	4,9477337	2,153303054	2,297741458	0,026174525	0,613359527	9,282107873	0,613359527	9,282107873
Construction year	28,31943649	89,55327135	0,316230061	0,753258421	-151,9419465	208,5808194	-151,9419465	208,5808194

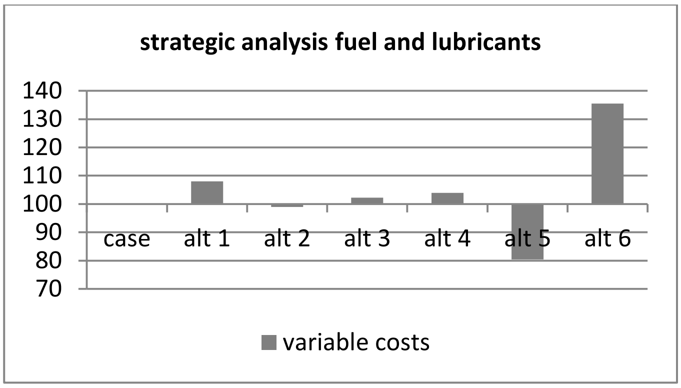
Annex 20: Results strategic analysis

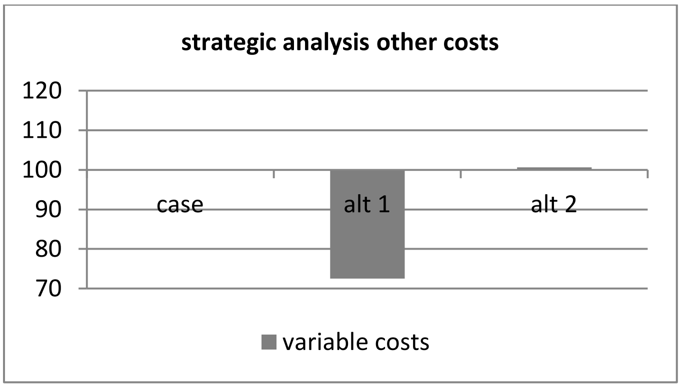
1. Results strategic analysis vessel type Spits per cost item

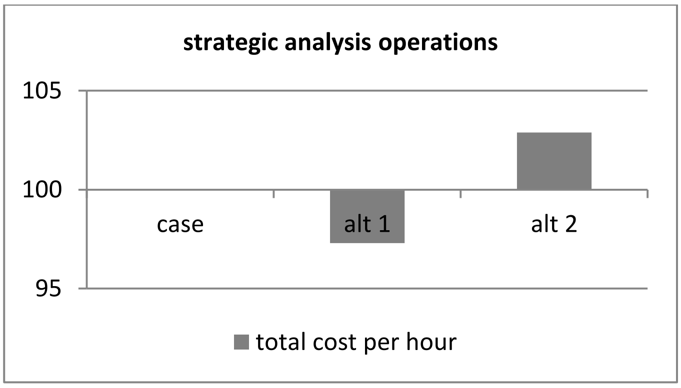




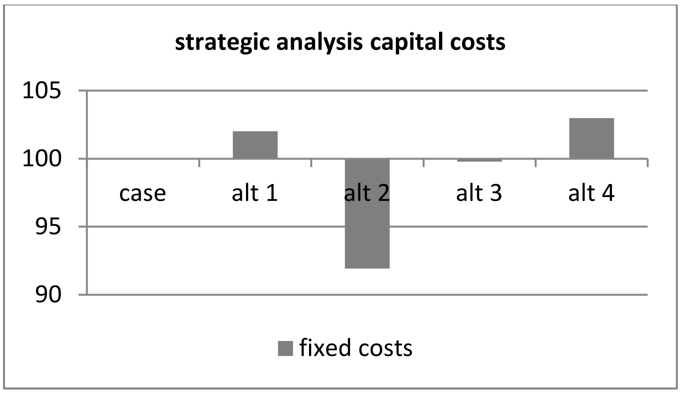


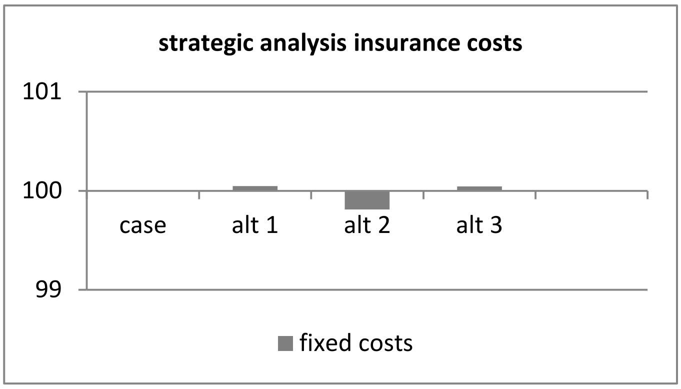


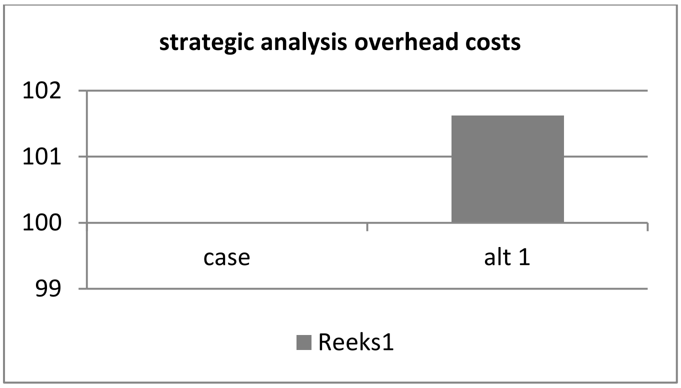


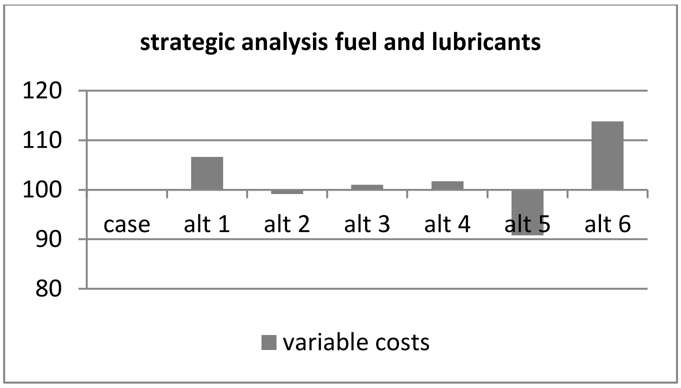


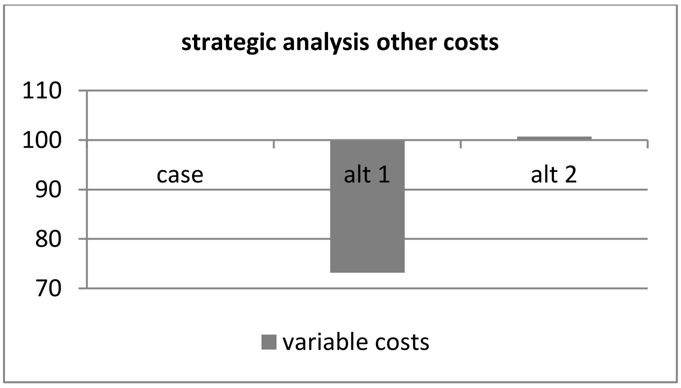
2. Results strategic analysis vessel type Rhine-Herne per cost item

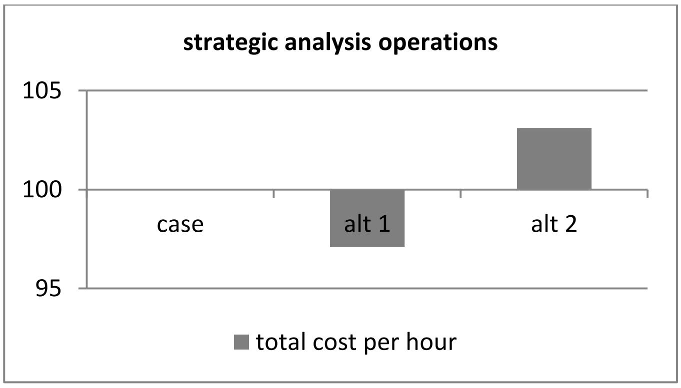




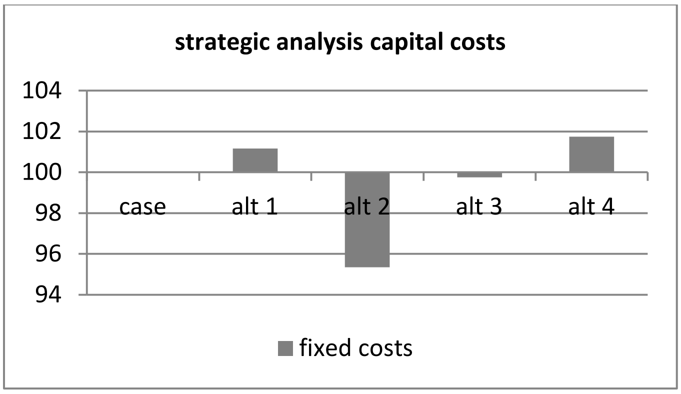


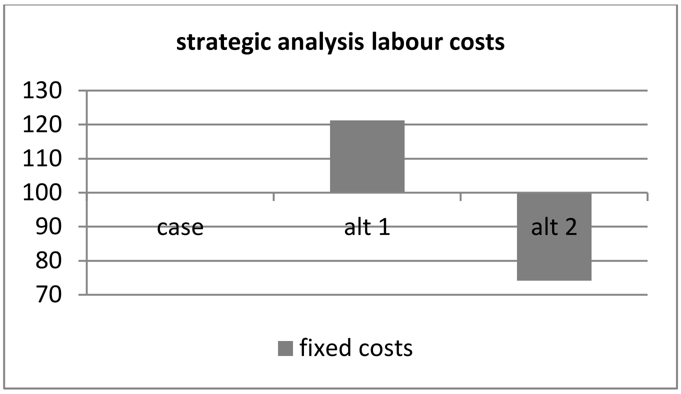


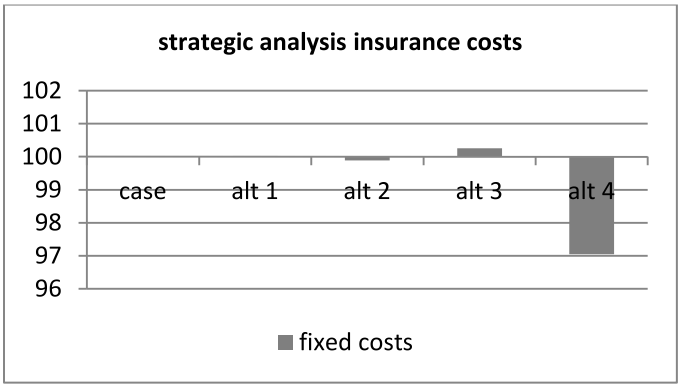


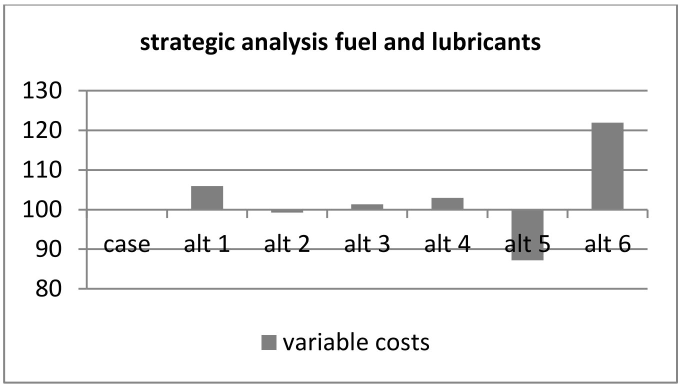


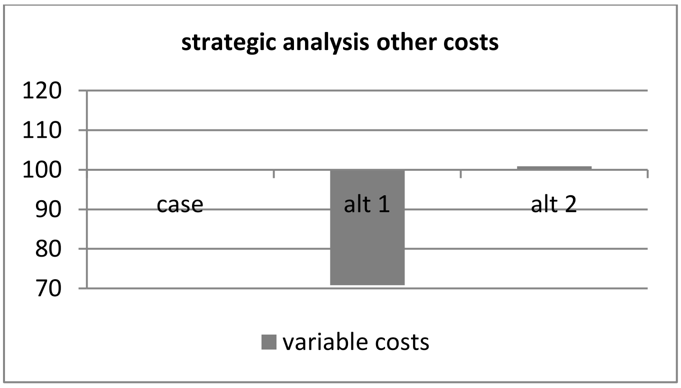
3. Results strategic analysis vessel type Kempenaar per cost item

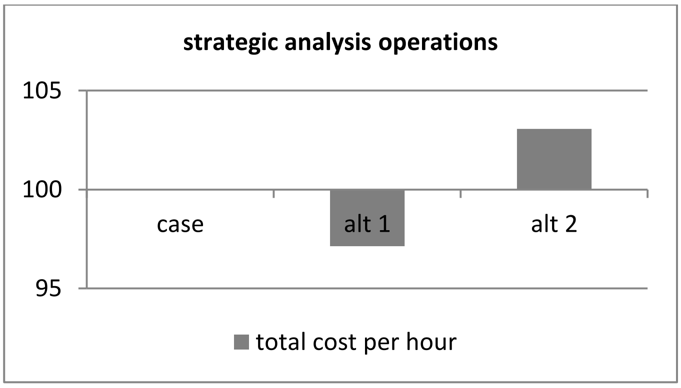




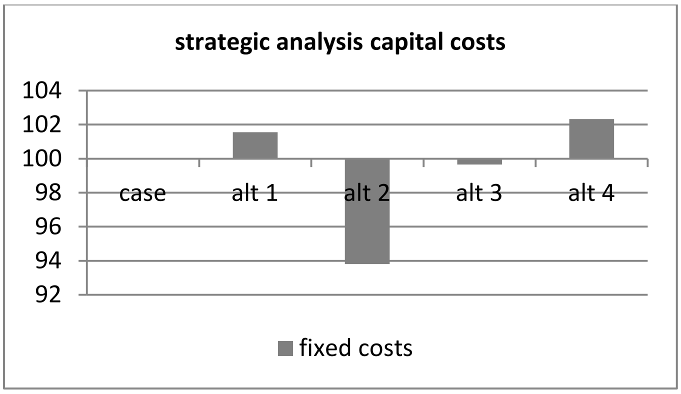


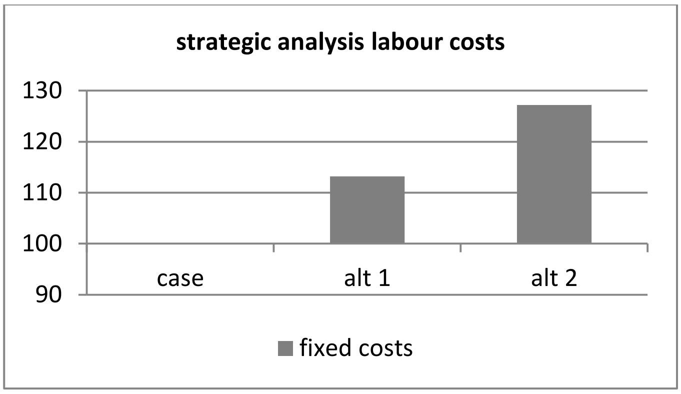


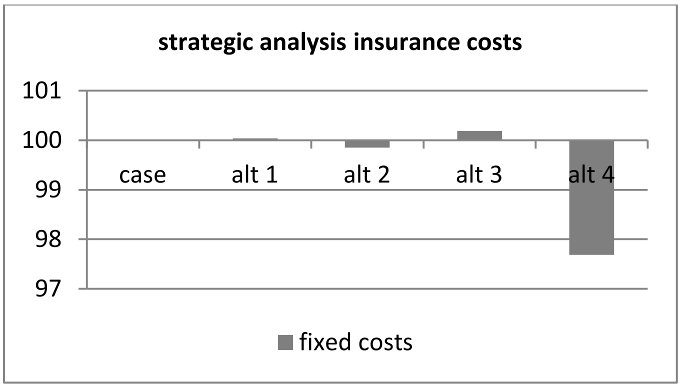


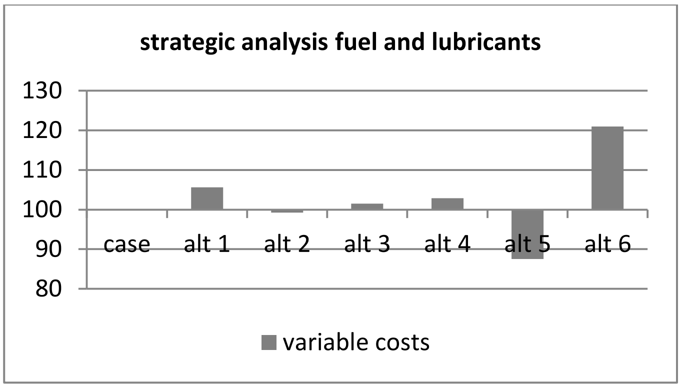


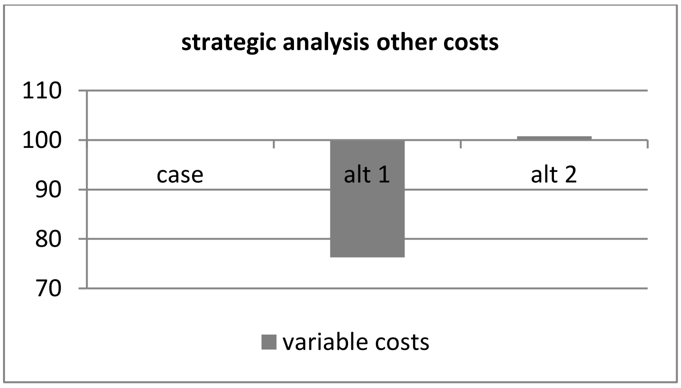
4. Results strategic analysis vessel type Canal du Nord per cost item

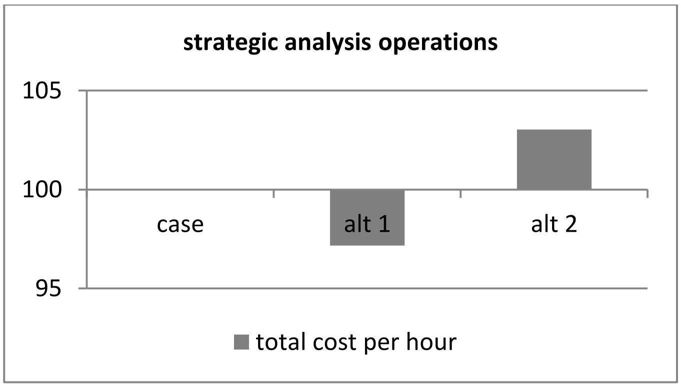




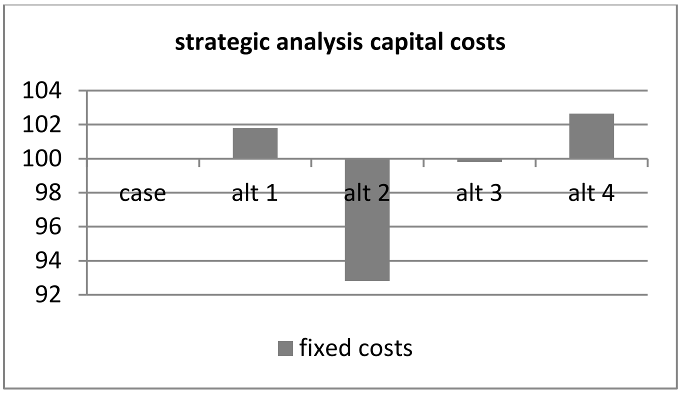


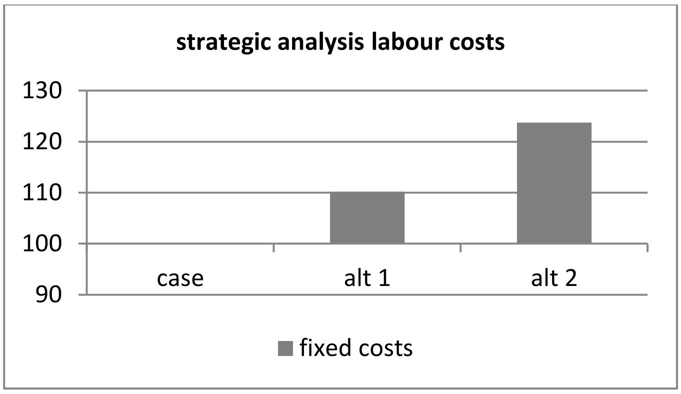


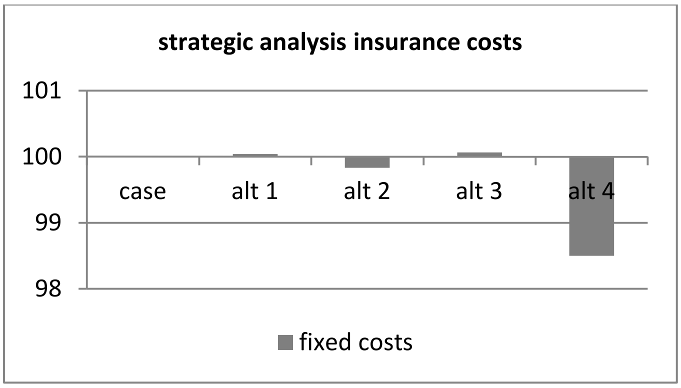


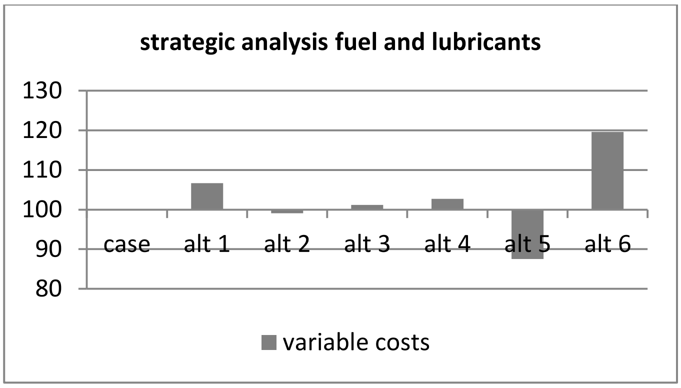


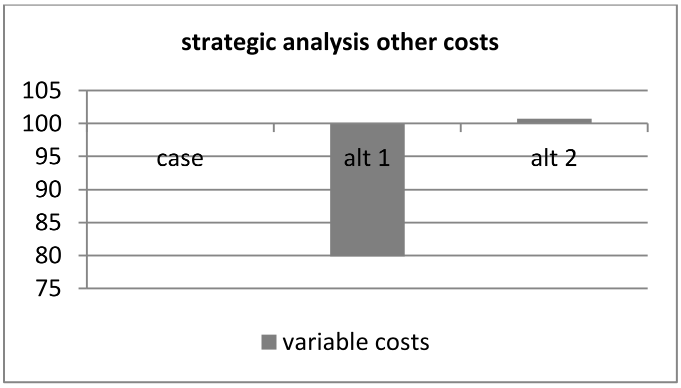
5. Results strategic analysis vessel type Dortmunder per cost item

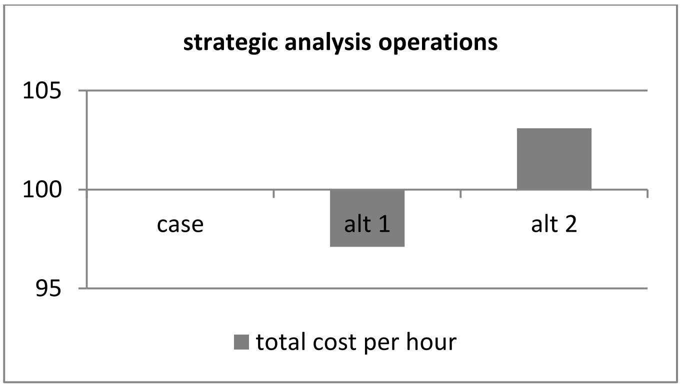




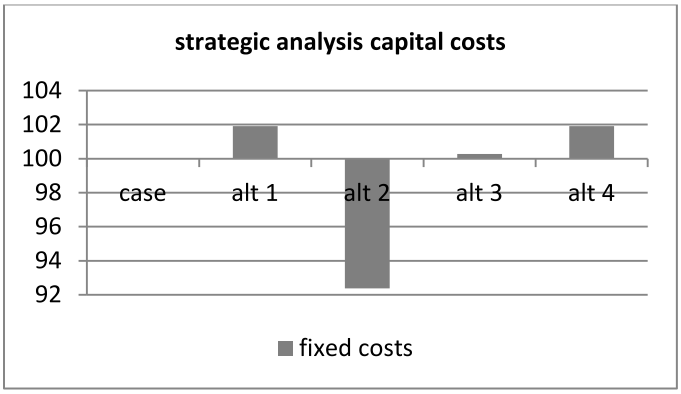


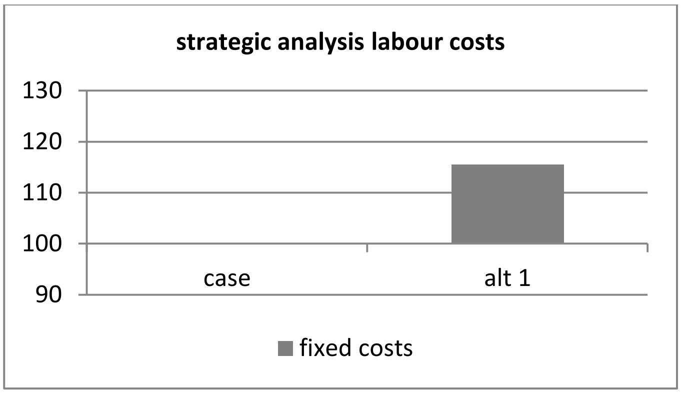


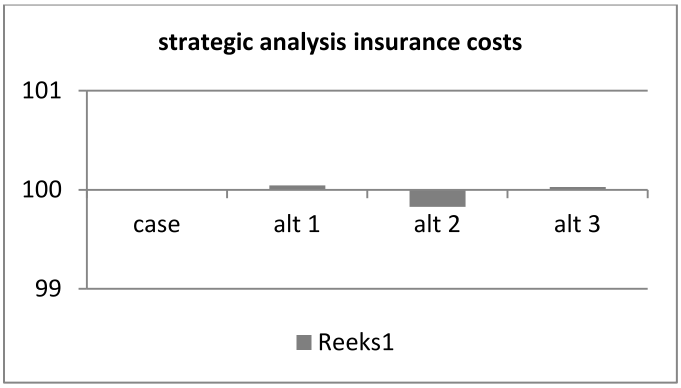


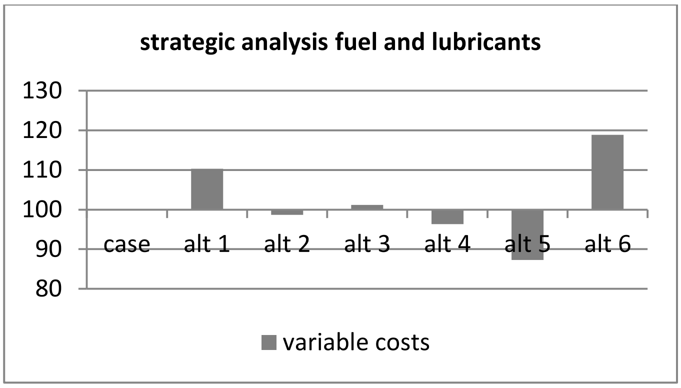


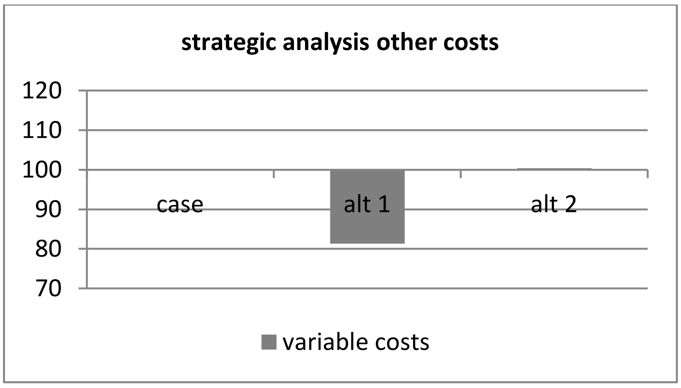
6. Results strategic analysis vessel type Large Rhine vessel per cost item

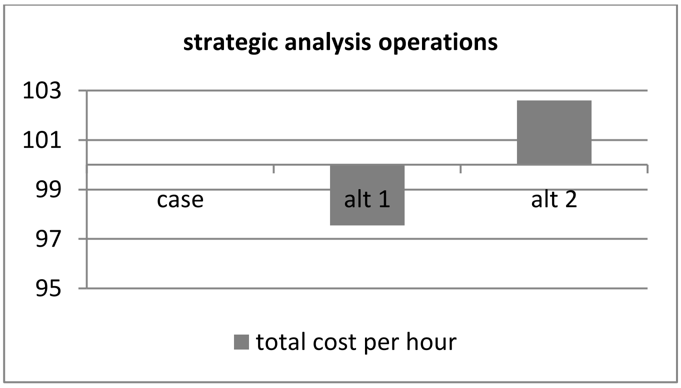




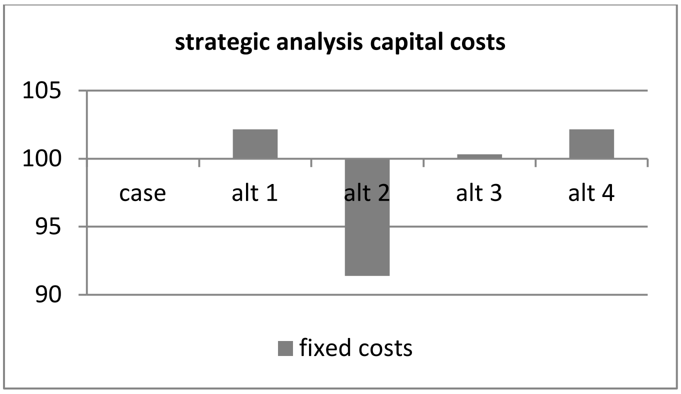


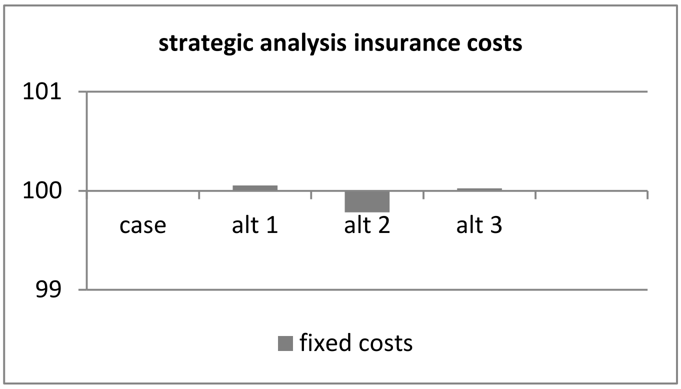


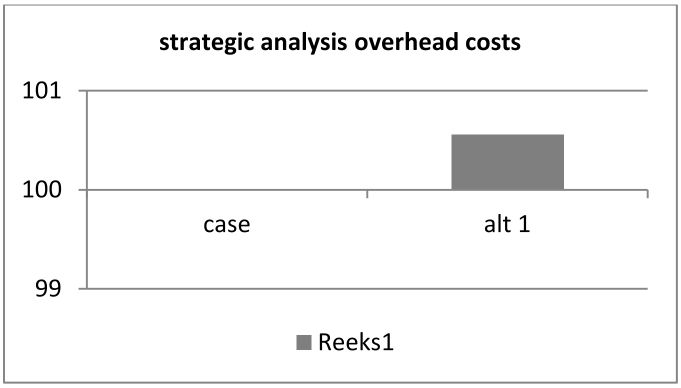


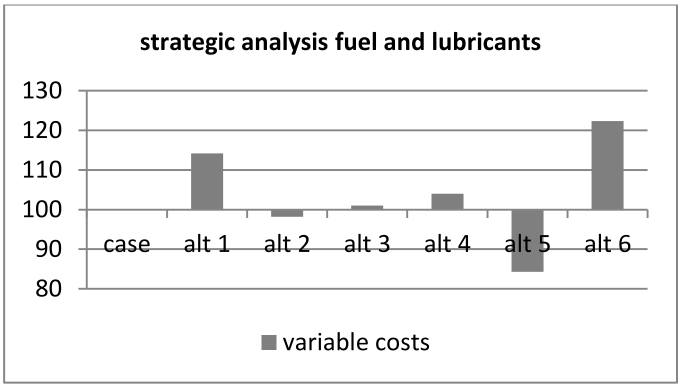


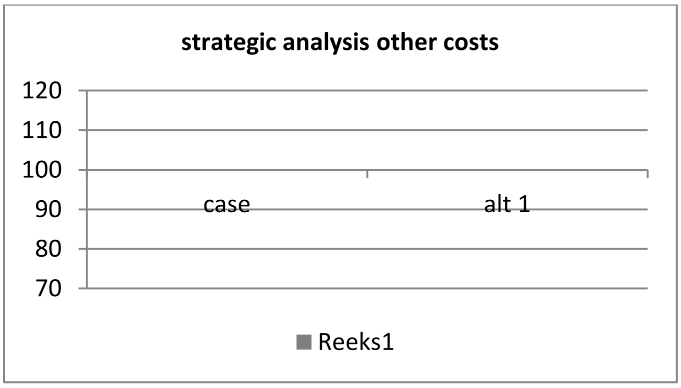
7. Results strategic analysis vessel type Large container vessel per cost item

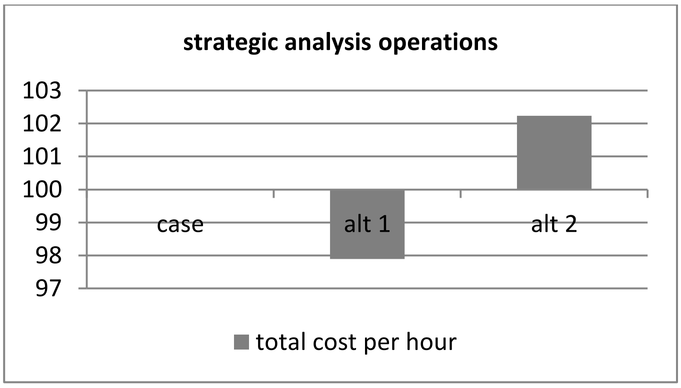












ANNEX 21: External costs (Bak M. et al. ,2008)

Air pollution costs in €/ship-km for Inland Waterways (Example Germany, HEATCO and CAFE CBA cost factors for Germany used)

Ship Type	Direct Emissions
	€/ship-km
Dry Cargo <250 ton	0.89
Dry Cargo 250-400 ton	0.89
Dry Cargo 400-650 ton	1.22
Dry Cargo 650-1,000 ton	1.86
Dry Cargo 1,000-1,500 ton	2.54
Dry Cargo 1,500-3,000 ton	4.63
Dry Cargo > 3,000 ton	4.63
Push barge <250 ton	6.05
Push barge 250-400 ton	6.05
Push barge 400-650 ton	6.06
Push barge 650-1,000 ton	6.04
Push barge 1,000-1,500 ton	6.05
Push barge 1,500-3,000 ton	6.05
Push barge > 3,000 ton	12.60
Tanker <250 ton	0.89
Tanker 250-400 ton	0.90
Tanker 400-650 ton	1.22
Tanker 650-1,000 ton	1.86
Tanker 1,000-1,500 ton	2.54
Tanker 1,500-3,000 ton	7.28
Tanker > 3,000 ton	7.28

Source emission factors: TREMOVE Base Case (model version 2.4.1).

Climate change costs in €ct/ship for freight transport on inland waterways. Central values and bandwidths are derived by using cost factors for 2010 as illustrated in Table 27

Ship Type	**Direct Emissions**
	€/ship-km
Dry Cargo <250 ton	0.08 (0.02-0.15)
Dry Cargo 250-400 ton	0.08 (0.02-0.15)
Dry Cargo 400-650 ton	0.11 (0.03-0.2)
Dry Cargo 650-1,000 ton	0.17 (0.05-0.3)
Dry Cargo 1,000-1,500 ton	0.23 (0.07-0.42)
Dry Cargo 1,500-3,000 ton	0.42 (0.12-0.75)
Dry Cargo > 3,000 ton	0.42 (0.12-0.75)
Push barge <250 ton	0.56 (0.16-1)
Push barge 250-400 ton	0.56 (0.16-1)
Push barge 400-650 ton	0.56 (0.16-1)
Push barge 650-1,000 ton	0.56 (0.16-1)
Push barge 1,000-1,500 ton	0.56 (0.16-1)
Push barge 1,500-3,000 ton	0.56 (0.16-1)
Push barge > 3,000 ton	1.14 (0.32-2.05)
Tanker <250 ton	0.08 (0.02-0.15)
Tanker 250-400 ton	0.08 (0.02-0.15)
Tanker 400-650 ton	0.11 (0.03-0.2)
Tanker 650-1,000 ton	0.17 (0.05-0.3)
Tanker 1,000-1,500 ton	0.23 (0.07-0.42)
Tanker 1,500-3,000 ton	0.65 (0.18-1.18)
Tanker > 3,000 ton	0.65 (0.18-1.18)

Source emission factors: TREMOVE Base Case (model version 2.4.1).

Costs of up- and downstream processes (fuel production, air pollution and climate change costs) in €/ship-km for inland waterway transport (Example Germany, Emissions from TREMOVE model, HEATCO and CAFE CBA valuation factors for Germany used, climate change valuation based on costs factors (€/t CO_2) for 2010 (Table 27)), Price base 2000

Ship Type	Indirect Emissions
	€/ship-km
Dry Cargo <250 ton	0.08
Dry Cargo 250-400 ton	0.08
Dry Cargo 400-650 ton	0.11
Dry Cargo > 3,000 ton	0.40
Dry Cargo 1,000-1,500 ton	0.22
Dry Cargo 1,500-3,000 ton	0.40
Dry Cargo 650-1,000 ton	0.16
Push barge <250 ton	0.52
Push barge 250-400 ton	0.52
Push barge 400-650 ton	0.52
Push barge 650-1,000 ton	0.52
Push barge 1,000-1,500 ton	0.52
Push barge 1,500-3,000 ton	0.52
Push barge > 3,000 ton	1.08
Tanker <250 ton	0.08
Tanker 250-400 ton	0.08
Tanker 400-650 ton	0.11
Tanker 650-1,000 ton	0.16
Tanker 1,000-1,500 ton	0.22
Tanker 1,500-3,000 ton	0.62
Tanker > 3,000 ton	0.62

Source emission factors: TREMOVE Base Case (model version 2.4.1).

Annex 22: People contacted for this research

Interviews and discussions:

Mr. Philippe Grulois - Verzekeringen Victor Huygebaert – Naviganda, Ghent

Mr. Frederic Swiderski - Economisch adviseur vzw ITB asbl, Brussels

Mr. Geert Van Overloop - Gedelegeerd Bestuurder De Grave-Antverpia n.v./s.a., Antwerp

Mr. Robert-Jan Zimmerman – Managing Director Mercurius Scheepvaartgroup, Zwijndrecht

Mr. Luc Geerts - Directeur CFNR SA, Antwerp

Mr. Danny Aerts - Frans D'HONDT & CO NV, Antwerp

Mr. Harrie Vugts - Post & Co B.V., Rotterdam

Mrs. Linda Segers - BDM, Antwerp

Mr. Bart Staes - BDM, Antwerp

Mr. Jan Poels-Ryckeboer - Marine underwriter Nateus, Antwerp

Mr. Paul Buyl - Technical advisor Marine & Transport Nateus, Antwerp

Mr. Lagaert - Relatiebeheerder Bank J. Van Breda, Antwerp

Mr. Cabus - Relatiebeheerder Bank J. Van Breda, Antwerp

Mr. Filip Mariën – Account manager BNP Paribas Fortis, Antwerp

Mr. Stefan Meeusen - Directeur NPRC, Zwijndrecht

Mr. Mario Lauwers - Hoofd bevrachtingen NPRC, Zwijndrecht

Mr. Martijn de Jongh - Hoofd bevrachtingen PTC, Rotterdam

Mr. Martin Seine - Financieel directeur PTC, Rotterdam

Mr. Christian Granier - Gérant AVR Affrètements van Reeth, Paris

Mr. Johan Bekaert - Euroclass, Beernem

Mr. Lucien de Boer - Stichting Abri, Ridderkerk

Mr. Rob van de brug - Slurink, Dordrecht

Mr. Christiaan Van Lancker - Bond Van Eigenschippers, Brugge

Mr. Antoine Coze - International Sales & Marketing Manager Touax, Paris

Mr. Zeeg Brasser - Proxiholder Eurobulk, Dordrecht

Mr. Bruno Vanlooy - Bevrachter C.B.O., Antwerp

Mr. Frank Hellebosch - Business Development C.B.O., Antwerp

Mr. Jan Vogelaar - Deputy director CBRB, Rotterdam

Mr. Honoré Paelinck – former CEO of NMBS and guest lecturer at dept. TPR (University of Antwerp)

Mr. Filip Verbeke - Extern Transportdeskundige nv De Scheepvaart / VOKA, Hasselt

Mr. Hotze Boonstra - Associate Professor Delft University of Technology

Mr. Erik van Toor – Manager Kantoor Binnenvaart, Rotterdam

Mr. René Overveld - Fleet manager Interstream Barging, Geertruidenberg

Statistics and other information:

Mrs. Martine Wijnbelt - IVR, Rotterdam

Mr. Herman Verschueren - Adviseur-generaal, FOD Mobiliteit en Vervoer, Brussels

Mr. Guido De Latte - Ship mortgage registry, Antwerp

Mrs. Hadewych De Sadeleer - Statisticus Algemene Directie Statistiek en Economische Informatie Brussels, Brussels

Mr. Steven Dubaere Statisticus - Algemene Directie Statistiek en Economische Informatie, Brussels

Mr. Robert Hekkenberg – Assistant professor Delft University of Technology

Mr. Jan Gilissen - nv De Scheepvaart, Hasselt

Mr. Chris Danckaerts - algemeen directeur nv De Scheepvaart, Hasselt

Mr. Roger Opdelocht - Secretaris Belgische TransportarbeidersBond sector Koopvaardij & Binnenvaart, Antwerp

Mr. Freddy Demuynck - Groupe S Dienst Maatschappelijke Zekerheid Binnenscheepvaart, Antwerp