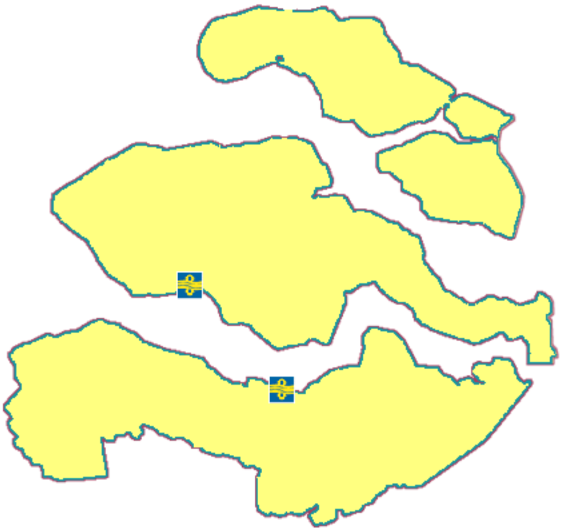
Inland navigation: Determining factors of modality choice

Applied to the companies located in the ports of Zeeland Seaports



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Preface

First of all, I want to thank the Erasmus University Rotterdam for offering the practical master Urban, Port and Transport Economics. After my HBO study, I was looking for a challenging master that has a more macro perspective on logistics and transport economy. In this master I have learned a lot about the fields of transport economics, urban economics and port economics.

When I was considering interesting thesis subjects, I contacted several governments in search of interesting internships. Zeeland Seaports responded positively on my request, by offering me an interesting thesis opportunity. In the first place, I like to thank David Moolenburgh for inviting me to Zeeland Seaports and discussing the various thesis opportunities. After deciding on the topic, I started my internship under the supervision of Tom Bogaert. He provided me with data and contact information, which is the basis for my thesis. This is why I want to thank Tom Bogaert for the time he spend on supervising my research.

During my research I have contacted over 40 persons to cooperate with my survey. I would like to thank all the companies that have responded on my survey. Without the help of these logistical managers, inland shippers, representatives of the inland shippers association and employees of Zeeland Seaports it would have been impossible to write this thesis.

Finally, I want to thank Michiel Nijdam, who is my thesis supervisor from the Erasmus University. Together we discussed several times about the progress and contents of my research. I would like to thank Michiel Nijdam for the time he spend on supervising my research and the quick response on my questions.

Steven Meerburg

Summary

In the strategic masterplan of Zeeland Seaports (ZSP), the ambition to increase the transported volume per inland navigation from 28.7 million tons in 2008 to 40 million tons in 2020 is presented. This growth must be realized by a combination of autonomous growth of the ports of ZSP and a modal shift.

The autonomous growth that can lead to an increased volume per inland navigation is especially dependent on the upgrade of the Seine – Scheldt inland waterway connection, the developments in the Scaldia port, the Axelse vlakte and the containerization. The Seine – Scheldt inland waterway connection will result in approximately one million tons transported by inland navigation in 2020. It is uncertain what the impact of the developments in the Scaldia port will be. The impact of the Axelse vlakte is still unknown. Containerization will lead to maximal 240.000 TEU transported from the Scaldia container terminal in 2020. It is uncertain whether the other two initiatives, that potentially result in an additional 1.5 million TEU transported by inland navigation, will become operational. Next to the autonomous growth, also a modal shift can contribute to the aspired volume transported by inland navigation from and to the ports of ZSP in 2020. In such a modal shift, cargo that is currently transported per truck is shifted to the transport mode inland navigation.

In order to stimulate such a modal shift, ZSP needs to gain insight in the factors that affect modality choice of companies located in the ports of ZSP. From literature is derived which factors influence modality choice most. Before inland navigation becomes an interesting modality to transport with, several basic conditions need to be present in a port. These are; a minimal required distance of transport, the right product characteristics and the efficiency of the port. The products that need to be transported do also have to meet several characteristics, for example large volumes and long keeping time. Also, the delivery time must not be to short, since inland navigation is not the fastest transport mode. Furthermore, both the shipper and the consignee need to be located at, or nearby a significant waterway. Efficiency affects the price and quality of the transport from and to a port. To learn what the impact of certain factors on modality choice is, four 'determining factors' are set up. These determining factors are supported by seventeen port indicators, that influence the quality of the parent factors. Below, an overview of the determining factors and underlying port indicators is presented.

Determining factors	*Port indicators*
Reliability	Locks, nautical safety, infrastructure and superstructure
Port efficiency	(Costs;) transport costs, port tariffs, (speed;) transport speed of the modality, accessibility, infrastructure, superstructure, (other efficiency factors;) waiting quays and other facilities.
Product characteristics	Volume, weight, value and perishability of the product
Perception / Image	Promotion

In order to encourage a modal shift, ZSP needs to understand the impact of each of the factors influencing the modality choice. This can help ZSP to adapt their policy so that investments become more cost effective and the aspired model shift can be attained. To discover the importance of the individual factors, a hierarchy is required, where weights are allocated to the determining factors and their underlying port indicators. The best method to do this is, is using the Analytical Hierarchy Process (AHP), where pair wise comparisons are used to distribute weights over the factors that affect modality choice. A survey is distributed over three respondent groups, making use of the pair wise comparisons. The first respondent group exists out of companies located in the ports of ZSP that organize their own transport. Group two exists out of companies located in the ports of ZSP that do not organize their transport themselves. The last group exists out of inland shippers, that are active in the ports of ZSP and the association of shipping companies, named Schuttevaer.

The results of the first group, clearly pinpoint 'port efficiency' as most important factor, influencing the modality choice. Especially the transport costs and speed are important. Also reliability of the transport service is of influence. Within this factor, the nautical safety is considered as the factor that influences the reliability of the transport mode most. For the second group, product characteristics are the most important. In this respondent group there are several companies that transport products in large volumes and low value. Products with these characteristics are often transported with inland navigation, since this is the most competitive mode where scale advantages can be achieved. Also, the determining factor port efficiency receives a high weight in this second group. In particular the costs and speed of transport are considered as important. The third group has another view on this subject. They designate reliability as most important factor. This is explainable since this group attaches much value to the strengths of their modality. Whenever their transport service becomes less reliable, the most attractive property of this mode becomes problematic. Next to reliability, also the speed of the transport mode and product characteristics receive high weights.

There are thus different opinions within the three respondent groups. For ZSP, the first group is the most important, since managers from this group do actually make the modality choice decision. Group one is thus decisive in the conclusions. The companies in group two are less important since it is often the customer of the company that organizes the transport. Besides, the average value of all the three groups is strongly similar to the preferences of the first group. In can thus be concluded that port efficiency influences modality choice most. Within this factor, costs and speed of the transport receive the highest weight. Also the nautical safety, as reliability aspect, receives a high score.

The factors that ZSP can affect (directly or indirectly) are; the locks, nautical safety, infrastructure, accessibility, port tariffs, waiting quays, other facilities and promotion. The factors that have been pinpointed as most important, namely the transport costs and speed, can not be influenced by ZSP. The other cost factor, port tariffs, has very low impact. From the factors influencing speed, accessibility receives the highest weight. Since 'accessibility' can be influenced by ZSP, this factor should receive the most attention, when a modal shift is pursued. Next to keeping the ports of ZSP accessible, also the (already sufficient) level reliability must be maintained. The most important factor that influences reliability is the nautical safety. Also this factor needs to be maintained and improved, in order to stimulate a modal shift. Other factors that ZSP can influence do not have a large impact on the modality choice decision of companies located in the ports of ZSP. This does not mean that these factors deserve no attention. Especially the capacity of locks and waiting quays needs to be monitored, so that no bottlenecks arise in the future. If bottlenecks are prevented, the attractiveness of the transport modes is not affected, so that the image can only improve.

CHAPTER 1 Introduction

1.1 Introduction

In the strategic masterplan of Zeeland Seaports (ZSP), the port authority of the ports of Vlissingen and Terneuzen, the ambition to increase the turnover per inland shipping from 29.5 million tons in 2006 to 40 million tons in the year 2020, is stated (Zeeland Seaports, 2008a). This growth has to be realized by both autonomous growth and a modal shift. In order to achieve such an increase in turnover, ZSP has to offer high quality facilities for inland navigation, so that new companies can be attracted and existing companies can shift their choice of modality from road to inland navigation. ZSP tries to realize this growth by investing in port efficiency improvements, promotion and keeping the tariffs for inland navigation at a competitive level.

The autonomous growth will mainly exist out of new cargo flows because of the upgraded Seine – Scheldt inland waterway connection, the development of the new port area 'Axelse Vlakte', the new sea-lock in Terneuzen and the container initiatives that are planned. These developments make the ports of Zeeland Seaports (POZSP) a more attractive location for new companies to locate. Also the companies that are already located in the ports of Zeeland Seaport can benefit from these developments. Also, the substantial extension of pulp and paper handling by Verbrugge in Vlissingen makes it possible for the POZSP to grow autonomously.

The waiting quays that are currently created in Vlissingen are another effort to stimulate the use of inland navigation. For the port of Terneuzen, there is also a plan for the extension of the quay facilities. Furthermore, ZSP tries to promote the development of multimodal inland terminals in order to facilitate more sustainable hinterland transport. There are however also other factors than infrastructure and promotion that can affect the growth of inland shipping. In this thesis is investigated which factors are most important factors that influence the choice of modality. When ZSP is aware of the importance of each of the determined factors, this knowledge can be used to make the inland navigation policy more effective. In this way, the aspired growth of volume transported by inland navigation can be persuaded in a more cost efficient way.

In this thesis is identified which are the determining factors for companies in their decision to organize their transport with a certain modality and whether ZSP has influence on these factors. The data retrieved from literature must be matched with the perception of companies in the POZSP and inland shipping companies. When this information is obtained, ZSP can adapt their policy more efficiently, so that the aspired level of transportation per inland navigation can be pursued more effectively. The research question that is to be answered in this thesis is:

What are the determining factors for companies located in the ports of Zeeland Seaports in their choice of modality when hinterland transport is organized? What is the impact of each of the determined factors?

To come to a final answer of this research question, several sub-questions are needed in order to build up the thesis and gather the required information. The sub-questions are:

- Which cargo types are transported by inland shipping?
- Which developments are taking place in the ports of Zeeland Seaports that have influence on inland shipping activities?
- What is what is the impact of these developments in the ports of Zeeland Seaports on the future cargo flows?
- What are the determining factors of modality choice from literature?
- What are the determining factors of modality choice from practice?
- What is the impact of each of these determining factors according to companies located in the ports of Zeeland Seaports?
- To what extend are these determining factors to be influenced by Zeeland Seaports?
- How can Zeeland Seaports use the derived determining factors in their policy to stimulate the use of inland navigation as a modality?

1.2 Methodology

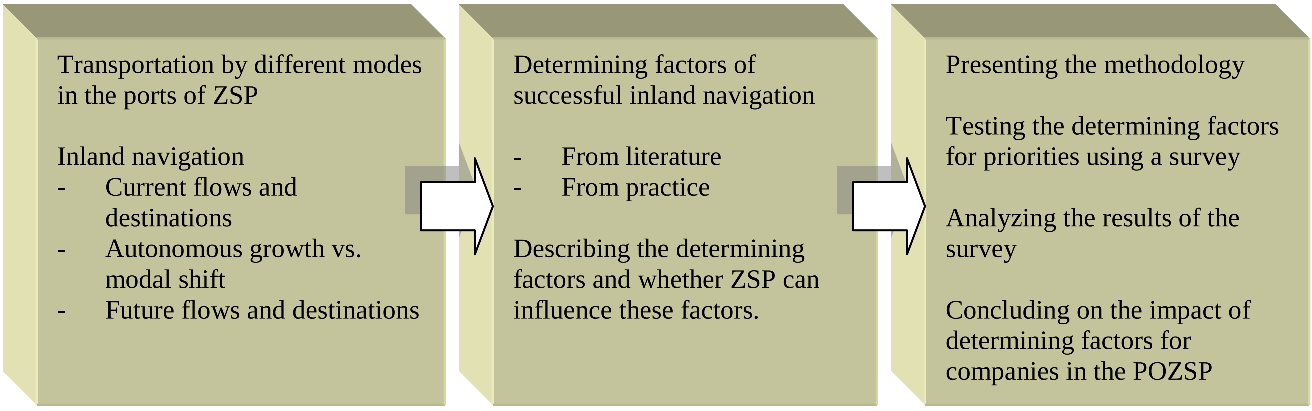
In order to answer the research question, several steps have to be taken. First of all, the current situation of ZSP needs to be presented in terms of modalities and cargo groups. Since the aspired growth of inland navigation can be realized by both autonomous growth and modal shift, these factors need to be further explored. This is done by describing the future developments in the ports of ZSP and their impact on the transportation by inland navigation.

In the second part of this thesis is described which determining factors affect the modal modality choice decision. First, these determining factors are derived from literature. Secondly, the practical experience of Zeeland Seaports is used to set up the determining factors and their underlying indicators. After deciding on which factors are used in this research, a further elaboration on all the determining factors and port indicators is presented. In addition, for each factor is described whether ZSP can have influence on it.

Thirdly, the used methodology is described. This methodology is used to test the opinion of three respondent groups on factors that influence modality choice. The first group exists out of companies that organize their own transport. The second groups contains companies that do not organize their own transport and the third group exists out of inland shippers and representatives of the inland shipping association Schuttevaer. A survey is used to test these three respondent groups on their opinion on the factors that influence modality choice. The outcome of the surveys is used to build a weighted model, so that the influence of each determining factor can be analyzed.

After analyzing the results of the survey for all respondent groups, conclusions and recommendations on the research question are presented. The build up is depicted in the flow diagram in figure 1.

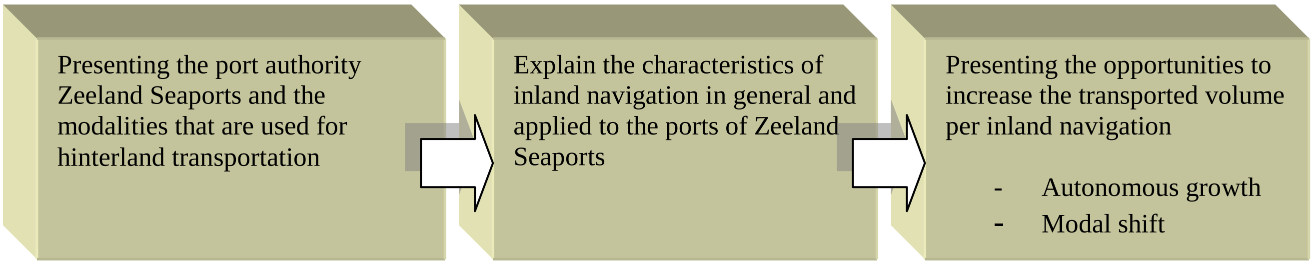
Figure 1: Flow diagram of steps in this thesis



CHAPTER 2 Increasing the transported volume per inland navigation

The build up of this chapter is presented in the flow diagram below.

Figure 2: Flow diagram chapter two



2.1 Zeeland Seaports

Zeeland Seaports (ZSP) is the port authority (PA) of the ports of Vlissingen and Terneuzen. The economic development, maintenance and exploitation of the ports are the main activities of ZSP. As a PA, ZSP has a landlord function in providing infrastructure to the private sector and leave all other activities to private firms. The function of ZSP is:

- Providing nautical safety in the port;
- Port planning and development;
- Setting and collecting port dues from shipping companies;
- Setting and collecting land rents from tenants;
- Port marketing, interest representation and provision of information about the port to relevant stakeholders (Nijdam et al, 2008).

ZSP is the third port in the Netherlands in terms of handled cargo after the ports of Rotterdam and Amsterdam. There are 250 companies active in the POZS. The income of ZSP is retrieved from a fixed part, the lease of a certain terrain in the port area and a variable part, the tariffs that are paid by ships that enter the port. The policy of ZSP is to offer port terrains to companies with good maritime accessibility, good hinterland connections and transparent laws and regulations. The ports of ZSP (POZSP) are mainly active in (break) bulk goods and do not offer the opportunity for large scale container handling yet. Together with the terminal operators, ZSP has the common goal of a good cooperation in terms of strategy, development of facilities, synergy, information exchange, marketing and acquisition.

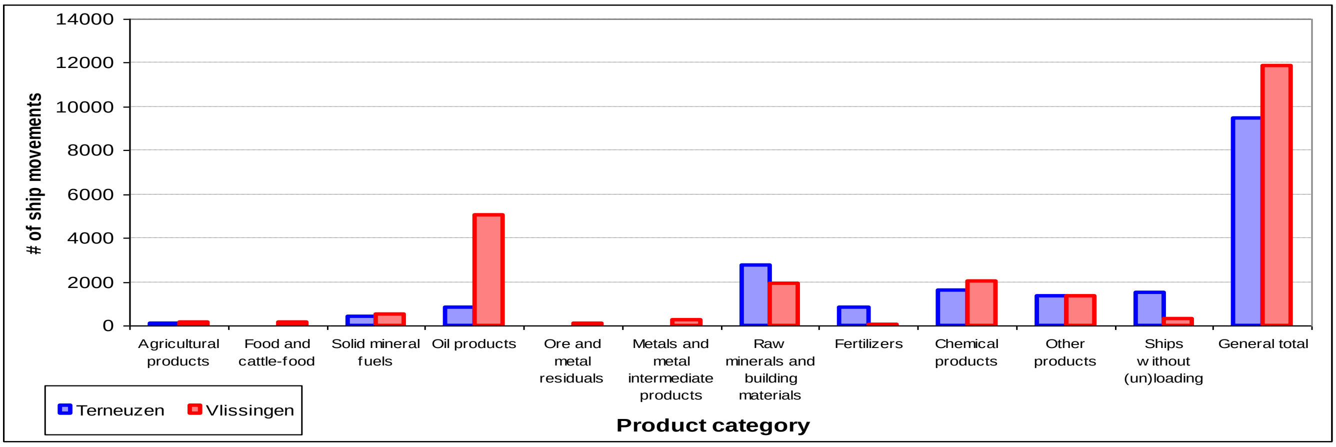
2.2 Modalities

The POZSP have access to the road, rail, inland waterway and pipeline network. All companies have access to the road network. Most companies do also have access to inland waterways, where rail and pipeline networks are not available for all companies. Logistical costs represent an increasing share of product prices. Shippers are constantly looking for ways to reduce their logistical costs. Choice of modality is very important in this reduction of logistical costs, since competitive advantages can be gained with this choice. Companies do however have to evaluate whether solely costs are important or whether transport quality factors are also of importance (Ribus, 2007). In the POZSP, in the year 2008, more than 30.2 million ton of cargo was transhipped from and to sea-ships and over 28.7 million tonnes with inland navigation. Inland navigation is thus an important market for ZSP, which is growing faster that seaborne transportation (ZSP, 2008a). Just as in other ports, road transportation is the mode with the largest cargo flows. In general, road transportation is the mode that is the most polluting and causes the most externalalities, therefore ZSP pursues a more sustainable modal split. This means that ZSP aims to shift cargo flows from road transportation to rail or inland waterway transport. These modalities are less polluting and cause less externalities such as congestion, air pollution and noise pollution. In the strategic masterplan (Zeeland Seaports 2008a), this sustainability goal is presented in the ambition to increase the volume transported by inland navigation.

2.3 Characteristics of current inland navigation activities

Inland navigation is the market leader in international transport of cargo from a Dutch perspective, in terms of volume. This modality is competing with road, rail and pipeline transportation to accommodate (hinterland) transportation. In the year 2008, 28.7 million tons of cargo is transported by inland navigation. The type of goods that is transported, measured in amount of ship movements, is presented in figure 2 below.

Figure 3: Ship movement per commodity in 2008



(Zeeland Seaports, 2009b)

From this figure can be concluded that for both ports, the most important cargo groups transported by inland navigation are raw materials & building materials, chemical products and fertilizers. The companies responsible for these cargo flows in Vlissingen are Total and Verbrugge. In Terneuzen, Dow, Oil Tanking, S.B.V., Yara and de Hoop are important players.

2.4 Destinations of inland navigation

The mode inland navigation is often used for long distances, because only at this transport over long distances competitive advantages can be achieved. This does however differ for each product category. Sand and gravel are frequently transported over shorter distances. This is often national transport from a sea port to a building location land inward. Because this product group is of low value, inland navigation is the most competitive transport mode. Other dry and liquid bulk and containers are often transported over larger distances and often to other countries (Ecorys, 2008d). The most important companies in the POZSP have their customers in the Netherlands, Belgium, Germany and the north of France. There are also products imported from and exported to the UK, Austria, Switzerland, Spain, Norway, Finland and Sweden and other EU countries (Zeeland Seaports, 2009b) . This is however not always possible by inland navigation since these countries are not all accessible by inland navigation. The survey that is conducted in this research confirms that the core area of transport by inland navigation exists out of the Netherlands, Belgium, Germany and France. From the twelve companies that have responded on the survey, only one company limits its transport area to the Netherlands and Belgium. In table 1, a more detailed insight in the destinations of a large number of companies located in the POZSP is presented and a geographical area is shown in figure 4.

Table 1: Destinations of companies located in the POZSP

Company	% Inland Navigation	Product group (NSTR)	Countries
Thermphos	0%	Chemical products	Ne, Be, Ge + EU
De Hoop	75%	Raw materials and building materials	Ne, Be, Ge, Fr, UK
S.B.V.	90%	Raw materials and building materials	Be, Ne, UK
Kloosterboer	30%	Agricultural products, foodstuffs and animal fodder and ores & metal waste	Be, Ne, Fr, Ge, Au, Ch, Sp, UK
Mercuria	45%	Agricultural products and petroleum products	Ne, Ge, Be, Fr
Havex / Verbrugge	60%	Wood, paper, pulp, metal, steel, fertilizers and chemical products	Ne, Be, Ge, Ch, Fr
Dow	25%	Chemical products	Ge, Ne, Be, Fr + EU
Ovet	75%	Solid mineral fuels, ores & metal waste, Crude and manufactured minerals, building materials and fertilizers	Be, Ne, Ge, Fr, UK
Yara	30%	Fertilizers	Ne, Be, Fr, UK + EU
Outokumpu	10%	Steel	Ge, It, EU
Vopak	34%	Chemical products	No, Ne, Ge, Be + EU
Heros	60%	Ores & metal waste, metal products and crude and manufactured minerals & building materials	Ne, Be, Fr, Ge, Se

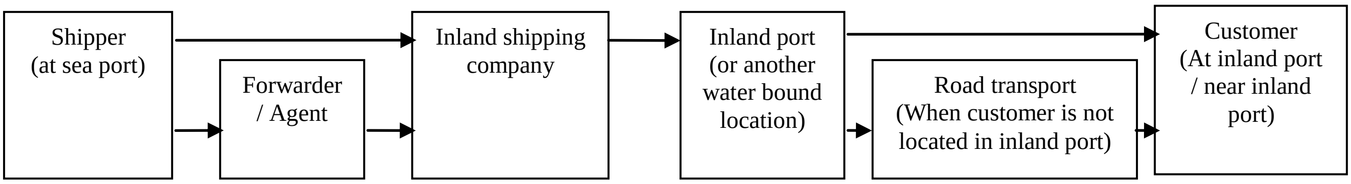
Figure 4: Destinations of inland navigation to and from the POZSP

(inlandnavigation.org)

2.5 Organization of inland navigation

In the transport chain, there are several parties which each have their speciality. In this paragraph, all players in the chain are described, according to the classification of Ecorys (2008d). In the scheme below, the relations between all the potential parties in the chain are presented.

Figure 5: Organization of inland navigation



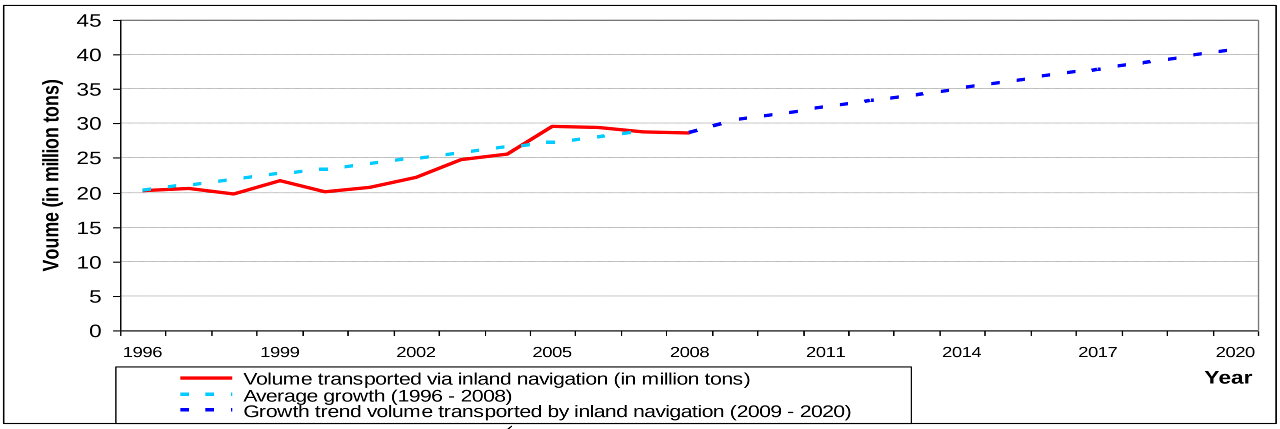
The shipper is the producer or owner of the cargo. When a customer purchases the cargo, the transport needs to be organized. When the terms of contract are ‘Free On Board’, the seller is responsible for delivery of the goods to the warehouse of the designated consolidator or carrier at the port. When the contract terms are ‘Port of discharge’, the seller has to organize the entire transport, including the insurance and freight charges (Tongzon, 2009). The shipper can choose to organize this transportation itself, but most of the time, forwarders or agents are contacted to organize the entire transport chain from shipper to customer. The forwarder tries to organize the transport in the fastest and most reliable way, against the lowest possible costs. The party that organizes the transport by inland navigation has to contact the inland shipping company that executes the transport of cargo over the inland waterways. These inland shippers are most of the time independent companies, owning only one ship. These companies pick up the cargo in the (sea) port, where the shipper is located and transport it to the (inland) port of destination. Whenever the customer is located on a water bound location, no further transport is needed. Otherwise, other transport modes need to be organized to transport the cargo to the customer, located at another location.

In the business of inland navigation, there are different niches, such as dry bulk, liquid bulk and containers. Each of these niches requires different kind of ships and operates on a different market. The dry bulk market exists out of the coal and ore business, where large volumes are transported over large distances. The sand and gravel business is strongly related to the building sector, which requires transport to locations with lower depth and thus with smaller ships. Liquid bulk is transported with special tankers, often in international flows. The transport of containers is the fastest growing market with both national and international flows. The shipping companies work for 50% with long term (yearly) contracts and for the other 50%, the transport contracts are for shorter periods, with fluctuations in both cargo type and routes. For a more detailed description of the organization of inland navigation, see appendix A.

2.6 Increasing the transported volumes per inland navigation

In 2008, the transported volume of cargo per inland navigation from and to ZSP was 28.7 million tons. According to the growth ambition of ZSP, this tonnage has to grow to 40 million tons in 2020 (Zeeland Seaports, 2008a). In figure 6 is presented how the transported volume has grown in the period 1996 – 2008. When this growth trend is continued, the goal will be reached in the year 2020. However, in the period 2005 – 2008, the volume is decreasing. With the current economic crisis, this decrease can potentially continue for a few years. In order to achieve the goal of 40 million tons in the year 2020, transported by inland navigation, change is needed.

Figure 6: Volume transported by inland navigation and growth trend



(Zeeland Seaports, 2009b)

The aspired growth can be achieved by *autonomous growth* and *modal shift*. The current port activities can be extended by attracting new companies or the expansion of companies that are currently located in the POZSP, since they will both lead to additional cargo flows. ZSP aims at the attraction and stimulation of companies currently located at the POZSP to develop sustainably. This involves the stimulation of sustainable initiatives to companies located in the POZSP and also with the attraction of new companies to the port. Sustainable transportation to the hinterland is encouraged, in order to increase rail and barge transportation, over the more polluting road transportation. Inland navigation is encouraged by offering a good infrastructure, additional waiting quays and promotion. Especially with the upcoming containerisation in the ports, the facilities for inland navigation have to be accommodated. It is up to the companies in the POZSP to organize their transport in the most efficient way. On the other hand, additional growth can be obtained by changing the choice of modality. When a company changes its transportation mode, this is called a modal shift. A modal shift from road to barge can help to obtain the 40 million tons, transported by inland navigation, as is aspired in the year 2020. Companies in the POZSP are responsible for the organization of their transport. The choice of the modality depends on many factors, which are elaborated at a later stage, categorized in determining factors. Next to the determining factors, also infrastructural improvements can result in more cargo flows. Examples are the upgrade of the Seine-Scheldt inland waterway connection, which adds the northwest of France to the accessible waterway network and the improvement of lock capacity and management.

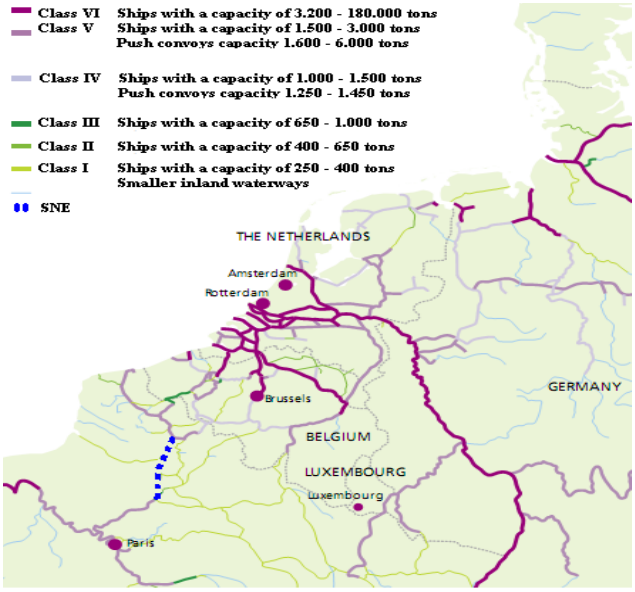
2.7 Autonomous growth - Port developments without containerisation

When containerisation does not take place in the POZSP, bulk will be the dominant cargo that will be transported by the different modes. Without the ability to handle containers on large scale, the POZSP need to improve other factors to remain an attractive port to locate in. Accessibility improvements can make a port more attractive. When a larger transport network becomes available, this can result in cost advantages for companies. Also other developments, such as clustering can be attractive for new companies. When containerisation does not take place, ZSP needs to be creative in their strategic development in order to retain the existing companies and possibly attract new companies. The major developments in the POZSP are the upgrade of the Seine – Scheldt inland waterway connection, which increases the accessibility by inland ships. Other major developments are the Axelse Vlakte and the Scaldia port development. These developments will be described below.

Seine – Scheldt inland waterway connection

The POZSP are located in the south west of the Netherlands and have good inland waterway accessibility. The inland shipping network in Europe is divided into CEMT classes. CEMT refers to the Conférence Européenne des Ministres de Transport, which established the classes. Each of the classes has a maximum size for vessels and push-tug combinations. The classification helps to determine where particular vessels are able to travel, concerning bridge heights, lock sizes, draught, waterway width and such. The POZSP are accessible for vessels of class VI, which is the highest class. Moreover, the inland waterway network of the POZSP is one of the worlds largest, with good accessibility to Antwerp, Rotterdam, Ghent and the Ruhr Area. There are however also areas that are less accessible by inland navigation. These areas are only accessible by low class waterways or are not accessible at all (BVB, 2008). The waterway network is shown in figure 7.

Figure 7: Inland waterways in northwest Europe



(BVB, 2007)

The northwest of France is an area with low accessibility. Because of bottlenecks above Lille and above Paris, these areas are only accessible with inland ships with a maximum capacity of 400 tons on the north – south route. This situation will change in the nearby future. Both the bottlenecks in France (2014) and Belgium (2016) will be upgraded, so that the area becomes accessible for class Vb ships with a capacity of 4.400 tons (KVK, 2007). This upgrade of the waterway network is a TEN project of the European Commission and is called the Seine Nord Europe (SNE). The upgraded waterway connection will change the modal split in France and result in more traffic per inland ship. What the impact for the POZSP will be, is dependent on cargo types that are transported with inland ships and growth expectations. The growth expectations for France are however impressive. From a steady 5 million tons per year in 2010 to a fifteen to twenty million tons after the year 2016 (VNF, 2006). The better accessibility makes it possible for larger ships to transport cargo by the waterway network over large distances. When using larger ships, economies of scale can be achieved. This cost benefit makes the transport mode more attractive. Also, when the modality becomes more common in the north – south transport axe, the frequency of liner shipping can increase. Higher frequency and higher capacity make the transport mode more attractive, which will result in more transport per inland ship.

Ecorys (2009) has made a prognosis about the impact of the upgraded Seine – Scheldt waterway on the ship intensity and extra transported volume on the KGT. In this prognosis, four different development scenarios are used to identify the number of ships sailing on the KGT, the transported tonnage and the growth difference with and without the upgraded Seine – Scheldt waterway. For more depth information about this classification, see appendix B. The effects of the SNE on the transported volume to the POZSP are presented in table 2.

Table 2: Prospects of ship intensity on KGT

Scenario	Number of inland ships sailing over KGT	Extra transported tonnage because of Seine – Scheldt connection	Extra tonnage because of Seine – Scheldt connection in percentages	Extra tonnage transported to or from the POZSP (11%)
2020 GE	70.604	11.612.000	28%	1.277.320
2020 TM	66.611	10.026.000	26%	1.102.860
2020 SE	52.505	9.959.000	28%	1.095.490
2020 RC	55.876	7.180.000	23%	789.800
2040 GE	85.186	16.148.000	30%	1.776.280
2040 TM	74.117	14.001.000	32%	1.540.110
2040 SE	63.102	13.864.000	40%	1.525.040
2040 RC	48.468	7.410.000	27%	815.100

(Ecorys, 2009)

The upgraded Seine – Scheldt inland waterway connection will thus result in an additional cargo flow between 789.800 – 1.277.320 tons. This amount is 10% of the aimed growth of ZSP that is described in the strategic masterplan of ZSP (2008). It can thus be concluded that a better accessibility will result in more transport by inland navigation. Waterborne locations near this Seine – Scheldt inland waterway connection become a more attractive location. The POZSP are also located on this upgraded inland waterway connection. Higher attractiveness of the location makes it easier to attract new companies. Therefore can be concluded that the upgraded Seine – Scheldt inland waterway connection will contribute to the autonomous growth of the POZSP.

Axelse vlakte

The Axelse vlakte is located in the Autrichehaven in Terneuzen. In this Autrichehaven, the quay is extended from a length of 225m to 855m. This extension of quay length makes it possible for larger ships to enter the harbour and for more ships to be handled at the same time. On the terrain of the Axelse Vlakte, several new companies will be located that can possibly work together in a cluster. In this cluster, the companies will make use of each others residual products (zeeland-seaports.nl). Until now, two companies have shown serious interest in locating at the Axelse Vlakte. Together with the nearby located companies Yara, Heros, Cargill and Nedalco, these companies will potentially increase the transported volume by inland navigation.

Scaldia port developments

Verbrugge has planned a large extension of their activities at their current location at the Scaldia port in Vlissingen. In 2011, five new terminals will be built, dedicated for the handling of pulp and paper products. This terminal extension project will make Verbrugge one of the major European players. This product is currently transported with inland navigation on large scale and has therefore high potential to contribute to the growth of volume transported by inland navigation (Bogaert, 2009b).

2.8 Autonomous growth - Port developments with containerisation

The POZSP has currently no large scale container handling terminals. There are however three initiatives for large scale container handling, that are planned to be implemented in the short term. Whenever this containerisation takes place, a large number of containers can be handled in the POZSP. This will affect the cargo flows by different transport modes and will increase the pressure to make more use of sustainable transport modes. For inland navigation, this means that several thousands of ships will make use of the existing infrastructure each year. With containerisation, the POZSP will thus develop in a different way. The POZSP will not only be strong in bulk, but will also be able to play a role in the container handling business. Containerisation can make the port a more attractive location. When companies are more easily attracted to the POZSP, this will automatically result in the growth of transported volume from and to the POZSP.

Containerisation

Over time, more and more cargo types are transported in containers. This trend forced large ports to acquire large scale container handling services in order to be attractive as a port of call. Without these container facilities, the port becomes less attractive for companies to locate. Because of the fierce competition in the Hamburg – Le Havre range, also the POZSP need to adapt to containerisation. There are currently three initiatives in the port of Vlissingen to set up large scale container handling services, namely the Westerschelde Container Terminal (WCT), the Verbrugge Container Terminal (VCT) and Scaldia Container Terminal (OTB, 2007). The statistics of each initiative will be discussed below. For detailed information, see appendix C.

The WCT is the original container handling initiative of the POZSP. Because of several setbacks, it is still uncertain if the WCT will be realized. The attracted terminal operator will be PSA/ HNN. In this terminal, specialized quays for inland shipping are planned, so that this modality can be used for 24 – 36 % of the volume that is transported to the hinterland. In the worst case, the turnover will be 2 million TEU per year with a share of 24% that is transported by inland navigation. In the best case, 2.5 million TEU will be transported with a 36% share of inland navigation (OTB, 2007 and Bogaert, 2009a). The VCT is an initiative of the TOC Verburgge, which is now active in the handling of bulk and general cargo. Since the building of the WCT has been expelled several times, Verbrugge has started up its own container handling initiative. The VCT is expected to handle 2.16 million TEU in the worse case, with a 25% share of inland navigation. In the best case scenario, 2.9 million TEU will be handled, also with a 25% share of inland navigation (OTB, 2007 and Bogaert, 2009a). The Scaldia Container Terminal is currently being realized as a joint venture of Zuidnatie and Sea-Invest. The capacity of the terminal will be 1 million TEU with a modal share of 24% of inland navigation (OTB, 2007 and Bogaert, 2009a).

The implementation of these initiatives will increase the container handing capacity enormously, which will have a large impact on the capacity of the infrastructure, which is used for further distribution. In every direction for inland shipping, locks have to be passed. If all three initiatives are executed, this will result in a maximum of 1.865.000 TEU in 2020 that will be transported with inland navigation north or east by the locks to the south. Whether the capacity of the locks is sufficient, will be discussed in chapter three.

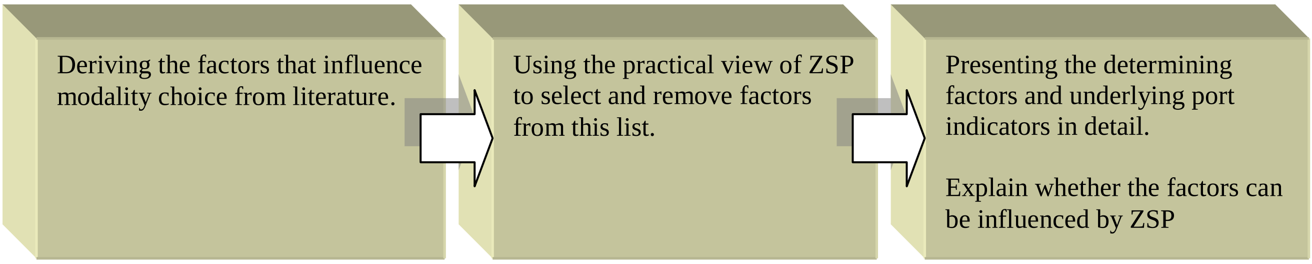
2.9 Modal shift

A modal shift is the shift from cargo from the one transport mode to the other. A modal shift can reduce the logistical costs and improve the efficiency of the logistic chain. Transport can be optimized by making a good distribution of cargo volumes over unimodal or multimodal chains. When the infrastructure capacity of the one mode is insufficient, than a modal shift is required. Especially in road transport, where different externalities take place, more and more modal shift is required. Cargo that was originally transported by trucks is than shifted to the train, inland ships or short sea ships (SSS). The challenge is to optimize the total logistic chain of multiple modes, so that the transport is organized efficiently (Verbreght, 2007). In order to make inland navigation a more attractive mode of transportation, there is a challenge to improve the cost – quality ratio. This can be done either by reducing costs at the same quality level, or increase the quality for the same cost level. This quality improvement can be achieved by making the port more accessible and reduce the time that inland ships need to enter the port, moore and finally handle the cargo. By improving the facilities of the port, it can become more efficient and thus more attractive to use inland navigation as modality. Next to the costs, there are many other factors that affect modality choice. These factors are discussed in chapter three.

Chapter 3 Determining factors of modality choice

In this chapter will be explained which are the determining factors when choosing a modality. In the flow diagram below, a schematic view of the build up of this chapter is presented.

Figure 8: Flow diagram chapter three



3.1 Determining factors affecting the modal choice from literature

In choosing a modality for the transportation of cargo, many factors play a role. The organization of transport is a logistic activity and in logistics the goal is always to organize transport in such a way that the right cargo is transported to the right location, at the right time, in the right quantities, against the lowest possible costs (Visser and van Goor, 1999). Costs are thus an important factor, but costs are always related to the quality of the transport. According to Cunningham (1982), shippers realize that transport is part of a total logistics chain, where mode selection is not solely dependent on costs, but also on service quality. The quality can exist out of many factors, such as described by Meuwissen (2005), Cunningham (1982), McGinnis (1989, 1990 and 1995), Matear & Gray (1993) and Cullinane & Toy (2000).

Meuwissen (2005) has presented three basic factors that are always required in order to potentially use inland navigation. There are many other factors that influence modality choice, these are explained by the other authors that are introduced above. However, the factors that are introduced by Meuwissen are used as starting point, since inland navigation is not competitive without the presence of these factors. These factors are presented in figure 9.

Figure 9: Modal choice factors according to Meuwissen (2005)

1) Destination of the cargo
2) Product characteristics
3) Efficiency of the port

Destination of the cargo

When a choice of modality is made for the transportation from A to B, distance is a crucial factor. Where trucks are the most conventional mode of transportation on shorter distances, inland navigation and rail transport have a minimum required distance to be competitive on price. This minimal required distance for a certain transport mode to be competitive is called a break even distance. According to PRC (2007), this break even distance for inland navigation can be differentiated for three situations:

1) The transport from A to B, where both locations are accessible by inland navigation.
2) The transport from A to B, where transhipment is needed once to realize the transport of cargo from inland ship to truck or train, to the final destination.
3) Transport from A to B with two time transhipment. In this situation, road transport is required for both the transport from A to the inland ship and transport from the inland ship to B.

In the first situation, the break even distance is >20 – 40 km. This minimum distance is required in order to transport by inland navigation in a competitive way. For the second situation, the break even distance is 80 – 120 km. An exception is the transport of containers which requires a minimal distance of 60 -100 km. This distance is larger because additional costs are made in this situation. Extra handling costs and extra transport costs are made, which result in a larger break even distance for the transported distance over water. The third situation is the situation with a break even distance of 180 – 225km (PRC, 2007). This can be explained because the requirement of transhipment on both sides. In this situation, cargo needs to be handled two times extra and also the transport to the water and from the water to the consignee have to be arranged. A larger distance over water is therefore required, so that over this transported distance economies of scale can be achieved. According to

Schuttevaer (2009), the official break even distance is 80 -120km. However, Schuttevaer (2009) states that this break even distance does only exist in theory and that transport over 10km can be competitively executed by inland navigation, as long as the volumes are sufficient. Over 60% of all transportation by barge has an origin or destination in a seaport. Inland navigation is a competitive mode in relation to road transportation if the distances are large, locations are water bound and limited transhipment is required. Accessibility is thus crucial in order to make transportation by barges work. When destinations are not fully accessible, whether this is caused by bottlenecks such as draft, locks and bridge heights or the absence of waterways, it becomes more attractive to transport with other transport modes (PRC, 2007).

Product characteristics
Not all cargo types are suitable to be transported by barges. Products that have high value, short keeping time or products that are fragile are not commonly transported by barges. PRC (2007) presents that barges are the dominant transport mode for the product groups: sand & gravel, ore, coal and chemical products. Barges are also the dominant transport mode of oil products, when pipeline infrastructure is lacking. From this list of products can be concluded that the transportation by inland navigation is especially strong in the transport of bulk goods. Road transportation is nowadays still responsible for the transportation of the largest share of containers. The required speed, accessibility of locations and the size of the flows that are transported can all be decisive in the decision to use a truck as a transport mode, instead of inland navigation. The cargo types that are presented by PRC (2007) match the cargo types that are transported in the POZSP, as presented in figure 3. The product characteristics are discussed in more detail in section 3.5.

Efficiency of the port
Port efficiency is dependent on a large amount of factors. First of all, the accessibility in terms of safety and capacity, which is decisive in the usage of inland navigation. Secondly, the quality of the facilities in the port, which can affect the time efficiency of inland navigation in the port. Inefficient processes will result in higher costs and make inland navigation less attractive as a transport mode (Schuttevaer, 2009).

The basic conditions are introduced and are now further discussed in more detail. Cunningham (1982) describes *speed, reliability, transit time* and *damage* as such service quality factors. In his research, also *commodity value, distance of transport* and *shipment size* are factors that contribute to the quality of the service.

McGinnis (1989) has also researched factors that affect modality choice and tested seven variables to eleven other researches. The factors that are important according to these eleven researches, ranked from most important to least important are:

Figure 10: Modal choice factors according to McGinnis (1989)

1) Freight rates (costs, charges)
2) Reliability
3) Transit time (time-in-transit, speed, delivery time)
4) Over, short and damaged (loss, damage, and tracing)
5) Shipper market considerations (customer service, user satisfaction, market competitiveness)
6) Carrier considerations (availability, capability, reputation, special equipment)
7) Product characteristics (perishability, packing requirements, new products)

Furthermore, all eleven authors concluded that most service qualities are more important than the freight rates. Therefore, McGinnis (1989) concludes that freight transportation choice is the result of interactions between service quality variables, although the importance of the individual variables varies among shippers and carriers. McGinnis (1990) suggests that price becomes in most instances a major factor after service objectives have been met. Transportation providers will face markets that are service-demanding and price-competitive. Transport firms can provide a service advantage, but this can not be sustained indefinitely. Transportation providers constantly seek to improve their advantages to minimize the effect of the direct price competition, which occurs when service levels are comparable across the industry (McGinnis, 1990).

Matear and Gray (1993) describe factors influencing freight service choice for shippers and freight forwarders. In their choice for choosing a sea ship or airplane as a modality, five variables are of importance. From these five, the route component is the least important and not significantly of influence to the freight service decision, according to Matear and Gray (1993). The components are presented in figure 11.

Figure 11: Modal choice factors according to Matear and Gray (1993)

1) Carrier characteristics (arrival time, good relationship with carrier, fast response to problems, able to handle special requirements and performance of urgent deliveries).
2) Timing characteristics (high frequency of service, on time collection and delivery, short transit time and departure time from origin).
3) Price characteristics (low price and special offers of discounts).
4) Control over involvement of by other parties (transport performance of trading partner, documentation completed carrier)
5) Route characteristics (know all routing attributes such as proximity to destination or origin).

In the search of freight route / modal choice decisions, Cullinane and Toy (2000) have put together a list of factors. This list is established after a content analysis as a systematic, quantitative, but simple methodology for establishing the most important factors indentified in extensive freight route/modal choice literature, which has been written over many years. In the content analysis seventy-five articles with relevant information are tested for the number of appearances of the individual factors in the text. The fifteen factors that are identified are ranked on number of appearances, which provides insights in the factors that are most important. The five most important factors that can be abstracted from this list are shown in figure 12.

Figure 12: Modal choice factors according to Cullinane and Toy (2000)

1) Cost / Price / Rate
2) Speed (transit time, terminal time or transhipment time)
3) Transit time reliability
4) Characteristics of the goods (type, value, value/weight ratio, volume, weight, density, shipment seize)
5) Service (unspecified)

These five factors are mentioned in more than 73% of all relevant articles. In the total summation, the factors 'loss and damage', 'flexibility', 'infrastructure capacity' and 'capability' are also mentioned many times. Cullinane and Toy (2000) can thus provide a list of determining factors for modality choice, based on 75 other researches. Therefore can be concluded that these factors are useful in this research, aiming at identifying factors that affect modality choice for companies located in the POZSP.

The final source of determining factors is De Vries (2000). Schuttevaer is a Dutch organization that represents the interest of inland shipping companies and has set up a list of factors that have influence on the modality choice by shippers. This list is presented in figure 13.

Figure 13: Modal choice factors according to De Vries (2000)

- Transport costs
- Handling costs
- Stock costs
- Costs for collecting / distribution of cargo
- Speed
- Flexibility
- Reliability
- Risk of damage
- Perishability
- Interest costs
- Chance of congestion / delays
- Damage to the environment
- Connections in the sea port
- Image
- Loading restraints
- Habituation / existing relations
- Tradition
- Manner of packaging
- Size of order
- Law
- Safety
- Staff

When the lists of determining factors affecting modality choice by Cunningham (1982), McGinnis (1989), Matear and Gray (1993), Cullinane and Toy (2000) and De Vries (2000) are compared, there are many similarities. Taking into account the number of articles that are used in the researches of and McGinnis (1989) and Cullinane and Toy (2000), a new list will now be set up, which will be used as main determining factors, further in this research. This list is presented in figure 14.

Figure 14: Final list of modal choice factors

Selection of determining factors affecting modal choice:

1) Reliability
2) Port efficiency — Sub factors: 'speed', 'cost / rate' and 'additional efficiency factors'
3) Product characteristics
4) Perception / Image

3.2 Determining factors affecting the modal choice, in practice

Now the determining factors affecting modal choice are set, based on literature, the factors need to be further defined and become more tangible. For each of the factors will be determined how the factor is practically present in the POZSP. Whenever is asked whether reliability affects modality choice, everyone will agree it does. The way reliability is measured in practical port related indicators, is however another question. To test the determining factors, several indicators are chosen that are more tangible. These tangible indicators can be used to further research the determining factors on their importance. Furthermore, the practical experience of ZSP with inland shipping is used to set up indicators. An example are the locks; not all ports are located behind locks. Therefore, locks are not always mentioned as indicator for reliability. For the port of Terneuzen, lock capacity is however a crucial indicator of reliability, according to ZSP. In this section is presented which determining factors are chosen to use in the further research. Also, the underlying factors, called port indicators, are summed up.

Determining factor 1: Reliability
Reliability is the percentage of shipments that is delivered at scheduled time (Beuthe et al, 2003). The variance in transport time is equal to the reliability of the mode. Whenever transport is organized with a certain modality, it is important to know what the chances of delay are and how long will this delay will be (McGinnis, 1989). Road transportation is dependent on road congestion and safety, where inland shippers are dependent on congestion at locks and nautical safety. Also the quality of the infrastructure and superstructure affect the possibility of delays and thus reliability. In the port there are several factors that affect reliability. In this research, *nautical safety, locks, superstructure* and *infrastructure* determine the determining factor reliability.

Determining factor 2: Port efficiency
This factor is very diverse and dependent on many variables. When ships enter the port, a high quality of service will make the flows more efficient. According to Notteboom (2008), port efficiency is about the speed of handing, waiting times, terminal productivity (superstructure), cost efficiency and port opening hours. Because this factor is so diverse, it is divided into three sub factors; *costs/rate, speed* and *additional port efficiency factors.*

Sub factor 1: Cost / rate
This port indicator represents the price which is paid for a modality to transport cargo from A to B. For inland navigation, this price contains the rate of the inland shipper company and port tariffs. The costs for transporting cargo by road or inland navigation differ per cargo type and destination. However the average price for transport per kilometre for road transport is 2.7 times higher than that of inland navigation (De Vries, 2000). Indicators for the determining factor costs in this research will be *port tariffs* and *transportation costs.*

Sub factor 2: Speed
The speed of a modality is the time that is required to transport cargo from A to B with a certain modality. Dependent on the requirements of the consignee a certain transit time can be required. Also the average transport speed is important. Trucks drive much faster than inland ships, and this can be an important factor in modality choice. In addition, superstructure and infrastructure are factors that affect the speed of handling on the quay. When specialized infrastructure and superstructure for inland ships is available, the cargo handling can be executed with high speed. In this research, *accessibility, transport speed, infrastructure and superstructure* will be used to explain the determining factor speed.

Sub factor 3: Additional port efficiency factors
Inland shippers need basic facilities in the port. Waiting quays and car transfer points are such facilities that can influence the efficiency of inland shippers. Whether this influences modal choice is uncertain. Therefore *waiting quays* and *additional facilities* are included under this determining factor.

Determining factor 3: Product characteristics
'Product characteristics' represents the various characteristics of the type of cargo that is transported. Cargo types can be defined according to different classifications. NSTR good classification is one of such classifications. Inland shipping is the dominant transport mode for many bulk groups (solid and liquid) and is also strong in containers (PRC, 2007). Almost all cargo can be transported by inland navigation competitively. It is however dependent on the *volume*, *weight*, *perishability* and *value*. These four characteristics are also the indicators used in this research.

Determining factor 4: Perception / image
De Vries (2000) mentions 'image' and McGinnis mentions 'carrier considerations' as factors that influence modality choice. ZSP thinks that perception as in image can be influenced by the factor promotion since this could influence the attractiveness of certain modalities and thus modality choice. The indicator explaining perception/ image in this research will be *promotion*.

Determining factors and the tangible indicators summarized
In the table below is summarized for each determining factor which port indicators have influence on the determining factor. On basis of these port indicators will be tested what the weight of each indicator actually is. The total list is shown in table 3:

Table 3: Final list of determining factors, specified in sub factors and port indicators

Determining factors	Sub factors	Port indicators
Reliability	-	Locks Nautical safety Infrastructure – reliability Superstructure - reliability
Port efficiency	Cost / rate	Port tariffs Transport cost
	Speed	Transport speed Accessibility Infrastructure – speed Superstructure - speed
	Additional efficiency factors	Waiting quays Additional facilities
Product characteristics	-	Volume of product Weight of product Value of product Perishability of product
Perception / image of inland navigation	-	Promotion

In the sections 3.3 – 3.6, the determining factors and their underlying port indicators are further described and applied to the situation of the POZSP. Each determining factor is influenced by several port indicators which can be influenced by either the PA, Rijkswaterstaat, shippers or the factor is dependent on the supply and demand on the market. The factors will be discussed in the following order:

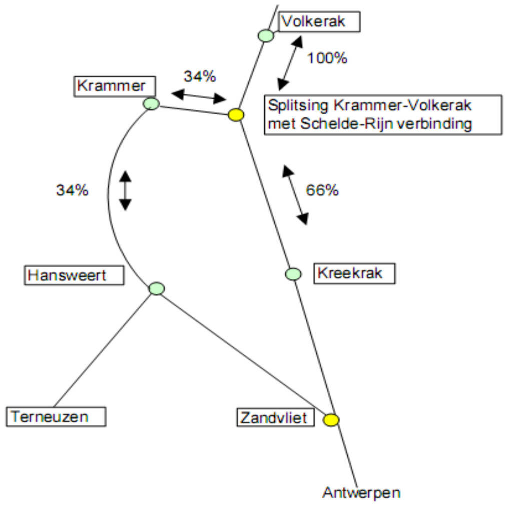
3.3 Determining factor 1 - Reliability

The variance in the expected transport time indicates how reliable a transport mode is. In road transportation, recurring congestion and non-recurring congestion can influence the traffic flow on the highway network (Golob et al, 2000). Recurring congestion is caused by routine traffic volumes that exceed the roads' capacity. Non-recurring congestion can be caused by incidents or road maintenance (Hallenbeck et al, 2003). Inland navigation is especially dependent on the presence of locks on the route and the average lead time of these locks. In addition, the nautical safety of the waterway network does also have influence on the reliability of the total transport time. Also, the availability of quay space can influence the required transport time. Because sea vessels have priority over inland vessels when they are mooring in the sea-port, this can cause higher waiting times for inland ships. A high variance in transport time affects the reliability of the transport mode. The more variance there is, the higher the risk of delay, which can result in additional costs. Delays do also affect the morale of the driver / captain, which can result in to other inefficiencies (Golob et al, 2000). The indicators that have been set up are locks, nautical safety, infrastructure and superstructure. These indicators will be explained below.

3.3.1 The presence of locks

In the province of Zeeland, there are many locks. This in necessary for the separation of salt and sweet waterways and for compensating the possible differences in water level. When companies located in the POZSP use inland navigation as a transport mode, often locks need to be passed when transporting cargo to their destination. An overview of locks in the province of Zeeland is presented in the figure below. In this figure, also the route choice on the north – south transport axe is indicated.

Figure 15: Overview of locks in the province of Zeeland



(Rijkswaterstaat, 2004)

The time that is needed to pass a lock is calculated in the total transport time. Therefore, passing a lock is not seen as a delay (Schuttevaer, 2009). However, when the ship intensity is high, there can occur congestion at locks. This congestion is a delay and will affect the reliability of the transport service. Especially the locks of Terneuzen are important for the POZSP. The capacity of the locks determines the amount of ships than can enter the port of Terneuzen. This lock complex in Terneuzen does currently exist out of three locks. Other delays at locks can result from technical problems or accidents with locks. The most important inland navigation routes are by the 'Kanaal Gent – Terneuzen' (KGT) and 'Kanaal door Zuid-Beveland' (KZB). These routes can only be entered by locks. The ships that pass these locks are both sea ships and inland ships. The total amount of ships passing the Terneuzen locks in the year 2007 is 67.354, from which 54.785 are inland ships. The Kreekrak locks have an intensity of 73.437 ships, from which 70.328 are inland ships. The Hansweert locks have an intensity of 52.469 ships, from which 43.605 are inland ships. (RWS, 2007). Although the number of ships passing the locks has remained stable over the last years, this will change in the nearby future. When the container terminals will all be realized, this will result in approximately 10.000 – 15.000 extra ship moves per year (OTB, 2007 and Bogaert, 2009a). In addition, the Seine – Scheldt waterway connection will generate an increase of ship movements in the KGT of approximately 5.000 – 15.000 ship movements in 2020 (Ecorys, 2009). According to OTB (2007), capacity problems are expected at both routes in 2010. Rijkswaterstaat, the organization responsible for water quality and capacity of waterways (and thus locks) expects especially bottlenecks at

Terneuzen, the Kreekrak locks and the Volkerak locks. There has been much attention for these future problems, which has resulted in the decision to build a new sea lock in Terneuzen. For the bottlenecks at the KZB are no solutions yet. The new sea-lock in Terneuzen will increase the capacity of the Terneuzen locks with 100.000 tons and is expected to be operational in 2018. This is beneficial for both Terneuzen and the Belgian ports because les congestion will occur, and reliability of the inland service will improve. More detailed information about the locks in the province of Zeeland can be found in appendix D.

3.3.2 Nautical safety

The definition of safety is: the state where there is no danger to persons or matter (Prins, 2003). The nautical safety can be defined as the number of one way or two way accidents involving damage to ships and or infrastructure (Ministerie van Verkeer en Waterstaat, 2004). The essence of nautical safety is; the less ship accidents and collisions, the safer the shipping activities and the safer the waterways. Ships want to sail the planned route as fast as possible, with as little difficulties as possible. This nautical safety can improve the speed and reliability of the cargo flows (Prins, 2003). The most common accidents in the Netherlands, in the period 1998 – 2002, are the collision with ships and the collisions with objects. When modes are compared, inland navigation is safer than road transportation, when measured per ton/kilometre (Ministerie van Verkeer en Waterstaat, 2004). Until 1990, the nautical safety has improved because of better on-board equipment and ship traffic management. After 1995 this trend is no longer visible. Since 1995, the nautical safety is more likely to decline (Marin, 2007). The major factor in this decline is increased ship intensity. In general can be stated that increasing ship intensity will lead to an increased number of accidents. Other factors that can influence nautical safety are increased vessel size, extending the width and depth of waterways, ship traffic management, the increased share of dangerous cargo transported, mutations in the chance of accidents and external factors such as wind, sight and currents (Marin, 2007). Additional factors could be economic growth and time pressure. When ships have to meet higher demands, this can increase the chance on accidents an collisions. According to a customer satisfaction research, the nautical safety of the waterways in the POZSP is reviewed as good (Integron, 2009). The POZSP score high on the factors ‘availability of communication resources’, ‘safety in the port’, ‘traffic signs in the port’ and ‘maintenance of wet infrastructure’.

To indicate what the level of safety in the waterways in the province of Zeeland is in comparison with the Netherlands in total, a table is presented below. In this table, a historical overview of shipping accidents in the period 1990 – 1998 is shown.

Table 4: Shipping accidents, a comparison

Type of accident	Traffic performance	Zeeland	The Netherlands in total
Collision in a lock	Number of ships / lock passages x 10^6	32,5	21,5
Collision between two ships	Number of ships / ship kilometres x 10^6	2,9	4,1
One way ship accident with lock	Number of ships / lock passages x 10^6	43,5	22,3
One way ship accident with bridge	Number of ships / bridge passages x 10^6	9,7	9,6
One way ship accident on waterway	Number of ships / ship kilometres X10^6	0,6	0,8
Ships run aground	Number of ships / ship kilometres X10^6	2,4	0,8
Fire / explosion	Number of ships / ship kilometres x 10^6	0,3	0,2
Sinking	Number of ships / ship kilometres x 10^6	0,4	0,4

Table D: Risk indicator (relative): Number of accidents with ships / traffic performance in the period 1990 – 1998 (Prins, 2003)

Because the province of Zeeland has an extended waterway network, with a relative high share of artificial objects in the water, several types of accidents score very high. Because of this, and high ship intensity on the waterways, a high traffic performance is achieved. Especially the collision with locks and one way ship accidents with locks can be explained because of these aspects. On the other hand, the broadness of the waterway network and the capacity can explain the good score of collisions between ships and one way ship accidents on waterways. Finally, the high score of ships that run aground can be explained by the morphological and hydrological features of the gullies of the Westerschelde (Prins, 2003). The Westerschelde is the waterway with the highest safety risks in the province of Zeeland. The running aground of ships is the most important safety issue. In the period 1979 – 1998, the number of accidents has reduced with almost 60%, indicating that the managers of safety on the waterways, together with ship improvements that are introduced in this period, have reduced the safety risk dramatically (Prins, 2003). In the period 1998 – 2007, there is a difference in the development of shipping accidents. Where the total of shipping accidents in the Netherlands has increased with 47%, the increase in Zeeland is over 155% (Rijkswaterstaat, 2008a and 2008b). From this can be concluded that the waterways in Zeeland have not made enough progress in terms of nautical safety. More detailed information on nautical safety can be found in appendix E..

3.3.3 Infrastructure - reliability

Over time, the demand for port infrastructure has changed. Ships are getting larger and the cargo that is being transported is becoming more diverse (Eriksen, 1998). Increased demands for port infrastructure can cause a shortage of land, requiring dredging deeper harbors and waterways. Also the rise of alliances causes a bundling of cargo flows, resulting in an increase in vessel size. Ports need to adapt to these larger vessels by offering longer quays and deep harbors and specialized superstructure (Eriksen, 1998). The POZSP need to offer sea ships and inland ships the right infrastructure for entering the port, mooring and waiting. The POZSP offer a multimodal network of infrastructural connections via the sea, inland waterways, rail, road and pipelines. Especially the capacity of road and inland waterway connections are good. The Westerschelde is the main access for sea ships, entering the POZSP. The port of Vlissingen is located directly near the Northsea and is accessible for the largest deep sea ships with a draft of 16.5m. The port of Terneuzen is located behind locks, where the draft is 12.5m. From the port of Terneuzen, the Kanaal Gent – Terneuzen (KGT) is an important waterway connection to transport to ports in Belgium and France.. This KGT has a length of 32 kilometers with class VI and is accessible for sea ships (max 265m x 34m x 12,25m) and inland ships (max 140m x 23m x 4m).

Next to this accessibility for the larger ships, it is also important that specialized quay infrastructure for inland ships is available. Since the value of time of sea ships is higher than that of inland ships, the sea ships have priority in loading and unloading at quays. Companies located in the port do often have a limited quay length, that is utilized by both sea ships and inland ships. This priority rule in favor of sea ships reduces the efficiency of inland ships since their waiting time for mooring becomes longer (Schuttevaer, 2009). It is thus important that companies offer specialized quay infrastructure to offer space for efficient inland shipping activities. However, when ships need to be (un)loaded immediately, it is always possible to change the planning. Companies can use their infrastructure flexible, so that the capacity does not have to be a problem. Since ZSP is a landlord port authority, ZSP provides the terminal infrastructure for the companies located in the POZSP. When companies locate in the POZSP, agreements must be made on the quality of the terminal infrastructure, which is determining the reliability of the cargo handling activities. ZSP can thus directly affect this factor.

3.3.4 Superstructure – reliability

The superstructure of companies located in the port exists out of an assembly of quay cranes, gantries, empty handlers, prime movers, trailers and other equipment (APM Terminals, 2009). ZSP is a landlord port authority and does not provide superstructure for the companies. This equipment has to be purchased by the companies located in the POZSP itself. The PA does not have a direct influence on the strategy of companies purchasing the superstructure. Companies that purchase superstructure have to consider the quality of the product against the cost of purchasing. In general can be stated that newer equipment is able to operate more efficient and handle more cargo in the same time as old(er) equipment. Companies can purchase new equipment that operates under high efficiency. In this way, delays can be reduced. This does however involve high investments. The other choice would be to purchase second hand equipment that is less efficient. It is also possible to purchase general equipment that can be used for a wide variety of ships. In this case, the superstructure is used for both inland and sea ships. The purchase price is thus beneficial, but the cargo handling activities will be less efficient and affect the reliability of the transport service.

3.4 Determining factor 2 - Port efficiency

Port efficiency is a broad factor that is crucial to modality choice. Under this factor, there are three sub factors identified, namely; *speed cost/rate* and *additional efficiency factors.* These factors are abstracted from Tongzon (2009) and Matear & Gray (1993). Because the literature presents a large variety of factors that influence port efficiency, these sub factors are used to present a total picture of underlying port indicators.

3.4.1 Sub factor 1 Costs

The costs for transporting cargo per inland navigation are distributed over several components. The costs for labour are the highest (>41%), also the costs for ship purchase and maintenance (>16%) and fuel (>23%) are significant (Ribus, 2007). Next to these costs, there are also other costs that make the transportation per inland navigation more expensive and thus less attractive. This determining factor is influenced by two set indicators; *port tariffs* and *transport rate*.

3.4.1.1 Tariffs

When barges enter the POZSP, a tariff has to be paid that is based on the capacity of the ship. Tariffs are mostly levied on gross tonnage (GT). This is the volume of all space that is available for cargo transport in a ship. Based on the prognoses of traffic intensity in the port can be calculated what the total income should be. Based on this required sum can be calculated what the tariffs per gross tonnage should be (ESCA, 2004). Another measurement method is based on handled volume. When for each market segment is calculated how much cargo is handled, the tariffs can be calculated in the same way as with the GT-method (ESCA, 2004). For the POZSP, tariffs are differentiated depending on the difference in use of the ports and the services enjoyed by the various vessels and types of vessels, surcharges for the use of ZSP berths and discount arrangements. Next to the capacity, also the tariff for waste disposal is differentiated according to gross tonnage size. A comparison will be made between solely the tariffs based on capacity of the ships entering the port, excluding the waste disposal charges. In the table below, the tariffs for the POZSP and competing ports in the area are presented.

Table 5:Overview of port tariffs in the POZSP and the surrounding ports

Tariff per ton							
		Vlissingen	Terneuzen	Rotterdam	Amsterdam	Ghent	Antwerp
Bulk	7 days	€0,08	€0,06	€0,095	€0,0968	-	€0,0868 / month
	14 days	€0,139	€0,104	€0,172	€0,1719	€0,08 – €0,09	
Containers	1 day	€0,04 / GT	€0,03 / GT	-	-	€1,6375/ TEU	-

(Port of Antwerp, 2008, Zeeland Seaports, 2008b, Port of Rotterdam, 2008, Haven Amsterdam, 2008 and Havenbedrijf Gent, 2008).

From this table can be concluded that the POZSP have an attractive tariff for bulk. Since no large scale container handling initiatives are located in the POZSP, the tariff for containers is not really relevant. It is expected that these tariff levels have low impact on modality choice (Tongzon, 1994). Therefore ZSP can choose to increase the tariff to extract more money. A price increase would however be somewhat strange since this strategy is the opposite of encouraging the use of inland navigation. Another choice can be to keep the tariff this low and use this factor in the promotional activities.

According to Tongzon (1994), port charges are a factor in attracting companies and cargo flows. However, shippers are more concerned with indirect costs associated with loss of markets, delays, loss of customer confidence and other inefficiencies (Tongzon, 1994). In the overall costs, port charges account for a low proportion and are therefore not of large influence on port selection. The tariffs for entering a port are levied directly on the organizer of the transport, the shipper or the forwarder. When the organizer of the transport makes the choice of modality, these costs are calculated in the total costs of transport. Although the tariffs represent only a small share of the total costs, they are of influence on port selection. According to Schuttevaer (2009), high port tariffs make inland navigation less attractive. The customer satisfaction research by Integron (2009) has measured the perception of companies on the tariffs in the POZSP. The price / quality ratio of the tariffs is reviewed as good. This factor can be influenced by the PA, but is expected to have low impact on port selection and modality choice.

3.4.1.2 Transport rate

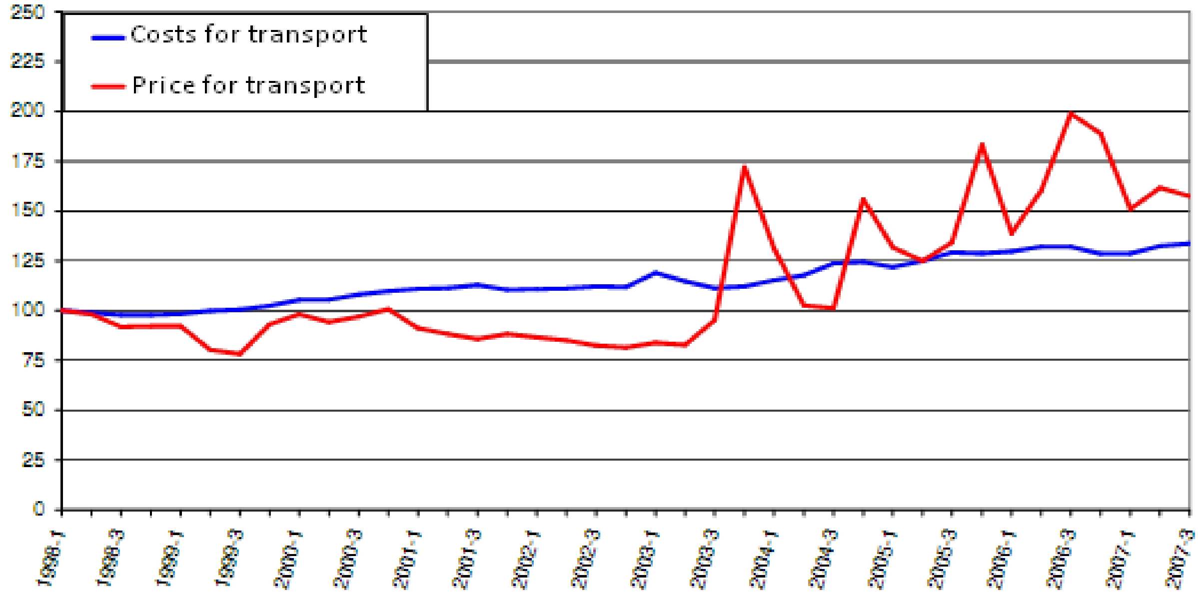
Transport rate is the rate inland shippers charge for their transport service. This factor is always mentioned first when discussing the factors that influence modal choice (Cunningham (1982), McGinnis (1989), Matear and Gray (1993), Cullinane and Toy (2000) and De Vries (2000)). In a market of free competition, the price is determined by the supply and demand. When the demand for the transport service is high, this will increase the price level and visa versa (Ecorys, 2008d). In order to indicate the development in prices over the last 5 years, Ecorys (2008d) has used several sources. First of all the contract relations. Half of the independent inland shipping companies works on basis of a yearly contract or a lease agreement with a fixed customer such as an inland terminal or a cooperation. Long term contracts do often result in dedicated services with dedicated ships. More and more independent and private shippers work together with other inland shipping companies, forwarders or logistical service providers. The relationships of shipping companies and forwarders is stable when it concerns price level. The relations between shippers and forwarders is however more fluctuating, depending on the supply and demand. Forwarders have relations with multiple shipping companies that sail under more or less fixed direction of the forwarder (Ecorys, 2008d).

In the inland shipping business, several cost factors play a role in the setting of price level, next to the supply and demand. These cost factors are fuel costs, capital costs and labour costs. Also maintenance, insurance and other costs contribute to the total price of transport. In general, the fuel costs will increase when the distances of transport are longer. The labour costs will remain at the same level and costs of capital will decrease relatively when distance increases (Ecorys, 2008d).

Fuel prices are dependent on the fluctuating purchase price on the market. The price level of fuel is dependent on political, seasonal and economic developments. The fuel price is a good indicator for price development over the middle long and long term. Over the last fifteen years, the price of crude oil has risen from $15 to $90, which affects the margins of inland shipping companies. The fuel prices are often indexed in contracts. The second cost factor is the cost of capital. The costs of purchasing a ship and its cranes determines a certain share of the total cost price. Normally price setting includes the initial purchase costs of a new ship. However, the insurance value is used more and more in order to reduce the price of the transport service. Labour costs vary with the size of the ship. The larger the ship the more personnel is needed, the higher the labour costs. In order to lower the price, more and more foreigners are deployed on inland ships (Ecorys, 2008d).

Because of fierce competition, inland shipping companies operate under their cost price. In this way they can cover their variable costs and partly their fixed costs. This strategy delivers more benefits than if ships have no cargo to transport. In the figure below, an index of the costs for organizing the transport and the prices that are asked for the transport is shown for the transport of dry bulk over the river Rhine in the period 1998-2007.

Figure 16: Development of costs and price of transport in the period 1998 – 2007 (Index 1998 = 100)



(Ecorys, 2008d)

The prices for inland shipping have increased strongly; 30% over the last 10 years. This is mainly the result of increasing fuel costs (25% increase over the same period). There is however no general price setting since there is a variety of cargo and destinations to transport to. The price is set at four moments in the transport chain.

1) The consignee purchases the product for a certain price which includes the delivery of the product;
2) The producer arranges transport with a inland shipping company, where price is negotiated;
3) The producer can also choose to contact a forwarder to organize the transport. The services of the forwarder also increase the total costs;
4) In case of situation three, the forwarder has to contact an inland shipping company and negotiate the price. Or, whenever the inland shipper has a contract with the forwarder, a standard price will be charged.

There are thus several moments in the organization of the transport where the price is set. This is mainly negotiated via telephone which excludes the opportunity for a central setting of the price. ZSP can not influence this price. It is up to the market and its players to keep the price attractive.

3.4.2 Sub factor 2: Speed

The speed of a modality is a crucial factor in the choice of a modality. When a consignee orders certain products, the parties agree on a certain delivery time. Dependent on this agreement, the transport can be organized. The speed of the transport is influenced by the multimodal accessibility of locations and the average speed of the transport mode that is chosen.

3.4.2.1 Transport speed

There is a large difference in transport speed between modalities. In general, road transportation is the fastest way of transporting. In this paragraph the speed of different transport modes will be discussed and there will also be more elaboration on the influence of speed on modality choice. The average transport speed of a truck is 60 km/hour or 42 km/hour during peak hours (Meuwissen, 2005) and the average transport speed of inland shipping is 30 - 35 km/hour (Janic, 2006 and Meuwissen, 2005). Blauwens (2004) does however state that the average speed of inland shipping is only 9km/hour. It is therefore hard to estimate the speed of inland navigation. The potential speed is dependent on whether the ship is sailing upstream or downstream and how many locks have to be passed. Also a comparison with the transport mode rail can be made. The average speed of a cargo train over a long distance is sixteen km/hour. Transport by rail is thus slower than inland navigation. The required speed is dependent on the transport agreements that the shipper and consignee have made. In this agreement there is also a strong link with product characteristics. Products of high value often require faster transport and are thus more easily transported by truck.

3.4.2.2 Accessibility

Nautical accessibility is the profile of maximum draft, maximum vessel length, tidal windows and restrictions to vessels (Notteboom, 2008). Nautical accessibility is part of the ports physical and technical infrastructure. According to Notteboom (2008), the selection of a port is partly dependent on the nautical accessibility. The port of Antwerp is for example dependent on tidal windows and the morphology of the Westerschelde, which affects the accessibility of the port. Also the locks are perceived as a negative factor (Notteboom 2006). Accessibility is crucial to attract terminal operating companies, since these companies are part of a transport chain that is dependent on efficient operations. Without good accessibility, the advantages elsewhere captured in the chain will be destroyed (Meersman et al, 2008). When looking at the quality of the waterway network surrounding the POZSP, this can be qualified as high quality. The ports of Vlissingen and Terneuzen have access to a class V or VI waterway network in the direction south to Ghent and Antwerp, north, to Rotterdam and east, to Germany and further. The draft of both ports is sufficient to offer inland waterway vessels of class V or VI access to most of the quays. The accessibility of the port of Terneuzen is slightly less than in Vlissingen because the port of Terneuzen is located behind the locks. ZSP has only a limited influence on the accessibility of the port. Since improvements in accessibility require large investments, there is always an agreement needed between multiple governments. Rijkswaterstaat is the player that is responsible for the quality of the waterway networks in Zeeland. When improvements in the accessibility of the waterway network are planned, multiple governments are needed to decide what investments are made. In the figure below, the waterway network of the northwest of Europe is presented. The POZSP are located in a dense network with high class waterways as is shown in figure 17.

Figure 17: The inland waterway network of the POZSP

(binnenvaart.be, 2009)

To test whether the customers of ZSP perceive the accessibility of the POZSP as good, a customer satisfaction measurement can be used. Integron has done a customer satisfaction measurement under the customers of ZSP in 2009, where accessibility was one of the best scoring factors.

3.4.2.3 Infrastructure – speed

The infrastructure that is present in a port affects the speed of cargo handling. When specialized inland shipping terminal infrastructure is present at the terminal, inland ships do not have to wait for sea ships, that normally have priority. With specialized terminal infrastructure, the cargo handling can be executed on high speed and thus efficient. When the average speed of cargo handling can be improved, the transport speed in the total transport chain can be improved, which improves the competitiveness of the transport mode. Companies can however always make some changes in their planning, so that priority shipments from inland ships do not encounter delays while (un)loading. It is thus uncertain whether infrastructure is of real influence on the sub-factor speed.

3.4.2.4 Superstructure - speed

The superstructure that is present at the quays can be used for loading and unloading of ships. To handle cargo with high speed and efficiency, specialized cranes are required. These cranes can work with higher speed than general cranes that are also used for (un)loading sea ships. The cargo handling company is responsible for the purchase of the superstructure and has to reconsider whether low costs are more important than efficient cargo handling operations.

3.4.3 Sub factor 3: Additional efficiency factors

Speed and costs are factors that are commonly mentioned in research on port efficiency. There are however also other factors that have impact. As a PA, ZSP tries to facilitate inland navigation as a transport modality as good as possible. Therefore, large investments in waiting quays and a car transfer point have been made. Also other facilities can be of importance to inland shippers. These factors will be presented in the next sub paragraphs.

3.4.3.1 Waiting quays

When barges enter the port for loading and unloading, waiting quays are needed. This waiting quay is a place where vessels can moor to a physical object, like a pole or quay, and wait for a short period. In most cases, vessels wait for locks or bridges to open. When vessels wait for loading or unloading at quays on companies' terrain, this does not count as a waiting quay. Rijkswaterstaat, the organization that implements the plans of the ministry of transport and public works is responsible for offering sufficient waiting quays in the Dutch waterways. ZSP manages the (waiting) quays within the smaller channels (Ecorys, 2008c). Several waiting quays are owned by ZSP, other waiting quays are owned by Rijkswaterstaat.

The capacity of waiting quays in the Westhofhaven in Vlissingen is currently sixteen quays. Since ship size is increasing over time, more space in the harbor is needed for the maneuvering of ships. The waiting quays that are currently operational need to be removed in order to make room for these larger ships. Furthermore, the ISPS code makes it impossible to use empty quays, which are owned by companies, as waiting quay. The ISPS code is adopted by the IMO to increase port security. All terminals in a port that receive international sea ships larger than 500 tons gross weight need to comply with the regulations as were set up by the ISPS (Zeeland Seaports, 2009a). Legislation makes it thus harder to provide capacity for ships that need to wait within the port. This has caused a shortage of waiting quay capacity in the port of Vlissingen (Zeeland Seaports, 2007).

In the POZSP there is thus a shortage of waiting quays. To facilitate a growth of inland navigation, new capacity of waiting quays in both ports is required. A first step is made in June 2009, when three new waiting quays were opened for use. Waiting quay 1 offers capacity for six ships of 110m or two ships of 135m, waiting quay 2 offers a capacity of four ships of 110m or two ships of 135 and waiting quay 3 offers capacity for six ships of 110 m or three ships of a length of 135m. There is also an opportunity to extend the capacity with a fourth waiting quay with the same capacity of waiting quay 2 (Zeeland Seaports, 2007). These waiting quays are located in the Cittershaven in Vlissingen and are adapted for the increasing vessel size, so that also larger ships can make use of these new waiting quays (Zeeland Seaports, 2009a).

3.4.3.2 Additional facilities

The presence of high quality additional services can make the ports more attractive. The first facility is the car transfer point. Barges often carry one or more cars with them during their trips. These cars can be lifted with an on board crane on the shore. Shippers use the car to do shopping, picking up kids from school and other private activities. Not all quays can be used for this activity. Only designated quays may be used for the transfer of cars from ship to shore. In the port of Vlissingen a new car transfer point is created in the Scaldiahaven. There is no car transfer point in Terneuzen. According to Schuttevaer (2009), this lack of basic facilities is a real bottleneck for inland shippers.

Other facilities, which are less crucial according to Schuttevaer (2009) are access to drinking water, leisure facilities and electricity. These facilities are considered as extra facilities that can contribute to a pleasant stay of a shipper in the port, but are not crucial for shippers to be available. In the POZSP it is possible to purchase large amounts of drinking water for a low price to supply the ship at certain drinking water access points. Other facilities in the port that can contribute to the ports quality and positive perception are the presence of nearby cafeterias and other leisure facilities. The final facility that is worth mentioning is the access of inland ships to electricity from the shore. This electricity can be used to charge certain on board devices and can save fuel usage as long as the ships are waiting at the quay.

3.5 Determining factor 3 - Product characteristics

Cargo that is transported has certain characteristics that can affect the choice of modality. The product characteristics that are relevant are; volume, weight, perishability and value. The product types that are currently transported by inland navigation are especially sand, gravel, ore, coal, oil and chemical products. Next to all these bulk types, also the transport of containers is growing. To understand which characteristics are most important in the modality choice, each of the characteristics will be further discussed below.

3.5.1 Volume

This is the size or contents of the cargo. Whenever cargo has to be shipped in small volumes, transport modes with low capacity are more suitable. When large volumes need to be transported, the choice has to be made whether all goods are transported with one inland ship or with a relatively high amount of trucks. When five m^3 of gravel needs to be transported, the choice of modality will be more likely to be a truck. When five thousand m^3 of gravel needs to be transported, trains and inland navigation become more attractive modes, because economies of scale can reduce the price of transport.

3.5.2 Weight

This product characteristic is also important in the modality choice, since trucks have a maximum capacity of cargo weight. The maximum weight of the vehicle, including driver and cargo in the Netherlands is 50 tons. There are thus limitations. In the business of inland navigation, there are several classes of inland ships. The largest inland ships, a push convoy of six barges, can transport 27.000 tons. The different capacities of the modes can thus also affect modality choice.

3.5.3 Value

According to TNO (2002), the NSTR goods can be divided into a low value group and a high value group. First of all, the NSTR qualification of cargo types will be presented in table 6.

Table 6: NSTR good classification

NSTR group	Description
NSTR 0	Agricultural products and life animals
NSTR 1	Foodstuffs and animal fodder
NSTR 2	Solid mineral fuels
NSTR 3	Petroleum products
NSTR 4	Ores and metal waste
NSTR 5	Metal products
NSTR 6	Crude and manufactured minerals, building materials
NSTR 7	Fertilizers
NSTR 8	Chemicals
NSTR 9	Machinery, transport equipment etc.

(Jonkeren et al, 2009)

The high value group exists out of NSTR groups 0, 1, 5, 8 and 9. The low value group out of NSTR groups 2, 3, 4, 6 and 7. TNO (2002) states that the cargo that is transported with trucks exists out of 65% all high value cargo. With inland navigation over 72% of all cargo is valued as low value cargo. The transport per train contains also 65% of high value cargo. These percentages are measured in the Netherlands, in the year 2000 in million tons. It can thus be concluded that inland navigation is especially strong in the transport of low value cargo.

Nevertheless, Schuttevaer (2009) states that potentially all cargo types are suitable to be transported by inland navigation. It can thus be expected that product characteristics is not the most important factor in modality choice. It is however interesting to test which of the four characteristics is assigned to be of the largest influence.

3.5.4 Perishability

This is the period that goods can be contained without a reduction of quality or price. When we discuss consumer goods, perishability means the time that a product remains eatable. When the date is expired, there are health risks. For non-consumer goods, the term perishability can also be used as affecting the value of the product. When a TV is developed and made available for sale, the price will be relatively high in the first period. However, two years later, there are many new models introduced on the market, which affects the value of the product. When perishability as a factor influencing modal choice is debated, it can be stated that the higher the perishability, the higher the speed of transportation that is required. Products with high perishability are more often transported by relative fast transport modes such as airplanes and trucks. Products that have low perishability or none at al, can also be shipped by the more slow transport modes train and inland navigation.

3.6 Determining factor 4 - Perception / Image

It is important how shippers and forwarders think about the qualities of the modality inland navigation. When the image is negative, it is less likely that inland navigation is used as a modality to ship cargo from or to the POZSP. In the previous paragraphs, the qualities of inland navigation are explained in comparison with road transport. In short can be concluded that the speed of road transport is higher, but the reliability of inland navigation is better. Which mode can transport under the lowest costs differs depending on the product characteristics and the distance of transport. All the qualities of the transport modes contribute to the image that the organizers of transport flows have.

Tongzon (2009) states that ‘in practice, the distinction between quantitative and qualitative factors is blurred because the port users perception of the level of port performance may not be a fair reflection of the actual performance. In many cases, perceptions can take precedence over actual performances’. Factors that can be measured and compared in an objective manner, such as costs, are called quantitative factors. Qualitative factors include subjective influences, such as flexibility and marketing efforts. Also the perception on cargo safety can affect the port’s reputation. Tongzon (2009) states that marketing and promotional efforts by PA and operators can highlight the positive characteristics of ports and their supply of modalities. The perception of ports can be influenced by promotion.

The promotion of the policy of ZSP is mainly executed by Zeeland Seaports itself. Also the Zeeland Port Promotion Council (ZPPC) is used for additional promotion activities. This is an organization representing more than 100 companies and organizations. The participants do all have a direct or indirect interest in the social and economical performance of the POZSP. The participants affect the policy and the execution of a variety of activities. The core business of ZPPC is the promotion of the activities POZSP and especially the promotion of inland navigation as a transport mode (zeeland-seaports.nl, 2009b). Schuttevaer (2009) is positive about the efforts of ZSP and ZPPC to promote inland navigation as a transport mode. According to the customer satisfaction research of Integron (2009), the management and exploitation of the port is graded a 7.43 (on a scale of 1 – 10). This indicates that the image of the POZSP is fine at this moment. There are however also some negative aspects present in the port. According to Schuttevaer (2009), the port of Terneuzen lacks basic facilities such as waiting quays and a car transfer point.

The image of inland navigation as a transport mode is affected by many factors. Next to the experience of transport organizers with this modality, also promotion by various players can affect the image of inland navigation. In the Netherlands, Schuttevaer, CBRB, BIB, BVB and many other parties are active in the promotion of inland navigation and protecting the interests of a variety of players. International, the ESO, EBU, and INE stand up for the interests of independent shippers and promote inland navigation in general. These parties try to affect the image of inland navigation in a positive way.

3.7 Influence of Zeeland Seaports on the determining factors

As a port authority, Zeeland Seaports can affect many of the determining factors. There are however also factors that are solely controlled by the shippers or companies located at the POZSP. In this paragraph will be explained which factors can be influenced by ZSP and which factors can not. This is summarized in the table below.

Table 7: Summary of port indicators and the influence of ZSP on them

Port indicators	Can the factor be influenced by ZSP?
Locks	Yes, in cooperation with Rijkswaterstaat and other governments
Nautical safety	Yes, in cooperation with Rijkswaterstaat and other governments
Infrastructure – reliability	Yes
Superstructure - reliability	No
Port tariffs	Yes
Transport cost	No
Transport speed	No
Accessibility	Yes, in cooperation with Rijkswaterstaat and other governments
Infrastructure – speed	Yes
Superstructure - speed	No
Waiting quays	Yes, in cooperation with Rijkswaterstaat and other governments
Additional facilities	Yes, in cooperation with Rijkswaterstaat and other governments
Volume of product	No
Weight of product	No
Value of product	No
Perishability of product	No
Promotion	Yes, but this factor is influenced by many other organizations

(Zeeland Seaports, (2009b), interviews with representatives of ZSP, (2009c) and Schuttevaer (2009))

Rijkswaterstaat is responsible for a high quality inland waterway network with high safety and an efficient lock network. ZSP does only have a direct influence on these factors within the area that ZSP manages. However, ZSP works together with several governments, including Rijkswaterstaat. Therefore it can make remarks on the bottlenecks that occur in the waterway network so that the issues of nautical safety and an efficient lock network receive more attention. The other two reliability factors are infrastructure and superstructure. As a landlord PA, ZSP is responsible for building the infrastructure. The shipping company is fully responsible for the purchase of the superstructure. This is however not as black and white as it seems. Both parties discuss the required infrastructure, so that the requirements of both parties can be established. Companies need to inform ZSP about the planned superstructure, so that the infrastructure can be adapted for the type of cranes that will be purchased by the company. This is however only the case if it concerns new port infrastructure. Existing infrastructure is harder to change. The additional costs that are made if certain changes in infrastructure are required, are calculated in the land rents, so that the company also contributes to the costs that are made.

Port efficiency factors can be divided into ‘costs / rate’, ‘speed’ and ‘additional efficiency factors’. Within the sub factor cost / rate, ZSP can influence the port tariffs, but not the transport costs. The inland shipping company and its employer negotiate on the price level. This can not be controlled by ZSP. The speed factors can be partly controlled by ZSP. The speed of the transport mode can not be influenced, but the accessibility can. ZSP is responsible for offering an efficient port infrastructure and multimodal accessibility. Together with Rijkswaterstaat they try to extend the network of all modalities, so that companies have options in transporting their cargo. The factors infrastructure and superstructure are discussed above. The additional efficiency factors are also influenced by both Rijkswaterstaat and ZSP. Together they determine whether these facilities are required. On the main waterways Rijkswaterstaat is responsible for these facilities and on the smaller waterways within the port, ZSP is responsible. It is however hard to make a solid distinction in this shared responsibility.

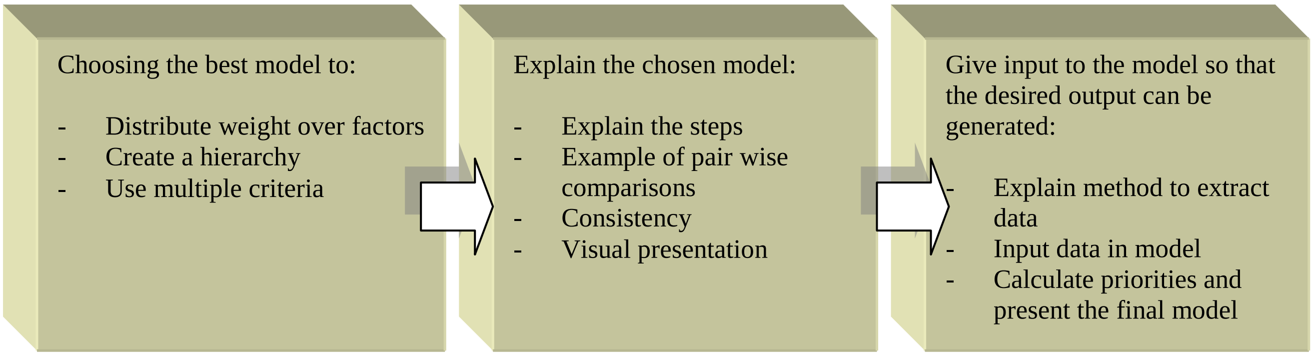
The product characteristics differ for each company. ZSP can not affect this factor for the existing companies. Whenever new companies are attracted, ZSP can scan for product characteristics. Whenever the characteristics are suitable for inland waterway transport, ZSP can decide to offer the required infrastructure and stimulate the company to purchase specialized terminal superstructure. This is however not common, since ZSP is mainly interested in the port dues that can be extracted from sea-vessels. These dues represent an important share of the income of ZSP, where the port tariffs for inland navigation do not.

The perception and image of inland navigation can be influenced by promotion. ZSP can contribute to a positive image by investing in a marketing campaign. This is however not a factor that can be controlled, since many other companies affect this factor. Also, when companies have a certain experience (positive or negative) with the modality, it is hard to improve this with promotion. ZSP does have influence, but is certainly not in control of this factor.

Chapter 4 Testing of the determining factors

The determining factors that have been identified in chapter three are tested in this chapter. The order of steps is depicted in the flow diagram below.

Figure 18: Flow diagram chapter four



4.1 Choosing a method to distribute weights

The determining factors have been derived from literature and are divided into categories. In this research must be determined how much each of these factors contributes to the choice of modality. Each factor is thus a criteria which is weighted in the decision making process. There are thus multiple criteria that are used to explain the choice for a certain modality for the hinterland transport. To analyse how all the individual factors contribute to the overall goal, a multi criteria analysis (MCA) is required. A MCA is a scientific evaluation method to make a rational choice between several alternatives. With a MCA the data can be organized and be made transparent, so that policy makers can make a substantiated decision (De Brucker, 1997). Famous examples of MCAs are the 'cost-benefit-analysis' and the 'environmental effect reporting'. In this research it is important to gain insight how much weight each of the determining factors has on the overall goal. It is thus necessary to use a model where weights can be allocated over the determining factors, so that a hierarchy can be build. This weight of the individual factors is determined by setting out a survey under companies located in the POZS. In this survey, all factors that influence modality choice have to be tested on importance. The method that is chosen to give weights to the factors is the *pair wise comparison method*. This method is chosen because it gives the best opportunity to compare various factors within one model, giving an ordinal weight and ranking to factors. The other possible methods are less suitable for several reasons, namely; methods are not usable for a large number of factors, methods are to complicated to use in a survey in writing, the method is time consuming or the fact that it is not possible to build a hierarchy, using the method. The pair wise comparison method does give the opportunity to test a large number of factors, build a hierarchy, test in a short time and make the survey accessible to fill in. In appendix F is further explained why this method is chosen and other methods are less suitable.

Pair wise comparison method

Two criteria are compared. In every comparison, the interviewed person needs to answer whether the factors are of equal importance of if one of the factors is moderately or absolutely more important than to other factor. This can be done on an ordinal nine-point scale. On basis of these pair wise comparisons, the relative priority of the independent criteria is determined. The pair wise method is often used in combination with a hierarchy and offers the advantage that with each comparison only two factors are compared and not a large amount of factors, which can lead to confusion. In section 4.2.1, an example of pair wise calculations is presented.

De Brucker et al (1997) does also offer several multi criteria analyses which can be used in this research. These are the 'sum of weighted averages', 'monetary evaluation methods', 'product of ratio's', the 'lexicographical method', the 'reference point-method', the 'global programming method', the 'indifference method' and the 'analytical hierarchy process method'. From all these methods, the Analytical Hierarchy Process (AHP) method is chosen because this is the only MCA that uses pair wise comparisons. Since pair wise comparison method is the most suitable to test the opinion of the respondent groups, this makes the AHP automatically the best MCA to use in this research. The AHP method provides a clear testing method that can be applied for the research on determining factors of modality choice.

4.2 The analytical hierarchy process

In this chapter is explained which measure is used to test the determining factors for their weight. This weight is required information because an indication of each factor affecting the modality choice for inland navigation is needed. First of all, the analytical hierarchy process (AHP) is explained, using the theory of Saaty. Secondly, the model is applied on this research. Thirdly, the data from the companies are used as input for the modal, which leads to a complete diagram of factors that influence the modality choice of companies in the POZSP.

4.2.1 The AHP technique

The analytic hierarchy process (AHP) is a structured technique for dealing with complex decisions, giving weights to multiple factors that determine a certain goal (Kurttila et al, 1999). This method, based on mathematics and psychology, is developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then. The AHP is used in a wide variety of decision situations, in fields such as governments, businesses, industry, healthcare and education. In this AHP, human judgements can be used in performing the evaluations. Elements can be evaluated and converted into numerical values, which can be used for comparison in a rational and consistent way (Saaty, 2001). The unique advantage of AHP is that it is a simple method to quantify or compare certain both qualitative and quantitative attributes (Kurttila et al, 1999). This capability distinguishes the AHP from other decision making techniques. AHP provides quantitative priorities that can be used in decision support. There is however no statistical assessment of the uncertainty of the results. To measure the consistency of the pair wise comparisons, the consistency ratio, resulting from the AHP calculations provides no direct information about the priorities' uncertainty (Kurttila et al, 1999).

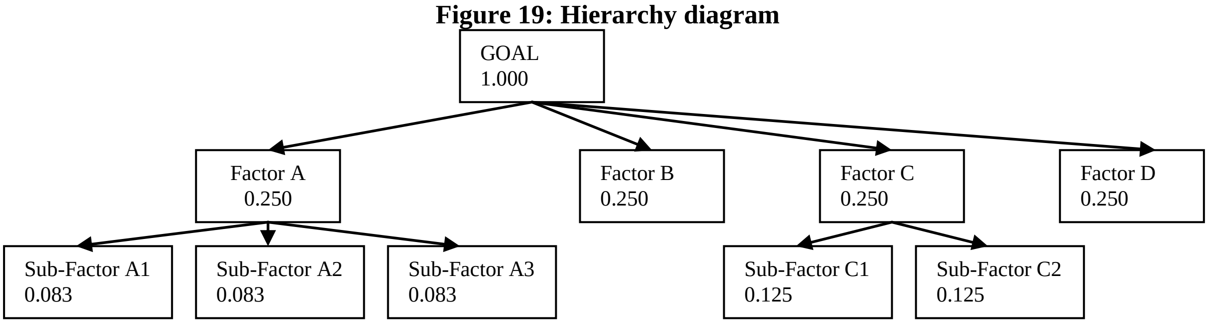
The procedure for using AHP is as follows:

1) Modelling the problem as a hierarchy, containing a goal, setting factors that determine the goal and the sub-factors that determine the main factors.
2) Use pair wise comparisons to establish priorities among the sub-factors and factors.
3) Build up a final model, including weights for each sub-factor and factors.
4) When the modal is finished it must be checked for inconsistencies
5) Final results can be presented using a consistent AHP model.

Modelling the hierarchy

In this phase, all factors determining the goal are ranked in several levels. On top, there is the overall goal. The second level contains the factors or categories that directly affect the overall goal. The third level exists out of sub-factors that each contribute to the factor on the second level. This model can be extended in even more levels in the same way as described above. The final diagram will often be shaped roughly like a pyramid. However, other than having a single element at the top, there is nothing necessarily pyramid-shaped about a hierarchy. In research, hierarchy models are often used to acquire detailed knowledge of a complex reality. By identifying each separate factors' components, a detailed image can be obtained, so that an understanding of the relation of the individual parts to the whole is gained (Saaty, 2001). A visualisation of the hierarchy is presented in the diagram in figure 19:

Figure 19: Hierarchy diagram



In this diagram, each box is called a node. The boxes descending from any node are called its children. The node from which a child node descends is called its parent. Groups of related children are called comparison groups. Once the hierarchy has been constructed, priorities to all nodes can be established. Priorities are numbers associated with the nodes of an AHP hierarchy. The numbers represent the relative weight of each node in a comparison group. The priorities of the criteria within one comparison group will ad up to 1.000. A node with the priority of 0.400 has twice the weight in reaching the goal as one with priority 0.200. The weight refers to the importance of the children in relation to the parent factor. The same counts for the factors that together determine the overall goal. In the diagram above, the priorities are positioned under the header of each node.

Pair wise comparisons
In order to quantify the perceived weight of each sub-factor, influencing the main factor, pair wise comparison can be used. In this pair wise comparison, single elements are compared (Saaty, 2001). The questions at stake, according to Kurttila et al (1999) are: *'(1) which of the two factors compared is of more importance?; and: (2) how much greater'?* This is done with the line-by-line method, where weights for each comparison can be entered intuitively. This method is shown in the table below, where the relevant weights of factors A, B, and C together determine the parent factor.

Table 8: Line-by-line table

									← Importance →								
	Absolutely less				Moderately less				Equal				Moderately more				Absolutely more
	-9	-8	-7	-6	-5	-4	-3	-2	-1/1	2	3	4	5	6	7	8	9
A – B												x					
A – C													x				
B – C											x						

Example:
You want to buy a car and the decision depends on the factors (A) costs, (B) safety, and (C) capacity. The factor costs is divided into (A1) purchase price, (A2) fuel costs and (A3) maintenance costs. And capacity is divided into (C1) cargo capacity and (C2) Passenger capacity. In the table an analysis on the first level is made where A is four times more important than B and five times more important than C. Also, B is three times more important than C.

In the table above, each factor is compared with the two other factors. In this way, the relative importance of each factor can be determined. It is of course difficult to compare costs (A) with safety (B), since safety can not be valued with money. However, in this table, the relative importance of each factor can be tested in a simple way. When factor A is less important, a negative value can be entered in the table. Equal scores can be entered by choosing the option -1 / 1. When A is far more important, a positive value can be entered. By entering a score for each pair wise comparison, the relative importance of each factor can be determined.

The scores that are generated in the line by line table can now be entered in an matrix. In this matrix, the calculations for pair wise comparisons can be made. The example that is mentioned above will be further calculated in the matrices below. In matrix 1, the scores from the example are filled in.

Figure 20: Matrix 1

	A	B	C
A	1	4	5
B	1/4	1	3
C	1/5	1/3	1

Matrix 1 is used to calculate the weight of each individual factor. The first step in the calculations is computing the percentage of each cell as percentage of the column total. This will result in matrix 2 below.

Figure 21: Matrix 2

	A	B	C
A	1/1,45 = 0,6897	4/5,3333 = 0,7500	5/9 = 0,5556
B	0,25/1,45 = 0,1724	1/5,3333 = 0,1875	3/9 = 0,3333
C	0,2/1,45 = 0,1379	0,3333/5,333 = 0,0625	1/9 = 0,1111
Column total	1,45	5,3333	9

When the weights of each factor per column are calculated, the average of each row must be computed. These average scores are the weight that each factor receives.
A = (0,6897 + 0,75 + 0,5556) / 3 = 0,6651
B = (0,1724 + 0,1875 + 0,3333) / 3 = 0,2311
C = (0,1379 + 0,0625 + 0,1111) / 3 = 0,1038

Now the weights of factors A, B and C are known, also the weights for the underlying factors of A and C can be calculated. This can be done by the same method as explained before. However, these weights indicate the influence of A1, A2 and A3 on factor A and C1 and C2 on factor C. When indicating the influence of A1, A2, A3, C1 and C2 on the overall factor (the factor above A, B and C), these weights have to be multiplied with the parent factor. To calculate all pair wise calculations and consistency ratios, a tool from the Canadian conservation institute (2009) is used.

Final model

The result of the basic hierarchy diagram with included priorities will be an overview of factors with their priority level, which can be ranked based on their impact. From this overview can be concluded what the impact of each individual sub-factor on the overall goal is.

Consistency

When the modal is finished and tested, the results must be checked for consistency. Whenever strange deviations are observed, these are marked as inconsistencies (Kurttila et al, 1999). Using pair wise comparisons it could occur that A is valued 3 times more important than B and B is valued 2 times as important as C. It would therefore be consistent if A was (2 x 3 =) 6 times more important than C. If not, the data are inconsistent (De Brucker et al, 1997). When A contains inconsistencies, the estimated priorities can be obtained by using the eigenvalue technique. The equation is follows:

$$(A - \lambda_{max} I)q = 0$$

In this equation, λmax is the largest eigenfactor of matrix A; q is its correct eigenfactor; and I is the identity matrix (Shinno et al, 2006). According to Kurtilla et al (1999), the correct eigenfactor, q, constitutes the estimation of relative priorities. In the matrix of pair wise comparisons, it is the first principal component. When the matrix does not include inconsistencies, q is the exact estimate of the priority vector. Each eigenfactor is scaled to sum up to one to obtain the priorities. Saaty (1977) has shown that λmax is always greater or equal to n (which indicated the number of rows / columns) (Kurtilla et al, 1999). $\lambda max = n$ if the pair wise comparisons do not include inconsistencies. The closer λmax is to n, the more consistent the comparisons are. The consistency ratio (CR) is obtained by comparing the consistency index (CI) with the appropriate one of the set of numbers from table Z. Each of these numbers is an average random consistency index (RI) derived from a sample of randomly generated reciprocal matrices using the scale -9 to +9. The CR and CI can be calculated with the following formulas (Chang et al, 2005):

$$CR = CI / RI$$
$$CI = (\lambda max - n) / (n-1)$$

Whenever the consistency ratio is closer to 0, the consistency is good. Whenever the consistency is closer to 1, the measurements are more random. Inconsistency is considered a tolerable error in measurement only when the ratio is under thirteen percent (Saaty, 1994). This rule of thumb is however weakened whenever it concerns a lower element of the hierarchy. Here, the CR must be multiplied with the relative weight of the element, so that also higher values than thirteen percent are allowed. For this specific research, the factors are not exact of interpretation, but rather broad defined, which is another reason to allow a higher CR. The acceptable level of consistency in this research will be 0.4. For further elaboration on consistency, see appendix G.

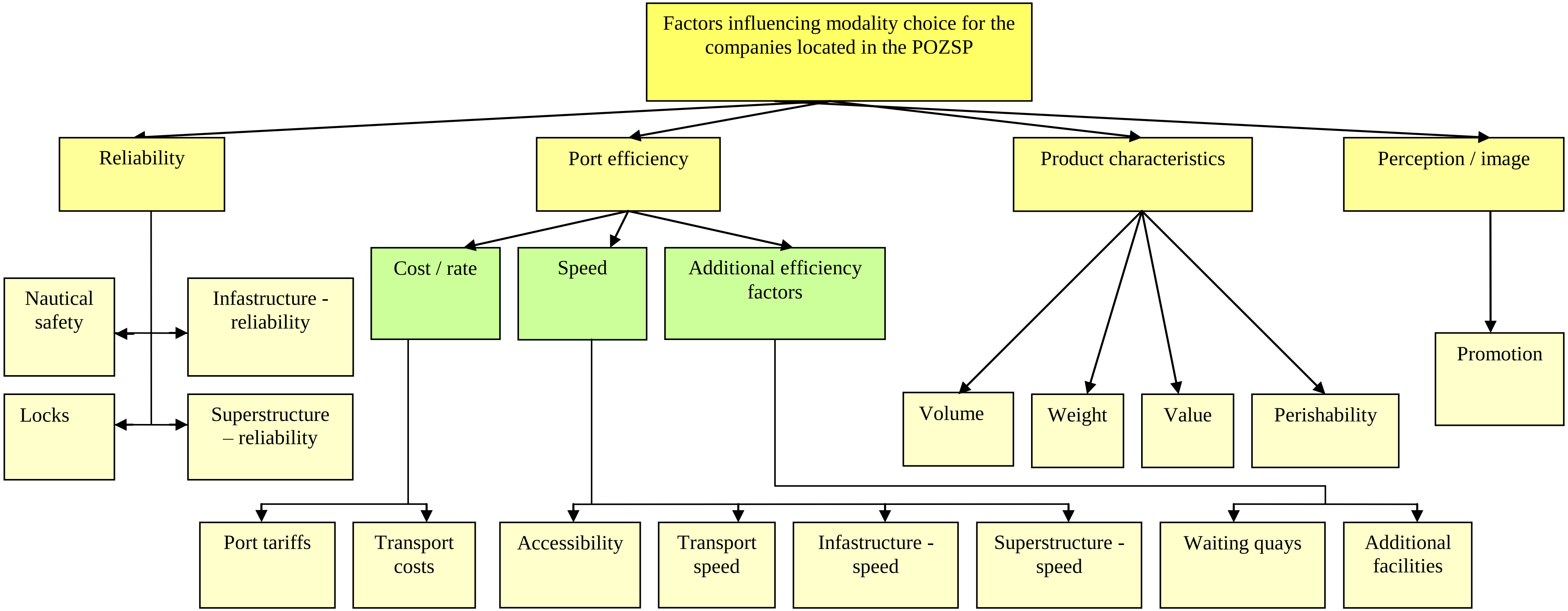
Results
When a diagram of the hierarchy is set up and pair wise comparisons of all factors on the same level are made, the final modal is finished. At this stage, input from interviews on the factors and sub-factors is required. When the input is compared and checked for consistency, this should provide a complete model of hierarchy with indication of priorities for each determining factor and its underlying (sub-factora and) port indicators. These are summarized in table 9.

Table 9: Overview of determining factors, sub factors and port indicators

Determining factors	Sub factors	Port indicators
Reliability	-	Locks Nautical safety Infrastructure – reliability Superstructure - reliability
Port efficiency	Cost / rate	Port tariffs Transport cost
	Speed	Transport speed Accessibility Infrastructure – speed Superstructure - speed
	Additional efficiency factors	Waiting quays Additional facilities
Product characteristics	-	Volume of product Weight of product Value of product Perishability of product
Perception / image of inland navigation	-	Promotion

In this model, the determining factors and their sub-factors will be applied in the diagram that is introduced in the previous paragraph. The basic hierarchical diagram that can be developed is presented in figure 20, on the next page. Notice that no priorities can be filled in the nodes yet. To acquire the input data, a survey is distributed over the most important companies in the POZSP, that already have some experience in inland navigation.

Figure 22: The hierarchy diagram



4.2.2 Input of the model

To gain insight in the view of companies located in the POZSP on the set determining factors, they are asked to fill in a survey. In this survey, the companies make pair wise comparisons so that weights can be distributed over the determining factors, sub factors and port indicators. The group of companies that is selected to participate in this survey are the sixteen companies that already use inland navigation to transport their goods to their clients, but also companies which have potential to start using inland navigation for their hinterland transport. Together, these sixteen companies represent a share of more than 80% of all cargo that is transported by inland navigation from or to the POZSP in the year 2008 (Zeeland Seaports, 2009b). From these sixteen companies, twelve companies have cooperated by filling in the total survey. The requested information from Havex / Verbrugge, Dow and Outokumpu is acquired by interviews. Within this group of companies, there will be a distinction between companies which organize their transport themselves and companies that do not. A summary is presented in table 11. This distinction is made in order to identify the opinion of the group of companies that makes the modality choice decision themselves. The opinion of this group is of the most importance to ZSP. Since forwarders and agents are not located in the POZSP but in the ports of Rotterdam and Antwerp, their opinion is not asked. The group of companies that organize the transport themselves take in their place. In this table, the first seven companies organize their transport themselves and the last five do not. The survey itself can be found in appendix H.

Table 10: Summary of the survey, companies located at the POZSP

Company	% Inland Navigation	Product group (NSTR)	Countries of customers and suppliers	Organizer of transport	Most important determining factor
Thermphos	0%	8	Ne, Be, Ge + EU	Thermphos	Port efficiency
De Hoop	75%	6	Ne, Be, Ge, Fr, UK	De Hoop	Port efficiency
S.B.V.	90%	6	Be, Ne, UK	S.B.V.	Reliability
Yara	30%	7	Be, Ne, Ge, Fr, UK + EU	Yara	Reliability
Havex / Verbrugge	60%	0, 4, 5, 7, 8	Be, Ne, Ge, Fr, UK, Ch, Au, Scandinavia	Havex / Verbrugge	Port efficiency
Outokumpu	10%	5	Fi, It, Ge + EU	Outokumpu	Port efficiency
Dow	25%	8	Ge, Ne, Be, Fr + World	Dow	Port efficiency
Kloosterboer	30%	0, 1, 4	Be, Ne, Fr, Ge, Au, Ch, Sp, UK	Agent	Port efficiency
Mercuria	45%	0, 3	Ne, Ge, Be, Fr	Consignee	Port efficiency
Ovet	75%	2, 4, 6, 7	Be, Ne, Ge, Fr, UK	Consignee	Port efficiency
Vopak	34%	8	No, Ne, Ge, Be + EU	Consignee	Product characteristics
Heros	60%	4, 5, 6	Ne, Be, Fr, Ge, Se	Consignee	Product characteristics

Another respondent group consists of inland shipping companies, that are asked to give their view on the weights of the determining factors. Three of the nineteen approached inland shipping companies, that sail regularly from and to the POZSP were prepared to fill in the survey. Together with Schuttevaer, they can give voice to the practical experience from the shippers point of view. In table 11, an overview of this research group will be presented.

Table 11: Summary of the survey, Schuttevaer and inland shipping companies

Player	Product group (NSTR)	Countries of origin and destination	Most important determining factor
Schuttevaer (1) C.J. de Vries	-	-	Product characteristics
Schuttevaer (2) Jan de Vries	-	-	Reliability
Inland shipping company 1: Courage	0, 1, 7	Ne, Ge	Reliability
Inland shipping company 2: Progress	3	Ne, Be	Reliability
Inland shipping company 3: Reggestroom	3	Ne, Be, Ge	Reliability

When the surveys are returned they are processed into the AHP by calculating the pair wise comparisons, so that weights can be allocated. Companies that filled in a survey with a high consistency ratios are contacted and asked whether possible mistakes are made during the survey. Only when the consistency is at a representative level ($\leq$0.3), the results are included in the final model. This is why the input of Mercuria is excluded from its group. The models exists out of the average values of all companies within a group, resulting in three separate models.

4.2.3 Building the model

Interviews with companies (two groups), Schuttevaer and inland shipping companies (one group) will result in three different hierarchical models which will be presented in this paragraph. Also a fourth model is presented, where the average off all participating companies is used. After the presentation of the four models, the differences will be analyzed.

Model one contains the average score of the companies that organize their transport themselves; Thermphos, De Hoop, S.B.V., Yara and Havex / Verbrugge, Outokumpu and Dow. Model two contains the average score of the companies that do not organize their transport themselves. This group contains Kloosterboer, Mercuria, Ovet, Vopak and Heros. Because the survey of Mercuria was returned with a high consistency ratio, this data is excluded from the model. Model three contains the average score of Schuttevaer and three inland shipping companies.

Figure 23: Model 1

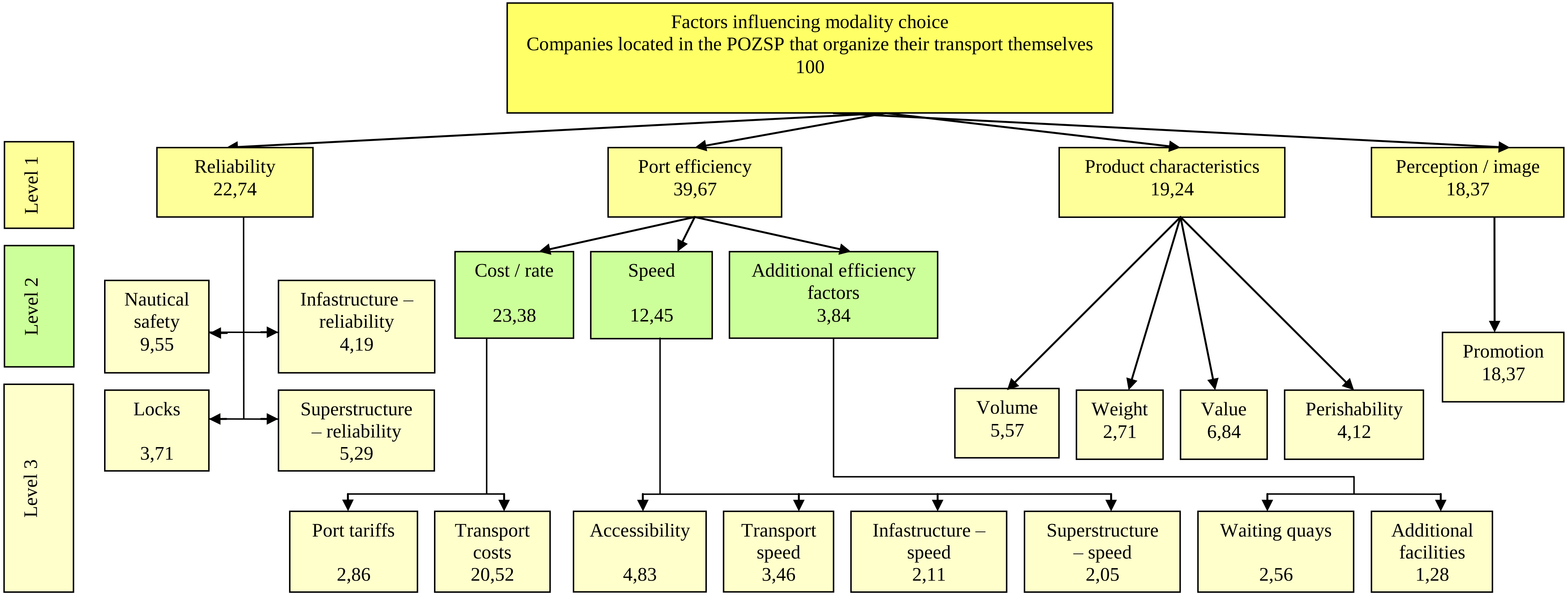


Figure 24: Model 2

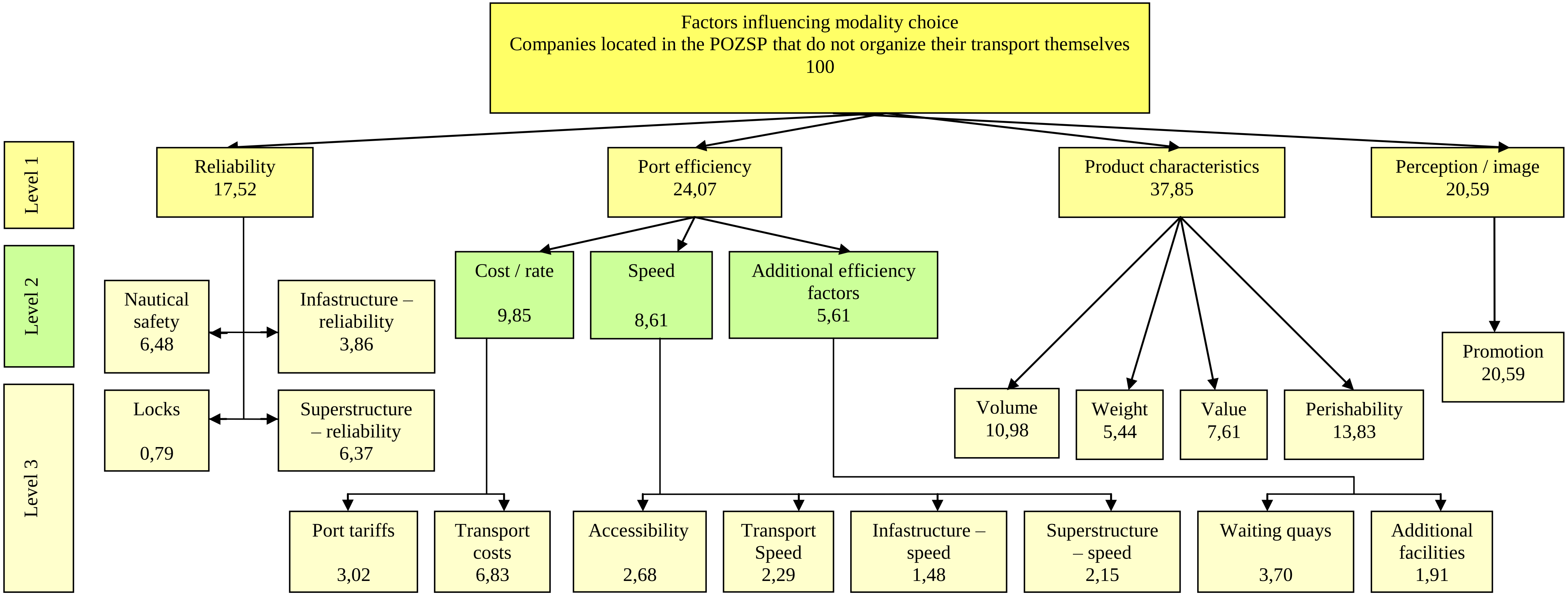


Figure 25: Model 3

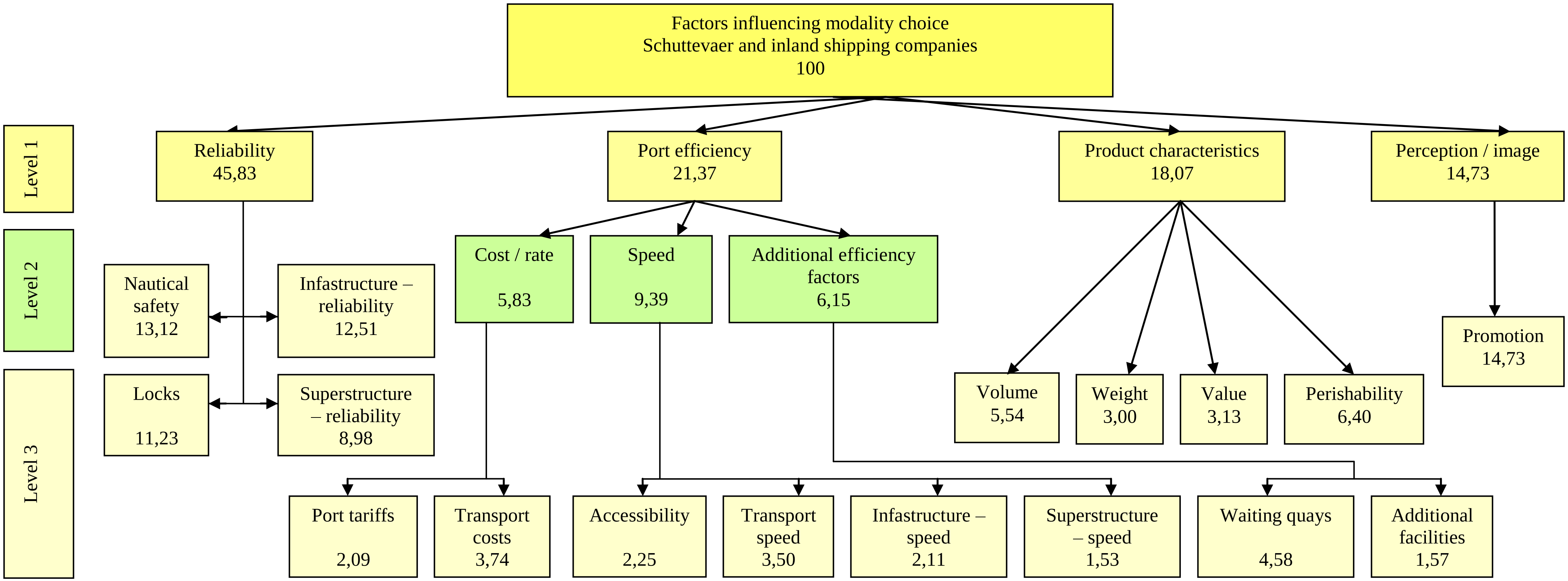
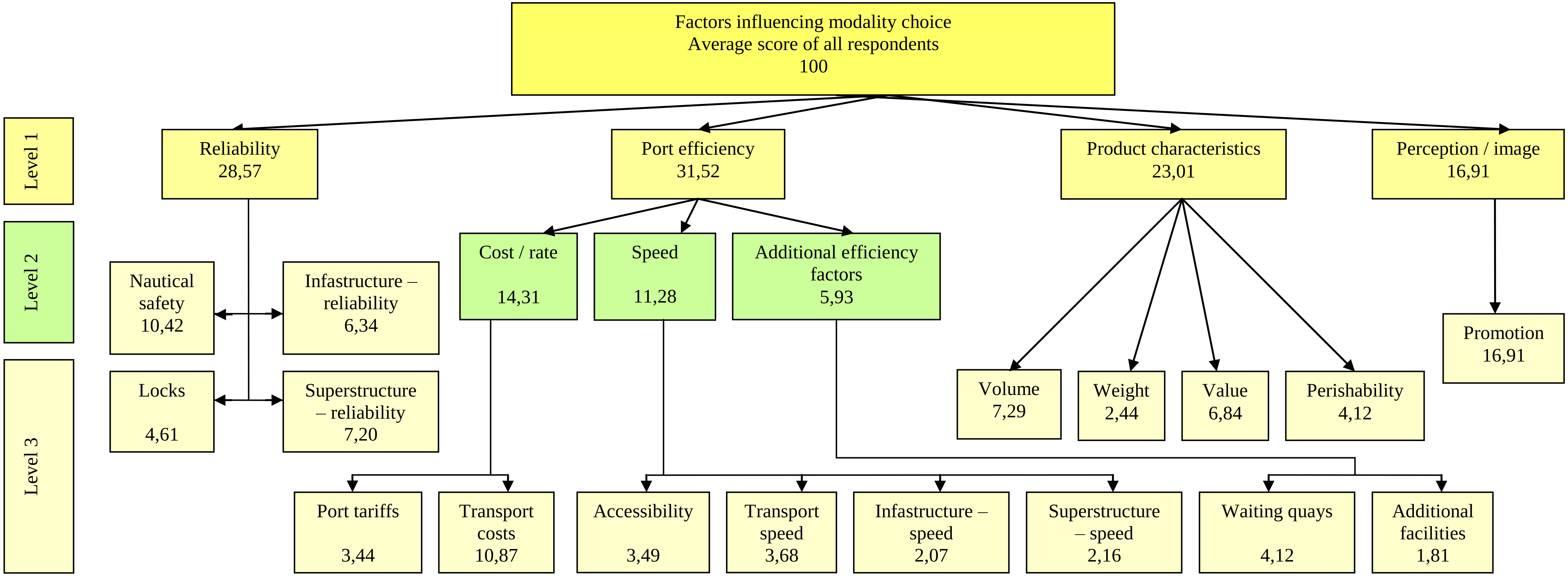


Figure 26: Model 4



4.3 Discussion AHP methodology

In this research, the determining factors that influence the choice of modality have been derived from literature. The AHP method is chosen as the method to give weight to the factors. The AHP makes it possible to build a hierarchy model where different sets of indicators are set up. On the first level, four determining factors are set up. These are: Reliability, Port efficiency, Product characteristics and Image. Under these factors, the port indicators are placed, which together determine the total weight of the parent factor. Where the determining factor is the parent, the port indicators are its children. In this research, the goal is to establish an overview which determining factors are the most important and which of the underlying port indicators does influence this determining factor most. A acquire this knowledge, surveys are filled in. Filling in the survey can be a difficult challenge since not all factors are easy to compare. For example; without an accessible port, the quality of the infrastructure and superstructure is not relevant. Therefore it can be that companies assume the accessibility of the POZSP is good and also allocate high scores to the other factors. Another answer of these companies can be to only allocate weight to this accessibility factor. The AHP method with pair wise comparisons does work in theory, but in practice, there are some difficulties to overcome. The interpretation of the results may therefore be somewhat subjective. During this research, several difficulties have been observed which can influence the reliability of the method. How these difficulties are overcome is explained below.

The first difficulty that is the result of this set up, is that some determining factors are supported by four indicators (e.g. reliability) and another factor is supported by only one factor (e.g. image / perception). Since image is determined only by the indicator ‘promotion’, this indicator determines the parent factor image for 100%. The reliability indicator ‘locks’ is one of the four indicators that determines the weight of the determining factor ‘reliability’. Therefore it is more likely that ‘promotion’ receives a higher weight than ‘locks’ since there are no other children in the group. The determining factor ‘port efficiency’ is supported by three sub groups (speed, cost and additional efficiency factors), which also exist out of several children. There are eight children that determine the overall parent ‘port efficiency’, therefore the probability of a high weight of these individual children is much lower than for example ‘promotion’. Therefore can be concluded that: the more levels there are, the lower the weight of the children will be. Another conclusion is that the more children support the parent factor, the lower the weight of the individual child will be. When only the third level of the hierarchy model is analyzed, this can lead to an incorrect picture. In the theory is described that in the perfect situation, each ‘determining factor’ should have a same amount of children, so that this difficulty can be overcome. Because the determining factors and its indicators from this research are derived from literature and the practical experience of ZSP, no changes are made in the initial organization of the determining factors and its indicators. However, when concluding on the model, this difficulty is taken into account by valuating the factor promotion with some reserve.

The second difficulty is the line-by-line table that is used to measure the pair wise comparisons in the survey. After distributing the survey there were some doubts whether the table is clear enough. Despite the example in the survey, it could be that the method of measuring is considered as to difficult. This conclusion is based on several high consistency ratios that were found in the returned surveys. Whenever the survey is filled in with a high consistency of the first level, it is not usable, since all underlying levels are also inconsistent. To resolve this situation, companies with a high consistency ratio are asked to reconsider some contradicting answers. Whenever the consistency is reduced to an acceptable level (below 0.3), the data are usable for this research. When data are consistent and thus not conflicting, it is assumed to be correct. Automatically, a correct and consistent answer indicates that the questions have been understood, so that this difficulty is overcome. The survey among inland shipping companies is adapted to prevent the difficulties in the line-by-line method. In this survey, another measuring method, instead of the line-by-line table is used. This second version of the survey is available in appendix I.

The third difficulty is that the participating companies have marginal insight in the outcome of the survey. The companies fill in several pair wise comparisons, without knowing what the outcome is. This has the advantage that companies focus on the pair wise comparisons without manipulating the outcome whenever this appears to be somewhat different than expected. This advantage is arbitrary. Whenever companies make mistakes in filling in surveys they can not easily detect this and correct the mistake. This difficulty is somewhat controlled by the consistency ratios. Whenever this consistency is high, it is probable that a mistake is made. How to handle this problem of high consistency ratios is described above. Also, when the outcomes are consistent but very devious from the other companies within the group, the ranking is checked by contacting the interviewee.

4.4 Analysis

In this paragraph, the average scores of the three models that are presented above are analyzed. In the final sub paragraph, the differences between the three models are discussed. For more detailed information about the companies and the model, see appendix J.

4.4.1 Analysis of model one

This model is the average score of the individual factors of the companies that organize their transport themselves. These companies are: Yara, de Hoop, Thermphos, S.B.V., Havex / Verbrugge, Dow and Outokumpu. Because logistic managers are responsible for the transport of their own product, this group of companies has a strong vision on the main factors that influence modality choice. On the first level of this model, reliability, port efficiency, product characteristics and perception / image are the factors that are defined. According to respondent group one, it is very clear that port efficiency is the most important factor in the modality choice decision. The second most important factor is reliability. Although reliability is crucial in the modal choice decision, costs are always the first factor that is taken into account. On the first level of analysis, product characteristics is the third factor in rank and 'image / perception' is valued with the least weight.

The port efficiency is divided into three sub groups, namely costs, speed and additional facilities. Within the factor costs, especially the transport cost are designated as an important factor. When transport is organized and the basic conditions for transport with different transport modes are available, companies look at the costs first. However, the time required for transport should not be a bottleneck, otherwise the modality is not attractive. Whenever the costs for transport by inland navigation are lower, but the time to arrival is twice as long, this can also be a problem. 'Additional efficiency factors' are considered as not important, although the companies expect that the present facilities for inland shippers can affect the price that is charged for inland shipping services.

Reliability is the second most important factor. Although the weight is almost twice as low when this factor is compared with port efficiency, reliability is considered as an important quality. Whenever the transport service of a certain modality is subject to high reliability risks, this transport mode is not attractive. Companies have indicated that the level of reliability in the POZSP is very good, since there are not many cases of large problems. The locks operate efficient, without large malfunctions or accidents. Therefore, companies do not allocate much weight to the factor locks. Within the determining factor reliability, nautical safety is considered as the factor that has most effect on the reliability of the transport service. Whenever accidents occur, this can result in larger delays than the delays that are the outcome of problems in the other factors within this group. Because the factor infrastructure is valued with a low weight, this factor affects reliability only to a small extend. The infrastructure that is present at the POZSP is considered as sufficient and does not affect the reliability in a bad way. Companies can intervene in their planning whenever a ship needs quay space to be (un)loaded directly, which explains why infrastructure does not receive much weight.

The third most important factor is 'product characteristics'. Within this factor, 'value' receives the highest score. This can be explained by the fact that products of low value can only be transported by modes that can transport large quantities against low costs. Modalities that are more expensive can not offer attractive rates to transport products of low value against a competitive price. The second most important factor is volume. This characteristic is valued as most important by four of the seven companies within this group. Whenever companies want to transport small volumes, trucks are often the only option as a transport mode. There is thus a minimum required volume necessary in order to make inland navigation an attractive transport mode. This minimum required volume affects the modality choice. Perishability is the third most important factor within this group and the factor 'weight' is of the least importance.

Image / perception receives the lowest score when analyzing the first level. This determining factor has only one underlying factor, namely 'promotion'. Other determining factors have four or more underlying factors. Therefore, the factors on the third level can not be compared in a fair way. Since promotion is the only underlying factor, the high score of promotion on the third level is explainable and should not be valued as if it of much importance, since this factor scores the lowest on the first level. Companies do not consider image as an important factor of the modality choice. Promotion can however contribute to the sustainability objectives of companies. Most companies in the POZSP have sustainability objectives where inland navigation and rail transport are preferable above road transport when costs are at an equal level. Promotion can thus be used to encourage companies to use sustainable transport modes and update companies about new developments in the sustainable transport from and to the POZSP.

The companies that gave input to this model are the only interviewed players that really make the transport decision. The other interviewed players that are analyzed in model two and three do not make the modality choice decision themselves. Since the first group is the most important for this research, company specific considerations of Dow, Havex / Verbrugge and Outokumpu are explained below, which can give more insight to the results of the first model.

Dow

Dow produces various chemical products that are transported mainly to Germany, Belgium, France and the Netherlands. Trucks are the most important modality to transport their products. Inland navigation is the second most important. For Dow, costs are the main factor in the decision of modality choice. The volumes that are transported are large enough to be transported by inland navigation, but this is not always the most cost effective solution. Whenever the consignees are not located near waterways, extra handling costs and road transport are required to deliver the product. Speed is the second most important factor. In the opinion of Dow, the reliability is also very important. The factors that affect reliability are however of a sufficient level, so that these do not result in significant delays. Whenever the reliability becomes slightly problematic, measures are taken, so that the product will be delivered at the consignee at the right time. Dow has various measures that can be taken to avoid certain reliability risks, so that the transport service remains at a high quality.

Outokumpu

When the transport of steel by Outokumpu is organized, the first factor that is taken into account is the transport speed. This factor receives the highest score in the survey. Next to speed, also transport costs and the volume of the transported product are important in the transport decision. An important destination of cargo flows of Outokumpu is the Ruhr area in Germany. This location can be served in a much quicker way by truck than by inland navigation. Because the shipments are small in terms of volume, inland navigation is not competitive. Also North-Italy is an important destination. This location can not be reached with inland navigation, but is very well accessible by train. Another important factor in their transport decision is the risk of damage, which is higher with multimodal transport, than with unimodal transport. Inland navigation does only become interesting whenever the reliability and speed of road transport become problematic.

Havex / Verbrugge

In the modal choice decision of Havex / Verbrugge, transport cost is the most important factor. Because Havex / Verbrugge has many customers that are located at waterborne locations, inland navigation is an important transport mode. Planning makes it possible to calculate when transport has to be sent in order to arrive at the requested time and date. Therefore, the factor speed is less important than costs. Because the product characteristics are also very suitable for inland navigation, this modality is used frequently. Furthermore, the reliability of the POZSP is considered as good, since there are not often problems with the factors that influence reliability. If there are delays, these are not substantial enough to interfere the operational activities of Havex / Verbrugge.

4.4.2 Analysis of model two

The companies that do not organize the transport of their products themselves have other priorities than companies that do organize the transport themselves. The companies that are part of this group are Kloosterboer, Ovet, Heros, Vopak and Mercuria. The data from Mercuria is not included in the model because of inconsistent data. In this group of companies, the player that organizes the transport is often the customer. For Kloosterboer, an agent organizes the transport. Because this model contains data from only four companies, a deviant opinion of a single company can have a large effect on the average of model two. From the model can be concluded that product characteristics affect modality choice most. The second most important factor is port efficiency. The factor image / perception is ranked third and the factor with the least impact on modality choice is reliability. This outcome is very different from that of model one. How this is possible will be explained below.

Product characteristics is clearly the most important factor. In particular, volume and perishability receive high weights. This can be explained because especially Heros and Vopak indicate that this factor is of large influence on modality choice. These companies transport ores & metal waste, metal products, crude and manufactured minerals & building materials and chemicals. These companies often transport large volumes, which can be transported with one ship or with many trucks. To save costs, inland ships can be used for transport. But this is only possible if the basic conditions for inland navigation are present. The distance must be long and the destination must be accessible via inland waterways. Also, the importance of the product characteristic ‘perishability of products’ can be explained, since products that have a short keeping time need to be transported with a mode that has high speed. In this case, inland navigation is not the most attractive mode.

The next most important determining factor is the 'port efficiency' and in particular the cost factor. Just as with the companies that organize the transport themselves, the costs of transporting the cargo from origin to destination is the most important port efficiency factor. Also the speed of transport is important. This factor can be linked with the perishability of the product, as explained above.

The third most important determining factor is the image / perception. This high score is mainly the result of the Ovet, that has weighted this factor very high. This is the only company that has pinpointed image / perception as most important determining factor. The influence of image is therefore the highest score on level three and therefore of large influence on the modality choice of these companies.

The factor that has the lowest impact on modality choice according to this response group is reliability. Why this factor is valued this low is hard to explain, since a reliable transport service is always of importance to transport companies. It is expected that the companies are satisfied with the current reliability level in the POZSP and expect that this level is maintained in the future.

4.4.3 Analysis of model three

This group exists out of three inland shipping companies and two representatives of Schuttevaer. This group has another view on the modality choice decision, since they are the (representatives of the) executing players. At the first level, reliability is pinpointed as the most important factor in modality choice. For inland shipping companies it is thus crucial that they can deliver a reliable service, so that their service remains attractive for shippers. The second most important factor is port efficiency. 'Product characteristics' is the third in this ranking, and image / perception of the modality is of the least influence.

Within the determining factor reliability, nautical safety is the factor that receives the highest score. All factors within this category do not lead to delays when there is normal ship intensity and when no technical errors are made. Whenever there is a problem with any of the four factors, the effect of nautical safety is likely to have the most impact on the reliability of the service, according to this respondent group. When ships run aground or collide with other ships or infrastructure, the delays can be substantial. The delays can also be significant when accidents with locks result in the temporarily closure of the waterway. The second most important factor is infrastructure. Inland waterway ships do often have to wait for sea ships that have priority to dock at terminal infrastructure. Separate infrastructure for inland ships can improve the reliability of the service, which is seen by this group as the most important factor. Locks are the third in ranking and superstructure is the least important factor. From this fact can be concluded that the impact of specialized superstructure instead of general superstructure is, in comparison with the other three factors, of the least influence on the reliability of the transport service.

The second most determining important factor is port efficiency. Within this group, speed is appointed as the factor that influences modality choice most. Next to the reliability of the transport service, transport speed and accessibility are also considered as very important. These factors are also crucial in order to make the inland shipping service successful. Accessibility is the most important port indicator, affecting the speed of the transport service. Whenever destinations are not accessible by inland navigation, extra handling and extra transport with trucks to the final destination are required. This makes the organized transport a multi modal transport service with higher costs. Accessibility is thus crucial for the inland shipping companies. The second most important port indicator is 'transport speed'. Whenever this indicator is further reduced, other modalities become more attractive than inland navigation, which is affecting the modality choice. Under this determining factor also the influence of transport costs and waiting quays are important. Costs are of course important since shippers depicted this as the first criterion in modality choice, which directly affects the supply of cargo that can be transported by the inland shipping companies. Waiting quays are the basic facilities that are required by inland shipping companies, when waiting in a port. When the capacity of waiting quays is low, the personnel of the inland ship can not go ashore. From the point of view of the shipping companies, the supply of waiting quays should be sufficient in each port.

Product characteristics are the third in order of importance. Within this group, especially the perishability and volume are weighted high. Perishability is always coupled to the transport speed of a mode. Since the transport speed of an inland ship is relatively low, perishability can pose as a problem in the modality choice decision. The importance of the factor 'volume' is also explainable, since inland navigation is only an attractive transport mode for large volumes. The weight and value of the products are considered as less important in the modality choice decision.

The final determining factor is image / perception. This factor receives the lowest score and is thus considered as the factor that has the least influence on modality choice. This is somewhat strange since Schuttevaer, an association that promoted inland navigation itself has 40% of the input to this average model. Again, when only the third level is analyzed, promotion receives a very high weight. This score should however be valued with some reserve, since promotion is the only 'child' of the determining factor, which automatically leads to a high weight at level three. Nevertheless, for inland shipping companies the image does contribute to the attractiveness of the transport mode. Promotion is able to make companies more aware of the durable character of the mode, which may potentially have an effect on the attractiveness of inland navigation.

4.4.4 Model 4 and the differences between models one, two and three

After analyzing the three models it is striking that each respondent group designates a different factor with the highest weight. This does not lead to a clear conclusion, but it does offer information about the opinion of the separate groups. For ZSP, it is especially important to know what the organizers of the transport see as important factors. Therefore, model one is the most important model for ZSP. Also the companies in respondent group two are important for ZSP, since these companies also transport large volumes. However, these companies do not organize their transport themselves, but this transport organization is executed by their consignees. Kloosterboer is an exception, since this company uses an agent as intermediate. This is why the second model is of less importance than model one. Model four is used to indicate what the average of all interviewed players is.

In model one and four, 'port efficiency' is pinpointed as most important factor. The underlying indicators that have the most weight are transport cost, accessibility and transport speed. Of these factors, only the accessibility can be indirectly influenced by ZSP. In order to retain and improve the efficiency level of the POZSP, accessibility should be the factor that receives the most attention. When looking at the second most important determining factor, reliability, the underlying indicator 'nautical safety' receives the highest weight. Nautical safety is thus also a factor that should be controlled and improved by ZSP. According to the participating companies, the reliability of the POZSP and thus the nautical safety is of a sufficient level. For the future, the most important factor to maintain or improve is the nautical safety. Especially when ship intensity increases, nautical safety can become an issue in the future. Since nautical safety has the largest effect on the total reliability of the service, a reduction of nautical safety can negatively affect the attractiveness of the mode inland navigation.

The factors that can be influenced (indirectly or directly) by ZSP do not particularly receive a high weight. Apparently, these factors are already of a high level and do not directly need more attention. It could also be that these factors have a very limited influence on modality choice and therefore do not receive much weight. When ZSP wants to encourage the use of inland navigation, only accessibility, nautical safety and perhaps infrastructure are factors that could use more attention. The other factors that can be influenced, namely; locks, port tariffs, waiting quays, additional facilities and promotion are not factors that have a large impact on the modality choice decision. When aiming at a modal shift, large investments in these factors are not expected to result in a voluminous modal shift. Only when there are expected bottlenecks in the future situation, these factors need attention. The capacity of the locks and waiting quays should therefore be monitored.

Chapter 5 Conclusions and Recommendations

5.1 Conclusions

In their strategic masterplan, Zeeland Seaports has stated its ambition to increase the volume transported by inland navigation from 28.7 million tons in 2008 to 40 million tons in 2020. When the growth trend over the last twelve years continues, this objective will be accomplished. However, since the year 2006, the volume transported by inland navigation has only decreased. Therefore change is needed so that the port can grow autonomously and a modal shift can be realized, which should result in the aspired growth of volume.

Autonomous growth and modal shift

The autonomous growth in the POZSP can be realized by several developments. The first development is the Seine – Schelde inland waterway connection, which is expected to generate one million tons, transported by inland navigation in 2020. The development of the Scaldia port, where additional cargo flows of woodpulp are expected, is the second development. The third development is the Axelse vlakte. It is unknown how large the transported volumes by inland navigation, originating from these last two developments, will be. The final development is the containerization of the POZSP. Without the containerization, it is difficult to realize the aspired growth. It is certain that one of the three initiatives, the Scaldia container terminal, will be build. The other two container terminals, which are of larger scale, are still uncertain of development. When only the Scaldia container terminal is developed, this will result in maximal 240.000 TEU transported by inland navigation. If also the other terminals will be realized, this could potentially result in an additional 1.5 million TEU, transported by inland navigation. It is unknown if the autonomous growth will be sufficient to realize the aspired tonnage transported by inland navigation. Therefore, also a modal shift is desirable. In a modal shift, cargo that is normally transported by other modalities is shifted to the modality inland navigation.

Basic conditions for competitive inland navigation activities

This research has identified the factors that affect the modality choice decision of companies in the POZSP. From literature is derived that several basic conditions are required in order to use inland navigation as a transport mode. Firstly, the companies in the port must have a water bound location and also the consignee needs to be close to a waterway. When this condition is met, a minimal transport distance is required in order to make the modality competitive. Additionally, the products that are transported must have certain product characteristics. When the transported products are shipped in a large volume, the scale advantages of inland ships can be attractive. Also, when products are of low value, inland navigation is often the most competitive mode to use. Several other characteristics can influence the modality choice. The final factor that is a basic requirement for successful inland navigation is port efficiency. The port needs to be accessible and offer a safe and reliable transport network.

Determining factors derived from literature and practice

From literature, factors that influence modality choice have been identified. Using the practical experience of ZSP, four ‘determining factors’ have been set up, that together influence the modality choice decision. These four are; Reliability, Port efficiency, Product characteristics and Image / perception. These determining factors are all influenced by underlying factors, which are defined as port indicators. In total, seventeen port indicators are set up that together determine the weight of the four parent factors.

Methodology

To test the impact of each of the determining factors on the modality choice of the companies located in the POZSP, a survey is used. In this survey, sixteen companies located in the POZSP, representing more than 80% of all transported volume per inland navigation are questioned on their opinion. Also, inland shippers and the shipping association Schuttevaer are approached. The methodology that is used to gather this information is the ‘analytical hierarchy process’, which uses pair wise comparisons to give weight to factors. This is the best method since it offers the opportunity to build a hierarchy and allocate weights over a large number of factors. In a survey in writing, the AHP can be applied easily and this method is not time consuming. The total respondent group is divided into three groups, namely; companies than organize their own transport, companies that do not organize their own transport and the third group exists out of inland shippers and the inland shipping association Schuttevaer. For these three groups their opinion on the determining factors and underlying port indicators is tested.

Results of the survey for the three respondent groups

Each of the respondent groups designates a different determining factor as most important. The first respondent group pinpoints ‘port efficiency’ and ‘reliability’ as most important determining factors. Especially the costs and speed of the modality are of influence on the modality choice. When the cost aspect of a certain modality is not competitive, this modality is not used for hinterland transportation. Also, the transport speed of the modality must be sufficient in order to deliver the shipment in the required time slot. Nautical safety, which is a reliability-factor, does also receive a high weight. When a modal shift needs to be stimulated, these factors have the most effect on the modality choice. The second respondent group has designated the ‘product characteristics’ as most important factor. This is explainable because the group exists out of several companies that transport large volumes of low value bulk products. In case of transporting these products it is important that no instant delivery is required. When this is the case, inland navigation is the only competitive modality. Next to ‘product characteristics’, also port ‘efficiency’ is important. Especially the costs and speed are important to this second group. The group of shipping companies and Schuttevaer has another opinion, namely that ‘reliability’ is the most decisive factor in the modality choice decision, since reliability in crucial to deliver a good transport service. When the service becomes unreliable, the advantage of inland navigation is diminished, which will have a large effect on the modality choice. The second most important factor is ‘port efficiency’, where again the transport costs and speed are considered as most important.

The determining factors that ZSP can influence to stimulate a modal shift

Port efficiency is clearly the most important determining factor affecting the modality choice decision. Therefore, ZSP needs to make sure that the efficiency of the port is improved or maintained at the same level. The current level of reliability is sufficient and companies do not foresee problems in the nearby future. Therefore the reliability factors do not receive high weights. Since it is of most importance to ZSP to find out what companies that actually make the modality choice decision designate as most important factors, this first group is considered as leading in answering the research question. Port efficiency and especially the transport costs, transport speed and accessibility are considered as most important factors and therefore deserve the most attention when ZSP is trying to stimulate a modal shift. Also the nautical safety is of importance. ZSP can not affect the transport cost and speed of the transport mode. The speed-factor ‘accessibility’ can however be influenced by ZSP. From this research can be concluded that it is important to keep the POZSP accessible and safe. These factors are namely the factors that affect the reliability and efficiency of the port most and can be influenced by ZSP (indirectly). The factors locks, waiting quays, port tariffs, additional facilities, promotion and infrastructure can also be influenced by ZSP, but these factors receive a lower weight. Only when there are expected bottlenecks in the future situation, these factors need attention. The capacity of the locks and waiting quays in comparison with the ship intensity should therefore be monitored.

5.2 Recommendations

There are some issues that ZSP should consider while using this research. Firstly, this thesis is the result of the ambition of ZSP to increase the transported volume per inland navigation to 40 million tons in 2020. This ambition is not further specified in terms of a growth volume realized by autonomous growth and a growth volume that is the result of a modal shift. It is thus possible that the aspired level of volume transported with inland navigation is achieved by attracting one new large company that uses inland navigation or realizing a large container terminal. Without specification of this growth, it is unclear how much volume must be gained by autonomous growth and how large the modal shift should be. From a sustainability point of view it would have been better to set a goal concerning a modal shift. This would result in more sustainable hinterland transport, instead of an absolute increase in transported volume. When a goal is set for a certain modal shift percentage, this research can be used in order to affect the factors that have the largest effect on modality choice in the most cost efficient way.

Secondly, in this research on the factors that affect the modality choice decision of companies located in the POZSP, several difficulties have appeared. In order to test the determining factors that have been deduced from literature, the AHP methodology is used. This method offered the best opportunities to give weight to factors. However, since not all factors exist out an equal amount of ‘children’, some results are viewed on with some reserve. It is therefore difficult to conclude on the results. Whenever the AHP method is used again for researching this subject, it is advisable to allocate an equal amount of ‘children’ to each parent factor, so that it becomes easier to draw conclusions on the results.

A third recommendation is to extend the research to other ports, so that the respondent group can be extended. When there is a larger respondent group, also forwarders can be included. Because this research is applied to the POZSP, where no large forwarders are located, this important group of companies that make the modality choice decision is not included in the research. In addition, from the experience of this research, it is advisable to execute the survey solely with face-to-face interviews or interviews by telephone instead of emailing surveys. The interview technique provides more information about the considerations that are made by companies and gives the opportunity to correct inconsistent answers.

A final recommendation to ZSP itself is to gather information about inland navigation on a more specific level. For example, 40% of the destinations of transport by inland navigation are unknown. From the data that is known, this is measured only at a national level. With this information it is difficult to do research on the status and opportunities of inland navigation. In cooperation with companies, this information can potentially be improved.

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Appendices

Appendix A Organization of inland navigation

In the transport chain, there are several parties which each have their speciality. In this paragraph, all players in the chain are described, according to the classification of Ecorys (2008d). Distinction is made between the transport of bulk good, chemical goods and containers.

Shipper

The shipper is the owner of the cargo and wants to remain in control of the organization of the door-to-door transport. The shipper wants to transport the cargo for the lowest price and the highest reliability from origin to destination. The organization can be executed by the shipper itself or it can be (partly) outsourced to an intermediary (forwarder or agent).

Forwarder or agent

These parties organize the transport for the shipper and are always trying to transport the fastest and most reliable way, against the lowest possible costs. Between the different chains they gain a margin that is their income. Next to the organization of the hinterland transport, they do also take care of administrative formalities. Also, when small shipments have to be transported, consolidation of smaller shipments can be arranged by forwarders, which can save costs. Forwarders distribute the different cargo volumes from different shippers over the inland shipping companies that are connected to them.

(Sea) Port

The port is the node between the sea transport and the hinterland transport. In the port, many companies are located who import raw materials and export final products.

Shipping company

This is the party that executes the transport over sea. The shipping company passes the costs to the shipper or forwarder.

Stevedore

The stevedore load and unload sea ships and transfer the cargo to inland ships or other modalities. A stevedore does only have a contractual relation with the shipping company and pass on the handling costs to the shipping company.

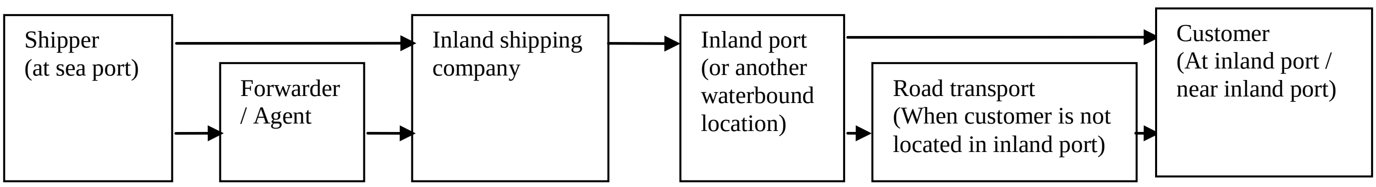
Inland shipping company / operator

This party is responsible for the execution of the transport of cargo over the inland waterways. The shipper, forwarder, shipping company and inland terminal can all be the customer of the inland shipping company. Inland shipping companies can work independently or work together in cooperation's. In 2002, 87% of the entire fleet does exist out of one ship companies. Half of the independent inland shipping companies works on basis of a year contract or is leased to a fixed customer (such as a inland terminal) or a commercial cooperation such as the CVB (Cooperatieve Binnenscheepvaart Vereniging). For specialized vessels also contracts of longer term can occur. The trend in this business is that independent shippers work together in some form. Inland shipping companies are connected to forwarders and agents to get access to cargo. This can thus result in yearly based contracts or single transport contracts.

Inland port

Just as the sea port, the inland port is a node and a space where companies can locate. In this inland port offers multiple terminals for cargo handling. In inland ports it is easy to switch the cargo from the one mode to the other.

Figure A1: Organization scheme of inland navigation



Dry bulk
The transport of *ore and coal* often contains large volumes on large waterways and thus with large ships. The transport of *sand and gravel*, often smaller ships are deployed because of the limited capacity of waterways that are used to reach building locations. The transport of sand and gravel is especially different from the transport of ore and coal because of different suppliers and receivers. Transport flows are often national and are transported in a lesser extend from and to sea ports. The segment has a strong relation with the building sector, causing the volumes to fluctuate over time. The transport of *metals* does for a large extend exist out of flows from the steal industries to metal producers. The segment of agribulk and other dry bulk exists out of relative small volumes between different locations.

Liquid bulk
This segment contains the transport of oil and chemical products per tank ship over the inland waterways. In the most cases, this transport contains international flows to Germany or Belgium.

Containers
The segment of container transport is the fastest growing segment and is for the largest part international transport. Flows are often transported by inland navigation from sea ports to inland ports.

Supply and demand
The inland navigation sector is conservative and thus not working with internet based supply systems. The business does rather remain the existing relations with the shippers in order to obtain cargo to transport.

In the *dry bulk sector* there are many suppliers and for the most segments also many demanding parties. There is free entrance to the market, although it is sometimes difficult to acquire the minimal size of ships. The exit barrier is high, since it takes about 25 years to amortize a ship. Shippers can diversify by offering a different capacity, but are further homogeneous. In this market there is free competition with a tendency to monopolistic competition.

In the *liquid bulk sector*, there are relatively few suppliers and also few demanding parties. In this market there is free entry and exit. Because of long term contracts, the market is not transparent, causing a monopolistic competition structure, where suppliers have market power.

In the *container sector*, there is free competition and free entry and exit to the market. There are many suppliers and asking parties. To guarantee the frequency of transport movements, the market does often work with long term contracts. In markets with free competition, there is the law of demand and supply that sets the prices.

Appendix B Prognoses Seine – Scheldt

The prognoses are set up out of four steps. The first step is the prognoses from the autonomous development of the transported cargo on basis of the 'welvaart en leefomgeving (WLO) scenarios'. The second step is the translation of the traffic prognoses to transport prognoses, including increasing scale. Thirdly, the prognoses of non-cargo shipments and recreational shipments are made. Finally, the prognoses are corrected for specific regional development, where this is not part of the autonomous development (Ecorys, 2009). The transport prognoses are split up into four scenarios that are presented in table B1.

Table B1: Scenarios of development

Scenario	Contents
Global Economy (GE)	Worldwide trade liberalization and an extension of the EU with Turkey and the Ukrain. GDP growth: 2,1%
Transatlantic Market (TM)	No strong Europe but a trade liberalization with the USA. GDP growth: 1,7%
Strong Europe (SE)	Europe, much attention for international collaboration. GDP growth: 1,2%
Regional communities (RC)	No strong Europe and limited international trade liberalisation. GDP growth: 0,7%

(Ecorys, 2009)

According to Ecorys (2009) it is difficult to identify to which ports these cargo flows will be shipped. The extra tonnage that will be shipped because of the Seine – Scheldt connection will be divided over the transport to or from the POZSP (11%), the transport via Terneuzen to other Dutch ports, German ports and ports in the northwest of France (65%) and the transport to Antwerp (24%). The prognoses are presented in the table below.

Table B2: Development according to different scenarios

Scenario	Number of inland ships sailing over KGT	Extra transported tonnage because of Seine – Schelde connection	Extra tonnage because of Seine – Schelde connection in percentages	Extra tonnage transported to or from the POZSP (11%)
2020 GE	70.604	11.612.000	28%	1.277.320
2020 TM	66.611	10.026.000	26%	1.102.860
2020 SE	52.505	9.959.000	28%	1.095.490
2020 RC	55.876	7.180.000	23%	789.800
2050 GE	85.186	16.148.000	30%	1.776.280
2050 TM	74.117	14.001.000	32%	1.540.110
2050 SE	63.102	13.864.000	40%	1.525.040
2050 RC	48.468	7.410.000	27%	815.100

(Ecorys, 2009)

The upgraded Seine – Scheldt inland waterway connection will thus result in an additional cargo flow between 789.800 – 1.277.320 tons. This amount is 10% of the aimed growth of ZSP that is described in the strategic masterplan of ZSP (Zeeland Seaports, 2008a).

Appendix C Container terminal initiatives

WCT

The WCT is the original container handling initiative of the POZSP. Because of several setbacks and the current economic crisis, it is still uncertain if the WCT will be realized. The terminal operator will be PSA/ HNN. The barge terminal will have a quay length of 1.000m. The turnover capacity of the WCT in 2020 will be between the 2 – 2.5 million TEU. The share of transhipment is estimated to be between 20-50%. Dependent on this share, other modes will be used for further transportation of the containers. Transhipment is the handling of cargo from one (large) ship to another (smaller) ship. These smaller ships sail to the smaller ports (Coeck et al, 2006). In the table below, two scenarios are presented that give an indication of this modal split in 2020 (OTB, 2007), using the maximum potential capacity (Bogaert, 2009a).

Table C1: Scenario container handling WCT

	Scenario 1 (worst case)		**Scenario 2 (best case)**	
Modality	**Amount of TEU handled per year**	**Modal split in %**	**Amount of TEU handled per year**	**Modal split in %**
Transhipment	400.000	20	1.250.000	50
Inland navigation	480.000	24	900.000	36
Rail	240.000	12	125.000	5
Road	880.000	44	225.000	9
Total	**2.000.000**	**100**	**2.500.000**	**100**

VCT

Verbrugge is a terminal operating company (TOC), that handles different kind of bulk goods, such as paper, steel and cars. Verbrugge has the ambition to handle containers in the nearby future. Because of the uncertainty of the build of WCT, Verbrugge started their own container initiative, the VCT. The terminal operator of the VCT will be Eurogate. The quay length for the barge terminal will be 350m. Because of the economic crisis, also this initiative is postponed until the market recovers. This container handling activity aims at a container turnover between 2.16 – 2.9 million TEU. The expected modal split for the VCT is presented below in two scenarios (OTB, 2007), using the maximum potential capacity (Bogaert, 2009a).

Table C2: Scenario container handling VCT

	Scenario 1 (worst case)		**Scenario 2 (best case)**	
Modality	**Amount of TEU handled per year**	**Modal split in %**	**Amount of TEU handled per year**	**Modal split in %**
Transhipment	540.000	25	725.000	25
Inland navigation	540.000	25	725.000	25
Rail	108.000	5	145.000	5
Road	972.000	45	1.305.000	45
Total	**2.160.000**	**100**	**2.900.000**	**100**

Scaldia Container Terminal

Sea-invest, a stevedoring company, has plans to start up a container terminal in a joint venture with Zuidnatie, a company active in stevedoring, logistics, cargo handling, warehousing, distribution and expedition. Together they want to operate a terminal with a maximum potential capacity of 1.000.000 TEU per year. The new terminal is being developed to handle mainly containers and offering additional services like stripping and stuffing, consolidation and sorting of containers. It is expected that the container terminal will be operational in 2010. The expected modal split of this terminal is presented in the table below (OTB, 2007), using the maximum potential capacity (Bogaert, 2009a).

Table C3: Scenario container handling Scaldia container terminal

Modality	**Amount of TEU handles per year**	**Modal split in %**
Transhipment	200.000	20
Inland navigation	240.000	24
Rail	120.000	12
Road	440.000	44
Total	**1.000.000**	**100**

Appendix D - Locks in the province of Zeeland

There is a difference in the capacity of the locks. Since the measurements and number of gullies differ, so does the average time that is needed for a ship to pass the lock. This information is presented in the table below.

Table D1: Characteristics of locks in the province of Zeeland

Locks	Number of locks / gullies	Measurements of locks	Average time for passing lock
Volkerak	3 Gullies	290 x 24 m	40 – 45 min
Krammer	2 Gullies	285 x 24 m	64 min
Hansweert	2 Gullies	320 x 24 m	38 min
Kreekrak	2 Gullies	320 x 24 m	59 min
Terneuzen	3 Locks	Westsluis: 290 x 40 m Midden sluis: 140 23,5m Oostsluis: 280 x 24m	95 min 56 min 70 min

(RWS, 2007 and RWS, 2004)

The intensity of ship movements on the KGT and KZB has been relatively stable in the last ten years, but are expected to grow. In the table below is presented what the expected ship intensity will be without container terminals and other developments. In these data, also ships sailing to other ports are included. An example is the port of Ghent, which is accessible via the KGT. Also recreational activities are included in these numbers, that represent the number of ships passing the locks. This explains the differences in amounts of inland ships in the locks and in the POZSP (OTB, 2007). The development of ship intensity is shown in table D2.

Table D2: Development in ship intensity on both routes

Routes	Situation 1997	Situation 2005	Situation 2020 (autonomously)
KGT	64.670	65.230	77.758
KZB	45.622	45.609	54.756

More detailed information, identifying the flows via the different locks is available for the year 2007 and presented in the table below.

Table D3: Number of ships passing the locks in the province of Zeeland

Routes	Total amount of ships in 2007	Amount of inland ships in 2007	Percentage inland ships
Kreekrak locks	73.437	70.328	96%
Hansweert locks	52.469	43.605	83%
Terneuzen locks	67.354	54.785	81%
Krammer locks	92.586	42.229	46%

(RWS, 2007)

The additional amount of ship movements because of the container initiatives are presented in the table below. These prognoses are derived from OTB (2007) and corrected for the maximal potential capacity as presented by Bogaert (2009a). An average of 122 TEU per ship movement is used to calculate the total ship intensity (OTB, 2007). This is presented in table D4.

Table D4: Overview of expected ship movements for each individual container terminal that is operational

Terminals	2020		2023 (full exploitation VCT)
WCT	Scenario I: 3.900	Scenario II: 7.045	Scenario II: 7.045
VCT	4.065	4.065	5.895
Scaldia Container Terminal	1.950	1.950	1.950
Total	**9.915**	**13.060**	**14.890**

New Sea – Lock Terneuzen
Currently, there are three locks in Terneuzen, namely; the Oostsluis (280m x 24m), the Middensluis (140m x 18m) and the Westsluis (40m x 290m). These locks are however not equipped to transfer the larger ships that are entering ports nowadays. For this reason and because of a shortage of capacity, there has been an extensive lobby for a new and larger sea lock. It is especially in the interest of the port of Ghent that this sea-lock is established. The POZSP have less demand for this expensive sea-lock since the larger ships can make use of the port of Vlissingen. However, it is in the advantage of both Ghent and the POZSP that the new sea-lock is established in Terneuzen, so that accessibility due to size, continuity and lock capacity can be improved (Port News, 2009). In return, the POZSP demand a fairer tariff for the exploitation of the rail network and better road accessibility in the southern direction.

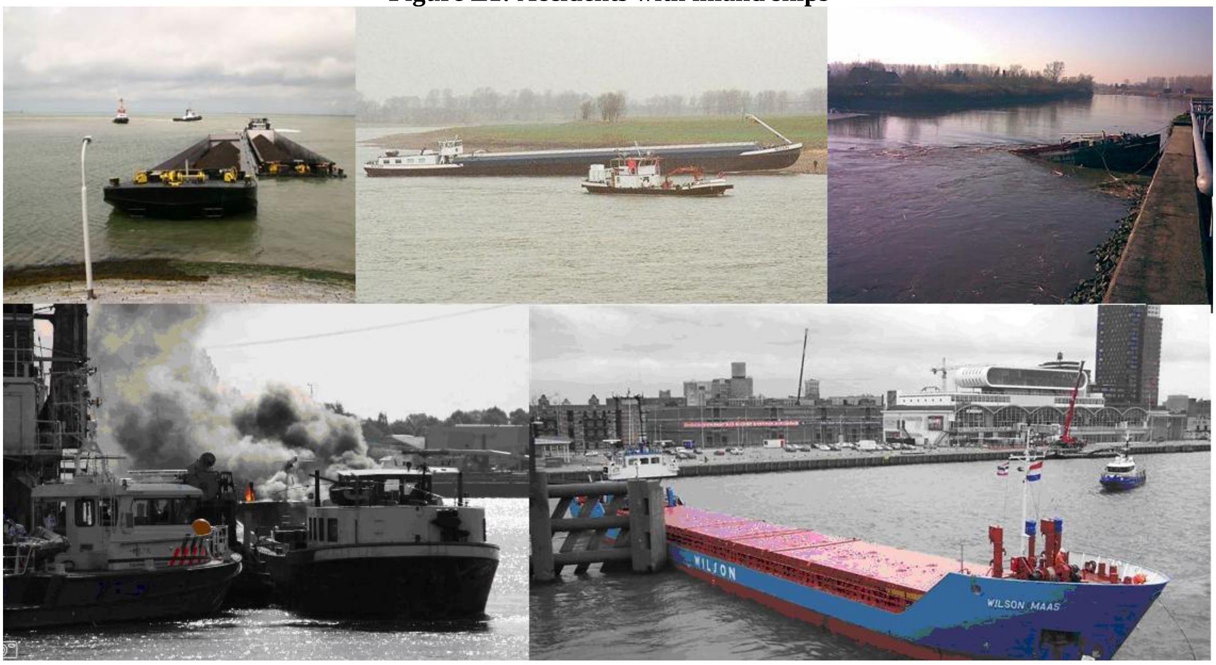
The new sea-lock should be ready by 2018 to allow ships with a length of 366metres, a width of 49metres and a draught of 14.5metres to gain access to the KGT. The capacity of the lock is 100.000 tons. Although the costs for this sea-lock are high, the durability will be for at least a hundred years (Port News, 2009). It is still unclear how the costs will be distributed between Belgium and the Netherlands.

Appendix E - Nautical safety

Four types of accidents can be distinguished, such as illustrated in figure E1, namely:

- Collision with ships (collision between two or more ships, with damage to at least one ship)
- Collision with objects (bridges, locks or stranding at beaches)
- Interaction between ships (no collision, but light contact between two or more ships, with damage to at least one ship)
- One way accidents (fire, explosion, leakage etc.)

Figure E1: Accidents with inland ships



The most common accidents in the Netherlands, in the period 1998 – 2002, are the collision with ships and the collisions with objects. In the measurement of nautical safety, barges, sea ships and recreational ships are included. The barges represent the largest share of accidents, around the 50% in the period 1998 – 2002 (Ministerie van Verkeer en Waterstaat, 2004). The cargo that is transported by these barges can be distinguished in the transport without dangerous goods, and the transport with dangerous goods. Although the amount of accidents with barges is increasing slightly, the share of barges with dangerous goods is declining from 17% to 10% in the period 1998 – 2002. Furthermore, the amount of accidents with fatal injuries is declining. Finally, when the modality of inland navigation is compared to road transportation, it can be concluded that it is safer, when measured per ton/kilometre (Ministerie van Verkeer en Waterstaat, 2004). Until 1990, the nautical safety has improved because of better on-board equipment and ship traffic management. After 1995 this trend is no longer visible. Since 1995, the nautical safety is more likely to decline (Marin, 2007). The major factor in this decline is increased ship intensity. In general can be stated that increasing ship intensity will lead to an increased number of accidents. Other factors that can influence nautical safety are increased vessel size, extending the width and depth of waterways, ship traffic management, the increased share of dangerous cargo transported, change in the chance of accidents and external factors such as wind, sight and currents (Marin, 2007). Additional factors could be economic growth and time pressure. When ships have to meet higher demands, this can reduce the chance on accidents an collisions.

Measures that can be implemented should aim at improving the ability to adjust the route and speed between certain points. Also the ability to react on external influences can be improved by improving communication. In this process of checking, detecting and adjusting, both on-board instruments and land-side communication can be used. Communication can be improved by using radar, GPS and AIS (Automatic Identification System). These instruments can thus improve the nautical safety of a port (Marin, 2004). A measure that is already implemented is the increased nautical safety by improving communication between ships and shore. New LED information panels that are placed in the KGT, who can inform shipper about bridge openings and other nautical information (Het Vasteland, 2006). These information panels should prevent ship accidents, such as collisions with rotating bridges, which have happened in the past. Secondly the safety on the Westerschelde will be improved by deepening the channel (Marin, 2007). According to the customer satisfaction research of Integron, the nautical safety is reviewed as good. The POZSP score high on the factors ‘availability of communication resources’, ‘safety in the port’, ‘traffic signs in the port’ and ‘maintenance of wet infrastructure’.

In the tables below is presented how the number of shipping accidents in the period 1998 – 2007 has developed.

Table E1: Shipping accidents in the Netherlands

Type of accident	1998	2003	2004	2005	2006	2007
Collision with infrastructure	70	73	158	118	152	145
Collision with objects	22	30	35	21	33	27
Collision with two or more ships	280	364	260	218	248	356
One way ship accidents	19	18	28	31	28	41
Interaction between ships	43	58	54	63	79	71
Accidents while ship is lying still	0	0	4	0	1	7
Other / unknown	0	0	0	0	0	0
Subtotal	434	543	539	451	541	647

(Rijkswaterstaat, 2008b)

Table E2: Shipping accidents in Zeeland

Type of accident	1998	2003	2004	2005	2006	2007
Collision with infrastructure	6	4	14	14	17	20
Collision with objects	3	4	2	4	2	6
Collision with two or more ships	9	36	23	21	33	43
One way ship accidents	7	0	2	4	0	2
Interaction between ships	11	7	8	10	18	20
Accidents while ship is lying still	0	0	0	0	0	1
Other / unknown	0	0	0	0	0	0
Subtotal	36	51	49	53	70	92

(Rijkswaterstaat, 2008a)

When table Y and Z are compared, there is a similar development and a similar pattern of shipping accidents. However, where the total of shipping accidents in the Netherlands has increased with 47%, the increase in Zeeland is over 155%. The type of ships that are often in these accidents are of class Va (Large Rhine ship or a single push convoy), VIb (four barge push convoy) and Vic (six barge push convoy). The causes of the accidents with inland ships are especially errors in controlling the ship and errors in factors in the surroundings.

Appendix F Choosing a method for weight distribution

According to De Brucker et al (1997), there are several methods to allocate weights directly, which are explained below. After presenting each method, the reason for rejection or selecting the method in this research is briefly explained.

Trade off method
In this method, the interviewed person needs to estimate with how many units factor A needs to increase to make the increase equal to an increase of factor B with one unit. The answer to this question provides the trade-off between both criteria. This procedure is followed for each couple of factors. This is method is not easy of use when a large number of factors needs to be weighted. The trade off method is therefore not suitable to be used in this research since there are many factors that need to be weighted.

Swing method
In this method, all criteria are set at the lowest possible level. The interviewed person has to indicate which criterion needs to be improved first. In this way, all factors can be ranked and each rank can be given a weight. For the second factor, a trade-off needs to be estimated which can be used to give weight to the second factor. This method continues until all factors are given a weight. This method is more difficult and more time consuming than the trade off method and will therefore not be used.

Rating method
The interviewed person is asked to distribute a certain amount of points (say 100) over all the factors. The designated score is used as to represent the relative importance of the factor. This is also difficult when a large number of factors needs to be weighted. This method is therefore not suitable to be used in this research.

Ranking method
In this method, all factors are ranked from most important to least important. This is a good method to find out which factors are the most important. It is however not a good method to build a hierarchy and it is also difficult to put weights on each factor. Therefore, this method is not used in this research.

Verbal-statements method
Verbal information is used to give weight to factors. This nominal scale information is converted in a five- or seven point scale of ordinal scale. This method will not be used in this research since it is time consuming and more difficult than other methods.

Pair wise method
Two criteria are compared. In every comparison, the interviewed person needs to answer whether the factors are of equal importance of if one of the factors is moderately or absolutely more important than to other factor. This can be done on an ordinal nine-point scale. On basis of these pair wise comparisons, the relative priority of the independent criteria is determined. The pair wise method is often used in combination with a hierarchy and offers the advantage that with each comparison only two factors are compared and not a large amount of factors, which can lead to confusion.

Scenario method
Several scenarios with their own set of weights are set up. Possible scenarios are for example ‘ecological scenario’ or ‘logistic scenario’. In an ecological scenario, the factors with more ecological value have a higher weight. In the logistical scenario, the weights are distributed differently. After setting the scenarios, the different scenarios are integrated and tested. This method can not be applied on this research since there are no scenarios.

All these methods can be used to allocate weights to factors in a MCA. Because pair wise comparisons offer the best method to give an ordinal weight and ranking to factors. This method is chosen to use in the MCA in this research on factors that influence the modality choice.

Appendix G Consistency

Consistency
When the modal is finished and tested, the results must be checked for consistency. Whenever strange deviations are observed, these are marked as inconsistencies (Kurttila et al, 1999). Using pair wise comparisons it could occur that A is valued 3 times more important than B and B is valued 2 times as important as C. It would therefore be consistent if A was (2 x 3 =) 6 times more important than C. If not, the data is inconsistent (De Brucker et al, 1997). To calculate the consistency, firstly a *pair wise comparison matrix* is needed. Below an example of such a matrix is presented.

Table G1: Pair wise comparison matrix

	A	B	C
A	1	1/3	1/6
B	3	1	1/4
C	6	4	1

In this matrix, factor B is three times more important than factor A. Therefore, in the section A,B the number 3 is filled in. Automatically, the inverse section B,A gets the value 1/3. The same is done for all other comparisons. The following step is the calculation of the *normal pair wise comparison matrix*. This is done by dividing the number of the section by the column total. This matrix is presented below.

Table G2: normal pair wise comparison

	A	B	C
A	0.1	0.06	0.1
B	0.3	0.19	0.18
C	0.6	0.75	0.72

The section B,B is thus calculated by dividing 1 by 5.33, which is the column total of table X. The third step is calculating the relative priority vector. This can be done by dividing the row total by the number of columns. This leads to the following relative *priority vectors*:

A = 0.26 / 3 = 0.087
B = 0.68 / 3 = 0.233
C = 2.07 / 3 = 0.690

According to the eigenvector method, the following equation is always present: $A \cdot W = n \cdot W$
In this equation, A is the pair wise comparison matrix from table X and W is the relative priority vector, as calculated above. The amount of elements in the pair wise comparison matrix is defines as *n*. When a matrix is set up where A is multiplied with W, the following matrix is the result.

Table G3: matrix for A multiplied by W

	A	B	C
A	0.087	0.078	0.099
B	0.261	0.233	0.173
C	0.522	0.932	0.690

The following step is to add up the rows so that the matrix product results in the following vectors:
A = 0.087 + 0.078 + 0.099 = 0.264
B = 0.261 + 0.233 + 0.173 = 0.667
C = 0.522 + 0.932 + 0.690 = 2.144

Now all vectors have been calculated, the vecors are divided by the relative priority vectors, which leads to the largest eigenvalue (λmax). This results in the following calculation:

0.264 / 0.087 = 3.034
0.667 / 0.233 = 2.863
2.144 / 0.690 = 3.107

λmax = (3.034 + 2.863 + 3.107) / 3 (number of values) = 3.001

when the pair wise matrix is fully consistent, the λmax is equal to *n*. When these two are not equal, this can be used to express the degree of consistency. The consistency index (CI) can be calculated by the following formula:

CI = (λmax – *n*) / (*n* -1).

When we apply this CI formula to the example which is used above, we see that CI = (3.001-3) / (3-1) = 0.0005. According to Saaty, this CI is still not sufficient to express consistency. CI needs to be compared to a the CI which results from a random consistency matrix CI*. The final step in calculating consistency in the consistency ratio (CR) is:

CR = CI / CI*

The outcome of this CR should be less than 13% in order to qualify as consistent. However, this is only the consistency of one pair wise comparison matrix. Whenever a research exists out of more groups of comparisons, they can compensate for each other (De Brucker, 1999), al long as this contains small inconsistencies. Also, when a CR is applied to a hierarchy, the CI of each element must be multiplied with the relative priority of the element. Therefore also higher CR than 0.13 are allowed.

Appendix H Survey companies in the POZSP

The survey that is distributed under the seventeen selected companies is presented below. Because all companies are located in the Netherlands, also the survey is in Dutch. The survey that is send to the inland shipping companies is adapted by the removal of question one and five and the adjustments of questions two, three and four.

Scriptie	*Steven Meerburg*
Onderwerp:	*Vaststellen van bepalende factoren voor de modaliteitkeuze voor de binnenvaart, toegepast op de havens van Zeeland Seaports*
Studie:	*Urban, Port and Transport Economics, Erasmus Universiteit*
Stageplaats bij	*Zeeland Seaports*

Namens Zeeland Seaports doe ik onderzoek naar de aantrekkelijkheid van binnenvaart als modaliteit in de vorm van een afstudeerscriptie aan de Erasmus Universiteit Rotterdam. Deze scriptie bestaat uit het onderzoeken van bepalende factoren voor modaliteitkeuze. Deze factoren heb ik met behulp van literatuur en praktische kennis van Zeeland Seaports opgesteld. Aan de hand van deze enquête wil ik toetsen hoe de vastgestelde factoren gewogen worden. De gegevens die naar voren komen zullen niet openbaar worden gemaakt in het rapport, maar dienen alleen als cijfermatige input voor een model en inzicht in modaliteitkeuze in het algemeen. Als u interesse heeft kunt u een samenvatting van de resultaten ontvangen.

De enquête is opgebouwd uit twee stukken, namelijk de organisatie van binnenvaart en enkele hiërarchie modellen welke dienen voor cijfermatige input van het onderzoek.

Organisatie van het achterland transport

1. Wie bepaalt de modaliteitkeuze voor het inrichten van uw transport naar het achterland?

A Het bedrijf zelf

B Een expediteur / forwarder, namelijk …………………………….

C Iemand anders, namelijk …………………………………………

2. Zet een kruisje in de keuzekolom bij de NSTR goederen groep(en) waarin de producten vallen waarin uw bedrijf actief is.

Keuze kolom	NSTR groep	Beschrijving
	NSTR 0	Landbouwproducten en levende dieren
	NSTR 1	Andere voedingsproducten en veevoer
	NSTR 2	Vaste minerale brandstoffen
	NSTR 3	Aardoliën en aardolieproducten
	NSTR 4	Ertsen, metaalafval en geroost ijzerkies
	NSTR 5	IJzer, staal en non-ferrometalen (incl. halffabricaten)
	NSTR 6	Ruwe materialen en bouwmaterialen
	NSTR 7	Meststoffen
	NSTR 8	Chemische producten
	NSTR 9	Voertuigen, machines en overige goederen (stukgoederen)

3. De belangrijkste herkomst regio's van de ingekochte producten zijn (Land en regio)

………

4. De belangrijkste bestemmingen van de verkochte producten zijn (Land en regio)

………

5. Voor het inrichten van uw achterland transport kunt u gebruik maken van meerdere factoren. Geef voor iedere modaliteit aan hoeveel goederen in percentages met deze modaliteit vervoerd worden.

A Wegvervoer ....%

B Binnenvaart ….%

C Trein ….%

D Anders, namelijk ……….…………… <u>….%+</u>

100%

Hiërarchie modellen

In mijn onderzoek heb ik vanuit de literatuur verschillende factoren kunnen vaststellen die de modaliteitkeuze in positieve of negatieve manier kunnen beïnvloeden. Omdat deze factoren meestal niet zo tastbaar zijn, zijn indicatoren vastgesteld die de bovenliggende factoren bepalen. De invloed van kosten / tarieven op modaliteitkeuze wordt bijvoorbeeld bepaald door de transportkosten en de havengelden. Door middel van deze enquête wil ik vaststellen wat voor de bedrijven binnen de Zeeuwse havengebieden de belangrijkste factoren zijn met betrekking tot modaliteitkeuze. Omdat het moeilijk is om kwalitatieve met kwantitatieve factoren met elkaar te vergelijken is het nodig om met behulp van een hiërarchie tabel gewichten te geven aan factoren. In deze hiërarchie tabel worden twee factoren (of indicatoren) vergeleken en moet worden aangegeven of deze van gelijk belang zijn (-1 /1) of dat de eerste factor belangrijker is (positieve score) of dat de tweede factor belangrijker is (negatieve score).

Voorbeeld:

Geef in de onderstaande tabellen aan of de eerste factor belangrijker is dan de tweede factor, met betrekking tot de modaliteitkeuze.

Als u bijvoorbeeld vind dat betrouwbaarheid (A) drie maal zo belangrijk zijn als imago (B), zet dan in de regel A – B een kruisje bij 3, zoals in de onderstaande voorbeeldtabel.

Als u vind dat efficiency van de haven (C) vijf keer zo belangrijk is als de betrouwbaarheid (A), zet dan in de regel A – C een kruisje bij -5 *(let op, negatieve waarde*).

Vind u het imago (B) van de modaliteit even belangrijk als de efficiency van de haven (C), zet dan een kruisje in -1/1.

									← Belang →								
	Veel minder belangrijk				Iets minder belangrijk				Gelijk				Iets belangrijker				Veel belangrijker
	-9	-8	-7	-6	-5	-4	-3	-2	-1/1	2	3	4	5	6	7	8	9
A – B											x						
A – C					x												
B – C									x								

6. De vastgestelde bepalende factoren voor modaliteitkeuze zijn:
A Betrouwbaarheid (Infrastructuur, Superstructuur, Sluizen en Nautische veiligheid)
B Efficiency van de haven (Infrastructuur, Superstructuur, Bereikbaarheid, Snelheid van de modaliteit, Kosten van de modaliteit, Haventarieven en Additionele efficiency factoren)
C Product karakteristieken (Volume, Gewicht, Waarde en Houdbaarheid)
D Imago/ Perceptie van de modaliteit

Vul de onderstaande tabel in door kruisjes te zetten in iedere regel.

									← Belang →								
	Veel minder belangrijk				Iets minder belangrijk				Gelijk				Iets belangrijker				Veel belangrijker
	-9	-8	-7	-6	-5	-4	-3	-2	-1/1	2	3	4	5	6	7	8	9
A – B																	
A – C																	
A – D																	
B – C																	
B – D																	
C – D																	

7. De factor betrouwbaarheid is op te delen in factoren die voor vertraging kunnen zorgen, namelijk:

A1 Nautische veiligheid
A2 Aanwezigheid van sluizen
A3 Infrastructuur van de terminal (speciale kade voor het binnenvaartschip, wachttijden voor aanmeren)
A4 Superstructuur van de terminal (speciale kranen voor het de overslag van lading van/naar binnenvaartschip)

Vul de onderstaande tabel in door kruisjes te zetten in iedere regel.

	← Belang →																
	Veel minder belangrijk				Iets minder belangrijk				Gelijk				Iets belangrijker				Veel belangrijker
	-9	-8	-7	-6	-5	-4	-3	-2	-1/1	2	3	4	5	6	7	8	9
A1 – A2																	
A1 – A3																	
A1 – A4																	
A2 – A3																	
A2 – A4																	
A3 – A4																	

8. De efficiency van de haven is op de delen in de volgende factoren

B1 Snelheid (Snelheid van de modaliteit, bereikbaarheid van de havens, infrastructuur van de terminal en superstructuur van de terminal)
B2 Kosten (Kosten voor het transport en haventarieven)
B3 Overige efficiency factoren (wachtsteigers, auto afzetplaats ed)

Vul de onderstaande tabel in door kruisjes te zetten in iedere regel.

	← Belang →																
	Veel minder belangrijk				Iets minder belangrijk				Gelijk				Iets belangrijker				Veel belangrijker
	-9	-8	-7	-6	-5	-4	-3	-2	-1/1	2	3	4	5	6	7	8	9
B1 – B2																	
B1 – B3																	
B2 – B3																	

9. De factor snelheid is op te delen in de volgende factoren

B1A Snelheid van de modaliteit
B1B Bereikbaarheid van de havens
B1C Infrastructuur van de terminal
B1D Superstructuur van de terminal (aanwezige kranen)

Vul de onderstaande tabel in door kruisjes te zetten in iedere regel.

	← Belang →																
	Veel minder belangrijk				Iets minder belangrijk				Gelijk				Iets belangrijker				Veel belangrijker
	-9	-8	-7	-6	-5	-4	-3	-2	-1/1	2	3	4	5	6	7	8	9
B1A – B1B																	
B1A – B1C																	
B1A – B1D																	
B1B – B1C																	
B1B – B1D																	
B1C – B1D																	

10. De factor kosten bestaat uit de factoren
B2A Transportkosten van de modaliteit
B2B Haventarieven
Vul de onderstaande tabel in door één kruisje te zetten

									← Belang →								
	Veel minder belangrijk				Iets minder belangrijk				Gelijk				Iets belangrijker				Veel belangrijker
	-9	-8	-7	-6	-5	-4	-3	-2	-1/1	2	3	4	5	6	7	8	9
B2A – B2B																	

11. De factor ‘overige efficiency factoren’ bestaat uit
B3A Wachtsteigers
B3B Additionele faciliteiten (auto afzetplaats, drinkwatervoorzieningen, cafetarias)
Vul de onderstaande tabel in door één kruisje te zetten

									← Belang →								
	Veel minder belangrijk				Iets minder belangrijk				Gelijk				Iets belangrijker				Veel belangrijker
	-9	-8	-7	-6	-5	-4	-3	-2	-1/1	2	3	4	5	6	7	8	9
B3A – B3B																	

12. De factor product karakteristieken bestaat uit
C1 Volume van het product
C2 Gewicht van het product
C3 Waarde van het product
C4 Houdbaarheid van het product (in de zin van houdbaarheidsdatum van voedingsproducten en economische levensduur van modieuze producten)
Vul de onderstaande tabel in door kruisjes te zetten in iedere regel.

									← Belang →								
	Veel minder belangrijk				Iets minder belangrijk				Gelijk				Iets belangrijker				Veel belangrijker
	-9	-8	-7	-6	-5	-4	-3	-2	-1/1	2	3	4	5	6	7	8	9
C1 – C2																	
C1 – C3																	
C1 – C4																	
C2 – C3																	
C2 – C4																	
C3 – C4																	

Als u in iedere rij van de vragen 6 tot en met 12 een kruisje heeft gezet, dan zijn alle modellen helemaal ingevuld. Dat is dan meteen het einde van deze enquête. Dank u wel voor de medewerking. Bent u geïnteresseerd in het ontvangen van een samenvatting van de resultaten?
A Ja, dit ontvang ik graag per ……………
B Nee

Dank u wel voor de medewerking,
Steven Meerburg, namens Zeeland Seaports

Appendix I Survey inland shipping companies

This survey is distributed under the inland shipping companies. Because all the inland shippers are Dutch, also this survey is in Dutch. The hierarchy models have been adapted to make the survey easier to fill in.

Scriptie Steven Meerburg
Onderwerp: *Vaststellen van bepalende factoren voor de modaliteitkeuze voor de binnenvaart, toegepast op de havens van Zeeland Seaports*
Studie: *Urban, Port and Transport Economics, Erasmus Universiteit*
Stageplaats bij *Zeeland Seaports*

Namens Zeeland Seaports doe ik onderzoek naar de aantrekkelijkheid van binnenvaart als modaliteit in de vorm van een afstudeerscriptie aan de Erasmus Universiteit Rotterdam. Deze scriptie bestaat uit het onderzoeken van bepalende factoren voor modaliteitkeuze. In deze enquête kunt u aangeven welke factoren u het belangrijkste vind waardoor u uw diensten succesvol kan uitvoeren en de binnenvaart een aantrekkelijke transportmodaliteit blijft.

De enquête is opgebouwd uit twee stukken, namelijk drie algemene vragen en enkele hiërarchie modellen welke dienen voor cijfermatige input van het onderzoek.

1. Zet een kruisje in de keuzekolom bij de NSTR goederen groep(en) waarin de producten vallen die u vervoerd.

Keuze kolom	NSTR groep	Beschrijving
	NSTR 0	Landbouwproducten en levende dieren
	NSTR 1	Andere voedingsproducten en veevoer
	NSTR 2	Vaste minerale brandstoffen
	NSTR 3	Aardoliën en aardolieproducten
	NSTR 4	Ertsen, metaalafval en geroost ijzerkies
	NSTR 5	IJzer, staal en non-ferrometalen (incl. halffabricaten)
	NSTR 6	Ruwe materialen en bouwmaterialen
	NSTR 7	Meststoffen
	NSTR 8	Chemische producten
	NSTR 9	Voertuigen, machines en overige goederen (stukgoederen)

2. Als u goederen vervoerd vanuit de havens van Zeeland Seaports, welke gebieden zijn dan vaak de bestemming? Kunt u dit specificeren naar land en regio / provincie?
   ……
3. Als u goederen vervoerd naar de havens van Zeeland Seaports, welke gebieden zijn dan vaak uw laadadres? Kunt u dit specificeren naar land en regio / provincie?
   ……………………………………………………………………………………………………

Hiërarchie modellen
In mijn onderzoek heb ik vanuit de literatuur verschillende factoren kunnen vaststellen die de modaliteitkeuze in positieve of negatieve manier kunnen beïnvloeden. Met behulp van hiërarchie modellen kan ik gewichten geven aan deze factoren. Deze modellen werken als volgt:

Voorbeeld:
A Kosten voor het transport per binnenvaart
B Betrouwbaarheid van de modaliteit
C Snelheid van de modaliteit

In de onderstaande tabel worden deze drie factoren in paren met elkaar vergeleken. U kunt aangeven welke factor u belangrijker vindt en hoe veel belangrijker (in een schaal van 2 tot 9. Als de factor slechts iets belangrijker is, vul dan een 2 of een 3 in. Is deze gemiddeld belangrijker, vul dan een 4,5 of 6 in. Mocht de ene factor veel belangrijker zijn dan de andere, vul dan een 7, 8 of 9 in. Als u bijvoorbeeld vind dat kosten (A) 3x zo belangrijk zijn als de betrouwbaarheid (gelijk belang) (B), dan vult u in de eerste regel in; A en een 3. Vind u de kosten (A) even belangrijk als de snelheid van de modaliteit (C), vul dan in de tweede regel in; gelijk en een 1.

Vind u de snelheid (C) drie keer zo belangrijk als de betrouwbaarheid (B) vul dan in; C en een 3.

Vergelijking	Welke belangrijker	Hoe veel belangrijker (schaal 1-9)
A – B	A	3
A – C	Gelijk	1
B – C	C	3

Onderstaand worden zeven van deze vergelijkingstabellen aan u voorgelegd. Bij het invullen van deze vergelijkingen is het wellicht gemakkelijk om eerst voor uzelf een rangschikking te maken van meest belangrijk naar minst belangrijk. Bijvoorbeeld; ACB, waarin B het minst belangrijk is.

4. De vastgestelde bepalende factoren voor modaliteitkeuze zijn:
A Betrouwbaarheid (Infrastructuur, Superstructuur, Sluizen en Nautische veiligheid)
B Efficiency van de haven (Infrastructuur, Superstructuur, Bereikbaarheid, Snelheid van de modaliteit, Kosten van de modaliteit, Haventarieven en Additionele efficiency factoren)
C Product karakteristieken (Volume, Gewicht, Waarde en Houdbaarheid)
D Imago/ Perceptie van de modaliteit
Uw eigen rangschikking is (A/B/C/D).......…………………………….… Vul na het maken van de rangschikking de onderstaande tabel in door de letter en het cijfer in te vullen in iedere regel.

Vergelijking	Welke belangrijker	Hoe veel belangrijker (schaal 1-9)
A – B		
A – C		
A – D		
B – C		
B – D		
C – D		

5. De factor betrouwbaarheid is op te delen in factoren die voor vertraging kunnen zorgen, namelijk:
A1 Nautische veiligheid
A2 Aanwezigheid van sluizen
A3 Infrastructuur van de terminal (speciale kade voor het binnenvaartschip, wachttijden voor aanmeren)
A4 Superstructuur van de terminal (speciale kranen voor het de overslag van lading van/naar binnenvaartschip)
Uw eigen rangschikking is (A1/A2/A3/A4)…………......………………... Vul na het maken van de rangschikking de onderstaande tabel in door de letter en het cijfer in te vullen in iedere regel.

Vergelijking	Welke belangrijker	Hoe veel belangrijker (schaal 1-9)
A1 – A2		
A1 – A3		
A1 – A4		
A2 – A3		
A2 – A4		
A3 – A4		

6. De efficiency van de haven is op de delen in de volgende factoren
B1 Snelheid (Snelheid van de modaliteit, bereikbaarheid van de havens, infrastructuur van de terminal en superstructuur van de terminal)
B2 Kosten (Kosten voor het transport en haventarieven)
B3 Overige efficiency factoren (wachtsteigers, auto afzetplaats ed)

Uw eigen rangschikking is (B1/B2/B3).......……………………………… Vul na het maken van de rangschikking de onderstaande tabel in door de letter en het cijfer in te vullen in iedere regel.

Vergelijking	Welke belangrijker	Hoe veel belangrijker (schaal 1-9)
B1 – B2		
B1 – B3		
B2 – B3		

7. De factor snelheid is op te delen in de volgende factoren
B1A Snelheid van de modaliteit
B1B Bereikbaarheid van de havens
B1C Infrastructuur van de terminal
B1D Superstructuur van de terminal (aanwezige kranen)
Uw eigen rangschikking is (B1A,B1B,B1C,B1D) …………........…….. Vul na het maken van de rangschikking de onderstaande tabel in door de letter en het cijfer in te vullen in iedere regel.

Vergelijking	Welke belangrijker	Hoe veel belangrijker (schaal 1-9)
B1A – B1B		
B1A – B1C		
B1A – B1D		
B1B – B1C		
B1B – B1D		
B1C – B1D		

8. De factor kosten bestaat uit de factoren
B2A Transportkosten van de modaliteit
B2B Haventarieven
Uw eigen rangschikking is (B2A/B2B).......……………………………..Vul na het maken van de rangschikking de onderstaande tabel in door de letter en het cijfer in te vullen in iedere regel.

Vergelijking	Welke belangrijker	Hoe veel belangrijker (schaal 1-9)
B2A – B2B		

9. De factor 'overige efficiency factoren' bestaat uit
B3A Wachtsteigers
B3B Additionele faciliteiten (auto afzetplaats, drinkwatervoorzieningen, cafetarias)
Uw eigen rangschikking is (B3A/B3B).......……………………………..Vul na het maken van de rangschikking de onderstaande tabel in door de letter en het cijfer in te vullen in iedere regel.

Vergelijking	Welke belangrijker	Hoe veel belangrijker (schaal 1-9)
B3A – B3B		

10. De factor product karakteristieken bestaat uit
C1 Volume van het product
C2 Gewicht van het product
C3 Waarde van het product
C4 Houdbaarheid van het product (in de zin van houdbaarheidsdatum van voedingsproducten en economische levensduur van modieuze producten)
Uw eigen rangschikking is (C1,C2,C3,C4) …………........…….. Vul na het maken van de rangschikking de onderstaande tabel in door de letter en het cijfer in te vullen in iedere regel.

Vergelijking	Welke belangrijker	Hoe veel belangrijker (schaal 1-9)
C1 – C2		
C1 – C3		
C1 – C4		
C2 – C3		
C2 – C4		
C3 – C4		

Als u in iedere rij van de vragen 4 tot en met 10 een antwoord heeft gezet, dan zijn alle modellen helemaal ingevuld. Dat is dan meteen het einde van deze enquête. Dank u wel voor de medewerking. Bent u geïnteresseerd in het ontvangen van een samenvatting van de resultaten?
A Ja, dit ontvang ik graag per ……………
B Nee

Dank u wel voor de medewerking,
Steven Meerburg, namens Zeeland Seaports

Appendix I Detailed information about the companies' surveys

Figure I1: Data model 1

Determining factors	Sub factors	Port indicators	Yara			De Hoop			Thermphos			SBV			Havex / Verbrugge			Outokumpu			Dow		
Reliability	-	Nautical safety	39,59		45,71	13,78		31,25	6,76		56,64	45,42		9,00	13,23		51,93	17,65		57,56	21,45		40,00
		Locks			39,46			6,25			4,17			21,00			7,89			19,01			20,00
		Infrastructure – reliability			6,93			31,25			19,59			21,00			20,09			11,71			20,00
		Superstructure - reliability			7,89			31,25			19,59			49,00			20,09			11,71			20,00
Port efficiency	Cost / rate	Port tariffs	28,73	70,35	16,67	40,96	65,84	16,67	47,33	73,45	10,00	12,88	47,37	10,00	58,33	73,91	10,00	49,79	22,67	10,00	63,23	72,74	10,00
		Transport cost			83,33			83,33			90,00			90,00			90,00			90,00			90,00
	Speed	Transport speed		17,39	23,43		25,29	12,77		8,91	6,08		47,37	54,13		19,16	9,79		70,15	60,71		21,50	62,46
		Accessibility			47,16			31,16			58,16			26,00			48,12			22,00			18,11
		Infrastructure – speed			12,29			28,04			17,88			13,95			21,04			8,65			9,71
		Superstructure - speed			17,12			28,04			17,88			5,92			21,04			8,65			9,71
	Additional efficiency factors	Waiting quays		12,26	50,00		8,87	50,00		17,64	80,00		5,26	90,00		6,94	80,00		7,18	50,00		5,76	75,00
		Additional facilities			50,00			50,00			20,00			10,00			20,00			50,00			25,00
Product characteristics	-	Volume of product	6,50		32,14	39,49		11,72	13,58		6,46	6,70		17,41	22,41		54,81	26,76		51,17	10,96		64,12
		Weight of product			32,14			11,16			6,46			5,41			21,52			7,80			14,07
		Value of product			32,14			66,35			49,79			24,53			16,62			23,78			14,07
		Perishability of product			3,57			10,77			37,29			52,66			7,05			17,25			7,73
Perception / image of inland navigation	-	Promotion	25,18			5,76			32,33			35,00			6,03			5,89			4,36		

Figure I2: Data model 2

Determining factors	Sub factors	Port indicators	Kloosterboer			Heros			Vopak			Ovet		
Reliability	-	Nautical safety	20,12		29,57	17,02		19,81	20,28		43,93	12,64		54,78
		Locks			3,29			4,61			4,12			6,12
		Infrastructure – reliability			19,57			30,85			18,29			19,55
		Superstructure - reliability			47,57			44,74			33,66			19,55
Port efficiency	Cost / rate	Port tariffs	34,12	47,37	10,00	15,73	50,07	50,00	15,87	33,33	50,00	30,54	32,88	12,50
		Transport cost			90,00			50,00			50,00			87,50
	Speed	Transport speed		47,37	14,58		31,02	25,00		33,33	55,46		31,31	11,49
		Accessibility			22,92			25,00			9,31			67,45
		Infrastructure – speed			14,58			25,00			18,86			10,53
		Superstructure - speed			47,92			25,00			16,36			10,53
	Additional efficiency factors	Waiting quays		5,26	50,00		18,90	50,00		33,33	88,89		35,81	75,00
		Additional facilities			50,00			50,00			11,11			25,00
Product characteristics	-	Volume of product	20,63		49,22	63,16		5,52	59,76		36,29	7,86		25,00
		Weight of product			15,17			5,38			11,97			25,00
		Value of product			5,38			22,04			27,95			25,00
		Perishability of product			30,24			67,07			23,79			25,00
Perception / image of inland navigation	-	Promotion	25,12			4,09			4,19			48,96		

Figure I3: Data model 3

Determining factors	Sub factors	Port indicators	Schuttevaer (Jan)			Schuttevaer (Kees)			Courage (Bruinsslot)			Binnenschip Progress			Binnenschip Reggestroom		
Reliability	-	Nautical safety	41,64		44,44	20,39		3,71	48,41		39,17	62,40		8,64	56,33		47,15
		Locks			11,11			31,48			27,92			26,49			25,50
		Infrastructure – reliability			22,22			32,40			16,46			48,82			16,53
		Superstructure - reliability			22,22			32,40			16,46			16,05			10,83
Port efficiency	Cost / rate	Port tariffs	31,02	22,31	16,67	5,45	17,02	33,33	23,11	22,54	33,33	22,66	18,81	10,00	24,61	55,71	85,71
		Transport cost			83,33			66,67			66,67			90,00			14,29
	Speed	Transport speed		6,60	23,26		60,08	30,55		45,40	27,92		75,53	59,58		32,02	44,95
		Accessibility			29,51			5,58			39,17			19,68			25,96
		Infrastructure – speed			35,07			31,94			16,46			11,98			17,07
		Superstructure - speed			12,15			31,94			16,46			8,77			12,02
	Additional efficiency factors	Waiting quays		71,09	85,71		22,90	50,00		32,06	66,67		5,66	90,00		12,26	80,00
		Additional facilities			14,29			50,00			33,33			10,00			20,00
Product characteristics	-	Volume of product	22,68		10,31	30,15		23,22	16,76		15,43	9,66		64,85	11,08		39,44
		Weight of product			4,26			23,22			12,42			23,39			19,72
		Value of product			24,09			7,34			31,55			6,77			16,94
		Perishability of product			61,33			46,22			40,60			4,99			23,89
Perception / image of inland navigation	-	Promotion	4,66			44,01			11,71			5,28			7,99		

Figure I4: Average of all three models + model 4: average of all companies

	Model 1			Model 2			Model 3			Model 4		
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Reliability	22,74			17,52			45,83			28,57		
Port efficiency	39,67			24,07			21,37			31,52		
Product charact.	19,24			37,85			18,07			23,01		
Image	18,37			20,59			14,73			16,91		
Total	100,01			100,02			100,00			100,01		
Cost / rate	58,93	23,38		40,91	9,85		27,28	5,83		45,40	14,31	
Speed	31,38	12,45		35,76	8,61		43,93	9,39		35,78	11,28	
Additional efficiency factors	9,69	3,84		23,33	5,61		28,79	6,15		18,82	5,93	
Total	100,00	39,67		100,00	24,06	0,00	100,00	21,37		100,00	31,52	
Nautical safety	42,02		9,55	37,02		6,48	28,62		13,12	36,46		10,42
Locks	16,30		3,71	4,54		0,79	24,50		11,23	16,15		4,61
Infrastructure-r	18,43		4,19	22,07		3,86	27,29		12,51	22,20		6,34
Superstructure-r	23,26		5,29	36,38		6,37	19,59		8,98	25,19		7,20
Total	100,00		22,74	100,00		17,52	100,00		45,83	100,00		28,57
Port tariffs	12,22		2,86	30,63		3,02	35,81		2,09	24,06		3,44
Transport cost	87,78		20,52	69,38		6,83	64,19		3,74	75,95		10,87
Total	100,00		23,38	100,00		9,85	100,00		5,83	100,00		14,31
Transport speed	27,82		3,46	26,63		2,29	37,25		3,50	32,64		3,68
Accessibility	38,77		4,83	31,17		2,68	23,98		2,25	30,96		3,49
Infrastructure-s	16,98		2,11	17,24		1,48	22,50		2,11	18,32		2,07
Superstructure-s	16,44		2,05	24,95		2,15	16,27		1,53	19,13		2,16
Total	100,00		12,45	100,00		8,60	100,00		9,39	101,03		11,39
Waiting quays	66,67		2,56	65,97		3,70	74,48		4,58	69,45		4,12
Additional facilities	33,33		1,28	34,03		1,91	25,52		1,57	30,55		1,81
Total	100,00		3,84	100,00		5,61	100,00		6,15	100,00		5,93
Volume of product	28,95		5,57	29,01		10,98	30,65		5,54	31,69		7,29
Weight of product	14,08		2,71	14,38		5,44	16,60		3,00	14,94		3,44
Value of product	35,54		6,84	20,09		7,61	17,34		3,13	24,65		5,67
Perishability of product	21,43		4,12	36,53		13,83	35,41		6,40	28,72		6,61
Total	100,00		19,24	100,01		37,85	100,00		18,07	100,00		23,01
Promotion	18,37		18,37	20,59		20,59	14,73		14,73	16,91		16,91