MARKET PERSPECTIVES FOR INLAND WATERWAY SHIPPING IN INTRA-EUROPEAN INTERMODAL TRANSPORT

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ABSTRACT

In the past years the growth of maritime container transport to and from seaports has been a success story for inland navigation. In this PhD thesis study the prospects for a similar growth of intra-European intermodal transport by inland navigation are investigated. In the first phase lists of prospective measures were composed on the micro, meso, and macro level. In the second phase these measures were put to test in 3 case studies: one of a successful project (floating motorway on the Danube), one of a project that failed (Danube Combined Services), and one to verify the results independently (hinterland carriage of short sea containers).

1. THE USE OF INTERMODAL INLAND SHIPPING TO OVERCOME EUROPEAN TRANSPORT PROBLEMS

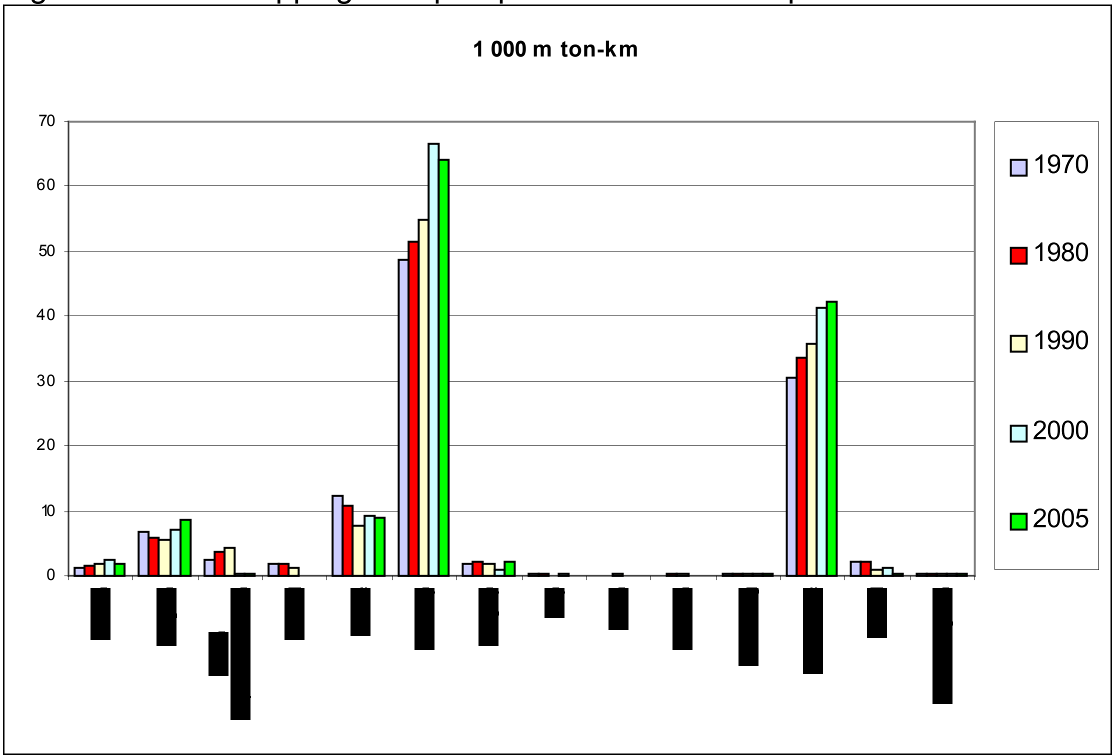
1.1 The Current Role of Inland Waterway Transport in Europe

In the year 2006, total transport volume of inland waterway transport in the European Union (EU-25) was 475 million tons. Of these, about three quarters were bulk transport: Minerals, petroleum, coal, ores, chemicals, and agricultural bulk material. While inland waterway transport today is mainly used for the carriage of liquid and dry bulk, for various reasons[1], in many of its market segments its share in modal split has decreased, so it could not participate in the growth of the European freight transport market, resulting from European integration and globalisation.

But, in the past 25 years, with new transport techniques and concepts inland shipping opened up new markets, such as the carriage of waste and oversized or heavy goods, roll on/roll off (Ro/Ro) transportation of cars, and lift on/lift off (Lo/Lo) traffic with maritime containers. Especially the transport of maritime containers, in the hinterland of the container handling seaports in the North Sea range (Antwerp, Rotterdam, and recently also Le Havre, Hamburg and Bremerhaven), has gained strong momentum. For example in container hinterland traffic for the port of Antwerp, the share of inland shipping has increased to almost 35 per cent!

The rivers Rhine, Maas and Scheldt provide a good natural access to the most important European seaports of Amsterdam, Rotterdam and Antwerp (the so-called ARA-range). Unsurprisingly, the most important navigation areas in Europe, for bulk as well as for container transportation, are the river Rhine corridor – consisting of the river Rhine itself and its main tributaries and adjacent canals – and the inland waterways between the Rhine/Maas delta and Belgium/Northern France. Germany has the largest number of inland ports (210), and is the most important market. But the competitive position of inland shipping is strongest in the Netherlands, where the densest waterway network can be found and where there is also a lot of domestic shipping. In France and Belgium, inland waterway transport has recovered in the last years. Almost 97 % of the transport performance of inland navigation within the EU-25 takes place in these countries (figure 1).

Figure 1: Inland shipping transport performance in European countries



Notes: Reunification of Germany in 1990, Separation of Czech Republic and Slovakia in 1993. For Sweden, Spain, Portugal, and Greece river/sea shipping is the only form of inland waterway transport. Therefore, the inland shipping performance is assigned to short sea shipping and not shown in this figure; for Finland, domestic short sea shipping is included in the figures for 1970-1990. Data sources: EC DG TREN (2007), sec. 3.2.6, and EC DG TREN (2004), sec. 3.2.12

1.2 The Benefits of a Greater Use of Inland Waterway Transport in Europe

Today in Europe more and more capacity restraints on road infrastructure are occurring, resulting in road congestion. All the forecasts for freight transport in an enlarged European Union point to a continuous increase of traffic in the future. Inevitably, road transport will account for the lion's share of this increase. This will affect the quality performance of the mainly road-based intra-European transport system negatively.

In addition to that, road transport is becoming more expensive, be it because of political measures (examples are the new working time regulations for truck drivers or the new toll systems for trucks using motorways), or be it because of a continuous increase in energy (diesel fuel) costs. Because of the scarcity of the resources this does not only result in increased transport costs and longer lead times, but also in negative consequences for the European economy.

Because railway transport faces similar problems as road transport (increase in energy costs, capacity restraints along important trade axes throughout the continent), it is useful to examine whether the integration of inland waterway transport can lead to advantages compared to the current transport system. On inland waterways, there is ample capacity available, so delivery can be carried out on time. The unit transport costs are smaller than for road and railway transport, which is a result of high energy efficiency and the reduced need for personnel. Inland navigation is safe and secure. Furthermore, from a macroeconomic perspective, inland navigation seems favourable with regard to external costs (costs incurred as a consequence of greenhouse gas emissions, noise, accidents etc.). This is one of the reasons why many European countries pursue a policy of modal shift from road to waterway, and why the European Commission has launched its action programme NAIADES.[2]

Of course inland navigation has some weakness, for example a low transport speed, and a limited network connectivity. This weakness can be compensated for by setting up intermodal transport chains in a way that one can benefit from the advantages of the different transport modes while overcoming some of their disadvantages. Carrying the cargo on different transport modes using one and the same loading unit which is transferred between the modes together with the cargo contained is characteristic for intermodal transportation.

1.3 Intermodal Inland Shipping in Intra-European Transport Chains - The Undeveloped Market

While inland shipping plays a constant part in hinterland traffic to and from the seaports along the ARA range, inland waterway transport on European rivers and canals has not attracted continental cargo in the segment of intermodal transport (table 1) – in spite of its high reputation in the maritime container business.[3]

Table 1: Market segments of intermodal transport in Europe

	Hinterland traffic	Continental traffic
Short sea shipping	X	X
Inland waterways	X	-
Rail	X	X

The reason for this phenomenon certainly has to do with the different features of continental and intercontinental intermodal transport chains:[4] In maritime transport chains, the inland waterway leg is used for pre- or on-carriage, whereas in continental transport, inland shipping represents the main course. The necessary bundling effort to fill up the capacity of inland ships is much lower in maritime transport chains, because the freight flows are pre-bundled in the seaports, increasing transport efficiency. Furthermore, the technical and functional features of the intermodal loading unit used in maritime transport chains, which is the maritime container, fit much better the technical framework of inland waterway transport. Coherently, the degree of standardisation of the intermodal loading unit is much higher for the maritime container, which is standardised by ISO. Plus, the driver of the development of intermodal inland shipping differs in both segments: In maritime transport chains, it is the deep sea shipping lines, while in continental transport chains, it is the road transport sector. The deep sea shipping lines need inland waterway transport for efficient hinterland collection and distribution, whereas the road transport industry competes with inland shipping in overland transport.

But, on the other hand, a very high potential is seen for the door-to-door intermodal carriage of intra-European cargo on inland waterways. A study commissioned by the German Federal Transport Ministry revealed that stackable swap bodies could be carried on inland waterways. The estimates for the Rhine corridor lie between 2.6 and 4.5 mil. loading units per year.[5] This means that, for inland navigation, the number of continental units carried could rise to the level of maritime units. Many experts agree that there is a high market potential in the breakbulk segment with palletised loads.

1.4 Research Questions

Now, given the fact that many experts do see a high potential for an integration of inland navigation into continental intermodal transport chains, how can such a continental intermodal transport system be achieved? It should be stated that the topic has already been dealt with by researchers. But existing studies have one thing in common: they focus on certain fields of action and certain aspects. Some concentrate on technology (e.g. loading unit and handling equipment), some on logistics, while others look more closely at the possible impact of governmental policy. In addition, most of the work is only conceptual, while real practical demonstration projects are rare. Many of the concepts (proposed solutions) remain on paper. Therefore, our study takes the challenge to specify a more comprehensive interdisciplinary theoretical framework for understanding continental intermodal waterborne transport and to verify it on actual intermodal projects. The central questions are:

“Which are the critical success and failure factors that explain innovative service development in continental intermodal waterborne transport? How do they interact? How do shippers and freight forwarders rank the cost and service parameters in their modal choice behaviour? How can the theoretical model be verified empirically on the basis of case studies?”

2. THE SCOPE OF THE ANALYSIS

In our analysis[6] we principally look at the problem on a micro level and share the position of the single economic actors (logistical deciders of shippers or freight forwarding companies) who are in charge of the modal choice. But the point of view will not be purely from the company’s perspective: for parts of the research, it might be sensible to take the position of a whole transport/supply chain because today, competition not only occurs between single companies, but between whole supply chains, and, as transport chains represent parts of these supply chains, also between transport chains (meso level perspective). As the decisions of the micro-economic actors and the competitiveness of the supply chains are influenced by the political framework, in certain stages of the analysis it may be necessary to look at the topic at the macro level as well.

The intermodal transport system to be developed concentrates on the carriage of semi-finished products and finished goods of a higher value, because in the carriage of low-value bulk goods, inland waterway shipping is already relatively strong, and because in the year 2015, consumer goods and machinery are expected to represent 40 % of inland waterway transport performance in Germany (the most important navigation area).[7]

Geographically, we focus on a waterway core network, consisting of the most developed and interconnected inland navigation areas in Europe, ranging from Flanders in the West and the Upper Rhine in the south-west to the Oder and the Baltic Sea in the north-east, and the Danube and the Black Sea in the south-east. Along this core network, many of the most important economic centres of Europe are located.

3. CRITICAL SUCCESS FACTORS FOR CONTINENTAL INTERMODAL INLAND SHIPPING: THEORY

3.1 The Theoretical Approach: Exploration and Cause-And-Effect Analysis

Until today, a host of measures have been proposed, coming from different disciplines, to stimulate continental intermodal inland waterway transport. The measures improve certain performance criteria of the intermodal transport chain that can be decisive factors for shippers and logistics service providers, when considering a modal choice. In the context of research resulting in my upcoming doctoral thesis[6], in an exploratory way, 47 measures to stimulate continental intermodal inland shipping were found, described and discussed. Altogether there are 14 technical measures, 5 organisational measures, 4 information and communication technology measures, 4 measures in the field of logistics, 3 measures in the field of marketing, and 17 political measures (the latter are applicable on the macro level). It was also described what kind of effects these measures cause.

If we know how the measures interact and of what importance the single factors are for the logistical deciders, we can draw conclusions and formulate critical requirements for the establishment of continental intermodal transport chains. Thus, a cause-and-effect analysis is to be carried out, to see whether the measures are synergistic, counteractive or independent. To achieve a consistent theoretical framework, the best case is when the cause-effect relationships are synergistic and can be used at the same time, strengthening the proposed effect. The cause-and-effect analysis carried out in the doctoral research resulted in the following requirements:

3.2 Theoretical Success Factors on the Micro Level

On the micro level, as *intermodal loading units*, pallet-wide containers or stackable swap bodies with an outer length of 45' (=13,716 mm) should be used. These should be designed 4-high stackable when laden. The loading units should be fitted with upper castings to be capable of top-lifted transhipment with spreaders, should be coded and marked and should show cargo securing devices according to relevant European standards.[8] These features allow for maximum transport and transhipment efficiency as well as for safety.

The *intermodal load transfer* should be done in the Lo/Lo mode. Gantry cranes equipped with automate spreaders and flippers should be used as handling equipment. This increases handling productivity and safety. If overall intermodal transhipment volume is low, along smaller regulated inland waterways reach stackers equipped with spreaders and flippers should be used instead of the gantry cranes, to reduce investment costs.

The *inland ships* should be multipurpose dry freight vessels (faster, higher draught) or pushing units (slower, less draught). Those are related to low sunk cost and increase the possibilities for bundling. The ships should carry the loading units either together with dry bulk or breakbulk cargo or together with maritime containers (in a mixed stowing scheme), to increase capacity usage. No ballast techniques should be applied, apart from trimming the ships (the carriage of ballast causes additional costs). River/sea vessels and cellular container vessels are limited in their operational use and therefore should only be considered whenever certain conditions are given.

Safety regulations on stowage, cargo, loading units and load platforms should be followed, depending on the type of cargo, to guarantee a high level of transport safety.[9]

As far as *tracking and tracing* is concerned, course supervision should be based upon mode-specific techniques (mainly satellite tracking), because they are already highly developed. Supply chain event management leads from the terminals, where current data on the transport status of the intermodal consignments are compared with timetables. That reduces information overflow and enables on-site backup solutions.

The *price* requested for the continental intermodal inland waterway transport should be a door-to-door price, including the intermodal load transfer, because this is what shippers prefer. The price should be based upon a ship utilisation ratio (the load factor regarding the number of loading units or TEU[10]).

3.3 Theoretical Success Factors on the Meso Level

As far as *transport organisation* is concerned, continental intermodal inland waterway transport services should be offered by an intermodal freight integrator. This part should be played by an open-minded freight forwarding company that is neutral towards modal choice. It should be located in an inland port developed into a freight village. Freight villages in inland ports allow for the provision of additional services, increased bundling activities as a result of on-location networking, and attract more cargo to terminals so that average handling costs decrease. The freight integrator caters for intermodal collaboration[11], bundling of freight flows, the development and organisation of logistical concepts, and all marketing affairs (one-stop shopping). It should offer complete logistical service packages including additional logistical services. This adds value for the client and reduces the client's focus on mere transport speed.

For reasons of cost efficiency, the *handling organisation* should reflect the throughput of the terminals regarding transhipment mode and opening hours: For a high throughput, Lo/Lo transhipment should be applied, with a high degree of automation. The higher the throughput, the longer the opening hours of the terminals should be. It is recommended to standardise terminal design and terminal operation systems and to establish a harmonised data exchange between the actors, when launching a terminal network. This leads to a higher terminal productivity, reduces transaction costs and improves transport flexibility.

In the field of *logistics*, the logistical concept of floating stock (substitution of stock keeping by transport processes) is to be implemented together with the concepts of intermodal freight lanes, additional logistical services and "true" just-in-time delivery. The floating stock concept is an enabler for the implementation of postponement strategies in distribution, increasing flexibility. Additional logistical services such as order-picking could be provided on the way. Intermodal freight lanes imply using different channels for distribution as far as transport modes are concerned. The "true" just-in-time philosophy strengthens transport reliability instead of transport speed, and this is expected to lead to a consideration of inland waterway transport.

3.4 Theoretical Success Factors on the Macro Level

First of all, to create synergistic effects within the political framework, all governmental and administrative levels should co-ordinate their actions (international, national/federal, regional, local). This is also important to infrastructure planning. *Inland waterway infrastructure* in terms of canals, regulated rivers, locks, drawbridges etc. should be upgraded and/or traffic telematics systems should be installed, to reduce sailing times and to increase efficiency as well as reliability and safety in transportation.[12] Waterways should be operated in the 24/7 mode, to reduce sailing time, and to increase punctuality, safety, flexibility, and ship productivity. Locks and drawbridges on less frequented waterways should be automated and remote controlled, to reduce operational costs of inland waterways.

With regard to costs and flexibility of the continental intermodal waterborne transport chain, a better awareness of an *increase of transport costs for competing road transport* by additional regulation or infrastructure user charge should be created. Many people think that a modal shift could be evoked by simply making trucking more expensive. But road transport is sometimes necessary for backup transportation (e.g. when a waterway is closed during a flood) or the application of the concept of intermodal freight lanes, and it is in most of the cases needed for pre- and on-carriage. Thus, a higher amount of costs incurred in trucking could also affect the continental intermodal waterborne transport chain negatively.

Public financial grants should be provided *for intermodal terminals* along the inland waterways to relieve the intermodal transport chain of high transhipment costs. Furthermore, the grants are an incentive for investment, so that a faster development and upgrade of terminals takes place. Public grants for terminal infrastructure should cover access to the terminals for all transport modes, to reduce transhipment times and to improve reliability performance. When constructing or upgrading terminals, *spatial planning*, port development plans and standards for handling equipment should be considered, to allocate the funding efficiently. Spatial planning, the development of inland ports to freight villages, and public financial support for terminals along inland waterways all reduce distances to the intermodal interfaces, so there are savings in pre- and on-carriage distances, and, thus, also in the high costs incurred in pre- and on-carriage on land, as well as in door-to-door transit times. Moreover, spatial planning and public financial support for the construction of terminals are significant enablers for an overall modal choice.

Apart from infrastructure and spatial planning, on the macro level, the role of transport policy is often considered to be limited.

3.5 Decisive Factors for Modal Choice

The most decisive factor for the modal choice of logistical deciders at shippers and freight forwarding companies is the level of door-to-door transport costs. This is a result of numerous previous research activities. As a consequence, all (synergistic) measures that considerably help to save transport costs should be implemented. Spatial planning is of high importance, influencing the points of origin/destination and the terminal locations, and therefore the transhipment costs and the costs for terminal haulage, which are the most relevant factors driving costs upwards.

Transport reliability is the outstanding service criterion. Flexibility is required in terms of varying shipment sizes, available capacities and frequent departures. The role of transit time is not clear, but there is a trade-off with transport costs, as some shippers have indicated that savings in transport prices can compensate for longer lead times when using inland shipping. Readiness of information, and therefore also course supervision and tracking and tracing, is gaining in importance. Transport safety is only decisive for the carriage of chemicals. Environmental aspects play a minor role.

There is often a mental barrier, resulting in many shippers and forwarders neglecting the new opportunities that the use of alternative transport modes could give their companies. To overcome the lack of knowledge on the benefits of inland waterway transport, promotion policy should be developed, because the awareness of intermodal transport services and its providers leads to a higher use of intermodal transport, and because the managers are short of time due to daily business. Logistical decision-makers have to be convinced, as their identification with the intermodal transport concept and their willingness to accept changes are important success factors.

4. CASE STUDIES TO VERIFY THE THEORETICAL MODEL

4.1 The Empirical Approach: Multiple Case Study Analysis

The empirical validation of a theory could be done in different ways: experiments, systematic surveys, using quantitative models, archival analysis, historic research, case studies, and computer simulations. Case studies are the preferred strategy when "how" or "why" questions are being posed, when a contemporary set of events is being assessed, and when the investigator has little or no control.[13] This is the case for our work when we investigate how different variables of the transport system involve each other when discussing innovative kinds of transport chains whose success we can rarely control. The focus on research questions on causes and effects leads to the conduct of an explanatory case study.

For the empirical verification three case studies were carried out. A multiple case study increases the generalisability of the findings and the external validity of the research. In addition to that, comparing the results of the analysis of different cases helps to gain additional information.

A screening of cases in the context of the PhD research resulted in 26 possible cases. After careful consideration, three cases were chosen: One successful case ("Floating motorway on the Danube"), one unsuccessful venture ("Danube Combined Services"), and finally one to carry out an independent assessment of the success and failure factors found in the two earlier case studies ("Hinterland carriage of containers for Rotterdam short sea terminals").

In each of the case studies, firstly, all relevant secondary information sources were checked. The information was clustered and stored in databases. The computer-assisted routines helped to develop these databases into case-specific knowledge bases. Then, (formalised) interviews with experts involved in the operations were made either by phone conversation, or by a questionnaire, or both.

4.2 Danube Combined Services

The Danube Combined Services (DCS) was designed as a regular door-to-door liner shipping service along the Danube river. As a pilot, the transport service started in May 2001, connecting industrial areas in Bavaria, Upper Austria and Hungary. It called at the inland ports of Deggendorf (DE), Enns (AT) and Budapest (HU). One weekly departure was provided between Enns and Budapest (distance 472 kilometres), and between Deggendorf and Budapest (644 kilometres), crossing the outer borders of the European Union. The pre- and on-carriage to and from these inland ports was carried out by trucks.

The relevant transport market for the DCS was large, but the clients were reluctant to use DCS. A problem was the imbalance of trade between Bavaria and Austria on the one hand and Hungary on the other hand. Also, in Hungary the road freight sector used to be dominant among the logistics service providers, then using trucks for east-west traffic. In the 9 months of operation less than 1,500 TEU were carried. DCS, being designed as a virtual transport operator, was declared bankrupt in spring 2002. Four reasons for that were named: 1) too small a capital base, 2) an erroneous company concept, 3) an erroneous evaluation of the market and 4) a focus on freight forwarders as customers for its transport service. A relaunch was planned, but did not occur.

Many things can be learned from the analysis of the DCS case. As far as the small capital base is concerned, the business plan of DCS was based upon public subsidy means which did not arise, although they had already been approved by the relevant public authority. This made the whole DCS operation dependent on public money. So a bigger company with more capitalisation could have managed the high level of fixed costs incurred after the project launch for the duration between the approval of the subsidy and the actual payment.

The most relevant failure factor for DCS was that the transport volume was too small for efficient bundling. A sufficient penetration of the regional markets was obstructed by the hinterland limitations, hampering bundling activities. Cargo was brought to Deggendorf as far as from Munich, which is 150 kilometres away. It would have been crucial to interconnect two conurbations along the Danube river, with a sufficient amount of local cargo, and rather balanced traffic flows in between. DCS should have been combined with maritime container transportation, to increase capacity use of the multipurpose dry freight vessel deployed.

Furthermore, the DCS service (at first) was not directly marketed to shippers, but only to forwarding companies. This was a mistake, because the forwarding companies abused the subsidised DCS prices for negotiations with their sub-contractors, to cut the prices for trucking. The project initiators started naïvely, without having secured contracts with any customer.

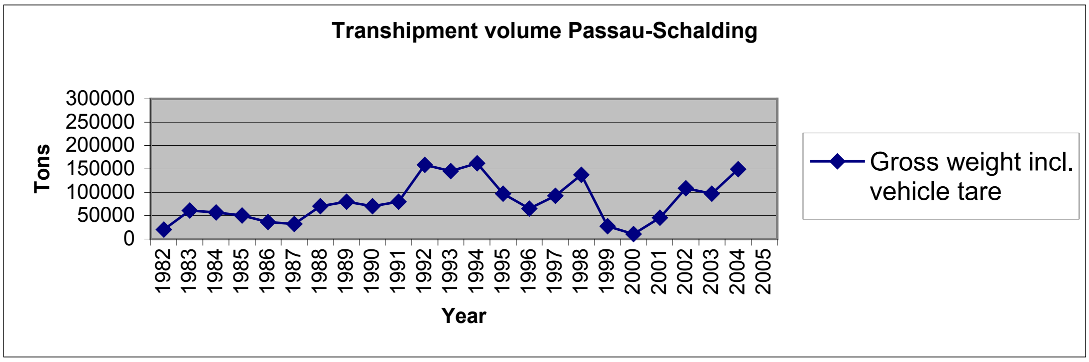
The intermodal loading units carried by the DCS were 45’ stackable swap bodies with a 3-high stacking capability. Their capacity is comparable to a modern semi-trailer engaged in road transport. It was the first time in Europe that such units were deployed for continental intermodal transportation. The loading units had been purpose-built for DCS and ran only in the DCS cycle. In the Danube region, the degree of containerisation is small, all the more so in continental transportation. This resulted in a geographically limited operational use. The provider of the intermodal loading units was not involved in the risk of sub-optimal capacity use, which was another mistake.

Finally, the service parameters of the DCS were not competitive. One weekly departure was regarded as insufficient, and the better framework conditions for competing road and railway transport, together with the longer transit time of DCS, led to a small acceptance, in spite of the principally attractive subsidised freight rates. At least, experts stated that delays in road transport caused by customs and border procedures and by congestion could be avoided by using DCS.

4.3 Floating Motorway on the Danube

The floating motorway on the Danube started in 1982 with the launch of a regular service between Passau (DE) and Vidin (BG) over a distance of 1,435 kilometres. It was the first floating motorway in Europe, and probably also the first floating motorway in the world (floating motorway = carriage of trucks, trailers and semi-trailers on Ro/Ro ships). The floating motorway serves transit traffic crossing Austria, Slovakia, Hungary, Croatia, Serbia and Romania. As Passau has a good road connection and is close to the German-Austrian border, it was the Danube port location which was best suited for bundling. Vidin was chosen because of its good road connection to/from Istanbul (TR). The service, provided by the door-to-door transport operator Donau-Lloyd-MAT, uses four unique Ro/Ro catamaran vessels. They are the first purpose-built Ro/Ro inland vessels for the carriage of semi-trailers, world wide. Donau-Lloyd-MAT was a joint venture of the Bayerischer Lloyd and the Bulgarian state-owned company SO-MAT, but after the fall of communism SO-MAT was privatised and later became fully controlled by the German transport company Willy Betz.

Figure 2: Development of the floating motorway 1982-2004



After more than 25 years of operation, we may state that the floating motorway on the transport relation between Passau and Vidin has been successful. What has changed throughput the years are the annual transport volume (see figure 2), the origins and destinations served via the Danube port of Vidin, and the loading units carried. Due to the shift in car production facilities to Eastern Europe, the volume of new cars using the floating motorway is increasing, so there is now little space available for the carriage of semi-trailers. The majority of semi-trailers that used to be carried by the floating motorway, belonging to the Willi Betz group, currently go by road. The reason why the semi-trailers go by road is that there is insufficient capacity in terms of Ro/Ro ships. The operator simply achieves a higher profit when assigning the loading space of the inland ships to car transportation. There are now newcomers in the market that want to launch neutral port-to-port shipping services for the semi-trailers of other transport companies, as there still is a high market potential. The new entrants face a lack of Ro/Ro inland ships and Ro/Ro transhipment capacity in the port of Passau. But this is expected to be solved soon.

There is a clear cost advantage of the floating motorway against road transport of up to 50 % for the carriage of a semi-trailer between Passau and Vidin, allowing for long pre- and on-carriage distances. Savings in fuel, personnel, and wear and tear plus savings in transit fees occur when using the floating motorway on the Danube. It is acknowledged that the Danube catamaran vessels with their low draught allow for efficient and economic transport throughout the whole year. The possible combination of the semi-trailers with all kinds of rolling cargo and the economies of scale that can be achieved by the Betz/SO-MAT Group with its large truck fleet deployed in the east-west traffic also play an important role in the cost advantage, as against road transport. With the help of the shipping service, the supplier can cope with shortage of international road transport permits, which had been the main trigger for the launch of the floating motorway during the Cold War.

A higher transport reliability than for road and railway transport is achieved, and a transit time Passau-Vidin of 5 days is guaranteed by the operator. A sufficient number of ships enables a timetable with buffers (roundtrip in 14 days, continuous operation) combined with a high transport frequency (3 weekly departures). The avoidance of delays occurring at the border crossings for road and railway transport is an important reason why the floating motorway service is used. Covering all transport options (road, Danube waterway) increases transport flexibility.

On the transport corridor between the North Sea and the Black Sea, road vehicles accounted for more than 90 % of the trade on the stretch crossing the south-east European countries. So from the very beginning, as articulated units were more common than road trains, semi-trailers with soft superstructure have been the most relevant loading units. Ro/Ro technology could be implemented immediately, while containerisation and intermodality are still at an early stage in the Danube region. Compared to container transportation, there is no immediate need for highly developed logistics sites in the hinterland of the Danube ports, since the only necessary partner - the truck - already enables door-to-door service. In addition to that, trucks and trailers are ideal cargo for vessels with restricted draught because they are not stackable.

Factors being unfavourable to the floating motorway are the high investment costs for terminals and Ro/Ro ships, the bad image of Danube shipping, and the demanding organisation of pre- and on-carriage by road (provision of trucks and truck drivers on both legs), resulting in a higher complexity in transport planning.

The critical and crucial success factors that could be derived after the analysis of the DCS and the floating motorway are summarised in figure 3:

Figure 3: Critical and crucial success factors, as found from the analysis of cases DCS and floating motorway on the Danube

Collaborative product development
Financial power of a freight integrator
Small sunk cost for investment
Continuous operation, high frequency of service

Crucial factors ("must have" condition)
Bundling in space
Bundling in quantity
Backup transportation
Guaranteed lead times
Collaboration in transport planning and operation
Easy intermodal load transfer

Restrictions on road transportation
Pressure to maintain safety and security in transport
Pricing strategy
Promotion
Road congestion, lack of railway slots

4.4 Hinterland Carriage of Containers for Rotterdam Short Sea Terminals

This case study was carried out to assess the success and failure factors found in the two earlier case studies.

In practice, hinterland carriage of continental containers by inland waterway occurs only in trade between locations in the United Kingdom (UK) or Ireland (IE) and places along the Rhine corridor. From the beginning, the Rotterdam area has been the interchange point between short sea carriage to/from the British Isles and the Rhine navigation. There is an enormous market potential, but there is also heavy competition as a result of the various other options (Channel Tunnel, ferries, unaccompanied Ro/Ro shipping).

It all started in 1970, when Dutch shipping line Geest North Sea Line (GNSL) decided to switch from Rhine/sea container shipping to short sea shipping plus inland waterway carriage for reasons of technical problems. One problem was the ship: Compared to a conventional Rhine vessel, the inland going sea vessels GNSL had used could not be manoeuvred on the busy Rhine river as well as the purely inland vessels. The other problem was the personnel: The skills and training of a sea captain are different from the skills and training of a boatmaster operating on the Rhine. In Rhine/sea shipping, the ship's crew had problems with the different practices of inland navigation, especially when sailing during the night.

In Germany, Emmerich was served for more than 15 years, with three-weekly departures. In addition, in 1978, GNSL started to use the services of inland waterway container transport operators between Rotterdam and places on the Upper Rhine. In 2004 GNSL returned to carrying out its own shipping service on the Rhine, between Duisburg and Rotterdam. It was continued when GNSL was acquired by Samskip group, and is still operational today. The dominant types of cargo carried in this trade have been chemicals and food products.

There are a lot of innovative components in this case. The operator introduced cellular pallet-wide containers onto the transport market, as well as a 45' pallet-wide container exhausting the maximum legal dimensions in European road transport. GNSL could be regarded as the first door-to-door multimodal container transport operator between the UK/Ireland and the Continent. It used container terminals as buffers for just-in-time delivery. GNSL can be characterised by an extensive forward and backward integration. It did not sell its services to re-sellers.

As a result of this case study, it can be stated that the *collaboration* aspect is not necessarily a success factor. In the container transport between UK/Ireland and the continent this is based on our finding that there is high intra-sector competition, and a strong belief that one must control the transport chain individually without interference of others.

Another finding is that the *provision of complete service packages* for transport-related activities is a crucial success factor (including transport by road, rail, and inland waterway, transhipment, supply of the loading unit (including inspection, maintenance, repair and cleaning), the processing of freight documents, transport monitoring and event management, intermediate storage at a terminal and just-in-time delivery). *Door-to-door transport* is closely linked with the complete service package. The finding that GNSL/Samskip could increase the efficiency of its services by carrying liquid and dry bulk containers for third party customers in a "quay-to-quay" service makes the door-to-door transport a critical, but not crucial success factor.

To compete with unimodal road haulage in continental transportation, one has to provide *pallet-wide loading units*, offering the same capacity for Euro pallets as the standard semi-trailer. The fact that DCS had failed does not contradict this statement: The problem with the DCS loading unit was not the pallet capacity, but its missing lack of market penetration.

The *electronic exchange of information between the actors* (port-terminal-shipping company-intermodal transport operator-trucker) can be added to the critical success factors, because it has been stipulated by the experts. For this reason, port information systems are a critical success factor, too.

A *parallel use of all land transport modes* (road, rail, inland waterway) has three advantages: Backup transportation in case of problems with one transport mode, the possibility to increase transport capacity at short notice, and the option to chose the best mode according to the service requirements and cost aspects for a certain shipment. The fact that one can also succeed without railway transportation makes the parallel use of all land transport modes a critical, but not crucial success factor. *Pre- and on-carriage by rail at suitable inland ports* is regarded as a measure to improve the attractiveness of continental intermodal inland waterway transport in the future. So it should be added to the theory as a critical success factor.

5. CONCLUSIONS AND OUTLOOK

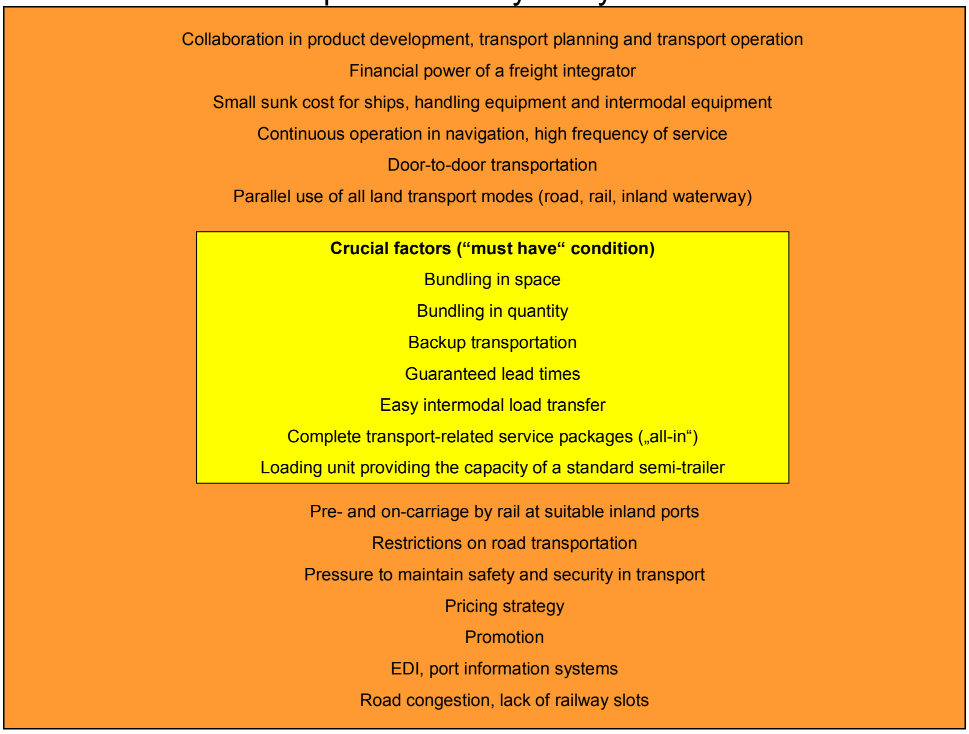
There is a market perspective for inland shipping in intra-European intermodal transport. These days, there are two developments that can help this kind of underdeveloped transport system to take off:

One is the increase in energy costs, affecting the whole European economy, coinciding with Europe’s strive for an independence of a limited number of energy suppliers. According to the European Commission, the energy consumption of inland shipping, per tonne-kilometre of transported goods, corresponds to 1/6 of the consumption on the road and to half of that of rail transport.[14] The multiple case study analysis showed that the oil crisis around 1980 represented a push factor for the floating motorway on the Danube as well as for the use of the Rhine in containerised UK trade. In the context of the increase in energy costs, many companies would switch to inland waterway and short sea transportation, if the road toll on motorways were to be increased, making road transportation more expensive, and if intermodal transport was exempted from this truck toll, reducing costs in terminal haulage.

The second recent development is the expectance of the return of the physical buffer (stock keeping) in the globally managed supply chains. Zero-inventory supply chains, characterised by a reduction of the number of warehouses, cross docking and just-in-time delivery using speedy vehicles, had emerged because of a continuous decrease in transport costs. This made the logistical managers focus their concepts on warehousing and inventory costs. These days, transport costs are increasing again, partly because of the rise of energy prices, partly because of additional mandatory security measures (moreover, stock keeping reduces risk in global supply chains). This is why the return of the physical buffer is expected. Every temporary warehousing process represents a bundling in time, potentially increasing lot sizes in transport. And this is most important for a high capacity use of inland ships, resulting in low transport costs per unit.

Logistical deciders should consider continental intermodal inland shipping whenever the specific points of origin/destination are not far away from a developed inland waterway. As far as the suppliers are concerned, they necessarily must screen the market to achieve maximum bundling, they must guarantee lead times, and they must offer “all-in” transport service packages at composite rates. They also must provide loading units offering the pallet-capacity of a semi-trailer that can be easily transhipped by the existing handling system (figure 4).

Figure 4: Final list of critical and crucial success factors, taking into consideration the multiple case study analysis



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NOTES

1 For instance: the continuous progress in truck technology, a further and further developed road network throughout Europe, liberalisation and deregulation of the road transport sector, a changed goods structure in the Western European economy, and new logistical concepts resulting in the carriage of small amounts of cargo at a high frequency of departure.
2 NAIADES stands for "Navigation and Inland Waterway Action and Development in Europe".
3 Source: Vrenken/Macharis/Wolters (2005), p. 7
4 cf Kaipel (2006), p. 92
5 cf Kessel+Partner/SGKV (2002), p. 18
6 I started this project when I was employed at the German "Studiengesellschaft for den kombinierten Verkehr". I carried it out on my own account, though. The PhD supervisors are Prof. Dr. Toon van der Hoorn (Dutch Ministry of Transport/University of Amsterdam, NL) and Prof. Dr. Ir. Rob van der Heijden (Radboud University, Nijmegen, NL). The title of the doctoral thesis is "The efficient integration of inland shipping into continental intermodal transport chains - measures and decisive factors". The thesis is expected to be published in late 2008.
7 cf Bundesministerium für Verkehr, Bau- und Wohnungswesen (2001), p. 17
8 For swap bodies, the European standard for stackable class A swap bodies should be taken into account (CEN/TS 14993). The upper castings should be designed according to ISO 1161 (such as the castings of the maritime ISO containers). The intermodal loading units should be coded and marked according to EN ISO 6346 or EN 13044.
9 Examples for applicable safety regulations are: RheinSchUO and RheinSchPV (stowage), ADR/RID and AND/ADNR (cargo), Convention for Safe Containers (loading units), and EPAL (load platforms).
10 TEU = Twenty foot Equivalent Unit. Normally, container transport volume is measured in TEU, referring to the length of the standard container box, which equals 6.1 meters.
11 Intermodal collaboration is important for attracting more cargo to inland shipping, for launching backup solutions, for reducing lead time at the interfaces (the terminals), and for providing seamless course supervision systems.
12 Transport and traffic telematics could partly complement and partly replace the need for additional infrastructure works.
13 cf Yin (2003), p. 9
14 cf http://ec.europa.eu/transport/iw/overview/assets_en.htm, online

PDF | In continental Europe, in recent decades, apart from container hinterland transport to and from the seaports, inland waterway shipping has had it | Find, read and cite all the research you need on ResearchGate.Â A large market potential has been identified for the intermodal carriage of intra-European cargo on inland waterways. In this thesis, the critical and crucial success and failure factors for this form of transport are discussed. Discover the world's research. 19+ million members. Intermodal transport with 5 mil. gross tonnage does not count in the calculation of the share between transport modes, because its partial performances are inclusive in road transport, railway transport or inland waterway transport. Road transport is long term the busiest transport mode in the Slovak Republic, it is characterized by high demands on infrastructure, which is still insufficient and there is a frequent congestion on various sections of infrastructure in the Slovak Republic (Bratislava, KoÅ¡ice, PreÅ¡ov, etc.), but also in Å½ilina region (Å½ilina, ÄŒadca, RuÅ¾omberok, etc.). Inland waterway transport is particularly relevant for certain corridors. Current market characteristics show that for cross-border traffic within the Rhine-Alpine corridor, inland waterways have a modal share of 54%. For the North-Sea Mediterranean corridor, IWW traffic amounts to 35%, 38% for the North-Sea-Baltic corridor and 14% for the Rhine-Danube corridor. 27. CCNR Market Observation - Annual report 2020 Freight traffic on inland waterways. Figure 3: yearly inland waterway transport performance in europe (in billion tkm). Export and Import. National traffic.