D1.4 Report on economic barriers to modal shift: challenges & best practices; recommendations

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Executive Summary

Modal shift in freight transport from road to Inland Waterways (IWWs) is a strategic objective prioritised by both the European Union (EU) and many of its Member States. Notwithstanding, IWWs remain underutilised in most Member States. Even in the small number of countries in which inland waterway transport (IWT) has a high market share and is well established, inland waterway freight transport volumes decreased in the period 2010-2020. From the macro perspective, the IWT sector as a whole has difficulties to maintain its modal share and thus support the EU's ambitions to shift freight to more sustainable modes of transport. Such challenges are partly due to the intense competition that the inland waterway transport (IWT) faces from road and rail transport modes but are also related to reducing transport demand from traditional industries in Europe resulting in a decline of bulk cargo transports.

Notwithstanding, there is a clear potential to increase the use of IWWs to their full potential and facilitate modal shift to IWT, although specific opportunities vary depending on the region and local context. This will require *inter alia* putting in place the right framework conditions. These could enable the sustainable use of IWT, as well as a better understanding and anticipation to the decision-making process behind the modal choice. Furthermore, the IWT sector needs to anticipate to the requirements of shippers and to provide one-stop-shop solutions for intermodal and multimodal chains. This means that also pre- and end haulage by road, transhipment and storage in ports need to be taken into the scope of the service offered by the logistic service supplier. The transport by barge therefore needs to be integrated in a seamless way and could also serve as 'floating storage'.

Having a better understanding of the rationale and principles of modal shift, the decision-making process behind a modal choice, the barriers and facilitators to modal shift is crucial. Equally important is stakeholder engagement and collaboration among key actors in the transport and logistics chain. Collaborations between parties in the chain may develop, synchromodal solutions. This means the choice of mode (rail, shortsea, road haulage or inland navigation) being dynamic and depending on the actual lead time and transport route possibilities. Synchromodal solutions take into account dynamics of capacity supply, utilisation, terminal waiting times, congestion on roads, costs etc.

In the context of modal shift from road transport, the shift could be towards either intermodal or multimodal transport, depending on the specific circumstances and logistics of the transport chain. The term "intermodal" is often used more commonly in the context freight transport using containers as load unit, particularly for longer distance and more complex transport chains. The term "multimodal" is often used in the context of freight transport, particularly for local and regional transport systems that use multiple modes of transport and where bulk transport is concerned or different types of load units are used for each mode in the chain.

Although the transport industry is nowadays much more complex than in previous centuries due to advances in technology, globalisation and greater volume of goods being transported across longer distances, as well as changes in consumer behaviour, the mechanism underlying modal shift essentially remains the same: when a transport mode becomes more advantageous than another (in terms of costs, convenience, quality, speed or reliability) over the same route or in the same market, a modal shift is likely to occur. However, the factors that influence modal choice can be complex and may vary depending on the specific context, such as the type of goods being transported, the distance of the route, and the availability of infrastructure and services. As such, it is important to consider these factors when promoting sustainable transport choices and encouraging modal shift towards more sustainable

modes of transport. Notwithstanding, modal choice is a very complex decision process, determined by a wide range of factors coming from different disciplines, such as economy, sociology, geography and psychology. It is often the result of a complex process that can take place consciously or unconsciously and which includes both objective and subjective determinants.

Focus and purpose of the report

Against this background, the report aims at providing a foundation of knowledge on modal shift (MS) in freight transport and framework conditions enabling the potential for modal shift from road to IWWs. The major objective of the work carried out under Task 1.4 is to identify facilitators and barriers -- economic and financial -- preventing the potential for freight modal shift to IWT. To this end, it investigates from a micro-perspective approach key factors underpinning modal choice and modal shift with the aim of identifying support actions and measures which could assist the IWT sector in its quest for achieving a higher share of modal shift at EU level. To this end, the decision-making process and the key actors and factors underpinning the freight modal shift to IWW is analysed. Next to best practices, support actions and measures are outlined, coupled with a set of recommendations which could assist the IWT sector to achieving a higher share of modal shift at EU level.

The report briefly presents **the micro approach conceptual framework** (chapter 2) -- a theoretical framework used to understand the decision-making processes of individual actors in the transport sector, such as shippers and carriers. The framework is based on the idea that transport decisions are made at the individual level and that these decisions are influenced by a range of factors, including the characteristics of the shipment, the transport mode, and the market environment.

Mode choice plays a critical role in the success of modal shift from road to inland waterway. To encourage mode shift to inland waterway transport, stakeholders in the transport industry can implement a range of measures, including improving the infrastructure for inland waterway transport, providing financial incentives for shippers and carriers, and promoting the environmental benefits of inland waterway transport. By addressing the key factors that influence mode choice, stakeholders can create an environment that encourages modal shift and contributes to the overall success of the initiative. Accordingly, **modal choice is discussed** in chapter 3**.** When making mode choice decisions, shippers consider a wide range of factors, including cost, speed, reliability, accessibility, and environmental sustainability. To encourage mode shift to inland waterway transport, stakeholders in the transport industry can implement a range of measures, including improving the infrastructure for inland waterway transport, providing financial incentives for shippers and carriers, and promoting the environmental benefits of inland waterway transport. By addressing the key factors that influence mode choice, stakeholders can create an environment that encourages modal shift and contributes to the overall success of the initiative.

Modal shift concept and phases distinguished: 1. inertia, 2. modal shift, and 3. maturity. These are described in chapter 4 and prepares the ground for further analysing the factors influencing the modal shift at micro and macro-level. These phases can vary depending on the specific market context. By understanding the different phases of modal shift, stakeholders can develop strategies that take into account the unique challenges and opportunities of their specific context. Economic and financial barriers to modal shift are defined and examples are provided in chapter 6. Furthermore, the impact of such barriers is discussed in relation to the three phases of modal shift.

Best practices and possible solutions for overcoming the economic and financial barrier are discussed in chapter 7. In this context an analysis of economic and financial barriers that are most salient in the inertia phase, the modal

shift phase, in the maturity phase and related solutions that can be used to overcome these barriers, such as public education campaigns, targeted incentives for early adopters, and regulatory reforms are outlined.

Key actors and their role in the modal shift decision making process and in setting the right framework condition for modal shift are presented in chapter 8. The ninth chapter specifically presents a deep-dive into main findings of the Multimodaal Vlaanderen (MMV) study case focusing on modal shift cases in Flanders, Belgium. In this programme, from end of 2017 till mid 2021 about 1095 companies were contacted of which 333 agreed to start up a modal shift business case. The success rate of these business cases was however disappointing: only 52 were successful in achieving modal shift to rail and IWT. The important outcome is that the vast majority of the successful cases/companies turned to IWT. They provided data for 39 cases, representing 12% of the business cases they handled in this period. By request MMV made a selection of representative cases (both successful and unsuccessful) which created the opportunity to look at the financial/economic barriers which come into play and which could positively or negatively influence modal shift. Accordingly, some of the main barriers to modal shift were identified as follows: unfavorable contractual arrangements, principles of supply chain management that work against modal shift, complexity of a multimodal chain, malfunctioning of maritime supply chains, which ultimately lead to an unfavorable total cost of ownership (TCO) compared to road transport.

The final chapter of this report discusses the key findings and outlines a set of possible support actions and measures to eliminate economic and financial barriers to modal shift in IWT. Accordingly, public policies and support measures by policy makers at national and regional level are outlined can be developed along the three phases of modal shift to encourage and facilitate the shift towards IWT. Against this background, the setting up of a **promotion centre for modal shift to inland waterway** providing services and carrying out activities targeted for all phases can be a useful strategy to encourage and facilitate greater use of inland waterway transportation.

List of abbreviations

CCNR	Central Commission for the Navigation on the Rhine
CIF	Cost Insurance Freight
EXW	Ex Works
FOB	Free on Board
FMCG	Fast moving consumer goods
GHG	Greenhouse gas emissions
ICY	Inland Container Yard
IFT	Intermodal Freight Transport
IWW	Inland waterway
IWT	Inland Waterways Transport
MS	Modal Shift

List of definitions

Carriers: Companies providing the actual transportation of goods. They may include barging companies, trucking companies, railroads, shipping lines, and airlines.

Customs and border protection agencies: Government agencies responsible for enforcing customs and trade regulations, and for collecting tariffs and other duties.

Freight forwarders: Companies acting as intermediaries between shippers and carriers - handling the logistics of arranging for the transportation of goods, including arranging for the necessary permits, documentation, and customs clearance.

Incoterms®: Acronym standing for international commercial terms. It is a trademark of the International Chamber of Commerce (ICC), registered in several countries.

Incoterms rules: A globally – recognised set of standards, used worldwide in international and domestic contracts for the delivery of goods. First published by ICC in 1936, the Incoterms rules provide internationally accepted definitions and rules of interpretation for most common commercial terms used in contracts for the sale of goods. They define important responsibilities of buyers and sellers for the delivery of goods under sales contracts and are the authoritative rules for determining how costs and risks are allocated to the parties. Incoterms rules are regularly incorporated into contracts for the sale of goods worldwide and have become part of the daily language of trade.

Intermodal transport: "the movement of goods in one and the same loading unit or road vehicle using successively two or more modes of transport without handling the goods themselves in changing modes" .

International inland waterways transport: Inland waterways transport between two ports located in different national territories.

Logistics service providers: Companies offering a wide range of logistics services, such as packaging, warehousing, and inventory management.

Multimodal transport: "the carriage of goods by at least two different modes of transport on the basis of a multimodal transport contract from a place at which the goods are taken in charge by the multimodal transport operator to a place designated for delivery situated in a different country"(ICC, 2014).

3PL providers: Third-Party Logistics providers (3PL) are companies providing logistics services, including transportation, warehousing, and distribution, to businesses that do not have their own logistics capabilities.

Shippers: Companies or individuals that need to transport goods from one location to another. They may be manufacturers, retailers, or distributors.

Port operators: Companies or government agencies operating ports and airports, and providing the infrastructure and services needed to handle the loading and unloading of goods.

Technology providers: This includes companies that provide technology solutions, such as transportation management systems (TMS), warehouse management systems (WMS), and global positioning systems (GPS), to support logistics and transportation operations.

National inland waterways transport: Inland waterways transport between two ports of a national territory irrespective of the nationality of vessel.

Transit inland waterways transport: Inland waterways transport through a national territory between two ports both located in another national territory or national territories provided that in the total journey within the national territory there is no transshipment.

The "modal split" of transport describes the relative share of each mode of transport, for example by road, rail or sea. It is based on passenger-kilometres (p-km) for passenger transport and tonne-kilometres (t-km) for freight or goods transport. The modal split is usually defined for a specific geographic area and/or time period.

In practice, an analysis of the modal split may exclude certain modes of transport. For example, the analysis may be limited to inland transport and therefore exclude sea transport and air transport.

The term "mode choice" refers to the choice shippers or other transport stakeholders make with regards the modes of transport for transporting their goods. Mode-choice changes often go hand-in-hand with changes of logistics chains. This means that an analysis of mode choice should also include logistics. Modal split or modal share refers to the share of goods transported via a certain mode *(e.g*. a rail modal share) and usually measured in tonne-kilometres. Most freight transport is offered in multimodal or intermodal transport chains. Intermodal transport requires standardised load units, *e.g.* containers.

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1. Introduction

1.1. Setting the scene

The present report on economic barriers to modal shift: challenges & best practices; recommendations (D1.4) provides an analysis from a micro approach perspective of the potential of modal shift from road to IWW with respect to the modal shift strategic objectives set in the relevant EU legislation and strategic policy instruments aimed at facilitating the use of IWT.

The literature review and the analysis carried out under Task 1.4 complement the foundation of knowledge on the modal shift concept, framework conditions and policy and legislative framework enabling the potential for modal shift from road to IWW. This is also highlighted by the other tasks within PLATINA3 - WP1, namely:

- Task 1.1 – Increasing modal shift and decarbonisation,
- Task 1.2 – standardised transport units, transhipping infrastructure & vessels design
- Task 1.3 – Synchro-modal logistics chains
- Task 1.5 – policy and regulatory actions encouraging and facilitating the use of IWT.

Task 1.4 complements the work from these other tasks by including an overview of and an assessment of economic and financial barriers to modal shift from road to IWW from a micro-economic analysis perspective. The main body of the report details the findings of available literature on freight modal shift from road to IWW, including key tasks carried out within the PLATINA2 Project. In broad terms, modal choice can be identified as the result of the decision process to choose between different transport alternatives. Therefore, in order to gain knowledge about the decision-making process underpinning the modal choice and gain more insight into the economic barriers preventing modal shift towards IWT, both qualitative and quantitative research approaches were employed. Thus, another relevant source for data collection and analysis as part of the PLATINA3 Task 1.4 work was the Modal Shift promotion initiative carried out by Multimodal. Vlaanderen (MMV) -- “Flanders’ Institute of Logistics (VIL). They provided data for 39 cases, representing 12% of the business cases they handled from 2017-2021. Furthermore, findings gathered via industry interaction and expert input provided by relevant stakeholders during the PLATINA3 2nd Stage Event organised on 19 October 2021 in Strasbourg were considered. Also, several semi-structured research interviews with relevant actors within the freight transport, logistics, research and academia were carried out. In addition, the findings reported by a study (hereinafter referred to as the Makait study) commissioned by the European Inland Waterway Transport Platform in 2022 to look into potential ways to increase the modal share of Inland Waterway Transport (IWT) are presented.

In the current report, economic barriers to modal shift refer to factors that prevent or discourage **transport companies** and **shippers** from choosing alternative modes of transport that are more environmentally sustainable or cost-effective. **These barriers can include** high initial costs, limited infrastructure, lack of government support, and market distortions, among others. Economic barriers are often broader in scope and affect multiple actors in the economy, such as businesses, consumers, and governments. On the other hand, **financial barriers** , also considered within the context of this report, refer to factors that limit or impede economic activities due to financial reasons, such as insufficient access to credit or capital, high interest rates, and lack of financial resources. Financial barriers are often more specific to individual actors in the economy, such as businesses and consumers. Notwithstanding, the relationship between economic and financial barriers is that financial barriers can be a component of economic barriers. For example, limited access to financing can be an economic barrier to freight

transport because it can limit the ability of businesses to invest in the equipment or technology necessary to transport goods efficiently. In this case, the financial barrier is a contributing factor to the broader economic barrier.

Addressing economic and financial barriers to modal shift is important because it can have significant environmental, economic, and social benefits. Moving goods from road to more sustainable modes of transport, such as inland waterways or rail, can reduce carbon emissions, decrease congestion on roads, improve air quality, and promote economic growth. Furthermore, using alternative modes of transport can provide cost savings for shippers and transport companies, as well as reduce the external costs associated with road transport, such as accidents and infrastructure maintenance. Thus, for the purpose of this task, both types of barriers will make the object of analysis.

1.2. The potential for modal shift in inland waterway transport

Modal Shift in freight transport has been advocated by policy makers, public authorities and researchers for more than two decades. The European Union as well as many of its Member States have set high targets for sustainability. The Sustainable and Smart Mobility Strategy (SSMS) (COM(2020) 789 final) aims to increase the share of inland waterway transport (IWT) and Short Sea Shipping (SSS) by 25% by 2030 and by 50% by 2050. The aim is to achieve "climate neutrality" by 2050. However, this goal can only be realized by shifting traffic to more sustainable modes and increasing the environmental compatibility of the various modes of transport. As the European Commission emphasized again in its NAIADES III action plan of June 2021(COM(2021)324 final), inland shipping has long been considered one of the most CO2-efficient modes of transport (per tonne transported) alongside rail. This clearly puts IWT at the heart of the Union's efforts to decarbonise the transport system. Notwithstanding, the target to increase SSS & IWT by 25% in 9 years is considered very ambitious in particular considering the progress so far. Even if volumes for IWT have increased the modal shift targets are very demanding.

Road transport absorbs more than 50% and since 2015 it has remained a very attractive mode due to the fact that it is simpler, more flexible, reliable and currently less expensive. Road transportation is the most widely used mode of transportation for goods and materials, yet IWT can be one of the main alternatives to road transportation for large and heavy shipments, as well as for goods that are not time-sensitive, in regions where navigable waterways are available. Furthermore, IWT has several environmental advantages over road and rail transport modes, such as lower emissions, higher energy efficiency, and reduced congestion, which can make it an attractive option for certain types of freight transport.

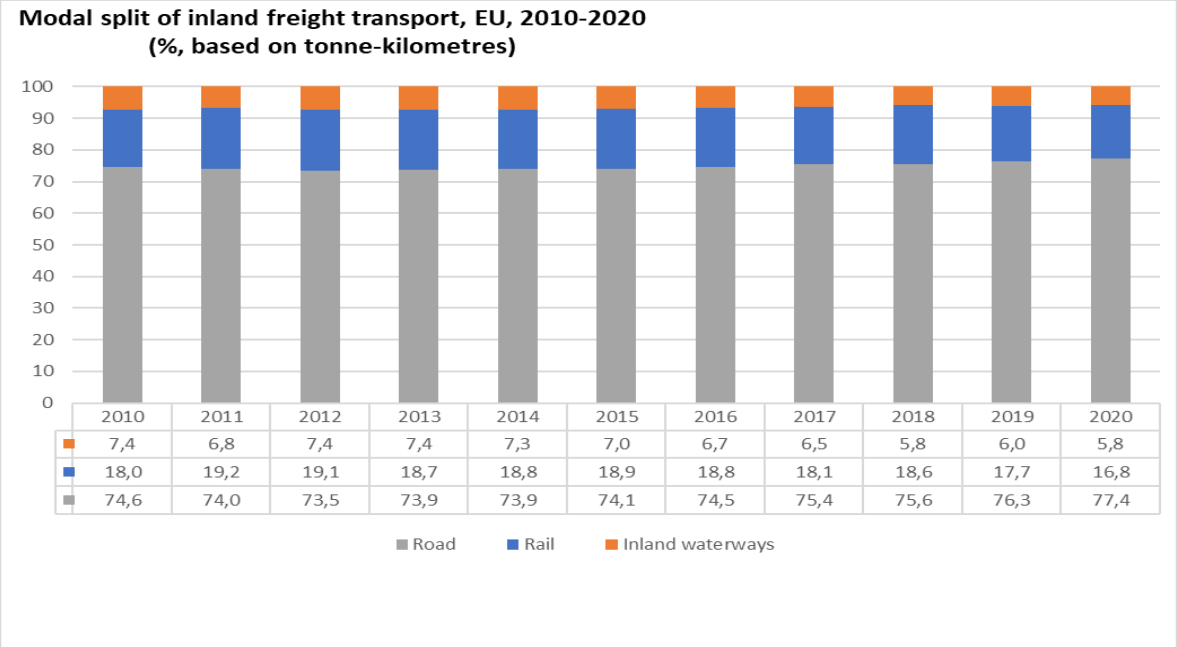
However, although IWT is often advertised to afford superior environmental performance, IWT allow comparatively high emissions of NOx and other particles (Cariset al., 2014; Fridell, 2011; Vierthet al., 2012), while other modes of transport are rapidly improving on that count. While IWT is generally considered to have lower carbon emissions compared to road or air transport, it is true that IWT can emit higher levels of NOx and particles. The emissions of these pollutants can be especially high in older or less well-maintained vessels. It is worth noting, however, that newer and more efficient vessels can significantly reduce emissions. Expressed in emissions per tonkm the air pollutant emissions of such modern vessels (e.g. equipped with Stage V NRE engines) are much lower compared to the emissions by a modern truck (Euro VI). In particular, the high energy efficiency of IWT provides an intrinsic and lasting advantage of IWT compared to other land transport modes such as road and rail transport. These other modes of transport have however been making strides to reduce their environmental impact as well. Notwithstanding, overall, the environmental performance of a given mode of transport depends on various factors, including the type and age of vessels or vehicles, fuel sources, and operational practices.

Indeed, as identified in the Central Commission for the Navigation of the Rhine (CCNR) Roadmap for reducing emissions in inland navigation (2022) , IWT will likely face fierce competition from other modes which enjoy greater financial capacity and RD&I resources for the energy transition, especially in terms of use and distribution of alternative fuels, and have already started massive investment plans to reach net carbon neutrality by 2050.

This is also pushed by legislative proposals such as for example ETS for road haulage and proposals for more strict emission limits on new trucks. Therefore, the inland waterway transport sector needs to develop concrete measures to realise this transition, both for air pollutant emissions and GHG. Wherever possible, careful attention should be paid to developments in other modes of transport, such as road, rail and short-sea shipping. Indeed, there is much to be learned from the experience gained by other modes regarding the energy transition. Moreover, it is important to take the multimodal context into account. If inland navigation were to lag behind in its transition process, transport demand might shift to other modes like rail, road or short-sea.

Nevertheless, the inability of IWT to gain some market shares, even in the countries where it is already well established can be seen in the graphs below. In fact, according to official statistics, over the last decade, modal split shares for inland transport have remained rather stable. The modal split of IWT at the level of the EU-27 was 5.8% in 2020 and thus behind road transport (77.4%) and rail transport (16.8%). Both rail and inland waterway transport lost shares for the benefit of road transport in 2020. Overall, road transport still reigns supreme before rail and inland waterways. IWT has been following a decreasing trend since 2012. This is mainly due to the changes in EU industries and the resulting changes in the type of transport demand: relatively less bulk transport on longer distances and higher shares of freight demand which is most suitable to be transported by trucks (e.g. parcels).

Figure 1. Modal split of inland freight transport, EU, 2010-2020

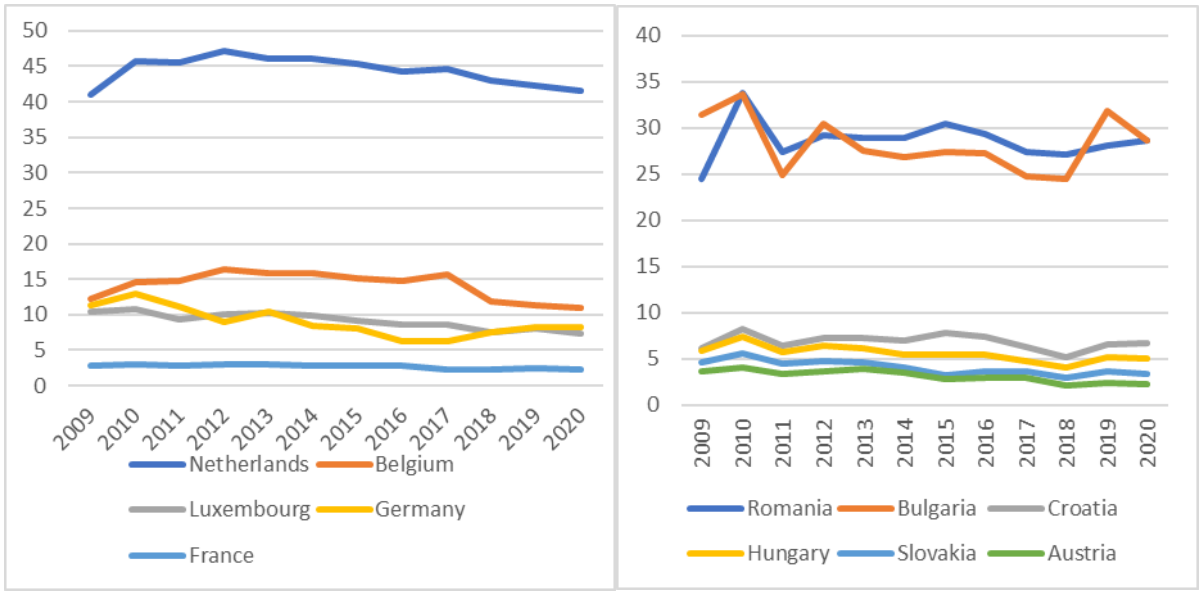


Note: Includes Eurostat estimates for rail transport for Belgium (2012-2019) and inland waterways transport for Finland (2017-2018), but does not include road transport for Malta, international transport of Cyprus (negligible) and inland waterways transport for Sweden (2008-2015: negligible). Figures may not add up to 100% due to rounding. Source: Eurostat (online data code: tran_hv_frmod)

As many EU countries do not have inland waterways, the overall modal split of IWT at the EU level should however not be used as a performance indicator for the success of inland waterway transport in the EU. In order to measure

the success of IWT in the transport market, it is preferable to look at the modal split evolution of IWT in countries where there is a sufficiently dense inland waterway network or where inland navigation has traditionally been important for goods transport.

*Figure 2.IWW Modal split evolution in Rhine & Danube Countries (in %, Based on Tonne-Km) **



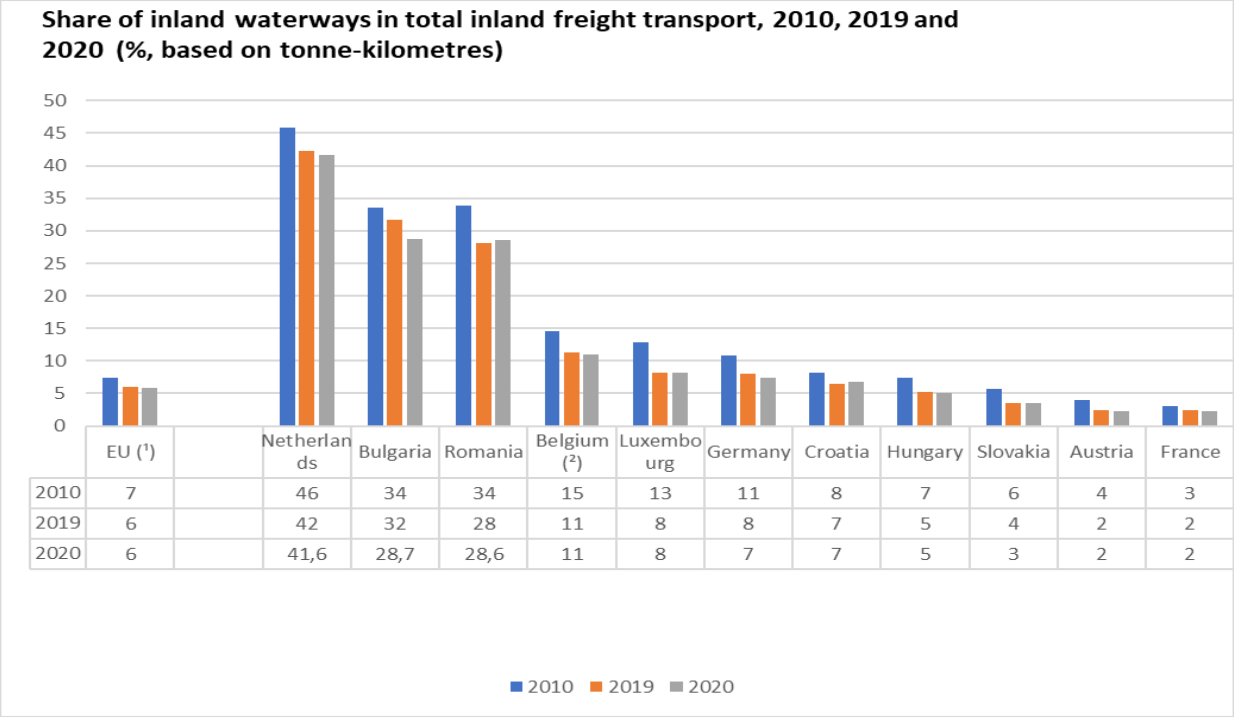
Source : Eurostat [tran_hv_frmod], Market observation of inland navigation in Europe (CCNR and EC)

* Share of inland waterway transport performance in total (IWT + Road + Rail) transport performance

Also, it can be noted that the share of inland waterways freight transport is very significant in the Netherlands (41.6 % in 2020), though still below the share of road (52.2 % in 2020). The comparatively high shares of inland waterways freight transport in Bulgaria (28.7 % in 2020) and Romania (28.6 % in 2020) are partly explained by the extensive traffic on the Danube and partly by the 'territorialisation' of road freight transport. In general, road haulage did see a strong growth because of changes in the type of transport demand. Industrial activities declined in Europe compared to a growth of the service sector which was boosted by e-commerce. The consequent type of transport fits quite well to the high speed and small consignment sizes which can be handled by road haulage (e.g. consumer goods, parcel distribution, e-commerce). However, on the Rhine corridor , inland waterway transport has been successful in the transportation of maritime containers related to deep-sea and shortsea transport. On the other hand, inland waterway transport was not successful (yet) in the transportation of palletized goods, dominated by road transport.

Fluctuation in freight transport performance by IWT (figure 4) can mostly be explained by the fluctuation in the economy and the related freight demand from captive markets for IWT. Such captive markets are the transportation of coal and ore, sand and gravel, oil and chemicals and agricultural bulk cargoes. Secondly, river conditions play a role, especially draughts which resulted in low water conditions (e.g. 2018) and therefore lower transport capacities.

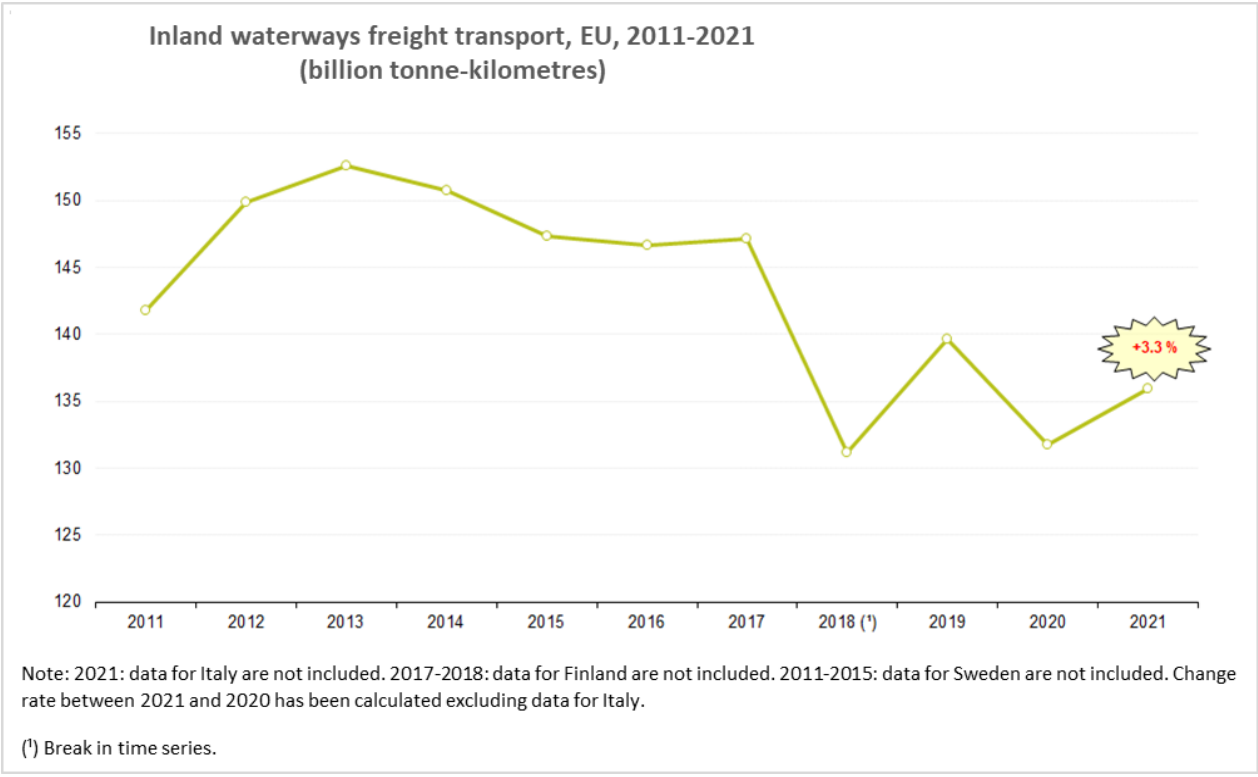
Figure 3.Share of inland waterways in total inland freight transport, 2010, 2019 and 2020



	EU (1)	Netherlands	Bulgaria	Romania	Belgium (2)	Luxembourg	Germany	Croatia	Hungary	Slovakia	Austria	France
2010	7	46	34	34	15	13	11	8	7	6	4	3
2019	6	42	32	28	11	8	8	7	5	4	2	2
2020	6	41,6	28,7	28,6	11	8	7	7	5	3	2	2

Source: Eurostat (online data code: tran_hv_frmod)

Figure 4.Inland waterway freight transport performance



Note: 2021: data for Italy are not included. 2017-2018: data for Finland are not included. 2011-2015: data for Sweden are not included. Change rate between 2021 and 2020 has been calculated excluding data for Italy.

(1) Break in time series.

Source: Eurostat (online data code: tran_hv_frmod)

2. The Micro-approach conceptual framework

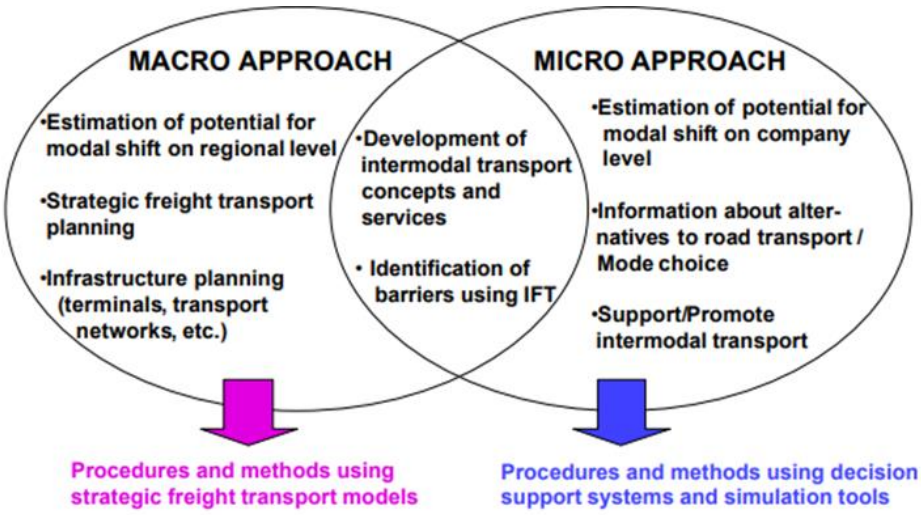
2.1. Identifying the potential for modal shift on company level

The literature review on identifying the potential for modal shift in freight transport carried out under the scope of Task 1.4 revealed several methodological approaches outlining how research is conducted. These approaches try to describe, explain and predict a mode choice, either by aggregated freight flows (macro-level) or at the level of individual companies (micro-level). Accordingly, one way to categorise these research methodologies is according to the type of data collected and analysed and the type of knowledge one aims to produce. Ruesch (2001) is among the proponents of such categorisation and the paragraph below presents his approach of distinguishing between macro and micro-level approaches and methodologies. Therefore, his paper presented during the 1st Swiss Transport Research Conference (STRC) in 2001[1], outlined that both approaches are taking into account the supply and demand side, but the macro approach focuses more on the supply side whereas the micro approach focuses more on the demand side.

The macro approach is a more strategic approach which identifies the potential for modal shift for regional, national and international freight flows. It requires as input data on the freight flows (origin, destination, information about the transport networks and transport offers and also affinity factors for various goods. The results provide an estimation on the potential for modal shift for a region or an origin-destination connection. Statements on company level and recommendations for individual mode choice are not possible. **The micro approach** is a more supply chain specific or individual tailormade approach which identifies the potential for modal shift on company level taking into account the decision-making process of the shippers. As input data, it requires data concerning the transport and logistics chains and freight flows (origin-destination)for the transported commodities at company level, as well as the key factors in the decision making process (cost, reliability, leading times, etc.).

The infographic below depicts the salient features of and the relationship between macro and micro methodologies identifying the potential to modal shift in freight transport, as well as the main components of each methodology.

Figure 5. Relationship between the macro and micro methodologies



Source RAPP AG/M. Ruesch, 2000

[1] https://www.strc.ch/2001/ruesch.pdf

2.1.1. Main steps to understand the potential for modal shift at company level

As illustrated by the micro-approach representation in Figure 6 such methodological approach can include the following steps.

1) Estimating the potential for modal shift on a company level
2) Information about alternatives to road transport /Mode choice
3) Supporting and promote intermodal transport solutions
4) Development of intermodal transport concepts and services
5) Identification of barriers using IFT

By following these five steps, a company can obtain a comprehensive understanding of the potential for modal shift and make informed decisions about the most effective ways to optimize its supply chain and reduce its environmental footprint. In principle, this requires analysing the current transportation modes used by the company, identifying the barriers to modal shift and evaluating the benefits of alternative transportation modes. Barriers can be cost, lacking infrastructure for transhipment as well as regulatory issues. Opportunities can be achieving cost reductions, more reliable supply chains (e.g. due to local storage at terminals) and improved environmental performance (carbon footprint, NOx emissions, noise etc.).

This analysis can help estimate the potential for modal shift and identify the most promising transport alternatives. It can be carried out by performing the following set of task and activities:

1. **Data collection**: Gather data on the company's current transport patterns, including the volume and type of goods being transported, the distances involved, and the modes of transport being used.
2. **Analysis of transportation costs**: Conduct a cost analysis to compare the costs of the current mode with those of alternative modes. This should consider not only direct costs such as transport and handling, but also indirect costs such as lead time, inventory holding costs, required load units. Further, identify the costs and benefits associated with each mode of transportation, including direct costs (such as fuel, maintenance, and labour costs), indirect costs (such as delays and congestion) as well as environmental costs (such as emissions and other impacts, *e.g.* linked to CO_2 pricing in future[2]).
3. **Analysis of environmental impact**: Assess the environmental impact of each mode of transport, including emissions, energy consumption and waste generation. Such environmental impact assessment and advantages of transport chains using inland waterway transport may help to acquire support (permits) and investments from public authorities, such as quay facilities and transhipment cranes or other means of financial support.
4. **Feasibility assessment**: Evaluate the feasibility of switching to alternative modes, considering factors such as infrastructure availability, lead time, and regulatory requirements, impact on production, storage, etc. Evaluate the regulatory and institutional barriers to modal shift, such as local regulations, tariffs, and infrastructure availability and possible support from local authorities.
5. **Identifying opportunities**: Based on the cost and environmental analysis and feasibility assessment, identify opportunities for modal shift and prioritize them based on potential benefits.
6. **Implementation planning:** Develop a plan for implementing the modal shift, including a timeline, budget, and performance metrics and tendering for possible contractors to take care of the new transport chain using IWT (including the related transhipment, storage, pre- end haulage, etc.).

[2] DG MOVE plans to integrate more parameters in calculator for combined transport directive proposal

2.1.2. Advantages and limitations of the micro-approach

There are some advantages of analysing modal shift from a micro - perspective and for the purpose of the present report the following are presented as follows:

- A micro approach provides a detailed understanding of the factors that influence modal shift decisions at company level. Often the specific local conditions and specific supply chain requirements determine whether a modal shift is realistic or not. For example, it can make a huge difference if there is a quay facility directly at the location of the origin/destination, as that will avoid transhipment and pre- end haulage costs which usually have a high share in the overall door-to-door costs. Understanding and identifying the specific needs and requirements of individual shippers enables an effective and efficient development of tailored solutions for modal shift.
- By focusing on individual firms, a micro approach can provide a more accurate representation of the reality of modal shift compared to a macro approach that relies on aggregated data.
- By understanding the specific factors that influence modal shift at company level, policymakers can design targeted policies and programs to encourage modal shift in specific sectors or regions.

Notwithstanding, there exist also limitations of analysing modal shift from a micro approach, such as:

- Transport volumes of individual companies are usually too small to fill an inland vessel frequently and to enable an acceptable frequency of the transport service. This especially occurs ifa transport service which can be used (e.g. like a container terminal which already has liner services on the required destination) is not yet available in the area. This is a major limitation. Combining volumes with other companies can be a solution but is hard to realise in practice.
- Time and resource constraints: Conducting a micro-level analysis can be time-consuming and resource-intensive, requiring data collection and analysis at company level.
- Limited generalizability: Results from a micro-level analysis may not be representative of the broader transportation sector and may not be applicable to other regions or countries.
- Difficulty in capturing broader economic and societal factors: A micro approach may not fully capture the broader economic and societal factors that influence modal shift, such as macroeconomic conditions, technological change, and policy developments.
- Data limitations: Data on modal shift at company level can be difficult to obtain and may not be available for all firms. This can limit the representativeness and accuracy of micro-level analyses of modal shift.

2.1.3. Conclusion

To conclude, a micro approach can provide valuable insights into the factors that influence modal shift decisions at company level, but usually end with insufficient volumes to set up new services. Therefore, it should be used in conjunction with other approaches to gain a more complete understanding of modal shift in the broader transportation sector.

3. Modal choice from a Micro Approach Perspective

Modal choice is a very complex decision process, determined by a wide range of factors coming from different disciplines, such as economy, sociology, geography and psychology. It is often the result of a complex process that can take place consciously or unconsciously and which includes both objective and subjective determinants. Objective determinants can typically be identified quantitatively, while subjective ones are qualitative (De Witte et al., 2013)[3]. Within the micro approach the decision-making process for modal choice plays an important role. This decision-making process on company level has been analysed in European (LOGIQ, LOGICAT) and national projects.

3.1. Factors influencing the mode choice

The micro approach conceptual framework is a theoretical framework used to understand the decision-making processes of individual actors in the transport sector, such as shippers and carriers. The framework is based on the idea that transport decisions are made at the individual company level and that these **decisions are influenced by a range of factors,** including the characteristics of the shipment, the transport mode, and the market environment. In the same vein, Patterson et al. (2008) and Samimi et al. (2010)[4] are referring to the same contributing **factors to modal choice** for freight transport.

3.1.1. Shipper and shipment attributes

These refer to the characteristics of the cargo being transported and the company that is shipping it. Shipment attributes include the type of goods being transported, their density (in terms of weight per unit of volume) and value per unit of the product being transported, their degree of perishability and shelf-life, and their packaging characteristics (Steer Davies Gleave, 2015). This can include the size and weight of the shipment, the value of the goods being transported, and the level of urgency or time sensitivity of the shipment. Shipper attributes include company size, accessibility to rail/road/IWW network, and custom and practice among decision-makers in shipping companies. The shipper's own resources and constraints, such as available budgets and operational capabilities, also play a role in their decision-making process.

3.1.2. Geographic and time characteristics

These refer to the spatial and temporal dimensions of the transport process. This can include the distance between the origin and destination points, the accessibility of the transport infrastructure, and the time sensitivity of the shipment. Other factors, such as congestion and weather conditions, can also impact the decision-making process.

Temporal factors, such as the distance covered and the flow rate, play an important role for modal choice. Rail and waterborne services are generally slower than trucks, thus making the latter a more attractive option for more time-sensitive and higher value goods (McKinnon, 2018). The European Court of Auditors estimated that goods moved across the EU by rail travel at an average speed of 18 km/h (European Court of Auditors, 2016). For all distances below 200 km, road transport mainly enjoys a time-related advantage over other modes; the shorter the travel time, the more important time becomes relative to cost (Danielis et al., 2005). This is quite in contrast with the freedom and flexibility of road-based transport, which can synchronise freight movements much better with

[3] Hollevoet, J. & Witte, A. & Macharis, Cathy. (2011). Improving insight in modal choice determinants: An approach towards more sustainable transport. file:///C:/Users/jtoma/Downloads/Improving_insight_in_modal_choice_determinants_An_.pdf

[4] Amir Samimi, Kazuya Kawamura & Abolfazl Mohammadian (2011) A behavioral analysis of freight mode choice decisions, Transportation Planning and Technology, 34:8, 857-869, https://www.tandfonline.com/doi/abs/10.1080/03081060.2011.600092

productivity and warehousing operations. Road transport is also more flexible in servicing just-in-time deliveries and operations.

3.1.3. Transport Attributes

These refer to the characteristics of the different transport modes available, including their cost, speed, reliability, and environmental impact. The availability of intermodal or multimodal transport options, which allow for the use of multiple modes of transportation, can also play a role in the decision-making process.

Operational factors complement the above-mentioned reasons that determine freight modal choice. Some types of goods are intrinsically better transported by certain modes. For example, great quantities of heavy bulk goods (e.g. coal, metals, chemicals, etc.) are predominantly transported by waterborne transport as they need to exploit their scale economies. Trucks are better suited for smaller quantities, which are mainly composed of manufactured and containerised goods. The latter especially are the markets which showed a steep growth over the past decades, while demand for transport of heavy bulk goods remained stable or declined. This also needs to be considered when looking at aggregated modal share figures for IWW.

3.2. Criteria influencing the mode choice

Accordingly, the main criteria for mode choice have been identified as cost, reliability, frequency of services and leading times (LOGIQ Summary report, RAPP 2000). It appears that the division of the decision power of actors varies between different supply chains, and each actor has its own priorities and criteria in mode choice. The three categories of variables identified as fundamental in affecting decision taken by actors were:

- Infrastructure networks
- Cost and quality factors
- Institutional environment of transport and relevant legal issues

3.2.1. Infrastructure networks

The infrastructure networks, including roads, ports, and rail and inland waterway transport networks, play a critical role in modal choice decisions, as they determine the feasibility and cost of different modes of transport. Availability and quality of infrastructure, such as the availability of intermodal hubs and the condition of transport networks, can influence modal shift by making alternative modes of transport more accessible and attractive. However, the IWT network density is low and the routes are longer and less frequent in most cases. The density of road transport networks increased almost everywhere in the EU during the 20th century, to the detriment of rail and waterway networks. The construction of motorways facilitated the “realignment” of the space economy to the road network; nowadays, only a small proportion of industrial facilities is located close to rail or canal networks (McKinnon, 2018).

3.2.2. Cost and quality factors

The cost and quality factors that influence the transport chains and actors’ behaviours include the costs of transportation services, the reliability and speed of delivery, and the environmental impact of transport. These factors interact to influence modal shift by determining the competitiveness of different modes of transport.

3.2.3. Institutional environment of transport and relevant legal issues

The institutional environment of transport, including trade agreements, environmental regulations, and tax policies, can encourage or discourage modal shift by affecting the relative costs and benefits of different modes of

transport. Legal issues, such as the regulation of intermodal transport and the rights and responsibilities of different actors in the transport chain, can also play a role in modal shift decisions.

These three categories of variables interact and influence each other, and changes in one can have ripple effects throughout the entire system, making modal shift a complex and dynamic process. Understanding the interplay of these variables is critical for developing effective policies and initiatives to encourage modal shift in freight transport. The LOGIQ research project which considered three types of actors (freight forwarders/road transport companies, shippers, shipping lines), had indicated that among the criteria examined: cost is the most important criterion in the decision-making process, reliability is the most important quality criterion, frequency of service provision is the most important criterion considered from the supply side, mainly to meet the reliability requirements.

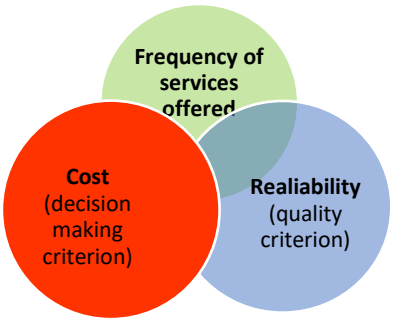


Figure 6.Key criteria influencing the modal choice decision making process

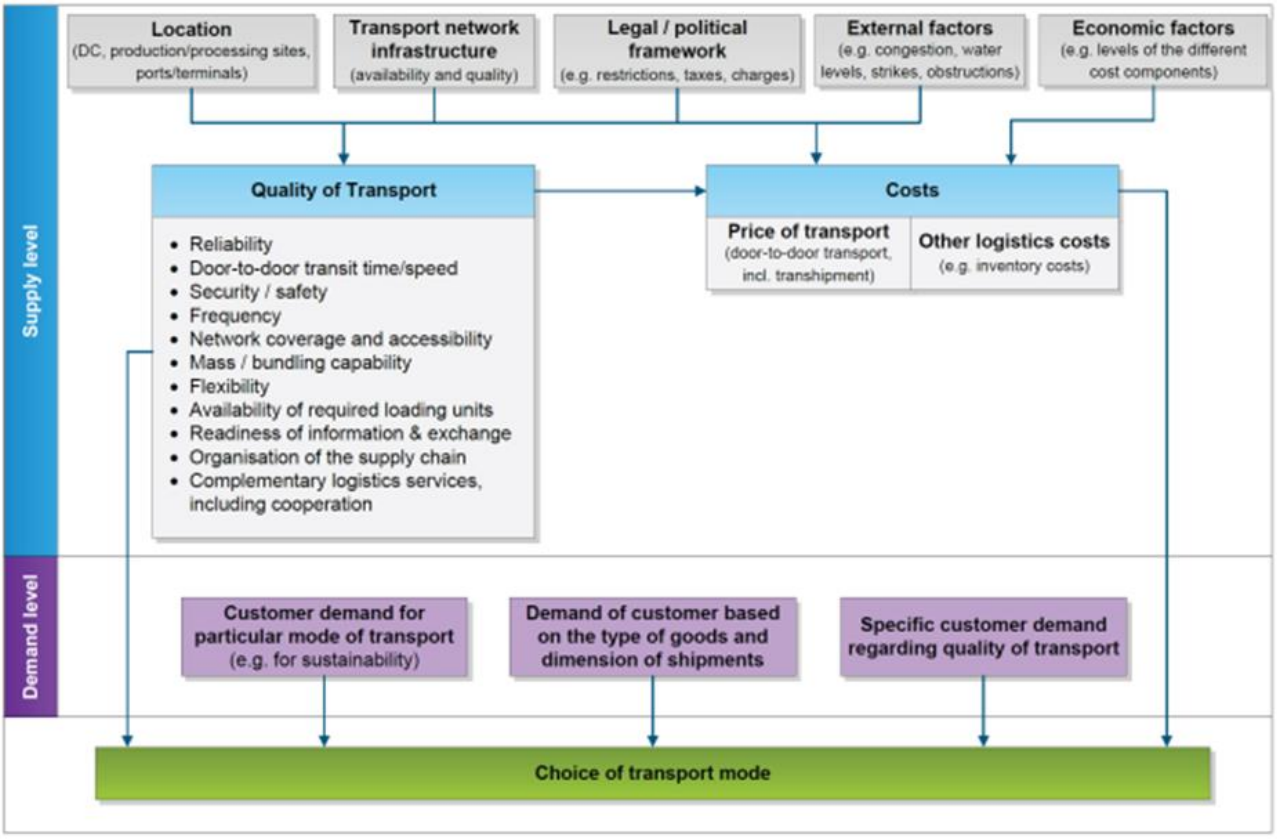
3.3. PLATINA2 conceptual framework for modal choice

A conceptual framework for modal choice to help identify the factors that influence a decision to choose a particular mode of transport was developed within the framework of PLATINA2 project (2014). This conceptual framework presents the main determining factors of logistics decision makers and is depicted in the infographic below (see Fig.7). The framework shows that on the supply level aspects such as the location, transport network infrastructure quality, legal framework, economic factors and external factors influence both the quality as well as the costs of transport. Indeed, from the supply side, the modal choice is mainly based upon two key drivers:

1) costs; 2) quality of transport service (door-to-door transit time, reliability, flexibility, safety/security, frequency, network coverage, bundling capacity, availability of loading units, information exchange, organization of the supply chain and complementary logistics services.)

These two key drivers are mainly influenced by the location of shippers, recipients and ports/terminals; the availability and quality of the transport network infrastructure; the legal and regulatory framework; economic factors; and external factors. Obviously, quality of transport also influences the transport costs. At the demand level, customers may have specific requests regarding the choice of a transport mode and the quality of transport based on the type of goods, the dimension of the shipments, costs, time and other factors.

Figure 7.Conceptual framework for a modal choice from PLATINA2 project



Source: PLATINA2 Deliverable 1.3, Comparison of Modal Shift Studies, 2014

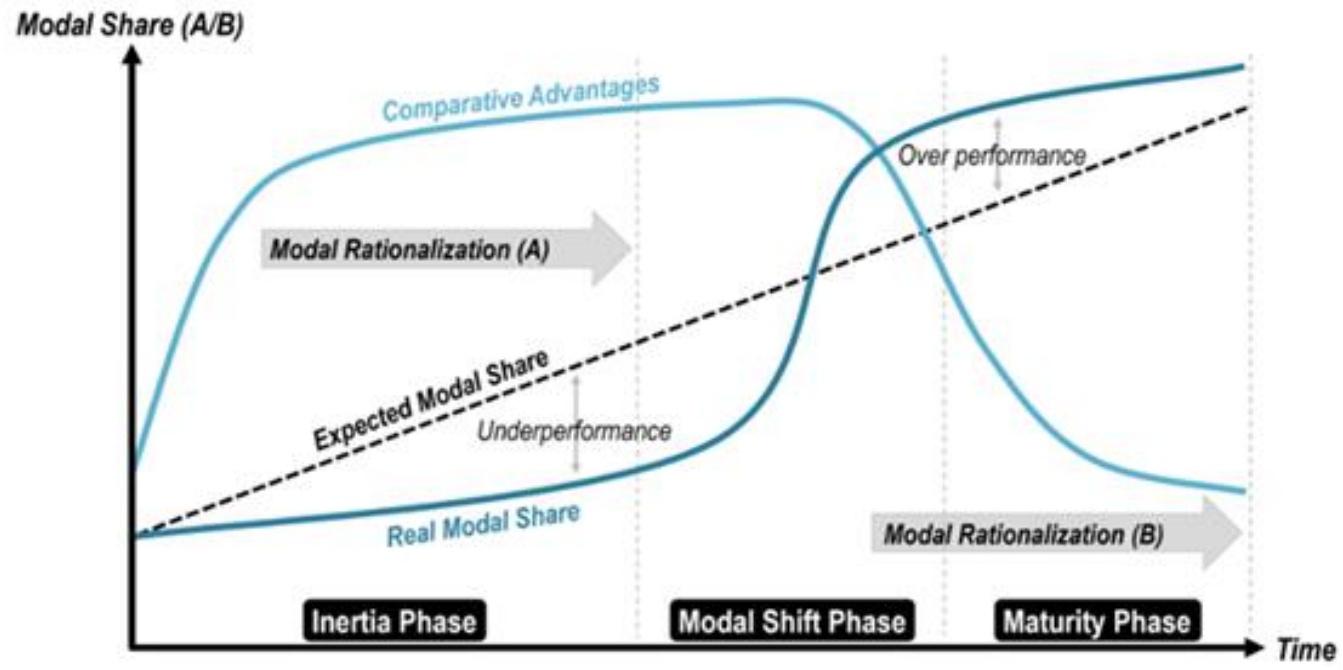
The PLATINA2 project reviewed also a number of practical cases, from which it became apparent that the most important criterion to select the transport solution is the total door-to-door cost. However, shippers are prepared to accept, for a certain period, a higher transport cost as long as the economic advantage on mid or long term is demonstrated. Furthermore, although environmental reasons are often mentioned as strategic driver, a shift to multimodal transport is usually only implemented if there is an economic advantage on business level.

4. Modal shift phases

Modal shift can be viewed as a process that occurs over several phases. These phases can vary depending on the specific context and the modes of transportation involved. However, by understanding the different phases of modal shift, stakeholders can develop strategies that take into account the unique challenges and opportunities of their specific context, and work towards a more sustainable and efficient freight transportation system.

According to Rodrigues (2020)[5], modal shift often takes place over three phases: inertia phase, modal shift phase and the maturity phase. The following section discusses all these phases, and the infographic below depicts the economic theory behind the concept.

Figure 8.Modal shift phases



Source : Rodriguez (2020)

4.1. The inertia phase

The inertia phase refers to a period of time when there is resistance to changing from one mode of transportation to another, despite the potential benefits of doing so. This resistance may be due to a variety of factors, including lack of information or awareness about alternative modes, a preference for established routines, or perceived risks or uncertainties associated with switching to a new mode. **The inertia phase can be a significant barrier to achieving modal shift and may require targeted efforts to overcome. These efforts may include education and outreach campaigns to raise awareness of the benefits of more sustainable modes of transportation, as well as incentives or regulatory changes that encourage the adoption of these modes.** It is important to note that the length and intensity of the inertia phase may vary depending on the specific context and the modes of transportation involved. For example, inertia may be less of a factor in industries where supply chains are more flexible and adaptable, or in regions where established intermodal transportation networks are already present.

[5] https://transportgeography.org/contents/chapter5/transportation-modes-modal-competition-modal-shift/

According to Rodriguez (2020), **the reasons behind inertia** are linked to accumulated investments and assets in the existing mode and its terminals. Thus, a corporation will be reluctant to relinquish those assets even if the comparative advantages of the other mode are significant. Management preferences also play a role as expertise was developed to manage flows in the previous mode, and may be difficult to adapt to the new mode. The negotiation of new procedures and contracts are tasks corporations are unwilling to undertake if the benefits are not readily apparent. The fact that the existing mode has proven reliability, even if costly, will also play in delaying modal shift. This may incite modal rationalization, implying that, given the existing (or perceived) competition, additional efforts will be made to more effectively use the assets of the existing mode. Supply chain management can also contribute to this inertia since a modal shift is likely to result in a change in the load unit, the frequency, and the time performance of freight flows, which requires an adjustment in practices. **The early adopters of a modal shift are thus likely to be new transport ventures willing to risk testing an unproven distribution system for the potential rewards of being the first. Enterprises already facing high transport costs on the existing mode, or entities receiving government subsidies (or being regulated) to do so are also potential early adopters.**

4.2. The modal shift phase

The modal shift phase refers to the time frame when **businesses and individuals begin to transition from less sustainable modes of transportation to more sustainable ones**. This phase typically follows the awareness and education phase, during which stakeholders are made aware of the benefits of more sustainable modes of transportation and the necessary infrastructure and operational changes are developed to support these modes.

During the modal shift phase, businesses and individuals may begin to use more sustainable modes of transportation, such as rail or inland waterways, in place of less sustainable modes such as road transportation. This may be driven by a variety of factors, including incentives or subsidies for using more sustainable modes, changes in pricing or regulations that make these modes more competitive, or improvements in the infrastructure and technology that support these modes.

The modal shift phase is an important step in the process of achieving a more sustainable and efficient freight transportation system. However, it is important to note that this phase may be challenging and may take time to fully realize. There may be lingering resistance or inertia among some stakeholders, and additional investments in infrastructure and technology may be necessary to fully support more sustainable modes of transportation.

4.3. The maturity phase

The maturity phase is the final phase of modal shift, following the modal shift phase. During the maturity phase, the use of more sustainable modes of transportation becomes more widespread and established, and the necessary infrastructure and operational changes are fully developed and optimized, thus implying limited incentives to shift cargo. At this point, the **market potential is reached with a new equilibrium in modal shares**. Their respective comparative advantages are of lesser variance, implying limited incentives to shift cargo. The focus becomes modal rationalization; **using modal assets more effectively and synchromodality** (as explained in PLATINA3 Deliverable 1.3). In the maturity phase, the use of more sustainable modes of transportation becomes the norm, and businesses and individuals are accustomed to using these modes as a regular part of their operations. This may be reflected in changes to supply chains, pricing and regulatory structures, and other aspects of the freight transportation system.

The maturity phase represents a sustainable state for the freight transportation system, with more efficient and sustainable modes of transportation being used to move goods in a way that reduces environmental impact, improves safety, and supports economic growth. However, it is important to note that achieving the maturity phase may require ongoing investments and efforts to maintain and improve the infrastructure and operational practices that support more sustainable modes of transportation.

4.4. Conclusion

Overall, the three phases of inertia, modal shift, and maturity provide a useful framework for understanding the process of shifting from road transportation to inland waterway transportation, and for identifying the key factors that may influence this process. Notwithstanding, these phases can vary depending on the specific market context. By understanding the different phases of modal shift, stakeholders can develop strategies that take into account the unique challenges and opportunities of their specific context, and work towards a more sustainable and efficient freight transportation system

5. Factors influencing modal shift decisions

According to Rodriguez (2020), a modal shift takes place in a context where from a macro perspective, there are changes in the transport supply due to changed market conditions and/or regulations or policies imposed. From a micro perspective, the decisions (behaviour) of companies (mostly for freight) are also changing. The modal shift decisions are influenced by both **endogenous factors (decisions by users and transport providers)** as well as **exogenous factors (cost factors, regulations, and policies**). (Rodriguez, 2020)

Endogenous factors refer to factors that are internal to the company, such as its operational efficiency, available resources, or business strategy. **Exogenous factors**, on the other hand, refer to external factors such as market conditions, regulations, and policies that may impact transportation choices.

- **Endogenous factors** that may influence a company's decision to shift to inland waterways transport mode could include things like the company's desire to reduce transportation costs or improve operational efficiency. For example, if a company operates in a region where waterways transportation is readily available and cost-effective, it may choose to shift its transportation mode to reduce costs and improve its bottom line.
- **Exogenous factors** that could influence a company's decision to shift to inland waterways transportation mode may include regulatory changes, changes in fuel costs, or concerns about the environmental impact of transportation. For example, if a government introduces regulations that incentivize or require companies to shift to more environmentally friendly transportation modes, companies may be more likely to consider shifting to inland waterways transportation to comply with these regulations.

Overall, both endogenous and exogenous factors can play a role in a company's decision to shift to inland waterways transportation mode. Companies need to consider both types of factors when making transport mode decisions to ensure they are making the most efficient and effective choices for their business.

In the context of the current report when discussing freight modal shift from road to inland waterway we will use the terms of **macro-level and micro-level factors. The Macro-level factors are the broad, overarching factors that impact the entire industry**, while **micro-level factors** are specific factors that affect individual companies or stakeholders. Micro-level factors could include the size and capacity of individual companies, the types of goods being transported, the specific logistics requirements of each shipment, and the capabilities and limitations of individual transportation modes. These factors are more specific to individual companies or stakeholders and can vary greatly depending on their circumstances.

5.1. Micro-level factors

5.1.1. Business models as enablers of modal shift

According to Makait (2022) a company's business model and its organizational structure, along with its service portfolio, as well as the degree of success in reaching its marketing and sales objectives will affect a company's (lack of) success when it comes to realising a modal shift. Nevertheless, the inclusion of the modal shift in a business model is a prerequisite. Accordingly, from a business economics perspective this is a key element which needs to be investigated. In the following sections some of the findings pertaining to this subject matter are presented in line with the Makait study.

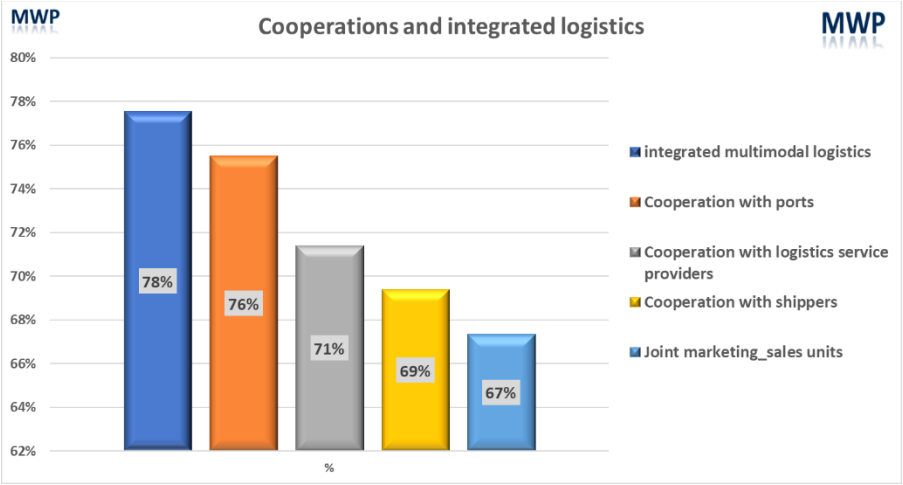
5.1.1.1. Services offered

Expanding the range of services offered by inland shipping companies often means offering integrated multimodal logistics services. In conjunction with multimodal logistics concepts, pre- and on-carriage services can also be offered. In addition, weather-related transport failures of the inland waterway can be partially compensated by using the road or rail. This is already being realized by various market participants. Since the market for integrated logistics services is a growth market, the ability to offer integrated logistics services is an important success factor.

However, small and medium-sized inland navigation companies are generally not in a position to implement integrated multimodal logistics services on their own. Therefore, for most of such smaller inland navigation companies, cooperation is an imperative to be able to offer integrated multimodal logistics services. Cooperation partners of inland shipping companies are mostly shippers, ports, logistics service providers and occasionally competitors of other means of transport. With this in mind, market participants were questioned in which areas cooperation would increase the attractiveness of inland navigation.

The following graph shows the answers to the question of whether and with whom cooperation makes sense for inland shipping companies and whether the service portfolio should be expanded to include integrated logistics services.

Figure 9. Cooperation and integrated logistics



Source : Makait, 2022

Accordingly, 78 % of the respondents see growth potential in the expansion of the offer in the direction of multimodal logistics concepts. Regarding cooperation, 76 % of respondents consider cooperation with ports and 71 % consider cooperation with logistics service providers to be sensible. Since other logistics service providers are necessary for the implementation of multi-modal logistics concepts, cooperation with them is inevitable.

In order to quickly achieve success in terms of multimodal logistics services, the cooperation with other logistics service providers should be relaunched as quickly as possible. This is also confirmed by most (91%) of the respondents who consider cooperations with logistics service providers and 82 % with shippers as measures that should be realized in the short term. A total of 67% consider the development of joint marketing and sales activities to be effective. The following figure shows the priority of the measures as a result of the analysis combined with the responses of the participants.

Figure 10. Cooperation, logistics concepts and marketing

Measures	Priority to ensure transport volume	Necessary implementation period	Growth effect	Need of public funding
Cooperation with ports				
Cooperation with shippers				
Cooperation with logistics service providers				
Joint marketing_sales units				
integrated multimodal logistics				

Source : Makait, 2022

Figure 11. Priorities to assure transport volumes

Priority to ensure transport volume	Necessary implementation period	Growth effect	Need of public funding
high	short time	lower	high
middle	middle	middle	middle
lower	long time	high	lower

Source : Makait, 2022

The greatest potential for growth is likely to arise from the integration of inland shipping into integrated multimodal logistics concepts. This means that larger companies in particular, belonging to a group of companies with a broad service portfolio, have the greatest chance of success. As already described elsewhere in the deliverables, larger investments will have to be made in inland navigation in the future. The capital required for this is usually easier for larger companies to obtain than small companies. Small and medium-sized companies should enter into cooperation with logistics partners as quickly as possible. Through cooperation and shared business interests, market potentials can be tapped and realized in the long term.

5.1.1.2. Sales

Another important aspect is sales. Inland shipping is in competition with trucks and trains. Road transport in particular mostly sells its services via forwarding agents. Most of the skippers have a forwarding agent or broker. These forwarding agents are in daily contact with their customers and often also pursue their own interests. Inland shipping companies should consider making even greater use of this distribution channel.

This means that smaller companies should cooperate with companies that are strong in sales as well as with companies that offer more complex logistics services, such as freight forwarders, ports and other logistic service providers.

Some larger corporate groups can often meet these requirements independently. They have their own sales organizations and can offer both transport and services such as transhipment in ports, interim storage and, in some cases, distribution by truck. Some companies also have a network of ports and terminals, as well as their own ships, trucks, and warehouses. By having their own sales organizations and transport infrastructure, these

large corporate groups can streamline their supply chain and gain greater control over their operations. They can also offer a more comprehensive suite of services to their customers, which can be a competitive advantage.

However, it's worth noting that even large corporate groups may sometimes need to partner with other companies to fully meet their logistical requirements. For example, they may need to outsource certain aspects of their operations if they don't have the necessary expertise or resources in-house. Additionally, partnering with other companies can help them access new markets and expand their reach.

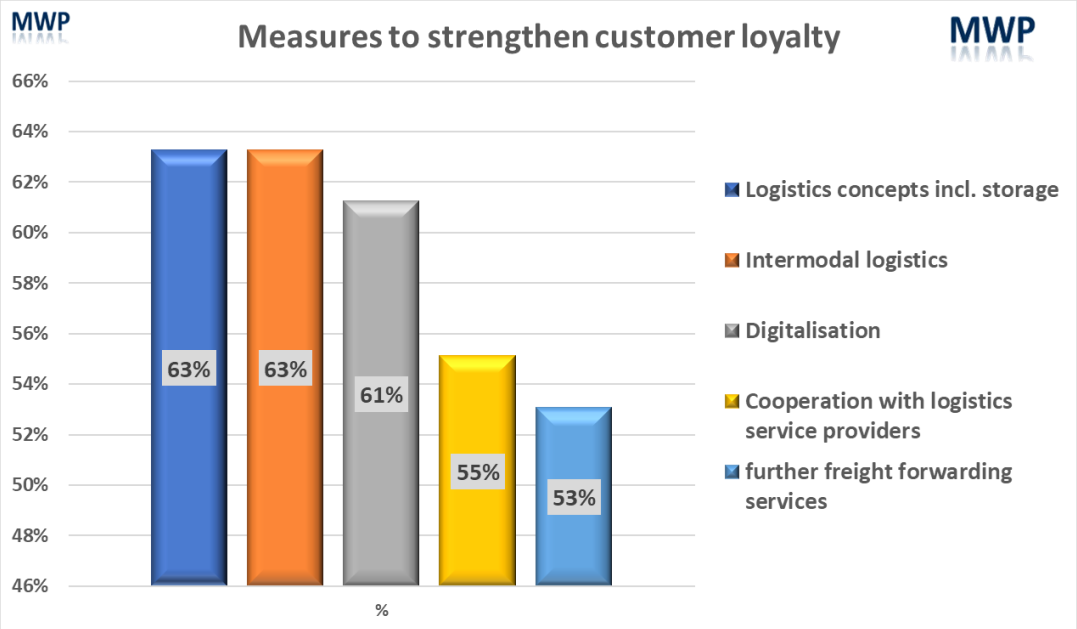
5.1.1.3. Implementation of intermodal integrated logistics concepts

A central point is cooperation on different levels. Stronger customer loyalty is a prerequisite for generating additional freight volume. According to the expert survey, the business models must be geared more towards the implementation of intermodal integrated logistics concepts, for example with the option of goods storage (63% need for action). In second place is digitalization with 61 %. With regard to digitization, there are already many close collaborations with customers, especially in larger inland shipping companies.

Examples are interfaces for order processing and information on transport processes. There is particular interest in setting up information systems about expected water levels and waiting times in front of locks. This information can be used for tracking and tracing information for customers and to optimize the use of inland waterways. These projects show the broad spectrum of aspects of digitization in inland navigation.

The advantage of adding freight forwarding services to the range of services is not rated as highly (53%). One reason for this could be the fear that in many cases this can only be achieved in close cooperation with freight forwarders and that direct customer contact could be lost as a result.

Figure 12. Measures to strengthen customer loyalty



Establishing regular traffic is a successful business model in many areas. This approach has already been implemented on a larger scale with container traffic. However, it can still be expanded and transferred to other areas with high demand. Overall, the analyses show that the current "business/operating models" need to be improved in many areas to achieve a modal shift from road to waterway. A key issue is the digitalization of

processes. This applies both to order processing, where medium sized and larger companies are already well advanced, and to process control.

There is further need for action with regard to cooperation, intermodal and integrated logistics concepts can often only be offered in conjunction with cooperative ventures. However, the need for action about cooperation differs greatly depending on the size of the company. Some large players already have Europe wide networks and can offer a wide range of ancillary services in addition to shipping. Previous analyses have shown that there is a considerable need for investment in fleet modernization. Many measures are unavoidable to continue to meet the requirements in terms of environmental compatibility. Many smaller companies will not be able to meet the resulting financing requirements without public subsidies. It is therefore to be expected that inland navigation, as in many other markets, will see a decline in the number of market participants and increasing concentration. An inland navigation company's business model, organizational structure, service portfolio, marketing, and sales strategies are all important factors that can impact its success in realizing a freight modal shift from road to inland waterways.

5.2. Macro-level factors

In the context of freight modal shift from road to inland waterway, **macro-level factors** are the broad, overarching factors that impact the entire industry. **Some examples of macro-level factors** in freight modal shift could be government policies and regulations, economic conditions, environmental concerns, and technological advancements. These factors impact the entire industry, and companies within the industry must respond to them to remain competitive. Indeed, **macro-level factors**, such as a change in fuel prices, tolls or taxes, regulations on emissions or safety, or changes in market demand can have a significant impact on a company's decision to shift from one mode of transport to another. Alternatively, government policies aimed at promoting sustainable and efficient transport systems, such as incentives for using IWT, can also encourage modal shift.

Table 1. Macro-level factors that can impact a company's decision to modal shift

Macro-Level Factors	Change in Fuel Prices	Tolls or Taxes	Regulations on Emissions and Safety	Changes in Market Demand	Government Policies
Impact on Modal Shift Decision	X	X	X	X	X
Example of Impact	Increase in fuel prices may motivate companies to switch to more fuel-efficient modes of transport	Changes in tolls or taxes may make certain modes of transport more or less cost-effective	Stricter regulations on emissions may make certain modes of transport less attractive	Changes in market demand may encourage companies to shift to more efficient or sustainable modes of transport	Government incentives for using IWT can encourage modal shift
Additional Information	-	-	-	If consumers demand more sustainable transportation options, companies may be motivated to invest in more sustainable transport solutions.	-

In this matrix, an "X" indicates the impact of a particular macro-level factor on the decision to shift modes of transportation. It can be seen that changes in fuel prices, tolls or taxes, regulations on emissions and safety, changes in market demand, and government policies can all have a significant impact on a company's decision to shift from one mode of transport to another.

For example, if fuel prices increase, companies may be more motivated to switch to more fuel-efficient modes of transport, such as rail or waterways, to reduce their transport costs. Similarly, changes in tolls or taxes may make certain modes of transport more or less cost-effective, depending on the specific circumstances. Regulations on emissions and safety can also play a role in shaping transport choices. For example, stricter regulations on emissions may make certain modes of transport less attractive. Another element is regulations that prioritize safety. This may encourage companies to invest in safer and efficient transport options, especially for dangerous goods (e.g. chemical products) which have high external safety risks and are better to be transported by IWWs compared to trucks or railways. Finally, government policies aimed at promoting sustainable and efficient transport systems, such as incentives for using IWT, can also encourage modal shift.

Also, micro-level factors , can influence companies to shift from one mode of transport to another. These factors **can include the cost of transport, transit time, reliability, capacity, speed, and environmental impact** (Fig.13).

This matrix provides a broad overview of how micro-level factors can impact modal shift decisions at the company level. However, the actual impact of these factors can vary depending on the specific context and needs of each company. An "X" has been included in the "Impact on Modal Shift Decision" column to indicate that each of these factors can influence a company's decision to shift modes of transport. For example, a lower cost of transport may make IWT more cost-effective than road transport, while a longer transit time may make IWT less attractive for time-sensitive deliveries.

Figure 13.Micro-level factors influencing modal shift

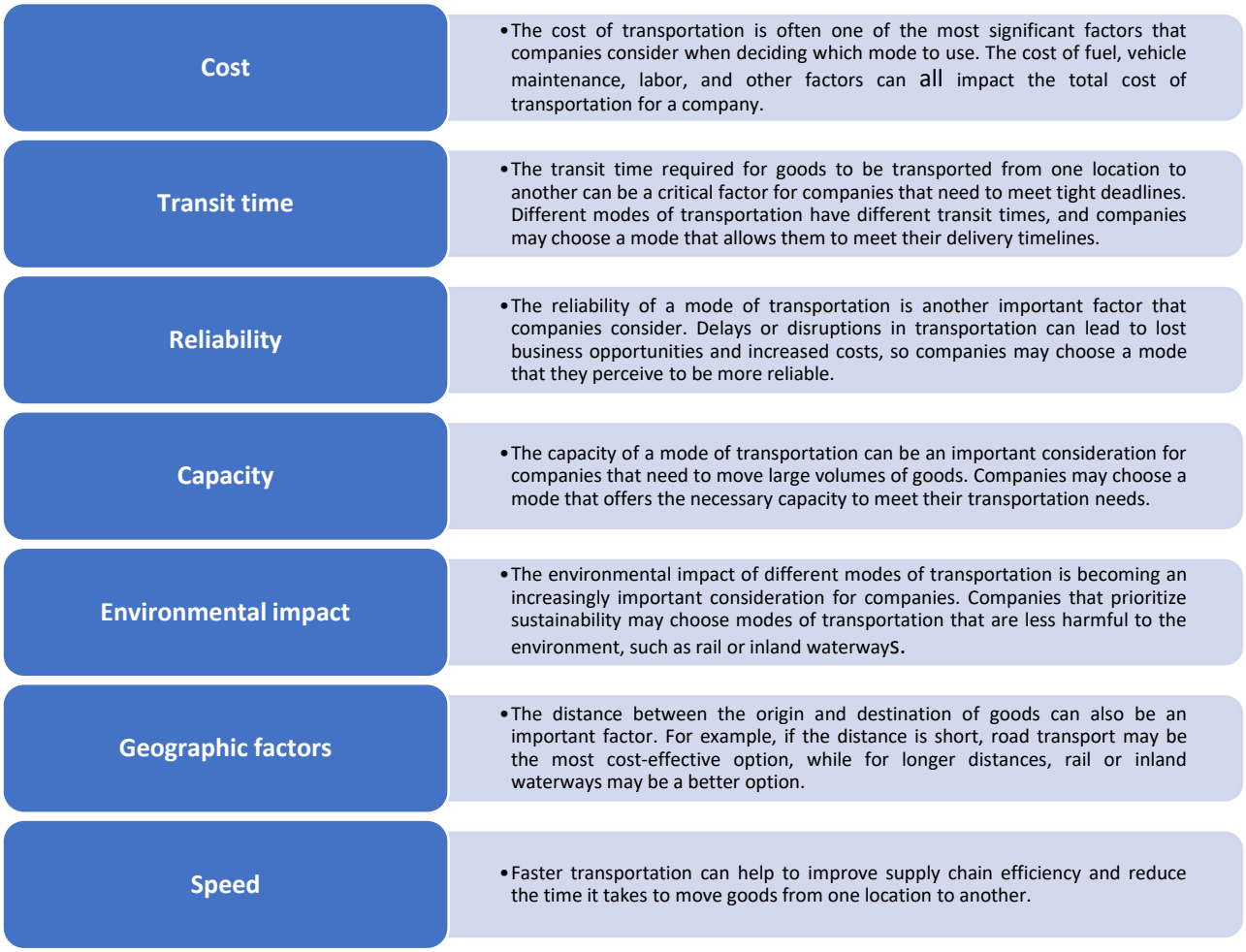


Table 2. Micro-level factors likely impact on a company's decision to modal shift

Micro -Level Factors	Cost of transport	Transit time	Reliability	Capacity	Speed	Envoironmnetl impact	Geographical factors
Impact on Modal Shift Decision	X	X	X	X	X	X	X
Example of Impact	Companies are likely to choose modes of transportat that offer lower costs, especially for bulkier or heavier goods.	Transit time can be a crucial factor, as companies may prefer faster modes of transport to ensure timely delivery of goods.	Companies are likely to choose transport modes that have a high level of reliability to avoid potential delays and disruptions to their supply chain.	The capacity of the transport mode is also important, as companies need to ensure that their goods can be transported in the required quantity.	Speed is another critical factor that companies consider, as it directly affects transit time and delivery speed.	Companies are increasingly concerned about the environmental impact of their transport choices and may prefer modes of transport that have a lower carbon footprint.	Geographical factors such as the location of the origin and destination, terrain, and infrastructure can affect modal shift decisions. Companies may need to consider factors such as waterways conditions, accessibility, and the availability of transport options.

Table 3.Micro-level factors' impact on modal shift decisions from road to inland waterway at the company level during the three phases of the modal shift

Micro-Level Factors	Inertia Phase	Modal Shift Phase	Mature Phase
Cost of Transport	Companies may not consider IWT due to a lack of awareness or familiarity with the mode.	Companies may start to explore IWT as a cost-saving option and may experiment with small-scale transport trials.	Companies may have established contracts with IWT providers and have optimized their supply chain to use this mode.
Transit Time	Companies may perceive IWT as too slow and may not consider it as an option for time-sensitive goods.	Companies may start to explore IWT for non-time-sensitive goods and may try to optimize their supply chain to reduce transit times.	Companies may have established reliable transport schedules and have incorporated IWT into their standard supply chain procedures.
Reliability	Companies may perceive IWT as unreliable due to concerns about weather, water levels, or infrastructure.	Companies may start to explore IWT options that offer higher reliability or may develop contingency plans to manage potential disruptions.	Companies may have established relationships with reliable IWT providers and have implemented risk management strategies to ensure continuity of supply.
Capacity	Companies may perceive road transport as more flexible and adaptable to changing demand levels.	Companies may start to explore IWT for larger or bulkier goods and may develop strategies to optimize their transport capacity.	Companies may have established a reliable transport network with IWT providers and have optimized their supply chain to make the most of this mode's capacity benefits.
Speed	Companies may perceive road transport as faster and more responsive to changing demand levels.	Companies may start to explore IWT for longer distances and may develop strategies to optimize their transport times.	Companies may have established reliable transport schedules with IWT providers and have optimized their supply chain to balance speed and cost factors.
Environmental Impact	Companies may not prioritize environmental concerns in their transport decisions.	Companies may start to explore IWT as a more sustainable option and may seek out providers with strong environmental credentials.	Companies may have incorporated environmental considerations into their standard transport policies and have developed a reputation for sustainable transport practices.
Geographical Factors	Companies may be limited by the availability of IWT options in their region or may not consider it as a viable option due to infrastructure limitations.	Companies may start to explore IWT options in nearby regions or may invest in transport infrastructure to support this mode.	Companies may have established reliable transport networks with inland waterway providers and have optimized their supply chain to make the most of the available transport infrastructure.

Potential facilitators and solutions for each of the micro-level factors that impact modal shift decisions from road to inland waterway transport, along with the actors that may be involved

1.Cost of Transport	
	•**Facilitators:** government subsidies or tax incentives for inland waterway transport, price transparency and competition among transport providers, economies of scale from increased transport volumes
	•**Actors:** government bodies, transport providers, industry associations
2.Transit Time	
	•**Facilitators**: improvements in infrastructure and technology to reduce transit times, development of intermodal transport solutions that combine inland waterway transport with other modes (such as road or rail), optimization of supply chain processes to reduce lead times
	•**Actors:** transport providers, infrastructure operators, logistics companies
3. Reliability	
	•**Facilitators:** investment in infrastructure maintenance and upgrades, use of weather forecasting and monitoring technologies to manage risk, development of contingency plans and alternative transport routes
	•**Actors:** infrastructure operators, transport providers, risk management experts
4.Capacity	
	•**Facilitators:** development of standardized container sizes and handling procedures, investment in port infrastructure to improve loading and unloading efficiency, collaboration among transport providers to increase capacity utilization
	•**Actors:** transport providers, port operators, industry associations
5. Speed	
	•**Facilitators:** investment in infrastructure improvements (such as channel deepening or lock upgrades) to improve vessel speeds, use of digital technologies to optimize transport routes and reduce waiting times, development of intermodal transport solutions that combine inland waterway transport with other modes to reduce overall transit times
	•**Actors:** infrastructure operators, transport providers, technology companies
6.Environmental Impact	
	•**Facilitators:** government policies and regulations that incentivize sustainable transport practices, use of low-emission vessels and fuels, development of environmental certifications and labelling schemes for transport providers
	•**Actors:** government bodies, transport providers, sustainability experts
7.Geographical Factors	
	•**Facilitators:** investment in transport infrastructure to support inland waterway transport, development of intermodal transport solutions to connect different transport modes, promotion of regional or national inland waterway transport networks
	•**Actors:** government bodies, infrastructure operators, transport providers, industry associations

6. Economic and financial barriers to modal shift

Economic barriers refer to factors that limit or impede economic activities due to economic reasons, such as high transportation costs, lack of infrastructure, tariffs and trade barriers, limited access to financing, and market access barriers. Economic barriers are often broader in scope and affect multiple actors in the economy, such as businesses, consumers, and governments.

On the other hand, financial barriers refer to factors that limit or impede economic activities due to financial reasons, such as insufficient access to credit or capital, high interest rates, and lack of financial resources. Financial barriers are often more specific to individual actors in the economy, such as businesses and consumers.

The relationship between economic and financial barriers is that financial barriers can be a component of economic barriers. For example, limited access to financing can be an economic barrier to freight transport because it can limit the ability of businesses to invest in the equipment or technology necessary to transport goods efficiently. In this case, the financial barrier is a contributing factor to the broader economic barrier.

Overall, economic and financial barriers are interrelated concepts that can impact freight transport and other economic activities. By understanding the differences and relationship between these two concepts, policymakers and businesses can develop strategies to address these barriers and promote economic growth and development.

Economic and financial barriers are related concepts but refer to different factors that can impede economic activities, including freight transport.

6.1. Economic barriers to modal shift

Economic barriers to modal shift refer to factors that prevent or discourage **transport companies** and **shippers** from choosing alternative modes of transport that are more environmentally sustainable or cost-effective. These barriers can include **high initial costs**, **limited infrastructure**, **lack of government support**, and **market distortions**, among others. They can hinder or prevent companies from choosing alternative modes of transport that are more environmentally sustainable or cost-effective. The economic barriers can be related to various factors, such as pricing, competition, market conditions, and infrastructure. Some examples of economic barriers to modal shift may include:

- **High Initial Costs**: The initial costs associated with switching to an alternative mode of transport, such as inland navigation, can be high. These costs can include investments in new equipment, facilities, and personnel.
- **Limited Infrastructure**: In some cases, the infrastructure required to support alternative modes of transport, such as inland navigation, may be limited or inadequate. This can include issues such as insufficient port facilities, insufficient locks and dams, or limited access to waterways.
- **Lack of Government Support**: The lack of government support or incentives for modal shift can also be an economic barrier. Government support can include funding for infrastructure, subsidies, or tax incentives.
- **Market Distortions:** Distortions in the market, such as subsidies or tariffs, can also be an economic barrier. These distortions can make alternative modes of transport less competitive in terms of pricing or reduce the demand for alternative modes of transport.
- **High infrastructure costs:** Developing and maintaining waterway infrastructure can be costly, and this can deter shippers and carriers from choosing IWT as their preferred mode of transport. The costs of building and maintaining locks, dams, and navigation channels can be high, and these costs may need to be passed on to the users of the waterway system.
- **Limited access and connectivity**: In some regions, the waterway system may be limited or disconnected from major transportation hubs, making it less attractive as a transportation option. This can make it

difficult for shippers and carriers to access waterway transport and may limit the frequency and reliability of waterway services.

- **Limited capacity**: In some cases, the capacity of the waterway system may be limited, which can lead to congestion and delays. This can make waterway transport less reliable and less attractive as a transportation option, especially for time-sensitive goods.
- **Price competition from other modes**: In some cases, other transportation modes such as road and rail may offer lower prices than IWT. This can make it challenging for waterway transport to compete on price, even if it offers other advantages such as environmental sustainability.
- **Lack of standardization**: The lack of standardization in waterway transport can make it challenging for shippers and carriers to use the system effectively. Different countries may have different rules and regulations, which can create confusion and add complexity to the decision-making process.
- **Uncertainty and risk**: The uncertainty and risk associated with waterway transport can also be a barrier to its adoption. For example, water levels can vary, making it difficult to predict delivery times accurately. This can lead to additional costs and uncertainty for shippers and carriers.
- **Limited intermodal options**: Intermodal transportation, which involves using multiple modes of transportation to move goods, is often seen as a more efficient and cost-effective option for shippers and carriers. However, the limited intermodal options for waterway transport can make it less attractive as a transportation option compared to other modes such as road and rail.
- **Perception of unreliability**: In some cases, waterway transport may be perceived as less reliable than other modes of transport such as road and rail. This can be due to factors such as weather-related disruptions, which can make it difficult to deliver goods on time. This perception of unreliability can deter shippers and carriers from choosing waterway transport as their preferred mode of transport.

In general, these economic barriers can make it challenging for shippers and carriers to choose IWT as their preferred mode of transport. Addressing these barriers will require a coordinated effort from key stakeholders to invest in waterway infrastructure, improve access and connectivity, increase capacity, standardize regulations, and reduce uncertainty and risk.

6.1.1. Impact of the economic barriers

In the inertia phase, most of the economic barriers have a high impact as the shift from one mode of transport to another requires significant effort and investment. In the modal choice phase, the impact of high infrastructure costs, limited access and connectivity, price competition from other modes, limited capacity, and limited intermodal options remains high as shippers and carriers evaluate different options and decide on the preferred mode of transport.

In the maturity phase, the impact of economic barriers decreases as waterway transport becomes a more established and reliable option, with the exception of limited infrastructure in inland areas which may remain a high impact barrier due to the need for investment in infrastructure. The perception of unreliability may also decrease as the waterway transport system becomes more established and reliable.

In the inertia phase, lack of government support and market distortions are likely to have a high impact as the shift to waterway transport requires government support and a level playing field in the market. In the modal choice phase, the impact of lack of government support and market distortions remains high as shippers and carriers evaluate different options and consider the level of government support and market distortions in their decision-making. In the maturity phase, the impact of Lack of Government Support and Market Distortions decreases as the

waterway transport system becomes more established and the market becomes more competitive and regulated. However, lack of government support may remain a barrier in the maturity phase if the government does not continue to support and invest in the waterway transport system. market distortions may also remain a barrier if there are still significant imbalances in the market that disadvantage waterway transport compared to other modes of transport.

Overall, these economic barriers can make it difficult for companies to shift from traditional modes of transport, such as road transportation, to alternative modes, such as inland navigation. To overcome these barriers, companies may need to explore alternative strategies, such as collaborating with other companies to share costs or working with government entities to secure funding and support for modal shift initiatives.

Table 4.Impact of economic barriers to modal shift from road to IWT along the different phases of the modal shift

Economic Barrier	Inertia Phase	Modal Choice Phase	Maturity Phase
High infrastructure costs	High impact	High impact	Moderate impact
Limited access and connectivity	Moderate impact	Moderate impact	Low impact
Limited capacity	Low impact	High impact	High impact
Price competition from other modes	Low impact	High impact	High impact
Lack of standardization	Moderate impact	Moderate impact	Low impact
Uncertainty and risk	Moderate impact	Moderate impact	Low impact
Limited intermodal options	Low impact	High impact	High impact
Lack of infrastructure in inland areas	Low impact	Moderate impact	High impact
Perception of unreliability	Moderate impact	High impact	Low impact
Lack of Government Support	High impact	High impact	Low impact
Market Distortions	High impact	High impact	Low impact

6.2. Financial barriers to modal shift

Financial barriers to modal shift in freight transport from road to inland navigation refer to the costs associated with using inland navigation as a mode of transport instead of road transportation. These costs can act as a barrier to companies that may be considering shifting from road transportation to inland navigation. Some examples of financial barriers to modal shift in freight transport from road to inland navigation may include:

- **Capital Costs: The cost of capital required to start an inland navigation service can be a financial barrier. This includes the cost of purchasing or leasing equipment, constructing or leasing port facilities, and establishing relationships with customers and suppliers.**

This includes the **high upfront investment costs associated with IWT**, as well as the **lack of access to financing for vessel acquisition** and port, terminal and waterway **infrastructure development**. Additionally, IWT may not be financially viable for smaller shippers, as they may not have the volume of goods required to justify the cost of using IWT. In addition, it is reported that shipping companies establishing new, regular IWT services are encountering certain financial barriers. Indeed, there can be various financial barriers that shipping companies may face when establishing new, regular IWT services. These barriers could include high initial investment costs for acquiring or leasing suitable vessels, as well as additional costs associated with adapting existing infrastructure, such as ports and terminals, to accommodate IWT operations. Additionally, shipping companies may face uncertainties and risks associated with the demand for their services, especially in cases of fluctuating, little or no existing market for IWT on a particular route. However, various support measures and financial incentives may be available from policy makers to mitigate these barriers and encourage investment in IWT[6].

- **Infrastructure Costs:** The cost of building or improving port infrastructure to facilitate inland navigation can be a significant financial barrier. This includes the cost of constructing new port facilities, dredging waterways, and installing navigation aids.
- **Equipment Costs:** The cost of acquiring and maintaining the barges and tugboats used in inland navigation can be a financial barrier. This includes the cost of purchasing or leasing barges and tugboats, as well as the cost of fuel, maintenance, and repairs.
- **Regulatory Costs:** cost generated by the compliance with environmental and safety regulations can result in a financial barrier for companies considering shifting from road transportation to inland navigation. This includes the cost of meeting emissions standards and ensuring compliance with safety regulations.
- **Intermodal Costs:** The cost of transferring cargo between different modes of transport can be a financial barrier. This includes the cost of transshipment and intermediate storage facilities, as well as the cost of handling and loading cargo onto barges.
  Indeed, transhipment costs can be a significant mode-specific variable cost. Transhipment refers to the process of transferring cargo between different modes of transport, such as from a road or rail transport to a barge. This process can involve a number of different costs, including:
  - Handling costs: Transhipment involves handling cargo multiple times, which can lead to additional handling costs.
  - Storage costs: If the cargo needs to be stored while it is being transferred between modes of transport, this can add to the overall cost of the transport.
  - Equipment costs: Transhipment may require specialized equipment, such as cranes or forklifts, which can add to the cost of the transport.
  - Delay costs: Transhipment can add to the overall transport time, which can lead to additional costs such as demurrage charges for delayed cargo.

In addition to transhipment costs, there may be **other mode-specific variable costs associated with IWT**, such as fees for using locks or bridges, as well as costs associated with maintaining waterway infrastructure. These costs strongly vary depending on the specific inland waterway and the country in which it is located. It is important for cargo owners and logistics providers to be aware of these costs and factor them into their transport planning and decision-making processes. In the main IWT countries in Europe where the majority of inland waterway transport takes place (*e.g*. Germany, Belgium and The Netherlands), such mode specific costs are very low or even zero for

[6] *Sara Rogerson, Vendela Santén, Martin Svanberg, Jon Williamsson & Johan Woxenius (2020) Modal shift to inland waterways: dealing with barriers in two Swedish cases, International Journal of Logistics Research and Applications, 23:2, 195-210, DOI: 10.1080/13675567.2019.1640665*

the operator as the maintenance of waterways is paid by the administrations (public funds), also in view of the Act of Mannheim in which it was agreed not to charge for the usage of the Rhine waterway.

Also, the **fixed costs of transport by barge** via terminals can be a significant factor in influencing modal shift from road to inland waterways. The fixed costs associated with barge transport, such as the cost of owning and operating the barge and terminal fees, are typically higher than the variable costs associated with road transport, such as fuel and driver wages. However, for longer distances and larger volumes of goods, the per-unit cost of barge transport can be significantly lower than that of road transport due to the economies of scale associated with larger vessels. At longer distances the costs for transhipment, storage and pre/end haulage are being offset by lower direct costs per kilometre of barge transport. Additionally, the fixed costs of barge transport are more predictable and stable than the variable costs of road transport, which are subject to fluctuations in fuel prices and other market factors. This can provide greater certainty for shippers and logistics providers in terms of budgeting and planning and may make barge transport a more attractive option for certain types of shipments. However, in many cases the lack of return load is a barrier for efficient transport chains using inland waterways, while road transport is more flexible in this respect.

Overall, while the fixed costs of barge transport can be a barrier to entry for some shippers and logistics providers, they may also be an important factor in driving modal shift from road to inland waterways for certain types of shipments where the advantages of barge transport outweigh the **higher upfront costs**, such as:

- **High volume**: Barge transport is most cost-effective for large-volume shipments, particularly those with consistent demand in both directions. This is because the fixed costs of barge transport can be spread over a larger number of units, resulting in lower per-unit costs. For example, commodities such as coal, aggregates, and grains are often transported by barge because they can be moved in large quantities and are often classified as ‘captive markets for IWW’ as other transport modes cannot provide competitive alternatives.
- **Heavy cargo**: Barge transport is particularly well-suited for heavy cargo, as barges can carry much larger loads than trucks or trains. This is particularly advantageous for shipments that are too heavy for standard road transport, such as construction equipment, large machinery, or oversized components.
- **Low value-to-weight ratio**: Barge transport can be a cost-effective option for shipments with a low value-to-weight ratio, as the cost of transport per unit of weight is relatively low. For example, bulk commodities such as sand, gravel, and other aggregates can be transported by barge because they are relatively low in value, therefore not time critical from a financial perspective but high in weight.
- **Longer distances**: Barge transport can be more cost-effective than road or rail transport for longer distances, particularly when the cargo is not time-sensitive. This is because the cost of fuel and other variable costs associated with barge transport are relatively low, while the fixed costs (e.g. cargo handling at ports, pre and end haulage) can be spread over a longer distance.
- **Environmentally friendly**: Barge transport is, when used at high load rates, a more environmentally friendly option compared to road transport, particularly for longer distances and larger volumes of cargo. This is because barge transport produces lower greenhouse gas emissions per unit of cargo moved than road transport, and can reduce the noise hindrance, safety risks, congestion and wear and tear on roads. When using modern engines in a barge (e.g. Stage V NRE or marinized Euro VI engines), there is also a clear advantage on the reduction of air pollutant emissions such as NOx and particulate matter.

To conclude, these financial barriers can make it difficult for companies to shift from road transportation to inland navigation. To overcome these barriers, companies may need to carefully consider the costs and benefits of using inland navigation as a mode of transport and develop strategies to manage the costs associated with this mode of transport. This may include partnering with other companies to share infrastructure and equipment costs, seeking financial assistance from government programs or private investors, and investing in intermodal facilities to reduce transfer costs.

6.2.1. Impact of the financial barriers to modal shift

Table 5. Impact of financial barriers to modal shift from road to IWT along the different phases of the modal shift

Financial Barrier	Inertia Phase	Modal Choice Phase	Maturity Phase
Infrastructure Costs	High impact	High impact	Low impact
Equipment Costs	High impact	Moderate impact	Low impact
Intermodal Costs	High impact	Moderate impact	Low impact
Capital Costs	High impact	High impact	Low impact
Regulatory Costs	High impact	Moderate impact	Low impact

In the inertia phase, all of these financial barriers are likely to have a high impact. During this phase, shippers and carriers may be resistant to change and may be unwilling to invest in the infrastructure, equipment, or capital necessary to make the modal shift to inland navigation.

During the modal choice phase, some shippers and carriers may be more open to considering inland navigation as an alternative to road transport. However, financial barriers such as equipment costs and intermodal costs may still have a moderate impact on their decision-making.

In the maturity phase, the impact of these financial barriers is likely to be much lower. As more shippers and carriers adopt inland navigation, the infrastructure and equipment necessary to support it may become more widely available and less expensive. In addition, regulatory costs may be reduced as governments and other stakeholders become more familiar with the benefits of inland navigation.

Overall, these financial barriers are likely to have the greatest impact during the inertia and modal choice phases of the modal shift from road to inland navigation. To overcome these barriers, shippers, carriers, and governments will need to work together to invest in the necessary infrastructure and equipment, reduce intermodal costs, and provide financial incentives to support the transition to inland navigation.

6.3. IWT specific barriers which generate additional costs and possible solutions

Table 6. IWT specific barriers and possible solutions

Barrier	Type
Complexity of transport chains	**Operational (mainly) and technical**
Shipping freight on IWW often entails high costs, as a result of the need to use road transport to bring the goods to the IWW network from origins that are spread over a wide area, and subsequently to a wide range of disparate destinations. One of the challenges of using inland waterway transport (IWT) is that it often involves additional pre- and post-haulage costs, particularly if the origin or destination of the cargo is not located directly on the IWT network. In many cases, cargo must be transported by road to or from the nearest inland port or waterway terminal, which can add to the overall cost of the shipment. Additionally, even when cargo is transported on the IWT network, it may need to be transhipped or stored at port facilities before being loaded or unloaded from a barge. This can result in additional costs for handling and storage, particularly if there is limited capacity available or if cargo needs to be stored for an extended period of time. This is also due to lack of clustering of industrial and logistics sites in the vicinity of terminals and along the waterways. Transhipment and storage costs, including port charges, can be high, for example when port dues are levied based upon the gross load capacity of the barge, instead of the actual load volume being transhipped. This complexity is also visible in the container transport segment characterised by a complex system with many different actors. Today, inefficiencies in container handling as well as congestion in seaports have a negative impact on container barge handling which results from disruptions at different levels of the container supply chain and with multiple underlying factors (a more detailed analysis of container barge handling in seaports is available in Annex 5) Shipping freight on IWW often entails high costs, as a result of the need to use road transport to bring the goods to the IWW network from origins that are spread over a wide area, and subsequently to a wide range of disparate destinations. One of the challenges of using inland waterway transport (IWT) is that it often involves additional pre- and post-haulage costs, particularly if the origin or destination of the cargo is not located directly on the IWT network. In many cases, cargo must be transported by road to or from the nearest inland port or waterway terminal, which can add to the overall cost of the shipment. Additionally, even when cargo is transported on the IWT network, it may need to be transhipped or stored at port facilities before being loaded or unloaded from a barge. This can result in additional costs for handling and storage, particularly if there is limited capacity available or if cargo needs to be stored for an extended period of time. This is also due to lack of clustering of industrial and logistics sites in the vicinity of terminals and along the waterways. Transhipment and storage costs, including port charges, can be high, for example when port dues are levied based upon the gross load capacity of the barge, instead of the actual load volume being transhipped. This complexity is also visible in the container transport segment characterised by a complex system with many different actors. Today, inefficiencies in container handling as well as congestion in seaports have a negative impact on container barge handling which results from disruptions at different levels of the container supply chain and with multiple underlying factors (a more detailed analysis of container barge handling in seaports is available in Annex 5).	
To address these challenges, it is important for logistics providers and cargo owners to carefully plan their shipments and work closely with IWT operators to optimize the use of available capacity and minimize the need for pre- and post-haulage by road. This may involve coordinating shipments to reduce wait times at port facilities, using advanced tracking and monitoring technologies to improve supply chain visibility and reduce the risk of delays or lost cargo, and investing in new infrastructure to expand the IWT network and improve access to inland ports and waterway terminals.	
Market cooperation	**Operational - administrative**
Competition between logistics service providers and the confidentiality of client data result in a lack of willingness to cooperate and share information. This results in fragmented services and a lack of critical mass to set up efficient and high-quality intermodal solutions.	
In order to promote modal shift, projects can be supported to analyse and demonstrate the added value of working together and to develop models for gain sharing and risk mitigation and starting up alliances and joint undertakings.	

Quality and density of the network	Technical - operational
Inadequate infrastructure (i.e. bottlenecks and missing links) is a major obstacle to inland navigation. The most common types of river bottlenecks and missing links are bridge clearance, adequate waterways and locks. On the land side, a lack of infrastructure and services, quays and terminal equipment, storage facilities and value-added services limit the smooth transfer between modes; thus hampering innovative multimodal concepts. For example, empty container depots, reefer plugs, container repair facilities, stuffing and stripping services for containers. Other limitations depend on limited opening hours and the locations that are available for terminal expansion.	
In order to promote modal shift, it is important to provide legal and financial support from the side of governments for development of the infrastructure and also to embed this in regional and national land use planning. Public private partnerships for such developments can be established.	
Information technology	**Technical - operational**
Technical and operational barriers are linked to the lack of availability and transparency of freight flow information, in combination with limited ICT facilities, as well as an absence of standards for communication and information exchange. Lack of information exchange and collaborative planning results in long waiting times for barges in seaports. This hampers the success of multimodal hinterland transport. In particular, the absence of real-time traffic information and forecasts about the traffic on the multimodal transport network has a negative impact on the efficiency and reliability of multimodal transport.	
In order to promote modal shift, projects can be started to develop information sharing platforms and exchange and planning platforms such as for example Nextlogic for container handling in the Rotterdam area.	
Navigability	**Technical - operational**
Low waters can limit proper navigation on inland waterways which could become an increasing challenge due to climate change. In fact, low waters in general have a negative impact on the cargo volumes transported on inland waterways. This is due to the reduction in the available draught of a vessel if there is less water under the keel. Such phenomena limit the potential to use large vessels. As a result, a larger number of barges or an increase in the turnaround of vessels is needed to transport the same amount of cargo in a period of low water as capacity is reduced on all vessels. In certain cases, in particular if the low water period is lasting for several weeks, and if water levels drop below a critical threshold, the resulting reduction in commodity transport volume can also affect industrial production. Low waters also lead to an increase in transport costs of inland navigation.	
In order to promote modal shift, projects can be started to mitigate the climate change (low water) impacts with reference to examples and recommendations from the PLATINA3 Deliverables 2.2 and 4.1.	
Vessels adapted to certain goods and IWWs	**Technical - Operational**
Indeed, inland waterways often have restrictions on the size, draft, and dimensions of vessels that navigate them, which limits the types of cargo that can be transported and the vessels that can be used for transport. This may lead to a situation where vessels are highly specialized for certain types of cargo and not suitable for transporting other types of goods, which limits the flexibility of the transport system. In addition, the second-hand market for vessels in inland waterway transport is relatively small, which could make it difficult to acquire vessels at a reasonable cost. This is partly because vessels are often highly specialized for certain types of cargo and may not be suitable for other types of goods, which limits the potential pool of buyers. As a result, vessel owners may be less likely to invest in new vessels, which can lead to an aging fleet and a shortage of suitable vessels for certain types of cargo. Overall, this may add to the costs of IWT and make it less attractive for certain types of cargo or for vessel owners. However, there are also efforts underway to address these challenges, such as the development of more standardized vessel designs and the promotion of vessel sharing arrangements to improve vessel utilization and reduce costs.	
In order to promote modal shift, financial support and RD&I projects could be provided to develop new vessel types focussing on new markets for IWT and modal shift, as an example, vessels and intermodal solutions able to efficiently move (continental) cargo, such as palletized goods currently transported by road.	

7. Overcoming barriers to modal shift

7.1. Potential public policies and support measures

Public policies and support measures by policy makers at national and regional level can be developed to encourage and facilitate the shift towards inland waterways transport (IWT), address key barriers and create a more favorable framework conditions for IWT.

1. **Awareness and information:** raising awareness of the benefits of IWT and providing information to stakeholders about the opportunities and challenges associated with this mode of transport.
   - Develop educational and outreach programs to raise awareness of the benefits of IWT and promote its use to potential users.
   - Provide training and education programs for transport professionals to increase their knowledge and skills related to IWT.
   - Conduct research and analysis to better understand the market demand and potential for IWT.
2. **Infrastructure and logistics:** developing the necessary infrastructure and logistics systems to support IWT, such as improving port facilities, developing intermodal connections, and creating a reliable and efficient transport network.
   - Invest in waterway infrastructure, such as locks, dams, and navigation channels, to improve the capacity and efficiency of the waterway system.
   - Develop intermodal connections between waterways and other modes of transport, such as road and rail, to improve access and connectivity.
   - Provide financial support and incentives for private sector investment in waterway infrastructure and logistics systems.
3. **Market development and promotion**: promoting IWT as a viable and competitive mode of transport and creating incentives for shippers and carriers to use this mode.
   - Develop marketing campaigns to promote IWT as a competitive and sustainable mode of transport.
   - Create financial incentives for shippers and carriers to use IWT, such as reduced tolls or fees for waterway transport.
   - Implement policies that encourage the use of IWT for specific industries or goods, such as bulk commodities or hazardous materials.

Table 7 below presents such possible public policies and support measures that can be developed by policy makers at national and regional levels along the three phases of modal shift to encourage and facilitate the shift towards IWT:

Table 7. Public policies along the three phases of modal shift

Policy Measures	Inertia Phase	Modal Shift Phase	Maturity Phase
Awareness and Information	- Develop informational campaigns to raise awareness of the benefits of IWT.	- Provide training and education programs for transport professionals to increase their knowledge and skills related to IWT.	- Conduct research and analysis to better understand the market demand and potential for IWT.

Infrastructure and Logistics	- Assess current IWT infrastructure and logistics systems to identify gaps and areas for improvement.	- Invest in waterway infrastructure, such as locks, dams, and navigation channels, to improve the capacity and efficiency of the waterway system.	- Develop intermodal connections between waterways and other modes of transport, such as road and rail, to improve access and connectivity.
Market Development and Promotion	- Conduct studies to identify the potential economic and environmental benefits of IWT for different industries and commodities.	- Develop marketing campaigns to promote IWT as a competitive and sustainable mode of transport.	- Create financial incentives for shippers and carriers to use IWT, such as reduced tolls or fees for waterway transport.

In the inertia phase, policy measures focus on raising awareness of the benefits of IWT and assessing the current state of infrastructure and logistics systems. This can include developing informational campaigns, conducting studies to identify the potential economic and environmental benefits of IWT, and assessing the current IWT infrastructure and logistics systems to identify gaps and areas for improvement.

In the modal shift phase, policy measures focus on investing in waterway infrastructure and developing intermodal connections between waterways and other modes of transport to improve access and connectivity. This can include investing in waterway infrastructure, developing intermodal connections, and providing training and education programs for transport professionals to increase their knowledge and skills related to IWT.

In the maturity phase, policy measures focus on creating financial incentives for shippers and carriers to use IWT and promoting IWT as a competitive and sustainable mode of transport. This can include creating financial incentives, developing marketing campaigns, and conducting research and analysis to better understand the market demand and potential for IWT. It is important to note that the specific policies and support measures implemented will vary depending on the specific context and needs of each country or region.

Potential measures to overcome financial barriers to modal shift from road to inland navigation and responsible actors:

1. **Infrastructure investment**: Governments and private sector actors can invest in building and maintaining waterway infrastructure, such as locks, dams, and navigation channels. This can help reduce infrastructure costs for shippers and carriers.
2. **Equipment and technology development**: Equipment manufacturers and technology providers can develop new, more efficient and cost-effective equipment and technologies for inland navigation. This can help reduce equipment costs for shippers and carriers.
3. **Intermodal collaboration**: Governments and private sector actors can work together to improve intermodal collaboration and integration, which can help reduce intermodal costs and increase efficiency.
4. **Financial incentives**: Governments can provide financial incentives such as tax breaks, grants, or subsidies to encourage shippers and carriers to shift to inland navigation.
5. **Regulatory reform**: Governments can reform regulations and policies to reduce regulatory costs and barriers to inland navigation, such as simplifying administrative procedures and harmonizing rules and regulations across different countries.

6. **Public-private partnerships**: Governments and private sector actors can form public-private partnerships to share the costs and risks of investing in and promoting inland navigation.
7. **Market-based mechanisms**: Governments can implement market-based mechanisms such as carbon pricing or emissions trading schemes to encourage shippers and carriers to shift to more sustainable modes of transport like inland navigation.

The responsible actors for implementing these measures may include governments, private sector actors, equipment manufacturers, technology providers, and logistics and transportation companies. It will require collaboration and coordination among all these actors to successfully overcome the financial barriers to modal shift from road to inland navigation.

Table 8. Extended matrix : Different Barriers, Facilitators and Actors

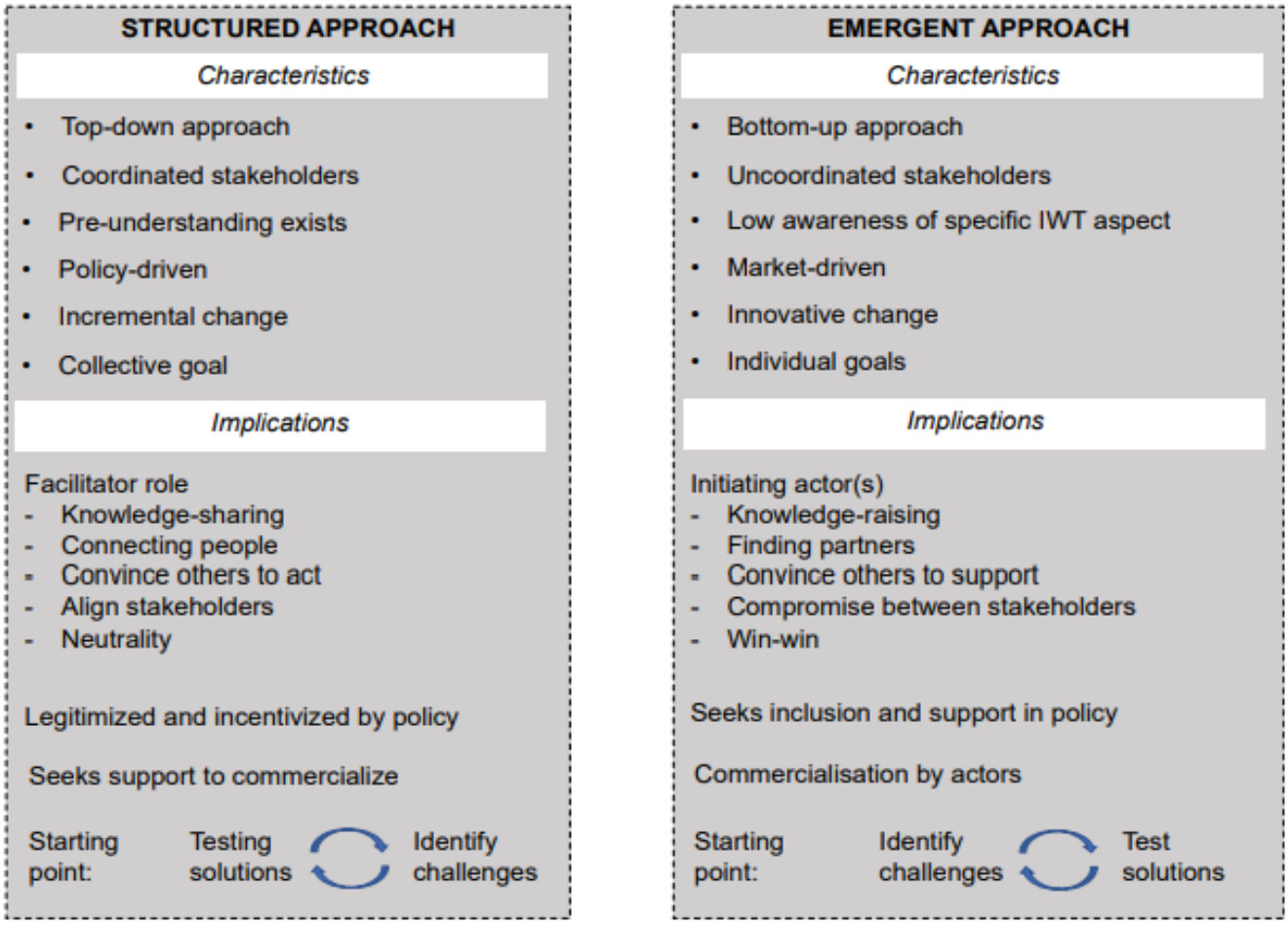
Factor/Category	Inertia Phase	Modal Shift Phase	Mature Phase
Macro-level factors			
Limited government funding for inland waterways infrastructure development	High financial barriers	High financial barriers	Moderate financial barriers
Facilitators/Solutions			
Public-private partnerships to share the cost of inland waterways infrastructure investments	Government agencies, inland waterways carriers, private investors	Inland waterways carriers, private investors	Government agencies, inland waterways carriers, private investors
Government subsidies or tax incentives for inland waterways transportation	Government agencies, inland waterways carriers	Government agencies, inland waterways carriers	Government agencies, inland waterways carriers
High costs of inland waterways infrastructure	High financial barriers	High financial barriers	Moderate financial barriers
Innovations in financing and funding models for inland waterways infrastructure	Inland waterways carriers, private investors	Inland waterways carriers, private investors	Inland waterways carriers, private investors
Government funding for research and development of new inland waterways technologies	Government agencies, inland waterways carriers, private investors	Government agencies, inland waterways carriers, private investors	Government agencies, inland waterways carriers, private investors
Lack of government policies to incentivize modal shift to inland waterways transport	High financial barriers	High financial barriers	Moderate financial barriers
Mandates or regulations to reduce emissions and promote sustainable transportation,	Government agencies, inland waterways carriers	Government agencies, inland waterways carriers	Government agencies, inland waterways carriers

including inland waterways transport			
Government funding for research and development of sustainable inland waterways transportation technologies	Government agencies, inland waterways carriers, private investors	Government agencies, inland waterways carriers, private investors	Government agencies, inland waterways carriers, private investors
Micro-level factors			
Personal preferences and attitudes towards inland waterways transport	Moderate financial barriers	Moderate financial barriers	Low financial barriers
Facilitators/Solutions			
Education and outreach campaigns to promote the benefits of inland waterways transport	Government agencies, inland waterways carriers, community organizations	Government agencies, inland waterways carriers, community organizations	Government agencies, inland waterways carriers, community organizations
Enhanced user experience for inland waterways transport, such as better access, comfort, and convenience	Inland waterways carriers, private investors	Inland waterways carriers, private investors	Inland waterways carriers, private investors
Limited availability of inland waterways transportation options	High financial barriers	Moderate financial barriers	Low financial barriers
Investments in infrastructure and equipment to expand the availability of inland waterways transportation options	Inland waterways carriers, private investors	Inland waterways carriers, private investors	Inland waterways carriers, private investors
Government incentives or subsidies to encourage the development of new inland waterways services	Government agencies, inland waterways carriers, private investors	Government agencies, inland waterways carriers, private investors	Government agencies, inland waterways carriers, private investors
Actors Behind Financial Barriers			
Inland waterways carriers	May not want to invest in new infrastructure or technology if current transportation options are profitable	May be more willing to invest in new infrastructure or technology if incentivized through government policies or initiatives	May invest in new infrastructure or technology to maintain competitive advantage

7.2. Promotion measures : the structured and emergent approach

According to Santén et all (2021)[7] , two general ways to engage with modal shift were identified, based on the findings of five case studies of modal shift promotion from land to IWT in the North Sea Region (data was collected over a three-year period (i.e., 2017– 2019), namely a structured and an emergent approach.

Figure 14. Approaches to promoting modal shift : the structured & the emergent approach



The structured approach to modal shift involves a planned and deliberate process of shifting from one mode of transport to another, typically through the implementation of policies, regulations, and infrastructure projects. This approach is often characterized by the involvement of government agencies and the development of long-term plans and strategies to encourage modal shift. The structured approach is well suited for large-scale and complex transportation systems, where a high degree of coordination and planning is required to achieve significant modal shift.

The emergent approach to modal shift, on the other hand, is characterized by a more organic and informal process of shifting from one mode to another, typically driven by market forces and the actions of individual actors. This

[7] Santén, V., Rogerson, S., Williamsson, J. & Woxenius. Modal shift to inland waterway transport: five case studies in the North Sea Region. European Journal of Transport and Infrastructure Research, 21(4), 43-61. https://journals.open.tudelft.nl/ejtir/article/view/5474

approach is often seen in small-scale and decentralized transportation systems, where market forces, such as changes in cost and quality, drive modal shift. The emergent approach is often more flexible and adaptable than the structured approach, but can also be less predictable and controlled.

The structured approach is more common in mature markets. In general, a pre-understanding of IWT exists, it may be a prioritised topic and interest exists among stakeholders. The collectively organised stakeholders coordinate in their attempts to establish IWT solutions. The structured approach is contrasted by the emergent approach, stakeholder-driven, bottom–up approach in which isolated, uncoordinated actors launch modal shift processes at specific points in the supply chain or in certain market segments. That type was most salient in Belgium and Sweden.

The cases involved variations along key dimensions associated with three central aspects identified in the literature on modal shift, namely market maturity, policy support (national and regional), and actor constellation. Across the cases, activities revolved around four principal themes related to realising modal shift: understanding the current situation, identifying potential solutions, testing solutions and promoting solutions. In addition, two other themes integrated into the four themes were identified as being critical to the process: getting stakeholders on board and identifying goods flows.

In the emergent approach we see less awareness of relevant specific IWT solutions. For example, in BE, although a mature IWT market in general, urban distribution was considered an immature market segment. In the emergent approach, entrepreneurs seize a market opportunity to establish IWT and entrepreneurs focus on common benefits, e.g. cost savings or improving environmental performance. Depending on the approach (structured or emergent), the modal shift process will differ, e.g. in activities and roles of actors. In a structured top-down process, one stakeholder can act as the facilitator of the process, sharing knowledge and connecting stakeholders. The facilitator needs to convince the other stakeholders to act and align them towards a common goal of the specific modal shift. For example, in the NL, the municipalities played a leading role, which motivated the commitment of companies to a collective initiative and facilitated the transition to testing potential solutions. In DE, a student competition was hosted, and a digital learning platform provided. Often, such a facilitator can provide a neutral party, in line with (Abrahamsson and Engström, 2019)8 that describe an inland navigation promotion agency.

Existing policy programmes can be used to support arguments to initiate IWT solutions. When authorities take on the facilitator role, they can use policy arguments to involve other stakeholders, to provide the legitimacy to make others participate and further incentivise stakeholders. A structured, top–down process may start with intrapreneurial activities among central stakeholders—for example, authorities and shipping companies—via promotion and knowledge building. With the structured approach the pre-understanding of IWT means that definitions of IWT and solutions exist, making it possible to move into tests of solutions more rapidly. However, if the specific aspect of modal shift falls outside previously identified solutions it may not be supported by policy and thereby top-down support becomes more difficult. Another challenge concerns commercialization, where the facilitator needs support from relevant stakeholders that can implement the modal shift.

[8] Abrahamsson, A., and Engström, E. M. (2019). Inland Waterway Transportation in Northern Europe - What Sweden could Learn from a Modal Shift Process in the Netherlands. M.Sc. Thesis, Chalmers University of Technology https://odr.chalmers.se/server/api/core/bitstreams/9f50f6ec-3be2-46a0-a8cf-1b7cc4c173e2/content

In the emergent approach, when industrial actors led bottom–up approaches to initiate modal shift, for example in SE and BE, the individual actors driving the process likely did not have all parts of the solution and rather than build alone in isolation, partners needed to be identified. In the emergent approach, networks and contacts developed from individual relationships. In SE, the entrepreneurs spent a considerable share of their time visiting goods owners. Further, in SE, considerable effort was devoted to making the modal shift appeal to other stakeholders to gain their support. Compared to the structured approach where the collective goal is clear, in the emergent approach there may be conflicting goals among stakeholders. With the process driven by an initiating actor from a private company, the incentives and goals may be less clear and other stakeholders may need to be convinced it is a win-win situation. Varying stakeholder engagement helps explain why the entrepreneurs in SE spent much time and energy on promotion. Both awareness-raising and compromises are needed in the emergent approach. In SE, for example, negotiations between transport operators and ports took place to reach agreements, and the entrepreneurs focused their attention on explaining the benefits to other stakeholders from their respective perspectives. There was also a lack of willingness from companies to commit their goods flows. An advantage in the emergent approach is that the stakeholder that can execute the solution is part of driving the change, meaning that transition to practice, i.e. commercialization, is easier. For example, in BE, goods flows were readily available. Financial resources and risk may be a drawback as seen in SE, where the entrepreneurs needed to secure investment in vessels, and in BE, where it was difficult for one goods owner to test vessel solutions single-handedly. Further, in the emergent approach policy support is not manifested but desired. In SE, the lack of governmental support was evident and slowed the process for the entrepreneurs. Finally, with the emergent approach, solutions emerge step-wise. Several iterations may be necessary between challenges and possible solutions.

Conclusion

It's difficult to say which approach is better for inland waterway transport as it depends on the specific context and transportation system in question. Both the structured and emergent approaches have their own advantages and limitations, and the most effective approach will depend on factors such as the size and complexity of the transportation system, the level of government intervention, the maturity of the market, and the existing infrastructure and services. In general, a combination of both structured and emergent approaches can be used to achieve successful modal shift in freight transport.

For example, in a large-scale and complex transportation system with a high level of government intervention and well-established infrastructure, a structured approach may be more appropriate. This would involve the development of long-term plans and strategies, as well as the implementation of policies and regulations, to encourage modal shift to inland waterway transport. On the other hand, in a smaller-scale and decentralized transportation system, an emergent approach may be more appropriate. This would involve the influence of market forces, such as changes in cost and quality, to drive modal shift to inland waterway transport.

In conclusion, both structured and emergent approaches can be effective for encouraging modal shift to inland waterway transport, and the most appropriate approach will depend on the specific context and transportation system in question. It's also worth noting that a combination of both approaches can be used to achieve successful modal shift in inland waterway transport.

7.3. National programmes and strategies promoting modal shift and sustainable transport

There are several national programmes and strategies in Europe aimed at promoting modal shift and sustainable transport. These initiatives are typically implemented at the national or regional level, and they can vary in scope and focus depending on the specific needs and priorities of each country. Some examples of national programmes and strategies to promote modal shift in Europe include:

Netherlands[9] - "Green Deal Zeevaart, Binnenvaart en Havens" signed in 2019 is a national programme aimed at promoting sustainable transport in the maritime and inland waterway sectors in the Netherlands. The programme includes measures such as incentives for the use of cleaner ships, investments in inland waterway infrastructure, and support for the development of intermodal transport solutions. In addition, all parties commit to a strengthened commitment and resources for modal shift from road to inland shipping and rail. Shippers, government, inland shipping and other sector organisations will work together in this. Also, an initiative in the Netherlands whereby the Dutch Government contributes 20 Euro for each container taken from the road and moved to IWT was recently launched.
In addition, in The Netherlands the programme "Topcorridors" the Lean and Green Off-Road programme[10] works on matchmaking and improving intermodal transport corridors and realising modal shift in close cooperation with forwarders, terminal operators, barge owners and shippers. Moreover, the Bureau Voorlichting Binnenvaart[11] has a long-standing role to provide information, support modal shift studies and answer questions from interested shippers. Recently they performed detailed studies and successful support work for modal shift of waste and recycling flows.

Austria [12]
For instance in Austria and Germany, special attention is given to shifting heavy-lift and large-volume transports from road to inland waterways. As outlined below , in Austria, a special decree of the Federal Ministry (SOTRA Decree) serves as an administrative regulation and makes mandatory the authorisation procedure for special transport operations, thus setting the framework for using the Danube waterway for particularly heavy, wide and high transports along the Danube corridor across borders. The special case in Austria shows that through issuing permits for road haulage, authorities can play a significant role in promoting the modal shift to inland waterways.

The steadily increasing number of special transport operations ("Sondertransporte – SOTRA") on Austria's roads, i.e. the transport of large and heavy general cargo outside the dimensions specified in the Motor Vehicles Act (KFG 1967 as amended), led to a project initiated by the waterway operator viadonau and the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) to improve the situation in close cooperation with the Austrian Federal Economic Chamber, the regional authorities and the transport industry. A special decree of the Federal Ministry (SOTRA Decree) serves as an administrative regulation and compels the subordinate regional authorities to carry out the authorisation procedure for special transport operations within the framework of the obligation to use the Danube waterway for particularly heavy, wide and high transports along the Danube corridor across borders.

[9] Green Deal - Climate Agreement (binnenvaart.nl)
[10] https://www.topcorridors.com/programma+goederenvervoercorridors/projecten/pijler+4/logistiek+makelaars+-+tsl/default.aspx
[11] https://bureauvoorlichtingbinnenvaart.nl/
[12] https://www.sondertransporte.gv.at/index_DEU_HTML.htm

Specifically, the decree stipulates that if the total weight of the load exceeds 160 t or the total height exceeds 4.5 m or the total width exceeds 5.6 m and the distance to be covered in Austria is at least 200 km, an inland vessel must be used as the mode of transport. Only if it is proven that such a transport cannot be carried out with an inland vessel or can only be carried out with disproportionate effort, the granting of a special transport permit for road transport is possible (cf. SOTRA regulation point 9). For this purpose, the applicant of the special transport must contact at least three shipping companies before submitting the application for a special transport permit and wait for a waiting period of at least 5 working days.
The requirement to prove that transport by waterway is not economically feasible represents a paradigm shift in Austrian transport policy and is seen as an important first step towards reducing CO2 emissions, relieving road infrastructure and increasing transport safety, as well as making better use of the free capacities of the Danube waterway.

Germany [13]

In 2019, the Federal Ministry for Transport and Digital Infrastructure, abbreviated BMDV, presented “the Master Plan Binnenschifffahrt” (Master Plan for Inland Navigation) that is intended to form the basis for making inland navigation sustainable and more attractive. It was developed in a cooperative process together with professional associations, the industry and other stakeholders. A key bundle of measures provides for the strengthening of multimodal transport chains, thus increasing the share of inland navigation in the modal split to 12 percent. Special attention will be paid to shifting heavy-lift and large-volume transports to inland waterways in order to relieve the roads and reduce CO2 emissions. In 2020, as a further action, a final report of approximately 100 pages of a created working group "AG Verlagerung von Großraum und Schwerlasttransporten (GST) von der Straße auf den Wasserweg und Schiene" (Working Group on the Shift of Large and Heavy Goods Transport from Road to Waterway and Rail) was presented.
The execution of special transports (heavy goods and large volume transports) on the road is generally subject to authorisation in Germany. This is handled nationwide via an electronic application and authorisation procedure ("Procedural Management for Large and Heavy Goods Transport" - VEMAGS). The inclusion of waterways and ports in the software of the VEMAGS procedure management system, financial incentives for the conversion or new construction of special ships that can accommodate large and heavy cargo, and the designation of micro-corridors as standard routes to the ports therefore promise particularly great prospects of success for more heavy cargo and project cargo on the water. In order to improve the infrastructure required for transport operations, the final report also recommends the creation of further transhipment facilities on the waterways.

The implementation of the Master Plan for Inland Navigation is monitored in ongoing status reports. The status report, dated September 2022, contains additions to the measures already defined and a new measure to additionally promote the shift of large and heavy cargo, namely measure Mod-10, which provides for a dialogue with the federal states (“Bundesländer”) regarding the licensing procedures for heavy cargo transports in order to achieve an optimisation of the licensing procedure with the aim of a stronger integration of inland navigation into the transport chain. It was also stated in the status report that the BMDV will examine regulatory measures that support priority special transport by waterway.

The funding guideline for the establishment of shuttle transport for large and heavy goods transport had not yet been completed by the end of 2022, so that the budget funds estimated for 2022 could not be spent on this. For

[13] https://bmdv.bund.de/SharedDocs/DE/Anlage/WS/statusbericht-masterplan-binnenschifffahrt.pdf?__blob=publicationFile
https://bmdv.bund.de/SharedDocs/DE/Anlage/WS/masterplan-binnenschifffahrt-en.pdf?__blob=publicationFile

administrative reasons, the BMDV was not able to spend the € 10 million from the emergency climate protection programme (Klimaschutz-Sofortprogramm) earmarked for 2022.

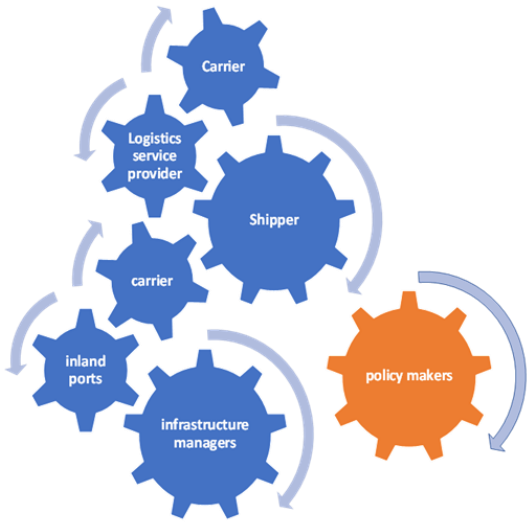
For instance, in the case of Austria and Germany, special attention is given to shifting heavy-lift and large-volume transports from road to inland waterways. For instance, in Austria, a special decree of the Federal Ministry (SOTRA Decree) serves as an administrative regulation and makes mandatory the authorisation procedure for special transport operations, thus setting the framework for using the Danube waterway for particularly heavy, wide and high transports that follow the Danube corridor across borders. The special case in Austria shows that to issuing permits for road haulage, authorities can play a significant role in promoting the modal shift to inland waterways.

Belgium - "Strategisch Plan 2050" is a national programme aimed at promoting sustainable and efficient transport in Belgium. The programme includes measures such as investments in transport infrastructure, support for the development of intermodal transport solutions, and the promotion of alternative fuels and vehicles. Furthermore, there exist several structured approaches in Belgium which promote modal shift on a case by case basis . The initiative run by Multimodal. Vlaanderen (MMV) – which is “Flanders’ Institute of Logistics (VIL)” neutral advisory service point that guides companies in their search for efficient and sustainable transport solutions. MVM works on a case-by-case basis, and just recently “Logistics in Wallonia “launched an initiative comparable to MMV.

8. Key actors and their roles in enabling modal shift to IWT decision making process

The decision of mode choice in the transport and logistics chain is typically made by the shipper, or the company or individual responsible for transporting goods. They will consider both macro and micro-level factors such as cost, transit time, reliability, capacity, and the type of goods being shipped, as well as regulatory and environmental considerations. In larger organizations, the decision may be made by a logistics or supply chain department, or by a designated logistics manager. They will take into account the company's overall transportation strategy, including its business goals, budget, and logistics network. In some cases, the decision may also be influenced by the carrier or logistics service provider, who may have expertise in a particular mode of transportation and can provide recommendations to the shipper. Freight forwarders, 3PL providers also can be involved in the process as they act as intermediaries and they have the knowledge and expertise on different modes of transportation and logistics services, they can help the shipper in making the decision on mode choice. In any case, it's a collaborative decision-making process that involves multiple stakeholders and it's very important to take into account the cost-benefit analysis of each mode of transportation and to evaluate the trade-offs in terms of time, cost, reliability, and environmental impact.

Figure 15. Key actors involved in the modal shift decision-making process



Source : own

Often the question of who owns the transport chain when shipping cargo by inland waterway transport arises.

The answer is that the ownership of the transport chain can vary depending on the specific arrangements and contracts involved. In some cases, the cargo owner may contract directly with the barge operator for the transportation of their goods, in which case the cargo owner has a high level of control over the transport chain.

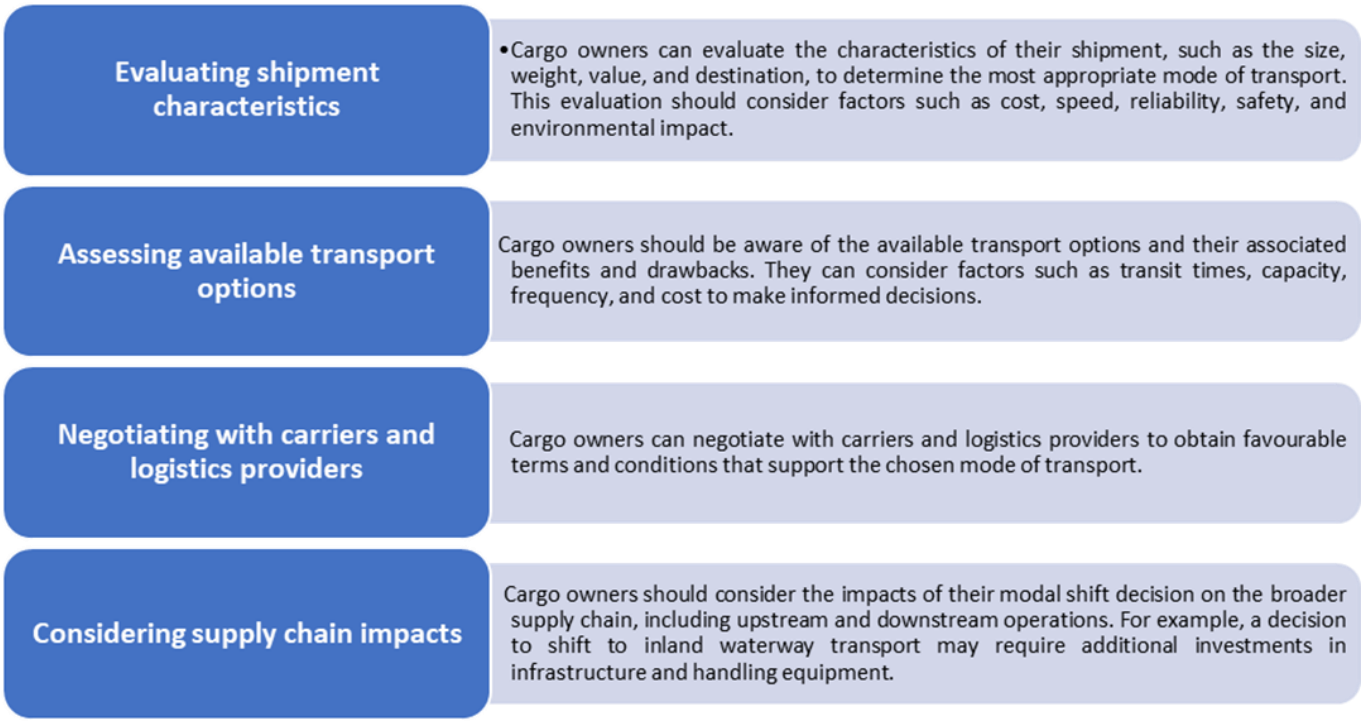
In other cases, logistics providers or freight forwarders may be involved in arranging the transport, and they may take on some or all of the ownership and management of the transport chain. Ultimately, the ownership of the transport chain depends on the specific contractual arrangements and agreements made between the parties involved in the transportation of the goods.

8.1. Key actors and their role in the modal shift decision making process

The next section looks in more detail at key actors in the transport and logistics chain and outlines their role in the decision-making process that influences modal shift. ***What is the role of a cargo owner in the decision-making process that influences modal shift?***

I. **The cargo owner (shipper)** plays a crucial role in the decision-making process that influences modal shift. As the party responsible for shipping the goods, the cargo owner is in the best position to evaluate the specific needs of their shipment and determine the most appropriate mode of transport. Furthermore, in view of the increasing Corporate Sustainability Reporting requirements, the cargo owner is also more and more accountable for the sustainability performance. Impact on the environment such as carbon footprint and air pollutant emissions will be increasingly important in decision-making on the transport modality to use. Some of the ways in which cargo owners can influence modal shift decisions include:

Figure 16. The role of shippers in modal shift decisions



II. **Logistics service providers** (including freight transport forwarders) undertake various logistics tasks within an intermodal transportation system. They provide a range of value-added logistics services, such as warehousing, distribution, organising transhipments, shipping, inventory management, co-packing, labelling, repacking, weighing, and quality control. They can also act as intermediaries for shippers with respect to both domestic and international intermodal transportation activities, also referred to as integrators. The logistics provider plays an important role in executing a modal shift to inland waterways. Their role includes:

- Identifying the best transport mode: The logistics provider works with the cargo owner to determine the most appropriate mode of transport for their shipment. This may involve evaluating the shipment's characteristics, cost, speed, reliability, and environmental impact, among other factors, to determine if inland waterway transport is the best option and which type/size of vessel is most interesting in combination with which loading unit (or bulk / project cargo) and where the transhipment and storage can best take place.

- Coordinating with other stakeholders: The logistics provider coordinates with other stakeholders in the supply chain, including barge owners, ports, terminals, warehouses and customs authorities, to ensure the smooth and efficient movement of goods. They also work with these stakeholders to address any issues that arise during the transportation process.
- Managing the shipment: The logistics provider manages the shipment from start to finish, including arranging for the pickup and delivery of the cargo, ensuring compliance with regulations, and providing real-time tracking and communication to the cargo owner.
- Providing value-added services: The logistics provider may provide value-added services to support the modal shift to inland waterways, such as consolidating shipments, optimizing cargo handling, and providing warehousing and distribution services.
- Ensuring cost-effectiveness: The logistics provider ensures that the modal shift to inland waterways is cost-effective by providing competitive pricing and identifying opportunities for cost savings, such as through consolidation or route optimization.

Overall, the logistics provider's role in executing a modal shift to inland waterways is critical to ensuring that the transportation process is efficient, reliable, and cost-effective. By identifying the best transport mode, coordinating with other stakeholders, managing the shipment, providing value-added services, and ensuring cost-effectiveness, the logistics provider can help cargo owners successfully shift to inland waterway transport.

III. **Carriers** are the transport operators or transport companies that perform the transport for the shippers or logistics service providers. Some carriers operate dedicated services, in which a vehicle or container serves a single customer. Others operate on the basis of consolidation, in which each vehicle or container may contain different customers' freight with different origins or eventual destinations.
What is the role of a barge owner or operator in the decision-making process for modal shift?
A barge owner or operator plays a critical role in the decision-making process for modal shift, particularly when it comes to shifting transportation from road to inland waterway transport. Their role includes:

- **Providing transportation services**: Barge owners and operators provide transportation services to cargo owners who choose to shift their transportation to inland waterways. This includes transporting the cargo from one point to another, coordinating with other stakeholders in the supply chain, and ensuring that the cargo arrives at its destination safely and on time.
- **Offering competitive pricing**: Barge owners and operators must offer competitive pricing to attract cargo owners who are considering a modal shift. This includes pricing their services competitively compared to other modes of transport, such as road, rail, and offering discounts or incentives for high-volume or long-term contracts.
- **Ensuring regulatory compliance**: Barge owners and operators must ensure that their operations comply with all relevant regulations, such as safety, environmental, and customs regulations, to provide a safe and secure service to their customers.
- **Investing in equipment and infrastructure**: Barge owners and operators must invest in their assets, such as barges and possibly also containers (e.g. a fleet of pallet-wide containers for continental cargo), to support their operations and provide efficient and cost-effective services to their customers. Interesting opportunities arise when barge owner/operators work closely together with inland terminal operators (or set up mergers or start joint ventures) to provide competitive door-to-door solutions directly for shippers or and for logistic service providers.

It is the interaction between these actors that determines the mode choice in freight transport, but the literature (ITF, 2022)[14] generally considers that shippers, and logistics service providers play a dominant role in this choice. In this context, the following reservations were made:

1. **First**, the choice of the preferred transport mode is often part of a larger decision-making process that includes other factors, such as supply chain strategies. The choice of transport modes is often derived from these other issues.
2. **Second**, although the subject of this section is mode choice, the actual choice for shippers and logistics providers is often between different logistics solutions that comprise several modes. Sometimes, one leg is served by several modes in parallel (synchro-modality). In this situation, modal combinations and operational schedules could be changed after the shipment is on the way, in response to new information. Transport chains are frequently constituted by several modes, which is then defined as multimodality, inter-modality and combined transport. Containerisation of freight transport has increased the possibilities of intermodal transport as it has reduced the time and costs of transferring cargo from one transport mode to another.
3. **Third**, in some freight-transport sectors the power of decision making might be shifting from shippers to carriers, due to increased market power and vertical integration. Vertically integrated carriers will give priority to infrastructure or modes that they operate themselves.

Decision making power may shift from shippers to logistics service providers for several reasons:

- Shippers who do not longer consider logistics as core business most likely will outsource all of their logistics operations after having negotiated service level agreements
- With respect to import/export flows there is the difference between merchant's and carriers' haulage. In the latter case the decision making is in the hands of the seagoing carriers. And currently seagoing carriers do heavily invest (mergers, acquisitions,...) in hinterland logistics (transport, warehousing, terminals). When investing in transport it is mostly about road and rail but not in IWT.

For example, container-shipping companies are also active in port-terminal handling and trucking: they will prefer to use their own port terminals that might not have rail connections and give priority to their own trucking services. In fact, handling priority is generally given to maritime cargo ships in case of disturbance at the seaports, which has a negative impact on other parties in the supply chain, including inland cargo vessels. This is mainly due to the 'call size' asymmetry of shipping companies compared to inland barge operators. This may translate into additional 'indirect costs', such as demurrage and detention charges levied by shipping companies, or higher administrative costs and time lost[15]. Market power in container shipping could give them the possibility to impose a certain bundle of transport modes that would not necessarily be in line with the preferred combination of the shipper. The wave of market consolidation which also took place in the last decades in the global container shipping industry, created further imbalances in the global container trade thereby providing further leverage for liner carriers (e.g. Maersk) to buying their way into the hinterland by buying the terminals, transport companies. They will probably have a much more influence on the decision-making, more than the cargo owners and the barging companies. Will that affect the IWT? Will it be a threat or an opportunity? We do not have an answer to these questions.

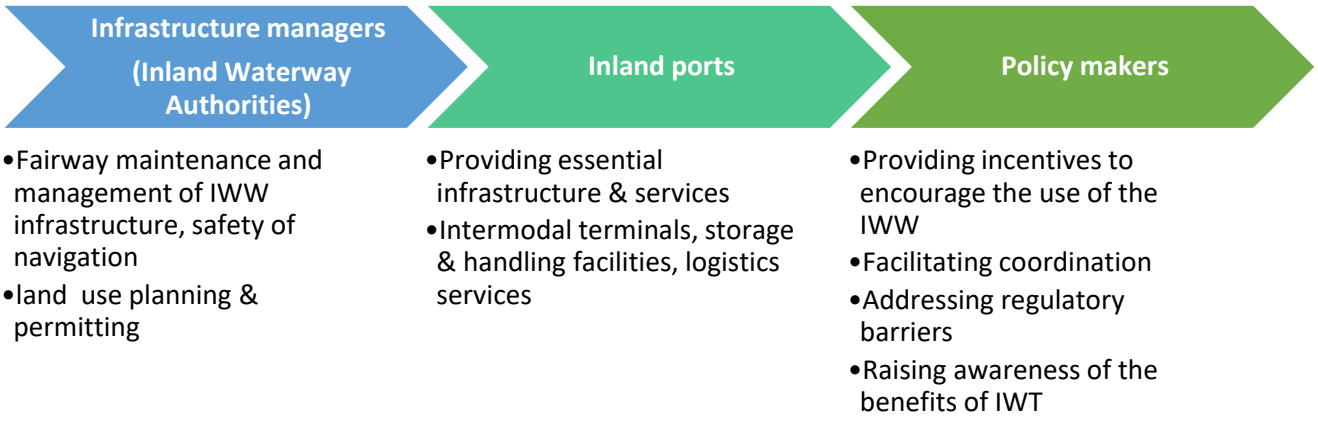
[14] Mode Choice in Freight Transport | READ online (oecd-ilibrary.org)

[15] Source: CCNR Secretariat analysis on the efficiency of inland navigation container handling in seaports. Full analysis is available in annex 3.

8.2. Actors that influence the framework conditions for modal shift to IWT

In addition, there are the actors that influence the conditions for private firms to operate:

Figure 17. Main actors influencing the framework conditions for modal shift



I. **Infrastructure managers** may be public entities, private entities or hybrid entities. They deal with the management of the physical network and infrastructure, including local roads and motorways, rail infrastructure, the waterways, intermodal port terminals, quay and berth facilities and so on. Thus, they play a central role by providing efficient physical networks and the necessary technology to control and optimise the use of infrastructure and facilities. In the case of IWWs, the Inland Waterway Authorities are mainly government agencies that are responsible for the maintenance and management of inland waterway navigation infrastructure and ensuring the safety of navigation on inland waterways. Local infrastructure managers and authorities play a crucial role in land use planning and permitting to allow local terminals and quays to be available and to function efficiently. This makes a key difference in the feasibility of modal shift but may conflict with other land uses along the water such as recreation and residential purposes.

II. **Inland ports** play a critical role in facilitating modal shift from road to inland waterways by providing essential infrastructure and services that enable efficient and reliable inland waterway transport. Inland ports serve as hubs for the transfer of cargo between different modes of transport, including road, rail, and inland waterway transport. Some specific ways by which inland ports can facilitate modal shift include:

- **Intermodal terminals:** Inland ports often have intermodal terminals that enable the transfer of cargo between different modes of transport. This can include the use of cranes and other equipment to load and unload cargo from barges, as well as the use of rail and road connections to move cargo to and from the inland port.
- **Storage and handling facilities:** Inland ports often have facilities for the storage and handling of cargo, including warehouses, container yards, and other storage areas. These facilities can help to facilitate the efficient transfer of cargo between different modes of transport, as well as provide temporary storage for cargo that is in transit.
- **Logistics services:** Inland ports can provide a range of logistics services and value added services to support the transport of cargo, including customs clearance, cargo consolidation, quality control, and transport planning. These services can help to streamline the logistics process and make inland waterway transport more efficient and cost-effective.

III. **Policy makers**, that is national governments and public administrations as well as transnational institutions such as the European Commission play a critical role in facilitating modal shift from road to inland waterways. Their role includes:

- **Providing incentives** to encourage the use of inland waterway transport which have a significant (measurable) impact on the reduction of total cost of transport . This may include infrastructure users fees , financial incentives, such as tax credits or grants, or regulatory incentives, such as exemptions from certain regulations or streamlined permitting processes. Policy makers shall also address externalities related to transport, i.e. the effects on others than the direct transport users that are not taken into account in the price of transport. Policy makers frequently aim to guide the transport and logistics system towards being more beneficial to society and providing resilient ways of operation. For example, the usage of specific corridors or type of vehicle/vessels and engines types, mode changes from road-based to water- and rail-based transportation, the reduction of externalities (like emissions of air pollutants), the consideration of environmental impacts, etc.
- **Facilitating coordination:** Policy makers can facilitate coordination between stakeholders in the inland waterway transport system, such as cargo owners, logistics providers, barge owners, and port authorities. This may involve creating fora for stakeholders to share information, identifying areas for collaboration, and supporting the development of industry associations.
- **Addressing regulatory barriers**: Policy makers can work to address regulatory barriers that may impede the growth of inland waterway transport. This may involve revising regulations that restrict the use of inland waterway transport or developing new regulations to reinforce the safety and sustainability of IWT.
- **Raising awareness of the benefits of inland waterway transport:** elements such as its environmental sustainability, cost-effectiveness, and reliability. This may involve launching public awareness campaigns or creating educational programs for stakeholders in the inland waterway transport system. **In addition, such measures by policy makers must be complemented by industry-led initiatives where economic entities, including barge owners must create awareness with regard to the competitiveness and environmental advantages of their services.**

8.3. Shippers and their influence on economic barriers

In the inertia phase, shippers may be hesitant to adopt alternative modes of transportation due to concerns about the reliability, cost, or availability of these options. Shippers may also be resistant to change if they have established relationships with carriers or are satisfied with their current transportation options. Macro-level factors such as limited government investment in alternative transportation infrastructure or policies that prioritize the use of traditional modes of transportation can further reinforce these economic barriers.

During the modal shift phase, they may be more willing to consider alternative modes of transportation if they are incentivized to do so through government policies or initiatives from carriers. However, economic barriers such as high initial costs of transitioning to alternative modes of transportation, limited availability of equipment or infrastructure, and concerns about reliability and efficiency may still be present. Shippers may also be influenced by micro-level factors such as personal preferences or attitudes towards different modes of transportation and the availability of alternative options in their area.

In the mature phase, they may continue to prioritize cost and efficiency when making transportation decisions. However, they may also be more willing to invest in new technologies or services that offer cost savings or efficiency improvements over the long term. Macro-level factors such as government investments in new transportation technologies or initiatives that promote sustainability and efficiency can also incentivize shippers to adopt new

transportation options. At the same time, micro-level factors such as personal preferences and attitudes towards different modes of transportation and the availability of alternative options in their area can also influence their decisions.

Overall, shippers can be an important actor behind economic barriers to modal shift in the freight transportation sector. Their decisions about which transportation options to use, and their willingness to invest in new technologies or services, can play a significant role in determining the economic viability of alternative modes of transportation.

9. Study case Multimodal. Vlaanderen (MMV)

Multimodal.Vlaanderen (MMV) is "Flanders' Institute of Logistics (VIL)" neutral advisory service point that guides companies in their search for efficient and sustainable transport solutions. This department was set up in October 2017 and though it is a non-governmental body the funding comes from the Flanders Government. Currently about 5 FTE's are employed. The starting point is the ever-growing traffic congestion. October 2022 was one of the heaviest traffic jam months since the start of measurements by the Flemish Traffic Centre in 2011. To slow down increasing road freight traffic, the Multimodal Advice Centre assists logistics service providers and shippers with the modal shift. Or in other words, the ambition is to help absorb the predicted growth in freight transport by making more efficient use of all existing and future capacity and infrastructure. MMV's works started with contacting companies who can potentially shift their cargo to either water or rail.

From end of 2017 till mid 2021 about 1095 companies were contacted of which 333 agreed to start up a business case. The success rate of these business cases was however disappointing: only 52 were successful in achieving modal shift to rail and IWT. The important outcome is that the vast majority of the successful cases/ companies turned to IWT. They provided data for 39 cases, representing 12% of the Business Cases handled from 2017-21. By request MMV made a selection of representative cases (both successful and unsuccessful) which created the opportunity to look at the financial/economical barriers which come into play and which could positively or negatively influence a shift. Barriers were categorised as: unfavourable contractual arrangements, principles of supply chain management that work against modal shift, complexity of a multimodal chain, malfunctioning of maritime supply chains. In the end, most of these categories led to an unfavourable total cost of ownership (TCO) compared to road transport.

Categorization of the barriers as identified by the case study is as follows:

Main findings - from an overall business perspective

1. Complexity of the logistics chain
   a. Who takes ownership of the logistics chain, who will do the orchestration? Who is the architect? that is quite unclear, and no one is willing to take the risk.
2. Services level agreement
   a. What is the service level agreement the service logistics provider can offer? Can 99 % on time be guaranteed ? The discussion is easier with a road haulage which drives from A to B, but much more difficult to discuss t in a muti-modal chain.
3. Contractual arrangements

9.1. What do "MMV use cases" tell us

In cooperation with MMV, 39 business cases were examined of which 25 cases were related to export/import of containers; the remaining 14 were continental flows. These 39 represent 12% of the cases MMV worked on. The objective of the 39 cases was to shift cargo from road to inland waterways.

For each of the cases master data as well as a list of decision criteria were listed.

Following elements could be considered as <u>master data:</u>

- For maritime flows
  - Type of company: cargo owner or service provider
  - Import or export

- From/to Port of Antwerp to/from where in the hinterland (total distance)
- Dry or reefer container and size
- Commodity
- Annual potential savings in both km as CO_2
- State of play of the project: executed, stopped, on hold

- For continental flows
  - Type of company
  - Type of commodity and its packaging
  - Can goods be transshipped?

More interesting however are the different parameters considered since they will have an impact on the decision and could be defined as economical/financial criteria. The parameters can be considered as barriers since depending on their values and the weighing of these values, they determine the "go" or "no go" of the modal shift.

9.2. Parameters taken into account for maritime flows

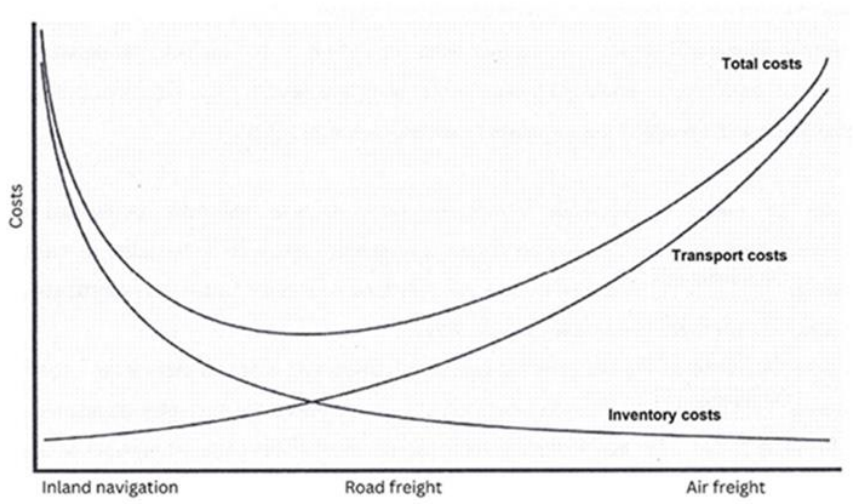
9.2.1. From the perspective of the cargo owner

- From the perspective of the cargo owner (or representative thereof) the following aspects must be noted Willingness to at least look into the matter; priority setting!
- How high is "climate change" on the agenda compared to for ex. cost savings? If applicable what the shareholders' values: profit rather than planet?
- Benchmark the company's current road freight to competitor's pricing
  - Assuming that multimodal transport is always more expensive than single mode (road transport) and assuming that the company has very favorable prices, multimodal will have a more challenging job to overcome the price difference
- Procurement policies
  - Not only the level of current pricing can play a role, but also the company's procurement policy
    - In case of longer-term contacts, the company will not be willing to change; even if road freight prices are not favorable any longer.
    - In multinational companies, annual contracts are often negotiated centrally and on a regional basis. This could mean that local management has very little room to move and/or has to go through a long process before any changes can be considered.
  - In case of longer-term contracts with dedicated service providers, it is possible that operations are organized specifically for that dedicated provider. A change in provider would drastically change the operations; which makes the switch extra complex or even not doable.
  - Also, in case of longer-term contracts the relationship may be such that parties agree to not only look at commercial aspects of the relationship, but also to the operational aspects (with or without potential gainsharing)
- Leadtimes as element of Supply Chain Management
  - Since leadtimes have an immediate impact on inventory levels and hence on the level of capital binding, leadtimes are a very critical parameter. The graph below (figure 14) demonstrates the impact of longer leadtimes on inventory and capital. It shows that the leadtime of a transport mode has an effect on the inventory that needs to be kept. The longer the leadtime,, the more inventory needs to be carried which results in an increase of the carrying costs. On the other hand, transport costs are supposed to be cheaper for IWT than airfreight. Both cost components are to be added in order to obtain the total costs and the optimum, which is in most casesroad transport. This would be the more quantitative aspect of Supply Chain Management. On a same note, for many

companies (in particular companies on the stock exchange) it is still the size (and hence the total cost) of the inventory which is the KPI and not the cost of transport as such.

- Leadtimes also impact the service levels suppliers agree upon with their customers. For example, if next day delivery is required,delivery becomes nearly impossible. This would be the qualitative aspect of Supply Chain Management.

Figure 18. The impact of longer leadtimes on inventory and capital costs



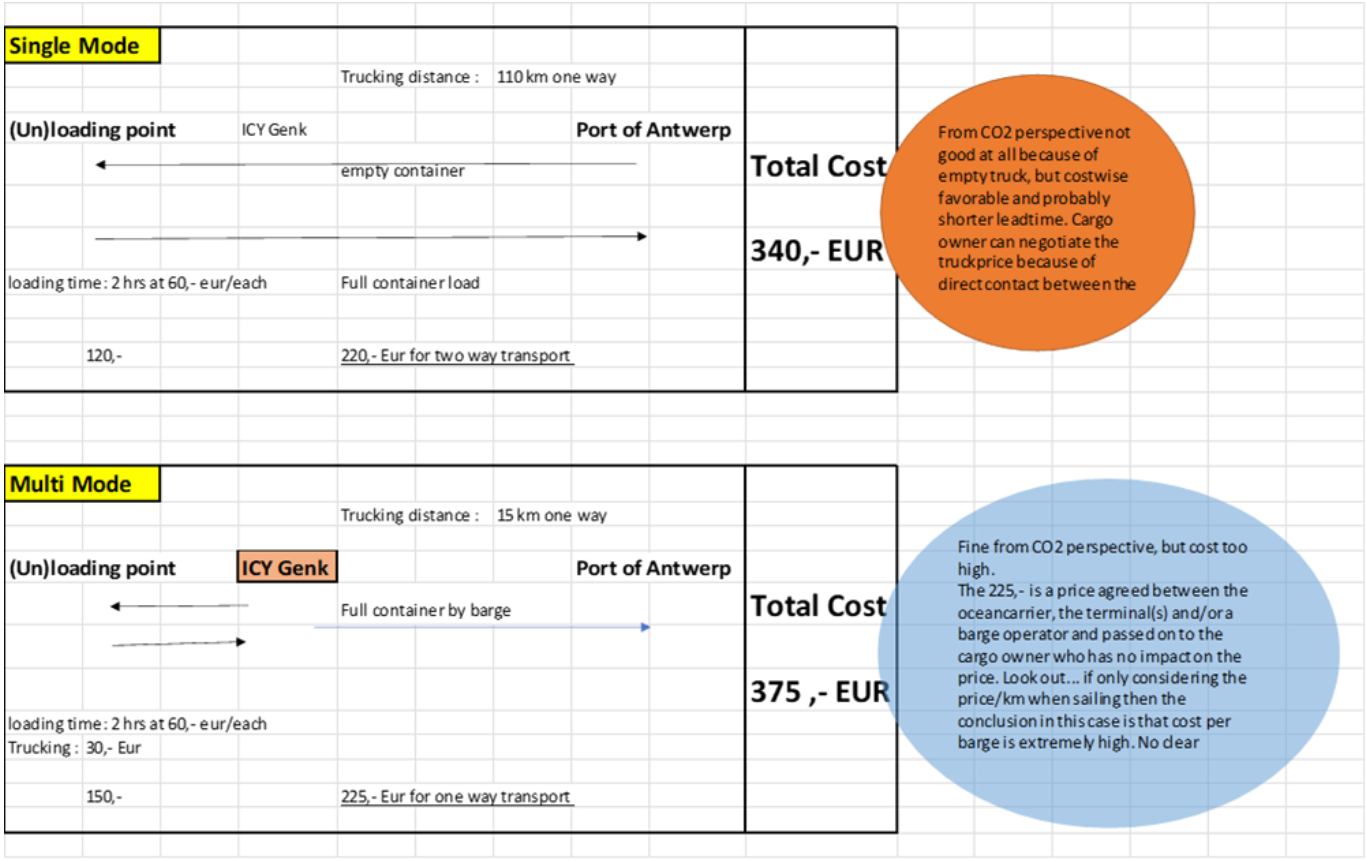
Source : Misschaert & Vannieuwenhuyse (2006)

- Incoterms
  - Incoterms are typically arranged between the seller and the buyer of the goods. Only very rarely is the Supply Chain Manager (or equivalent) involved in that part of the negotiations. The same applies for the Procurement Department; their responsibility is buying transport services and they are not involved in the sales contracts of their company.
  - The chosen Incoterm stipulates who organizes and pays for the transport. This for example means that it can very well happen that an importer of Chinese goods cannot decide how to organize the transport from the seaport to the agreed upon destination in Europe. Even if the importer would prefer to have a multimodal solution, the importer can only advise and not decide.
  - Detailed explanations regarding Incoterms can be found in annex 1.

- When looking at the transport between the Inland Container Yard ICY and the (un)loading point, the so called first/last mile two elements play a role.
  - The time needed to load/ unload the container/truck and the waiting time at the loading/unloading point is mostly estimated at 2 hours and consequently invoiced for two hours.
  - The cost of driving to/from the ICY to the unloading point.
  - The business cases show that all cases need to be looked at individually, but as rule of thumb one can say
    - If waiting time is charged and the driving distance is above 25 km one way, Modal Shift is cost-wise not an option. The sum of the last/first mile plus the sailing cost will exceed the cost of a roundtrip truck transport.

- In case no waiting time is charged or if there is no waiting time plus a distance of less than 25 km; Modal Shift could be beneficial.
- See the info graphs below explaining the issue.

Figure 19. Modal shift cases



- **Remark1:** the Single mode way forward is poor for the climate but also bad for mobility, as the container is moved twice over the same distance (1X empty + 1X loaded). In terms of efficiency no type of road transport is as unsatisfactory as container haulage
- **Remark2:** Barge prices for ICY depend strongly on the expected availability of specific container types at that specific ICY location. Example: The BCTN terminal in Laakdal (Nike) has more import of 40' containers than export. For this specific terminal ICY prices for export of 40' container will be favorable while ICY pricing for import will be quite expensive, as the ocean carrier calculates an expected cost of repositioning the excess of empty import containers for which no export customers can be found.
- **Remark 3**: Both the graph as well as remark 1 and 2 only apply to maritime container flows.

9.2.2. From the perspective of the ocean liner

- Do they have a hinterland strategy?
  - Do they have an Inland Container Yard (ICY) or cooperation with an inland terminal/port? If yes, from/to the seaport by barge is possible.
  - Or don't they? In that case, it's truck only.
- How is their import/export balance?
  - Excess of empty TEU's? Then stock of empty containers can be held in the hinterland. If not, then chances are that empty ones will have to return to the Seaport immediately which could undo the advantage of an ICY.

- First mile/last mile; in other words, what's the distance between the (un)loading point and the ICY?

9.3. Parameters taken into account for continental flows

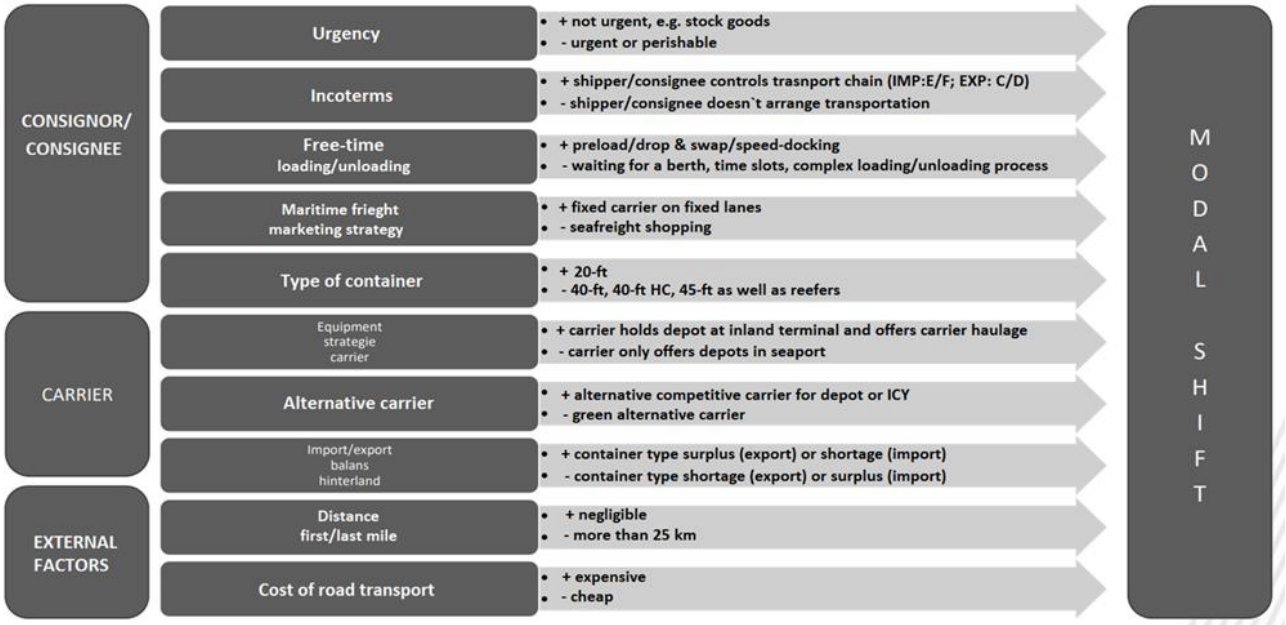
9.3.1. From the perspective of the cargo owner

- Willingness to at least look into the matter; priority setting!
- How high is “climate change “ on the agenda compared to for ex. cost savings?
- Benchmark the company’s current road freight to competitor’s pricing; see above
- Procurement policies; cfr above.
- Can the goods be packaged and handled so that they are IWT-worthy? For example from pallets to bulk?
- Very often the packed goods (pallets) will have to be transported multimodal in a container, mostly in a 45' pallet wide container. The main question is who will provide the 45' container? In case of maritime transport, the use of a 20/40' sea container is included in the price. In continental transport business models, this is very often not the case. Who will provide the 45' container and who will arrange the return of the containers (too expensive if those containers have to return empty).
- Are volumes big enough in terms of batch sizes?
- Steadiness of flow of goods (truckload by truckload) or are peaks (per barge) manageable at the sending and/or receiving end.
- Leadtimes; cfr above.
- Incoterms: see above.

9.3.2. From the perspective of the service provider

- Is there a multimodal alternative available?
- If available, is the service “door to door”?
- Suitable vessels available?

Figure 20.Existing economic - financial barriers to modal



Clarification fig. For many of the blocks/criteria listed above an indication is given stating under which conditions the criterium works in favor of modal shift or constitutes a serious barrier. For example, if goods are perishable, it makes no sense to go for a slower transport mode.

About the 25 maritime flows

Out of the 25 cases presented in Table 3 only 5 made the shift, and the main reasons which prompted the decision are listed below:

- CO_2 reduction has higher priority than costs.
- Too high demurrage costs when using road freight.
- 20 ft containers in combination with short first mile made MM competitive.

These 5 cases reduced the kilometers driven by the 25 cases by 450.000 of the 2.100.000, and the number of shipments were reduced by 5100 out of 15.435. CO_2 reduction is, depending on the case, between 31 and 76%.

17 cases were still pending, but the potential success rate seems not to be promising due to:

- Unchangeable INCOTERMS
- No priority for the cargo owner or changed priorities
- Difficulties to find local ADR truckdrivers
- Missing or too expensive Inland Container Yard

Figure 21.Excerpt cases maritime flows

M.V ref	Type bedrijf	Titel	Import / export	Modusaanduiding	Status	KM besparing / jaar
BC-1182	LDV	Import HvA - Roeselare	IMPORT	Binnenvaart	Afgevoerd	46.000
BC-1231	Verlader	Export Waregem - HvA	EXPORT	Binnenvaart	Afgevoerd	19.000
BC-1260	LDV	Export Oudenaarde - HvA	EXPORT	Binnenvaart	Afgevoerd	17.000
BC-1163	Verlader	Import HvA - Wevelgem	IMPORT	Binnenvaart	In uitvoering	11.000
BC-1202	LDV	Export Waregem - HvA	EXPORT	Binnenvaart	In Uitvoering	130.000
BC-1207	Verlader	Export Nijlen - HvA	EXPORT	Binnenvaart	In Uitvoering	14.000
BC-1224	Verlader	Export Menen - HvA	EXPORT	Binnenvaart	In uitvoering	174.000
BC-1225	Verlader	Import HvA - Oostrozebeke	IMPORT	Binnenvaart	In Uitvoering	69.000
BC-1248	Verlader	Export Izegem - HvA	EXPORT	Binnenvaart	In uitvoering	41.000
BC-1265	Verlader	Import HvA - Aalbeke	IMPORT	Binnenvaart	In Uitvoering	141.000
BC-1284	Verlader	Import HvA -Zwevegem	IMPORT	Binnenvaart	In uitvoering	9.200
BC-1289+1290	Verlader	Export + Import Oostrozebeke - HvA	COMBINATIE	Binnenvaart	In uitvoering	48.000
BC-1295	Verlader	Export Ieper - HvA	EXPORT	Binnenvaart	In Uitvoering	196.000

About the 14 Continental flows

The 14 cases represented a potential shift from road to water of circa 2.210.000 km/year and depending on the case a saving of CO_2 between 15 % and 84 %. In 5 cases the shift was made and this resulted in a saving of 1.394.000 km/year and CO2 savings in the range mentioned here above. One case, however, already accounted for about 50 % of the savings in km.

This shows that, apart from 1 case, switching to multimodal transport is done even if the TCO increases.

Figure 22.Continental flows cases

KM besparing / jaar	CO2 besparing	Shipments / jaar	Ton / jaar	Km-afstand A - B	Price difference; <1 means MM is cheaper
16.500	30%	100	2400	374	€ 0,70
374.000	21%	1300	40000	145	€ 2,01
232.000	15%	6450	208500	100	€ 1,97
626.250	84%	3750	100000	90	€ 1,09
146.160	37%	840	23500	100	€ 1,39

9.4. Multimodaal Vlaanderen's Inland Container Yard (ICY) Concept

With the ICY concept, shipping companies themselves are responsible for the transport of the containers via barge or rail from or to the nearest container terminal in the hinterland, where they keep empty containers as a depot. In this way, empty containers are no longer picked up or returned to the port, which in itself means a halving of the number of truck journeys. The full containers are transported intermodally at ICY, so that only the route between the hinterland terminal and the loading or unloading point has to be undertaken by road.

The ICY concept should benefit all parties involved. The role of the forwarder remains unchanged: booking the sea freight, including the transport between the terminal and the port, arranging the pre- or post-transport by truck between the terminal and the loading or unloading point, taking care of the necessary documents, (customs) formalities and other value-added services. Shipping companies in turn gain insight into the hinterland movements of their equipment, which should ensure that they can manage their pool of containers more efficiently. Shippers, for their part, are offered a sustainable intermodal solution at competitive rates, which, according to Intermodal.Vlaanderen, is often difficult with the traditional method where the container departs and arrives at the port. Finally, ICY offers the advantage that the 'free time', the time by which the customer has to return the container to the shipping company, only starts to run from the hinterland terminal and not from the seaport.

Figure 23. Multimodal alternative : maritime CTRS in carrier haulage (ICY)

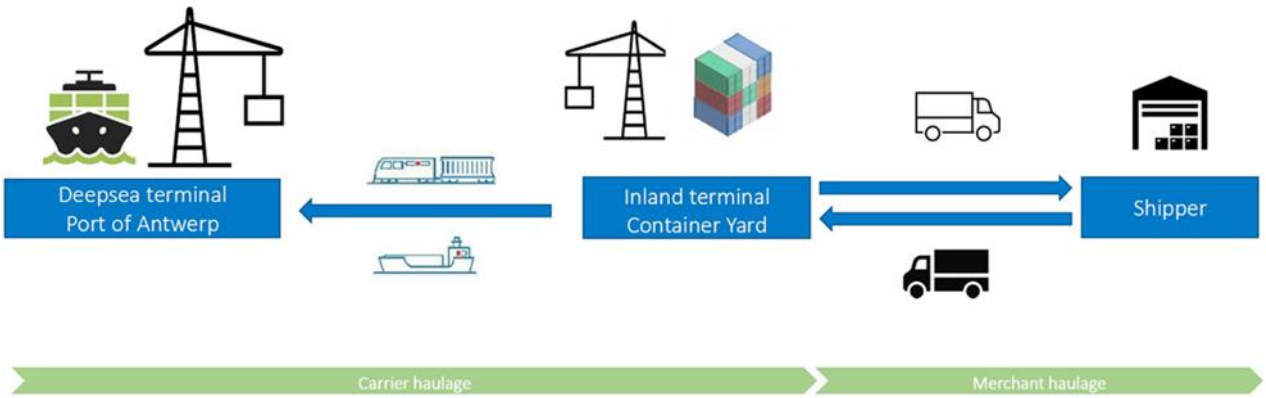
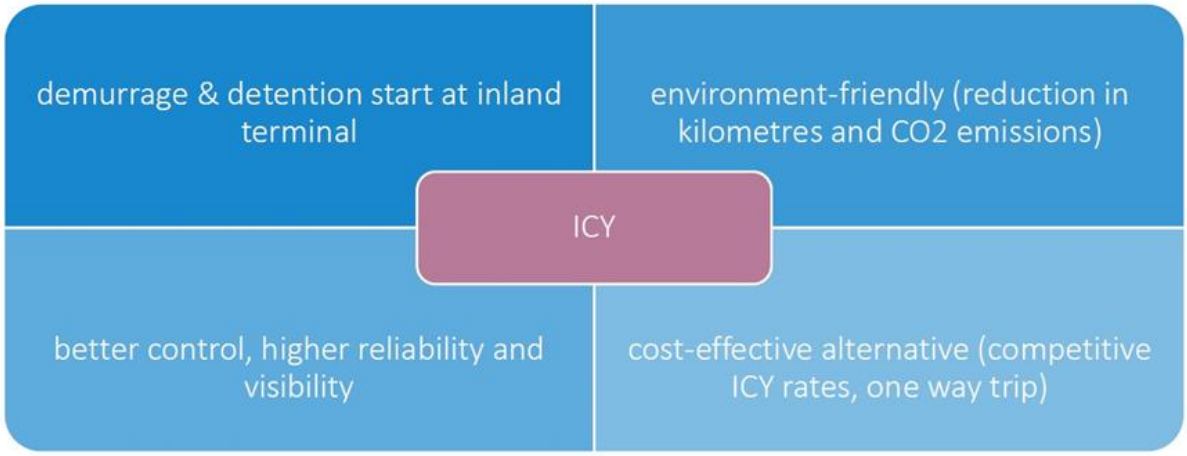


Figure 24.ICY characteristics

Figure 25. ICY advantages



9.4.1. Best practice ICY Concept

- Shipper based in Genk
- Import 300 containers (mix 20'/40') a year via Port of Antwerp
- As-is: 100% road (one way 112 km / roundtrip 224 km)

Figure 26 Inland solution ICY

	Benchmark (as-is)	ICY set-up
Transport mode	Truck	Barge
Equipment	mix of 20' and 40'	
Number of handlings	2	4
Transit door-2-door	Direct	A-B / A-C
Truck-KM (roundtrip)	224 km	10 km
Cost (indication) in €	380 €	20-ft: 220€ + 110€ = 330€ 40-ft: 250€ + 110€ = 360€
Total # truck-km	67.200 KM	3.000 KM (-96%)
Ton CO2	67 Ton	35,4 Ton (-47%)

9.4.2. The ICY concept benefits and replicability

The ICY concept is becoming increasingly popular due to the benefits it offers[16]. Firstly, it provides a cost-effective and efficient way to transport containers from seaports to inland locations, reducing the transport cost and time. Secondly, it reduces congestion at seaports by transferring the containers to the ICY, where they can be sorted and dispatched according to their destination. Thirdly, it enhances security by providing a centralized location for container handling, reducing the risk of theft, damage, or loss of containers during transportation. In an ICY, containers are typically stacked in rows, and cranes are used to load and unload them onto barges or trucks for further transportation. The ICY also provides other services such as customs clearance, documentation, and container maintenance, ensuring that the containers are in good condition and ready for further transport. Overall, the ICY concept plays a crucial role in improving the efficiency and effectiveness of inland barge transport, reducing the cost and time of transportation, enhancing security, and improving the overall supply chain management.

The ICY concept can be replicated in different locations and regions, depending on the specific needs and requirements of the supply chain. In fact, many countries and regions around the world have already adopted the concept and established their own logistics hubs to support their inland transport operations.

However, the replication of the ICY concept requires careful planning, investment, and coordination among different stakeholders. The establishment of an ICY involves a significant amount of infrastructure development,

[16] How does an Inland Container Depot (ICD) work? (2021) https://www.allcargologistics.com/inland-container-depot

including the construction of container handling facilities, storage yards, access roads, and other supporting infrastructure. It also requires the involvement of various actors, including shipping lines, freight forwarders, trucking companies, and other logistics providers, to ensure smooth operations and seamless coordination of container movements. Moreover, the success of the ICY concept depends on various factors such as the location, connectivity, regulatory environment, and market demand. Therefore, before replicating the ICY concept, it is essential to conduct a thorough feasibility study and assess the market potential, operational feasibility, and financial viability of the project. The key to replicating this concept is to tailor it to the specific needs and requirements of the supply chain and ensure that all relevant stakeholders are involved in the process.

Martens Brewery makes modal shift for export from road to water

Martens Brewery is testing export shipments via the Port of Genk according to the ICY (Inland Container Yard) concept. The first test results are promising: 153,000 fewer kilometers driven and 62 tons less CO_2.

The Limburg family business brews a wide range of beers for the European continental market and for importers worldwide. The company is committed to innovation and sustainability throughout the entire chain. More sustainable transport is of course part of this vision.

A study by Multimodal.Vlaanderen inspired the company to send export shipments via the Port of Genk. Previously, this was undertaken by road, over the busy E313 to the port of Antwerp. The first tests went smoothly, so the company decided to transport additional volumes to Antwerp via inland shipping.

The potential in terms of mobility impact and CO2 reduction is considerable. In a first phase, up to 1,000 containers per year may be transported to Antwerp via inland shipping, resulting in 153,000 avoided kilometers on the motorways and the Antwerp ring road. The reduction of 33% CO2 compared to road transport also contributes to making logistics more sustainable.

In addition to cost savings, the analysis also showed the benefits of local transport. Because the empty export containers are collected in Genk, they are always positioned in time for loading in Bocholt. This makes warehouse planning and operations more efficient.

COMPO EXPERT in Deinze is active in the production and distribution of specialized fertilizers.

These are supplied, among other things, from their location in Krefeld. Until recently, the bags on pallets were transported by truck over a route of 260 km, of which 145 km on Flemish roads.

A thorough internal evaluation led to the decision to structurally supply the bags on pallets by barge. In concrete terms, 8 trips of around 700 pallets each will be sailed each year. The 5,600 pallets are loaded into a 1,250-ton barge, which covers the 390 km journey on the water in 4 days (loading on day A, unloading on day D), with effective sailing between 6 am and 10 pm.

”The detailed business case of Multimodal.Vlaanderen was a trigger for us. But we certainly didn't decide overnight. The trials were critically examined for elements such as damage sensitivity.

On the entire Krefeld – Deinze route, 234 journeys per year (one way) are saved or almost 61,000 km. The follow-up route (unloading quay – Deinze branch) is limited to less than one kilometer.

This modal shift saves a total of about 34,000 truck kilometers on Flemish roads. CO_2 reduction 30 %. Despite a longer sailing route (390 km of waterways compared to 260 km of road), 30% of CO_2 emissions are avoided over the entire route.

A survey by TIMCONSULT

In 2017 Timconsult , a renowned consultancy company in the field of logistics and now part of the Transporeon group, carried out a survey regarding hinterland traffic. 44 cargo owners, situated within the Le Havre- Hamburg port range, were requested to answer questions regarding the criteria they use when deciding about which transport mode to use for their import/export flows to/from the mentioned seaports. 114 answers came in and this led to the following outcome, in descending order: cost, reliability, leadtime, plannable, flexibility. 5 typical Supply Chain criteria, where then followed by environment and policy/regulation-oriented criteria. Regarding the question under which condition a change of transport mode would take place the answers were again Supply Chain driven. First came higher reliability followed by lower costs and shorter leadtimes. See Annex 2 : Supply Chain criteria and principles for further information.

10. Conclusions and possible recommendations for modal shift support and promotion measures

10.1. Key findings

A company's business model, organizational structure, service portfolio, marketing, and sales strategies are all important factors that can impact its success in realizing a freight modal shift from road to inland waterways.

In general, a successful modal shift from road to inland waterways would require a coordinated effort across the company, involving changes to its business model, organizational structure, service portfolio, and marketing and sales strategies. At company level, the concept of modal shift in freight transport involves a company's decision to shift its transportation of goods from one mode of transportation to another, in order to improve the sustainability and efficiency of its transportation operations. This decision is often motivated by a variety of factors, such as increasing transportation costs, concerns about environmental sustainability, or a desire to improve the reliability and timeliness of transportation services. For example, a company may decide to shift its transportation from road to rail in order to reduce transportation costs, particularly for long-distance transportation. Alternatively, a company may choose to shift its transportation to inland waterways in order to reduce emissions and improve sustainability.

The decision to shift transportation modes typically involves a careful evaluation of the costs and benefits of different transportation options, as well as an assessment of the specific needs and requirements of the company's transportation operations. This evaluation may involve a range of factors, including the type and quantity of goods being transported, the distance of transportation, the availability and quality of transportation infrastructure, and the regulatory and policy environment.

Mode choice elements plays a critical role in the success of modal shift from road to inland waterway. When making mode choice decisions, shippers and carriers consider a wide range of factors, including cost, speed, reliability, accessibility, and environmental sustainability.

In the context of modal shift from road to inland waterway, mode choice can have a significant impact on the overall success of the initiative. To encourage mode shift to IWT, stakeholders in the transport industry can implement a range of measures, including improving the infrastructure for inland waterway transport, providing financial incentives for shippers and carriers, and promoting the environmental benefits of inland waterway transport. By addressing the key factors that influence mode choice, stakeholders can create an environment that encourages modal shift and contributes to the overall success of the initiative.

Key actors in the transport and logistics chain, such as shippers, carriers, terminal operators and freight forwarders, should be made aware of the various factors that influence modal choice, as well as of the urgency that they contribute towards realising modal shift towards more sustainable modes of transport.

By understanding these factors, relevant actors can remove barriers and identify opportunities to further promote and incentivize the use of sustainable transport modes, including inland waterway transport. This can involve developing innovative transport solutions, such as intermodal connections that combine different modes of transport, and implementing policies and regulations that encourage sustainable transport choices.

Addressing economic and financial barriers to modal shift is important because it can have significant environmental, economic, and social benefits.

Moving goods from road to more sustainable modes of transport, such as inland waterways or rail, can reduce carbon emissions, decrease congestion on roads, improve air quality and promote economic growth. Furthermore, using alternative modes of transport can provide cost savings for shippers and transport companies, as well as reduce the external costs associated with road transport, such as accidents, congestion and infrastructure maintenance.

In the context of modal shift to inland waterways, the three phases of inertia, modal shift, and maturity can be applied in a similar way as in the broader theoretical framework of modal shift.

- **During the inertia phase**, there may be resistance among businesses and individuals to shift from road transportation to inland waterway transportation, despite the potential benefits. This may be due to various factors such as a lack of awareness, limited access to necessary infrastructure, or a preference for established routines. Overcoming this inertia may require targeted efforts such as educational campaigns, incentives or regulatory changes, or investment in infrastructure.
- **During the modal shift phase**, businesses and individuals begin to transition to more sustainable modes of transportation, such as inland waterways. This phase may be driven by changes in pricing or regulations, incentives for using more sustainable modes, or improvements in the infrastructure and technology that support these modes. During this phase, it is important to build the necessary infrastructure, capacity, and operational practices to support inland waterway transportation, and to promote the use of this mode to the broader freight transportation community.
- **The maturity phase** is reached when the use of inland waterway transportation becomes more established and widespread, and businesses and individuals have fully adopted this mode as a regular part of their operations and are using IWT in a synchromodal operation. This may be reflected in changes to supply chains, pricing and regulatory structures, and other aspects of the freight transportation system. During this phase, the focus may shift to maintaining and improving the infrastructure and operational practices that support inland waterway transportation, and to further promoting the use of this mode to additional stakeholders.

Macro-level and micro-level factors can play a significant role in determining the types of barriers that emerge in different phases of modal shift.

Macro-level factors: These are the broader economic, social, and political factors that affect transportation at a national or regional level. Examples include **government policies, infrastructure investments, and demographic trends.**

- Inertia phase: During the inertia phase, the primary barrier is often a lack of political will or funding to invest in alternative modes of transportation. This can be driven by macro-level factors such as a focus on maintaining the status quo, budget constraints, or a lack of public support for change.
- Modal shift phase: In the modal shift phase, macro-level factors such as government policies or infrastructure investments can facilitate the adoption of alternative modes of transportation. However, barriers may still exist, such as the need for significant changes to existing infrastructure or competing demands for resources.
- Mature phase: In the mature phase, macro-level factors can continue to shape transportation patterns, but the focus may shift more towards maintaining and optimizing existing systems rather than significant changes to infrastructure or policies.

Micro-level factors: These are the individual-level factors that affect transportation choices, such as personal preferences, attitudes, and access to transportation options.

- Inertia phase: In the inertia phase, the primary barrier may be a lack of awareness or understanding of alternative transportation options. Other barriers could include a lack of access to alternative modes of transportation or concerns about safety or reliability.
- Modal shift phase: In the modal shift phase, micro-level factors such as personal preferences and attitudes can play a significant role in determining whether individuals adopt alternative modes of transportation. Other barriers could include a lack of access to convenient or affordable options or concerns about travel time or reliability.
- Mature phase: In the mature phase, micro-level factors may continue to influence transportation choices, but the focus may shift more towards optimizing existing systems and addressing specific barriers that may be preventing certain populations from accessing transportation options.

Actors behind the barriers can vary depending on the specific context and phase of modal shift. In some cases, government agencies or policymakers may be responsible for creating or removing barriers, while in other cases, individuals or private companies may play a more significant role. Understanding the interplay between macro-level and micro-level factors can help identify the most effective strategies for overcoming barriers and promoting sustainable transportation options.

In the inertia phase, economic barriers may stem from limited government budgets or political will to invest in alternative modes of transportation. Actors behind these barriers could include government agencies, private companies, and individuals who are resistant to change or are unable to afford the costs of transition.

During the modal shift phase, economic barriers may include high initial costs of transitioning to alternative modes of transportation or inefficient and unreliable transportation options. Macro-level factors such as government policies and incentives that promote the adoption of alternative modes of transportation and increased investment in transportation infrastructure can help to overcome these barriers. However, personal preferences and attitudes towards different modes of transportation and limited access to affordable or convenient options can also be factors. In this phase, governments, private companies, and individuals who are willing to invest in or adopt alternative modes of transportation may play a more significant role.

In the mature phase, economic barriers may include high costs of maintaining or upgrading existing transportation infrastructure and limited funding for innovative transportation technologies or services. Macro-level factors such as government policies and investments that prioritize maintenance and optimization of existing transportation infrastructure and technological advancements that improve transportation efficiency and affordability can help to overcome these barriers. However, personal preferences and attitudes towards different modes of transportation and limited access to affordable or convenient options can still be factors. In this phase, governments, private companies, and individuals who are willing to invest in or adopt new technologies or services that improve transportation efficiency and affordability may play a more significant role.

Modal Shift Phase	Economic Barriers	Macro-level Factors	Micro-level Factors	Actors Behind
Inertia	- Lack of funding or investment in alternative modes of transportation. - High costs of transitioning to alternative modes of transportation.	- Limited government budgets or political will to invest in alternative modes of transportation.	- Limited awareness or understanding of alternative transportation options. - Limited financial resources of individuals.	Government agencies, private companies, and individuals who are resistant to change or are unable to afford the costs of transition.
Modal Shift	- High initial costs of transitioning to alternative modes of transportation. - Inefficient or unreliable alternative modes of transportation.	- Government policies and incentives that promote the adoption of alternative modes of transportation. - Increased investment in alternative modes of transportation infrastructure.	- Personal preferences and attitudes towards different modes of transportation. - Limited access to affordable or convenient transportation options.	Governments, private companies, and individuals who are willing to invest in or adopt alternative modes of transportation.
Mature	- High costs of maintaining or upgrading existing transportation infrastructure. - Limited funding for innovative transportation technologies or services.	- Government policies and investments that prioritize maintenance and optimization of existing transportation infrastructure. - Technological advancements that improve transportation efficiency and affordability.	- Personal preferences and attitudes towards different modes of transportation. - Limited access to affordable or convenient transportation options.	Governments, private companies, and individuals who are willing to invest in or adopt new technologies or services that improve transportation efficiency and affordability.

Shippers are important actors behind economic barriers to modal shift in the freight transportation sector. Their decisions about which transport options to use, and their willingness to invest in new technologies or services, can play a significant role in determining the economic viability of alternative modes of transportation.

Their interaction with macro-level and micro-level factors to influence economic barriers in different phases of modal shift:

- **In the inertia phase,** shippers may be hesitant to adopt alternative modes of transportation due to concerns about the reliability, cost, or availability of these options. They may also be resistant to change if they have established relationships with carriers or are satisfied with their current transportation options. Macro-level factors such as limited government investment in alternative transportation infrastructure or policies that prioritize the use of traditional modes of transportation can further reinforce these economic barriers.
- **During the modal shift phase**, shippers may be more willing to consider alternative modes of transportation if they are incentivized to do so through government policies or initiatives from carriers. However, economic barriers such as high initial costs of transitioning to alternative modes of transportation, limited availability of equipment or infrastructure, and concerns about reliability and

efficiency may still be present. Shippers may also be influenced by micro-level factors such as personal preferences or attitudes towards different modes of transportation and the availability of alternative options in their area.

- **In the mature phase**, shippers may continue to prioritize cost and efficiency when making transportation decisions. However, they may also be more willing to invest in new technologies or services that offer cost savings or efficiency improvements over the long term. Macro-level factors such as government investments in new transportation technologies or initiatives that promote sustainability and efficiency can also incentivize shippers to adopt new transportation options. At the same time, micro-level factors such as personal preferences and attitudes towards different modes of transportation and the availability of alternative options in their area can also influence their decisions.

10.2. Possible recommendations for support and modal shift promotion measures

By understanding the different phases of modal shift, stakeholders can develop strategies that take into account the unique challenges and opportunities of their specific context, and work towards a more sustainable and efficient freight transportation system.

The following type of actions can be considered:

1. **Awareness and education**: raising awareness among stakeholders, including shippers, carriers, and consumers, of the benefits of more sustainable modes of transportation. This may involve education and outreach efforts to communicate the advantages of different modes, as well as the environmental and social costs of less sustainable modes.
2. **Infrastructure development**: developing the necessary infrastructure to support more sustainable modes of transportation. This may include investments in ports, terminals, and intermodal facilities that can facilitate the transfer of goods between different modes.
3. **Incentives or regulatory changes**: to encourage the use of more sustainable modes of transportation. This may include incentives for shippers and carriers to use sustainable modes, as well as changes to pricing or regulations that favour more sustainable modes.

These three actions are often interconnected and may occur simultaneously or in a different order depending on the specific context. For example, infrastructure development may be a prerequisite for operational changes, or operational changes may be necessary to generate the demand needed to justify infrastructure investments. Overall, the development of public policies and support measures that are tailored to the specific needs of each phase can help to facilitate the modal shift to inland waterways and ensure that this mode of transportation becomes a sustainable and efficient option for freight transportation.

As a result, at today's current conditions we experience a modal shift from inland waterway to road and rail.

It is therefore essential to have a two-step approach:

1) Preserve the existing markets, to avoid reverse modal shift

In order to preserve the existing market of the inland navigation (industrial, raw materials and agribulk), the IWT sector mainly needs predictability.

This could be achieved by **investment in infrastructure**, for example to ensure high service levels in terms of the water level conditions, an ideal situation would be to have 250 cm of depth for all 365 days during the year on the

fairway. Furthermore, maintenance of locks and other infrastructures is also a pre-requisite. In addition, synchro modal transport may help to solve temporary problems on the infrastructure network. For example, by cooperating more closely with rail transport to create synergies and makes both rail and IWT stronger and more resilient to disruptions in the system (e.g. as a result of severe droughts causing extreme lower water levels like we saw in 2022).

2) Modal shift

If and only if the "predictability" factor is solved or mitigated, the inland waterway transport could look to other markets for increasing its share. At this stage, **the investment in means of transport and technology** is essential. Technology "greening" and IT systems are the answer in the long run.

The greening of the fleet should be harmonised on the entire stretch of the river (or rivers), so that all shipowners get indiscriminatory access to "alternative energy" supply. The implementation of IT solutions for navigation will also lead to significant cost reductions, making inland navigation competitive for other types of cargo as well.

With predictability in one pocket and greening/technology in the other, inland navigation ***could*** *become a solution* for new types of cargo flows compared to those served today. But for a modal shift, much more is needed. Cargo will not simply move from one mode of transport to inland navigation. It is also about **promoting** this alternative as "the solution", from a political level up to each and every stakeholder and providing significant support for studies and works on local, regional, national and European level.

Policy makers can play a significant role in influencing the decision-making process around modal shift in freight transport by providing a supportive policy and regulatory framework.

Some courses of action by which policy makers can influence this decision-making process.

Authorities can target initiatives and policies to form relevant alliances and support modal shift by approach, while practitioners can relate and be inspired by the described activities in the varying contexts and adhere to entrepreneurial roles. Realising large-scale modal shift requires multi-actor engagement, openness to emergent solutions and long-term endurance.

Overall, the development of public policies and support measures that are tailored to the specific needs of each phase can help to facilitate a modal shift to inland waterways and ensure that this mode of transport becomes a sustainable and efficient option for freight transportation. Public policies and support measures can be developed along the three phases of modal shift to inland waterways to encourage and facilitate the shift towards IWWs, as follows:

In the inertia phase:

- **Education and awareness campaigns**: Policy makers work with industry stakeholders to develop educational and awareness campaigns to promote the benefits of inland waterway transportation and increase awareness of the infrastructure and equipment needed to use this mode of transportation.
- **Research and development**: Investment in research and development helps to identify opportunities to improve the efficiency, reliability, and safety of inland waterway transportation.

In the modal shift phase:

- **Financial incentives**: Governments offer financial incentives, such as tax credits or subsidies, to companies that shift their transportation operations to inland waterways.

- Infrastructure investment: Governments invest in infrastructure improvements and upgrades, such as the construction of new ports and waterways, to support the increased use of inland waterway transportation.
- **Regulatory support**: Governments provide regulatory support, such as streamlined permit processes and exemptions from certain regulations, to make it easier for companies to use inland waterways and ports and to build terminals and quays.
- **Industry collaboration**: Industry stakeholders work together to develop more efficient logistics and supply chain management processes that integrate inland waterway transport into existing operations, one-stop-shop solutions for shippers.

In the maturity phase:

- **Continued investment in infrastructure and technology**: Continued investment in infrastructure and technology helps to further improve the efficiency and reliability of inland waterway transport.
- **Encourage competition and collaboration**: Encouraging competition in the market helps to ensure that companies have access to the best possible services at the lowest possible cost. In addition, collaboration can support the development of synchro modal solutions to make best use of available network capacities and efficiencies.
- **Research and development**: Ongoing investment in research and development helps to identify new opportunities to improve the sustainability and efficiency of inland waterway transport.

Competition to inland waterway transport from other modes of transport, such as road or rail, is a major issue in the modal shift context. Both road and rail offer some advantages over inland waterway transport, such as faster and more flexible transportation options for smaller volumes of goods, and in some cases, a wider range of origin and destination locations. In addition, they may have more developed and efficient infrastructure and logistics networks, which can offer cost savings for certain types of shipments.

To compete with these other modes of transport, inland waterway transport operators and stakeholders may need to focus on improving **the reliability and speed of their services**, reducing the costs and time associated with transhipment and other pre- and post-transport activities, and addressing other barriers to the wider adoption of inland waterway transport, such as regulatory and administrative burdens, and limited market size and competition.

Additionally, there may be opportunities **to explore new business models and partnerships** with other transport modes, such as multimodal transport solutions and synchro modality (see PLATINA Deliverable 1.3)[17], which can help to address some of these challenges and promote greater use of inland waterway transport. It involves the use of different transport modes to move goods from origin to destination. Inland waterway transport can be integrated with other modes, such as road, rail, and sea transport, to create a more efficient and sustainable logistics chain. This requires close cooperation between the different transport operators, as well as investment in the necessary infrastructure and equipment, such as intermodal terminals and intermodal load units (containers) which can be exchanges between road, rail, IWT and sea transports.

Another example is granting road haulage permits selectively which may be an effective way for authorities to promote the use of inland waterways for freight transport. By giving preference to companies that are willing to make greater use of waterways, authorities create an incentive for companies to shift away from road transport

[17] https://platina3.eu/integration-of-iwt-in-synchromodal-logistics-chains/

and towards more sustainable modes of transport. We suggest the following courses of action for authorities to grant permits selectively:

- **Offering incentives**: Authorities offer incentives, such as tax breaks or subsidies, to companies that use waterways for transport which can help to offset the costs of shifting to waterway transport and encourage companies to consider this option.
- **Imposing higher fees or restrictions**: Authorities impose higher fees or restrictions on companies that rely solely on road transport. As an example, authorities impose higher tolls or congestion charges on trucks, or restrict the use of certain roads or routes to reduce congestion and emissions. This would create a disincentive for companies to rely solely on road transport and encourage them to explore alternative modes, such as inland waterways.
- **Prioritizing permits**: Authorities prioritize permits for companies that make greater use of waterways for transport. For example, authorities give priority to companies that use waterways for a certain percentage of their freight transport, or to companies that have invested in infrastructure or equipment to support waterway transport.

By granting permits selectively, authorities create a level playing field for all transport modes and encourage companies to explore more sustainable and efficient modes of transport, such as inland waterways. This helps to reduce congestion, emissions, and energy consumption, while also promoting economic growth and job creation in the waterway transport sector.

Another potential business model is the use of digital platforms to optimize the use of inland waterway transport. These platforms provide real-time information on vessel availability, cargo volumes, and transport routes, allowing shippers to make informed decisions about which mode to use and when. They also facilitate collaboration between different transport operators, enabling more efficient use of resources and reducing costs.

Partnerships between public and private stakeholders can also play an important role in promoting inland waterway transport. Public authorities invest in infrastructure, provide financial incentives, and support the development of new business models, while private operators bring their expertise and experience to the table. By working together, these stakeholders help overcome some of the barriers to modal shift and promote the use of more sustainable transport modes, including inland waterway transport.

Some potential recommendations that policy makers could consider to eliminate financial and economic barriers to modal shift from road to inland waterway transport:

1. Establish funding mechanisms to support the development and maintenance of port, terminal and inland waterway infrastructure, which helps to reduce infrastructure costs for shippers. But they need to be structural and not campaign based.

2. Implement regulatory measures that promote fair competition between different transport modes and encourage the use of environmentally sustainable modes like inland waterway transport.

3. Promote the development of innovative business models and partnerships that enhance the competitiveness of inland waterway transport, such as multimodal / synchro modal transport solutions.

4. Provide financial incentives or subsidies to shippers that make use of inland waterway transport, such as reduced port fees or fairway dues. As an example the recently launched initiative in the Netherlands whereby the Dutch Government contributes 20,- Euro for each container taken from the road and moved to IWT.

5. Reduce administrative burdens associated with customs and border police formalities, particularly in cross-border sections between Schengen and non-Schengen states, to facilitate more seamless and efficient transport operations.

These are just a few potential recommendations that could help to eliminate financial and economic barriers to modal shift from road to inland waterway transport. The most effective measures will depend on the specific context and needs of each country or region.

Also, setting up a promotion centre for modal shift to inland waterways would be a useful strategy to encourage and facilitate greater use of waterborne transportation for freight movement. This is especially relevant for countries where IWT is relatively unknown and small in size.

Such a centre could provide a focal point for stakeholders such as shippers, logistics providers, and barge operators to come together to share information, discuss best practices, barriers to modal shift, understand their composing factors and to help devise facilitators in a collaborative way.

The promotion centre could also play a role in raising awareness of the benefits of waterborne transportation, including its cost-effectiveness, sustainability, and capacity to handle larger volumes and heavier cargo than road transport. This could be realised through targeted marketing and outreach efforts, such as webinars, seminars, or other events that bring together stakeholders to discuss the advantages of modal shift.

Additionally, the promotion centre could help to facilitate greater coordination and collaboration among stakeholders to overcome some of the challenges associated with modal shift, such as infrastructure limitations, regulatory barriers, or information gaps. This could include initiatives to standardize contracts and procedures for barge transport, establish more efficient transhipment facilities, or advocate for policy changes to support greater investment in inland waterway infrastructure. Overall, a promotion centre for modal shift to inland waterways could be a valuable resource for stakeholders looking to explore the potential benefits of waterborne transportation, and could help to facilitate a more efficient, sustainable, and cost-effective freight transport system.

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Annex 1: comparative advantages behind Modal Shift

A modal shift occurs when one mode has a comparative advantage in a similar market over another compared to another mode. Comparative advantages can take various forms, such as costs, capacity, time, flexibility, or reliability. Environmental performance could be considered a comparative advantage. In this context, modal shift is viewed as an opportunity for companies to optimize their supply chains and reduce costs, while also reducing their environmental impact. Notwithstanding, depending on what is being transported, the importance of each of these factors varies. For some, time is of the essence, and a modal shift will occur if the new mode offers time improvements or if new capacity is no longer available, while for others, it is mostly a matter of costs. The outcome is a series of decisions made by companies (for freight) to shift to another mode if comparative advantages are significant.

The comparative advantages behind a modal shift can be in terms of costs and price, convenience, speed, or reliability. When comparing modes of transport, "convenience" generally refers to the ease of using a particular mode of transport, including factors such as accessibility, speed and flexibility:

- Accessibility means how easy it is to access and use the mode of transport, including the availability of terminals, and other infrastructure and the required management and administrative work
- Speed means the speed of travel, including the time it takes to reach the end user and any potential delays. This can be important for the final client, especially if dealing with time critical goods like perishables which lose value over time or parcel express services. Moreover, the speed determines also the number of loading units which are needed and the number of goods which are in transit but for which the capital value needs to be taken into account. Long transit times for valuable goods are therefore costly from a financing point of view.
- Flexibility concerns the degree of flexibility offered by the mode of transport, including the ability to adapt to changing requirements and schedules and to load return cargo to increase efficiency of the operation. For inland waterways, the flexibility and opportunity to acquire return cargo is much more limited compared to trucks, because of the sheer size of volumes needed and the limited waterway infrastructure compared to the dense road network.

Another key factor that may influence the convenience of a particular mode of transport include the level of safety. This concerns the risk of accidents or other incidents, including external safety risks in case of dangerous goods transport. For freight transport, mostly the convenience related elements in combination with changing type of freight demand (e.g. Business to Consumer e-Commerce) have implied a shift to faster and more flexible modes when possible and cost-effective, namely trucking. Furthermore, a modal shift can further be nuanced by time shift which has monetary impact due to costs associated with holding inventory, for which the use of the same mode takes place in another time period, likely when there is less congestion. Time shift refers to the shift of transportation demand from peak periods to non-peak periods. This can have a monetary impact due to costs associated with holding inventory. For example, if manufacturers normally ship their products using road transport during peak hours, they may face higher transportation costs due to increased traffic and congestion. If they shift their transportation demand to non-peak hours, they may be able to reduce transportation costs and also avoid the costs associated with holding inventory for longer periods of time.

Similarly, if retailers normally receive their products using rail transport during peak hours, they may face capacity constraints and delays. If they shift their transportation demand to non-peak hours, they may be able to access more capacity, reduce delays, and avoid the costs associated with holding inventory for longer periods of time.

In general, time shift can help to balance transportation demand and reduce congestion, while also reducing transportation costs and the costs associated with holding inventory. Therefore, it can be concluded that in a situation of congestion, it is likely that a time shift will be preferred to a modal shift; hence the possibility that freight delivery can be rescheduled.

Annex 2: Facilitators and barriers to modal shift from road to intermodal transport in the category of economics

The facilitators and barriers to modal shift from road to intermodal transport in the category of economics are price or cost related and refer to the transport itself and as well as to shipment size and properties of cargo. In the literature reviewed, transport costs or prices are commonly named to be a very decisive factor for the mode choice decision making. To make intermodal transport a preferred alternative to road haulage, generalized transport costs would have to be equal or lower (Hanssen et al., 2012), thus the extra costs due to pre- and post-haulage (PPH) as well as transhipments at the intermodal terminals must be offset by the lower costs of the long-haul transport (Bärthel and Woxenius, 2004).

Generalized transport costs refer to the total cost of transporting goods from one point to another, considering all the relevant costs and expenses associated with the transportation process. These costs include not only the direct costs of shipping, such as fuel, labour, and equipment, but also the indirect costs associated with the transport, such as administrative costs, insurance, and maintenance. In the context of intermodal transport, generalized transport costs would include the costs associated with pre- and post-haulage, terminal handling, and any other costs incurred in the transportation process. To make intermodal transport a preferred alternative to road haulage, the generalized transport costs of intermodal transport must be competitive with or lower than those of road transport.

The total costs of intermodal transport (including pre- and post-haulage and transhipments at terminals) need to be competitive with or lower than the costs of road haulage. This is because intermodal transport typically involves additional handling and transfer costs compared to road transport, such as loading and unloading at terminals and transport to and from the terminals (PPH). However, the advantage of intermodal transport is that it can often offer economies of scale and other benefits for long-haul transport, such as higher load capacities, lower fuel consumption, and reduced environmental impacts. Therefore, to offset the extra costs of PPH and terminal transhipments, the lower costs of long-haul transport must be realized and passed on to customers to make intermodal transport a more attractive option.

Annex 3: Barriers associated with service quality and market characteristics and legal barriers

Service quality

This includes the reliability, speed, and efficiency of IWT services, as well as the availability of information on IWT services. If IWT services are not reliable or efficient, shippers may opt for other modes of transport that can better meet their needs. For the extended use of IWT in particular, barriers to service quality include insufficient reliability and long transport times, particularly due to transhipment (Konings, 2009[18]). In IWT, loading capacities and transport times vary according to waterway conditions (Dorsser et al., 2020)[19], especially on free-flowing rivers (Hekkenberg et al., 2017[20]). Caris etal.(2014)[21] have added that IWT also requires lock and quay coordination to avoid delays. Beyond that, the large cargo capacities of IWT vessels compared with road transport vehicles imply lower transport frequencies (Konings, 2009; Meers et al., 2017[22]; Otterström and Torpfält, 2016[23]), particularly for services requiring large vessels, in order to ensure economic viability (Vierth et al., 2012). Modal shift generally confronts inertia (Garberg, 2016) that requires a corresponding mental shift among shippers.

Market characteristics

This includes factors such as the level of competition among transport modes, the availability of infrastructure, and the extent of integration of IWT into the overall transportation system. For example, if there is a lack of intermodal connections between IWT and other modes of transport, it can limit the effectiveness of IWT as a transportation option. Barriers associated with market characteristics, by contrast, relate to the potential for economies of scale due to restrictions placed upon market size, competition among modes of traffic, the condition of IWWs, vessel and crew requirements, business models and environmental concerns.

Indeed, barriers associated with market characteristics can impact the competitiveness of IWT. For example, restrictions on the size of the market and a focus on short term business perspectives can limit the potential for economies of scale, which may make IWT less cost-effective. On the other hand, fierce competition between barge owner/operators (e.g. on the spot market) reduces freight rates for the brokers and their customers. Additionally, competition from other modes of transport, such as road or rail, can limit the market share of IWT. The condition of IWWs and vessel and crew requirements can also impact the efficiency of IWT operations. Finally, business models that are not well-suited to the unique characteristics of IWT, as well as environmental concerns, can also pose challenges to the development of the sector.

Competing with other modes is further complicated by the IWT dynamics and cost structure, which diverges from standard practices for other modes (Vierth et al., 2012). For example, at low water conditions, the price of transport

[18] Konings, Rob. 2009. "Intermodal Barge Transport: Network Design, Nodes and Competitiveness." PhD thesis, Delft University of Technology. [Google Scholar]

[19] Dorsser, C. van, Vinke, F., Hekkenberg, R., & Koningsveld, M. van. (2020). The effect of low water on loading capacity of inland ships. European Journal of Transport and Infrastructure Research, 20(3), 47–70. https://doi.org/10.18757/ejtir.2020.20.3.3981 https://journals.open.tudelft.nl/ejtir/article/view/3981/4788

[20] Hekkenberg, R., C. van Dorsser, and J. Schweighofer (2017) Modelling sailing time and cost for inland waterway transport, European Journal of Transport Infrastructure Research, Vol 17, No. 4, pp. 508-529

[21] Caris, An; Limbourg, S.; Macharis, C.; van Lier, T. & Cools, Mario (2014) Integration of Inland Waterway Transport in the Intermodal Supply Chain: a Taxonomy of Research Challenges. In: Journal of Transport Geography, 41, p. 126-136

[22] Meers, D., Macharis, C., Vermeiren, T., and van Lier, T. (2017). Modal choice preferences in shortdistance hinterland container transport. Research in Transportation Business & Management, 23, 46-53. doi: http://dx.doi.org/10.1016/j.rtbm.2017.02.011

[23] Otterström, V., and Torpfält, S. (2016). Inlandssjöfart - från teoretisk möjlighet till potentiellt utförande (Inland shipping - from theoretical possibility to potential realisation). B.Sc. Thesis, University of Gothenburg.

by barge is much higher and the reliability drops. This may negatively surprise interested clients and withhold them from usage of the inland waterways where such situations may occur. IWT has also had limited success with price competition, *e.g.*in Sweden (Garberg, 2016)[24], even if examples exist of a lower price compared to road (Platz, 2009).

The cost structure of transport by barge typically includes the following cost components which may vary depending on the specific circumstances of the shipment, such as the distance travelled, the type of cargo, and the route taken.

- **Vessel costs**: This includes the cost of owning and operating the barge itself, such as fuel, maintenance, and crew wages and capital costs for the vessel and hardware.
- **Terminal costs and last mile**: This includes the cost of loading and unloading cargo at the terminal, as well as any fees for the use of the terminal facilities and possibly also cost for storage and pre- end haulage operations to the final client (origin/destination).
- **Navigation costs**: This includes the cost of navigating the waterways, such as fees for the use of locks, bridges, and other infrastructure (if applicable – not applicable in important parts of Europe) .
- **Insurance and regulatory costs**: This includes the cost of insuring the cargo and complying with regulatory requirements, such as safety and environmental regulations.
- **Administrative costs:** This includes the cost of managing the shipment, such as documentation, tracking, and customer service, IT, etc

In general, however, the cost structure of transport by barge is often more heavily influenced by fixed costs, such as vessel and terminal costs, rather than variable costs, such as fuel and navigation costs, which are more significant for other modes of transport, such as road. Also, **manning costs** are a significant component of vessel costs in transport by barge. Manning costs include wages, benefits, and other compensation for the crew members who operate and maintain the barge. The number of crew members required will depend on the size and type of barge, as well as the regulatory requirements of the jurisdiction in which the barge is operating. In some cases, manning costs may also include the cost of training and certifying crew members to meet regulatory requirements or specialized job functions. Manning costs can be a significant part of the total cost structure of transport by barge, particularly for longer-distance or more complex shipments that require additional crew members or specialized expertise.

To conclude, the fixed costs of transport by barge can be a significant factor in influencing modal shift from road to inland waterways. The fixed costs associated with barge transport, such as the cost of owning and operating the barge and terminal fees, are typically higher than the variable costs associated with road transport, such as fuel and driver wages. However, for longer distances and larger volumes of goods, the per-unit cost of barge transport can be significantly lower than that of road transport due to the economies of scale associated with larger vessels and higher capacity utilization rates. Additionally, the fixed costs of barge transport are more predictable and stable than the variable costs of road transport, which are subject to fluctuations in fuel prices and other market factors. This can provide greater certainty for shippers and logistics providers in terms of budgeting and planning, and may make barge transport a more attractive option for certain types of shipments. Overall, while the fixed costs of barge transport can be a barrier to entry for some shippers and logistics providers, they may also be an important factor in driving modal shift from road to inland waterways for certain types of shipments where the advantages of barge transport outweigh the higher upfront costs.

[24] Garberg, B. 2016. Regeringsuppdrag: Analys av utvecklingspotentialen för inlands- och kustsjöfart i Sverige (Government Investigation - Analysis of the Potential for Inland and Coastal Shipping in Sweden).

Regulatory barriers

This includes **legal barriers**, such as regulations that make it difficult to obtain the necessary permits or approvals for operating inland waterway vessels as well as to build quays,tranship cargo in ports and to execute the pre-end haulage. There may also be administrative barriers, such as lengthy and complex administrative procedures for obtaining permits, which can discourage the use of IWT. Another major regulatory barrier, is the still complicated, time-consuming administrative requirements associated with customs and border police formalities on the Danube, at cross-border sections between Schengen and non-Schengen states. These requirements can cause delays and increase costs, making IWT less attractive compared to other modes of transport. However, there have been efforts to simplify and streamline customs and border police formalities for IWT in Europe, such as the adoption of the EU Customs Code and the introduction of electronic customs systems.

However, while customs and border police formalities can also be a barrier for road transport, they generally have less impact compared to inland waterway transport, especially when it comes to international shipments. This is because road transport can more easily avoid crossing international borders or make use of specialized border crossing procedures, such as bonded warehouses, which can reduce the time and administrative burden associated with customs and border formalities. However, there are still administrative and regulatory requirements associated with inland navigation, such as licensing, safety regulations, and environmental standards, which can be a barrier to entry for new or smaller players in the market but are needed to ensure safe deployment as well as public support and confidence in inland navigation.

Annex 4: Incoterms and modal shift

INCOTERMS and modal shift are related as INCOTERMS provide standardized terms for international trade contracts that define the responsibilities and liabilities of buyers and sellers regarding the delivery of goods. These terms can affect the choice of transport mode used to transport goods between the parties. For example, if the INCOTERM used requires the seller to deliver goods to a specific location, the mode of transport used may be different than if the buyer is responsible for collecting the goods. The choice of transport mode can impact the cost, speed, and environmental impact of the shipment, which can influence the decision to shift from one mode of transport to another.

EX works and modal shift

EXW (Ex Works) is an INCOTERM that indicates that the seller's responsibility is to make the goods available at their premises, and the buyer is responsible for all the transportation costs, risks, and arrangements from the seller's premises to the final destination.

EXW can impact modal shift by giving the buyer greater control over the choice of transport mode, which may influence the decision to shift from one mode of transport to another based on factors such as cost, speed, and environmental impact. For example, if the buyer is located in the same city as the seller, they may choose to transport the goods by road or rail instead of air or sea to reduce transportation costs.

However, the use of EXW may also create challenges for the buyer, as they are responsible for all aspects of transportation and may face challenges such as coordinating logistics, arranging customs clearance, and dealing with multiple suppliers. Therefore, the choice of INCOTERM used, including EXW, may impact the modal shift by influencing the buyer's decision regarding the most suitable mode of transport for the shipment.

CIF and modal shift

CIF (Cost, Insurance, and Freight) is an INCOTERM that is commonly used in international trade contracts. It indicates that the seller is responsible for the cost, insurance, and freight of the goods to the port of destination.

CIF can impact modal shift by incentivizing the use of ocean transport over other modes of transport, as it includes the cost of freight to the port of destination. This can be an advantage for large, bulky, or non-time-sensitive shipments. However, it may not be suitable for time-sensitive or high-value goods where air or land transport may be more appropriate.

The choice of transport mode will depend on various factors such as the nature of goods, the distance, the urgency, and the cost. CIF may be used in conjunction with different modes of transport to cover the transportation of goods from the port of origin to the final destination, and the choice of mode may be influenced by the INCOTERM used.

FOB and modal shift

FOB (Free On Board) is a shipping term that indicates that the seller is responsible for delivering the goods to the port of shipment and loading them onto the vessel, but the buyer is responsible for arranging and paying for the transport of the goods from the port of arrival to their final destination.

In terms of modal shift, the use of FOB does not necessarily have a direct impact on the choice of transportation mode. However, if a buyer is located far from the port of arrival, they may need to use a combination of transportation modes to move the goods from the port to their final destination, and this may include the use of inland waterways, rail, or road transport. In some cases, the use of FOB may actually incentivize modal shift, as buyers may seek to minimize their transportation costs by using more sustainable modes of transport, such as inland waterways or rail, to move goods from the port to their final destination. However, the choice of transportation mode ultimately depends on a variety of factors, including the distance between the port and the final destination, the nature of the goods being transported, and the availability and cost of different transportation modes.

Annex 5: Supply Chain criteria and principles

Supply chain criteria refer to the specific factors or metrics that are used to evaluate the performance and effectiveness of a supply chain. The criteria are used to identify strengths and weaknesses in the supply chain, and to help guide improvements and optimizations. Here are some common criteria used to evaluate supply chains:

1. Delivery performance: This refers to the ability of the supply chain to deliver products to customers on time and in the desired quantities. Delivery performance can be measured by factors such as order lead time, delivery lead time, order fill rate, and order accuracy.
2. Cost: This refers to the total cost of the supply chain, including the costs of procurement, production, transportation, and inventory management. Supply chains should be evaluated on their ability to minimize costs while maintaining or improving service levels.
3. Quality: This refers to the quality of the products and services that are delivered through the supply chain. Quality can be measured by factors such as defect rates, customer complaints, and product returns.
4. Flexibility: This refers to the ability of the supply chain to respond to changes in customer demand, production schedules, and other factors. Flexibility can be measured by factors such as lead time for changes, supplier response time, and production lead time.
5. Sustainability: This refers to the environmental and social impact of the supply chain. Supply chains should be evaluated on their ability to minimize waste, reduce carbon footprint, and promote social responsibility.
6. Innovation: This refers to the ability of the supply chain to develop new products, processes, and services that meet changing customer needs and market trends. Supply chains should be evaluated on their ability to drive innovation and create value for the organization and its customers.
7. Collaboration: This refers to the ability of the supply chain to work collaboratively with suppliers, customers, and other stakeholders to optimize performance and achieve common goals. Supply chains should be evaluated on their ability to foster collaboration and partnerships.

By using these criteria, organizations can evaluate the performance of their supply chain and identify areas for improvement and optimization. This can help organizations to achieve their business goals, enhance customer satisfaction, and gain a competitive advantage in the marketplace.

Supply chain principles refer to the fundamental concepts, practices, and strategies that guide the effective management and optimization of the flow of goods and services from the point of origin to the point of consumption. Here are some key principles of supply chain management:

1. Customer Focus: The supply chain must be designed to meet the needs and expectations of the end customer. All activities should be driven by a customer-centric approach.
2. Integration: The different parts of the supply chain (such as suppliers, manufacturers, distributors, and retailers) must be integrated and aligned to work together towards common goals.
3. Efficiency: The supply chain must be designed to operate efficiently and effectively, minimizing waste, optimizing resource utilization, and reducing costs.
4. Flexibility: The supply chain must be able to respond quickly to changes in demand, supply, and other factors, and be adaptable to evolving business needs.
5. Collaboration: Effective supply chain management requires collaboration and communication among all parties in the supply chain, including suppliers, manufacturers, distributors, and retailers.
6. Transparency: There should be transparency in the supply chain, with accurate and timely information flow among all parties in the supply chain.
7. Sustainability: The supply chain should be designed with a focus on sustainability, minimizing the environmental impact and promoting social responsibility.
8. Continuous Improvement: The supply chain must be continually evaluated and improved to identify and address areas of inefficiency, waste, and opportunity for improvement.

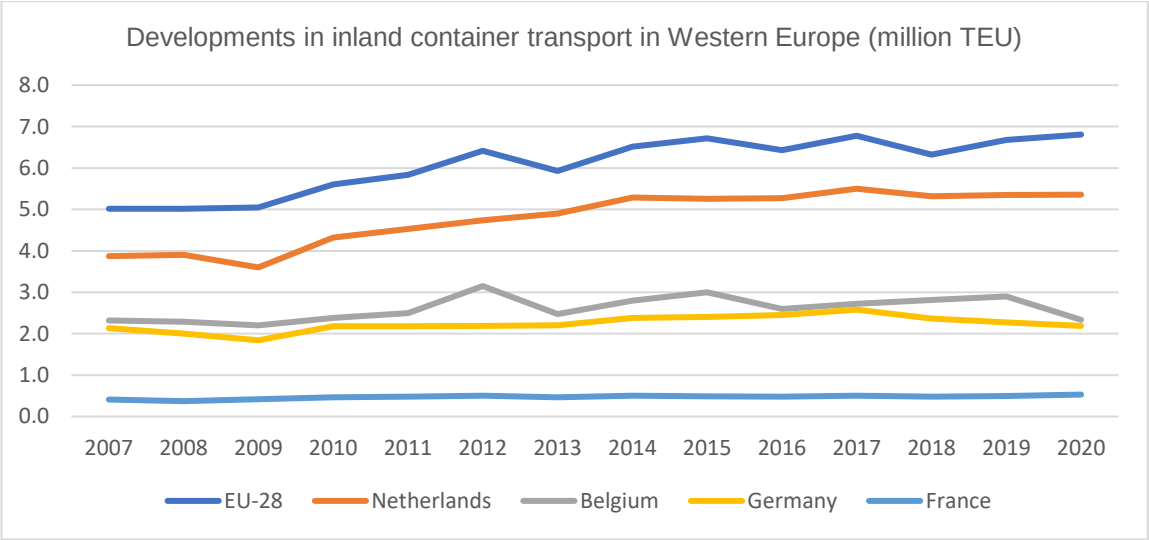
These principles guide the development and implementation of effective supply chain strategies and practices that help organizations to achieve their business goals and meet the needs of their customers in a competitive and rapidly changing business environment.

Annex 6: CCNR Secretariat analysis about container barge handling in seaports

Trends and issues affecting handling of inland vessel cargo in seaports

Container transport development since 2000

Over the years, inland waterways have contributed to the development and performance of port activities and today, barge hinterland transportation is a key element in large seaports with hinterland connection. Large seaports are important transshipment places, not only for maritime vessels, but also for inland vessels, as they represent the interface between maritime trade and hinterland transport. Strong hinterland connections with such seaports are therefore a cornerstone of the Rhine navigation's success.
The heavy concentration of the container market on the Rhine region and its growth since 2000 on the traditional Rhine is a concrete example of how successful connections with seaports have allowed Rhine navigation to take advantage of opportunities provided by international trade.



Source: Eurostat [iww_go_actygo]

In addition, inland shipping has a high share in modal split in the two largest European seaports Rotterdam and Antwerp.
For instance, in the Port of Rotterdam in 2020, container throughput was 14.3 million TEU. 38% of the containers that move between the Maasvlakte terminal and the hinterland were transported by inland vessels.
In order to exploit the potential of container transport even further, a constant improvement of the Rhine navigation's integration into logistics chains is a cornerstone, in particular to adapt to changes affecting global trade flows. Ensuring a faster and more efficient inland vessel cargo handling in seaports is essential to reinforce the role of inland navigation as an economically relevant means of transport.
However, particularly in western ports such as Rotterdam and Antwerp, inland vessels are still faced with long waiting times in seaports. This situation has a negative impact on inland navigation transport.
The difficulties faced by inland navigation are exacerbated by the persistent timetable irregularities of maritime navigation and soaring energy prices (compared to the rail sector). In addition, recent events such as the Covid-19 crisis, the Suez Canal incident (ship blockage) as well as the Brexit, led to increased congestion issues at the level of seaports, highlighting further their vulnerability and the need to find solutions to address this challenge.

Several disruptions in the container supply chain influencing handling in seaports and leading to inefficiencies for inland cargo vessels

Inefficient handling of inland navigation containers in seaports is not a new problem. Today, inefficiencies in container handling as well as congestion in seaports continue to be a challenge for inland navigation, which results from disruptions at different levels of the container supply chain and with **multiple underlying factors**:

- increasing global demand and growth in container traffic, use of ever larger container ships (megaships). Indeed, the increase of scale in vessels and operations in the deep-sea terminals creates greater peaks in demand for handling capacity, leading to waiting lines for barges, unreliable liner shipping schedules.
- lack of coordinated planning of handling for the entire seaport, lack of cooperation and information sharing between the different actors of the supply chain. For instance, lack of swift information to barge operators or inland terminal in case of changes in the "Expected Time of Arrival (ETA)" or "Expected Time of Departure (ETD)" of sea-going vessels can have important impacts on the planning of inland terminals and barge operators. Indeed, changes in ETA leads to adjustment of Cargo Closing and Opening Times.[25] In the case of exports, efficient exchange of information can thereby prevent containers from being delivered too late by barge operators (i.e. after the Cargo Closing Time, leading to the containers being moved to the next sailing) or too early (before the Cargo Opening Time and leading to containers not being accepted by the deep-sea terminals). complexity of the container logistics chains with a large number of players having different kind of arrangements with shippers.
- lack of a direct contractual relation between the deep-sea terminals and the container barge operator, although such contractual relationships are observed in some instances.[26] This leads to a lack of binding agreements on an operational level what enables both parties to cancel or reschedule even in last minute without any financial consequences.
- longer loading and unloading processes of inland vessels, due to the need to stop at different terminals within the seaport. This also increases the risk of schedule disruptions, overall limited capacity and
- lack of dedicated handling capacity (berths, cranes, labour force) for inland waterway transport as well as a lack of (at times) storage capacity[27] in terminals and in ports.
- increasing tightening of demurrage and detention conditions[28] from the shipping companies. Such a tightening of the demurrage and detention conditions is taking in particular two forms: decrease in the agreed periods during which containers can be used free of charge and increase of the detention and demurrage charges outside this free period. This ultimately puts more pressure on the timeframe in which containers can be supplied or disposed of free of charge around a deep-sea call and further increases the peak load.

Handling priority to maritime cargo over inland cargo

Beyond these factors, handling priority is generally given to maritime cargo ships in case of disturbance at the seaports, what plays against other parties in the supply chain, including inland cargo vessels.

A main reason for this is the **strong commercial position of the shipping companies compared to container barge operators**. The so-called "call size": indeed, the containers transported are regularly delivered to the maritime terminals in small numbers instead of being collected and delivered in large numbers by ship(s). From a business perspective, it is therefore more interesting for terminal operators as well as for the port authorities to handle greater numbers of containers.

This situation is reinforced by:

the use of larger ships, which consists in a further guarantee for an increase in volume and business,

the fact that barge operators, to secure the reliability of the transport operation, are put in a position where they must include large time margins when planning their terminal visits, what also affects the reliability of the transport

[25] Which consists in the time window when containers can be delivered at the seaport terminals and be handled. This time window can be adjusted depending on the ETA. Concrete example of the ECT terminals in the Port of Rotterdam: Containers must be present at the ECT terminals no later than 24 hours prior to the arrival of the seagoing vessel (based on ETA). Containers submitted after the Cargo Closing Time are moved to the next sailing. ECT terminals accept containers from 8 days prior to the arrival of the seagoing vessel (based on ETA). Containers arriving before this Cargo Opening Time are not accepted.

[26] For instance, in the form of fixed window agreements between barge operators and deep-sea terminals.

[27] This could be explained by the increased dwell times or peaks in container transport activities resulting in less space being available to stack containers and ultimately less handling capacity.

[28] Detention and Demurrage charges are applicable to customers using containers from maritime carriers longer than a free period. Both (charges and free-period) are agreed upon between the two parties in a contract. Demurrage charges apply to containers used inside the terminal while detention charges apply to containers used outside the terminals.

operation at a deep-sea terminal. In practice, container barge operators have to make an early request for the handling of containers in the seaport. The terminal then assigns a final timestamp for the call. This has to be done for each terminal. The issue is that when there is no capacity, timestamps are delayed or not delivered.
In addition, a wave of market consolidation also took place in the last decades in the global container shipping industry, creating further imbalances in the global container trade and for instance, providing further leverage for liner carriers to tighten their demurrage and detention conditions. Indeed, between 2016 and 2018, the major liner carriers in the east-west trades reorganized themselves into three space sharing alliances:

Alliance	**Carriers**
2M	Maersk, MSC
Ocean Alliance	CMA CGM, Cosco, Evergreen
THE Alliance	Hapag Lloyd, ONE, Yang Ming

Source: ITF, 2018

The main reason behind such consolidations was to cope with the difficult market conditions faced since the 2008 global financial crisis and enable to reduce costs, better manage ship capacity and enhance efficiency. At EU level, such consolidation is made possible by the Consortia Block Exemption Regulation (CBER).

Focus on the Consortia Block Exemption Regulation (CBER)

At EU level, such consolidations are regulated by the EU competition law. EU law generally bans agreements between companies that restrict competition.
However, the Consortia Block Exemption Regulation (CBER) enables, under certain conditions, shipping lines with a combined market share of below 30 percent to enter into cooperation agreements to provide joint cargo transport services.
On the one hand, such consortia can lead to improvements in productivity, service quality and lower price for consumers, as far as there is sufficient competition, and there is no agreement on price or shares on the market. On the other hand, consolidation can also result in negative impact namely reduced competition, constrained supply, market power abuse, and higher rates and prices. Hence the need for regular monitoring and assessment of consolidation trends in container shipping and their effect on the supply chain.
However, according to many stakeholders, shippers, ports, terminals, freight forwarders, port service providers and inland waterway transport, this legislation has several flaws.
An important concern seems to be the lack of transparent data on consortia, which prevents the effective monitoring of their performance and their effects[29]. Without such data, it is not possible to evaluate properly whether the CBER should be renewed or not.
Another concern is the lack of a proper definition of relevant geographic markets to assess market shares. In fact, a report by the International Transport Forum in 2019[30] indicates that most of the consortia on trades to and from Europe were likely to exceed the threshold, but that this was not possible to know with full certainty considering the way the regulation is formulated and the lack of data collection on consortia.[31]
In light of this, the last time when the CBER was renewed in 2020, several associations denounced the fact that the Commission failed to demonstrate that the continuation of the CBER would benefit transportation users and service providers, i.e., consumers[32]. In fact, such associations consider that the CBER led to deterioration in the quality of service and in an abuse of power (due to the dominant role of consortia) towards service providers within the logistic chain and therefore an erosion rather than increase in economic benefits to share with users and consumers.

[29] https://www.itf-oecd.org/reviewing-competition-exemptions-liner-shipping
[30] Container Shipping in Europe Data for the Evaluation of the EU Consortia Block Exemption, 2019, ITF: https://www.itf-oecd.org/sites/default/files/docs/container-shipping-europe-eu-consortia_3.pdf
[31] https://www.mdst.co.uk/is-there-still-competition-in-liner-shipping
[32] Joint press release by CLECAT, ETA, EBU, ESC, FEPORT, GSF, GSA and UIRR on the renewal of the CBER

Negative impact on inland navigation transport[33] [34][35]

Inefficient handling of inland container vessels has negative impacts, both financially and in terms of reliability of IWT. Ultimately, this leads to loss of competitiveness for IWT compared to other modes. Given the role inland waterway transport is expected to play on the way to climate neutrality, this situation does not play in favour of modal shift to inland waterway transport. In practice, a negative modal shift - from inland waterways to road transport - is already being reported.

Delays at container terminals can quickly cause a domino effect, meaning that subsequent terminals are also affected if agreed time slots are no longer reached due to delays at previous terminals. For instance, in Rotterdam in 2019 and in Antwerp in 2020, delays amounted up to 20-30 hours on average, but peaks of 60 hours were sometimes registered. Such negative impacts affect the Rhine region but also beyond, Western Europe in particular. Regarding the Upper Rhine specifically, Switzerland reported that, inland waterway transport market participants with the Upper Rhine as their final destination, fear a sustained loss of market shares as a result of the inland container handling inefficiencies in seaports
Inefficient handling has a high impact on the reliability of inland waterway transport:
Additional waiting times and delays in the delivery of containers;
Average turnaround times of inland vessels in the hinterland increase;
Fixed sailing schedules customary in inland container shipping are not always adhered to (if a delay takes place in one terminal, the inland vessel may not be in time for the agreed time window for handling at the next terminal).
Furthermore, the reliability criterion is of key importance in the decision of shippers or freight forwarders to choose one mode over another. The negative impact of inefficient handling of container barges on the reliability of inland waterway transport plays against modal shift.

Such inefficiencies also have an important impact from an economic and financial point of view, impacting overall transport costs, for instance:

- Direct costs such as the deployment of (extra) vessels to deliver containers which should have overwise been delivered by the vessels stuck in the port;
- Indirect costs such as: demurrage and detention charges which are charged by the deep-sea shipping companies for the use of their equipment inside or outside the terminal longer than the agreed free period, time loss and administrative costs (plannability of vessels deployment suffers);

This ultimately leads to a decrease of productivity for the barge operator which otherwise could have used the time saved for other transport operation;
In exchange for guaranteed handling capacity, some terminals charge additional costs to the inland container shipping sector. While this is a perverse effect of congestion, some inland barge actors seem to accept such additional charges if this is for the benefit of enhanced reliability. The enforceability of such agreements between the container barge operator and the terminals seems to be a concerning issue in some instances. In fact, questions remain as to, for instance, the responsibility of the terminal operator if it fails to respect a certain time slot and the claim compensation of the container barge operator.
If such costs cannot be absorbed by container barge operators, they can be passed on to final customers. In fact, as there is generally no commercial link between the barge operators and the terminal operators, barge operators cannot hold terminal operators responsible in case of delay and ask them to pay for the extra costs the delay generated. Such extra costs are therefore generally borne by the barge operators.

Possible solutions to improve container barge handling in seaports

There is no “one-size-fits-all” solution to improve container barge handling in seaports. In fact, the potential solutions will have to combine measures implemented at different levels, in different fields and according to different timeframes.

[33] Congestie containerbinnenvaart in de Rotterdamse haven: Een structureel probleem, LINc, December 2021
[34] International Journal of Shipping and Transport Logistics :”Container barge (un)reliability in seaports: a company case study at the port of Antwerp”, by Virzhiniia Oganesian, Christa Sys, Thierry Vanelslander, Edwin Van Hassel
[35] Marktbeobachtung Güterverkehr - Situation der Binnenschiffer in den deutschen Seehäfen und den ZARA-Häfen, Bundesamt für Güterverkehr, 2019

Until longer term solutions are also available, such as investments in dedicated barge handling infrastructure in the seaports, it is imperative to find measures having a positive effect on container handling in the short-term.
For the long-term, several solutions and measures are being developed in order to improve container barge handling. Some of them lie in digitalisation, the improvement of information exchange between the ports' actors, others in the development of new container handling concepts implying new organisation and co-operation models between the different parties in the supply chain. It seems clear that solutions to address this problem must combine measures addressing infrastructure/capacity but also the organisation of the overall logistics within the seaport and possible disruptions in the container supply chain.

Existing measures and best practices set up by the actors along the container supply chain to improve container barge handling in seaports

Enhanced cooperation and awareness building among the actors in the container supply chain under the umbrella of seaport authorities

For the short-term, it is clear that enhanced cooperation and exchange of information between the different actors in the container transport chains and port operations can generate "quick-wins".

Organising workshops at regular intervals between the relevant stakeholders in the container supply chain can also be a way to foster such cooperation for the short-term, such as in the seaports of Rotterdam and Antwerp where consultations take place on a regular basis and in a structural manner. This enables to set up specific action plans and develop strategies to improve container handling which are suitable to the maximum number of actors in the supply chain. For instance, an action plan for container barge transport was signed by the Antwerp port community in 2018. Such cooperation also results in awareness building on the functioning of the entire supply chain, to make each actor aware of the consequences of its actions on the rest of the chain.

One measure that is worth mentioning as an outcome of such consultations in Rotterdam is the introduction of inland container shipping guidelines for the port of Rotterdam. This document is addressed to shippers and freight forwarders and contains recommendations about the way all parties involved in the port operations can have an influence on the development of a more transparent and efficient structure for the inland container shipping chain. It notably underlines the importance of information sharing and contractual agreements.[36]

Association of inland ports for the benefit of information exchange[37]
Through cooperation and networking, the flow of goods can be made more efficient by improving bundling concepts for containers in the hinterland and optimising container movements at the seaport terminals.
Rheincargo: association of the ports of Cologne, Düsseldorf and Neuss
DeltaPort Niederrheinhäfen GmbH: association of the city port of Wesel (salt, animal feed), the Rhine-Lippe port (heavy cargo), the ports of Emmelsum and Emmerich (containers), and the port of Orsoy (bulk cargo).
Inland port in Duisburg cooperates with the port of Dortmund: cooperation between port locations enables a better shift of road freight transport to waterways.

More flexible cargo opening and closing times
Strict cargo closing and opening times can play to the detriment of inland barge operators, depending on the operational areas. For the trade in the Rhine region and beyond, strict cargo opening and closing times as well as unpredictable delays of seagoing vessels lead to severe and lasting competitive disadvantages for inland navigation, particularly when the journey time to the seaport last for 3 to 5 days (i.e. Basel to Rotterdam), as highlighted by Switzerland. Indeed, strict cargo closing and opening times are particularly problematic when container vessels are already en route from the hinterland and which, on arrival at the seaport, are confronted with adjusted cargo closing or opening times and cannot unload their containers at the seaport terminals as planned. The extension and flexibilisation of such cargo closing and opening times or more generally operating hours for the handling of inland

[36] https://www.portofrotterdam.com/sites/default/files/2021-06/inland-container-shipping-guidelines.pdf
[37] Marktbeobachtung Güterverkehr - Situation der Binnenschiffer in den deutschen Seehäfen und den ZARA-Häfen, Bundesamt für Güterverkehr, 2019

waterway cargo in the seaport terminals appear as an important short-term measure to improve container barge handling.

More fixed window agreements

Fixed windows for barge handling provide room for improved container barge handling as they enable barge operators to be unloaded and loaded at fixed times. This enhances reliability for barge operators and solutions should be found to make such fixed window arrangements available to more barge operators in seaports. However, fixed windows are not always adhered to and are not proposed by all deep-sea terminals. In addition, fixed window agreements are generally subject to meeting specific criteria.

In the Port of Rotterdam for instance, it has been possible for barges to make use of fixed windows at the ECT deep-sea terminals since 2019.

While the benefits of such fixed window agreements between deep-sea terminals and barge operators are clear, their use requires specific criteria to be met by inland vessel operators:

A minimum call size. At the ECT terminals in Rotterdam, this minimum call size has been set at 175 per vessel call at the ECT Delta and at 150 for the ECT Euromax.

Payment of a fee. At the ECT terminals in Rotterdam this fee amounts to 750 euros for a single vessel and 1250 euros for a combination of two vessels attached to each other.

The enforceability of such agreements between the container barge operator and deep-sea terminals must be ensured in order for such agreements to be sustainable on the long run.

In practice, both handling of barges outside and within such fixed windows is however expected to take place.

Continued and enhanced cooperation between inland barge operators

Outside such fixed windows, concepts to enhance container barge handling are also being pushed forward under the impulse of inland barge operators. In the Port of Rotterdam, Barge Transferium Maasvlakte, which connects the inland barge terminal in the Hartelhaven port area to the ECT Delta deep-sea terminal, has been in service since June 2020.[38] It consists in a partnership between the terminal operator ECT and a consortium of inland barge operators and terminals. According to this agreement, ECT makes a section of terminal quay and a crane as well as a crane team available to the consortium on fixed days and times, at a fixed rate, while the handling planning is managed by the barge operators themselves. This transfer point concept was initially fleshed out by the Danser Group and Combi Terminal Twente who subsequently formed a consortium with 26 other parties to ensure that the Transferium capacity would be utilised. This arrangement is not subject to minimum call size. However it is subject to a standard rate and requires resources from inland barge operators to be dedicated to the planning.

In the port of Antwerp, the barge operators WeBarge and Contargo Transbox[39] have been operating container shuttle operations together in the Port of Antwerp since the beginning of January 2021. They are bundling their volumes with the purpose of optimising their container shuttle services to and from the maritime terminals. This can be seen as a “natural” way of cooperating to optimise operations.

This kind of cooperation can also be found in the bundling and hubs concepts which are explained in the next section.

Consolidation hubs: concepts and implementation[40][41]

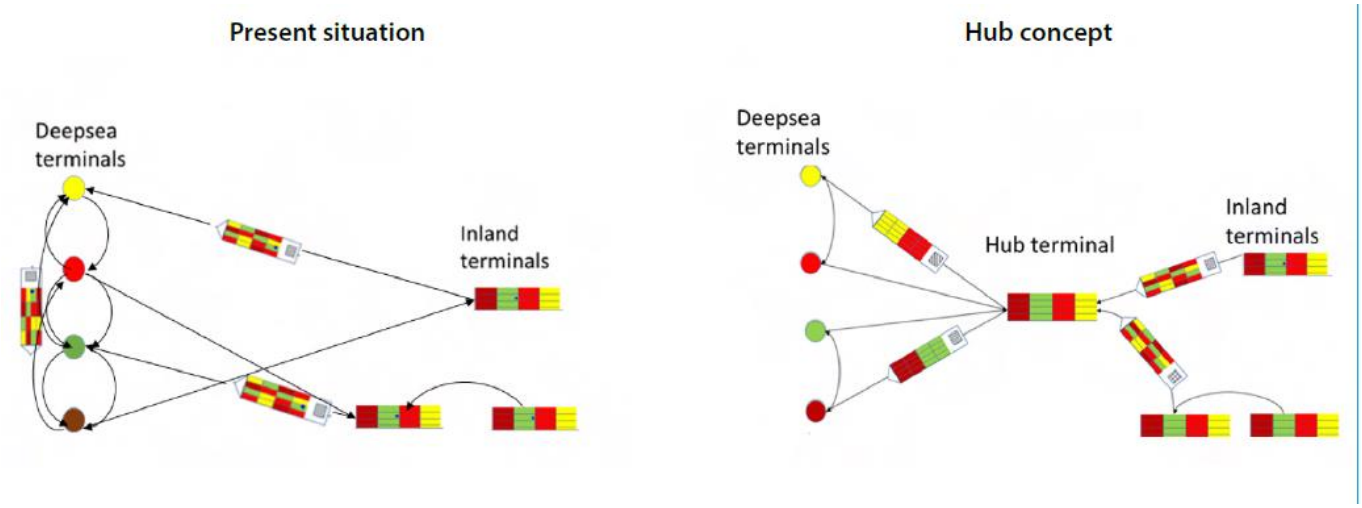
Containers transported on inland waterways are regularly presented at sea terminals in small numbers spread over several vessels, instead of being collected and delivered in larger numbers by one or a few vessels. To optimise handling at the deep-sea terminal, call sizes of barges can be increased through the consolidation of container barges. Such consolidation can take place in the hinterland or in the port directly and can be schematised as follows:

38 https://www.portofrotterdam.com/en/news-and-press-releases/launch-barge-transferium-maasvlakte

39 https://www.contargo.net/en/news/2021-01-22_contargo_transbox_und_we/#:~:text=Since%20the%20beginning%20of%20January,optimising%20their%20container%20shuttle%20services.

40 https://www.portofantwerp.com/en/optimising-container-barge#bundeling

41 https://www.contargo.net/en/news/2021-01-22_contargo_transbox_und_we/



Source: CE Delft, Outlook hinterland and continental freight 2020

Beyond an increased call size for barges in the deep-sea terminals, other advantages can result from this concept. If one ship serves one or two deep-sea terminals instead of visiting several terminals in one trip, handling can be optimized in deep-sea terminals leading to higher reliability. Depending on the location of the hub, the total number of kilometers can be reduced, which could also offer opportunities for vessels running on batteries for instance. However, this concept also comes with shortfalls, the main ones being extra transshipment operation leading to extra costs and legal issues. Currently such costs are borne by the inland navigation sector.

Hubs in the ports[42][43][44]

In the port of Antwerp, the concept of consolidation was first introduced through the implementation of a five-year project in 2018. This pilot project consisted in the setting-up of minimum call size of 30 moves at deep-sea terminals and the implementation of a consolidation hub in the port and five in corridors to Antwerp. Extra handling costs on the side of barge operators linked with the use of such hubs are covered by subsidies. During the course of this pilot project, the Port noticed that the consolidation hub in the port was not used as much as expected while and that barge operators adapted and collaborated to consolidate their container volumes, either outside consolidation hubs or in those in the corridors. As a result, the consolidation hub in the port was terminated and only the consolidation hubs on the corridors currently remains.

In the Port of Rotterdam, the concept of container bundling has been applied since 2018.
In the port, containers are bundled at Maasvlakte, Waal-Eemhaven and Alblasserdam and transported directly by inland vessels to and from the deep-sea terminals according to a fixed schedule.
These initiatives in both ports have resulted notably in call sizes that are two to four times bigger than previously and in shorter port calls (approximately -40%).

Hubs in the hinterland[45]
In the hinterland, barge operators can work in hubs to bundle containers. They have assigned slots for scheduled services at one or more deep-sea terminals.
The port of Duisburg is for instance the most important hinterland hub of the ARA ports with regular services to the ports of Rotterdam and Antwerp.
Bundling taking place in hinterland with services to the **Port of Rotterdam** are organized in the form of corridors partnerships, for instance, the North West Central Corridor, the West Brabant Corridor, the Ruhr Express and the Limburg Express.

42 https://www.portofantwerp.com/en/optimising-container-barge#bundeling
43 https://www.portofrotterdam.com/sites/default/files/2021-06/bundle-nodes-map-port-of-rotterdam.pdf
44 https://www.portofrotterdam.com/en/news-and-press-releases/port-authority-welcomes-new-market-initiatives-increased-container-bundling
45 https://www.portofrotterdam.com/en/news-and-press-releases/corridor-partnerships-help-strengthen-inland-container-chain

These partnerships are the outcome of an inland container shipping consultation organised in 2017 at the initiative of the Port of Rotterdam Authority. This sector-wide consultation was set up in response to increasing waiting times for inland container vessels at terminals in the port of Rotterdam.
The corridor partnership concept was created according to the following observation: there are different shipping connections between the port of Rotterdam and regions in the hinterland. A great number of inland terminals are located along these routes which are used by many inland vessels.
Thus, various barge operators and inland terminals have decided to work together to bundle the flow of containers destined for specific deep-sea terminals. As a result, large volumes of containers can be moved between the different deep-sea and inland terminals using inland vessels that sail according to a fixed schedule. In addition, the barge operators and the deep-sea terminals have agreed to load and unload containers during specific time slots, and to put through a minimum number of containers (moves) per inland vessel. These agreements have made the handling of inland container shipping flows in the port of Rotterdam both more reliable and more efficient.
The first corridor partnerships set up in 2018 were the West Brabant Corridor (WBC) and the Ruhr Express. They were soon followed by the North West central corridor, the CAN corridor, the Limburg Express and the Maascorridor.

In the **Port of Antwerp,** in the context of the pilot project launched in 2018 and referred to in a), the consolidation hubs corridors proved to be successful and will continue to be promoted. This cooperation on the corridors is also supported by the project "Barge Express"[46]. 2,6 million euros are available as part of this project in view of setting up fixed corridor shuttles from inland terminals to deep-sea terminals in the Port of Antwerp. A main added value of such shuttles is that they will benefit from fixed window agreements with the deep-sea terminals and therefore increased reliability.

Overflow hub[47]

The Port of Rotterdam is exploring the possibility of implementing overflow hubs to use capacity more efficiently, absorb peaks more effectively, spread volumes and respond to changes in the chain. Such overflow hubs can be understood as a temporarily depot where containers can be diverted to in case of huge delays or any other urgent situation that requires the (direct) need of a back-up scenario. It allows the sea and inland shipping processes to be disconnected so that disruptions to one process do not affect the other. As soon as the situation allows, the volume diverted to the overflow hub should be transported to the original destination.

To make sure that all types of volumes and flows can be diverted to these overflow-hubs, legal, governance and economic issues still need to be addressed before this concept can be applied in practice. In particular, a main challenge lies in identifying who would be responsible for transporting containers from these overflow hubs to the deep-sea terminals (arranging the transport, supporting the costs, supporting the responsibility in case of delays at the deep-sea terminals or damage during transit), and how the costs should be divided (because costs and benefits do not accrue to the same party).

"Mega" hubs

The concept of an overflow hub described above is rather foreseen in case of urgent situations. However, it could be envisaged that such hubs could be available at all times, thereby enabling fixed-hubs systems. It would allow to disconnect the sea and inland shipping processes on a more structural basis and would provide certainty on the side of barge operators regarding where and when to unload their containers. On the side of the hub, a stable utilisation and long-term operation is required in order to be viable from an economic point of view. Such hubs could consist in "mega hubs". It would remain possible for barge operators to call directly at deep sea terminals when fixed windows are agreed upon, but such mega hubs could be alternatives for barge operators not calling directly at deep-sea terminals. The same legal, governance and economic issues outlined above would also need to be addressed.

[46] https://www.vlaanderen.be/impulsprogramma . In this project, the Port of Antwerp partnered up with the Flemish government, North Sea Port and Lantis.
[47] https://www.portofrotterdam.com/en/logistics/connections/intermodal-transportation/inland-shipping/optimising-inland

Enhanced planning and anticipation of possible disruptions[48]

Central planning as a best practice

An example of a best practice to optimise handling plans lies in central planning. In the Port of Hamburg, deep-sea terminals (HHLA and Eurogate) set up a joint company[49,] Hamburg Vessel Coordination Center (HVCC), to coordinate vessel approach, the rotation and stow planning of feeder vessels and barges, the communication with all stakeholders regarding vessel calls as well as the coordination of ultra-large vessels during the approach and departure. The objective was to increase handling quality and schedule reliability.

In the Port of Antwerp, one single office has been drawing up the barge handling schedules for the PSA, MPET and DP World terminals since 2019. Among the next steps foreseen to improve this central planning, it is envisaged that barge scheduling is available on a 24/7 basis.

Digitisation

The share and/or exchange of data have become essential in a globalized world where planning processes need to be as efficient as possible. A key challenge is therefore to make information systems compatible with each other so that they can be used by all those involved in the process. A prerequisite for this is the willingness of all process participants to share their information with each other which, according to professionals from the sector, is not always the case. In fact, the lack of willingness can be explained, on the one hand, by the confidentiality problems this implies, on the other hand, by the fact that barge operators do not want to bear additional costs for the use of such systems without the assurance that such systems are operational.

In this regard, berth management systems ensure a cross-company exchange of data and information flows of all parties involved in the process.

Port of Hamburg:

No digital berth management system for inland shipping.

Development of a digital platform specifically for inland vessels that can be used to centrally coordinate ship calls (HPCC).

A digital port map is currently being created and will provide an overview of all public inland vessel berths.

Port of Rotterdam:

"Nextlogic concept[50]" (for inland container vessels only): it consists of a planning tool and an information platform that ensure timely handling of inland container ships in seaports. The container flows in the port of Rotterdam are to be managed across all terminals.

Portbase[51]: it uses the Port Community System to provide a platform for all parties to exchange information relating to the logistics chain involving Rotterdam. This enables obtaining real-time information about a container's current status.[52] All deep-sea terminals are connected to this system, but it is not yet the case of all of the port locations (terminals and depots).[53]

Navigate[54]: this platform offers a visual overview of all deep sea, short sea, rail and inland shipping connections that run via the port of Rotterdam. It then allows operators to share their transport schedules free of charge and in real time.

Cargo Tracker[55]: this application allows shippers and freight forwarders to 'track and trace' a container's journey via the port of Rotterdam to its destination in the hinterland.

Port of Antwerp:

The platforms "C-POINT" and NextPort offer a complete package of applications to promote digital communication between all actors present in and around the port of Antwerp. These platforms provide dedicated barge transport systems implemented at the level of the port such as the Barge Traffic System (BTS). It enables barge operators to

48 Marktbeobachtung Güterverkehr - Situation der Binnenschiffer in den deutschen Seehäfen und den ZARA-Häfen, Bundesamt für Güterverkehr, 2019

49 Information about HVCC available here: https://www.hvcc-hamburg.de/site/assets/files/1/feb_2020_hvcc_company_presentation-1.pdf

50 Nextlogic is a joint initiative of ship operators, seaport terminals, depots, shipping companies and inland terminals in cooperation with the Port of Rotterdam Authority and the Dutch Ministry of Infrastructure and the Environment.

51 Portbase services are smart I T solutions aimed at facilitating the easy and efficient exchange of data in the logistics chain.

52 Source: Port of Rotterdam

53 https://www.portbase.com/en/services/hinterland-container-notification-barge/

54 https://connect.portofrotterdam.com/shaping-the-future?utm_campaign=&utm_content=CBL_SNF_campagne1_TEM15_wp7-shaping-the-logistics-chain_2021_EN%20

55 idem

request terminal berths, to consult the positions of barges in Flanders and the Netherlands in advance. It is mandatory for all container terminals and for all barges that load or unload containers. In 2018, an action plan was signed with a focus of improving the BTS and rendering it more efficient. Nevertheless, it seems that the information exchange is still sub-optimal. The underlying causes are unclear (administrative, political, financial).

Port of Bremerhaven:

No digital berth management but the port authority is staffed and available every day at any time to answer enquiries about berths.

Inland vessels are registered with the port authority by radio or telephone.

The project Binntelligent aims to optimise the coordination between the actors involved, in particular the interaction between inland ports and seaports as well as between waterborne and landborne modes of transport.

Port of Amsterdam:

No digital berth management but there is a digital port map showing the berths for inland vessels.

The reporting obligation of inland vessels entering and leaving the port is done by contacting the harbour master via VHF radio channels.

RPIS (RheinPorts Information System): new cooperation project of the 9 Upper Rhine ports entitled "RPIS 4.0". The project with a financial volume of €1.4 million aims to extend the RPIS platform to new traffic and develop new digital services for the port community. The project coordinated by the port of Karlsruhe runs until April 2022.[56] It consists in a comprehensive port communication system (traffic management platform) in the hinterland which covers today the handling of container vessels at numerous inland ports on the Upper Rhine.

Port of Marseille and the Rhône-Saône axis: implementation of the MeRS project which focuses on the Blockchain technology. The latter consists of securely sharing the recording and tracking of transactions and goods thanks to a general data pooling logic in real time.

Through the continuous inventory of exchanges, the blockchain offers a permanent overview of the logistical process. The result is an increased capacity for anticipation and, consequently, greater fluidity in the management of transport.[57]

Capacity and infrastructure

Investments in dedicated barge handling infrastructure in the seaports. Small cranes could be used to enhance the handling of the barges and dedicated handling space/berths for inland barges could be developed to reduce the waiting time of the barges. Nevertheless, outstanding issues remain, notably as to which actor would bear the responsibility of these investments and what the cost-benefit analysis of these investments would be.

Moreover, it would be interesting to examine the impact of the barges' size on the congestion level at the terminals and the implication of the different sizes on economies of scale and transportation cost.[58]

Ensuring that sufficient labour force is available for the handling of container barges. Labour force is not always available for the handling of container barges. This can result from labour shortage, from the labour force being occupied with the handling of a large maritime ship or from the lack of optimisation of the labour force shifts. The availability of dedicated teams for the handling of container barges could be a solution (i.e. fixed window or example of the Barge Transferium Maasvlakte). Digitisation can certainly also improve optimisation of shifts.

Improving navigability conditions between seaports and the hinterland.

For instance, increasing the size of lock chambers can enable the transit of larger vessels, thereby improving the interconnection between the different basins. This is illustrated by the example of the lock of Lanaye in Belgium.[59]

Nevertheless, even if handling inefficiencies in seaports are strongly linked to commercial issues, it seems that they cannot be solved by the market alone. Such inefficiencies would ultimately lead to difficulties in achieving the ambitious European and national modal shift to inland waterways targets. This justifies possible interventions on the side of national public authorities which can have a non-negligible influence on this issue.

56 https://www.strasbourg.port.fr/actualites/rpis-4-0/

57 https://lefrenchsmartportinmed.com/les-actualites/mers-une-blockchain-mediterranee-rhone-saone

58 Container barge congestion and handling in large seaports: a theoretical agent-based modeling approach, Journal of Shipping and Trade, December 2019

59 https://ec.europa.eu/transport/sites/default/files/3rd_workplan_nsm.pdf

Public intervention: regulatory, financial and policy measures

Public funding at European, national and regional levels

Several examples of projects and programmes supported by public funding exist in various fields.

There are many programmes (generally multiannual) at national level addressing the **infrastructure needs for inland navigation**. Collaboration between the Port authorities and the relevant Ministries could take place/be strengthened to determine the infrastructure needed to address the issue of congestion/inefficient handling for barges in seaports.[60][61][62] The Trans-European Transport Network (TEN-T), through the CEF programme, supports the construction of infrastructure in European ports. Member States' support is generally needed for a project to receive fundings. Application for funding should be sufficiently anticipated by the different parties to ensure that the different projects are supported at national level.

Public funding is also available in other fields. The NOVIMOVE project is for instance an EU-funded project which works, in collaboration with stakeholders of different backgrounds, on reducing waiting times at seaports in the Rhine-Alpine corridor from Rotterdam/Antwerp all the way to Basel. Through virtual simulations, scaled model tests and full-scale demonstrations, it conducts research on how to improve the logistics of inland waterway transport.[63] The RPIS project mentioned above was also supported by the EU Interreg funds.

Public funding can also play a role in subsidising projects for the benefit of enhanced planning through digitisation.

Several examples of public funding being provided to support market solutions also exist. This is the case of:
the pilot project in the Port of Antwerp relating to consolidation, where the setting up of hubs and the extra handling linked to their use were subsidised
the "Barge Express" project aiming at developing corridor container shuttled.

A financial intervention from national authorities could also be appropriate to support over capacities which would only be used in some instances (peaks in congestion, economic boom leading to an unexpectedly high number of containers for a certain period…). Indeed, from a business perspective, it might not be economically viable to invest in such extra capacities.

Another possible measure is to price the higher external costs of other modes of transport; containerised transport by road for example causes higher emissions (noise, GHG, etc.) and wears roads and bridges several more times than a car. In comparison, IWT is more sparing to public goods like air, etc.

Political influence leading to market or regulatory changes

To influence competition law at European level

Organisations representing the inland waterway profession at European and national levels are raising awareness regarding the possible risks linked with the ever-growing market power of deep-sea shipping companies giving them leverage to:

- tighten demurrage and detention conditions (often to the detriment of rail or inland navigation which have longer round trips than road);
- gain market shares on the land-side logistics (transport of containers from seaport to hinterland and vice-versa), thus competing directly with freight forwarders.

It appears important to ensure that such developments are always in favour of an efficient container supply chain and modal shift.

Competition authorities are the best placed to monitor the competition setting in the container shipping market and evaluate its impact on the container supply chain.

This requires improved data collection and transparency on the side of maritime carriers, in particular regarding the shipping rates and charges.

60 https://www.portofrotterdam.com/en/building-port/accessible-port
61 https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en
62 https://www.haropaport.com/fr/rouen/projet-damelioration-des-acces-maritimes-du-port-de-rouen
63 https://novimove.eu/concept/

On the short term, attention could be set on the ongoing evaluation of the CBER regulation to assess whether it should be renewed and if so, according to which conditions.
On the longer run, guidelines on the use of detention and demurrage conditions or other behaviours which could possibly disturb the level playing field or modal shift objectives could be developed.

To build awareness among the actors in the container supply chain and authorities whose decisions can improve container barge handling

For instance, in France, under the influence of public authorities, the pooling of Terminal Handle Charges (THC) is now applied in Dunkerque, and more recently in the port of Marseille-Fos. Indeed, in France, container barge operators must bear part of the handling costs while for other modes this is borne by the maritime companies. This situation has a negative impact on the competitivity of inland transport compared to other modes. This situation can be addressed by pooling THCs, meaning, that the additional handling costs are no longer borne by the container barge operators alone[64]. Similarly, the merger of the ports on the Seine axis (Rouen, Le Havre and Paris), whose objective was amongst other to optimise container handling processes, was stimulated by public authorities. A similar reflection is underway for the Rhône-Saône axis.

In the Netherlands, under the pressure from the Dutch government, the Port of Rotterdam agreed with its operators that on Maasvlakte 2, intermodal transport must capture at least 65% of total container transport flows to the hinterland. Rotterdam is the only documented example in Western Europe where modal split targets have been formally integrated in legally binding clauses of terminal concession contracts. This certainly puts additional pressure on deep-sea terminals to ensure that the container barge handling process is efficient. However, it remains to be seen how such clauses will be enforced and whether the integration of such modal shift clauses will lead to improvements.

The inland container shipping guidelines developed by the container barge handling platform in Rotterdam could be promoted at European, national and regional levels to influence the development of a more transparent and efficient structure for the inland container shipping chain. In this process, the need to introduce binding agreements on an operational level (between barge operators and deep-sea terminals) could be highlighted further.

Similarly, the importance of the Rhine in optimising the container logistic chain should be promoted. For instance, studies showing how the container logistic chain would be affected in case Rhine navigation would no longer be available could be relevant. Data from the 2018 low water episode on the Rhine could certainly be used for this purpose. This could raise awareness among the different actors among the container supply chain about the importance of inland navigation for the transport of containers to and from the hinterland and therefore point to the need to ensure reliable and efficient container barge handling.

Exchange information and good practices at international level

Exchange of information and good practices at international level can play an important role to improve container barge handling. This can take the form of regular exchanges and presentation about projects in various Rhine States to improve container barge handling and, on the other hand, regular reporting from Rhine Member States, from organisation representing the profession or from the container barge handling platforms in Rotterdam or Antwerp. Indeed, this would enable Member States to possess up-to-date information and learn from best practices implemented in the various member States in order to take action directly where possible or influence the decision-making process at the right level where needed (at the level of ports, at national level, at European level…).

Stimulate policy measures to foster modal shift and reliability of inland navigation

Should demand for container barge transport increase in the future, it will be necessary to improve the efficiency of container barge handling to accommodate for this increased demand.

[64] https://portsetcorridors.com/2022/le-ministre-des-transports-annonce-des-mesures-en-faveur-du-fluvial/

The positive development of container barge transport requires the inland navigation leg of the container transport chain to perform efficiently, to ensure that shippers, freight forwarders, or maritime carriers continue to choose inland navigation to transport their containers from and to the hinterland. This calls for policy measures fostering modal shift to inland navigation, its sustainability and its reliability.
How to improve the sustainability of inland navigation?
Should external costs be internalised?
How to improve the resilience of inland navigation to low waters?
How to ensure year-round navigation?

Avenues for the future

The Covid-19 pandemic brought another dimension to the problems of congestion in seaports and inefficient container barge handling as new restrictions at the terminals aggravated the infrastructures bottleneck. This crisis particularly enhanced three key-elements:
The necessity of achieving a higher degree of predictability for arrival and departure times.
The need for a well-functioning slot management: it can ease the current pressures on ports, carriers and shippers caused by congestion and the consequent unpredictability and increased expenditure. A slot time provides each involved actor with the opportunity to plan ahead and coordinate their activities towards achieving the common goal of a predictable and timely delivery. At the same time supply chain visibility is improved.
The need for data sharing: a well-functioning slot management regime depends heavily on data sharing. In fact, the purpose of this regime is to enable all affected actors to share a common situational awareness which is particularly important when plans and forecasts begin to change.[65]

In order to stimulate modal shift to inland navigation, the issue of inefficient handling of inland waterway cargo in seaport must be addressed. Cooperation and exchange of information between the different actors in the transport chains must continue and be improved. This is particularly relevant when contractual agreements are being arranged. When it comes to demurrage and detention for instance, establishing appropriate parameters with the deep-sea shipping company could reduce time pressure on the delivery and collection of containers.
It seems necessary to find the right equilibrium between low costs and quality of transport. For instance, in a press release published in early 2021,[66] EBU underlined the necessity for Port Authorities to focus on quality instead of mainly focusing on volumes and traffic. In fact, this strategy led to the increasing number of megaships which have a disrupting effect on the overall quality of the local port operations as they have priority. Thus, many European seaports suffer from congestion which affects the reliability of inland navigation operations and therefore affects its image.

Finding this equilibrium certainly requires shared efforts on the side of all actors involved in the transport chain: Port authorities (maritime and inland), Member States, EU, local/regional authorities, maritime industries, container barge operators, shippers/forwarders, terminal operators.

65 https://www.maritime-executive.com/editorials/how-time-slot-management-could-help-resolve-port-congestion
66 https://www.ebu-uenf.org/wp-content/uploads/Port-handling-congestion_EBU-reaction-on-ESPO-20210208.pdf

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