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Modal shift to inland waterway transport: five case studies in the North Sea Region

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Modal shift from road to water is a strategy prioritised by both the European Union and many of its member states. However, inland waterways remain underutilised in most member states, and even the small number of countries in which inland waterway transport is well established, the sector faces fierce competition from road-based solutions. There is potential to develop tools and strategies for expanding the use of inland waterways by better understanding what activities key actors can rely on to facilitate modal shift. In this multiple-case study, we identify activities that actors perform to realise modal shift to inland waterways in five cases from the North Sea Region, by conducting interviews, workshops, and field observations. In each case, the process of modal shift varied depending upon which actor initiated specific activities, the order of performing activities and the number of iterations required to advance. Activities revolved around understanding the current situation, identifying potential solutions, testing solutions and promoting solutions. Getting stakeholders on board and identifying goods flows were

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integrated in all themes. The structured and emergent approach were outlined, highlighting varying starting points (mature or immature market) and actor engagement (facilitating or initiating roles). Different actors could assume leading roles. 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.

Keywords: *inland waterway transport, modal shift, actor collaboration.*

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1. Introduction

The modal shift from road to water is an overarching transport strategy for the European Union (European Commission, 2011) and a prioritised developmental pathway for the transport sector in Sweden, the United Kingdom and the Netherlands, among others (Berglund, 2019b; BVB, 2017; Wiegmans, 2018). Key reasons for such emphasis on the modal shift to water include the need to reduce greenhouse gas emissions by using more energy-efficient transport solutions and desires to reduce congestion on over-utilised parts of the road network as well as local pollution and noise from trucks in urban areas (Medda and Trujillo, 2010). However, despite the official goals and potential benefits of the modal shift to water, inland waterways (IWW) constitute an underutilised mode of transport in several domestic transport markets. For EU-28, the European Commission (2020) reports that traffic on IWW produced 135 billion tonne-kilometres in 2018. That accounts for some 5,3% of the 2560 billion tonne-kilometres produced by IWW together with the competing modes of road, rail, and pipeline. Ten member states report no inland waterway transport (IWT) at all, and six member states report less than 0,1% of tonne-kilometres. As an example of a country with a marginal market share for IWW, the Swedish authority Trafikanalys (2016) estimates that IWW transported about 0,12% of the domestic tonnes in 2014. As part of the tonnes moved domestically with maritime transport, only 0.7% of was within an IWW system and 7% in a combination of IWT and coastal shipping. On the other end of the scale of IWT's share of the domestic transport work excluding sea and air, the Netherlands reports 41%, Romania 26%, Bulgaria 24% and Belgium 16% (European Commission, 2020). Although leading Europe in using domestic IWW (CBS, 2016), IWT in the Netherlands continues to face stiff competition from attractive road solutions and, in turn, the potential need to reverse modal backshift to road (Abrahamsson and Engström, 2019). Thus, in light of national and EU-wide goals for long-term sustainability, initiatives that expand the use of IWT and prevent that modal backshift are greatly needed.

Nevertheless, as shown in research and public reports, the modal shift from more flexible road-focused transport solutions to services provided on often less-developed IWT transport markets is particularly challenging because several actors need to coordinate their activities (Caris *et al.*, 2014; EMMA, 2019; Rogerson *et al.*, 2020) adding complexity. Although those aspects of modal shift have long been examined in the shift from road to rail, they have recently received increased attention in research on the shift to short sea shipping (Raza *et al.*, 2020; Vierth *et al.*, 2019; Westin *et al.*, 2016) and IWT as well. Caris *et al.* (2011), for instance, have shown that the Port of Antwerp has established functional links with regional nodes in the hinterland for more competitive hinterland transport via IWW and rail. More recently, Wiegmans *et al.* (2020) observed a similar strategy implemented by the Port of Rotterdam Authority to serve a hinterland overlapping with Antwerp's; however, they downplayed the port-centric perspective on developing the hinterland

network and instead stressed the role of smaller rail and IWT terminals. In other work, Meers and Macharis (2014) have thoroughly analysed why the location of new rail and barge terminals matter in designing efficient transport systems and, in the process, challenged the assumption of the more, the merrier. Addressing stakeholder cooperation in the development of European hinterland container networks since the 1960s, Notteboom (2007) has compared rail with IWT and differentiated monopolistic, state-owned railways that control the full rail transport system from small, agile, family-owned barge operators in how they cooperate with other stakeholders. Although Notteboom concluded that radical organisational changes in the barging industry have fostered an increased market share in the hinterland of Antwerp and Rotterdam, the specific context in which modal shift occurs, along with the technological particulars of the modes involved, continue to pose unique, context-specific challenges for the modal shift from road to water.

In fact, research on that topic indicates a general lack of knowledge about the priority and order of activities performed and the type of actors involved in modal shift processes linked to IWT (Kotowska *et al.*, 2019a; Rogerson *et al.*, 2020). While Abrahamsson and Engström (2019) reported on modal shift process, they also found that the process was not followed in practice in several of the companies studied. Therefore, the actors' different roles in specific contexts and the types of activities that they prioritise remain largely unknown. Thus, the purpose of this article is to identify and categorise activities that key actors regard as being necessary in specific scenarios of modal shift as a means to clarify how modal shift to IWT occurs under different circumstances. To that purpose, we developed three research questions:

- 1) Which actors play a prominent role in the modal shift in specific contexts?
- 2) What activities are considered to be necessary for key actors to achieve a modal shift?
- 3) How is the process of modal shift structured?

By answering these questions, this article contributes to literature on modal shift by describing how diverse types of actors, activities and setting-specific characteristics interact and, by extension, influence the development of the modal shift to IWT.

In what follows, Section 2 reviews literature on IWT and presents an activity-centred framework for understanding modal shift. After that, Section 3 describes the method followed in our study, which, due to modal shift's complexity, was designed as a comparative multiple-case study. Section 4 presents our analysis of the cases to illustrate how their various activities are interrelated and can be arranged by different actors. Last, Section 5 discusses what our results imply for management strategies and policymaking supporting the modal shift to IWT.

2. Frame of reference

This section reviews research on barriers facing the modal shift to IWT, especially types of actions identified as necessary to realising the modal shift and types of entrepreneurial stakeholder collaborations shown to facilitate change in logistics systems.

2.1 Barriers to modal shift

As in studies on other intermodal systems, including road-to-rail transport, researchers interested in such systems involving IWT have spent considerable time and energy on identifying barriers to expanding the use of IWT. Both peer-reviewed and grey literature pinpointing such barriers has been processed by Rogerson *et al.* (2020), who classified them as being related to four key areas: regulation, finance, service quality and market characteristics.

A major regulatory barrier, for example, is the complicated, time-consuming administrative paperwork associated with cross-border IWT along Europe's rivers (Pfosser *et al.*, 2018). Another is generally uncertain regulatory landscapes, particularly in immature markets such as Sweden's (Otterström and Torpfält, 2016), specifically regarding cabotage (Garberg, 2016), crew

requirements (Treiber and Bark, 2018), piloting fees and fairway dues (Arvidsson *et al.*, 2017). In Sweden, such immature regulation derives from not only from the scarcity of canals and navigable rivers but also that most IWT in the country requires rivers, canals and large lakes with difficult wave and ice conditions. Sweden's case is not unique, however, for regulations placed upon using IWT barges hinder Belgium's use of coastal areas as well (Vantorre *et al.*, 2012).

For shipping companies, establishing new, regular IWT services means encountering certain financial barriers. Relevant to IWT's competitiveness with all-road transport are semi-fixed costs, including port fees, fairway dues and piloting fees (Garberg, 2016; Olsson and Ronold, 2017); mode-specific variable costs such as transshipment costs (Konings, 2009; Wiegmans and Konings, 2015); and higher variable costs, including pre- and post-haulage expenses (Wiegmans and Konings, 2015). Those costs can also be uncertain, which only contributes to the financial risk for entrepreneurs (Olsson and Ronold, 2017).

Transport buyers' modal choice depends upon transport characteristics including not only cost but also transport time, reliability and certain parameters of transport quality – for example, on-time delivery and damaged goods (Flodén *et al.*, 2017; Meers and Macharis, 2014). For the extended use of IWT in particular, barriers to service quality include insufficient reliability (Kotowska *et al.*, 2019a) and long transport times (Konings, 2009; Meers *et al.*, 2017; Platz, 2009; Vierth *et al.*, 2012), particularly due to transshipment (Konings, 2009). In IWT, loading capacities and transport times vary according to waterway conditions (Dorsser *et al.*, 2020), especially on free-flowing rivers (Hekkenberg *et al.*, 2017). Caris *et al.* (2014) 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; Otterström and Torpfält, 2016), 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 (Meers *et al.*, 2017; Vierth *et al.*, 2012).

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. Competing with other modes is further complicated by the IWT fee structure, which diverges from standard practices for other modes (Vierth *et al.*, 2012). IWT has also had limited success with price competition, e.g. in Sweden (Garberg, 2016), even if examples exist of a lower price compared to road (Platz, 2009). Meanwhile, physical barriers such as water levels (Christodoulou *et al.*, 2020; Dorsser *et al.*, 2020; Hekkenberg *et al.*, 2017; Vierth *et al.*, 2012) and bridge clearances (Christodoulou *et al.*, 2020; Konings, 2009) hinder shipping companies from using large vessels that would lower costs and support competitive pricing. In certain geographical areas, wave height (Vantorre *et al.*, 2012) and ice conditions require vessels with sturdier designs, which raises costs even more (Olsson and Ronold, 2017). Further, the lack of suitable quay sites for IWT and especially limited conditions of the quay for e.g. loading equipment is another common factor discussed (Berglund, 2019a; Platz, 2009). Added to that, traffic management often prioritises land transport and is particularly reluctant to open municipal bridges for IWW vessels during rush hours (Garberg, 2016). Other concerns are vessels adapted to certain goods and IWWs that restrict flexibility and second-hand markets for vessels (Vierth *et al.*, 2012). Last, although IWT is often touted to afford superior environmental performance, IWWs allow comparatively high emissions of SO_x, NO_x and other particles (Caris *et al.*, 2014; Fridell, 2011; Vierth *et al.*, 2012), and other modes of transport are rapidly improving on that count as well.

2.2 How to achieve a modal shift

Whereas most of the literature is devoted to identifying barriers to modal shift, proposals for overcoming them remain scarce but are not entirely lacking. To date, authors have proposed actions to be taken by barge operators in terms of fleet management (Fazi *et al.*, 2015) and technical innovations (Wiegmans, 2005; Wiegmans and Konings, 2007), by ports (Kotowska *et al.*, 2018,

2019a; Wiegmans *et al.*, 2020), by both parties jointly (Pinchasik *et al.*, 2020) and by public actors along waterways (Mihic *et al.*, 2011; Pfoser *et al.*, 2018), both in countries throughout the Baltic Sea Region (EMMA, 2019) and in a single country (Garberg, 2016).

Ways of overcoming barriers differ significantly between countries with mature versus less-developed IWT markets. In mature markets, where IWT is the chief alternative to road transport, modal shift is often a matter of enhancing market coordination, even by simply informing transport buyers about existing services, as in the Port of Rotterdam Authority's cooperative scheme with local authorities and IWT operators. In that case, the port provide information and a platform to support buyers with accessing feasible intermodal services between the hinterland and ports (Kotowska *et al.*, 2019a). The Port of Rotterdam Authority additionally requires a certain share of non-road hinterland transport in concession agreements for container terminal operators (van den Berg, 2015). Among other strategies, implementing standardised information systems, at least in Europe's northern ports, has overcome the barrier of tedious paperwork (Kotowska *et al.*, 2019a). Further, to reach better price competition with road, an important factor is the required bundling activities that is needed at terminals for reaching a high capacity utilisation in large inland ships through, consolidating goods flows, and for this reason the development of inland ports to freight villages is important (Platz, 2009).

In less-developed IWT markets, where rail often constitutes the dominant alternative to road, focus often falls on raising awareness of IWT's benefits (Rogerson *et al.*, 2020). Kotowska *et al.* (2019b), who took the perspective of a port authority in viewing the underutilised, underfunded Oder River, assessed a comprehensive list of external and internal measures. More specifically, external measures include upgrading the Oder Waterway, measures to restore confidence in inland shipping, measures to increase the supply of transport services, measures to increase the demand organising inland shipping operations and measures to create inland shipping development policies. For internal measures, measures with regard to increasing the supply of transport services is included as well as actions taken to increase the demand and measures to implement innovations in navigation.

2.3 *The role of entrepreneurs and entrepreneurial stakeholders*

Modal shift is often regarded as an entrepreneurial activity, thereby implying the involvement of entrepreneurship and innovation as forces that achieve change. Both concepts, frequently explored in literature on freight transport, indeed seem to pose significant implications for freight flows, no matter how much their complexity stifles their integration into the development of freight modelling (Tavasszy, 2020). Innovation and entrepreneurship, though studied from analytical perspectives such as collaboration (De Martino *et al.*, 2013; Wagner and Sutter, 2012) and business model development (Björklund *et al.*, 2017; Sandberg, 2013), are inherently driven by individuals with entrepreneurial aspirations, whether in incumbent organisations or new ventures. For example, in the Swedish intermodal road-to-rail sector, incumbent publicly owned stakeholders with expertise in wagonload rail transport have largely been replaced by smaller entrepreneurial firms with a background in road transport (Flodén and Woxenius, 2017). To clarify those entrepreneurial aspirations, entrepreneurial actors tend to be divided into entrepreneurs and intrapreneurs depending upon the organisations with whom they engage. On the one hand, *entrepreneurs* – that is, individuals engaged in developing organisations or organisational solutions (Gartner, 1989) – facilitate processes behind the abovementioned phenomenon. Entrepreneurs can act independently of each other and drive development by changing established institutions or even implementing new ones (Peters *et al.*, 2011). On the other hand, *intrapreneurs*, defined as individuals engaged in entrepreneurial activities within incumbent organisations (Antoncic and Hisrich, 2003), spur action and promote organisational learning (Gapp and Fisher, 2007). As such, they are often involved in processes of innovation in which external stakeholders – customers, for instance (da Mota Pedrosa *et al.*, 2015) – are highly active. When the public sector plays a central role in transport, intrapreneurs, dubbed “political entrepreneurs” in the study on establishing intermodal terminals by Bergqvist *et al.* (2010), are essential.

3. Method

This paper reports on five explanatory case studies (Yin, 2003) of modal shift promotion from land to IWT. The cases took place in the North Sea Region – namely, in Belgium, Germany, the United Kingdom, the Netherlands and Sweden. Data was collected over a three-year period (i.e., 2017–2019) using project communications, workshops, interviews and field observations.

The cases (see Table 1) consist of individual actors and groups of actors from both the public and the private sector that actively pursued inland modal shift from land to water. These actors have been addressed in previous literature as important for IWT. The cases were chosen based on three criteria. First, the cases were required to be contemporary (Yin, 2003) and accessible. Hence, at least one of the actors from each case context was required to participate in the Interreg North Sea Region IWT 2.0 project. This requirement was made to guarantee that the actors would be dedicated to work to (Interreg, 2020) *“mobilise potentials and capacity to move freight to yet under-used waterways” and remain as active cases during the period of the study. It also ensured that the authors had continuous access to data and that causal relationships could be verified with the participants, something that improves the internal validity (Stone-Romero, 2009; Yin, 2013) of each case.* The participation in the Interreg project thus offered a base line in terms of both activity and transparency. Second, although the cases involved clusters of actors working with different issues associated with modal shift the intent was to study specific actor types or actor constellations within each case. Hence, as seen in Table 1 each case allowed for a thorough explanatory study of how and why (Yin, 2003) a specific type of actor or actor constellation worked with the issue of achieving modal shift from land to water. Third, the difference in context where modal shift was sought after. The cases were recent, being still ongoing or having ended in 2021. Yet, the cases involve variations in key dimensions associated with three central aspects identified in the literature on modal shift (see Table 1): market maturity, policy support (national and regional), and actor constellation. Aspects such as EU policy, climate and technological access are close to identical which allows the study to isolate the effects of those three key dimensions and reduced extraneous variation (Eisenhardt, 1989) between the cases.

Representatives from each of the cases participated in regular and continuous project communications with the authors. These communications consisted of phone calls, physical and online meetings as well as emails. The case studies were initiated with an Interreg project start-up meeting in 2017 where the participants were getting familiar with the specific case setting through dialogue and compiled information packages. Project communications then provided the study with data about the progress of each case.

The project communication provided opportunities for workshops and field observations. The cases did differ with regards to focus on hardware and infrastructure. Hence, study visits were judged as vital in four specific cases (BE, GB, NL and SE) where such tangible aspects were of particular importance both to the actors that were studied. These study visits allowed for on-site visits to case related facilities and infrastructure such as terminals, loading, and unloading facilities and the actual waterways.

Two to three workshops were carried out with participants from each case. Each workshop was 1-1,5 hours long and had 10-13 participants from the specific cluster of actors. The workshops were preceded by a briefing by the case organizations on the current situation and progress with IWT. The workshops dealt with case-specific and cross-case topics which were discussed with the goal of pinpointing activities both performed and planned, challenges to IWT development, problem-solving tactics, stakeholder involvement, and progress made. During the workshops reactions and comments were documented through note-taking by one of the researchers.

Table 1. Description of the cases.

Case	Actors in focus	Data collection and verification	Market maturity	Description
Belgium (BE)	Cargo owner (i.e. building supplier) Regional municipality National IWW authority	Planning of test & study visit (Nov 2017) Workshops (Oct 2018, May & Oct 2019) Project communications Validation (Dec 2020)	High	Upcoming municipal regulations limiting road traffic in the city of Ghent have created pressure for new solutions by water. One company, a building supplier, has sought CO ₂ -neutral distribution options by water; the regional municipality has focused on transshipment solutions between land and IWT; and the national IWW authority has played a central role in setting regulatory conditions for piloting new solutions. For urban IWT the market maturity is low.
Germany (DE)	Port	Workshops (Oct 2018, May & Oct 2019) Project communications Validation (May 2021)	High	Due to a general lack of IWT-related knowledge amongst younger generations, bremenports has developed case studies and a web platform for higher education, with the ambition of expanding knowledge about IWT-related opportunities by introducing new learning tools.
Great Britain (GB)	Regional IWW authority	Study visit (Oct 2018) Workshops (Oct 2018, May & Oct 2019) Project communications Validation (Dec 2020)	Low	The canals and waterways in the Leeds region could be more extensively used for cargo operations between the Humber estuary and inland locations. The regional IWW authority has started the development of the waterways for being used by class III vessels, and of attracting new goods flows to IWT.
The Netherlands (NL)	Local municipality Regional municipality	Study visit and interviews (Oct 2018) Workshops (Oct 2018, May & Oct 2019) Project communications Validation (Dec 2020)	High	To prevent modal backshift from IWT to road, flows of new goods need to be attracted to class IV waterways, while the waterways also need to be upgraded to class V. The municipality of Drachten has driven those changes by involving local companies in identifying suitable flows of goods, new logistics solutions and promoting the need for upgrading the waterways towards other policy makers in the region.
Sweden (SE)	Two entrepreneurs in shipping operations	Study visit (Sep 2018) Interviews (Mar 2017 – Jan 2019) Workshops (Apr 2018, Jan 2019) Validation (Apr 2021)	Low	No IWW vessels operate in the river Göta älv or lake Vänern, two classified IWW fairways. While the two entrepreneurs performed activities to launch new IWW operations, the research institute acted as an analytical expert of the IWT potential and disseminating knowledge of potential IWT solutions (e.g. by informing stakeholders of IWT's potential).

In both SE and NL cases interviews were conducted with the representatives from the organizations involved as well as stakeholders associated with those organizations. In the Swedish case this meant interviews with entrepreneurs, cargo owners, freight forwarders, policy makers, and ports. In total 15 interviews were conducted with Swedish actors between 2017 and 2019. In NL nine interviews were carried out with six cargo owners, Drachten municipality, the Dutch Inland Navigation Information Agency and an IWW authority. These interviews dealt with the motivations behind actions, the ongoing work with IWT, the setting with regards to market

development, policies etc. and associated choices. The interviews were conducted by the researchers (SE) and supervised master students (NL). In the latter case information was confirmed in the interaction with the NL representatives. Detailed notes were taken in all the interviews, and recordings of NL interviews allowed researchers to transcribe specific parts. For the interviews that were not recorded, notes and interpretations were verified with the interviewees.

At the end of the project validation of the results from the analysis of the case studies were conducted through online meetings of roughly 30 minutes in length. During these meetings the representatives from the case organizations were asked for feedback and comments. The resulting feedback was compiled, and the analysis was adjusted in the event that mistakes had been made.

The analytical process built on a thematic analysis of the empirical data, conducted by identifying the contextual aspects and detailed activities of each case – for instance, entre- and intrapreneurial activities targeting barriers in a specific setting. In order to theorize from the study (Eisenhardt, 1989), the cases, we categorised the findings from each case study into key activities and then compared them both across cases and with the analytical framework developed from the literature review. More than 50 detailed activities were recorded and then categorised, for example the detailed activity ‘identify suitable locations’ was categorised under ‘identifying goods flows. As described above, the outcome of the analysis was then validated through interaction with representatives from each case. This resulted in an iterative interpretative process (Eisenhardt, 1989; Welch *et al.*, 2011) which strengthened the internal validity (Eisenhardt, 1989; Yin, 2013) of the study. Out of this process, descriptions of each case were compiled (Table 2), and from them, a fundamental thematic model of the modal shift process was developed (Figure 1).

4. Approaches for modal shift

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. Instead of being sequential, the themes capture activities, all oriented towards realising the modal shift from road to IWT that relate to each other and can be performed in parallel. Subsection 4.1 showcases activities in relation to each theme, after which 4.2 describes the interrelationships between the activities, 4.3 analyses two modal shift approaches and 4.4 highlights the entrepreneurial role in modal shift.

4.1 Principal themes of activities driving modal shift to IWT

In each case, the primary activity of the actors involved was *understanding the current situation* in order to identify challenges to their particular modal shift to IWT and actors who were or could be important to realising that shift. In the case in Belgium (BE), for instance, a central activity was organising round-table discussions with stakeholders at which key challenges could be formulated and prioritised via Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis and market analysis. In Great Britain (GB), the infrastructure was the top concern, and infrastructure bottlenecks were identified for IWT alongside a goods flow mapping and an advisory group to be established. In Sweden (SE) interviews and workshops with stakeholders were hosted to shed light on their shared situation. In all of the cases, the actors identified challenges after analysing the current status of the situation or a pre-understanding of it. Such challenges included operational and legislative hurdles (BE), improving waterways (e.g. reconstructing locks in GB and upgrading fairways to class V in the Netherlands), obstacles in port and terminal operations (e.g. lack of transshipment equipment and high port handling fees in SE) and regulations (e.g. costly piloting fees in SE). In GB, SE and the Netherlands (NL), high investment costs and difficulties in securing sufficient volumes for the IWT service were highlighted as two major challenges. In Germany (DE),

by comparison, the lack of IWT-related knowledge among logistics decision makers was identified as a clear setback.

Once the current situation was sufficiently understood in each case, the actors advanced to *identifying potential solutions*. Examples of activities conducted at that stage included commissioning additional studies to identify suitable actions for addressing specific challenges. In several of the cases, negotiations and discussions with stakeholders (e.g. senders or receivers of goods, shipping companies, ports and authorities) were central to the process of identifying and agreeing upon solutions. For example, in BE, regulations needed to be in place to allow for IWW tests, which required dialogue with both the local and national authorities. In SE, the project quickly pinpointed that two activities able to lower costs were bargaining with ports for reduced handling fees and lobbying authorities for exemptions to costly pilot regulations. In BE, the actors stressed that solutions were needed in various areas, not only to revise existing regulations but also to resolve technical, operational and financial setbacks by pursuing transshipment solutions, for example. In GB, the locks, acting as bottlenecks, demanded a design plan of specific options including how to attract investments to fund infrastructural updates. To counter the lack of knowledge about IWT in DE, various means of dissemination were analysed, and an overall narrative of modal shift examples was developed to inspire key stakeholder groups.

To take an initial step towards realising the modal shift to IWT, the actors typically engaged in *testing solutions*. To that end, pilot projects were sometimes conducted that, if successful, not only illustrated the concept of IWT but also enabled learning about challenges as well as solutions and promoting IWT services to stakeholders. In the NL, a test demonstrated that flows of goods with various characteristics and from several companies located near the IWW could be consolidated for return flows using spare capacity on a barge between Drachten and Amsterdam. The pilot project also illuminated the operational situation (e.g. how to load and unload various goods without risking damage). In SE, one entrepreneur organised a test early in the process that demonstrated how transport on the river Göta älv and transshipment in ports could be conducted, even if the containers were not loaded with goods. As such, the test allowed the entrepreneur to accomplish the crucial task of informing stakeholders about the potential of IWT solutions and the magnitude of plans for transforming IWT in Sweden. Another example emerged in DE, where training courses were implemented as a first step in educating students about IWT. Further, an event called an "Innovation Challenge" in DE attracted students to present ideas for more innovations in inland shipping.

Because solutions need to be known in order to be implemented, *promoting solutions* was another central theme in realising the modal shift to IWT. Solutions were often promoted by creating informational and/or educational materials, arranging workshops and seminars and/or by lobbying policymakers or other regulatory actors. In the NL, a promotional video was produced after the initial pilot project with the purpose of attracting more companies to use IWT and to ensure that the upgrade of waterways was on the agendas of local, provincial, national and international government agendas. The video, along with a report about the pilot project, was pivotal when justifying the need for funding to upgrade the waterways from class IV to class V, which would accommodate operations by vessels with a maximum length of 110 m. In SE, both entrepreneurs devoted their efforts to marketing IWT's potential, because general knowledge about IWT (e.g. concerning inland barges) and potential logistics solutions using IWT was quite low in the region and among national authorities.

Last, realising modal shift required stakeholders to be attracted to and actively participate in the modal shift process. Thus, *getting stakeholders on board* was important at all stages of that process, meaning that it was necessary to identify, attract and convince stakeholders, namely about IWT's various benefits. Particularly valuable to attracting stakeholders was *identifying flows of goods*, meaning identifying and convincing companies with goods types and supply chains suitable for IWT that IWT was indeed valuable. To that end, understanding which stakeholders need to be involved and connecting with them were essential tasks. To be sure, the same pattern surfaced in

several cases. For example, in BE, round-table discussions were crucial to getting companies on board and organised as forums to understand the current situation and identify IWT-oriented solutions. Later in the process, a consortium of companies interested in urban waterway logistics formed in collaboration with the municipality of Ghent for the purpose of finding additional solutions. In GB, establishing a freight advisory group proved to be crucial for similar reasons. In that case, companies with flows of goods conducive to modal shift were identified by mapping flows of goods, which resulted in a geographical analysis of locations and flows. In the NL, direct contact was established between the local municipality and 16 companies sending or receiving goods in the area. In turn, those actors continually discussed IWT's potential and sought to identify solutions that would promote modal shift. Those meetings with local companies were thus important, both to identify potential flows of goods and to motivate actors to use IWT. In the NL and SE, pilot projects played the additionally central role of engaging stakeholders and promoting IWT to them. In SE, the entrepreneurs contacted the stakeholders to jointly identify ways forward as part of pinpointing potential solutions, while the researchers arranged seminars and workshops to promote IWT, engage and inform stakeholders about it and better understand stakeholders' specific perspectives on IWT. The entrepreneurs also contacted companies along the IWW in order to identify flows of goods and inform potential customers about new potential container-based IWT services.
























4.2 Interrelationships between activities and actors in modal shift

On the whole, the cases revealed that the principal themes for activities (i.e. understanding the current situation, identifying potential solutions, testing solutions and promoting solutions) could be performed in different orders, in parallel and in various iterations for realising a modal shift to IWT. These activities are exemplified based on collected data in each case in Table 2.

In BE, GB and SE, where the actors needed to understand the current situation and the conditions of IWT in general, the modal shift process began with activities that established such an understanding. By comparison, the actors in DE and the NL had a pre-understanding of their situation and instead focused their initial activities on identifying solutions. In DE, based on past experience, the port clearly understood the challenges and thus oriented activities towards identifying solutions for them (i.e. bridging the knowledge gap about IWT). In the NL, the municipality already had a pre-understanding of the current situation due to long-term focus on such activities and recruited external experts to identify an innovative transport concept. Further, in NL, a stakeholder group was created in order to identify goods flows to test that concept.

Iterations between the activities were particularly salient between understanding the current situation and identifying potential solutions, especially in BE and GB, where the former fed into the latter. For instance, in GB, financial dilemmas were identified as challenges that funding from and agreed upon by stakeholders could overcome, followed by another round of situation analysis about operational and technical issues. That iteration prompted the identification of new (e.g. technical) challenges that were thereafter handled as part of identifying potential solutions (e.g. planning the design in further detail and reconstruction of locks). In that way, once one dilemma was resolved, the next one could be addressed, although new problems could appear that would reset the process or require parallel work.

Table 2. Examples of activities in themes for realising modal shift in the studied cases. (SIT = Understanding the current situation, SOL = Identifying potential solutions, TES = Testing solutions, PRO = Promoting solutions).

Case	Theme				
BE	 Round table discussions with companies & formulate challenges.	 Evaluate challenges, dialogue with authorities about regulations for tests.	 Perform market analysis and perform a test trip on the urban IWW.	 Find solutions to obstacles from test and a suitable barge for operations.	 Promote solution and test new electric barge.
DE	 Analysing means of disseminating IWT knowledge.	 Implementing training courses and an innovation challenge for students.	 Inform about IWT solutions and best practice towards logistics students and younv professionals.		
GB	 Establish advisory group, goods flow mapping and identify infrastructure bottlenecks.	 Design plan of options to adapt the locks for Euro class II vessels. Plan capital investment.	 Operational, cost and technical review and further analysis of lock design options .	 Further detailing design for building lock adaption options.	 Promotion of final lock design and seek grant funding for modifications.
NL	 Meetings with companies to prepare for tests.	 Consolidated goods flows for return barge trip.	 Promotional video. Learnings from test.	 Input from companies to find new solutions.	 Identify solutions based on input and promote IWT.
SE	 Understanding stakeholder perspectives, map and contact cargo owners.	 Bargaining fees with ports and lobbying for exceptions of piloting regulations. Finding initial volumes and an operational schedule.	 Combined test and promotion event: show case barge transport on Göta Älv for stakeholders.	 Analysis of inland port equipment and discussing with cargo owners their potential in using IWT.	 Partner with operator, ports and hauliers, explain business opportunities to stakeholders and provide a market offer to cargo owners.

The cases also revealed the importance of conducting tests as part of the modal shift process. From case to case, the tests typically served different purposes. In BE and SE, they were performed in parallel with other activities. In SE, a test was used to promote IWT among stakeholders early in the modal shift process; in BE, two tests were performed at different stages in the process, first to assess current IWT conditions and second, when an electric barge was to distribute goods to Ghent in promotion of the solution. In the NL, an initial test was followed by promotional activities (e.g. a video was distributed) and another analysis of the situation to identify additional challenges (e.g. with loading and unloading goods). Thus, lessons learned from the test about loading facilitated the analysis of new problems, the identification of improved solutions and, in turn, the decision to conduct a second test, which was a virtual demonstration in a simulator. The cases in GB, NL and SE showed that when identifying and working with potential solutions, it is crucial to promote the solutions to secure the commitment of stakeholders and boost their viability. Promotional activities were thus also performed after or in parallel with other types of activities.

4.3 Two modal shift approaches

The process of modal shift to IWT can be categorised based on how the actors approach the subject. The cases indicate two general ways to engage with modal shift a structured and an emergent approach. Figure 1 highlights key characteristics and central implications of the structured and emergent approach that exemplifies differences in context, activities taken and roles of actors for both approaches.

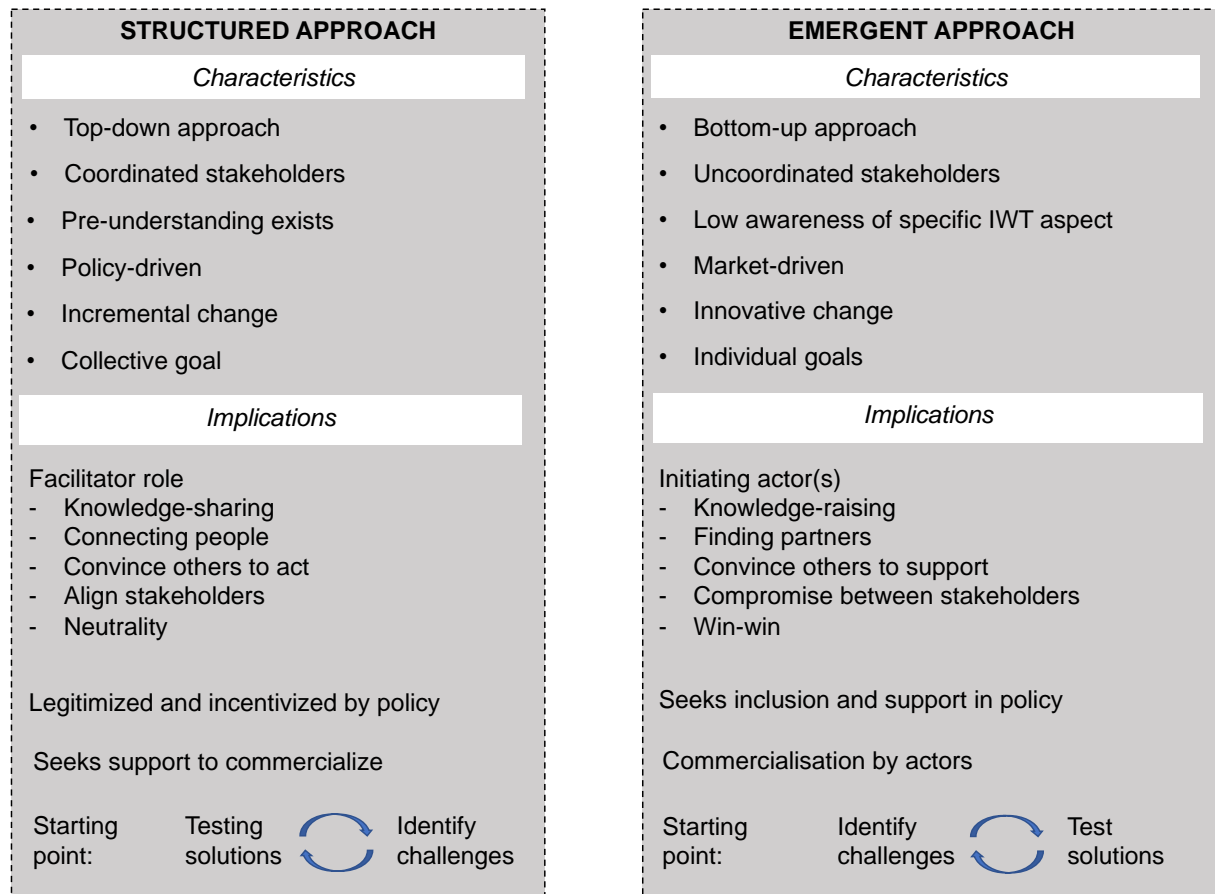


Figure 1. Comparison of structured and emergent approaches to the modal shift process

The first type, Structured approach, most strongly demonstrated in NL, is focused around a collectively organised initiative in which multiple stakeholders engage in a top-down attempt to establish an IWT-oriented solution. In the structured approach entrepreneurial activities are encouraged by policy programs and intrapreneurial activities get legitimacy by policy goals. 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 second type: an emergent, 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 BE and SE. In the emergent approach there is 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 intrapreneurs focus on common benefits, e.g. cost savings or improving environmental performance.

Depending on 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) that describe an inland navigation promotion agency. Existing policy program 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.

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 do not have all parts of the solution and rather than build alone in isolation, partners need to be identified. In the emergent approach, networks and contacts develop 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 that 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.

4.4 Entrepreneurial roles supporting modal shift

By collecting, processing and distributing information within organizations who engage in intermodal activities, intrapreneurs managed to amass resources that supported modal shift to IWT. For example, in GB, where considerable resources were dedicated to improving waterways, individuals within the IWW authority had to both develop knowledge and muster internal support while also working with external stakeholders to develop solutions. In DE, by comparison, one port recognised that the knowledge about IWT among logistics decisions makers needed to be improved, and tools were thus developed to support training and education. Although that initiative began within these organisations, external actors benefited from this work since the

results later spread through cooperation with educational institutes. In BE, intrapreneurs within the company that mobilised flows of goods to assure participation and drive modal shift played a crucial role when collaborating with key actors that in turn could accelerate or steer the process by influencing the mentioned activities. However, as all cases showed, relying upon either intrapreneurs or entrepreneurs exclusively in order to realise modal shift is insufficient. Instead, both were necessary, and stakeholders often needed to interact before a systematic shift to a more IWT-oriented transport system could be conceptualised. Added to that, several individuals demonstrated the importance of both types of entrepreneurial roles by switching between entrepreneurial and intrapreneurial work, thereby supporting a modal shift to IWT both by testing different ideas in new ventures and lobbying organisations from the inside.

5. Discussion and conclusions

Although challenges associated with shifting to IWT have been examined before, the holistic view of a modal shift process and the details in the range of activities actors can take to support the shift has been unclear in previous research. By studying cases with similar overarching policy goals (e.g. EU support of IWT), technological maturity and climatic challenges that nevertheless differ regarding market development, national regulatory maturity and stakeholders' understanding of IWT, we were able to exemplify a wide range of activities that are pivotal for a modal shift to IWT. The comparison between the cases adds to previous research, such as Katowska *et al.* (2019b) and Platz (2009), by addressing varying contexts, actor roles and the order of activities over time. The cases show that different types of actors (e.g. local and regional municipalities, authorities, shipping companies, distribution companies and ports) can lead the modal shift process. Our results thus corroborate the finding of Wiegmans *et al.* (2020) that container hubs and ports do not necessarily spearhead and coordinate hinterland development efforts with other stakeholders, but that inland terminals can also assume that role.

Our study confirmed past findings about barriers and stakeholder engagement as well as expanded upon them by adding layers of complexity, especially regarding the iterative and inclusive nature of modal shift processes. Whereas past studies have revealed various barriers to modal shift, including regulatory, financial, service-related and market-related ones (Rogerson *et al.*, 2020), we focused on specific activities targeting modal shift, and in this article, we have categorised those activities into four principal themes (i.e. understanding the current situation, identifying potential solutions, testing solutions, promoting solutions) and further discussed two integrated themes (getting stakeholders on board and identifying goods flows) drawn from practices observed in five cases in the North Sea Region. Even though these overarching themes were common for the cases, the details exemplified the wide range of possibilities for actors to impact a modal shift, e.g. how and why to involve stakeholders, ways of promoting IWT, how to use piloting tests as part of the process, and what technical solutions to aim for. The results clarify that modal shift is far from linear and simple demarcations for who should do what, when or where, particularly regarding the order of activities, parallel activities and iterations between activities. Since actors may prioritise activities differently in varying settings, an understanding of what motivates actors to engage in specific activities may require highly context-specific explanations.

While the processes in the cases varied, two approaches were apparent and outlined: structured or emergent. These explain differences in starting points as well as actor engagement. This categorization is useful for stakeholders to understand challenges they are facing as well as how activities or policy should be targeted. Authorities can use an understanding of what type of approach underlies the modal shift attempts to create strategies, form relevant alliances (e.g. business areas in mature markets such as NL and BE), and adapt the necessary support to enable modal shift to IWT. For example, the emergent approach combined with policy support to direct activities among actors may increase the pace in the modal shift process. Such policies could target

clear ambitions and goals of IWT development on regional or national level to convince others to support the initiatives. An important point is also that even in a mature market, an emergent approach can occur, particularly if a specific solution is less well-known in a new market segment, such as urban transport in BE. A combination of both approaches, e.g. where authorities or municipalities can take a facilitator role in a context similar to BE, can favour the development further. In both approaches a key learning for policymakers is their role in contributing to knowledge-building. Considering the prevalence of regulatory barriers (Otterström and Torpfält, 2016; Pfoser *et al.*, 2018) and physical barriers (Christodoulou *et al.*, 2020; Konings, 2009; Vierth *et al.*, 2012), knowledge building is critical for convincing actors to engage with IWT. Increasing knowledge is particularly relevant in emergent approaches, while in structured approaches focus can instead be on sharing available knowledge.

Maturity of the IWT market, also factored into each case's starting point. Cases with immature markets required more effort and more iteration between understanding the current situation and identifying potential solutions, as well as sustained focus on securing stakeholders and identifying flows of goods, two cross-cutting themes that need to be integrated in all four themes of the modal shift process. Beyond that, testing IWT solutions was crucial to promoting activities, understanding the current situation and identifying potential solutions. As shown in the NL, such processes generate materials and knowledge that can be reapplied when approaching other stakeholders.

Our study also confirmed past findings about the business challenges associated with IWT (e.g. (Notteboom, 2007; Olsson and Ronold, 2017; Wiegmans and Konings, 2015), specifically for emergent approaches, such as in SE, where entrepreneurs could not develop suitable business models or attract sufficient goods flows despite media attention and the involvement of incumbent shipping companies (Williamsson *et al.*, 2020). As that example shows, authorities cannot expect an IWT market to materialise if neither market nor regulatory conditions change significantly. In such contexts, authorities may study how they can simplify regulation (Pfoser *et al.*, 2018) and minimise disincentives such as piloting fees and fairway dues (Arvidsson *et al.*, 2017) for operating IWT.

The results can be used by researchers and practitioners to structure modal shift processes and prioritise activities for key actors depending upon how they understand the current status of their specific processes. More specific managerial implications for industrial actors – companies (e.g. cargo owners), shipping operators and ports – relate to the examples of activities, that can be addressed depending upon the context, and pre-understanding of challenges that needs to overcome. Those examples may even inspire and clarify possibilities for actors engaged in facilitating modal shifts. In particular, industrial actors can learn from the categorization of approaches to adapt their activities and understand the difference between participating in a structured and an emergent approach. Also, the entrepreneurial roles, both in terms of intrapreneurial and entrepreneurial work, were crucial for the modal shift process, e.g. by testing of ideas in new ventures and lobbying organisations from the inside.

As a final note, this article reports ongoing research. Further studies will examine the modal shift process of actors in the North Sea Region in order to elucidate the long-term effects of specific activities on the process. Because our multiple-case study was limited to situations in northern Europe, further research would also benefit from broadening the scope to include other geographical areas and contexts.

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