

Article

Inland Shipping to Serve the Hinterland: The Challenge for Seaport Authorities

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Abstract: The competitiveness of seaports is predominantly affected by factors external to the ports themselves, connected mainly with the quality of the hinterland and foreland infrastructure. Measures taken in these areas are reflected in the main objectives of the port strategies. Concurrently, the measures may have adverse environmental impacts (pollutant emissions, noise, land occupancy, etc.) and deteriorate the life quality of the port city's communities. Therefore, measures taken by seaport authorities to improve their competitiveness must also heed the idea of sustainable development (sustainable port strategy). The answer to this challenge is the idea of green ports, being an element of the corporate social responsibility (CSR) strategies of seaports. One of the elements of this concept is promoting more environmentally friendly transport modes/transport chains in serving the hinterland as an alternative to road transport. Inland shipping is the most environmentally friendly and also cost-competitive mode of transport. Therefore, a modal shift from road to inland waterways is one of the elements of the European Union sustainable transport policy, as well as also gaining importance in the development policies of seaport authorities as an element of a green port strategy. However, this issue has been relatively rarely addressed in the seaport economics literature. In particular, there has been a lack of studies that would make it possible to answer the question of what kind of action should be taken by seaport authorities in order to increase the share of inland shipping in hinterland transport. This article aimed to develop a concept of a promotion policy to be applied by seaport authorities to increase the share of inland shipping in hinterland transport. The study used the elements of a multiple case study design method which included the following seaports: Antwerp, Rotterdam, Hamburg, and the Marseilles–Fos port complex. This article was dedicated to identifying, analyzing, and classifying the policies implemented by these European seaports to promote inland waterway transportation. The research showed that these actions were quite similar in terms of their scope. The actions were classified as external and internal initiatives. The most common external actions included initiatives that improved the quality of inland waterways and the quality of shipping connections with the hinterland. Internal initiatives focused on improving the port's infrastructure for barges and on implementing an appropriate information policy. The presented concept of a promotion policy can be a road map for all port authorities aiming to improve the quality of inland shipping as a mode of hinterland transport.

Keywords: port authority; inland shipping; promotion policy; hinterland connections; sea–land transport chains

1. Introduction

Today, the competitiveness of seaports and port companies is predominantly affected by factors external to the ports themselves, connected mainly with the quality of the infrastructure that enables access to the ports from land and sea. Measures taken in these areas are reflected in the main objectives of many port strategies [1–4]. At the same time, measures in these areas may have an adverse effect on the natural environment and deteriorate the life quality of the communities living around port cities [5,6]. Measures taken by seaport authorities to improve their competitiveness must therefore heed the idea of sustainable development (sustainable port strategy). The answer to these challenges is the increasingly developed (and widely discussed in the literature) idea of green ports, being an element of the corporate social responsibility (CSR) strategies of seaports [7–15]. One of the elements of this concept is promoting more environmentally friendly transportation modes in serving the hinterland as an alternative to road transport [16–19]. Therefore, connecting seaports with the hinterland by means of high-quality inland waterway transport infrastructure may become a significant competitive advantage in the port services market, while at the same time perfectly fitting within a sustainable port strategy [20].

An increase in the importance of inland waterway transportation as an alternative to road or railway transport on seaport–hinterland routes is connected with economic and noneconomic changes taking place in seaport environments [21]. These changes are attributed first and foremost to the policies aimed at mitigating the negative impacts of business activity, including transport, on the natural environment, lives and health of people, and pressure put on searching for savings in transportation costs [22]. The sustainable development of transport is becoming an increasingly important element of economic policy, including transport policy, both at the level of supranational (such as the EU), national, regional, or local administration as well as for transport companies [23–28]. The situation of the global raw material markets has also had an impact on the lowest-ever rates for sea shipping. The only section of the sea–land transport chain where it is still possible to look for transport cost savings is the land section: from the seaport to the hinterland or from the hinterland to the seaport. A seaport is a key link in any sea–land transport chain and it may, through active investment and information policy, have an influence on the structure of the hinterland transport, thus contributing to the sustainable growth of transport [29]. Inland waterway transport is one of the transport modes that are the least detrimental to the natural environment. At the same time, an appropriate inland shipping promotion policy that is devised and implemented by seaport authorities is a prerequisite for the development of this transport mode in serving the seaports' hinterland.

The main aim of this article was to develop a concept of a promotion policy to be taken by seaport authorities in order to increase the share of inland shipping in hinterland transport. This article is especially dedicated to identifying, analyzing, and classifying the policies implemented by selected European seaports to promote inland waterway transportation. The research has shown that these actions are quite similar in terms of their scope. At the same time, a proper policy in this area may contribute to an increase in the share of inland shipping in hinterland transport, and consequently, to the sustainable development of transport. In order to fulfil the primary objectives of this article, a case study of selected European seaports (which have the highest share of inland shipping in hinterland transport) was applied. Although the article focused specifically on the selected European seaports, the proposed concept could be used in numerous ports across the world. Thus, the research results presented in this article provide generalized conclusions.

2. Literature Overview

Seaports, being transport nodes, constitute basic links in the sea–land transport chains [30,31]. Their competitiveness is decisive for the position of the whole sea–land transport chain [31–38]. There are many factors that are decisive for the competitive position of seaports, including, first and foremost, geographical location, appropriate technical facilities, efficiency of the port operation (including ship handling speed and transshipment rate), handled cargo weight, technological

advancement, technical and operational innovativeness within the port, level of port fees, and the scope of additional port services on offer [39–47]. When a seaport is viewed as a fundamental but not the only link in a sea–land transport chain, it is necessary to account for its competitiveness factors, such as the total time and total cost of cargo delivery [48], including the hinterland transport costs [49] and the quality of the hinterland transport connections [50]. A major role in creating a competitive position of seaports is played by the seaport authorities, who, as landlords, manage the port infrastructure and implement the port policy aimed at improving access to the port from the foreland and hinterland [1,51–53].

The present-day policy is affected by the increasing significance of the sustainable growth concept [54–57]. Sustainable transport, defined as a proper balance between economic, social, and environmental values [54], has become one of the major elements of contemporary seaport strategies concerning green ports [58–60]. As the sustainable growth policy has become more important, the role of seaport authorities in its implementation has also been subject to change. The changes in the policy and the role of seaport authorities were discussed by Cheon and Deakin [61], Chang and Wang [62], Sheu et al. [63], Wang and Notteboom [64], Kang and Kim [65], Di Vaio and Varriale [66], and Acciaro et al. [13]. A seaport is “an enterprise” that has a considerable social impact, i.e., environmental pollution, noise, and congestion. Therefore, a need has arisen for cooperation between the port and the other stakeholders, especially shipping lines or the city [67–71]. The key role and recommended tasks of port authorities in the implementation of the idea of the green port concept regarding air pollution and waste management processes in the port industry were discussed in the research undertaken by Di Vaio et al. [72].

In order to decrease the externalities of transshipment operations directly affecting the environment, ports take a number of measures that include discounts on port dues for ships with lower emissions, a reduction in the speed of a ship entering the port, discounts for ships using low-sulfur fuel, discounts for rail operators using low-emission locomotives, a ban on the entry of vehicles with high emissions, and cold ironing the supply of shore power to ships, replacing diesel automated guided vehicles (AGVs) with electric ones, or also terminals supplied with power from renewable sources [72].

In this context, the role of seaport authorities is to strive not only to increase transport accessibility as such, but first and foremost, to improve accessibility to transport modes that are environmentally friendly [73,74] and cost-competitive at the same time. Such conditions are fulfilled by inland shipping.

A well-functioning seaport, as a link in a sea–land transport chain, may contribute to a modal shift from roads to land–sea transport chains [21,75–80], and can also, by developing a port access policy, change the hinterland transport structure to make it more environmentally friendly, thus contributing to a decrease in transport externalities [81]. Inland shipping is considered to be the most environmentally friendly transport mode when compared to rail or road transport [81,82]. According to the EU Commission, energy consumption in inland shipping is lower by ca. 17% when compared to road transport and by 50% in relation to rail transport [83]. Franc and Fremont [81] proved that shifting cargo from road to inland shipping on the Le Havre–Paris route would reduce CO₂ emissions by 20% to 50%. Environmental effects generated by inland vessels may be as much as six times lower than those generated by road vehicles [82]. Therefore, inland shipping is a strongly promoted mode of transport both in the EU as well as in other parts of the world, and also as a way to provide the environmental sustainability of seaports in view of competitiveness [21,84–88].

However, not all seaports have access to inland waterways, and even if they do, not all of them make proper use of it. Therefore, the issue of promoting inland waterway transport in the activities of seaport authorities is an important problem. However, this issue has been relatively rarely addressed in the seaport economics literature. In particular, there has been a lack of studies that would make it possible to answer the question of what kind of action should be taken by seaport authorities to increase the share of inland shipping in hinterland transport. This is an important issue that requires more detailed research in this area.

3. Materials and Methods

This article aimed to develop a concept of a promotion policy for inland shipping by seaport authorities, which may contribute to an increase in the share of inland shipping in hinterland transport. This concept is dedicated to seaports that have access to inland waterways. To reach this aim, elements of the multiple case study (MCS) design method were applied, as it makes it possible to apply a wider scope of techniques and tools to source and analyze data when compared to quantitative (statistical) methods [89–91]. According to the principles of the MCS method, in the first stage, three research questions were posed:

- Why do seaport authorities pursue a proactive policy of promoting and facilitating inland shipping to serve the purposes of hinterland transport?
- How do seaport authorities encourage port users/customers to use inland shipping for the purposes of hinterland transport?
- What types of measures do they take in order to streamline the handling of inland vessels?

Based on these questions, the following proposition was stated: only an active promotion policy that includes external and internal initiatives can contribute to an increased role of inland shipping in the seaport's hinterland transport.

The next step of designing the MCS method was to define the unit of analysis. The authors focused on the strategic activities of the seaport authorities aiming to increase the share of inland shipping in hinterland transport.

In order to identify the seaports for inclusion in the case studies, the statistical analysis method was applied. The basic source of information for the statistical analysis was the data published by Eurostat. Based on these data, inland waterway transport was analyzed with regard to individual European countries. Then, countries with traffic of over 50 million tons per year were selected for further studies. For each of the selected countries, based on the deliberate sampling method, one representative seaport was selected. Consequently, the following four seaports were included in further analysis: Antwerp, Rotterdam, Hamburg, and the Marseilles–Fos port complex, which all pursue a proactive policy of promoting and facilitating inland shipping.

The next stage of the research study was to source the data. The data used in this study were sourced from information materials issued by seaport authorities, port companies, transport companies, and from press releases. The analysis of the gathered research material led to the identification and classification of measures that should be taken by seaport authorities to increase the share of inland shipping in hinterland transport.

The following step of the study was an assessment of actions taken by the seaports in the promotion of inland shipping, and consequently, the development of the recommended concept of promotion policy for inland shipping in hinterland transport. To validate the identified measures, the analysis of changes in the share of inland shipping of hinterland transport was developed.

4. Results

4.1. *Inland Shipping in Serving the Hinterland of Selected European Seaports: The Subject of the Study*

Inland shipping is a transport mode that is used to a variable extent in the transport systems of individual European countries. Approximately 500 million tons of cargo per year is carried via European inland waterways, and the leading countries in this respect are Belgium, the Netherlands, Germany, and France (Figure 1). International transport constitutes more than half of the total transport volume. This shows how important it is for the development of inland waterway freight transport to create international waterway connections and to unify the technical and legal solutions on a pan-European level.

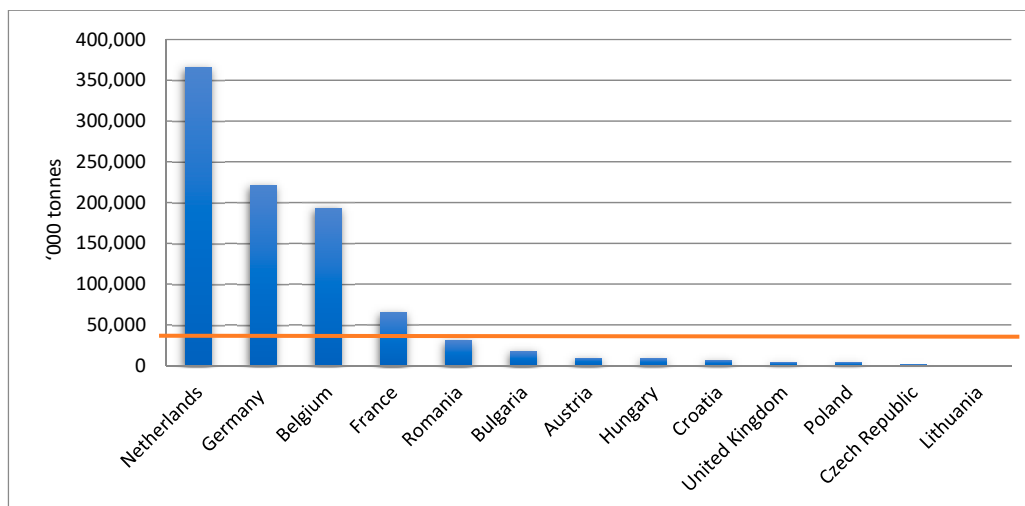


Figure 1. Inland waterway freight transport in Europe, broken down into countries (thousand tons) in 2016 [92].

According to the Eurostat data for 2016, the share of inland waterways (in ton-kilometers calculated for road, railway, and inland waterway transport) amounted to 6.6% for the whole European Union. Inland waterway transport is mainly used to transport bulk cargo such as ores, coal, coke, chemicals, and agricultural produce. Containerized cargoes have a growing share in inland waterway transport (over 9% in 2015). The largest number of containers are transported via inland waterway routes in Belgium and the Netherlands, mainly to and from the seaports in Antwerp and Rotterdam. In Germany, containers are carried mainly along the Rhine route and to/from the seaport of Hamburg. For many seaports, inland shipping constitutes an important mode of hinterland transport and is a factor that is decisive to their competitive position. Therefore, the seaport authorities take numerous measures aimed at improving the conditions of inland barge handling in the port and hinterland. The multiple case study involved the four seaports (and the port authorities) located in the countries characterized by the largest inland waterway transport volumes in Europe, i.e., the ports in Antwerp (BE), Rotterdam (NL), Hamburg (DE), and Marseilles–Fos (FR). Table 1 provides the basic data describing these seaports.

The shares of inland shipping in the analyzed seaports are different. More than 915 inland barges per week are handled in the port of Antwerp (ca. 48,000 per year), of which 190 constitute regular connections with inland ports located in Belgium, The Netherlands, Germany, or Switzerland. The port cooperates with 85 inland shippers, of which 45 handle containers. The port of Hamburg has 15 regular liner services per week to/from the inland ports located in the central part of Germany and the northeast of the Czech Republic (Decin, Losice), as well as the ports located in the Elbe estuary, i.e., Gluckstadt and Brunsbüttel. Most of the cargo is carried via the Elbe Lateral Canal (ca. 90%) and only 10% via the Elbe river. A total of 95% of the cargo results from Germany's foreign trade. The Marseilles–Fos port complex has 10 liner service vessels per week, linking the port with other ports located along the Rhone, in particular with Lyon; the farthest port into the north is Chalon-sur-Saône, located 500 km away from the Fos-sur-Mer port.

Table 1. The basic data of selected seaports in the context of inland shipping.

Port	Antwerp	Rotterdam	Hamburg	Marseilles–Fos–Sur–Mer
Main information/inland waterway connections	Located on the Northern Sea, it is one of the biggest ports in Europe; container hub; due to the convenient location of the port in the Scheldt–Meuse–Rhine delta, the port is connected to 1500 km of the European network of inland waterways and over 75 inland ports all over Europe, some of which play the role of dry ports	Situated in the estuary of the Rhine and Meuse rivers that link Rotterdam with inland ports in The Netherlands, Germany, Belgium, France, Switzerland, and Austria, and via the Rhine–Main–Danube canal, with ports in Central and Eastern Europe. The biggest port in Europe; container hub	Situated 130 km inland from the open sea, on the Elbe river; the middle section of the Elbe river and the Elbe Lateral Canal connect the Hamburg port with German business centers, i.e., Hanover, Braunschweig, Salzgitter, Wolfsburg, and the Ruhr district; the third biggest inland port in Germany, exceeded only by the ports in Duisburg (52 million tons) and in Cologne (11 million tons)	Located on the Rhone river which connects it with major cities in the south of France: Lyon, and also other ports located in the Rhone–Alpes and Burgundy regions; container hub for the south of France.
Annual turnover	Nearly 200 million tons, of which 60% comprises general cargo (mainly containerized)	Nearly half a billion tons of cargo, of which almost 70% are bulk cargoes; the remaining 30% comprises mainly containerized cargo	Nearly 150 million tons; two-thirds of it comprises general cargo, mainly containerized; a considerable part of the cargo comes from or is intended for Eastern European countries	ca. 80 million tons of cargo a year, of which more than half comprises oil and its products; 11 million tons constitute containerized cargoes

The role of inland shipping in transporting cargoes to/from the analyzed seaports is presented in Table 2.

Table 2. The role of inland shipping in serving the hinterland of selected European seaports in 2016.

Port	Share of Inland Shipping in Hinterland Transport (Total Cargo (Containers))	Number of Handled Barges (Thousand per Year)
Antwerp	41% (38%)	48
Rotterdam	62.6% (38.2%)	110
Hamburg	11.5% (2.2%)	10
Marseilles–Fos	no data (8.4% *)	no data

* in 2015.

4.2. Types of Measures Taken by Seaport Authorities in Order to Increase the Share of Inland Shipping in Serving the Hinterland

The initiatives taken by the seaports have focused on both external and internal measures (Figure 2). The most frequently applied external measures include activities aimed at improving the quality of inland waterways, which results in better accessibility of the port, activities related to improving the quality of connections with the hinterland, as well as activities related to changes in administrative procedures.

The measures mostly taken by the selected seaport authorities to improve the infrastructure of inland waterways have been focused on cooperating with the institutions responsible for the condition of inland waterways, indicating the existing “bottlenecks”, and coordinating the investments. In the case of the Port of Antwerp, the port authority closely cooperates with the inland waterway transport administration (NV De Scheepvaart and Waterwegen en Zeekanaal). In order to improve the port accessibility, the port authority, in cooperation with the Flemish government, completed several projects such as:

- The renovation of the Van Cauwelaert lock;
- The construction of mooring quays on the Scheldt River (Ketelplaat);
- Improving the parameters of the Albert Canal (widening the Canal and increasing the clearance under the bridges to enable the carriage of four layers of containers (9.10 m).



PORT AUTHORITY'S MEASURES		EXTERNAL	Inland waterways infrastructure	<ul style="list-style-type: none"> → Cooperation with institutions responsible for the condition of inland waterways → Indicating the existing “bottlenecks” → Coordination of investments
		Quality of hinterland connections	<ul style="list-style-type: none"> → Cooperation with inland ports → Acquiring shares in inland ports → Investing in inland terminals operating as dry ports 	
		Administrative	<ul style="list-style-type: none"> → Measures aimed at simplification of border clearance procedures in seaports and/or transferring them to inland ports → Creating centers for promoting inland shipping, to integrate various port users 	
		INTERNAL	Quality of barge services	<ul style="list-style-type: none"> → Infrastructure: <ul style="list-style-type: none"> ▪ Construction of dedicated barge terminals ▪ Construction and modernization of infrastructure to serve barges in the port (berths, waste disposal points, electric power supply for barges) → Infostructure: <ul style="list-style-type: none"> ▪ Providing systems for automatic identification of barges ▪ Providing systems for barge service coordination in the port ▪ Integrating inland shipping in logistic systems, including barge connections in Information Technology (IT) systems for sea-land supply chain planning
		Land management	→ Provisions on the minimum share of inland shipping in hinterland transport, added to port areas’ lease agreements	
		Information promotion and	<ul style="list-style-type: none"> → Information platforms for shippers, made available online, providing information on inland shipping possibilities → Information platforms for carriers, providing information on loading opportunities 	
Innovations		<ul style="list-style-type: none"> → Research studies → Aimed at increasing the demand for transport services (e.g., LNG) → Aimed at improving the quality of transport services 		

Figure 2. The concept of recommended measures taken in order to streamline inland shipping in the hinterland.

Similarly, in the case of the Port of Hamburg, where actions taken, for example, by the land government in cooperation with the port authority, led to the development of Ahrensburger's list, which includes 24 priority transport projects (apart from Hamburg, four other areas in northern Germany: Lower Saxony, Bremen, Mecklenburg–Vorpommer, and Schleswig–Holstein were involved). With regard to inland shipping, the list stipulates projects regarding the improvement of waterway parameters for the Elbe–Lübeck Canal, Mittelwasser (the Minden und Dörverden lock), and the Weser estuary as well as a project that aimed to improve the accessibility of the Hamburg port from the sea for the largest container ships, dredging and modernizing the Lower and Outer Elbe. The list was included in the National Concept for Maritime and Inland Ports (Nationale Hafenkonzept für die See und Binnenhäfen). The German government is planning to invest ca. 47 million euro in inland waterway infrastructure, inter alia, in the Lüneburg boat lift in Scharnebeck, located on the Elbe Lateral Canal. This will cost 10 million euro. Following the modernization, the new lock will make it possible to increase the parameters of tug–barge combinations up to 185 m in length and 12 m in width.

To improve the quality of hinterland connections, the seaport authorities usually cooperate with inland ports, acquire shares in inland ports, or invest in inland terminals operating as dry ports. For example, in the Port of Antwerp, one of the projects of the “Master Plan for Barges Transport” consists of investing in the Beverdonk terminal located on the Albert Canal, where containers brought by barges to/from the port are consolidated. Working towards closer communication with the hinterland, the Antwerp Port started cooperation with terminals and ports in the hinterland, for example, Limburg, Genk, Brussels, Liège Trilogoport, Rail Terminal Chemelot (RTC), and Geleen. Similarly, the Rotterdam Port Authority stimulates the development of inland shipping by taking up shares in inland ports or by leasing terminals in inland ports. The Rotterdam Port Authority possesses, for example, the Wanssum Intermodal Terminal, located in the southeast of the Netherlands, and Alphen aan den Rijn, located 60 km away from Rotterdam. As a result, it is estimated that by 2035, transport volume by barge will have risen to 9 million TEU (Twenty-foot Equivalent Unit), and by rail, up to 3.7 million TEU per year. To strengthen the relations between the port and the hinterland, The Marseilles–Fos Port Authority has invested in intermodal terminals in the hinterland. It has a 16% stake in the Lyon Terminal company, whereas in 2010, it purchased 10% of the shares in the SAS Pagny Terminal. The terminal is located in Burgundy, 500 km away from Marseilles, on the Saône Canal, halfway between the northern coast of France and Marseilles, and it plays the role of a logistic terminal.

The third kind of external measure is the administrative actions that are focused on the simplification of border clearance procedures in seaports and/or transferring them to inland ports or creating centers for promoting inland shipping to integrate various port users. For example, shortening the time spent by barges in the Marseilles–Fos port was achieved largely due to the simplified procedure described as PMF (Maritime Rail or Inland Waterway Procedure). The procedure enables the clearance of goods in inland ports. The possibility of applying this procedure improves the competitive position of inland shipping and railway in relation to road transport. The advantage of this solution is that the bill of lading issued for the cargo also covers transporting the cargo to and from the port by rail or inland shipping (i.e., this procedure is applied to all containers loaded in the port) and functions as a simplified transit document. Thanks to this solution, the transit time through the port does not exceed 48 h. Moreover, an IT platform was established to serve the port's stakeholders, the purpose of which is to streamline the cargo flow through the port. Operators, forwarders, shipping agents, customers, and carriers are directly connected to the system, and may consequently monitor the physical state, customs clearance status, or location of the container in real time. In the Port of Hamburg, to raise the port users' awareness of intermodal transport possibilities, the Centre for Promotion of Short Sea and Inland Shipping was established. This is a public–private initiative focusing on consultations between entrepreneurs, forwarders, and shippers that aims to raise the awareness of intermodal transport possibilities involving short sea shipping, inland shipping, and railways. As a result, road transport volume has so far been decreased by ca. 1 bn ton-kilometers. The Centre is financed by the Association for Promotion of Short Sea Shipping (der Verein zur Förderung des

Kurzstreckenseeverkehrs, VFKS SV) based in Bonn, which is comprised of 40 members, inter alia, the German Ministry of Transport and Digital Infrastructure, the Lands of Baden-Württemberg, Hamburg, Mecklenburg-Vorpommern, Lower Saxony, North Rhine-Westphalia, and Saxony-Anhalt, as well as shipping companies, forwarders, port, and railway operators, etc. [93].

The second group of initiatives taken by seaport authorities are internal measures that include actions focused on improving the quality of barge services, changes in the port's management, improving the information systems, and developing the innovation programs. To improve the quality of barge services, seaport authorities take steps to raise the quality of the port's infrastructure as well as infostructure. For example, the Port of Rotterdam has been fully adapted to handle barges. There are more than 50 barge wharves equipped with, among other things, electric power outlets. To solve the problem of congestion, the Port Authority supports activities aimed at the construction or separation of dedicated barge terminals. A few such terminals are already in operation. These are the Hartel Terminal, Delta Barge Feeder Terminal of ECT, and the Rotterdam Container Terminal, all of which are located in the Maasvlakte area [94]. Dedicated barge terminals are concurrently planned at each new terminal located in the Maasvlakte 2 area. Additionally, a terminal-neutral Barge Service Centre is planned to be established in the Port of Rotterdam, which will operate independently from deep-water terminal operators. To improve barge handling in the Port of Antwerp, two dedicated mooring berths have been arranged and equipped with electric power supply and waste disposal points (annual capacity of facilities is 5000 tons). Similarly, in the Port of Hamburg, the number of berths dedicated only to barges and inland vessels is planned to be increased, and in a more distant future—to better integrate inland shipping in the logistic chain—inland shipping is planned for inclusion in the “Feeder Logistic Centre” system.

To improve the port's infostructure, the analyzed seaport authorities focused on three activities:

- Providing systems for automatic identification of barges;
- Providing systems for barge service coordination in the port;
- Integrating inland shipping in logistic systems including barge connections in IT systems for sea-land supply chain planning.

The previously mentioned Antwerp Port Master Plan provides, inter alia, a requirement that any barge entering the port must be equipped with an automatic identification system (AIS) transponder, which improves barge safety in the port. Another element of the Master Plan is to improve the handling of container barges that call at several terminals. To that end, the barge transport system (BTS) was established, which plays a key role in communication between the barges and terminals and facilitates the precise planning of the sequence and timing of barge handling at the terminals. In addition, in combination with AIS and by optimizing the functioning of the locks and barge berths occupancy planning, the system accelerates handling. In the future, the so-called Barge Coordination Centre is planned to be established, where the BTS system will be extended to all barges in the port. The inland shipping promotion program introduced in the Port of Rotterdam stipulates that a dedicated IT platform will be provided to enable better coordination between barges and deep-water terminal operators. The drawback of the current, not yet fully coordinated system, is the fact that barges have to call at 8–10 terminals in the port, which considerably extends their berthing time and often leads to delays in deliveries to hinterland areas. The NEXTLOGIC program, involving, inter alia, the Ministry of Infrastructure and Environment, APM Terminals, ECT, VRTO (deep-water terminal operators), HCRA depots, and LINC (inland terminal operators), aims to create an IT system to enable the coordination of barge calls at container terminals and the ongoing planning of barge service timetables to optimize delivery times [95]. The Marseilles-Fos Port Authority strengthens cooperation with inland ports within the framework of the MedLinkPorts platform, which comprises nine trimodal terminals located in the Rhone-Saône corridor: Pagny Terminal, Chalon-sur-Saône, Mâcon, Villefranche sur Saône, Lyon Terminal, Vienne-Sud/Salaise-Sablons, Valence, Avignon-le Pontet, and Arles, and two

seaports: Marseilles–Fos and Sète and the French Waterways Administration (Voies Navigables de France). The task of the MedLinkPorts platform is to:

- Reinforce the position of the ports of Marseilles and Fos-sur-Mer in relation to their natural hinterland;
- Promote intermodal transport, particularly inland shipping;
- Improve the “door-to-door” offer by encouraging cooperation between all sea- and inland ports.

Another internal measure taken by seaport authorities is the policy of land management. For instance, the Rotterdam Port Authority plans to make the terminal operators increase the share of environmentally friendly transport modes in hinterland transport by changing some of the provisions in their lease agreements. The agreements stipulate that the share of inland shipping in hinterland transport can be no less than 45%, and of railway, no less than 20%. According to the forecasts, by 2035, container transshipments between the port and hinterland will reach 20 million TEU.

The third internal measure is proper information and promotion. The inland shipping promotion program implemented by the Rotterdam Port Authority has been created in cooperation with the local authorities, inland shipping operators, and other stakeholders. To promote inland shipping, the port authority has taken a number of measures aimed at the better coordination of barge handling in the port as well as to inform inland waterway transport operators and cargo shippers who want to use inland shipping for hinterland transport. Moreover, the port authority has been running an intensive information campaign addressed towards inland vessel operators. The Port’s official website provides information on the dedicated barge wharves and their technical equipment, information on permissible parameters of inland vessels, as well as the port regulations on handling barges and their cargo (in English). There is a platform called “Inland Links”, dedicated to cargo shippers, which makes it possible to identify possible transport chains from the Rotterdam Port to destinations in Europe and specify the delivery time and transport distance. The platform provides data on (railway and barge) liner services connecting the port with hinterland terminals, any available loading opportunities (identifying the optimal connections), and the parameters of the terminals. Moreover, the platform offers an “empty depot tool” with data regarding the location of empty containers in inland ports. Thanks to this information, customers are able to deposit or collect a container, while inland operators know there is a need to reposition the containers. A quite similar IT platform was created and installed on the official website in the Port of Antwerp (“The Port of Antwerp Connectivity Platform”), which provides, among other things, information on any possible intermodal connections between the port and hinterland.

The last identified action taken by the seaport authorities was to participate in research studies.

The Ports of Antwerp and Rotterdam, for example, participate in the LNG Master Plan that aims to introduce LNG, both as cargo and fuel, into inland waterways. The project participants include 33 beneficiaries (i.e., representatives of sea- and inland ports, inland vessel owners) and 50 companies as well as organizations that run parallel projects regarding LNG. The project assumes the construction of two barge bunkering terminals in the Ports of Antwerp and Ruse (Bulgaria). Moreover, the LNG Master Plan stipulates the:

- Identification of markets in the inland ports’ hinterland;
- Analysis of social costs and benefits of using LNG;
- Transferring the know-how from maritime transport to inland waterway transport;
- Creating a European harmonized legal framework to use LNG as fuel and cargo in inland shipping;
- Providing technical solutions for newly built and refitted inland barges to enable them to carry LNG or use LNG as fuel;
- Developing a complex strategy for LNG in accordance with the EU policy with regard to transport, energy industry, and environmental protection;

- Preparing the project for implementation (using The Connecting Europe Facility (CEF) funds and other EU programs);
- Producing prototypes of LNG-fueled vessels.

Under this project, the first tug–barge combination refitted to LNG was officially delivered in June 2014.

The measures identified in the study contribute to the increase in the share of inland shipping in the seaport hinterland transport system. Based on the example of containerized cargoes, all analyzed seaports have recorded an increase in the share of inland shipping (Figure 3).

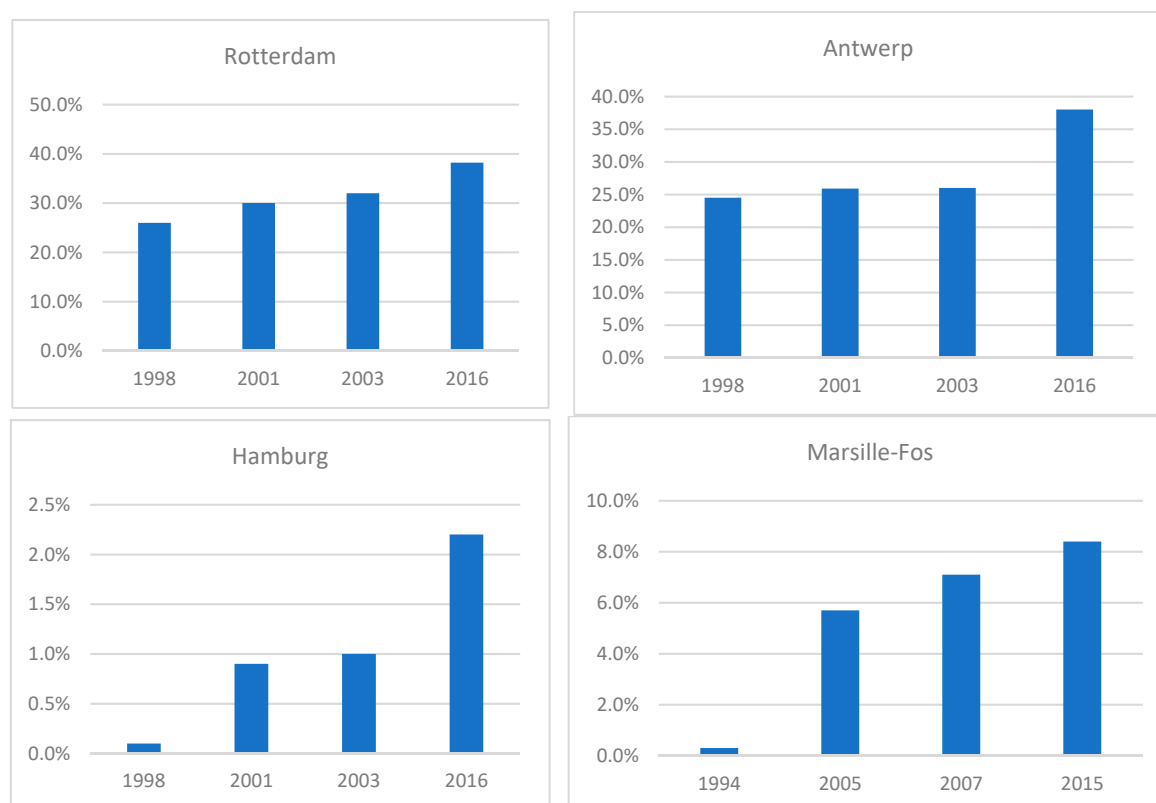


Figure 3. The comparison of the share of inland waterway transport in serving hinterland (containers) of the analyzed seaports in selected years.

It should also be emphasized that the implementation of external measures regarding inland waterway infrastructure investments is a necessary condition of the effectiveness of the other measures in the proposed concept of inland shipping promotion policy in serving the seaports' hinterlands. The waterways leading to the analyzed seaports for the majority of parts meet the requirements according to the AGN agreement (European Agreement on Main Inland Waterways of International Importance).

5. Discussion

This paper focused on the policies implemented by different seaports in order to promote inland waterway transport as an important element of sustainable port strategy. A proper policy in this area may contribute to an increase in the share of inland shipping in hinterland transport, and consequently, to an accomplishment of sustainable development of transport at the local, regional, national, and even international (EU) level.

Our research contribution to the literature is the identification and classification of the seaport authorities' measures that aim to promote inland waterway transport, and thus identification of the

concept of a promotion policy to be applied by seaport authorities to increase the share of inland shipping in hinterland transport in the context of a sustainable port strategy. The study has shown that the identified, classified, and analyzed measures taken by the authorities of the selected European seaports are similar in many aspects and focus on both external and internal measures.

The external measures included activities related to improving inland waterway infrastructure, the quality of hinterland connections, and administrative support in this area. Internal initiatives mainly included measures aimed at improving the barge infrastructure, and also an appropriate information policy. New dedicated barge terminals have been established, along with fully equipped berths. In the context of creating logistic chains involving inland shipping, a more and more important role is played by online IT platforms addressed to both the shipping companies and cargo shippers, informing them of the transport services offered, available intermodal connections, available loading opportunities, parameters of terminals in inland ports, and the services they offer, etc.

Last but not least, all the programs implemented by the seaport authorities are often planned in cooperation with central, regional, or local governments. Active cooperation with the administration responsible for waterways helps identify “bottlenecks” in hinterland transport so that measures can be taken to eliminate them. Identification and indication of strategic goals would not be possible without an open dialogue with port users and other stakeholders. This particularly applies to cooperating with the institutions responsible for the maintenance and development of waterway infrastructure, as a necessary condition for the effectiveness of the implementation of the proposed internal measures is the appropriate quality of inland waterway infrastructure (external measures).

The research study allowed us to verify the existing knowledge in the area of the promotion policy of port authorities for inland waterway transport as a an environmentally friendly transport mode in the seaport–hinterland distribution network. The recent literature has tended to focus on inland shipping as a hinterland transport mode primarily in terms of issues such as the sustainable growth concept and sustainable transport, the cost competitiveness of seaports, and the modal shift from roads/rails to sea–land transport chains. The issues of promotion policies implemented by seaport authorities refer to rather general activities with regard to improving the quality of the whole structure of hinterland transport.

A promotion policy as such that focuses on inland shipping has hardly ever been addressed in the literature. Simultaneously, this transport mode requires specific promotional activities due to its specific features, such as lower competitiveness in terms of time when compared to road and rail transport.

The proposed concept of promotion policy is in line with the EU transport policy, focused on reaching a sustainable low-carbon economy by 2050. One of the key objectives of this policy is the modal shift of freight from roads to more environmentally friendly transport modes such as rail and inland shipping. The recommended measures taken in order to streamline inland shipping in the seaports’ hinterland transport system may therefore also provide support for policy actions at the EU level (as recommendations and guidelines).

As a managerial implication, the presented concept of a promotion policy can be a road map for all port authorities aiming to improve the quality of inland shipping used as hinterland transport. The implementation of measures proposed in the concept will contribute to improving the competitiveness of the port in compliance with sustainable development principles. Apart from the environmental aspect, access to the “third” transport modes of a seaport–hinterland distribution network may also increase their competitiveness (from the shippers’ point of view) to other seaports in the region, which do not have such options. Inland shipping is not only environmentally friendly, but also a cost-competitive transport mode at the same time. Supporting the development of this transport mode may be also a tool for improving the accessibility of seaports, combating increasing congestion in the hinterland cargo distribution.

The research showed that the seaport authorities are the major players in the process of supporting the development of inland waterway transport in their hinterland distribution network. At the same

time, the effectiveness of the actions undertaken by seaport authorities are conditioned through cooperation with other stakeholders, in particular, with the public institutions responsible for maintaining the inland waterway infrastructure.

The proposed concept of the promotion policy can also be a measure of an extension of the research undertaken by Di Vaio et al. [72], which focused on managerial Key Performance Indicators (KPIs) for environmental sustainability and energy efficiency in the port industry, but only regarded air pollution and waste management processes. The concept can also be the basis for further research, particularly with the use of multicriteria decision making (MCDM) methods that are capable of accounting for both quantitative and qualitative issues and multistakeholder involvements [22,96,97]. In particular, the identified measures may constitute decision variables in the model of the share of inland shipping in hinterland transport. The implementation of the model may then contribute to the improvement of the environmental performance of sea–land transport chains.

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