A Review of Port Initiatives to Promote Freight Modal Shifts in Europe: Evidence from Port Governance Systems

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Abstract: This study analyses how port governance systems in Europe have influenced the implementation of port initiatives focused on promoting modal shifts in freight transportation. Through a comprehensive review of port strategies, this research identified 49 individual modal shift initiatives among 21 port authorities in Europe. The results show that ports located in the Northern regions and managed by local governments, particularly in Belgium and the Netherlands, are leaders in executing strategies for modal shifts in freight transportation. Technological solutions and promoting intermodal transportation were found to be the most popular initiatives used to promote hinterland movements of freight by rail and waterborne transportation.

Keywords: green ports; modal shift; port governance; sustainable transport

1. Introduction

As a response to, and facilitator of, increasing international trade during the past few decades, shipping networks and port infrastructure have emerged as an essential element in global logistics chains and as important contributors to the economic and social development of their nearby regions [1]. Port hinterland connections have facilitated the distribution of freight to the end consumer while simultaneously becoming a decisive factor in port competition [2–11].

Despite these positive aspects, port activities and actions have raised environmental concerns in their local areas [12]. From a maritime perspective, emissions from vessels have caused adverse effects on human health and climate change, particularly when located within ports where the local populations are at most risk [12–17]. At the same time, from the hinterland perspective, increasing road freight tonnage servicing ports has led to a considerable increase in negative externalities, such as road congestion, air emissions, noise pollution and accidents [18–20].

To address this reality, many public agencies and private actors have developed policies and initiatives to both abate and/or mitigate the negative effects of maritime air emissions [21] while at the same time promoting a modal shift towards water-based modes of freight transportation. In this regard, several studies indicate that shifting freight from roads to less environmentally damaging modes of transportation, such as rail and the use of waterborne transport, resulting in a net positive environmental impact on cargo distribution. (Note that waterborne transport comprises both shipping and inland waterway transport) [11,18,19,22–30]. The basis for this rests fundamentally with the significantly greater fuel efficiency of both rail and water modes (particularly the latter) compared to road freight. Given the close correlation between fuel use and emissions, in theory, this underlyng assumption should become manifest in terms of a modal comparison of the ratio of environmental damage to the volume of cargo carried, i.e., environmental damage per unit of freight transported. While this is certainly the case when considering the emission...
of carbon and other greenhouse gases [31] (p. 64), it is somewhat counter-intuitive that, at least in the case of shipping, it is not yet strictly valid for the emission of pollutants.

Although knowledge exists on adverse environmental effects and there are efforts towards implementing policies promoting modal shifts, road freight transport remains the dominant mode of transportation in most regions of the world, including Europe. This dominance of road freight is explained by competitive factors, such as transit distance, door-to-door transit times, flexibility in shipment, frequency of deliveries and scheduling, as well as the already large share of road freight in the transportation market [24,32]. The competitiveness of rail and water modes in terms of these sorts of factors is critical in influencing a modal switch away from roads. While the relative unit price of transportation is clearly an advantage for rail and, especially, water modes, it is important that their role within the wider logistics system serves to ensure greater certainty in delivery times and replenishment cycles. At the same time, investment in technology can be aimed, for example, at reducing loss and damage to cargoes, even in terms of their perishability. Ultimately, however, the inherent environmental advantages of rail and water modes may prompt freight mode decision-makers to eschew the road mode to achieve greater sustainability in their supply chain that can be marketed as such and, thus, secure “green” marketing advantages.

In fact, Europe represents a fascinating case study. On one hand, as a highly developed and populated region, the European Commission has focused on forging a single economic marketplace along with territorial cohesion and a common transport policy. On the other hand, although the role of port authorities is crucial for the region’s unity, a common European port policy on market regulation does not yet exist. The European Commission’s attempt to achieve uniformity in the governance and regulation of intra- and inter-port competition by enacting the Port Services Directive in the mid-2000s resulted in failure. A majority of the European Parliament twice rejecting its adoption [33]. The proposal embodied controversial provisions relating to greater transparency in the setting of port dues, market access to port services, the granting of concessions to the providers of port services and the right of a ship’s crew to handle cargo, all of which were unacceptable to most EU member states [34].

A new EU Regulation 2017/352 entered into force in March 2019, “establishing a framework for the provision of port services and common rules on the financial transparency of ports” [35]. This EU port policy focuses on the minimum qualifications required of potential port service providers, the minimum safety and environmental standards required in port operations, how state aid regulations apply to port investments, common rules on transparency and greater accountability, the role of ports within the trans-European network, the simplification of port procedures and various aspects relating to employee relations, including training needs. This regulation is widely acknowledged as a considerably watered-down version of its historical antecedents [34,36], which presumably explains its political acceptability. As such, the status quo of heterogeneity in approaches to port policy across the EU member states has continued, even beyond the recent introduction of this new EU regulation. Consequently, each port authority has individual governance structures and individual programs (usually beyond the minimum requirements) to combat environmental problems associated with freight transportation to and from their port.

Given the predominant role of Europe’s ports in promoting strategies related to the environmental performance of hinterland activities [37], this research aims to outline how distinct port governance systems influence the enforcement of port programs deployed to promote freight modal shifts in its hinterland. In particular, the main purpose of this study is to analyze the relationship between port governance and initiatives implemented by single ports. Additionally, the study considers port initiatives conducted in collaboration with external actors, such as regional institutions and national governments, as well as those taken based on private sector initiatives and/or unilaterally.

Against a context where there is a dearth of literature on the hinterland dimension of green port strategies to promote the modal shift of transportation [37–39], the relevance
of this study relies on finding a relationship between port governance systems and port initiatives for promoting modal shifts within Europe.

The remainder of the paper is organized as follows: Section 2 provides a review of different initiatives for enhancing environmental performance in Europe by promoting modal shifts, as well as a description of the port governance system in the region. Section 3 reports an empirical analysis of the modal shift initiatives implemented by European ports. Section 4 describes the main results of this study. Finally, the last section outlines the main conclusions to be drawn from the analysis.

2. Port Initiatives for Modal Shift in Europe

This section lays the foundation for understanding the influence of port governance structures on implementing strategies to prompt modal shifts in freight transport within Europe. First, this section presents an exploratory analysis of management actors that have initiated studies, incentives and actions promoting such modal shifts. To classify them, this analysis not only reviews strategies applied by regional institutions but also initiatives established by local governments, private organizations and port authorities. Second, this research outlines how different port management systems in Europe influence decisions on implementing port-related environmental programs to enhance inland traffic distribution by modal shifts. For this reason, this section describes the main features of the port governance strategies in Europe.

2.1. Green Transport and Port Strategies in Europe

Europe has a complex group of governmental agencies and stakeholders to promote port-related environmental strategies to reduce air pollution related to hinterland traffic. Specifically, several organizations have focused on programs to shift cargo from road to both rail and waterborne transport. This research considers particular port strategies and port initiatives resulting from collaboration with public and private institutions. In summary, Figure 1 illustrates different levels of management actors involved in promoting a modal shift in freight transportation.

![Figure 1. Management actors involved in freight modal shift initiatives (source: own elaboration).](image)

From a regional perspective, several directives from the European Commission have instigated green freight actions in ports. Herein, the EU White Paper on Transport aimed to cut carbon emissions from transport through different strategies. For modal shifts, their goal is to shift 30 percent of road freight to rail or waterborne transport by 2030 and more
than 50 percent by 2050 [40]. Furthermore, the European Commission has initiated specific strategies on common transport policy to promote freight modal shifts. In this regard, initiatives such as the Trans-European Transport Network (TEN-T) have been instigated to facilitate the design of an efficient transport network throughout the EU, as well as to develop the motorways of the sea (MoS) concept to strengthen short sea transportation as an alternative to using the road transport system.

Besides the European Commission’s directives, the European Sea Ports Organisation (ESPO) has promoted environmental guidelines and plans in European ports. To encourage cooperation between seaports in the region, in 1997, this institution founded the EcoPorts Foundation to identify the environmental attributes of port activities [41] and to develop a collaborative environmental benchmarking tool for members. This network now comprises 102 ports in 25 countries across Europe. In parallel, ESPO also developed the Port Performance Indicators: Selection and Measurement (PPRISM), as a project co-funded by the European Commission, to identify port performance indicators and evaluate the impact of the European Port System on economic, social and environmental development [42].

Furthermore, since 2017, ESPO takes part in the World Port Sustainability Program, established by the International Association of Ports and Harbors (IAPH) to enhance debate and share experiences and to coordinate port cooperation on implementing sustainable port strategies [43].

Finally, through its European Regional Development Fund, the EU has co-financed several regional development programs. An interesting example is the North Sea Region Program [44], which has facilitated cooperation to develop projects on innovation, green energy, sustainability management and sustainable transport among countries in the North Sea region. For instance, from 2010 to 2013, the Interreg Program developed the “Foodport” strategy to improve the transport logistics system for food supply chains within the region [45]. The project involved developing green transport corridors for food products between regions around the North Sea. This led to modal shift pilots along the identified green transport corridors and developing (new) food platforms or hubs.

From a national perspective, some governments have initiated projects and strategies to promote sustainable port development with a focus on freight modal shifts. For example, initiatives like the Méditerranée Rhône-Saône (MeRS) project, established by French national institutions, the Port Authority of Marseille-Fos and technical corporations, has conducted an innovative technology system using Blockchain to register and control the movement of freight through multimodal transport from the Port of Marseille-Fos to the region [46]. In particular, this current study aims to analyze single initiatives implemented by port authorities that focus on shifting freight from road to other modes. For this reason, this research has not considered general programs, such as the EcoBonus System introduced in some countries, such as Sweden, Italy, the United Kingdom and Norway.

Similarly, the Port of Gothenburg, in Sweden, has expanded a double-track rail line on the back of state aid granted in 2020 to fund the infrastructure. As a result, the Gothenburg Port Line commits to increasing port capacity and simplifying the transfer of cargo from road to rail [47]. In practice, as well as facilitating a modal shift from road to rail, by reducing the comparative costs of rail against other modes, this investment will also inevitably prompt some modal shifts from sea to rail [48–51].

Finally, from a local perspective, individual stakeholders, such as private and port authorities have implemented initiatives to promote a more sustainable modal split by promoting modal shifts in freight transportation. Specifically, the analysis considers cross-sector (private firms and port authorities) collaborative initiatives to promote traffic distribution by modal shifts. In particular, private firms can comprise not only shippers and consignees but also logistics service providers. An interesting example of a private firm action is the “Green Barge” developed in Amsterdam by Flora Holland in 2010. This initiative has brought about a switch in the transport of ornamental plants from road to inland waterway through establishing a synchronomodal system between different actors [52].
In addition, the Port of Barcelona, together with the SEAT automotive factory, has promoted a railway line to not only transport automotive components but also new cars between the port facilities and the factory plant [53].

In the case of port authorities, some of them have introduced environmental programs to internalize negative externalities associated with their activities [54]. Hence, some port authorities have joint efforts to execute green policies. To illustrate, since 1991, through its 46 representatives, the Baltic Ports Organization has aimed to support port collaboration and the sustainable development of maritime transport in the Baltic region. In the case of environmental actions, eight members established the Environmental Working Group to pursue appropriate and efficient compliance with regulatory requirements on environmental measures in their ports, for example, with SOx, NOx and waste management requirements [55].

Individual ports have also instigated specific strategies to strengthen using less polluting modes of transportation, such as rail and waterborne transport. An interesting case implemented by the Port of Rotterdam aims to ensure that modal shifts remain an attractive modal choice for carriers. Thus, since 2015, the Port Authority has included modal split obligations in concession contracts with container terminals [39,56].

Furthermore, the Port of Antwerp has conducted several technology applications. On one hand, the Antwerp Intermodal Solution permits better synchronization between port stakeholders, with the intention of strengthening connectivity with the hinterland. On the other hand, the Antwerp Connectivity Platform aims to interconnect port customer demand and optimal intermodal solutions.

2.2. Port Governance in Europe

To understand how port governance systems in Europe can influence promoting port strategies on freight modal shift, it is important to understand the different port governance structures, which exist among European port authorities.

Although the European Commission has centered its efforts on developing a single economic marketplace, the process of introducing a common European port policy and integrating port agents’ coordination is far from being achieved [57,58]. In parallel with this situation, since the 1980s, port authorities have experienced increased privatization of their operations [59–61]. As a result, international private firms have started to operate several ports through concession contracts [57,62–65].

Hence, Europe’s port authorities comprise various governance systems, which may be a key factor influencing the demand for hinterland transport to and from a port [66]. Thus, this study aims to determine how port governance models in Europe can influence promoting port hinterland transport strategies.

Considering the classification developed by [66], Europe’s port governance system can be classified into three main categories. The first category would be a market approach, based on a private management organization, with its own individual financial resources and its prices regulated solely by free-market forces. This specific governance system is predominant in the United Kingdom. Second, a hybrid port system covers all port authorities managed by regional or local governments. In this regard, local governance establishes port price regulation and contributes to the financing of port infrastructure. This port governance system is common in Northern Europe. Finally, the third category is the bureaucratic port system, including individual port authorities managed by the central government with strict regulation and less price flexibility. This system is predominant in Southern Europe, although there does exist some variation within this model. In France [67], Spain [68] and Italy [69], for example, significant control over the coordination of ports (including the approval of changes to port pricing) is retained at the level of a national government, together with the ability both to determine how national port governance is structured and to define the role of a port authority, typically disallowing any engagement in commercial activities. In contrast, Greece and Portugal have instituted greater liberalization in recent years, with private sector involvement and using concessions now being more generally
applied [70,71]. A recent, comprehensive review of port governance worldwide is provided in [70]. Figure 2 summarizes the classification of port management systems across Europe, developed by [66].

Figure 2. Classification of port governance systems in Europe (source: own elaboration based on [66]).

3. Analysis

This section presents an empirical analysis to identify individual port authority strategies implemented within Europe, which aim to promote the modal shift from road to rail and waterborne transport.

Based on a comprehensive list of port authorities located in Europe, the study compiled all of these port initiatives through a snowball sampling technique. Considering the database developed by [37], this study conducted an original investigation of modal shift initiatives implemented by European ports. Specifically, the research has reviewed information from various sources, such as official publications of the European Commission and both international and regional institutions, governmental websites, policy papers, reports from port authorities, the communications of private firms, and academic studies.

As a result, this study has identified 49 initiatives among 21 port authorities focused on promoting a modal shift in transportation. In particular, this research considers ports with diversified traffic (e.g., container, bulk, ro-ro freight and vehicles) and located in the Core Network Corridors of the Trans-European Transport Network [40]. Note that this study focuses primarily on initiatives implemented within the European Union. Figure 3 shows the location of the European port authorities considered within the analysis (see Appendix A for a list of all port authorities contained in the database, with data about port policy strategies and governance characteristics).

As can be seen, port authorities located in the Northern regions, mainly Belgium and the Netherlands, are the leaders in implementing initiatives focusing on modal shift. A case study conducted by [6] analyzed efforts to achieve a modal shift in transport flows within Belgium and the Netherlands.
To analyze different patterns of port initiatives within the European region, a detailed database was designed (and populated), identifying a list of specific characteristics of port authorities. First, to identify potential collaborations between ports, the organization responsible for promoting each initiative was included. Second, the type of transport mode that the initiative aims to promote is identified, i.e., rail, waterborne transport or both simultaneously. Finally, to classify the types of initiatives, which have been implemented, a particular framework based on six primary targets (or goals) of each initiative is utilized, as well as a set of 24 approaches to implementation. This framework was designed based on a study published in Swedish by the Swedish Environmental Protection Agency [71] (p. 12). Table 1 describes the main factors or classifications within this framework.

Table 1. Main factors of the framework.

| Target Categories (Goal) | Implementation (Application System) |
|-------------------------|-------------------------------------|
| Administrative          | Legislation; norms; limit; agreement; inspection; technical requirement; environmental classification; supervision |
| Economic                | Fee; grant; discount; tax; tax deduction; subsidies; trade with emissions; reimbursement; certificate/ allowances |
| Informative             | Coordination program; technology |
| Research                | Development of research; technique evaluation testing |
| Construction Promotion of transport | Railway; inland waterway; intermodal |

Source: authors’ modification of a categorization system originally presented in English in a report by [72] (p. 31).

4. Results

This study developed a qualitative analysis using descriptive statistics to explore how all different aspects and categorizations have affected the implementation of port initiatives. First, we considered measures implemented by particular port authorities. As a result, initiatives have been promoted not only by individual port authorities but also by collaborating with public and private entities. Hence, we distinguish between the main entity responsible for supporting port authority strategies among the 21 ports in the sample. Table 2 summarizes the variety of organizations responsible for promoting each initiative.
Table 2. Organizations responsible for promoting initiatives.

| Organization Responsible                                      | Percentage of the Total (%) |
|--------------------------------------------------------------|----------------------------|
| Port authority (own initiative)                              | 43                         |
| Collaboration with private firms                             | 23                         |
| Collaboration with regional institution (EU)                 | 20                         |
| Collaboration with national governments                      | 12                         |
| Collaboration with national governments and private firms    | 2                          |

Source: own elaboration.

Thus, port authorities have conducted 43 percent of their own initiatives to enhance modal shift against 57 percent of strategies executed in collaboration with several institutions. In this regard, port collaborations with private firms represent 23 percent of the total number of programs. Similarly, port initiatives supported by regional institutions (i.e., European Commission Programs) represent 20 percent of the total. Finally, only 12 percent of port participation is handled by national governments. At the same time, cooperation within public–private partnerships only represents 2 percent of the total.

Second, in the case of promoting modal shift specifically, 51 percent of all measures have focused on enhancing using modal shift through railway transportation. In comparison, 27 percent of all port initiatives aim to promote a shift of cargo from road to waterborne transportation. Finally, 22 percent of the total strategies have emphasized using both modes of transportation, i.e., rail and waterborne transport, simultaneously. Figure 4 shows the main results of modal shift promotion among initiatives in the analysis.

Figure 4. Modal shift promotion among initiatives (source: own elaboration).

In Sweden specifically, the Mälar shuttle (Mälarpendlan) ([73]) is a recently developed example of an initiative undertaken as a collaboration between the port sector and a private shipping company to achieve a modal shift from road to waterborne transport. In this case, the ports in Lake Mälaren (Mälarhamnar), the Ports of Stockholm (Stockholms Hamnar), Hutchison Ports Stockholm, and the shipping company Wallenius Marine are collaborating to move cargo from land-based modes to inland waterways to serve the East coast ports of Norvik, Västerås, Köping and Stockholm Frihamnen. In line with Sweden’s “National Freight Transport Strategy”, which aims to achieve “efficient, high-capacity and sustainable freight transport” [74], the Mälar shuttle is assumed to relieve the land infrastructure and
to contribute to sustainable development in the Greater Stockholm area by relieving the roads from trailer traffic.

In terms of “collaboration with national governments”, another example from Sweden is the commitment made by the Port of Gothenburg to developing and promoting short sea shipping services to and from the port as a condition for receiving a 1.25 billion SEK investment from the Swedish state to fund 50% of the costs of deepening the fairway at the port. The state investment forms part of Sweden’s National Infrastructure Plan 2018–2029. It is predicted to yield a socioeconomic benefit of 5 billion SEK [75].

In final consideration of all 49 port initiatives implemented among 21 ports in Europe, this study applies a particular framework used to classify each initiative. Specifically, all strategies were classified considering the primary target of each measure (administrative, economic, informative, research, construction, and promotion) as well as a set of application systems used to implement each target. Table 3 shows the results of this classification among the initiatives analyzed in this study.

Table 3. Organizations responsible for promoting initiatives.

| Target Category          | Implementation System          | Results |
|--------------------------|--------------------------------|---------|
| Administrative           | Limit                          | 1       |
| Economic                 | Discount                       | 1       |
| Informative              | Coordination program           | 1       |
|                          | Technology                     | 16      |
| Research                 | Development of research        | 3       |
| Construction             | Railway                        | 11      |
|                          | Intermodal terminal            | 2       |
| Promotion of transport   | Railway                        | 1       |
|                          | Waterborne transport           | 4       |
|                          | Intermodal                     | 9       |
| Total of initiatives     |                                | 49      |

Source: own elaboration.

The table shows that the most popular practices among ports for achieving a modal shift in transportation have been the promulgation of technological systems, construction of railway infrastructure and promoting intermodal transport. In the case of technology, the implemented initiatives tend to revolve around: the provision of integrated solution platforms (i.e., “one-stop shops” across modes and different operators) for the timetabling and booking of carrier capacity and slots for freight shipments; the allocation of space for freight in container yards and at berth (i.e., yard and berth planning algorithms and solutions) and; general traffic planning routines for optimizing routing options and using infrastructure within a dynamic context. All of these strands of technological innovation facilitate system synchronomodality [76–78]. The users of port services can dynamically optimize their modal and route choices on a real-time basis, albeit within the legal and operational constraints established within longer-term contracts.

More generally speaking, through the implementation of innovative systems, ports have applied digital platforms to simplify information sharing and improve collaboration within the port community. For example, through its Intermodal Planner System, the Port of Amsterdam provides real-time information on intermodal connections and possibilities to their port customers [79]. In the construction of railway infrastructures, several ports have invested in rail infrastructure to increase port capacity and to promote the transfer of cargo from road to rail. To illustrate, the Port of Barcelona has adapted the port rail facilities to the standard rail gauge in Europe [80]. Regarding promoting intermodal transport, port policy programs have designed combined transport strategies to support cargo transshipment
from road to rail and waterborne transport. For instance, in collaboration with the Port of Nuremberg, the Port of Rotterdam has initiated the Bavaria–Rotterdam connection to integrate rail with inland waterborne transport services, based on a regular, scheduled frequency [81].

In contrast, limits on administrative initiatives and economic discount strategies are the least common measures. Regarding limits, implementing modal split obligations in concession contracts at the Port of Rotterdam is a unique case worldwide. Similarly, the Port Authority of Rotterdam has implemented a strategy to enhance using inland waterborne transport by giving discounts on port fees for using green inland barges.

The implementation of such port strategies is typically motivated by an attempt to better control and coordinate flows into and out of the port in question to facilitate using existing capacity that is already highly utilized and/or for competitive reasons; either to ensure the capture of cargo at source within its hinterland or to establish greater customer loyalty through the higher quality modal provision and vertically integrated logistics.

The last step of the analysis is to examine the results further by looking into how port initiatives are distributed according to the number of implementations and initiatives. Figure 5 cross-references the number of measures introduced by port authorities and the diversity of applications systems used.

![Figure 5. Ports grouped by initiatives and application systems (source: own elaboration).](image)

As a result, three group structures emerge. First is the group of 15 port authorities (in blue) that implement between one to three initiatives by using just one application system. Specifically, these ports authorities are: Barcelona, Dunkirk, Gdansk, Genoa, Gent, Gothenburg Helsinki, Paris, Ravenna, Sines, Southampton, Trelleborg, Wilhelmshaven, Zeebrugge and Stockholm. Following this, a second group of five ports (in green) emerges, with different levels of implementation methods and numbers of measures. In particular, these port authorities are Amsterdam, Antwerp, Felixstowe, Hamburg and Marseille. Finally, the top right corner (in red) indicates that the Port of Rotterdam has a broad range of implementation methods and a high number of individual measures, indicating its emphasis on applying programs to promote a modal shift in transportation. Certainly, the Port of Rotterdam, with 15 different initiatives, has emerged as the clear green port leader in Europe. These results are in line with the study of [37]. Through a worldwide review, the authors suggest that the Port of Rotterdam, Los Angeles, and Long Beach were the most advanced ports in implemented green hinterland strategies.
5. Discussion

This study reveals that port authorities located in northern European countries tend to be more proactive in implementing initiatives to promote modal shifts in freight transportation. This tendency may be related to the fact that such ports are located in countries with a high share of rail. In Sweden, for instance, 31 percent of freight transport is shipped by rail [82]. Actually, ports with an extended availability of rail facilities within port terminals are mainly located in the north of Europe. According to [66], port rail facilities with trains of more than 700 meters in length are: Rotterdam (Netherlands), Antwerp (Belgium), Hamburg (Germany), Bremen (Germany), Zeebrugge (Belgium), Le Havre (France), Genoa (Italy), Duisburg (Germany), Marseilles (France), Strasbourg (France), Gavle (Sweden), Bristol (UK) and Amsterdam (Netherlands). In this regard, the results indicate that investment in rail infrastructure is one of the most common port initiatives to promote freight modal shift.

In parallel, natural infrastructure, such as inland waterways, facilitates implementing modal shift programs. In fact, 43 percent of freight transport in the Netherlands is already transported by inland waterways [82]. Thus, it is not surprising that the Port of Rotterdam, as the largest port in Europe, emerges as the study’s clear leader of green ports.

The results also indicate that port size and port terminal connectivity can affect implementing initiatives to promote a modal shift in freight transportation. They also suggest that technological solutions, construction of railway infrastructure and promoting intermodal transport are the most popular initiatives used to expand freight movement by rail and waterborne transportation.

Actually, implementing technological solutions may be related to the fact that port authorities tend to be more proactive in collaborating with private firms.

Some other implications of the results are related to the role of port authorities in implementing environmental initiatives. Although the adverse environmental effects of port activities have raised efforts to implement green policies to reduce freight transport emissions on both the seaside and landside, the approach to achieving this has been very different. From a seaside perspective, the study of [21] suggests that economic incentives, through discounts on port fees, are the most popular initiative to reduce maritime air emissions. In contrast, in the hinterland perspective, port programs for enhanced technological solutions are the most common measures to promote freight modal shift. This result is in line with the worldwide review of [37], which suggests that technological programs and infrastructure investments are the leading measures to achieve sustainable hinterland transport.

6. Conclusions

This study examines how port governance systems in Europe have influenced implementing initiatives to promote modal shifts in freight transportation. Through a comprehensive review of port strategies, 49 individual modal shift initiatives among 21 ports in Europe were identified. In particular, we found evidence that ports located in the Northern regions, particularly in Belgium and the Netherlands, are leaders in executing freight modal shift strategies.

Overall, it can be inferred from the results of this study that port authorities with hybrid systems (i.e., managed by regional or municipal governments) tend to be more proactive in implementing initiatives for promoting modal shifts in freight transport. Indeed, ports may benefit from having flexible regulation on port pricing systems.

Although the research focuses on port initiatives for promoting modal shifts in the European Union, the analysis could be extended to non-European regions to gauge the possibility of improving modal shifts in freight transportation beyond EU borders.

Further research could usefully examine the influence of factors, such as port location and facilities, price-setting structures or port decision-makers on implementing initiatives for prompting freight modal shift. Studies in the future should similarly consider the influence of unprecedented political decision-making processes (such as Brexit) on developing
transport programs in Europe. Evaluating the effects of initiatives for realizing modal shift and the subsequent environmental and other impacts also provides a fertile arena for further research.

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### Appendix A

#### Table A1. Port Authorities List.

| Port Authority (Country) | Port Governance System * | Name of the Initiative | Organization Responsible for the Initiative | Promotion | Target (Goal) | Implementation (Application System) |
|--------------------------|--------------------------|------------------------|---------------------------------------------|-----------|---------------|--------------------------------------|
| Amsterdam (Netherlands)  | Hybrid                   | Amsterdam Barge Shuttle | Port authority (own initiative)              | Waterborne transport | Promotion | Inland waterways                        |
|                          |                          | Intermodal Planner      | Port authority (own initiative)              | Both (railway and waterborne) | Informative | Technology                        |
|                          |                          | Optimizing Rail Connection | Collaboration with regional institution (EU) | Railway | Construction | Railway                        |
|                          |                          | Green Barge—FloraHolland | Collaboration with private firm (FloraHolland) | Waterborne transport | Informative | Coordination program                |
| Antwerp (Belgium)        | Hybrid                   | Development of rail network | Port authority (own initiative)              | Railway | Construction | Railway                        |
|                          |                          | Antwerp Intermodal Solution | Port authority (own initiative)              | Both (railway and waterborne) | Informative | Technology                        |
|                          |                          | Antwerp Connectivity Platform | Port authority (own initiative)              | Both (railway and waterborne) | Informative | Technology                        |
|                          |                          | Central Booking Platform | Collaboration with national government       | Both (railway and waterborne) | Informative | Technology                        |
| Barcelona (Spain)        | Bureaucracy              | Autometro               | Collaboration with private firm (Seat)       | Railway | Promotion | Railway                        |
|                          |                          | Cargometro              | Collaboration with private firm (Seat)       | Railway | Promotion | Railway                        |
|                          |                          | Rail Connection (UIC)   | Collaboration with regional institution (EU) | Railway | Construction | Railway                        |
| Dunkirk (France)         | Bureaucracy              | Designa multimodal transport system | Collaboration with regional institution (EU) | Both (railway and waterborne) | Research | Development research              |
| Felixstowe (UK)          | Market                   | TESCO rail link         | Collaboration with private firm (TESCO)      | Railway | Promotion | Railway                        |
|                          |                          | Felixstowe Rail Terminal | Collaboration with regional institution (EU) | Railway | Construction | Intermodal                      |
|                          |                          | “Paris” Transport Management Solutions | Port authority (own initiative)              | Both (railway and waterborne) | Informative | Technology                        |
| Port Authority (Country) | Port Governance System | Name of the Initiative | Organization Responsible for the Initiative | Promotion | Target (Goal) | Implementation (Application System) |
|-------------------------|------------------------|------------------------|---------------------------------------------|-----------|---------------|-------------------------------------|
| Gdansk (Poland)         | Bureaucracy            | Extension of the road and railway network | Collaboration with regional institution (EU) | Railway   | Promotion     | Intermodal                          |
| Genoa (Italy)           | Bureaucracy            | Genoa Past Corridor (Tiger Demo) | Collaboration with regional institution (EU) | Railway   | Promotion     | Intermodal                          |
| Ghent (Belgium)         | Hybrid                 | Extension of the Mercatordock (Multimodal Terminal) | Collaboration with regional institution (EU) | Both (railway and waterborne) | Promotion  | Intermodal                          |
| Gothenburg (Sweden)     | Hybrid                 | The Gothenburg Port Line (Hamnbanan) | Collaboration with national government | Railway   | Construction   | Railway                            |
|                         |                        | Arken-Core Rail Road Terminal (Nordic Maritime Link) | Collaboration with regional institution (EU) | Railway   | Construction   | Railway                            |
| Hamburg (Germany)       | Hybrid                 | TransPORT rail | Port authority (own initiative) | Railway   | Informative    | Technology                         |
|                         |                        | Intelligent Transport System (ITS) for inland waterway shipping | Port authority (own initiative) | Waterborne transport | Informative | Technology                         |
|                         |                        | Taking Action/Creating Values | Collaboration with national government | Both (railway and waterborne) | Research | Development research               |
| Helsinki (Finland)      | Hybrid                 | Vuosaari Terminal link | Collaboration with national government | Railway   | Construction   | Intermodal                          |
| Marseille (France)      | Bureaucracy            | Improvement of multimodal logistics platforms at the port of Marseille | Collaboration with regional institution (EU) | Railway   | Promotion     | Intermodal                          |
|                         |                        | Port of Marseille—The MeRS project | Collaboration with national government | Railway   | Informative    | Technology                         |
| Paris (France)          | Bureaucracy            | Franprix entre en Seine | Collaboration with private firm (Casino Group) | Waterborne transport | Promotion | Intermodal                          |
| Ravenna (Italy)         | Bureaucracy            | Idrovia Ferrarese | Collaboration with national government | Waterborne transport | Promotion | Inland waterways                   |
| Port Authority (Country) | Port Governance System * | Name of the Initiative | Organization Responsible for the Initiative | Promotion | Target (Goal) | Implementation (Application System) |
|------------------------|--------------------------|------------------------|---------------------------------------------|-----------|--------------|-----------------------------------|
| Rotterdam (Netherlands) | Hybrid                   | Modal Split Obligation | Port authority (own initiative)             | Both (railway and waterborne) | Administrative | Limit |
|                        |                          | HIRO Research Project  | Collaboration with private firm (Contargo) | Railway   | Research     | development research               |
|                        |                          | BAYROLO (Bavaria-Rotterdam connection) | Port authority (own initiative) | Railway | Promotion | Intermodal |
|                        |                          | Nexlogic (Hintland Container Notification Barge) | Port authority (own initiative) | Waterborne transport | Informative | Technology |
|                        |                          | River Guide (berths planning) | Port authority (own initiative) | Waterborne transport | Informative | Technology |
|                        |                          | OnTrack | Port authority (own initiative) | Railway | Informative | Technology |
|                        |                          | Scope | Port authority (own initiative) | Waterborne transport | Informative | Technology |
|                        |                          | Navigate Rotterdam | Port authority (own initiative) | Both (railway and waterborne) | Informative | Technology |
|                        |                          | The Barge Performance Monitor | Port authority (own initiative) | Waterborne transport | Informative | Technology |
|                        |                          | Container transferium (The Container Exchange Route) | Port authority (own initiative) | Waterborne transport | Promotion | Inland waterways |
|                        |                          | PortShuttle Rotterdam service | Port authority (own initiative) | Railway | Promotion | Intermodal |
|                        |                          | Fresh Corridor | Collaboration with private firm | Both (railway and waterborne) | Promotion | Intermodal |
|                        |                          | Betuweroute rail line | Collaboration with private firm | Railway | Construction | Railway |
|                        |                          | Inland Port Dues | Port authority (own initiative) | Waterborne transport | Economic | Discount |
| Sines (Portugal)        | Bureaucracy              | Port Single window (Janela Única Portuária) | Port authority (own initiative) | Railway | Informative | Technology |
Table A1. Cont.

| Port Authority (Country) | Port Governance System * | Name of the Initiative | Organization Responsible for the Initiative | Promotion | Target (Goal) | Implementation (Application System) |
|--------------------------|--------------------------|------------------------|---------------------------------------------|-----------|---------------|--------------------------------------|
| Southampton (UK)          | Market                   | TESCO rail link        | Collaboration with private firm (TESCO)      | Railway   | Construction  | Railway                             |
|                           |                          | Southampton–Midlands rail corridor | Collaboration with national government and private firm | Railway   | Construction  | Railway                             |
| Stockholm ** (Sweden)     | Hybrid                   | Mälar shuttle (Mälarpendeln) | Collaboration with private firms            | Waterborne transport | Promotion | Inland waterways                   |
| Trelleborg (Sweden)       | Hybrid                   | New gate for intermodal units | Collaboration with regional institution (EU) | Railway   | Construction  | Railway                             |
| Wilhelmshaven (Germany)   | Hybrid                   | Intermodal terminal     | Port authority (own initiative)             | Railway   | Promotion     | Intermodal                          |
| Zeebrugge (Belgium)       | Hybrid                   | PortConnect             | Collaboration with private firm (PortConnect) | Waterborne transport | Informative | Technology                          |

Source: own elaboration. * Classification of port governance system based on [66]. ** The initiative affects the ports of Stockholm and ports in Lake Mälaren. To avoid double-counting the same initiative, the study considers the largest port, i.e., Stockholm.
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