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Port Initiated Incentives and Fees for more Sustainable Transport from a Hinterland Perspective

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Abstract: This present framework aims to identify incentives and fees established by ports in order to improve the environmental performance of its connecting transport network, with focus on hinterland logistics. Through an analysis of several case studies around the world, it has been identified and analysed five main incentives from a Swedish perspective with the help of key stakeholders. Thus, this study permits proposed measures based on effect and feasibility for further research. The results from the workshop session suggests that the reduction of air emission measure, the modal shift and intermodal incentive would have higher impact on sustainability. However, not all cases would gain industry acceptance and finally, only the reduction of air emission incentive would be easy to implement and be interesting to analyse in the future.

Keywords: Port fees, incentives, sustainable ports, sustainable transport, hinterland transport, intermodal transport.

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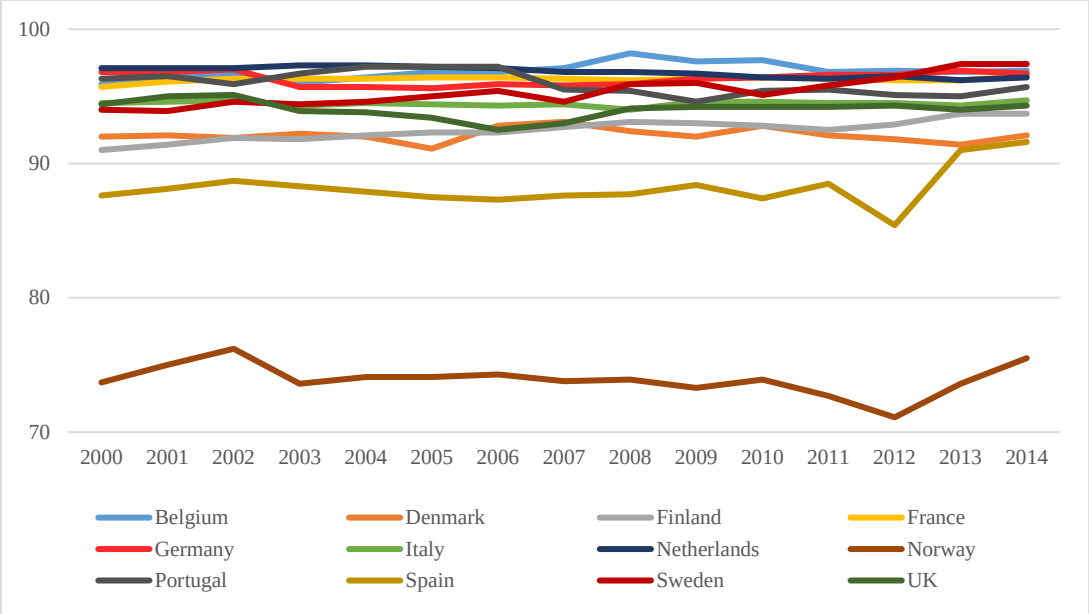
1. Introduction

The recent increase in freight traffic has challenged the movement of goods due to the necessity to extend port facilities to overland use in order to facilitate the traffic distribution through intermodal transport chains. Inbound goods are distributed to the hinterland[1] by different modes of transport, such as land, rail or inland waterways. However, part of the environmental effect of shipping happens in the port zone or in the nearby area (OECD, 2011). In this regard, factors such as the efficiency of the transport distribution, the selection of the mode of transport, the type of vehicles and fuels used, have an effect on the environmental impact of hinterland distribution of cargo. Generally, transportation by rail and inland waterways require less energy per ton and generate less greenhouse gas emissions[2] than road transportation (OECD, 2011). Figure 1 illustrates the share of CO_2 emissions from road in total CO_2 emissions from transport for a number of selected countries in Europe and Figure 2 shows the share of CO_2 emissions from rail in total CO_2 emissions from transport for a number of selected countries in Europe. In the case of roads, the values of the share are between 70 and 90 per cent (Figure 1, continuous line). In contrast, the values of the share of CO_2 emissions from rail are between 0 and 2.3 per cent (Figure 2, dashed line).

[1]The land behind the coast.

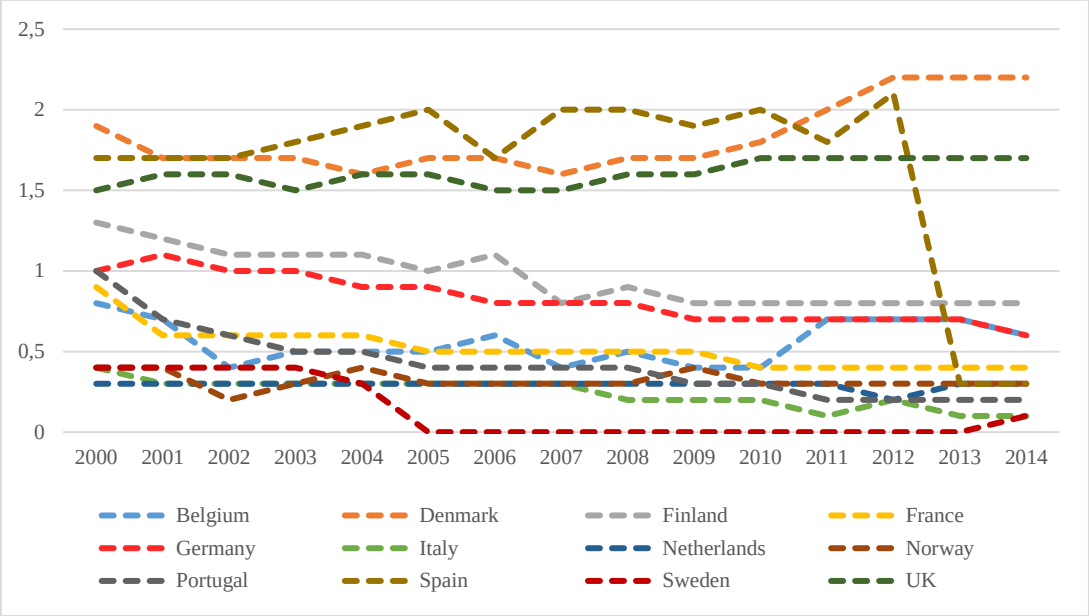
[2]Based on the Eurostat's concepts and definitions database, "The main greenhouse gases include: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), as well as ozone depleting chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs)"

Figure 1. Share of CO_2 emissions from road in total CO_2 emissions from transport



Source: Own elaboration based on the selection of countries from OECD database

Figure 2. Share of CO_2 emissions from rail in total CO_2 emissions from transport



Source: Own elaboration based on the selection of countries from OECD database

The following sub-sections analyzes the importance of intermodal transportation as a way to improve environmental performance. In addition, the aims of this research, as well as its limitation analysis are also described.

1.1. Relevance of intermodal transportation and environmental

In the recent decades, there has been a change in shipping traffic that has generated a new international trade scene[3]. Trade flows are directly related to economic growth. Because of new trunk routes, the location of the industry has become less important due to cheaper, faster and safer transportation of containers (Stopford, 2009).

In the context of vital interface between land and sea, the role of port infrastructure in global logistics chains has become fundamental for firms. In this regard, due to a globalized market, logistics chain decision makers have to consider the attributes of the whole chain rather than its individual parts (UNECE, 2010). In particular, port hinterland connections have to be evaluated by different criteria. Thus, in addition to the existence of physical infrastructure, it is relevant to contemplate infrastructure attributes, such as speed, capacity and quality, as well as measures related to environmental performance (UNECE, 2010).

Thus, port authorities have to focus on the performance of their hinterland connection in order to ensure higher traffic and competitive position (Zhang, 2008; UNECE, 2010; Bergqvist, 2015), where the latter is mainly based on intermodal transport networks (Notteboom and Rodrigue, 2005).

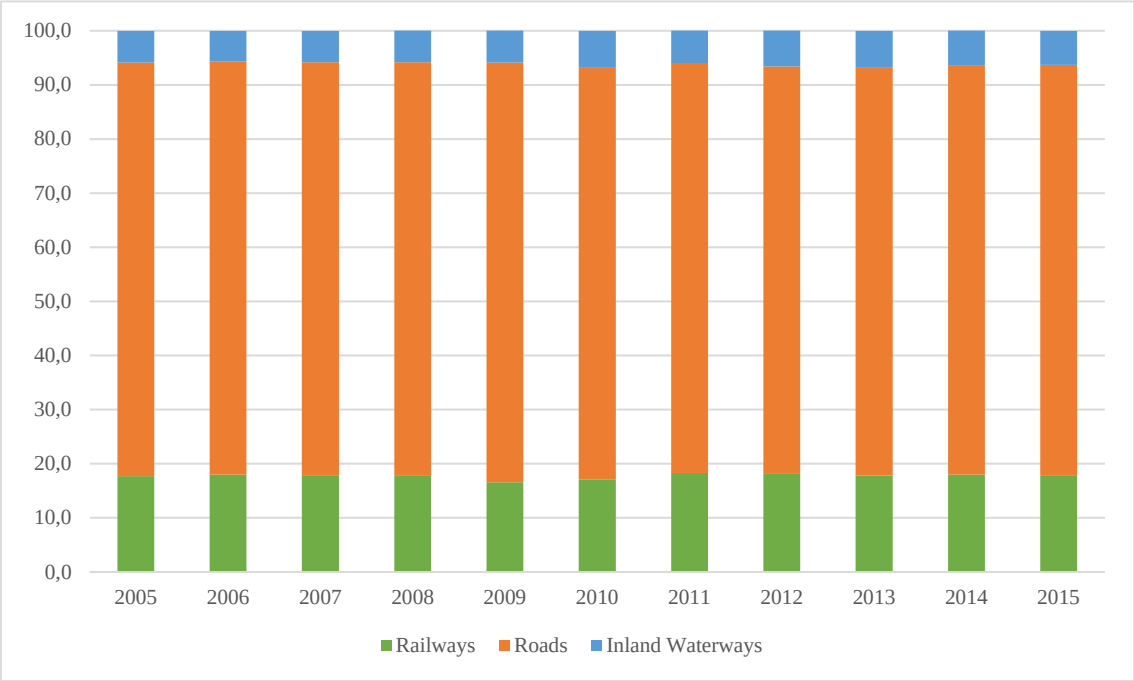
Zhang (2008) explains that, although modal split differs highly between seaports, intermodal transport permits using different modes of transportation more efficiently, reducing transport cost, congestion on the roads, and air emissions. According to Van den Berg (2015), increasing the proportion of intermodal transport can reduce the environmental impact of freight transport by achieving better environmental performance, including lower energy use and reduced air emissions.

Although road transport is still a dominant mode of transport, as a result of the increase in container traffic, the importance of intermodal transport system has increased. To illustrate this, Van den Berg (2015) mentioned that transport sector produces more than one-fourth of the total CO_2 emissions. Several incentives have been applied in order to

[3]According to UNCTAD (2016), the estimated containerized cargo flows in 2015 was 24 Millions of Twenty-foot equivalent units (TEU) in the Transpacific route; 22 Millions of TEU in the Europe-Asia route and finally, 7 millions of TEU in the Transatlantic route.

look for ways to reduce the CO_2 emissions and increase sustainability within freight transport. (Van den Berg, 2015). In this regard, Figure 3 shows the percentage of modal split of freight transport from 2005 to 2015 in EU-28.

Figure 3. Modal split of freight transport EU-28



Source: Own elaboration based on Eurostat database

In the last decades, ports have recognized the environmental externalities of logistics and transportation and have started to develop green policies (Bergqvist and Egels-Zandén, 2012). The study by Gardner, Marlow, and Pettit (2006) shows that ports are aware of the externalities, but choose not to consider them because they are more complying with environmental regulation. In addition, Bergqvist and Egels-Zandén (2012) and Bergqvist et al. (2015) illustrate that several tools like green port dues, port handling fees and road pricing, are available and can be feasible.

Ports are key hubs in international transport chains that have the potential for the internalization of both social and environmental externalities by means of differentiated fees and other incentives. Thus, ports can internalize external costs and promote the composition of sustainable transport solutions through environmental and Corporate Social Responsibility (CSR) strategies. In contrast to analyzing the “green” incentives and port dues related to the seaside, this research has a focus on hinterland logistics.

Furthermore, based on different case studies, this study examines how different port agents evaluate specific situations in the Swedish system.

1.2. Purpose and research question

This present framework aims to identify incentives and fees established by ports in order to improve the environmental performance of their connecting transport network, with focus on hinterland logistics.

There are several reasons to implement a differentiated port incentives and fees system for hinterland. Firstly, it can contribute to distributing traffic in a different way and consequently, solving problems such as time, land congestion, modal shift and environmental concerns. Second, these instruments can improve port efficiency by decreasing land congestion at the port, like queuing times or cargo handling. Third, transport carriers can enjoy higher efficiency and better utilisation of resources as a result of a more effective modal shift distribution for that specific port and its related hinterland. Fourth, depending on what the revenues from the port dues are used for, there can be investments in the infrastructure and equipment that provide a significant increase in transport operation efficiency. Finally, from a social perspective, the overall utilisation of infrastructure enables more efficient use of infrastructure resources and investments. Environmental efficiency improves as the city is able to distribute traffic in a way that minimises the local environmental impact, e.g. pollution, safety, noise, vibrations, etc.

For this purpose, this present study has the following objectives:

- Identifying and analysing real case studies related port initiated incentives and fees for more sustainable transport from a hinterland perspective.

- Be a guide for port agents in order to implement environmental performance instruments.

- Evaluate the feasibility of different port initiated incentives and fees from a Swedish stakeholder perspective.

1.3. Delimitation of research analysis

Although different sources of information have been used and there is no common database with all port authorities around the world, this research covers most of the large-

scale cases worldwide. It should be mentioned that in some case studies there was no data description available.

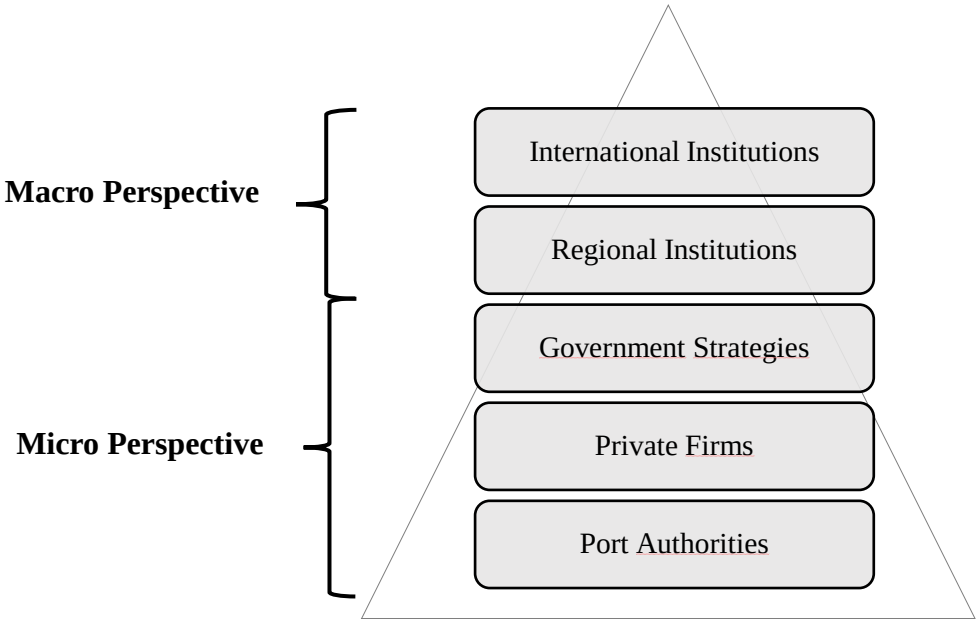
This framework is organised as follows: section 2 outlines the main theoretical features of intermodal transportation and the environmental concerns in the literature; Section 3 provides specific case studies of port authorities used by institutions to improve the environmental performance on hinterland logistics as well as a description of different criteria; Section 4 describes five different cases; Section 5 provides the main results from the workshop of the project group. Finally, the last section is devoted to establishing the main conclusions of this research.

2. Literature review from a general to specific research analysis

In the last decades, there has been an increase in awareness, in the port and maritime community, of the need for action regarding environmental concerns, focusing particularly on the effects of climate change on the port environment and actions for its mitigation (OECD, 2011). As a result, several governments and institutions have initiated studies, strategies and actions to improve the environmental performance.

This section presents a literature review on general and specific management actors and it provides a discussion on incentives and instruments for the improvement of the environmental performance. In order to classify them, two different perspectives are established. On the one hand, a macro perspective considers general incentives applied by public policies (international and regional institutions). On the other hand, a micro perspective considers government strategies, private policies and port authority plans for more environmentally friendly hinterland transport. Figure 4 summarizes all different actors.

Figure 2. Diagram of different actors



Source: Own elaboration

2.1. Macro perspective: general incentives

Several public institutions have implemented different environmental performance strategies. Firstly, various international initiatives provide new steps towards becoming greener. In this regard, one of the main initiatives is the World Port Climate Initiative (WPCI) established by the International Association of Ports and Harbors (IAPH) with the aim to provide a mechanism for assisting the ports to combat climate change. As a result, in 2008 the C40 World Ports Climate Declaration was adopted, which elaborates several initiatives to reduce CO_2 emissions, including those related to hinterland transport.

Secondly, many regional institutions in Europe and America provide new systems to promote environmental initiatives.

In the case of Europe, general initiatives such as the “EU White Paper”, “Clean Cargo Initiative” and the “EU Green Paper” on common transport policy, show clear need for a modal shift (Van den Berg, 2015).

In addition to the port infrastructure, the European Sea Ports Organisation (ESPO) has promoted environmental policies and plans in European ports. As a result, and in order to promote the ESPO Green Guide, in 1999 this institution established the EcoPorts Foundation, a network of European ports, to identify the significant environmental aspects of ports activities, products and services. Similarly, the PPRISM project aims to identify a set of port performance indicators in order to measure the impact of the European Port System on society, the environment and the economy.

More specifically, other projects, such as the NoMePorts project, elaborate performance plans to reduce noise and provide a guide for good practice on noise management for industrial port areas.

Furthermore, some particular platforms, like Green Freight and Logistics website or Green Freight Europe, provide access to information on the freight sector. These programs aim to improve debate and share information among different actors.

Finally, certain regional institutions, like Baltic Port Organization, promote an Environmental Working Group in order to improve the discussion and synergies among specific port authorities of the region.

In the case of America, the American Association of Port Authorities (AAPA), has developed the Environmental Management Handbook (EMH) as a guide for environmental administration of port authorities (OECD, 2011).

2.2. Specific incentives- different actors

This section focuses on incentives and fees established by specific actors such as public agents, e.g. governments, private firms and port authorities, to improve the environmental performance of their connecting transport network with focus on hinterland logistics.

On one hand, there are government projects such as EcoBonus System. For example, there is an idea to introduce a temporary ECO bonus system in Sweden to encourage a shift from transport by road to shipping, in order to reduce greenhouse gas emissions and air pollution from freight transport The government would support new intermodal transport and compensate for additional costs that may be associated with establishing new maritime transport solutions as part of the transport chain. Similar system is implemented in Italy, UK and Norway (Trafikanalys, 2017).

On the other hand, some private firms have applied specific incentives in order to promote more sustainable transport. In this regard, the European research consortium, Best Practice Factory for Freight Transport (Bestfact), collects the greatest freight transport initiatives in Europe. For instance, Tesco has a network link between different UK ports and distribution centers in the United Kingdom.

Finally, some port authorities have established specific environmental programs. For instance, the Port of Rottedam cooperates with other institutions in order to guide green initiatives through the “Rotterdam Climate Initiative”. This initiative aims to reduce air emissions in the Rotterdam area. (OECD, 2011). Likewise, one of the most relevant examples is from the Port of Los Angeles and Long Beach, which on November 2006 adopted The Clean Air Action Plan to reduce air pollution by applying different strategies on ships, trains, trucks, energy, terminal equipment and harbor craft.

This present study will focus on port authorities’ initiatives and specific private firms’ strategies that are present in ports.

3. Evaluation of cases

This section examines the empirical analysis used in this study. To determine the most relevant case studies established by ports to improve the environmental performance of their connecting transport network with focus on hinterland logistics, a selection criteria, based on different categorization, has been considered. In order to collect the data different case studies and databases have been taken into account.

3.1. Categorization

Similarly, as the study of Svensson and Andersson (2011), this framework considers a list of dimensions to analyze all different incentives established by port authorities.

1. Port name
2. Identification program name (if it is available)
3. Objective (Goal):
   Intermediate goal: Intermodal Incentive; Modal Shift.
   Final goal: Reduction of air emission; Reduction of noise; Reduction of land congestion.
4. Application (Design):
   Certification; concession contract; dedicate infrastructure; engine; improve of knowledge; monitoring program; port dues and subsidy funds; regulatory instruments; Specific mode of transportation.
5. Type:
   - Tool: A specific instrument for implementation.
   - Incentive: A proposal that encourages public or private actors to do something
6. Environmental concern:
   - Reduction of air pollution
   - Reduction of noise
   - Reduction of congestion (generally, land congestion)
7. Target the incentive:
   - Air emissions
   - Decibels
   - Planning
8. Units of measure (if it is available)
   Types of emissions: CO_2, GHG, NOx.

Containers

Monetary values

9. Parameters: specific limits
10. Mode of transport involved: Road, Rail, Barge
11. Duration: Start / End / Status
12. Area of action:
    - Port access: port entrance and port zone.
    - Port region: zone adjacent to the port such as city or logistic center.
    - Hinterland: land area located behind a coastal region.
13. Actors:
    - Leader: Institution/s that manage the tool or incentive.
    - Participants: Members that apply the tool or incentive.
14. Incentives:
    - Neutral Impartial process.
    - Addition (fee): process of charge.
15. Brief description and comments:

    Main characteristics, process and results (if it is available).

3.1.1. Goal and design classification

In order to analyze and homogenize all different case studies, it has been conducted a criteria based on the objective (goal) of the incentive and the application (design), i.e. how the incentive had been implemented.

All the case studies have been analyzed and homogenized based on the objectives and the application of the incentives.

3.1.1.1. Goals

Five main goals have been considered, split into intermediate goals, such as intermodal incentives and modal shifts, and final proposals, such as reduction of air emissions, noise and land congestion.

- Final goals.

- Air emission: reduction of air pollution.

- Noise: reduction of noise from vessels, trucks and train locomotives.

- Land congestion: reduction of traffic flows in the port zone.

- Intermediate goals:

- Intermodal incentive: Promote the cooperation between two or more transport modes.

- Modal shift. Transfer traffic from a congestion mode (road) to a less congested (rail, inland waterway)

3.1.1.2. Designs

Ten different types of applications have been considered.

- Certification: Granting of authorization or license.

- Concession contract: Modal split obligation for the terminal operators.

- Dedicated infrastructure: construction of specific facilities (e.g. corridors, rail access)

- Engine: source of power or engine swap.

- Improve knowledge: Instruction educational programs for professionals.

- Monitoring program: Inventory and emissions control.

- Port dues and subsidy funds: subsidies charges to promote sustainability.

- Regulatory instrument: Implementation of different specific patterns.

. Specific mode of transportation: Use of a particular transport.

- Technology: Electronic devices and computing platforms.

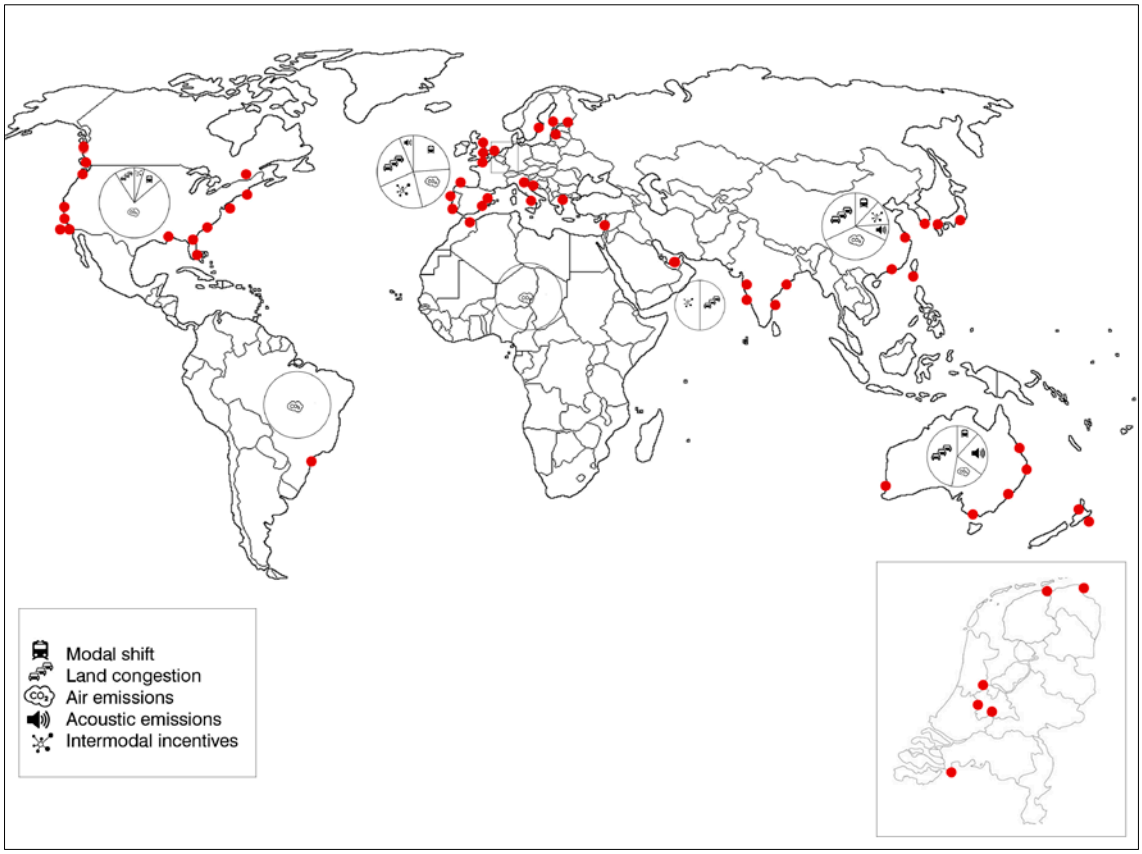
3.2. Data collection

In order to consider as many case studies as possible, several sources (such as BestFact case studies, Green Ports project, IAPH database, OECD report (2011; 2012), World Port top hundred ranking) have been consulted in order to compile a comprehensive list of port authorities with a total of 365 port authorities related to container handling[4]. After checking them, a total of 77 potential case studies, presenting a total of 160 initiatives, have been considered.

The methodology used to collect the greatest amount of case studies, it has been based on the snowball technique. In this regard, it has been started with a matching of IAPH database and World Port Ranking in order to create a common list of port authorities. Following, it has been checked port authorities websites as well as project documents like Bestfact case studies, Green Port projects and private firms' internet sites. Finally, it has been added initiatives from secondary research such as academic studies (De Langen, 2008; Motono et al., 2017; Van den Berg, 2015; Van den Berg and De Langen, 2014) and official reports of public institutions (UNECE, 2010 and OECD 2011; 2012). Table in the Annex 1 summarizes all case studies based on this classification. Figure 5 shows the location of all case studies around the world.

[4] Specifically, it has been considered 44 potential cases of the top hundred container port worldwide ranking (including a total of 148 port authorities) and 33 of IAPH database and other sources.

Figure 5. Location of case studies



Source: Own elaboration based on different sources of information

The study tried to include cases in all the continents. Table 1 summaries all cases studies and incentives in all the different regions.

Table 1. Summary of all different case studies by location and incentives

	Case studies	Incentive /tool
Africa	**1**	**1**
Australia	**10**	**18**
Asia	**17**	**28**
Europe	**29**	**65**
Middle East	**2**	**2**
North America	**17**	**45**
South America	**1**	**1**

Source: own elaboration based on the results

Table 1 shows that Europe is the region with more cases focus on improve the environmental performance of their connecting transport network. Following this region, North America and Asia present the same amount of port cases. However, North America has more incentives and tools than Asia. Additionally, Australia has several cases as well as incentives and tools. Finally, Middle East, Africa and South America are the regions with lowest number of case studies.

4. Examination of specific case studies

From the 77 case studies examples were selected and presented in this section according to two criteria. First and for most, five main goals described above were taken into account. In addition, cases were selected depending on how closely they correspond to the Swedish case. The Annex 2 provides summary tables with these case studies.

4.1. Case example on air emission goal

This case is located in the Port of New York and New Jersey, United Stated. This initiative, called "Truck-replacement program", started in 2010 and it aims to help port truckers replace older, higher-polluting trucks with newer ones with lower-emission engines.

Federal Congestion Mitigation and Air Quality Improvement (CMAQ) Program and Diesel Emission Reduction (DERA) Program finance this program. The Port Authority of New York and New Jersey demand the independent owner operators or licensed motor carriers that own port drayage trucks with old engines[5], and that frequently serve the port[6] to replace their trucks. The new vehicles must have engines that meet or exceed 2007 federal emissions standards.

The potential candidates may apply for the funding for a maximum of two replacement trucks. After the start of the application process, this may take from 45 to 60 days before the new truck is received. The grant covers up to 50 percent of the cost of a replacement truck or up to US $25,000. (The Port Authority of Port of New York and New Jersey, 2017).

The initial replacement program was open from 2010 to 2013. As a result, a total of 429 cases were replaced and funded by the federal grant money. Furthermore, in 2014, due to

[5]Old engine is defined as trucks with engine model of the years 1994-2000 (Class 8 Drayage Trucks) that frequently serve the port, which is defined as at least 150 times in the last 12 months. (Port of New York and New Jersey, 2017)

[6]Considering that at least 150 times in the last 12 months, and who agree to continue with the replacement truck for five years (Port of New York and New Jersey. 2017)

the successful results, the Port Authority decided to extends truck-replacement program for four more years.

In addition to this program, since March 2016, all Drayage Trucks seeking entry into any Port Authority Terminal must be registered in the Port Truck Pass prior to the date of entry. The online registration takes around 20 minutes and it is free of charge. This tool is part of the Clean Truck Program, which is an action in the Clean Air Strategy for the port, as well as the Truck replacement program. (The Port Authority of New York and New Jersey, 2017)

4.2. Case example on acoustic emission goal

This case study is located in Auckland, New Zealand. The main idea of this incentive, lead by the Port Authority, the National Road Carriers and the Road Transport Association New Zealand, is to apply educational programs in order to encourage truck drivers to eliminate noise from air braking at night. (The Port Authority of Auckland, 2017). Unfortunately, the Port Authority does not provide additional information according to the course syllabus.

4.3. Case example on land congestion goal

This case study is located in the Port of Los Angeles and Long Beach in the United States.

This incentive is called Pier Pass Program and it aims to established night and Saturday shifts at both ports through a Traffic Mitigation Fee (TMF) during peak hours.

Since 2005, both port authorities and the State government lead this program with focus on port carriers. The aim of this program is to encourage port carriers to use additional shifts per week in all the international container terminals. As an incentive to use the new OffPeak shifts, and to cover the added cost of the shifts, using a congestion pricing model, a Traffic Mitigation Fee (TMF) is required for most cargo movement during peak hours (Monday through Friday, 3 a.m. to 6 p.m.).

The TMF also helps pay for the labor and other costs of operating the OffPeak shifts. All fees collected, minus the costs incurred by Pier Pass to manage the program, are allocated to the terminal operators according to the volume of cargo they handle.

The existing Pier Pass program, which collects USD 20 per TEU from all importers or exporters, is refunded in part to containers that leave/arrive at the terminal in these new off-peak hours. The off-peak shifts might occur on weekends during the day, or possibly after 5 pm on weekdays. This situation creates a “virtual container yard” which would be an internet-based matching service for empty containers. This would reduce the number of vehicle miles travelled associated with the movement of empty containers.

Since 2005, more than an average of 60,000 trucks per week have been diverted to the off-peak shifts (The Port Authority of Los Angeles and Long Beach, 2017).

4.4. Case study on modal shift

This case study is from the port of Oakland, United States. Since 1993, Heavy Weight Corridor has been improving the movement of heavy containers from the city of Oakland to the port terminals. This specific infrastructure is led by Oakland city council that allows the chief of police to designate new roadways and controls so that the trucks do not use residential streets but instead specific truck routes in the city. In addition, the port authority requires truck drivers to have a special port vehicle permit in order to access the port facilities. (The Port Authority of Oakland, 2017)

4.5. Case study on intermodal incentive

This case study is located in the Port of Rotterdam, Europe. Since 2015, the Port of Rotterdam has wanted to secure a modal shift through the contractual terms. Thus, this port authority has made binding agreements with container terminals at *Maasvlakte 2*. The idea is to implement modal split obligations in the concession contract of the terminal operators with the aim to realize a modal shift towards rail and inland waterways.

In this regard, Table 2 shows the Port of Rotterdam specified the minimum desired modal split in its proposal and it is evaluated as a part of the decision-making process by the port authority.

Table 2. Minimum desired modal split

Transport mode	2015	2020	2025	2030	2035
Road	45%	42%	40%	37%	35%
Rail	16%	17%	18%	19%	20%
Inland shipping	39%	41%	442%	44%	45%

Source: Own elaboration based on Van den Berg and De Langen, 2014

As a negative incentive, the port authority of Rotterdam introduced a penalty for tenants if they do not meet the modal split demanded by the port authority (Van den Berg, 2015; De Langen, 2008).

5. Analysis of the results- workshop outcomes

This section analyses the main results from the workshop attended by fourteen different members and stakeholders of the project group[7] on the 12th of June 2017.

The aim of this session was to obtain an assessment of the case studies described above in order to configure a conceptual framework for the Swedish case. In this regard, the participants were provided with an evaluation form of port related measures. A sample of the form is available in Annex 3.

In this evaluation form, ten potential and feasible measures have been presented (five sea related and five hinterland related). Each measure was discussed in smaller groups during the workshop.

For each example of measure, all groups had to indicate their opinion in relation to the defined criteria, as well as provide comments. The criteria used for evaluation was:

- How big of an impact do you think this measure might have in terms of promoting more sustainable transport?

- Would this measure gain industry acceptance?

- How difficult do you think it would be to implement this measure?

- Overall, how interesting is it to analyze this measure further in the project?

Finally, the score was set according to a 4-level scale (4: very; 3: somewhat; 2: not really; 1: not at all).

For the purpose of the analysis of the results, the mean, the median, the standard deviation as well as the frequency histogram have been calculated for each evaluation criteria. In the latter case, Annex 4 provides all the results.

[7] MAI - Miljöstyrande avgifter och incitament för hamnar

In order to interpret the results, scores close to 1 are considered as low, and those close to 4 the opposite. Scores between these extremes were considered as “indifference”. The indifference reference value was 2.5.

In continuation, the main results and comments related to the hinterland case studies are analysed.

5.1. Results on air emission case study

This measure, applied in the Port of New York and New Jersey, has focus on rebate for trucks with cleaner engine.

Table 3. Results on air emission case study

Evaluation criteria	mean	median	Standard deviation
Impact on sustainability	3.3	4	0.855
Industry acceptance	2.4	2	1.044
Difficulty to implement	2.4	2	1.261
Further analysis	2.8	3	1.215

Source: Own elaboration based on the workshop outcomes

Firstly, considering the mean and median values, it seems that this measure has the highest expected impact on enhancing sustainability. Specifically, considering participants' annotations, this measure could have high impact on cleaner trucks that move to and from the port. Also, this promising measure could have more impact if there is a specific fast lane for vehicles with high environmental footprint. However, considering the distance and the size of the system, the impact would be lower. In this regard, rearranging trucks, rather than overall replacement, is expected, because high performing engines are probably only used in the port and older ones are used elsewhere.

Secondly, it seems that industrial acceptance would be lower because it depends on the design. Thus, this system requires a new fee to be established from which to give rebates. However, it seems difficult. A possible solution would be that Swedish state gives rebates for personal cars (“miljöpremie”). However, the participants suggested that only larger companies interested in the environment would accept this measure, but not the other firms.

Thirdly, all participants considered that this incentive is not too difficult to be implemented, but with some remarks. On the one hand, it is important to implement it in

many ports at the same time to avoid discrepancy in the competitive landscape / to ensure consistency in the competitive landscape / to ensure consistency in competition among the ports. On the other hand, the implementation could be problematic due to the technical standards. Finally, it is difficult to cover and target international traffic, especially for ro-ro, where foreign trucks are passing through the ports.

Finally, the participants consider that it would be of value to continue with further analysis. One proposal suggests designing a system where truck companies need to report their trucks in order to collect cargo from port. Other proposal is to establish which agent should give the financial support. Another possible solution could be to offer rebates for local trucks only instead of long haul ones, which would require further measures, such as fee per kilometre or reduced fees (for example, for non-fossil fuels) instead of engine.

5.2. Results on acoustic emission case study

This measure were applied in the Port of Auckland. This incentive offers an educational program to encourage truck drivers to eliminate noise from air braking at night.

Table 4. Results on acoustic emission case study

Evaluation criteria	mean	median	Standard deviation
Impact on sustainability	1.7	2	0.611
Industry acceptance	2.7	3	1.251
Difficulty to implement	2.5	2.5	1.314
Further analysis	1.5	1	0.934

Source: Own elaboration based on the workshop outcomes

First of all, in the case of impact on sustainability, the participants gave lower scores. Specifically, they considered that it is not a big issue for several reasons. First, there are not many residents close to the ports in Sweden. Second, noise from trucks is lower than the noise made by ramps, loading and unloading, and vessels. And finally, not many ports have cargo delivery or pick up during night.

Moreover, it seems that the industry would accept this measure in order to make things better.

Thirdly, the participants scored the difficulty of implementation with indifference. On the one hand, they considered that it is complicated to reach to the foreign drivers and

establish a program. And on the other hand, as a direct and simple measure to implement it could be received well.

Finally, it seems that it is not important to consider this measure for further research. The participants considered that in the case of noise, train and vessels are more relevant than trucks.

In sum, this measure seems to be easy for an industry acceptance however the relevance is weak. When ports evaluate noise, ships are more significant than trucks. A possible application could be raising awareness on loading and unloading operation, which primarily requires technical measures on ramps/ bridges/equipment.

5.3. Results on land congestion case study

This measure was applied in the Port of Los Angeles and Long Beach. The objective is to implement a payment of Traffic Mitigation Fee during peak hours at terminal gates.

Table 5. Results on land congestion case study

Evaluation criteria	mean	median	Standard deviation
Impact on sustainability	2.3	2.5	0.778
Industry acceptance	1.9	2	0.954
Difficulty to implement	2.2	2	0.835
Further analysis	2.2	2	1.079

Source: Own elaboration based on the workshop outcomes

According to the evaluation, all participants scored for the impact on sustainability with indifference. From a positive perspective, it depends on the city and the type of ports, where this measure would be more interesting for container ports. Also, this measure implies a reduction of queues which could be effective because it entails less congestion and more efficient traffic, but it would depend on the costs/savings. From a negative point of view, traffic flow or congestion is related to the schedules of the ships. For instance, in the specific case of Trelleborg port (one of the stakeholders in the project group), the shipping companies want to arrive/depart at more or less the same hour. Additionally, Google maps provides traffic information so drivers today have access to best travelling time thus, it is not obvious how effective this measure would be.

Second, the participants consider that the industry would not really accept this measure, since it depends on the demand and on traffic. Moreover, they stated that it would be difficult to introduce a new fee.

Thirdly, it seems that the implementation would not be really difficult. In this regard and considering the comments, this measure requires parking space (i.e. waiting space) and implementation of new fees. However, the participants suggest that there is a risk that "dirty old trucks" (or other trucks) take the road, for longer distances, instead of the ferry. Finally, this implementation has an implicit risk to lose large important customers.

Finally, the participants suggest that further research should consider logistic terminals as an alternative. Also, they stated it as important to define what is a "peak hour", establish a way to avoid drivers from waiting for lower fees, and determine if the peak hours should be the same every day, week and year.

5.4. Results on modal shift case study

This measure is taken from the case study in the Port of Oakland, where a specific Heavy Weight Corridor is designated for the movement of containers from port region to port terminals.

Table 6. Results on modal shift case study

Evaluation criteria	mean	median	Standard deviation
Impact on sustainability	2.5	3	1.029
Industry acceptance	2.8	3	1.143
Difficulty to implement	3.2	3	0.835
Further analysis	2.3	2	0.985

Source: Own elaboration based on the workshop outcomes

First, all participants consider that the impact on sustainability is high. In general, modal shifts from road to rail or waterways have a great impact on sustainability. However, if the modal shift is within the port it has lower impact than if the shift is to/from the port. This measure could be interesting for ports with high local traffic congestion, so the impact would be in the local areas.

Secondly, considering the mean and median values, it seems that the industry would accept this measure as long as it is possible to reduce congestion and time. Thus, it is

important to consider the city as accountable for taking this measure instead of the port; however, it is up to the market to decide which mode of transport to choose.

Thirdly, the participants consider that it is difficult to implement this measure. It would greatly depend on who is covering the costs of the implementation, since this measure has a lot of money involved. The costs depend on whether the ports have the infrastructure or it needs to be constructed. Rail infrastructure requires large investment and there are no ports with substantial and feasible inland waterways. In Swedish ports it might be difficult to implement it because there are not too many alternative routes.

Finally, they consider a relatively low need for further analysis. In this regard, it would be necessary to form a larger traffic plan and specify clearly who would build and fund the project. It would be interesting to consider traffic flows without railroads; however, the problem is that nowadays many ports charge trains but not trucks, and here is the largest potential to change their behaviour. The scenario should be designed using the ECOBONUS logic, for example, in a scenario where there is a logistic partner closer to the port with private infrastructure and with longer vehicles (trucks).

5.4. Results on intermodal incentive case study

This measure is taken from the Port of Rotterdam case study. The modal split minimal limits are controlled by the concession contract and exceeding these limits generates penalties for the terminal operating company.

Table 7. Results on intermodal incentive case study

Evaluation criteria	mean	median	Standard deviation
Impact on sustainability	3.0	3	1.044
Industry acceptance	2.6	2.5	0.900
Difficulty to implement	2.3	2	1.055
Further analysis	2.5	2	1.087

Source: Own elaboration based on the workshop outcomes

Firstly, it seems that the impact on sustainability would be high. Thus, to make an even greater impact, it would be a good idea to introduce this measure not only for the environment but also as a Corporate Social Responsibility (CSR) strategy. Nevertheless, the participants raise the question of road electrification. Thus, in the future, it might become questionable whether railway and inland waterways are better alternatives to road.

Secondly, according to the participants' answers, the industry would be indifferent to the acceptance. It would depend on the cost and expectations, and not on demand. In this regard, it should be included in the Environmental permit (miljötillståndet). Perhaps, though, it could be difficult for terminal operators to accept this measure. There are no penalties today in Gothenburg but there are clear expectations for terminal operators to work on sustainability and increase rail transport. Terminal operators can/should not take full ownership of the issue; cooperation with the port authority, the city, and possibly other agents, are needed.

Thirdly, from the outcomes, it seems that it is not really difficult to implement this measure. Determining the decision makers and the funding agents would be the most difficult. This would depend on the terms in the contracts, which are signed for long term. In the case of Sweden, there are not too many landlord ports with independent operators. This should be a national question, not driven by ports but by the government.

Another issue that emerged from different groups was that not all ports have rail tracks. So, it could be difficult to implement this measure due to the limited capacity of the railway. Finally, the main problem is that it is not the ports or shipping companies that decide, but the forwarding agents.

Finally, it seems that no further analysis is really needed. It is not considered as a solution because it only moves the problem along. Lower environmental impact should be rewarded. Road is eventually getting cleaner due to electrification. However, it is considered an interesting field for governance studies. Railway fees (if they exist) should be removed and the trucks should be charged more. The measure should be implemented at the same time in many ports, which means it would affect the competition among the ports.

6. Conclusions

The current growth in freight traffic has challenged the distribution of goods through intermodal transport chains in the port area. Within this context, ports are focus on improving their hinterland connection in order to guarantee their traffic and competitive position. Consequently, the intermodal transport network has an effect on the environmental impact of hinterland distribution of cargo. In this regard, it is relevant to study how ports can internalize environmental externalities and promote sustainable transport solutions through different strategies.

This present framework aims to identify incentives and fees established by ports in order to improve the environmental performance of its connecting transport network, with focus on hinterland logistics. At the same time, this study permits proposed measures based on effect and feasibility from the analysis of real case studies.

Through an analysis of data collection on different case studies around the world, 77 cases and 160 incentives have been identified. Thus, in order to analyse and homogenize all different case studies, it has been conducted a criteria based on the objectives and the application of the incentives established by ports. In this regard, this research has scientific value due to it is one of the first and most comprehensive mapping of port initiatives incentives and fees related to sustainable transport from a hinterland perspective. Illustrative, Table 8 summarizes the main results based on these groups of categories.

Table 8. Summary of case studies based on goals and design combination

GOAL / DESIGN	Intermodal incentive	Modal shift	Acoustic emissions	Air emissions	Land congestion
Certification	-	-	-	2	1
Concession contract	1	-	-	-	-
Dedicate Infrastructure	8	16	-	1	6
Engine	-	-	-	19	-

Improve knowledge	-	-	1	1	-
Monitoring program	-	-	3	22	1
Port dues and subsidy funds	3	1	-	5	1
Regulatory instrument	-	-	4	8	6
Specific mode of transportation	3	6	-	1	-
Technology	4	-	2	5	29

Source: Own elaboration based on the results.

From the results, it seems that the most common objectives are modal shift incentives through a dedicated infrastructure, reduction of air emissions from engines, as well as monitoring programs and reduction of land congestion applying technology services. In contrast, knowledge improvement, and the application of port dues and subsidy funds are the least common designs. However, while a system of measures is a promising tool for improving the environmental and social performance of transportation systems, this is not a sufficient criterion for a solution to be successfully implemented. Equally important is how different actors perceive the tool and how it influences relations between actors in the transportation system. In this regard, it has been analysed five specific case studies from a Swedish perspective with the help of key stakeholders.

The results from the Workshop session suggests the following outcomes. Firstly, air emissions measure, modal shift and intermodal incentive would have higher impact on sustainability. In contrast, the reduction of noise emission incentive and the reduction of land congestion plan would have lower impact on sustainability. Secondly, key stakeholders considered that only the reduction of noise incentive and the modal shift incentive would gain industry acceptance. Thirdly, except for the case of reduction of air emissions, the rest of measures would be difficult to implement. Finally, the air emission incentive would be interesting to analyse for further research.

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Annex 1. Summary table of all case studies:

Port Authority	Id. Name	Goal	Design	Type	Envir. Concern / Target	Mode of transport	Duration	Actors (Leader / Participants)	Brief description	Reference
Amsterdam	*Sustainability and Innovation Fund*	air emissions	Port Dues and Subsidy Fund	Tool	Air Pollution / CO2	n.a.	2009-2012 (on-going)	PA / PA and Port companies	To incentive innovative sustainable projects. The city funding rules and EU regulations.	IAPH -WPCI
	Amsterdam Barge Shuttle	modal shift	Specific mode of transport	Incentive	land congestion / CO2, Nox, PM	barge (floating cranes)	since 2008	PA / PA, Terminal Operators and Service Operators	From ships and terminals to other terminals on inland waterways.	IAPH case
	Intermodal Planner	Intermodal incentive	Technology	Tool	land congestion / planning	barge, rail and short sea	since 2015	PA / Transport Companies, Agents and Freight Forwarders	Digital platform between transport operators and container terminals.	PA Website
	Walstroom	air emissions	Engine	Tool	Air Pollution/ CO2, Nox, PM	vessels	since 2008	Eneco / Port of Amsterdam, Rotterdam and Drechtsteden	Facilitate the processes of shore electric power.	Bestfact case
	Green Barge-FloraHolland	Intermodal incentive	Specific mode of transport	Incentive	land congestion / CO2	barge	since 2010	Private Firm / Private firm, municipality and PA	Transport of ornamental plants through a synchro-modal manner using inland waterway.	Bestfact case
Antwerp	*Liefkenshoek Tunnel*	modal shift	Dedicated Infrastructure	Incentive	land congestion/ CO2	rail	since 2014	PA / port users	Rail tunnel to promote rail freight	PA Website
	Iron Rhine	modal shift	Dedicated Infrastructure	Incentive	land congestion/ CO2	rail	since 2007	PA / port users	rail connection. Reopened in 2015	PA Website
	Central Booking Platform	land congestion	Technology	Tool	land congestion/ CO2	barge and rail	since 2016	Antwerp Freight Forwarders' Ass, Private firms and the PA / idem	Transport customers book their services mainly based on cost efficient level.	Bestfact case
	Intermodal Solution and Connectivity Platform	Intermodal incentive	Technology	Tool	land congestion/ CO2	rail, barge and road	n.a.	PA / port users	Intermodal Solution is a modal split service. The connectivity Plataform provides information about transport options.	OECD Round Table Report
Auckland	*Vehicle Booking System*	land congestion	Technology	Tool	land congestion/ CO2	road	Since 2007	Private Firm (1-stop Connections) / PA	Trucks book slots in advance for picking up and dropping off containers. Encouraging off-peak truck travel and improving travel predictability.	PA Website and Private Firm Website
	Rail connection	modal shift	Dedicated Infrastructure	Incentive	land congestion/ CO2	rail	Since 2010	PA and KiwiRail / PA	Rail connection between freight hubs at Wiri, South Auckland, and the Waitematā seaport	PA Website
	Best Available Unit	land congestion	Technology	Incentive	land congestion/ CO2	road	n.a.	PA / PA and industrial cooperation	Only 20%-30% of the trucks visiting the port are carrying full loads in and out. Cooperation to remove unnecessary travel from the road.	PA Website
	Educational efforts	acoustic emissions	Improve knowledge	Incentive	Acoustic Emission/ Decibel	road	n.a.	PA, National Road Carriers and the Road Transport Association New Zealand / Truck drivers	Encourage truck drivers to eliminate noise from air braking at night	PA Website

	noise- control initiatives	acoustic emissions	Regulatory Instrument	Incentive	Acoustic Emission/ Decibel	equipment, rail, vessels	n.a.	PA / port users	Several noise-control initiatives: Elimination of rail crossing alarms; minimization of rail shunt moves. operate within strict noise limits	PA Website
Baltimore	*Dray Truck replacement program*	air emissions	Engine	Incentive	Air Pollution / GHG	dray trucks	since 2015	Maryland Port Adminsitration / PA and truck owners	Mitigated the potential adverse impacts of diesel engines at its terminals. (Engine swap).	PA Website
	Locomotive Retrofit Program	air emissions	Engine	tool	Air Pollution / GHG	rail	n.a.	PA / Equipment owners	Reduce air pollution and GHG associated with the transport of goods to and from the Port. Retrofitting diesel particulate filters inside diesel-powered dredging equipment.	PA Website
Barcelona	*Bcn Zero Carbon*	air emissions	Monitoring Program	Tool	Air Pollution / GHG	trucks	since 2014	PA / PA, Terminal Operators and Service Operators	Inventory of GHG emissions. The objective that the port becomes GHG emission-neutral for its goods.	PA Website
	EcoCalculator	air emissions	Technology	Tool	Air Pollution/ CO2	vessel, road and rail	at least since 2012	PA / Port Carriers	Is a web tool for calculating the CO2 emissions associated with a particular transport route (sea and land).	PA Website
	RePort	air emissions	Engine	Tool	air pollution and acoustic/ CO2, Nox, PM and dB	trucks	from Jan 4, 2016, until Oct 15, 2018	PA / Port Carriers	Develop an innovative technology to convert Diesel engines into Dual-Fuel ones. (Engine swap)	PA Website
	Autometro / Cargometro	Intermodal incentive	Dedicated Infrastructure	Incentive	land congestion/ CO2	rail	since 2008 / 2009 (adaptation in 2005)	Private Firm (SEAT Factory) / PA, ZAL and private firm (SEAT Factory)	Rail connection between Zona Franca, factory in Martorell and Port of Barcelona to be shipped further.	Bestfact case
Botany	*Terminal Appointment system*	land congestion	Regulatory Instrument	tool	land congestion planning	trucks	since 2011	PA / truck owners	Trailer drivers and the terminal operators were subject to penalties	Motono, et al., IAME 2017
	RFID	land congestion	Technology	tool	land congestion planning	trucks	since 2011	PA / truck owners	The cost of monitoring was recouped by a newly introduced port wharfage fee of AUS$10 per TEU for both import and export containers	Motono, et al., IAME 2017
	Trailer parking slot	land congestion	Technology	tool	land congestion planning	trucks	since 2011	PA / truck owners	Trailer parking slot in order to prevent early or late arrivals at the gate	Motono, et al., IAME 2017
Bremen	*noise protection*	acoustic emissions	Regulatory Instrument	tool	Acoustic Emission/ Decibel	trucks and equipment	since 2007	PA / port users	Residential buildings with noise absorbing windows, doors and roofs. Noise level is reduced down to a maximum of 35 dB in the houses	IAPH case
Brisbane	*Monitoring program*	air emissions	Monitoring Program	Incentive	Air Pollution / GHG	trucks and equipment	since 1999	PA / port users	Monitoring of ambient concentrations of dust.	PA Website
	Vehicle Booking System	land congestion	Technology	Tool	land congestion/ CO2	road	Since 2007	Private Firm (1-stop Connections -Apply in Patrick and DP World) / PA	Trucks book slots in advance for picking up and dropping off containers. Encouraging off-peak truck travel and improving travel predictability.	Private Firm Website
Busan	*Gate Automation System*	land congestion	Technology	Tool	Air Pollution/ CO2	trucks	n.a.	PA / Truck drivers	Containers between both ports	OECD Report
	Inter Port Expressway	modal shift	Specific mode of transport	Incentive	Air Pollution/ CO2	trucks shift to barge	since 2007 / by 2014	PA / port users	Barge supports to coastal transportation between the two ports	OECD Report

	Coastal transportation between ports	Intermodal incentive	Port Dues and Subsidy Fund	Tool	Air Pollution/ CO2	coastal shipping	n.a.	The Korean Government / Port Users	Support to coastal transportation between the two ports	OECD Report
Chennai	*Chennai Ennore Port Road Connectivity Project*	land congestion	Dedicated Infrastructure	Incentive	land congestion planning	road	since 2000	PA and State Gov / NHAI, Gov of TamilNadu, Chennai Port Trust and Ennore Port Ltd	Roads link	PA Website
	Four lane Elevated Link Road	land congestion	Dedicated Infrastructure	Incentive	land congestion/ CO2	road	since 2017	Ministry of Shipping / PA, State government and IIT Madras	Elevated toll road directly links the southern end of Chennai Port to Maduravoyal on NH 4 without interfering with the city road system.	PA Website
Drechtsteden	*Walstroom*	air emissions	Engine	Tool	Air Pollution/ CO2, Nox, PM	vessels	since 2008	Eneco / Port of Amsterdam, Rotterdam and Drechtsteden	Facilitate the processes of shore electric power, increasing its usage rate instead of diesel generators. This has a positive effect on the noise and environment emissions. Reduction of 95% NOx, 99% PM10, 5% CO2.	Bestfact case
Felixstowe	*Vehicle Booking System*	land congestion	Technology	Tool	land congestion/ CO2	trucks	Since 2007	PA / Truck Drivers	A real-time appointment system used by hauliers wishing to deliver or collect containers.	PA Website
	RHIDES	land congestion	Technology	Tool	land congestion planning	trucks	since 2004	HPH Ltd, Felixstowe Port Users and Freight Transport Association / truck drivers	An identity card for hauliers at the port entrance	PA Website
	PARIS-HPH	Intermodal incentive	Technology	tool	land congestion planning	trucks shift to road, rail and feeder	since 2013	Huchison Port Holdings / Shipping Lines	An executable transport plan automatically and in real-time. To reduce the number of empty containers being transported and operation costs.	PA Website
	TESCO rail link	modal shift	Dedicated Infrastructure	Incentive	land congestion/ CO2	rail	since 2013	Eddie Stobart rail links / PA,Eddie Stobart rail links and Tesco	Road to rail connection modal shift through large contract and the linking of the Tesco National Distribution Centre in Daventry	Bestfact case
	Terminal Appointment system	land congestion	Regulatory Instrument	tool	land congestion planning	trucks	since 2007	DP World / truck owners	A reservation fee of GBP 1.16 per container during peak hours while there is no charge the rest of the time / Turnaround was reduced 30 min	Motono, et al., IAME 2017
Fremantle	*Vehicle Booking System*	land congestion	Technology	Tool	land congestion/ CO2	road	Since 2007	Private Firm (1-stop Connections -Apply in Patrick and DP World) / PA	Trucks book slots in advance for picking up and dropping off containers. Encouraging off-peak truck travel and improving travel predictability.	Private Firm Website
Gangavaram	*Monitoring program*	air emissions	Monitoring Program	Tool	Air Pollution/ CO2	vehicles	n.a.	PA / port users	Monitoring air quality and pollution control measures to maintain air quality	PA Website
Genoa	*Port Single window*	land congestion	Technology	tool	land congestion/ planning	vessels, rail and trucks	Since 2010	PA / port users	Facilitate electronic documentation	PA Report
Gijon	*Monitoring program*	air emissions	Monitoring Program	Tool	air pollution and acoustic / CO2	vehicles	n.a.	PA / port users	monitoring air pollution control measures to maintain air quality	PA Website
Gladstone	*Monitoring program*	air emissions	Monitoring Program	Tool	Air Pollution/ CO2	vehicles	n.a.	PA / port users	Monitoring to provide accurate real-time data on particulate concentrations and wind speed.	PA Website

Guangzhou	*Green truck project*	air emissions	Technology	Incentive	Air Pollution / GHG	trucks	since 2010	Regional Gov. / Port Users	Skirts (panels between rear wheels) reduce the amount of wind underneath the trailer and can improve fuel economy by up to 5 %.	World Bank Report
Haifa	*New cargo gateway*	land congestion	Technology	tool	land congestion/ CO2	trucks	since 2016	PA / PA and Truck drivers	A truck passing by automatic sensors that check it and also its driver within just 90 seconds	PA Website
Hakata	*Hakata Port Logistics IT system*	land congestion	Regulatory Instrument	tool	land congestion/ planning	trucks	since 2000	Hakata Port Terminal Co.Ltd and local gov/ truck drivers	obliged all trailers to register their container information and trailer information in the HiTS	Motono, et al., IAME 2017
Hamburg	*Smart Port Logistics*	land congestion	Technology	Tool	land congestion/ CO2	trucks	Since 2011	The Hamburg PA, Deutsche Telekom and SAP / Truck drivers	Logistics IT solutions for traffic management system	Bestfact case
	EVE program	land congestion	Technology	Tool	land congestion/ CO2	vehicles	n.a.	PA / port users	Data merged in one system to determine the traffic situation. data evaluation and serves to determine reliable indicators for road traffic in the port	PA Website
	Parking Space Management	land congestion	Technology	Tool	land congestion/ CO2	trucks	2015	PA / Truck owners	The mobile app of smartPORT logistics will inform truck drivers about capacities on the individual car parks and allow them to “book” parking bays.	PA Website
	Port Road Management Centre	land congestion	Technology	Tool	land congestion/ CO2	vehicles	Since 2011	PA / port users	Port Road management system to make the existing road network more efficient traffic flows. In the future, drivers will be able to switch to alternative routes in time.	PA Website
	The Intelligent Railway Point	land congestion	Technology	Tool	land congestion/ CO2	rail	pilot project since 2015	PA / port users	The Port Railway’s network equipped with multi-sensor technology.	PA Website
	The mobile all-purpose sensor	land congestion	Technology	Tool	land congestion/ CO2	vehicles	n.a.	PA / port users	The sensor transmits its position and ID to a central system that collects this information and provides it for further processing.	PA Website
	Smart Road	land congestion	Technology	Tool	land congestion/ CO2	vehicles	pilot project since 2014	PA / Road users	Implement information technology systems in monitoring a road section in the Port.	PA Website
	Soundproofing windows	acoustic emissions	Regulatory Instrument	Incentive	Acoustic Emission/ Decibel	vehicles	n.a.	HAfenCity / HafenCity and Hamburg's residents	Building license for residential constructions with the obligation for noise protection at windows area. Noise emissions are decreasing	IAPH case
	Lärmtelefon	acoustic emissions	Technology	tool	Acoustic Emission/ Decibel	vehicles	Since 2014	HHLA container terminal and Hamburg PA / HHLA container terminal	Telephone connection between the staff of the terminal operator and the residents that may call when emissions increase.	IAPH case
Helsinki	*Vuosaari Terminal link*	Intermodal incentive	Dedicated Infrastructure	Incentive	Air Pollution/ CO2	rail and trucks	n.a.	Finland Government / Port users	Railroad and expressway for trucks	IAPH case
	Monitoring program	acoustic emissions	Monitoring Program	Incentive	Acoustic Emission/ Decibel	vessel and vehicles	n.a.	PA / PA and city planning	Monitored the noise emissions of port operations. Noise caused by port operations must not exceed 55 dB during the day or 50 dB at night. A noise barrier was built.	PA Website

	Helsinki Region Environmental Services Authority	air emissions	Monitoring Program	Incentive	Air Pollution/ CO2, Nox, PM	vessels, vehicles and ind machines	n.a.	Helsinki Region Environmental Services Authority/ PA and residents	One movable air quality monitoring stations is located within the Port of Helsinki area.	PA Website
Hueneme	*Non-compliant Truck Reporting System (NCTRS)*	air emissions	Regulatory Instrument	Incentive	Air Pollution / GHG	trucks	since 2010	PA / PA and California Air Resources Board (CARB)	Document and report all trucks not in compliance with the California Air Resources Board (CARB) drayage truck regulation	PA Website
	Air Emissions Inventory	air emissions	Monitoring Program	tool	Air Pollution / GHG	vehicles	since 2009	PA / PA	Quantify the air quality impacts associated with maritime operations.	PA Website
Hull	*Drax High capacity biomass wagon*	modal shift	Dedicated Infrastructure	tool	Air Pollution / GHG	rail	Since 2016	Private Firms / Private Firms and Rail Operators	Service of bespoke wagons specifically for biomass flows corridor.	Bestfact case
Immingham	*Drax High capacity biomass wagon*	modal shift	Dedicated Infrastructure	tool	Air Pollution / GHG	rail	Since 2016	Private Firms / Private Firms and Rail Operators	Service of bespoke wagons specifically for biomass flows corridor	Bestfact case
Jawaharlal	*Monitoring program*	air emissions	Monitoring Program	tool	Air Pollution / GHG	trucks and equipment	since 2014	PA / port users	The monitors are designed to provide accurate real-time data on particulate concentrations	PA Website
Kaohsiung*	*Automatic Gate System*	land congestion	Technology	Tool	land congestion/ CO2	trucks	n.a.	PA / Truck owners	An automatic gateway management system for back entrance of Terminal and up-grade the existing automatic gateway management system	PA Website
	License plate recognition System	land congestion	Certification	tool	Air Pollution/ CO2	trucks	n.a.	PA / PA and EPB of Kaohsiung City	To reduce road dust from freight transport and set up a vehicle license plate recognition system at Checkpoint No.55	PA Website
	Review mode of transportation	land congestion	Monitoring Program	tool	land congestion/ CO2	trucks	n.a.	PA / container shipping carriers and container trucking carriers	Coordinate with container shipping carriers and container trucking carriers to set up a container truck forecasting system	PA Website
Keelung*	*Monitoring program*	air emissions	Monitoring Program	tool	Air Pollution / GHG	truck	since 2013	PA / Environmental Protection Bureau of Keelung City	A 24-h air-quality monitoring system	PA Website
	Monitoring program	acoustic emissions	Monitoring Program	tool	Acoustic Emission/ Decibel	traffic flows	since 2013	PA / Environmental Protection Bureau of Keelung City and PA	The noise-level standards are divided by time, with 80 dB in the day an, 70dB in the evening and 65 dB at night	PA Website
Khalifa	*Etihad Rail*	Intermodal incentive	Dedicated Infrastructure	Incentive	land congestion/ planning	rail	since 2014	Abu Dhabi Ports Company (ADPC) / Khalifa Port and Kizad	An integrated bulk and railway terminal facility at Khalifa Port as part of the UAE's national railway network.	PA Website
Kitakyushu	*Wakato Tunnel (undersea highway)*	land congestion	Dedicated Infrastructure	Incentive	land congestion/ planning	road	since 2013	not specified / Port Users	Designed as a submarine tunnel across Dokai Bay for easier access. faster, safer and more reliable access	PA Website
Koper	*New entrance for heavy goods vehicles*	land congestion	Dedicated Infrastructure	tool	land congestion/ planning	road	since 2010	PA / PA and Koper City	A new entrance to the port zone establish a direct four-lane highway between the motorway and this new entrance.	PA Website
Le Havre	*SME group- pooled transport flows*	Intermodal incentive	Technology	Incentive	land congestion/ planning	road	since 2007	Shipping companies Buffard Logistique and Bostyn, freight forwarder BLD Intemational, and shippers Braid Logistics	SME group with mutual distribution service where the companies load shipments in one lorry for a single destination, so there are eight lorries on the road.	Bestfact case

								and Chauss'Europe / Le Havre SMEs		
Leixoes	*The Via Interna de Ligação ao Porto de Leixões*	modal shift	Dedicated Infrastructure	Incentive	air pollution and acoustic emissions/ CO2	trucks	n.a.	not specified / PA	Specific route link of 3km dedicated only to port traffic	IAPH case
Los Angeles and Long Beach	*Alameda Corridor*	modal shift	Dedicated Infrastructure	Incentive	land congestion/ CO2	rail	since 2002	Authority of Alameda corridor / PA (LA and LB)	Specific corridor route of 32km dedicated only to port traffic. It took 20 years and US$2.4 billion in investment to complete the project.	Program Website
	Clean Air Action Plan (CAAP)	air emissions	Regulatory Instrument	Incentive	Air Pollution/ CO2	ships, trucks and train	since 2005	Both PA and the South Coast Air Quality Management District, California Air Resources Board and U.S. Environmental Protection Agency / PA (LA and LB)	Clean Trucks Program: monitoring and inventories of air emissions. Port-related emissions have dropped 85% for diesel particulate matter, 50% for nitrogen oxides, and 97% for sulfur oxides.	Program Website
	CAAP - Clean Truck Fee	air emissions	Port Dues and Subsidy Fund	Tool	land congestion/ CO2	trucks	Since 2009	PA (LA and LB) / Truck owners	Obtained data from electric gate access evaluates in the Ports' drayage Trucks Register. The $35/TEU fee will be assessed on every loaded container move performed by trucks that are not fully exempt from the Clean Trucks Fee	Program Website
	CAAP - Air quality monitoring	air emissions	Monitoring Program	Tool	Air Pollution/ CO2	n.a.	since 2008	PA (LA and LB) / Port Users	The Ports collect air and weather data in the harbor area on a real-time in the Port region.	Program Website
	CAAP - Inventory of air emissions	air emissions	Monitoring Program	Tool	Air Pollution/ CO2	vehicles (equipment)	since 2005	PA (LA and LB) / Port Users	The Ports conduct emissions inventories every year to track their progress and provide total emission reductions compared to the baseline year of 2005.	Program Website
	CAAP- Pacific Harbor Line (PHL)	modal shift	Dedicated Infrastructure	Incentive	Air Pollution/ planning	rail	since 1998	Private Firm (Anacostia) and PA / Private Firm (Anacostia Firm)	The Harbor Belt Line (HBL).The railroad has 18 route miles with a web of 59 miles of track. Private owner	Private Firm Website
	Pier Pass Program: Traffic Mitigation Fee	land congestion	Port Dues and Subsidy Fund	Tool	Air Pollution/ CO2	trucks	since 2005	State Gov. / Carriers	Traffic Mitigation Fee (TMF) of US$50 per TEU on the consignee when the trailer enters or exits a gate is required during peak hours. Off-peak extended gate hours program established night and Saturday shifts at both ports.	Program Website
	Zero Emission Technology	air emissions	Engine	Incentive	Air Pollution/ CO2	heavy -duty trucks	Since 2006	PA (LA) / Port partners with vehicles and engine manufacturers	The Port is testing electric plug-in yard tractors. Electric heavy-duty on-road trucks and battery-electric heavy-duty trucks.	PA Website
	Intermodal Container Discount Program	Intermodal incentive	Port Dues and Subsidy Fund	Tool	land congestion/ CO2	rail	since 2009	PA (LA) / Ocean Carriers	Data obtained from terminal tenant to load and unload empty container	PA Website
	AB 2650	air emissions	Port Dues and Subsidy Fund	Tool	Air Pollution/ CO2	trucks	since 2003	PA / PA and Terminal Operators	The stated purpose of AB 2650 was to reduce emissions from truck idling at terminal gates. In a penalty of $250 on marine terminal operators for each truck idling more than 30 minutes while waiting to enter the terminal gate.	OECD Round Table Report

Melbourne	*Mode Shift Incentive Scheme (MSIS)*	modal shift	Port Dues and Subsidy Fund	Incentive	land congestion/ CO2	road shift to rail	n.a.	Victorian State Government / PA	This initiative supports industry to shift more containerized freight from road to rail.	PA Website
	Noise Assessment software	acoustic emissions	Technology	tool	Acoustic Emission/ Decibel	roads and vehicles	since 2014	The Port of Melbourne Corporation / Port users	The Port of Melbourne Corporation is committed to effectively managing the noise impacts associated with the redevelopment of Webb Dock.	PA Website
	Vehicle Booking System	land congestion	Technology	Tool	land congestion/ CO2	road	Since 2007	Private Firm (1-stop Connections -Apply in Patrick and DP World Terminals) / PA	Trucks book slots in advance for picking up and dropping off containers. Encouraging off-peak truck travel and improving travel predictability.	Private Firm Website
Miami	*Electronic security gates*	land congestion	Technology	Tool	land congestion/ CO2	vehicles	n.a.	PA / PA, port partners and Federal Government	Reduce truck idling times	PA Website
Montreal	*Monitoring program*	air emissions	Monitoring Program	Tool	air pollution and acoustic/ CO2	vehicles	n.a.	PA / port users	The monitors are designed to provide accurate real-time data on particulate concentrations	PA Website
	new track entry portal	land congestion	Technology	tool	land congestion/ planning	truck	since 2011	PA / port users	New truck entry portal that has reduced transaction times by 80% and waiting times by 50%.	PA Website
	Replacement vehicles	air emissions	Engine	incentive	Air Pollution / GHG	vehicles	Since 2001	PA / Port Fleet	The port's fleet of service and maintenance vehicles has been replaced with hybrid vehicles (engine swap). Reduce GHG by 39%.	PA Website
	Multiple-generator locomotives	air emissions	Engine	Tool	Air Pollution / GHG	rail	Since 2010	PA / Port Locomotives	The port's locomotives have been replaced with multiple-generator locomotives that reduce greenhouse gas emissions.	PA Website
Mumbai	*Monitoring program*	air emissions	Monitoring Program	Tool	air pollution and acoustic emissions/ CO2	vehicles	n.a.	PA / port users	The monitors are designed to provide accurate real-time data on particulate concentrations	PA Website
Nagoya	*Nagoya United Terminal System (NUTS)*	land congestion	Regulatory Instrument	tool	land congestion/ planning	trucks	since 2005	Nagoya harbor transport association; Nagoya PA and Ministry of transport / truck drivers	Reduce the gate service time	Motono, et al., IAME 2017
	screening center system	land congestion	Technology	tool	land congestion/ planning	trucks	since 2011	Nagoya harbor transport association; Nagoya PA and Ministry of transport / truck drivers	Examines containers and trailer documents and eliminates the improper document trailers.	Motono, et al., IAME 2017
Napier	*Vehicle Booking System*	land congestion	Technology	Tool	land congestion/ CO2	road	Since 2007	Private Firm (1-stop Connections) / PA	Trucks book slots in advance for picking up and dropping off containers. Encouraging off-peak truck travel and improving travel predictability.	PA Website
Nelson	*Noise Management Plan*	acoustic emissions	Regulatory Instrument	Incentive	Acoustic Emission/ Decibel	vehicles	n.a.	PA and Nelson city council / Port Users	Framework for mitigating noise in affected houses in the residential area and providing management of noise at source.	PA Website
New Orleans	*Clean Truck Replacement Incentive Program*	air emissions	Engine	Incentive	Air Pollution/ CO2	trucks	since 2016	PA / Truck owners	Enables truck and fleet owners to invest in cleaner air through early truck replacement with cleaner models, year 2012 or newer.	PA Website

New South Wales	*Monitoring program*	air emissions	Monitoring Program	Tool	air pollution and acoustic emissions/ CO2	vehicles	n.a.	PA / port users	The monitors are designed to provide accurate real-time data on particulate concentrations	PA Website
New York and New Jersey	*Truck Replacement Program*	air emissions	Port Dues and Subsidy Fund	Incentive	Air Pollution/ CO2	trucks	Since 2010	Federal Congestion Mitigation and Air Quality Improvement / PA and Truck Owners	Trucks engine swap. PortTruckPass	PA Website
	Port of NY and NJ Clean Air Initiatives and Harbor Air Management Plan	air emissions	Regulatory Instrument	Incentive	Air Pollution/Nox	vehicles	Since 2014	PA / The Port and Commerce Dept	Implemented an Environmental Management System to ensure compliance with air quality laws and regulations.	IAPH -WPCI
North Carolina State (NCSPA)	*Carolina Connector Intermodal terminal- Queen City Express*	Intermodal incentive	Dedicated Infrastructure	Incentive	air pollution and land congestion/ CO2	shift from truck to rail	Since 2017	N.C. Transportation Dept and CSX Corp / Port Users	The only direct freight rail corridor service and a direct access from the Port of Wilmington to the Carolina Connector Intermodal terminal	PA Website
Oakland	*Heavy Weight Corridor*	modal shift	Dedicated Infrastructure	Incentive	land congestion/ planning	trucks	since 1993	Oakland City Council / PA, PublicWorks Dept and the chief of police	Roadways for the movement of heavy containers to enable additional facilities to have access to the port. Three documents: heavy container permit program; special port vehicle permit and truck route.	PA Website
	CTMP- Clean Trucks	air emissions	Regulatory Instrument	Incentive	Air Pollution/ CO2	trucks	since 2010	PA / Truck owners	Clean Truck registration and a truck ban that is consistent with the January 2010 CARB deadline for drayage trucks.	PA Website
	AB 2650	air emissions	Port Dues and Subsidy Fund	Tool	Air Pollution/ CO2	trucks	since 2003	PA / PA and Terminal Operators	The stated purpose of AB 2650 was to reduce emissions from truck idling at terminal gates. In a penalty of $250 on marine terminal operators for each truck idling more than 30 minutes while waiting to enter the terminal gate.	OECD Round Table Report
Paris	*Franprix entre en Seine*	Intermodal incentive	Specific mode of transport	Incentive	land congestion/ CO2	barge	since 2012	Private Firms (Franprix) / Private Firm and Terminal de seine	A new multi-modal chain for Franprix supermarket stores.	Bestfact case
Piraeus	*Monitoring program*	air emissions	Monitoring Program	tool	air pollution and acoustic emissions/ CO2	vehicles	n.a.	PA / port users	The monitors are designed to provide accurate real-time data on particulate concentrations	PA Website
Port Metro Vancouver	*Traffic Management Centre*	land congestion	Technology	tool	land congestion/ CO2	traffic flows	Since 2013	PA / PA	Real time monitoring of traffic conditions incident management	PA Website
	Truck Licensing System	air emissions	Certification	tool	Air Pollution/ CO2	trucks	Since 2013	PA / Truck owners	License. Data requirements such as minimum fleet size, truck age, safety and environmental	PA Website
	Rail engine	air emissions	Engine	tool	Air Pollution/ CO2	rail	n.a.	Canada Pacific Railway (National Gov.) / idem	Engine power and data obtained from rail services	Government Website
	Northwest Ports Clean Air Strategy	air emissions	Monitoring Program	Incentive	Air Pollution/ CO2	vessels, trucks, rail and harbor craft	since 2010	PA / port users	Air-quality monitoring system.	IAPH -WPCI
	Truck Clean Program	air emissions	Engine	Incentive	Air Pollution/ CO2	trucks	since 2008	The Northwest Ports Clean Air Strategy / PA	Trucks entering container terminals must have a model-year 1994 or newer engine, have a valid	PA Website

									Radio Frequency Identification (RFID) tag, and register in the Port.	
	Terminal Appointment system	land congestion	Regulatory Instrument	tool	land congestion/ planning	trucks	since 1999	PA / truck owners	TAS regulation is mandatory for truck owners. To reduce port access congestion, in 2013 it imposed a fine (CND 50 per trip) when the turnaround time exceeded 90 min.	Motono, et al., IAME 2017
Portonave	*Monitoring program*	air emissions	Monitoring Program	Tool	air pollution and acoustic emissions/ CO2	vehicles	n.a.	PA / port users	The monitors are designed to provide accurate real-time data on particulate concentrations	PA Website
Prince Rupert	*Monitoring program*	air emissions	Monitoring Program	Tool	air pollution and acoustic emissions/ CO2	vehicles	n.a.	PA / port users	The monitors are designed to provide accurate real-time data on particulate concentrations	PA Website
Ravenna	*Idrovia Ferrarese*	modal shift	Specific mode of transport	Incentive	land congestion/ CO2	inland vessels	n.a.	not specified / Port Users	New infrastructure system for waterway transport from Mantua to Ravenna	Bestfact case
Rotterdam	*Modal Split Obligation*	Intermodal incentive	Concession Contract	Incentive	Air Pollution/ CO2	containers rail and road	Since 2015	PA / Terminal Operators	Data obtained from terminal operators	PA Website
	Truck engine power	air emissions	Engine	Tool	Air Pollution/ CO2	trucks	since 2013	The municipality of Rotterdam / Truck Owners	Engine power and data obtained from truck engine	PA Website
	Betuweroute rail line	Intermodal incentive	Dedicated Infrastructure	Tool	Air Pollution/ CO2	rail	since 2007	PA, Railfeeding and Alstom / idem	160 km dedicated railway link, which connects Rotterdam port and Germany border. It cost Euro 4.7 billion and took 13 years to complete it.	PA Website
	Verkeersonderneming	Intermodal incentive	Dedicated Infrastructure	Incentive	land congestion/ CO2	traffic flows	Since 2008	The Ministry of Transport and the Municipality / Road Users	road link	PA Website
	Inland Port Dues	Intermodal incentive	Port Dues and Subsidy Fund	Tool	Air Pollution/ CO2	vessels, vehicles and ind machines	Since 2012 (obligatory until 2025)	PA / Inland Vessels	Inland port dues. Data obtained from ship engine (five categories of discounts)	PA Website
	Container transferium	modal shift	Dedicated Infrastructure	Incentive	land congestion/ CO2	trucks shift to barge	Since 2015	PA / PA	Transfer platform. Data obtained from terminal operators	OECD Round Table Report
	Rijnmond Regional Air Quality Action Program	air emissions	Regulatory Instrument	Incentive	Air Pollution/ CO2, Nox, PM	road, ship, railway	since 2010	Rijnmond Executive Council / Adm. Authorities	Air action plan (different initiatives)	IAPH -WPCI
	PortShuttle Rotterdam service	modal shift	Specific mode of transport	Incentive	land congestion/ CO2	trucks	since 2015	PA / PA and GVT Group	Exchange containers between various deep-sea terminals. This permits to offer the speed and reliability that transportation by trucks lack due to the road congestion on the A15-A16.	GreenPort Website
	Walstroom (shore power)	air emissions	Engine	Tool	Air Pollution/ CO2, Nox, PM	vessels	since 2008	Eneco / Port of Amsterdam, Rotterdam and Drechtsteden	Facilitate the processes of shore electric power, increasing its usage rate instead of diesel generators.	Bestfact case
	Fresh Corridor	Intermodal incentive	Dedicated Infrastructure	Incentive	land congestion/ CO2	barge	since 2007	Private Firm (Frugi Venta) and PA / Private Firm	The Fresh Corridor encourages intermodal transport of refrigerated cargo. In the Netherlands and Belgium. Rotterdam Coolport	Bestfact case

	Argonon-LNG Dual fuel inland transport	air emissions	Engine	tool	Air Pollution/ CO2, Nox, PM	barge	since 2010	Private Firm (Deen Shipping) / Private Firm	Argonon is the first inland waterway transport vessel on dual fuel in Europe, i.e. liquefied natural gas (80%) and diesel as fuel for ignition (20%).	Bestfact case
Salerno	*Salerno Porta Ovest*	land congestion	Dedicated Infrastructure	Incentive	land congestion/ CO2	road	since 2012	PA and Salerno Municipality / idem	Construction of a new motorway link as a solution of traffic problems in the western part of the town.	PA Website
San Diego	*Clean Air Program*	air emissions	Regulatory Instrument	Incentive	Air Pollution/ CO2	trucks and vehicles	since 2007	PA / port users	Identify a clean air strategy for future changes to Port operations. Review under the California Environmental Quality Act (CEQA)	PA Website
Seattle	*Truck Clean Program*	air emissions	Engine	Incentive	Air Pollution/ CO2	trucks	since 2008	The Northwest Ports Clean Air Strategy / PA	Trucks entering container terminals must have a model-year 1994 or newer engine, have a valid Radio Frequency Identification (RFID) tag, and register in the Port.	PA Website
	Truck Replacement Program	air emissions	Engine	tool	Air Pollution/ CO2	trucks	since 2016	The Nortwest Seaport Alliance / Truck Owners	Engine swap. Owners may have any combination of trips to the two ports, as long as they have made 200 or more in the last year.	PA Website
	Northwest Ports Clean Air Strategy	air emissions	Regulatory Instrument	Incentive	Air Pollution/ CO2	vessels, trucks, rail and harbor craft	since 2010	PA / port users	Emission reduction strategies implemented by ports in the region and proposal performance goals to reduce particulate matter.	IAPH case
Shangai	*Standarization of river vessels*	Intermodal incentive	Specific mode of transport	Incentive	land congestion /planning	vessels	since 2004 until 2020	China's Ministry/ China's Ministry and PA	At the end of 2003 was announced a new standard on container ships and truck ro/ro ships. It is planned that standardization of river vessels. Project until 2020	OECD Round Table Report
	River-Coast direct shipping	modal shift	Specific mode of transport	Incentive	land congestion/ planning	vessels	since 2006	China's Ministry / China's Ministry and PA	Establish a river-coast direct shipping route from inland ports in the Yangtze River to the Yangshan deepwater port.	OECD Round Table Report
	Seagoing vessels	modal shift	Dedicated Infrastructure	Incentive	land congestion/ planning	vessels	since 1998	China's Ministry / China's Ministry and PA	Upgrading of waterway conditions, especially the water depth.	OECD Round Table Report
Sines	*Port Single window*	land congestion	Technology	tool	land congestion/ planning	vessels, rail and trucks	Since 2009	PA / Port Users	The Information Safety Management System as a single window wants to avoid "double transshipping" in the port terminal.	PA Website
South Carolina-Charleston	*Clean Truck certification*	air emissions	Certification	tool	Air Pollution/ CO2	trucks	since 2014	PA / Truck owners	Certification for truck owners based on truck engine	PA Website
	Monitoring program	air emissions	Monitoring Program	tool	Air Pollution/ CO2	vehicles	n.a.	PA / port users	The monitors are designed to provide accurate real-time data on particulate concentrations	PA Website
Southampton	*Southampton-Midlands rail corridor*	modal shift	Dedicated Infrastructure	Incentive	land congestion/ CO2	heavy rail	since 2007	Rail Network Providers, PA and Rail Freight Operators / Port Users	W10 gauge on the key rail corridor between the Port and the main inland centres of demand. The proportion of container train services has increased from 0% in 2007 to 70% in 2012.	Bestfact case
	TESCO rail link	modal shift	Dedicated Infrastructure	Incentive	land congestion/ CO2	rail	since 2013	Eddie Stobart rail links / PA,Eddie Stobart rail links and Tesco	Road to rail modal shift through large contract and the linking of the Tesco National Distribution Centre in Daventry.	Bestfact case

	Terminal Appointment system	land congestion	Regulatory Instrument	tool	land congestion/ planning	trucks	since 2006	DP World / truck owners	A reservation fee of GBP 1.16 per container during peak hours while there is no charge the rest of the time. Turnaround was reduced 30 min	Motono, et al., IAME 2017
St. Petersburg	*Sea Port of Saint-Petersburg*	land congestion	Technology	Incentive	land congestion/ CO2	trucks	Since 2016	Administration of Saint-Petersburg / Port Users	Traffic control office took measures to prevent congestion by trucks nearby Gapsalskiye Gates and on the adjacent streets.	PA Website
Stockton	*The Port's Truck Traffic Control Plan*	air emissions	Technology	Incentive	land congestion/ CO2	trucks	Since 2008	PA / PA	The Port has installed signage on Rough & Ready Island directing truck traffic to the Stockton Port Expressway.	PA Website
Sydeny	*Vehicle Booking System*	land congestion	Technology	Tool	land congestion/ CO2	road	Since 2007	Private Firm (1-stop Connections -Apply in Patrick and DP World Terminals) / PA	Trucks book slots in advance for picking up and dropping off containers. Encouraging off-peak truck travel and improving travel predictability.	Private Firm Website
Tacoma	*Truck Clean Program*	air emissions	Engine	Incentive	Air Pollution/ CO2	trucks	since 2008	The Northwest Ports Clean Air Strategy / PA	Trucks entering container terminals must have a model-year 1994 or newer engine, have a valid Radio Frequency Id tag, and register in the Port.	PA Website
	Northwest Ports Clean Air Strategy	air emissions	Regulatory Instrument	Incentive	Air Pollution/ CO2	vessels, trucks, rail and harbor craft	since 2010	PA / Port Users	Emission reduction strategies successfully implemented by ports in the region and propose performance goals to reduce particulate matter	IAPH -WPCI
	Truck Replacement Program	air emissions	Engine	tool	Air Pollution/ CO2	trucks	since 2016	The Nortwest Seaport Alliance / Truck Owners	Owners may have any combination of trips to the two ports, as long as they have made 200 or more in the last year.	PA Website
Taichung*	*Monitoring program*	air emissions	Monitoring Program	tool	Air Pollution / GHG	trucks	since 2013	PA / Environ. Protection Bureau of Taichung City	A 24-h air-quality monitoring system	PA Website
	Monitoring program	acoustic emissions	Monitoring Program	tool	Acoustic Emission/ Decibel	traffic flows	since 2013	PA / Environ. Protection Bureau of Taichung City and PA	The noise-level standards are divided by time, with 80 dB in the day an, 70dB in the evening and 65 dB at night	PA Website
Taiwan Inter. Port Corp	*Automatic Gate System*	air emissions	Technology	Tool	Air Pollution/ CO2	trucks	Since 2015	Taiwan Inter. Port Corp / Port of Keelung, Port of Taipei, Port of Su-Ao, Port of Taichung, Port of Kaohsiung	Radio frequency id and optical character recognition to verify the identity of the trucks, containers, and drivers. Short gate inspection from 120 sec to 20 sec. Reduction of CO2emissions/vehicles from 24,6g to 15.2g	PA Website
Tallinn	*Monitoring program*	air emissions	Monitoring Program	Tool	Air Pollution/ CO2	vehicles	n.a.	PA / port users	Monitory program system for air pollution	PA Website
Tanger Med	*Gateway management system*	air emissions	Technology	Tool	Air Pollution/ CO2	electric vehicles	deadline 2017	PA / Employees of APM Terminals and port users	Grade the existing automatic gateway management system	PA Website
Tokyo	*Access road to offshore new terminal*	modal shift	Dedicated Infrastructure	Incentive	land congestion/ CO2	trucks	since 2012	national government	Access road to new port terminal, which links with the highway. It took 20 years of construction at a cost of US$2.4 billion.	Motono, et al., IAME 2017
Triestre	*Rail connection*	air emissions	Dedicated Infrastructure	Incentive	Air Pollution/ CO2	trucks	since 2013	Private Firm / PA, rail and logistics companies	Rail connection that reduced emissions (reduction of 75% of CO2)	Bestfact case
Tyne	*Drax High capacity biomass wagon*	modal shift	Dedicated Infrastructure	tool	Air Pollution / GHG	rail	Since 2016	Private Firms / Private Firms and Rail Operators	Service of bespoke wagons specifically for biomass flows corridor.	Bestfact case

Valencia	*Monitoring program*	air emissions	Monitoring Program	Tool	air pollution and acoustic emissions/ CO2	vehicles and trucks	n.a.	PA / port users	A 24-h air-quality monitoring system	PA Website
Vancouver (Washington)	*Columbia River Clean Diesel*	air emissions	Engine	Incentive	Air Pollution/ CO2	vessels, rail and trucks	Since 2013	PA / port users	Clean program focus on engine power	PA Website
Venice	*Off shore terminal*	land congestion	Dedicated Infrastructure	Incentive	land congestion/ CO2	vessels and traffic	since 2012	Venice New Port Container and PA / idem	Positioned 8 miles offshore (20 m depth and protected by a 4.2km long breakwater dam)	PA Website
Wilhelmshaven (JadeWeserPort)	*A29 Motorway and Intermodal terminal*	Intermodal incentive	Dedicated Infrastructure	Incentive	land congestion/ CO2	vehicles	Since 2011	not specified / Port Users	Truck forecasting system and road link.	PA Website
Yokohama	*Drive Slow*	air emissions	Improve knowledge	Tool	land congestion/ CO2	vehicles	since 2010	PA / port users	Campaign that encourages port customers to decrease CO2, accidents and costs	PA Website
	Domestic Container Transportation	air emissions	Specific mode of transport	Incentive	air pollution and land congestion/ CO2	barge	n.a.	PA / port users	Barge for domestic container transportation (reduction of 80% of CO2).	PA Website
Zeebrudge	*PortConnect*	modal shift	Specific mode of transport	Incentive	land congestion/ CO2	inland vessels	since 2003 and 2010	PA / PA	Vessels. Containers, roro and all kind of cargoes	PA Website

Source: Own elaboration based on different sources of information

* TIPC administrers Taiwan's 7 international ports (Keelung, Taichng, Kaohsiung, Hualien, Taipei, Suao and Anping) and two domestic ports (Budai and Penghu)

PA=Port Authority

Annex 2- Summary table of different case studies examples

	Air emission	**Acoustic emission**	**Land congestion**	**Modal shift**	**Intermodal incentive**
Port name	*Port of New York and New Jersey*	*Port of Auckland*	*Port of Los Angeles and Long Beach*	*Port of Oakland*	*Port of Rotterdam*
Identification name	Truck Replacement Program	Educational Efforts	Pier Pass Program: Traffic Mitigation Fee	Heavy Weight Corridor	Modal Split Obligation
Application (design)	Engine	Improve knowledge	Port dues and Subsidy fund	Dedicate Infrastructure	Concession Contract
Type	Incentive	Incentive	Incentive	Incentive	Incentive
Environmental Concern	Air emissions	Noise	Air pollution	Land congestion	Air pollution
Target the incentive	CO_2 emissions	Decibels	CO_2 emissions	Planning	CO_2 emissions
Units of measure	Engine	Vehicles	Containers	trucks	Containers
Parameters	Up to 50 % of the cost of a replacement truck or a max of $25,000. Engine Model Years 1994-2000.	Not specified	Not specified	Specific limits	Not specified
Mode of transport involved	Trucks	Trucks	Rail and Road	Trucks	Rail and Road

Duration	Since 2010	Not specified	Since 2005	Since 1993	Since 2015
Area of action	Port area	Port area	Port terminals	Port region	Port terminals
Actors	*Leader*: Funded by federal Congestion Mitigation and Air Quality Improvement (CMAQ) Program and Diesel Emission Reduction Program (DERA)	*Leader*: Port Authority; National Road Carriers and the Road Transport Association New Zealand	*Leader*: State Government and Port Authority	*Leader*: Oackland City Council	*Leader*: Port Authority
	Participants: Port Authority and truck owners.	*Participants*: truck drivers	*Participants*: Carriers	*Participants*: Port authority, PublicWorks Department and the chief of police	*Participants*: terminal operators
Incentives results	Addition	Neutral	Addition	Neutral	Addition
Brief description and comments	Enables truck and fleet owners to invest in truck replacement with cleaner models.	Encourage truck drivers to eliminate noise from air braking at night	Night and Saturday shifts at both ports through the TMF during peak hours.	Roadways for the movement of heavy containers to have access to Port terminals.	Modal split obligation for the terminal operators

Source: Own elaboration

Annex 3- Evaluation form of port related measures for sustainability

Name:

Organization:

Ten potential and feasible measures have been selected; five sea-related and five hinterland related:

Sea-side	**Hinterland**
Case 1: Port fees related to emissions of NOx	Case A: Air Emissions – Engine
Case 2: Port fees related to emissions of CO_2	Case B: Acoustic emissions – Improve Knowledge
Case 3: Port fees related to emissions of particles (PM)	Case C: Land congestion – Port dues and subsidy fund
Case 4: Port rebate related to connection to Onshore Power Supply (OPS).	Case D: Modal Shift – Dedicate Infrastructure
Case 5: Port rebate related to slow steaming in fairways	Case E: Intermodal Incentive – Concession Contract

Each measure will be discussed in smaller groups at the workshop, and this evaluation form, which will be collected after the meeting, allows for further personal comments to the project group.
For each example of measure, please indicate your opinion in relation to the defined criteria as well as any comment. The criteria used for evaluation are:

- How big <u>impact</u> do you think this measure can have in terms of enhancing more sustainable transport?
- Would this measure gain industry <u>acceptance</u>?
- How difficult do you think this measure would be to <u>implement</u>?
- Overall, how interesting is it to <u>analyze</u> this measure <u>further in the project</u>?

The score is set according to this 4-level scale:

4	3	2	1
Very	Somewhat	Not Really	Not at All

SEA-RELATED

Case 1: Port fees related to emissions of NOx: similar to the system used today by the Swedish Maritime Administration with a stepwise incitement with higher weight of auxiliary engines.

Criteria	Score	Comments
Impact on sustainability		
Industry acceptance		
Difficulty to implement		
Further analysis		

Case 2: Port fees related to emissions of CO_2: either similar to indicators in indexes such as Environmental Ship Index (ESI) or Clean Shipping Index (CSI) or possibly only related to type of fuel used.

Criteria	Score	Comments
Impact on sustainability		
Industry acceptance		
Difficulty to implement		
Further analysis		

Case 3: Port fees related to emissions of particles (PM): either similar to indicators in indexes such as Clean Shipping Index (CSI) or possibly related to type of fuel used or abatement techniques such as filters.

Criteria	Score	Comments
Impact on sustainability		
Industry acceptance		
Difficulty to implement		
Further analysis		

Case 4: Port rebate related to connection to Onshore Power Supply (OPS).

Criteria	Score	Comments
Impact on sustainability		

Industry acceptance		
Difficulty to implement		
Further analysis		

Case 5: Port rebate related to slow steaming in fairways: a rebate is received for reduces speed close to the port city (for instance from the pilot boarding point or a certain distance from the port).

Criteria	Score	Comments
Impact on sustainability		
Industry acceptance		
Difficulty to implement		
Further analysis		

LAND RELATED

Case A: Air Emissions – Engine: rebate for trucks with cleaner engine models. A measure applied in Port of New York and New Jersey.

Criteria	Score	Comments
Impact on sustainability		
Industry acceptance		
Difficulty to implement		
Further analysis		

Case B: Acoustic emissions – Improve Knowledge: educational programs to encourage truck drivers to eliminate noise from air braking at night. A measure applied in Port of Auckland.

Criteria	Score	Comments
Impact on sustainability		
Industry acceptance		
Difficulty to implement		
Further analysis		

Case C: Land congestion – Port dues and subsidy fund: payment of Traffic Mitigation Fee during peak hours at terminal gates. A measure applied in Port of Los Angeles and Long Beach.

Criteria	Score	Comments
Impact on sustainability		
Industry acceptance		
Difficulty to implement		
Further analysis		

Case D: Modal Shift – Dedicate Infrastructure: specific Heavy Weight Corridor for the movement of containers from port region to port terminals. A measure applied in Port of Oakland.

Criteria	Score	Comments
Impact on sustainability		
Industry acceptance		
Difficulty to implement		
Further analysis		

Case E: Intermodal Incentive – Concession Contract: the modal split minimal limits are controlled by the concession contract and exceeding these limits will generate penalties for the terminal operating company. A measure applied in Port of Rotterdam.

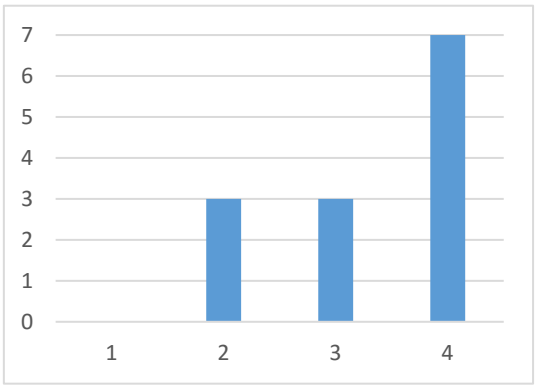
Criteria	Score	Comments
Impact on sustainability		
Industry acceptance		
Difficulty to implement		
Further analysis		

Have we missed any highly potential, interesting and feasible measure?

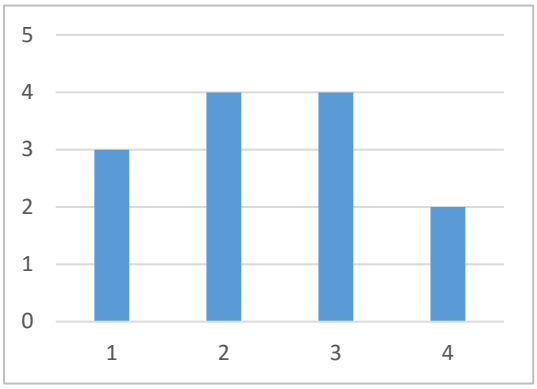
Annex 4. Frequency histogram for each evaluation criteria

Case A: Air Emissions – Engine:
Rebate for trucks with cleaner engine models. A measure applied in Port of New York and New Jersey.

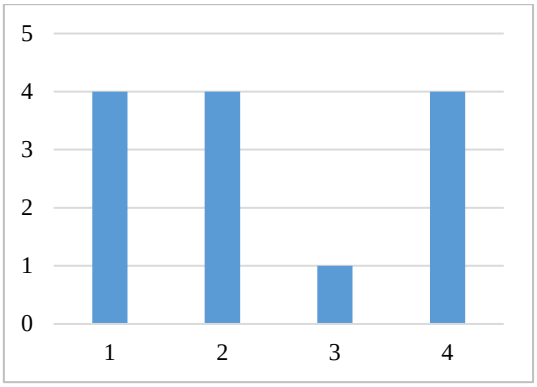
Impact on sustainability



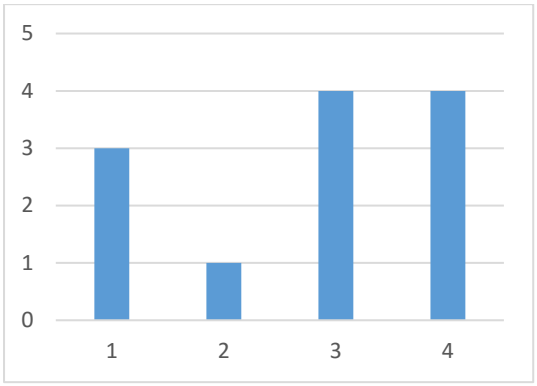
Industry acceptance



Difficulty to implement



Further analysis



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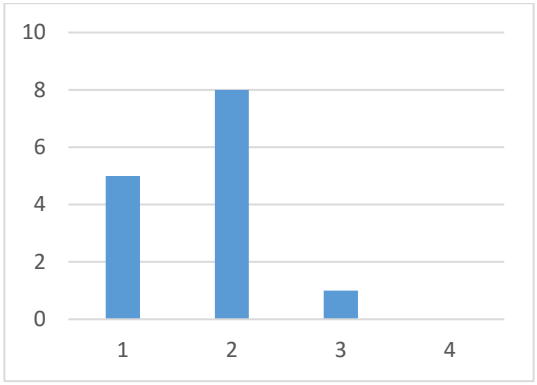
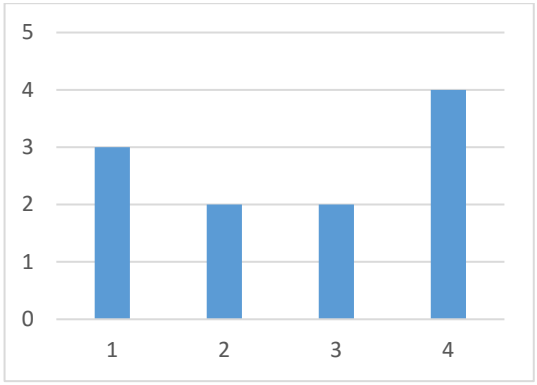
Impact on sustainability



Industry acceptance



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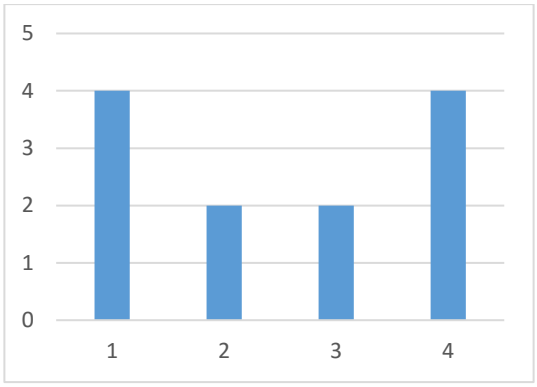
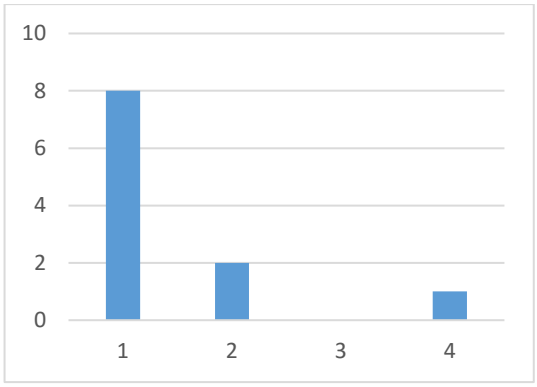


Further analysis



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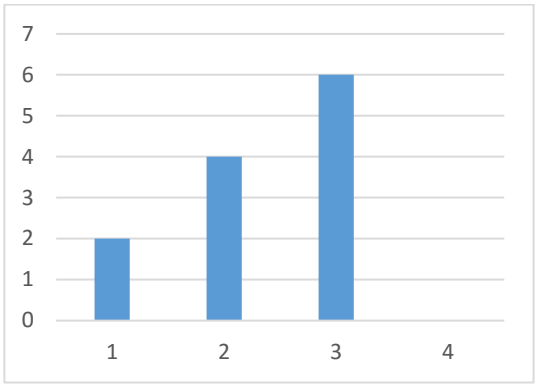
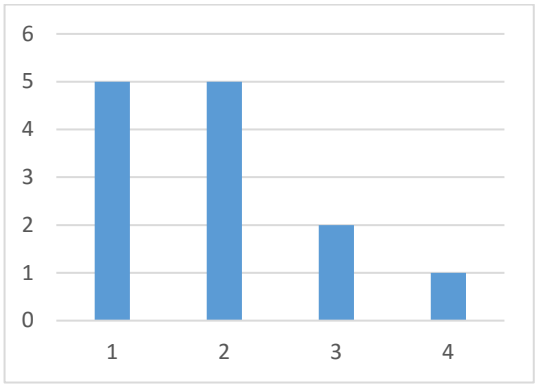
Case C: Land congestion – Port dues and subsidy fund:
Payment of Traffic Mitigation Fee during peak hours at terminal gates. A measure applied in Port of Los Angeles and Long Beach.

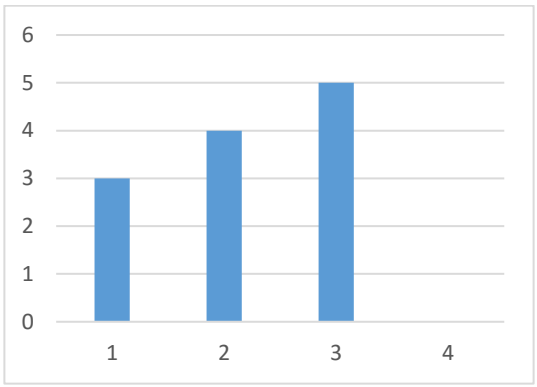
Impact on sustainability



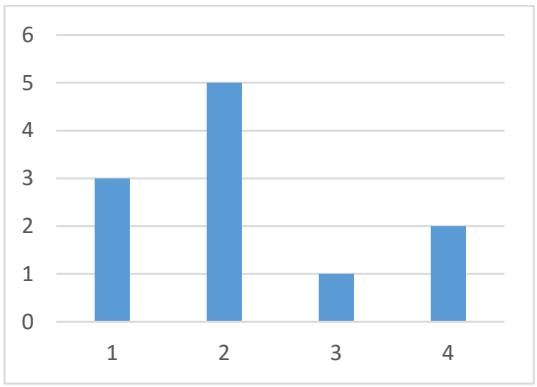
Industry acceptance



Difficulty to implement



Further analysis



Case D: Modal Shift – Dedicate Infrastructure:
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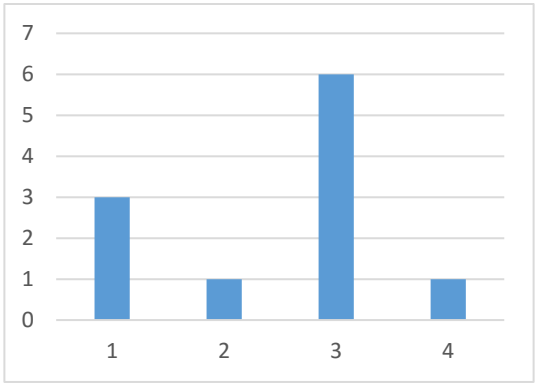
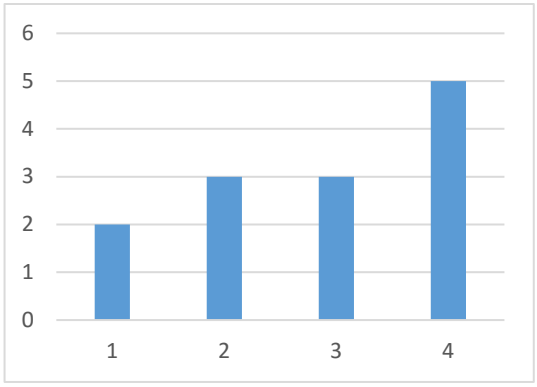
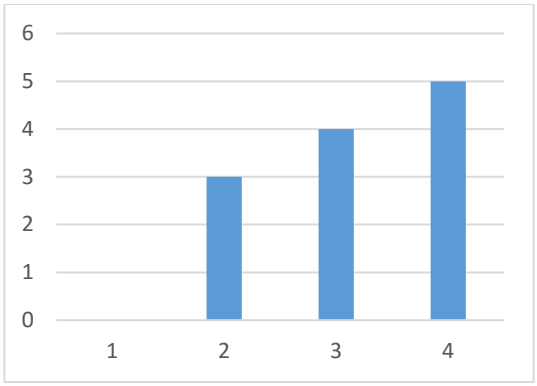
Impact on sustainability



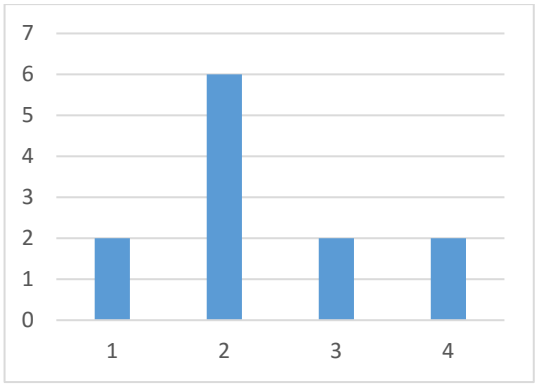
Industry acceptance



Difficulty to implement

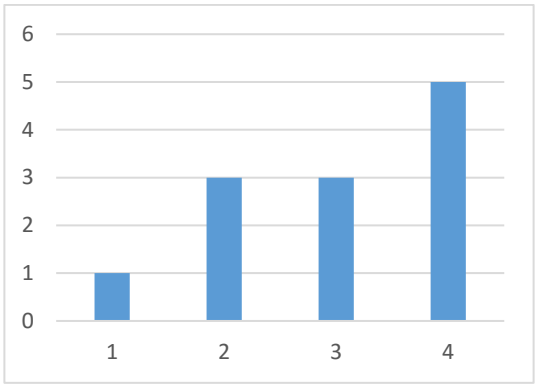


Further analysis

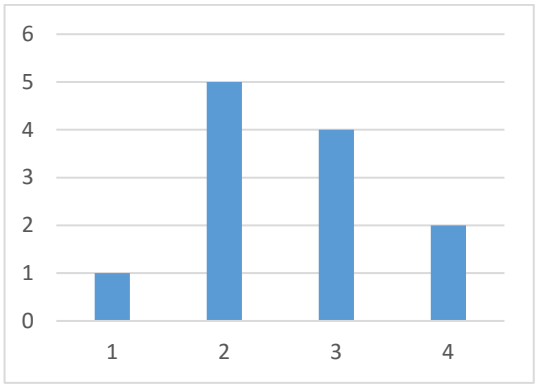


Case E: Intermodal Incentive – Concession Contract:
The modal split minimal limits are controlled by the concession contract and exceeding these limits will generate penalties for the terminal operating company. A measure applied in Port of Rotterdam.

Impact on sustainability



Industry acceptance



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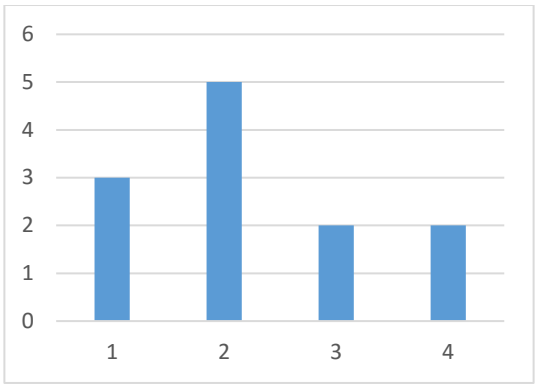

Further analysis