UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

# From A Global Review of Port Noise Management Initiatives to A Specific Port City's Case Study

**Graduate School**

**Master of Science in Logistics and Transport Management**

Supervisor: Marta Gonzalez-Aregall

Master Students: Qianru Shi and Shiying Xu

## Abstract

The increasing port activities enrich the contents of port-city interaction. With the awareness of global climate change and marine environment protection, more and more ports intend to become environmental-friendly or green ports. Both literature and practice on reducing emissions of air, waste and sewage are growing and developing, but fewer attention has been paid to the port noise emission and its impacts for nearby sensitive receivers. This research chooses the port noise management to find the gap and make a feasible proposal for Port of Gothenburg on noise initiatives dealing with issue in American Cruise Terminal.

Through a global review of current ports having noise mitigation measures, the results show that only 46 out of 204 ports have taken such action. Total 126 measures are identified, classified and analyzed with selected parameters on port noise. Europe has the most ports for actively dealing with noise problems, and top 5 ports taking more measures are Port of New South Wales, Port of New York and New Jersey, Port of Helsinki, Port of Auckland, and Port of Metro Vancouver. The most common initiatives are technology (both directly and indirectly), infrastructure (in port area) and investigation (by monitoring). In addition, the stage of mitigation, noise source type, and governance ownership are analyzed. Then in the case study, Port of Los Angeles is implementing customized noise mitigation plans according to different projects in port, and the effectiveness is proved. Also the port-city interaction in Los Angeles gives lessons from various aspects to port of Gothenburg.

That the local situations lead to uniqueness of each port city make us realize that in terms of the port-city interaction on port noise issue, both two parties are indispensable. And with the help of professional acoustics knowledge, port authority should be aware of the overall situation across the world and the necessity of learning from some advanced port cities.

Keywords: port noise, initiative, port city

## Acknowledgement

The Master thesis has been written under the Master program of Logistics and Transport Management with the support from the people involved.

Thereby, we would like to express our gratitude to our supervisor Marta Gonzalez-Aregall who helped us identify topic and offered constructive advice and comments on the thesis. We are also grateful to the employees from Port of Gothenburg who replied to our questions with patience and shared valuable information with us. At last, we would like to show our appreciation to all the members in the seminar group that read our thesis and give constructive feedback. The thesis could not have been done without these persons.

**Qianru Shi** **Shiying Xu**

**May 25, 2019**

# Table of content

## List of figures



## List of tables

## Abbreviations

ACT: American Cruise Terminal

CMS: complaint management system

EPS: External Power Supply

MGA: mutual gain approach

NI: noise identification

NM: noise mapping

PAS: public awareness system

PoG: Port of Gothenburg

PoLA: Port of Los Angeles

PoN: propagation of noise

PTC: port traffic control

UP: urban planning

dB: Decibel

dBA: A-weighted sound level

Hz: Hertz

# 1 Introduction

In this section, the authors majorly present the background of this research, from which the research problems and purposes would be described as well. With such clear awareness of the port noise issue and aims to fill the gap, the structure of the Master Thesis is mentioned through a mapping chart.

## 1.1 Background

As the shipping industry develops, the increasing port activities are viewed as a double-edged sword for port cities in different aspects. Port cities have a dominant role in the urban areas and the hinterlands, especially to connect and complete the transport network, and they also 'play a role either as growth centers and as centers of innovation and modernisation or as restrictive influences on economic and social development' (Gleave, 1997, p257). So far, at a European scale, compared to other human activities such as urbanization and tourism due to creating more jobs and more exchange flows of people plus cargos, thus the overall impact of present port activities probably seems relatively weak and indirect to human living environments (Stojanovic, Smith & Wooldridge, 2006). If in such a way to view the impact of port activities, people including residents and workers who are involved in the port-city interaction, which could have a higher risk to be exposed to long-term environmental issues caused by port activities without effective action.

Nowadays, for many global major ports, environmental management (Brooks & Cullinane (Eds.), 2006) plays an important role in the long-term sustainable development. The interaction between port and city also needs to be reconsidered and fulfilled from various perspectives. Actually, whether it is a city developed by a port or a city developing its port reflects the phenomena that there are increasing contents of port-city interaction. Thus in term of dealing with the environmental problems resulted from port activities, both two sides are ought to pay attention to it and need further deep cooperation.

Recently, within the segmentation of port environment management, noise management has become one of the priorities of environmental management performance (ESPO, 2013) that ports consider, with the awareness that environmental noise is a threat to public health and well-being (Basner et al., 2014; Goines & Hagler, 2007)) and even possibly to woodland structure (Francis, Kleist, Ortega & Cruz, 2012). Additionally, with the goal to eliminate negative effects on individuals, it has been attached great importance since there is a fact that noise is one of the most frequently complained about environmental problems in Europe (Hellmuth, Classen, Kim & Kephalopoulos, 2012). Table 1 presents the priority of noise issue of the EU port sector over time. it is clear to see that noise has been attached more attention by European ports since 1996 when it was not even within top 10 environmental priorities. After 13 years the significance of noise surged and it has sustained a high priority in recent years. Table 2 indicates that the percentage of the European ports which give positive responses to noise has mounted to 68% last year with a growth of 16%. In some sense, port noise has made more ports not ignore this issue anymore.

Table 1 Priority of noise issue of the EU port sector over time

| 1996 | 2004 | 2009 | 2013 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| 10+ | 5 | 1 | 4 | 3 | 3 | 3 |

Source: ESPO Environmental Report 2018

Table 2 Percentage of EU ports that monitor noise pollution

| 2013 | 2016 | 2017 | 2018 |
|---|---|---|---|
| 52 | 57 | 64 | 68 |

Source: ESPO Environmental Report 2018

## 1.2 Problem description

However, even with a growing emphasis on dealing with port noise, it is found that the majority of many ports only take cargo terminals into consideration as the noise management site while few initiatives specifically are taken for passenger terminals. In a port, a terminal is “a section of the port consisting of one or more berths devoted to a particular type of cargo handling” (Stopford, 1997, cited in Mangan, Lalwani, & Fynes,

2008, p30). As a terminal is one of the busiest spots, operation on the berth and noise sourced from vessels and devices is more likely to affect human health of people working or living nearby. With the same reason, being proximate to the downtown can be controversial. For example, in the cruise port of Barcelona, as the cruise terminal is recommended to be located near the city, thus passengers can get to the center on foot (Ros Chaos, Pino Roca, Saurí Marchán & Sánchez-Arcilla, 2018). This geographical characteristic of cruise terminals could be competitiveness, in other words, which is within walking distance to the center and is beneficial to not only passengers but cruise tourism of the city. On the other hand, the terminal is closer to the agglomeration of human daily activities, which means acoustic emission from the terminal can have more serious impacts and the victims could involve more people from diverse groups.

The growing attention paid to environment protection occurred in developed countries, and the European Union has made enormous strides in the global environmental arena and developed a considerable global standing since the 1970s (Zito, 2005) that many other countries in the rest world are following. In fact, Sweden has achieved outstandingly and led the environmental protection in Europe, through ecologically based on technological innovation and social democracy (Rowe & Fudge, 2003). And Port of Gothenburg (henceforth referred to as PoG) always emphasizes sustainability and green port development, so that Gothenburg Port Authority (2018, p16) mentions one of the sustainable objectives for 2025 is to become "a respected innovator in sustainable transport concepts" and the port's environmental impact will be reduced which is meant to contribute to the city's local environmental targets. It could be viewed as a good form of port-city interaction. So far, as for the achievement in operation taken for reducing noise, PoG receives fewer noise-related complaints than ports in other parts of the world receive (ibid). Correlatively, it is calculated that around 100 000 residents in Gothenburg are exposed to traffic noise exceeding the national guideline of 55 dBA (Göteburg Stad, 2015), which is measured inside resident homes and here traffic only refers to city public traffic except maritime transport. Thus data about the noise emission from port activities in Gothenburg is not available among current sources.

## 1.3 Research Purpose

Therefore, being aware of lacking researches about the port noise management instruments by port cities across the world but increasing need to manage this issue, the primary purpose of the study is to summarize the initiatives taken by the port cities all over the world. The exploratory review will address a relatively complete discussion for the similarities and differences on dealing with the noise issues by port cities, which would make up a table or map of the global review of port cities initiatives on port noise reduction. And from the previous discussion, City of Gothenburg and Port of Gothenburg shares the same values for sustainable development and goals for a better environment. And since we are going to further analyze the noise issue in the American Cruise Terminal in the following parts, the second research purpose is to make proposals for the PoG, specifically for ACT.

Located on the west coast of Sweden (Ogren & Barregard, 2016), Gothenburg is the second biggest Swedish city (Börjesson & Kristoffersson, 2015) following Stockholm. Due to the special features of natural environment and industrial development, its major Scandinavian port contributing to the movement of materials and products, and generating emissions as well (Kalmykova, Rosado & Patrício, 2015). So far, PoG is the biggest port in Scandinavia and home to various kinds of terminals (Port of Gothenburg, n.d.c). The terminals for cargo transportation lie in comparably peripheral sites, while the terminals for passengers are located in the city center. We find the ACT can be more influencing as it is closer to residential areas in comparison with other passenger terminals.

2017 became the last year for Frihamn in Gothenburg operating as cruise terminal due to urban re-construction scheme. The new terminal is named America Cruise Terminal in memory of the terminal's glorious history - the first Swedish American Line vessel sailed to America from here a century ago (Port of Gothenburg, n.d.a). From spring 2018 this new municipally-governed cruise terminal relocated at Stigbergskajen in Masthugget, on the same side of the river as the city centre, with a distance of 12 km (Port of Gothenburg, n.d.b).


Figure 1: Before and after relocation of ACT

Source: authors' own modification from Google Map

*Notes: the double-way arrows represent the distance between these passenger terminals and nearby residential areas on the southern side of the river. And highlighted circle area majorly is city center.*

The authors have reached out to someone responsible for this new cruise terminal for getting some basic knowledge of noise problem at the terminal. To date, they have received only one complaint triggered by an old cruise that was staying over the night. This figure, however, does not prove there is no noise pollution from the cruise terminal. From the interviewees we know during daytime inhabitants do not often hear noise emitted from the terminal due to heavy road traffic (EPA Victoria, 1991), yet the cruise terminal noise still exists. Moreover, the sources of port noise comprise not only ship but various activities (ESPO & Guide, 2012), and the ACT seems inactive. As for the PoG, quite few measures are taken to mitigate noise except onshore power (EPS) on cargo terminals reducing noise in some way. In addition to realizing that there is a lack of onshore power charge for cruise vessels, the authors believe that noise by cruise activities worths further investigation and discussion.

## 1.4 Research questions

In order to fulfill the purposes of the thesis, two research questions are developed:

1) What initiatives are being taken by port cities around the world to manage noise?
2) What are the possible initiatives that can be applied to Port of Gothenburg, specifically to the America Cruise Terminal?

With clear purposes and research questions, this study would accomplish values mainly in academic research and practical management. Although many types of research about noise caused by road, rail, and airline transport have been done, and lots of discussions on the port management focusing on pollution as air emission, vessel waste, and water are made, it lacks how a green port can interact with a green city (Gothenburg & Co, n.d.) through taking suitable initiatives. Hence, this research is expected to address the gap by summarizing the global port cities how to take actions to reduce the noise of port activities in an integrated overview. Moreover, as for the port cities which engage in shipping cargo as well as passengers, cruise terminals are normally located close to the city center, thus through our research could ACT in Gothenburg get a constructive suggestion on management to reduce noise from the port activities.

## 1.5 Disposition

Based on the previous part introducing the background and describing the research questions, the research is planned to further deepen the understanding of the port noise issue and the learning about correspond initiatives. Then constantly enriched knowledge framework would be built up through reviewing literature on port activities, port noise and port city. The current situation of lacking international attention on port noise makes this research clearly aim to address a global review of port noise instruments by looking through creating a common list of port cities and summarizing the measures or initiatives taken by them, before further analysing the results with classification and possible correlation. In the end, the global review with author-defined parameters would help come up with a feasible proposal for Port of Gothenburg, with the help of case study.

The structure of the research is arranged relatively according to the mapping chart (see Figure 2), which represents the process that authors think about how to promote the research with the aim to achieve two major expected contributions.

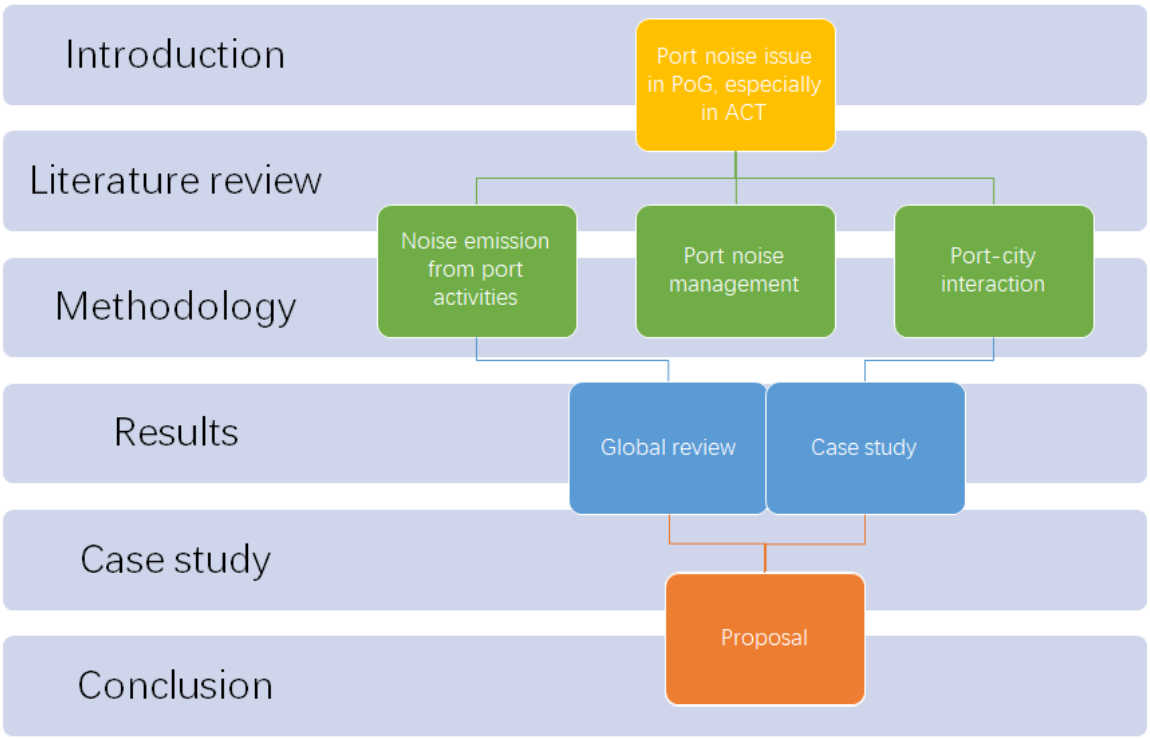


Figure 2: Mapping chart of thesis

Source: Own elaboration

## 1.6 Delimitation

First of all, through the briefly previous investigation and research, so far, there is a lacking of systemic summary of port noise management, let alone the categorization in term of the type of terminal or port activities. In addition, the authors find it impractical to clearly group the noise initiatives according to the implemented spots of cargo terminal (de Langen et al., 2007) and passenger terminal (Tzannatos, 2010) since even most port authorities are not specific to differentiate them, which makes it hard to discuss what measures are the most suitable for the cruise terminal in this research. In order to avoid confusion in future analysis, this study will conduct a general discussion of all the port noise mitigation measures found, whether for cargo or passengers.

Then the research object is the noise from port activities, as discussed in the literature review, even the authors have repeatedly stressed that noise emissions do not occurred in the remote hinterland but from industrial activities and traffic flowing through port area either entering into or from the urban area, the traffic noise is still hard and ambiguous to define. Thus to except the trucks and railway in the port, the authors have

to group that the movement of the berth-side or yard-side other mobile cargo-handling vehicles all belongs to the port industrial activities, which could avoid unnecessary misleading. It would not consider all kinds of noise mitigation on the port hinterland, which might hardly avoid the limited scope of research if there exist some serious noise issues about port activities beyond the spatial range discussed in this research.

And lastly, the authors also find that some ports are natural habitats, rich in animal and marine life, and have the noise mitigation plan for marine mammals, especially for endangered species (Buxton et al., 2017), rather than humankind. Although these port cities are taking initiatives on port underwater noise (Slabbekoorn et al., 2010) and there is no doubt that port noise management for nature creatures should be encouraged, they are not included in the result of the global review. It could be considered as an option for future research.

# 2 Literature review and Theoretical framework

This section will present the previous researches related to this topic and provide the readers with the theoretical knowledge to understand following sections. There are mainly three categories with connections being discussed. Port activities have great impacts on its city both positively and negatively, especially during the process of deepening port-city interaction, the long-term social-economic development has attached great importance to the environmental management for both sides. Thus, the issue of port noise is the emphasis that the authors are going to investigate both basic concepts and comprehensive understanding of current management.

## 2.1 Port activities

As Stopford (2009, p81) defines that a port is "a geographical area where ships are brought alongside land to load and discharge cargo – usually a sheltered deep water area such as a bay of river mouth", from the spatial perspective, port activities could happen from the internal port area to the outer urban area, even extending to the external hinterland as long as they are related to the port. However, port activities in this study are specifically human activities mainly centering around the port area and the city area in which it is located. In addition, the chosen segmented spatial port activities are the same ground where port-city interaction starts, changes and strengthens, since Gleave (1997) states that port activities often shape urban areas through the spatial structure of certain functional regions. The type of those functional regions also changes as port become a local logistics center and tourism spot to create more functions.

### 2.1.1 Positive impacts by port activities

The impacts of port activities on port cities contains various aspects. In a positive way, although to pursue their commercial objectives and implement environmental programs (Stojanovic et.al, 2006) often could be faced with dynamic challenges, ports are still the stable centers of integrated transport and logistics systems. And there is another positive impact on employment levels that 'in a region with one million workers, an increase of 1 million tons of port net throughput would determine an immediate increase of about 400–600 jobs, depending on the model specification' (Bottasso, Conti, Ferrari, Merk & Tei, 2013, p37), thus port activities are important for individual livings and hardly possible to be replaced. Again, Dooms, Haezendonck and Verbeke (2015)

confirm this added value is important to convince stakeholders with the evidence, as mentioned before that the positive impacts range from macro contribution for the whole region even the country to micro development in term of resident incoming and better living environment brought by waterfront redevelopment (Hoyle, 2000).

### 2.1.2 Negative impacts by port activities

When it comes to the negative impact, most cause for concern than environmental issues. As Stojanovic et.al (2006) mention

> "port developments have the potential to significantly affect: Ecology and Nature Conservation, Landscape, Archaeology and Cultural Heritage, Recreation and Tourism, or Drainage and Water Quality. New activities in ports may give rise to Visual Impacts, Health impacts such as Lighting, Noise and Vibration, or Environmental impacts including Air, Water and Soil Quality issues." (Stojanovic et.al, 2006, p166)

Therefore, emissions from ships, port activities (other than ships), and industrial activities in port (Trozzi & Vaccaro, 2000), which directly lead to different pollutions and makes more ports and stakeholders reconsider the importance of these passive impacts of port activities. In other words, all ports are faced with the same challenge as the establishment of a balance between economic and ecological interests (ibid). With the deepening of research on environmental issues during port activities, Gupta, A., Gupta, S. and Patil (2005, p134) categorized seven major pollution problems caused by port and harbor activities except noise pollution. And other perspectives to categorize impacts are put forward, for instance, Hurley (2004, cited in Morris & Gibson, 2007, p450) suggests three separate environmental concerns due to the impacted fields.

It could be learned from the categories shown above that environmental impacts by port activities have raised up more public attention, especially on the pollution of air and marine water quality. The environmental concern mentioning noise even without clear definition still helps the authors realize gradually increasing attention and consideration to resolve.

Faced with such challenge, noise pollution from port activities pushes different parties to take initiatives. Puig, Wooldridge, Michail and Darbra (2015) analyze and discuss the results of the Dashboard 2013, with a result as the Top-10 environmental priorities

of the port sector and the benchmark performance in the environmental management of European ports. The ranking of priority always changes year by year, but the content of air quality, water quality, garbage/port waste, noise, energy consumption, dredging and dust remains stable. However, in practice, the urgency of dealing with the noise pollution due to port activities is underestimated for a long time, compared with other environmental issues. To fill in the gap of researches and cases on noise issue by port activities is the priority in this research.

## 2.2 Port city

### 2.2.1 Definition

The absence of a unified definition for the 'port city', in some extents, reflects the fact that it is difficult to analyze as a single unit (Reeves, Broeze & McPherson, 1989; Morvan, 1999). One possible definition stresses the geographical characteristics of ports and cities. As Ducruet and Jeong (2005) define the "area in transition" (Hayuth, 1982; Hoyle, 1989) at a local scale and the nodal system as a whole, including multiple cities and ports within a regional area at a wider scale. Then the idea of "system" (Forno, 1985, cited in Ducruet, 2011) again brought up that it is a city where port and maritime activities have such a strong influence on the local economy that the city depends on the port to exist. Similarly, UNCTAD (2008) recognizes the significance of port cities in boosting all levels of the economy (particularly seaborne trade) over the last three decades. Lee, Yeo and Thai (2014) share the same opinion, thus defining port city as a city that is home to a port and relies on port directly-related and/or indirectly-related activities. Simple causality or complementarity cannot simply explain the concept of a port city.

Attributed to the astoundingly rapid development of port activities (Lee et al., 2014), port cities have been expanding not only in size, but the definition of the port city has broadened over time. Since maritime transport always plays an important role in the process of human history, together with the increasing density and level of human activities, the definition of port city varies from time to time. Many urban-port models study the nature of relationships between ports and port cities, and the matrix of port-city relations developed by Fleming and Hayuth (1994) and modified by Ducruet (2005) are helpful as a start. Hence, in this research, considering spatial and economical as a

crucial factor for most major cities having ports, the authors define the research object of port city as a city having a port in the network of world maritime market, and more importantly, the economic heart of a city is its port (Verhetsel & Sel, 2009).

### 2.2.2 Port-city interaction

A port, though seen by its community as an economic engine with high economic value (Suykens, 1989), in fact, there is no need to prove the Ports' economic importance to earn the support of their community, their states, counties, and cities (ibid), on the contrary, sharing the same values and interests more than economic development is the key to maintain long-term support. Just as Caramuta, Giacomini, Longo, Padoano and Zornada (2018) mention that the port-city interrelationship which includes not only technical aspects, but also, social, environmental, governance and economic issues. With more researchers studying on this topic, gradually enriched aspects in port-city relationships, as Hoyle (1999) points out

> "Whereas short-term financial gain may be the primary objective of a developer, the affected communities are concerned with the wider implications for socio-economic and political change, and ultimately with the sustainability of the changes introduced on whatever scale." (Hoyle, 1999, p66).

From other points of view on the interaction content, port-city relationships, in fact, cover a wide range of themes related to logistics, tourism, tertiary activities, and planning (Bienfait & Delsalle, 1989; Amato, 1999). Generally speaking, the start of relationship and interaction between port and city comes from the economic interests of both sides, then it expands to other different aspects. Moreover, Lee, Song and Ducruet (2008) put forward two port-city relationships: one is in favour of port-city integration, while the other one, in contrast to the former one, is supportive of segregation of port from the city. Also, we could view port-city interaction as a system, according to the classification by Hayuth (1982), consists of the spatial system (mainly comprising the changing land use in the port) and the ecological system (mainly comprising environmental issues).

As more values created by the service industry like tourism, ports begin to have another important economic role developed from leisure and tourism, thus there is a logical synergy between the port and urban functions (Daamen and Vries, 2013) offered by

related port tourism activities like in the case of Barcelona and Marseille, but "such a port–urban mix hardly seems possible in port areas dominated by transshipment and industrial business functions" (ibid, p9). Additionally, Griffin and Hayllar (2006) explores two waterfront precincts in Australian cities and suggest that waterfront construction is vital regarding the context of the overall experience of the tourist within a city. Therefore, as more economic contribution could be made by the port attracting tourism, contents of interactions between Port of Gothenburg and City of Gothenburg would be further enriched. And to provide a better natural environment and perfect facilities, leading Gothenburg to be an attractive destination for tourists and a better city to live in, both Port Authority and port city should collaborate in developing sustainably.

### 2.2.3 Long-term port-city interaction on environment

In the *FUTURE NOISE POLICY - European Commission Green Paper* (European Commission, 1996), the environmental noises, induced by traffic, industrial and recreational activities are considered as the main local environmental problem, especially in urban areas. Although this Green Paper only proposed new framework outlining options for reducing road traffic noise, rail noise, air transport, outdoor equipment except port noise, it helps decision makers take noise abatement into consideration with a higher priority in the long term.

From an environmental aspect, the pollution and emissions from port activities recently have become major considerations in the development and operation of ports and port areas (Beresford, Gardner, Pettit, Naniopoulos & Wooldridge, 2004). So in this research, the authors think that the port-city interaction on the environmental issue of noise is the main task since the attitude towards the role of a port in a city can be contingent on attention to the environment. For example, as environmental (sound, air) and safety regulations do play a dominant role in keeping the general public away from port activities (Daamen and Vries, 2013), but if they are only passively away, the author is still skeptical about whether the implementation and application of some common regulations will become a new hindrance to further cooperation and integration of ports and cities.

In the case of ACT, the relocation caused by the urban plan seems irrelevant to the waterfront redevelopment due to lacking solid information from the City of Gothenburg.

However, from the perspective of long-term interests, initiatives taken by the port or municipal government to manage noise on this new location and reduce its impact on nearby residential areas are necessary for future development.

### 2.2.4 Organizational factor in port-city interaction

It seems that port-city interaction sometimes is shaped by the organizational relationship between city and port. When it comes to the organizational factor, the 'level of environmental legislation has been influencing the patterns of marine conservation and port development and operation' (Stojanovic et al., 2006, p165). The vast majority of city governments have a certain legislative power to promulgate administrative regulations. It could clearly be learned that the organizational structure of the port and city could be a factor to affect good interaction.

Based on previously discussing the importance of the organizational factor in port-city interaction, regarding it as one of the vital parameters, the authors shall start with the clear definition of port management governance models by mainly using administrative models under the world bank reform toolkit (World Bank Port Reform Toolkit, WBPRTK, 2007). Moreover, the authors would combine it with the governance ownership later, since the WBPRTK models focus more on the allocation of responsibilities. The WBPRTK (ibid) outlines four port administration models differen by 'whether public sector, private sector or mixed ownership provider is to provide services, their orientation (local, regional or global), who owns the superstructure and capital equipment, and who provides dock labour and management' (Brooks, 2004, p169).

Later, the authors find that Baird (2000) provides the best overview of four models (two with differing emphasis on mixed public/private provision). From his research, only under private management model, regulator is private sector. In term of the role played by local government when dealing with the port noise issue, it is necessary to consider the identification by Baltazar and Brooks (2006) as:

1) Central government-owned and controlled;
2) Government -owned but management and control decentralized to a local government body;

3) Government-owned (national, regional or municipal) but managed and controlled by a corporatised entity;
4) Government-owned but managed by a private sector or a public-private partnership;
5) Full privately owned, managed and controlled.

Therefore, the authors have combined the two ways (see Table 3) to study the possible correlation between efficacious port noise initiatives and port-city interaction, which is mostly shaped by the type of governance ownership of the port authority.

Table 3: Governance ownership of the port authority adjusted to the research

<table>
<tr><th>Responsibilities</th><th>Service</th><th>Tool</th><th>Landlord</th><th>Private</th><th>In this Research</th></tr>
<tr><td rowspan="5">Governance ownership</td><td>Central government-owned and controlled</td><td></td><td></td><td></td><td>Federal/Central ownership</td></tr>
<tr><td colspan="2">Government -owned but management and control decentralized to a local government body</td><td></td><td></td><td rowspan="4">State-owned; public-mixed Municipal; public-private mixed;</td></tr>
<tr><td></td><td colspan="2">Government-owned (national, regional or municipal) but managed and controlled by a corporatized entity</td><td></td></tr>
<tr><td></td><td></td><td>Government-owned but managed by a private sector or a public-private partnership</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Full privately owned, managed and controlled</td><td>private</td></tr>
</table>

Source: adapted and modified from World Bank Port Reform Toolkit, module 3, p. 21., and Baltazar and Brooks (2006).

## 2.3 Port Noise

In a general way, the problems caused by noise pollution are serious as European Environment Agency (2016, p5) mentions that 'almost 20 million adults are annoyed and a further 8 million suffer sleep disturbance due to environmental noise'. Night time noise greater than 40 dB(A) has been suggested to potentially lead to sleep disturbance (World Health Organization Regional Office for Europe, 2009). In the same aspect, noise pollution in the marine and port environment shall not be underestimated. In term of port noise, increasing researches and investigations about the effects of noise within port cities are carried out, for instance, the case study made by Litvin, Luce, and Smith (2013) which reflects a conflict between the local community and port economic function as a local commercial key component mentioning that residents living near the terminal complain air and noise pollution generated by cruise ships. To develop local tourism, the common rule is to locate the terminal's heart-of-the-city location ideal (ibid), however, at the cost of some residents. Therefore, based on the negative impacts of port noise, this study is going to update the initiatives from port cities around the world due to insufficient literature on the trend of port management on noise pollution.

### 2.3.1 Definition and sources

"Port noise can be classified as industrial noise." (Schmidt, Steenbeck, Borsch, Hofmann, & Kroh, 2019, p22), in general coming from traffic and port industry (NoMEPorts, 2008). Two of industry-related sources, ship berth and cargo handling are what distinguishes port noise from other common kinds of noise (Morretta, Iacoponi & Dolinich, 2008). Among the vessels berthed, Morretta et al. (2008) deem ferry and cruise ships as main culprit because passenger terminals are mostly located near to the areas that are densely populated for the sake of tourism.

In the case study of Port Harcourt, Omubo-Pepple, Briggs-Kamara and Tamunobereton-ari (2010) find that public address systems (loudspeakers) turn out to be one of the major noise pollution sources. Also according to Trozzi and Vaccaro (2000), sources of noise can be individuated in port areas in the following three areas:

1) road traffic as passenger car and heavy vehicle (trucks);
2) goods movement (from machinery);
3) rail traffic noise in port and in surrounding areas.

It could be learned from the grouping above, noise caused by port activities basically related to the movement of the marine cargos including passengers.

In this research, port noise becomes an underestimated challenges regarding the interaction between port and city. The main research object on port noise shall align with the research purposes, hence the noise caused by port activities would only focus on overlapping area of city and port instead of expanding to its hinterland. Port noise sourced from the major port area and the nearby residential area would further be classified and discussed when the port noise management instruments are analyzed by some related parameters to noise sources. But it is obvious that the sources of port noise are often grouped as traffic-related and port industry-related. Hence, as for this research, it is necessary for the authors to establish a clear judgment principal of port noise sources for further analysis of the measures.

### 2.3.2 Negative externalities

Port noise are detrimental to both humankind and ecosystem (Schenone, Pittaluga, Repetto & Borelli, 2014). There is a broad range of potential effects of these sounds, especially when they are very loud or when they are less intense but long lasting (Popper and Hastings, 2009). This paper does not involve the impacts on nature, especially on the marine mammals. Instead, only the impacts on city, comprising of people in the urban area and workers at the port, are taken into account here. They suffer physically and psychologically, as shown in Figure 3. Apart from health damage, Noise Exploration Program To Understand Noise Emitted by Seagoing ships (henceforth referred to as Neptunes) (n.d.) introduces a few economic effects, e.g. medical care cost, production loss, insulation expense, etc.

Such negative externalities are not in a single way from port to city but vice versa. Dissatisfied and even irritated victims may complain, leading ports to be penalized or compelled to operate restrictedly. Sometimes relocation to peripheral sites can happen as well (Axell, Bolin & Svedin, 2004).

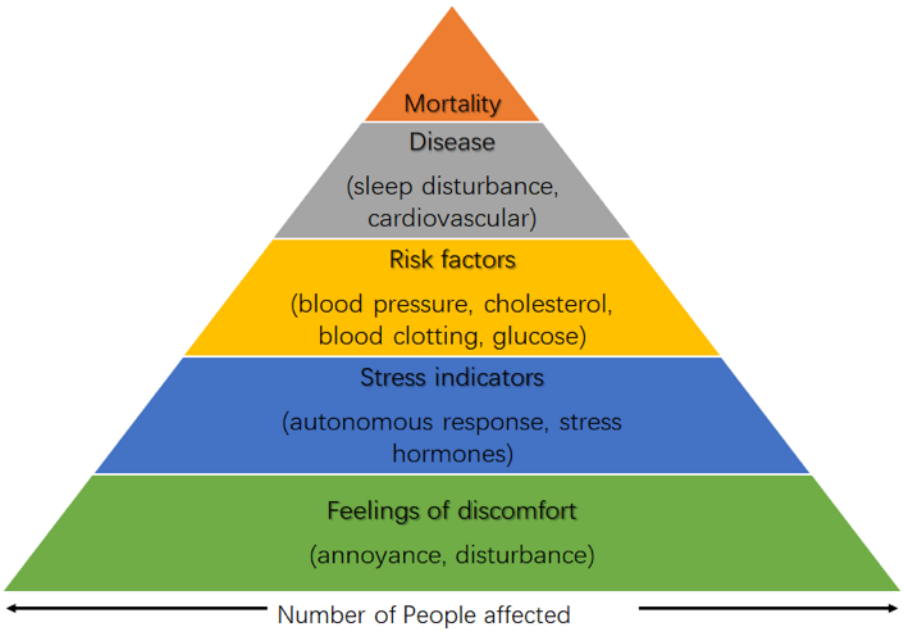


Figure 3: Severity of health effects of noise and number of people affected

Source: WHO report 2011, 100

### 2.3.3 Term of Acoustic emission

Due to the professionalism of the noise study, there are many terminologies to measure noise. On the one hand, acquiring the term of acoustic emission could help the authors to understand the difference in noise initiatives among these port cities. On the other hand, it also helps the authors to choose a relatively appropriate term or unit of a baseline to know whether the initiatives are effective or not in the subsequent case study.

1) Decibel (dB), defined by the statement that two amounts of power differ between one transmission unit at two ratios, and later adopted for the" transmission unit" (Martin, 1929). However, none of a term used for quantities could fully embodies the characteristics of an object, thus this term also leads to confusion and error in application (Horton, 1954). Also during the process of making global review, dB is not the most commonly used by port cities as a unit of measurement.
2) Sound pressure level (SPL), with intensity are expressed as a sum of acoustic modes, given in terms of the blade force mode components (Namba, 1977). And

many researchers are using it to study relationships with other acoustics terms, for instance, Shaw (1974) finds a function of frequency at 15° intervals in azimuth to achieve transformation to the human eardrum. On the other hand, Dromey and Ramig (1998) compare SPL effects and rate on respiratory, phonatory, and articulatory behavior.

3) Frequency, in general, "the primary signal was correctly detected 75%–90% of the time while signals with frequencies at approximately 150 to 200 Hz" (Greenberg & Larkin,1968, p1513). As for the low and high frequency out of normal human hearing, 55 dB HL is the baseline as the degree of hearing loss, especially when this degree of hearing loss was present at frequencies of 4000 Hz and above (Hogan & Turner, 1998, p440). But in this research, either low or high frequency of sounds is not discussed, particularly about the negative impact on marine mammals caused by low-frequency port noise.
4) A-weighted sound level (dBA), the A-weighted sound pressure level indicates the human response (e.g. loudness and annoyance) to environmental sounds caused by living, transport, etc (Parmanen, 2007). Actually A-weighting has been criticized as not applicable on the short-term loudness and annoyance of road-traffic sounds with wide variation in low-frequency content (Nilsson, 2007).
5) Equivalent noise level (Leq), the equivalent level was defined as a continuous sound level compared to the actual noise observed with all the variations embedded (Zannin, Ferreira & Szeremetta,2006). Thus, with the consideration of clear measurement period, Leq is often used in initiatives taken by port cities related to specific time period.
6) Day/Night noise level (Ld/Ln), also some cases develop it as day-evening-night level (DENL) to differentiate noise level in specific time zone shaped by human activities. Hence, "day-night average sound level is still the most adequate noise descriptor for use in environmental impact analyses to assess the annoyance and overall impact of noise from general transportation" (Finegold, Harris & von Gierke, 1994, p29), which is also found in many port cities who applies regulations to measure the impact or emission of port noise.

Apart from these commonly used terms described above, the authors also find other terminologies such as Community noise equivalent level (CNEL) that is an average A-Weighted sound level specified but may be of arbitrary duration including 1 and 24

hours (Berger, 2003) and Ambient noise level, which is usually used to measure the marine activities' impacts on marine habitat (Hildebrand, 2009). However, some terms are not widely applied by port cities, and some are out of our consideration in this research, due to the main focus is people working and living in port and nearby residential area.

To sum up, both theoretical researches and real practices all indicate that measurement of acoustic emission shall combine more than one term to completely and objectively reflect the real situation faced with by different groups.

### 2.3.4 Port noise management and mitigation

#### 2.3.4.1 Projects

Because of the shorter distance between passenger port and residential area, the noise issue becomes more complicated owing to a higher level of noise emission and impacts. For instance, Puig et al. (2015) list the EcoPorts Noise Management System for ports and NoMEPorts who have been developing a noise management for ports from 2005 to 2008. In order to deal with port noise problem, some ports are acting on mitigation of noise pollution, collaborating and setting up many projects and programs. Here the brief introduction of two projects where GoP is involved.

(1) Neptunes

Since noise emission is no longer a local or regional but global trouble, 11 ports across the world initiated the project called "Noise Exploration Program To Understand Noise Emitted by Seagoing ships", aiming to address acoustic nuisance from ships at berth (Neptunes, n.d.). The program (n.d.) is divided into four stages:

1) Inventory for understanding and insights of noise pollution
2) Measurement protocol to measure noise level of different vessels moored
3) Noise label, after quantification outcome, in terms of sound power level and proportion of low frequency sound.
4) Best practice guide summarizing various actions to mitigate port noise

(2) GCP

Green Cruise Port (Schmidt et al, 2019) – Sustainable Development of Cruise Port Locations" project was launched in 2016 in order to promote cruise industry in Baltic Sea regions (BSR) in an environmental-friendly manner. Organizationally GCP is made up of 20 entities: port authorities, cruise lines, a non-profit state-owned organization together with a maritime institute. Geographically all BSR countries and the neighboring North Sea are involved. For achieving both economic boost and environmental advancement in the cruise sector GCP (ibid) sets up an action plan for 2030 constituted by four phases: strategic planning, operational planning, monitoring and improvement, as well as execution. Figure 4 presents top 5 environmental actions of every concrete target in the operational stage.

| Measure | Area | Emission focus | | | | Evaluation | |
|---|---|---|---|---|---|---|---|
| | | GHG | Air | Noise | Waste | Impact | Efforts |
| **Vessel-related emissions** | | | | | | | |
| On-shore power supply | Ship-port interface | ☑ | ☑ | ☑ | | 🟢 | 🟡 |
| LNG bunkering facilities: truck-to-ship | Ship-port interface | ☑ | ☑ | ☑ | | 🟡 | 🟢 |
| LNG | Vessel fuels | ☑ | ☑ | | | 🟡 | 🟡 |
| Energy efficiency measures | Vessel | ☑ | ☑ | | | 🟢 | 🟡 |
| Exhaust silencers | Vessel | | | ☑ | | 🟡 | 🟢 |
| **Port-related emissions** | | | | | | | |
| Emission reduction target | Whole port area | ☑ | ☑ | ☑ | ☑ | 🟢 | 🟢 |
| Obtain "green" energy | Whole port area | ☑ | | | | 🟢 | 🟢 |
| Eco-driving lessons | Pier & CHE | ☑ | ☑ | ☑ | | 🟢 | 🟢 |
| Waste fee reduction | Whole port area | | | | ☑ | 🟢 | 🟡 |
| LED technology | Terminal building | ☑ | | | | 🟡 | 🟢 |

Figure 4: Top 5 environmental actions

Source: Green Cruise Port

2.3.4.2 Global Organization

Since sustainable development of marine activities is important for the human being, not only the regional cooperation is carrying on, but also more global organizations are

working on it. Here we mainly discuss the representative international organization as the International Maritime Organization **(**IMO) who plays a leading role in marine environment, to get a current global status of implementation and promotion on port noise management.

As the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. (IMO, n.d.a), in term of the noise issue, the Code on Noise Level on Board Ships published by IMO from 1982, which are 'regulations, recommendations and advice are intended to provide Administrations with the tools to promote "hearing saving" environments on board ships' (IMO, 2014, p1), IMO keeps making efforts on the noise from shipping industry including port area. And for example, a ship that meets the 70 dB(A), which IMO external noise limit would be applied to (IMO, 1975, cited in Merk, 2013).

When the authors browse the overall content of IMO's work on marine environment whose focus has changed over the last few decades to include a much wider range of measures to prevent marine pollution, but the structure of mandates is quite complete as "Pollution prevention", "Pollution Preparedness and Response", "Ballast Water Management", "Biofouling ", "Anti-fouling systems", "Ship recycling", "Port reception facilities", "Special Areas under MARPOL", "Particularly Sensitive Sea Areas (PSSA)", "London Convention and Protocol", "GESAMP (Group of Experts on the Scientific Aspects of Marine Environmental Protection)", and "Technical Cooperation on Marine Environment" (IMO, n.d.b).

To better promote the process of mandates, the Marine Environment Division of IMO also executes a number of donor-funded major projects in the area of marine environment protection (IMO, n.d.c), which is divided into seven projects. But it is obvious that the emissions by ships like air, waste, chemistry and GHG are the major objects taken initiatives by IMO. And these projects are hardly directly related to port noise but it is still positive to implement IMO mandates across the globe. Even as IMO mentions that an interesting survey result is that noise exposure for the port community (workers, neighbours) is also perceived as an environmental challenge, although to a somewhat lesser extent (Starcrest Consulting Group, LLC, CE Delft, & Civic Exchange,

2015). Thus, the lack of global consensus on the port noise issue, which could result from its being not as "urgent" enough to attract enough attention as other issues.

In addition, it is found that some other international organizations are paying more attention to environmental impacts triggered by the port activities. For instance, the Organization for Economic Co-operation and Development (OECD), whose mission is to promote policies that ensures the environmental implications of economic and social development are taken into account (OECD, n.d.), have published a few researches and studies like *Ranking port cities with high exposure and vulnerability to climate extremes* (Nicholls et al., 2008) that offers important data about port cities to this research. Take Nils Axel Braathen (2011)'s book for an example of the related port noise issue, which is found that the author provides examples of the environmental problems related to port activities like noise, and highlights the limitation of the negative impacts by policy instruments.

To sum up, although the port noise management is promoted within a considerate number of port cities, the incomplete specific guideline for port noise from international organizations still exists and makes it difficult for this research to outline the global review.

#### 2.3.4.3 Regulations

Noise legislations vary remarkably from country to country (Neptunes, n.d.), which could explain lack of international standards of managing port noise and hardly-reached global cooperation on this issue. So far through the efforts from few organizations regardless of whether international or regional, the authors have found (see in Figure 5) that responsibilities are mainly taken by ports and shipping industry and partial regulations do make difference such as the noise code on board by IMO. But most regulations are hard to measure since different regulators would consider various interests related to practical situations.

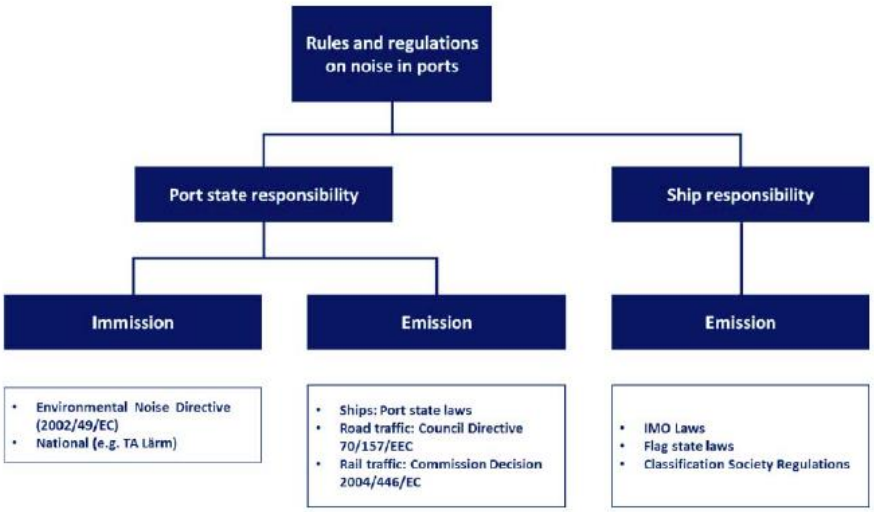


Figure 5: Rules and regulations on port noise

Source: Green Cruise Port, 2018

2.3.4.4 Noise level threshold

In order to easily get a basic judgment of some policies or baseline applied by port cities, the research would select a noise level threshold by looking through current widely-used threshold from authoritative reports or rules. Ut at Laeq 8h levels of 75 dBA and lower, even prolonged occupational noise exposure will not result in noise-induced hearing impairment (ISO, 1990). This value is equal to that specified by WHO (Berglund, Lindvall, Schwela & World Health Organization, 1999). And the World Health Organization (ibid) recommends that for a good night's sleep, continuous background noise should stay below 30 decibels and individual noises should not exceed 45 decibels (European Commission, 2015). According to European Commission (2016), the authors also find that 55 dB Lden is quite commonly used to measure outside daytime noise of residential area from traffic or other activities. And above 55 dB long-term average exposure, noise can trigger elevated blood pressure and lead to ischaemic heart disease (European Commission, n.d.). Therefore, in the following analysis and discussion, the noise level of 55 dB is going to be the baseline to define the ‘annoying noise’ (Shepherd et al., 2011) for people working and living around port areas.

Also as for the noise in working environment, if a sound reaches 85 dB or stronger, it can cause permanent damage to hearing (Dangerous Decibels, n.d.). Thus the authors

disagree that many sources state or imply that sounds as loud as 85 decibels (dB) are safe and are “unlikely to cause damage.”, let alone 90 dB for eight-hour working (Selwyn, 2010). The only evidence-based safe noise level for hearing is a surprisingly low 70 dB average noise exposure for 24 hours (American Tinnitus Association, 2016). Therefore, the authors regard 85 dB as the maximum of port noise tolerance in a short time.

#### 2.3.4.5 Management and mitigation measures

Given the harm of noise exposure there is a necessity for ports to become a nice neighbor and some ports are endeavoring to become good neighbors. According to Axell et al. (2004) port noise management is supposed to include the following 8 steps:

1) Noise mapping and modelling at and near the port is the very beginning of the whole process, equipping the port with a sense of its noise issue. “you can’t know what you can’t measure” (Peris-Mora, Orejas, Subirats, Ibáñez & Alvarez, 2005, p.7). Noise mapping is one of the best ways of understanding environmental noise (Tsai, Lin & Chen, 2009), which belongs to simulation computer models and GIS, which is used to quantify and visualize noise effects based on these noise levels (de Kluijver & Stoter, 2003).
2) Source identification helps find the spots with grave noise nuisance.
3) Evaluation is necessary to test the effectiveness of the instruments being taken. Besides, the project Green Cruise Port (Schmidt et al., 2019) recommends another criterion evaluation can base on: costs of implementation. An initiative associated with plenty efforts is seldom preferred though conducive. Combining the two criterion ports are able to figure out cost-effective solutions.
4) This is followed by an action plan of measure adjustment and betterment to lower noise level in ports.
5) Next step is to implement the new actions.
6) Complaint handling cannot be utterly eliminated no matter how advanced the measures are. The complaints should be taken seriously with feedback, but more importantly with actions.
7) Follow-up is aimed to assess how the actions are influencing the adjacent communities.

8) Administrative work consists of documentation, reporting and communication to stakeholders for being transparent and fulfilling duties.

In this paper part of the focus of port noise management is placed on measures to address acoustic discomfort, aligned with the purpose of the paper. According to noise stages, the project NoMEPort (n.d.) and Merk (2013) put forward three types of measures (see Figure 5) and the project Neptunes (n.d.) supplements a fourth kind,

1) Reduction at the origin, frequently deemed fundamental, refers to to tackle acoustic impacts on board the ship.
2) It is viable to abate noise when it is travelling in the air.
3) The third one targets at victims of noise pollution.
4) The rest falls into other measures which barely reduce noise directly but indirectly.


Figure 6: from noise source to receiver
Source: Neptunes, n.d.

Neptunes (n.d.) makes an overview of common instruments (see Table 4 to Table 8) with description, audience, expected result together with estimated cost (with regard to complexity to execute, time and capital needed). Audience refers to the objects addressed to, namely the parties who are in charge of the instruments. The cost has four levels where A, B and C represents low, intermediary and high cost respectively, CS represents cost saving. Although all of them contribute to abating noise negative externalities arising from port activities, for most ports the first measure overrides the other three in that without doing so they can barely expand (Axel (Ed), 2011).

Table 4: Mitigation at the source

| Title | Description | Audience | Result | Cost |
|---|---|---|---|---|
| Machinery | Machinery on board a ship | Shipowners, shipbuilders, shipping companies, ship | 1-20 dB | A-C |

| | | | | |
|---|---|---|---|---|
| | | engineers, maintenance staff | | |
| Silencer | equipment to abate sound close to the source | Shipowners, shipbuilders, shipping companies, ship engineers, silencer manufacturers, maintenance staff | 1-30 dB | A-C |
| External Power Supply | Replacing vessels' auxiliary engines with external power supply when ships berthed | Shipowners, shipbuilders, shipping companies, ship engineers, terminal owners, port authorities, ship's crew, maintenance staff | 1-10 dB | C |
| Public address systems | Communication for emergency and entertainment announcement on vessels | | Indirectly reducing the nuisance of residents | A-C |

Source: adapted from Neptunes

Table 5: Mitigation during propagation

| Title | Description | Audience | Result | Cost |
|---|---|---|---|---|
| Propagation of noise | Extending distance or constructing shielding | Shipowners, shipping companies, terminal owners, port authorities, maintenance staff | 6 dB per distance doubling or 1-10 dB | A-C |

Source: adapted from Neptunes

Table 6: Mitigation at receiver

| Title | Description | Audience | Result | Cost |
|---|---|---|---|---|
| Insulation | Insulating dwellings | Port authorities, city planners, real estate owners and investors, building owners, contractors | Indirectly 1-30 dB | A-C |
| Mutual Gain Approach | Mutual understanding when port is | Port Authorities, terminals, governments | Acceptance/perception/ compensation | CS |

| | | | | |
|---|---|---|---|---|
| (MGA) | developing | | | |
| Expectation | Informing residents of noise produced by port activities | Port Authorities, terminals, governments as port owners | Acceptance/perception | CS |
| Urban planning | When designing a residential district | Authorities, architects and urban planners | Depends on the type of work being done | B-C |

Source: adapted from Neptunes

Table 7: Other measures

| Title | Description | Audience | Result | Cost |
|---|---|---|---|---|
| Awareness | Sustainable transformation in awareness and behaviour | Sailors, port authorities, terminal staff, tug captains, shipowners | Depends on the type of work being done | A |
| Organisational planning | Measures taken by non-government organisations | Port authorities, terminal staff | Depends on the type of work being done | B-C |
| Complaint management systems | Listening, acting and replying to complaints regarding acoustic emission | Port Authorities, (local) authorities | Acceptance | A-B |
| Cargo | Internal operation (ship) and external operation (harbor) | Shipowners, shipbuilders, shipping companies, ship engineers, terminal owners, port authorities, cargo handling operators, ship's crew, maintenance staff. | Indirectly reducing the nuisance of residents | |
| Manoeuvring | Berthing manoeuvre for reaching or leaving | | Indirectly reducing the nuisance of residents | A-C |

Source: Adapted from Neptunes

# 3 Methodology

This section describes and motivates the methodology selected in this thesis, consisting of research approach, data collection, research design and research quality. The aim is to elaborate on how the study was composed to fulfill the purpose of the study.

## 3.1 Research approach

In this research the purpose is to obtain a sense of how port cities worldwide perform concerning acoustic emission. Collis & Hussey (2014) argue that qualitative methods place focus on interpreting data. Port noise management initiatives is a relatively unexplored topic, and there is a necessity of an exhaustive investigation to collect data. In the study a global review has been performed. After data were collected they were interpreted to contribute to the parameter table serving to analyse the findings. That qualitative research is characterized by subjectivity gives rise to that the outcomes are hard to generalize (Bell, Bryman & Harley, 2018). In spite of the disadvantage, this topic is rather new and lack of knowledge, hence it needs deeper understanding via interpretation on the findings gathered from various sources, echoed by Bryman and Bell (2015). This method is especially applied for the first question "What initiatives are taken by port cities around the world to manage noise". For the second question "What are the possible initiatives that can be applied to Port of Gothenburg, specifically to America Cruise Terminal" qualitative approach alone does not suffice. Thereby, quantitative methods are necessary and adopted in the study. The results have been analysed and interpreted with the help of quantitative methods to become more understandable and perspicuous.

The study uses abductive reasoning, a hybrid of deductive and inductive reasoning (Bryman and Bell, 2015). As aforementioned, the topic is new accompanied by uncertainties. The thesis adopts deduction by reviewing literature to obtain a deeper knowledge concerning the topic. Then data were collected and analysed to investigate the performance of the port cities on the list on tackling noise pollution, after which the conclusions were drawn. This can be seen as inductive approaches, typically associated with small sample size as well as in-depth study (Saunders, Lewis & Thornhill, 2007). The fundamental merit of abduction is that it can be employed for exploring new topics (Kolko, 2011).

## 3.2 Data collection

### 3.2.1 pilot study

To help complete the research design through identifying some possible crucial features of the research object (Arnold et al., 2009), a pilot study that might lack effective hypothesis-testing (Arain et al., 2010) but still offers some direct and indirect facts to the authors for improving the feasibility of this research. In practice, the authors had conducted a semi-structured interview, which are made up by a group of open-ended questions (DiCicco-Bloom & Crabtree, 2006), with Martin Eskelinen, who is the Cruise Operation Manager at the department of Business Area Energy and Cruise. This interview aimed to get relatively complete information about the America Cruise Terminal due to the lack of detailed information on the official website.

Furthermore, the authors kept following-up contact via e-mails with Martin Eskelinen to learn more about the specific noise issue around the America Cruise Terminal. From the interview and e-mails, the data about the America Cruise Terminal was used to clarity the demand of studying potential problem and later help make the feasible proposal.

### 3.2.2 Full port list creation

There is no existing common list of all port cities around the world (Aregall, Bergqvist & Monios, 2018), so the authors need to create our own list. And in order to find out those port cities taking initiatives on port noise, the methodology used in this research is to match all possible related databases (shown in the Table 8) then to get an outcome of cross-comparison supplement. Using the World Port Source, which provides basic information for the ports in 196 countries around the world (World Port Source, n.d.a) as a tool, the authors are able to check the selected ports through links of official websites. Since the port noise issue mostly depends on the busy port activities related closely to local, regional, national and international economic transactions, the authors believe that the more important role played by the port in development of city and its hinterland, the more likely sustainable development is to be considered and promoted, so the port-city interaction on port noise management would be a focus point. Thus following this logic, the final common list (See Appendix 1) contains 204 port cities

around the world. A qualitative review was made through searching all available information on these ports in the list by visiting port official websites, noise management projects, sustainable reports, city regulations, and some researches on specific cases about port noise. As a result of an exhaustive review, 46 ports with 126 initiatives on port noise emission are found and further analyzed.

Table 8: Databases to create full port list (own elaboration)

| **Database** | **list title** | **level** | **aspect** | **No. of member** |
|---|---|---|---|---|
| OECD | Port-cities and their population and port growth in Europe and North America and Asia | regional | population | 50 |
| | Leading cities in port-related research | global | port cities | 26 |
| | World port ranks on centrality measures 2011 | global | ranking measures | 20 |
| UNCTAD | Container ports throughput for 80 developing countries/territories and economies in transition | global | container ports | 40 |
| world shipping council | top 100 ports in the world in 2015 | global | container | 100 |
| iaph | Database of IAPH Member Ports | global | international association of ports and harbours | 200 |
| aivp | membership | global | the worldwide network of port cities | 184 |
| World council on city data | membership | global | noise issue | 12 |
| C40 cities | membership | global | take bold climate action | 94 |

### 3.2.3 Secondary data

Based on the databases as listed before to create the common list, the process of collecting data majorly focusing on the integrity and representativeness of global port

cities. Then to collect pertinent information for this research, a global review has been carried out of the ports on the list through looking through the official websites along with scholarly articles to find all related data about noise initiatives. In other words, the process of collecting two types of data is different, one pays attention to quantity, one pays attention to quality, that is, the content of information. Also, in the latter case study, data that can prove effective measures is vital for collection.

## 3.3 Research design

### 3.3.1 Parameter list creation

After checking the list and find useful information about noise initiatives taken by port cities, another important step in the analysis is to understand possible interaction between parameters during the process of measures being considered, decided, developed and evaluated. These parameters suggested by previous literature review and then selected are shown in the Table 9: they represent internal and external, direct and indirect parameters concerning port noise issue from some general aspects (the listed "common parameter") to relevantly classified aspects (namely the "specific parameter").

In addition, the integration of the indicator analysis and the multi-actor multi-criteria methods (Caramuta, Giacomini, Longo, Padoano & Zornada, 2018) provides an alternative to define the key stakeholders in the noise management when the authors define and select the parameters, even later to help make proposal for the Port of Gothenburg. Thus excluding few too localized features and some parameters with ambiguous definition, the analysis of parameters would start with assuming the process of how the port authority will take measures on port noise and all possible related stakeholders. The main purpose of evaluation is to show possible correlation within parameters and to provide port cities with a feasible framework that helps them to decide, design and develop the noise initiatives. In this research, consequently, a proposal for Port Authority of Gothenburg to American Cruise Terminal would consist of results found. And the collection of information about regulation applied to each port on noise mitigation is aiming to figure out a commonly used baseline or reference for later analysis but not to study the possible relation, since regulation always differs due to local situations.

Table 9: Selected parameter list (own elaboration)

| common parameter | specific parameter | | |
|---|---|---|---|
| | name | definition | example |
| noise initiative | title of initiative | the general title of initiative used by ports | machinery; EPS; silencer |
| | Category of policy/measures | The type of initiatives taken by the port city on port noise with further grouping according to subcategory | technology, infrastructure; investigation; communication; permission; pricing |
| | Stage of initiative | the phases of mitigation | source; propagation; receiver; other; supportive |
| | Noise source | The generators of port noise | Industry (operation; construction); traffic |
| | term of acoustics emission | terminology used for measurement or setting baseline | dB; dBA; Hz; Ldn |
| | Expected reduction/ effect | results of noise project with available data | evidence like noise reports |
| | Estimated costs | The extent of investment and other cost for implementation | Low; medium; high |
| | stakeholders | All possible parties or individuals involved in port noise management | Participants; victims; performers; beneficiary |
| | Evaluation | a well-designed process must have pre- or after- evaluation | Pre-assessment; noise mapping; noise screening |
| feature of port | country | indirect impact on decision and initiatives on port noise | national regulation; environmental awareness |
| | Distance to residential areas | Spatial distance between noise sources and receivers could shape the propagation | Depending on each port |
| | Port authority management | Organizational structure would define personnel arrangement and responsibility | governance; centralization; privatization |
| regulation | applied regulation | principle applied to port policy on noise or direct reference on initiatives | national regulation; state regulation; city regulation; port authorized policy |
| | regulator | the regulation maker | central government; state |

| | | | |
|---|---|---|---|
| | | | government; city government; port authority |

### 3.3.2 Categorization

To fill the lack of systematic categorization of initiatives taken for mitigating port noise, considering the current classification from similar professional research in other fields less understandable, the authors plan to use more widely-accepted concepts to generalize all initiatives found. In the later analysis, this categorization is also helpful to grasp the global situation of approaching port noise and find out differences under different classifications. Here are the main 6 categories:

1) Communication: the process of sharing or exchanging important information to enhance the understanding and awareness of port noise management.
    a) Internal: within a port organization, here it mainly refers to the education for port workers and vessel crew to perform in a greener approach.
    b) External: among a port authority and other involved stakeholders including companies, local community, etc.
2) Infrastructure: various kinds of infrastructure are constructed or improved to beat noise nuisance. It is further divided into 3 groups according to the where the initiatives apply.
    a) Port: building some noise mitigation construction or adapting new requirements and materials to current buildings within port area;
    b) Port-city interface: building some noise mitigation construction in the transition space between port and residential area.
    c) Residential area: building some noise mitigation construction or adapting new requirements and materials to current buildings in residential area.
3) Investigation: noise prevention measure, though not directly contributing to diminishing acoustic emission and excluded by some classification, often taken before and after the implementation of noise mitigation project/program.
    a) Monitoring: using some sound sensors to detect changes at various spots during specific time period, to achieve quantitation of the noise emission.
    b) Mapping: applying some mathematical software or computer applications to the digitalization and modelization of collected quantitative data.

c) Identification: figuring out the noise source before making suitable mitigation measures.

4) Permission: port rules and regulations to standardize various kinds of activities in term of operation generated noise.
   a) Operation: official permit of time, devices, location, etc., mainly targeting at all kinds of cargo-handling activities.
   b) Construction: official permit of time, devices, location, etc., for construction activities in port to redevelop or expand infrastructure.
   c) Traffic: official permit focusing on the movement of cargo or passengers by transportation tools like rail, truck, bus, barges, etc.
5) Pricing: ships can be charged lower fees if they implement measures on noise mitigation, or in other forms of tax related to noise mitigation.
6) Technology: refers to cutting-edge measures targeting at improving ships and land-based vehicles
   a) Direct: working directly on machinery elements that trigger noise, e.g. propulsion
   b) Indirect: working not directly on machinery elements that trigger noise, e.g. silencer and external power supply

### 3.3.3 Case study

The exploratory case study is in general adopted for a research question that is comparably new or has not been much studied, aiming to identify patterns to develop instead of testing certain hypothesis (Collis and Hussey, 2013). After a global review of methods taken by ports to address noise, a port city will be specifically studied to gain an in-depth knowledge of what the port is doing and whether it has come to fruition. Thus in term of the selection of suitable port, since learning from the result found in this research, the major reason to choose a better port for the case study is that a complete procedure design for the port noise management including noise evaluation, initiatives and regular noise reports with sufficient data. New challenges often occur when a port construction project takes more space and create more noise emission, also leading to increasing operation. The port management model applied to the port is same as the port of Gothenburg as the municipal governance structure, and the interaction with local community in both two port cities shall be emphasized, as well as the shared values on environment. In order to ensure the Port of Gothenburg could learn lessons

to combine local situations and specific demands, the available information like reports or data is a must to know whether the noise initiatives are effective or not.

## 3.4 Research quality

### 3.4.1 Reliability

In terms of the research quality, the authors mainly adopt interpretivism that is often characterized by low reliability but high validity (Collis and Hussey, 2013). Since basically reliability tests the consistency of research (Adams et al, 2007) and hardly is used for testing qualitative research, but it could refer to the quality concept in qualitative study with the purpose of "generating understanding" (Stenbacka, 2001). According to the previous definition, the authors collect and summarize the latest data, and rarely consider the possible deviation owing to changeable internal and external environment for port activities, so that it could be regarded as low reliability. On the other hand, the latter concept can correspond to the purpose of the research to come up with a global review, which would narrow the gap of academic researches among different port environment issues and rise up attention on port noise. Moreover, the examination of trustworthiness is crucial (Golafshani, 2003) to ensure reliability in qualitative research, the sources of data collection as databases, academic researches and port official publications are credible in a period of time. Even with critical attitude towards these sources, the authors also have some confidence in the reliability.

### 3.4.2 Validity

The validity refers to the extent to which a test measures what it is supposed to measure (Collis and Hussey, 2013), reflecting the strength of a conclusion (Adams, Khan, Raeside & White, 2007). In other words, it is reflected on whether the results in this research are applied to other studies or not. Adams et, al (2007) mention that two major kinds of validity are Internal (relationship between program and outcome, eg causal relationship) and external (ability to generalize outcome to other settings). The result of a global review on port cities with initiatives on port noise affecting human beings is bound to generalize and contribute to the sufficient researches. Although the authors have counted and analyzed the number of port cities with noise management, the aim of the global review is to offer people with an analytic way to deal with port noise in their own particular situation. And through the case study, the proposal made for Port

of Gothenburg, specifically for American Cruise Terminal also fits the aim to help related parties to attach importance to port noise and proactively take measures. It is obvious that the validity of the research is considerably high.

# 4 Results

This section starts with basic findings from the global review in the perspective of geographical distribution of cases, noise source, initiative popularity. The ports are then segmented according to initiative quantity against initiative diversity. At last discussion concerning the findings are presented. The results exclude actions not concrete enough to analyze or not within this research scope. In this way, the authors have found 46 out of 204 ports with in total 126 initiatives to subdue port noise contamination. In other words, 22% on the full port list are coping with annoying noise problem.

## 4.1 Geographical distribution of cases

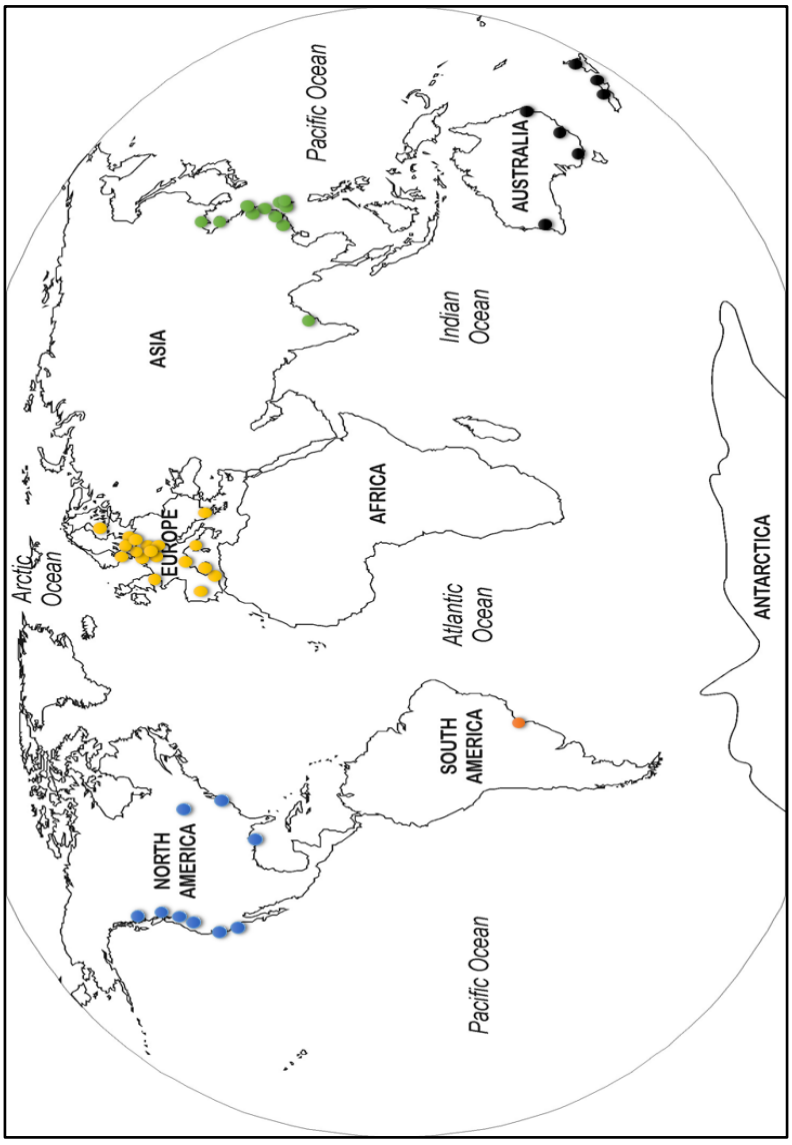


Figure 7: Location of cases (points)

Source: own elaboration

Table 10: Summary of cases by location (own elaboration)

| Continent | Cases | Initiatives | |
|---|---|---|---|
| | | Total | Per case |
| Asia | 10 | 19 | 1.9 |
| Europe | 18 | 40 | 2.2 |
| North America | 9 | 33 | 3.7 |
| Oceania | 8 | 33 | 4.1 |
| South America | 1 | 1 | 1 |
| Total | 46 | 126 | 2.7 |

Figure 6 maps the ports working on noise. Table 10 lists the number of initiatives adopted in various continents. It shows that Europe has 18 cases, the highest number. Asia (10) occupies the second place, followed by North America (9), Oceania (8) and South America (1) in sequence. It is a little disappointing but not surprising that not a single case is found in Africa and Antarctica, and that only one case is identified in South America. Antarctica, owing to geography and harsh weather, is not easily accessible nor livable; while Africa and South America are struggling to improve economy, thus paying little attention to the environment, let alone acoustic emission that fails to obtain as much attention across the globe as other environmental issues do, e.g. air emission and water (Murphy and King, 2014). In terms of the total number of initiatives, Europe (40) tops the list again. Oceania and North America share the second place with 33 initiatives, a modest lag. In Asia 19 are implemented, nearly half of those in Europe. Once more South America (1) bottoms the list. Oceania (4.1) and North America (3.7) have the highest figures of initiatives per case, which means each port tends to take multiple actions. It is a different situation in Europe (2.2) and Asia (1.9) where actions are more dispersed.

## 4.2 Noise source

Much as the noise sources are not articulated in the most cases, the actions are taken more or less help reason out the sources, but some are too vague to specify hence

marked as n/a, which are excluded here. To make it clearer to understand, Figure 7 illustrates how noise sources are categorized in this these. Noise emitted from port industry activity amounts to 90 (71%), 43 (34%) of which arise from port operation, the foremost trigger. Traffic accounts for merely 7%. The low occupation can due to either traffic indeed being quieter, or traffic-related noise not counting port noise because port authorities take limited duties for it (NoMEPorts, 2008).

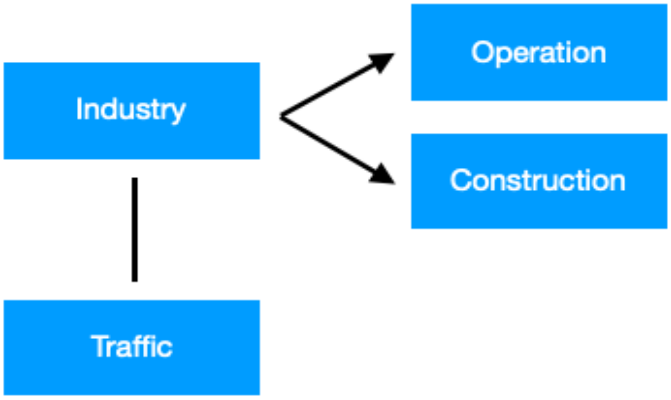


Figure 8: Port noise source

Source: own elaboration

Table 11: Port noise sources in the cases (own elaboration)

| Source | Subsource | Number |
|---|---|---|
| Industry | Operation<br>Construction<br>N/A | 43<br>9<br>38 |
| Traffic | Traffic | 9 |
| N/A | N/A | 27 |
| Total | | 126 |

## 4.3 Initiative categorization

Table 12: Categories and subcategories of initiatives (own elaboration)

| categories | subcategories | | |
|---|---|---|---|
| communication | internal | external | |
| infrastructure | port | interface | resident |

| | | | |
|---|---|---|---|
| investigation | monitoring | mapping | identification |
| permission | operation | construction | traffic |
| pricing | | | |
| technology | direct | indirect | |

In the current modern era, it is not striking that Technology (43) defeats any other category. Its subcategory Indirect (23) is the most popular and Direct (19) is the third most popular amongst all the subcategories. Following is Infrastructure (30), more constructed within the port area (20), which is only second to Indirect, than in the residential area (6) or at the interface (4). Then comes to Investigation (23), a widespread noise prevention means. In comparison with Identification and Mapping that are applied in few cases, Monitoring (16) can absolutely be viewed as prevailing. Permission (15) and Communication (13) are less but not rarely employed. The occurrence of external communication more than doubles that of internal one, which means training and education upon port staff to foster the awareness of green operation seem to not yet suffice. The last option is Pricing (2), reflecting that ports do not usually work hand in hand with shipping lines on acoustic emission.

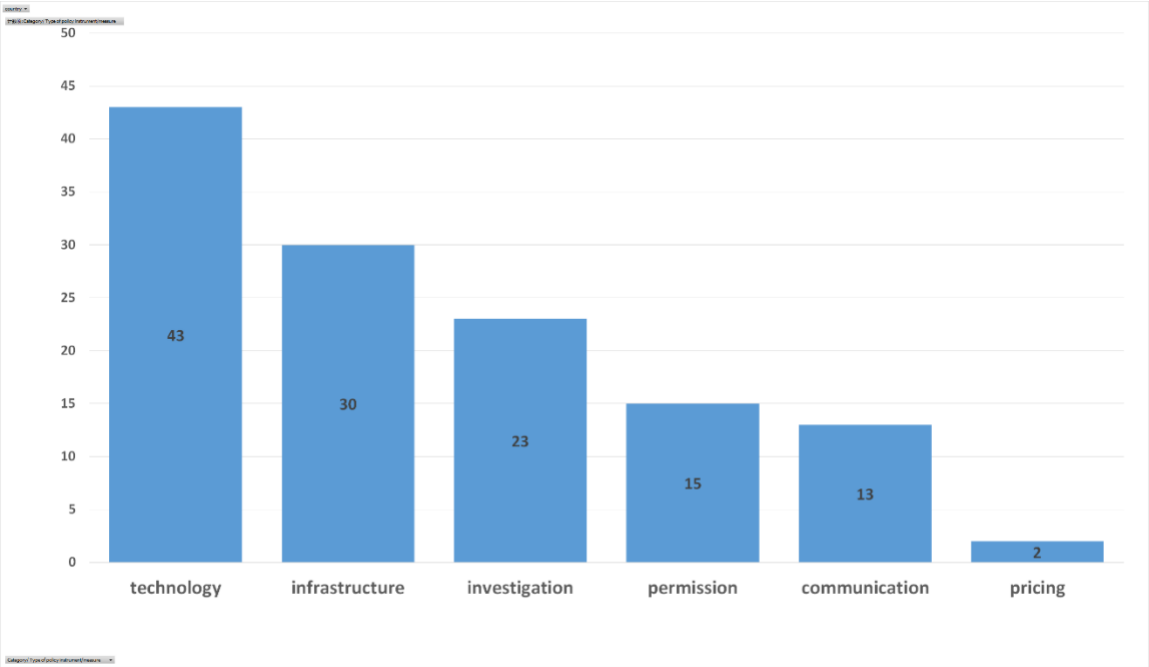


Figure 9: Ranking of initiative categories
Source: own elaboration

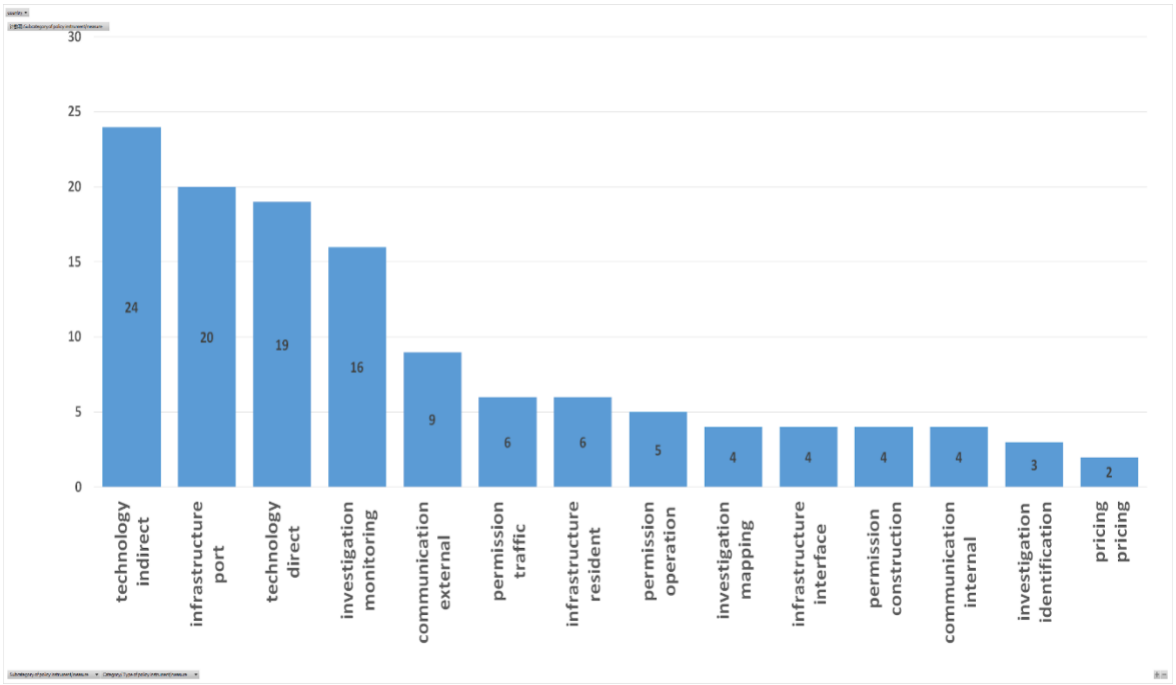


Figure 10: Ranking of initiative subcategories

Source: own elaboration

## 4.4 Noise stage

As introduced in literature review, Neptunes (n.d.) segmented solutions to noise abatement according to noise stages. With the overall goal of the Neptunes project is to increase awareness and gain support to reduce noise from seagoing ships (Neptunes, n.d.) Best Practice Guide (ibid) is to provide a number of proven and applied noise measures that can be used to mitigate ship-generated noise at berth. Since the main noise trigger in Neptunes report is the seagoing ships at berth, but port activities in this research are not limited to ships. As discussed before, port activities regarded as noise sources include industrial activities consisting of operation and construction, as well as traffic flow within port-city area. Apart from construction in the port to expand infrastructure and improve capacity, all of operation and traffic (within port and city) aiming to handle the "cargo flow" are necessary to be segmented or further classified. As a result, those measures categorised as "Cargo" and "Manoeuvring" by Neputus would be classified into "Machinery" here instead and the definition of "Machinery" applied in this research is correspondingly broader.

Moreover, the authors enrich the kinds of initiatives, which are defined according to the phases of mitigation. In many practical cases of ports working on noise issue, for

example, many ports view monitoring as an important part of the noise management, and in this research, the authors believe that monitoring also functions as a method to prove the effectiveness of initiatives. Hence, such measures shall not be ignored, especially with the trend of booming information technology in digitalisation. As a result, a new category of mitigation is added as Supportive. One new measures, NASA-cooperation that is not brought up in literature is to be supplemented and fit into Other.

Thereby 126 instruments fit into 4 groups and 18 sorts. Those that keep the same as in Neptunes have been introduced before and are not explained here.

1) Source:
    a) Machinery: besides machines on board a ship, those for cargo loading and unloading, port construction and vehicles driving within the port city are included as well.
    b) Silencer
    c) External Power Supply (EPS)
    d) Public Address System (PAS): communication for emergency and entertainment announcement on any vehicle, not only on ships
2) Propagation:
    a) Propagation of Noise (PoN)
3) Receiver:
    a) Insulation
    b) Mutual Gain Approach (MGA)
    c) Expectation
    d) Urban Planning (UP)
4) Other:
    a) Noise Mapping (NM): In this research, the authors regard it as a visualization tool used for digitalising data of noise management.
    b) Noise Identification (NI): in practice, it often functions as primary part before taking specific initiatives to identify what actual individual noises were causing the high peak sound levels (Kahn, et al., 1998). Although it doesn't have direct effect of reducing noise impacts, it matters the determination of acoustics sources and type of initiatives, thus it is sorted into group of supportive measures.

c) Monitoring: the application of some sensors in fixed points to detect the continuous changes of noise over time enables parties engaged in port noise management to assess the urgency of taking action, as well as the effectiveness of on-going initiatives.

d) Awareness

e) Complaint Management System (CMS)

f) Tug: using tug for berth maneuver

g) Regulation: schedule of port operation

h) Port Traffic Control (PTC): requirements of vehicle standard operations (Shannon et al, 2016) within the port city

i) NASA-cooperation: control sound from flight off the coast, which is new and not introduced in literature. This unique case happens in Houston, US, where the innovative research center for aircrafts is located. NASA uses area of Port of Houston to do experiments, consequently the cooperation is an outcome of localization and not able to generalize to other ports.

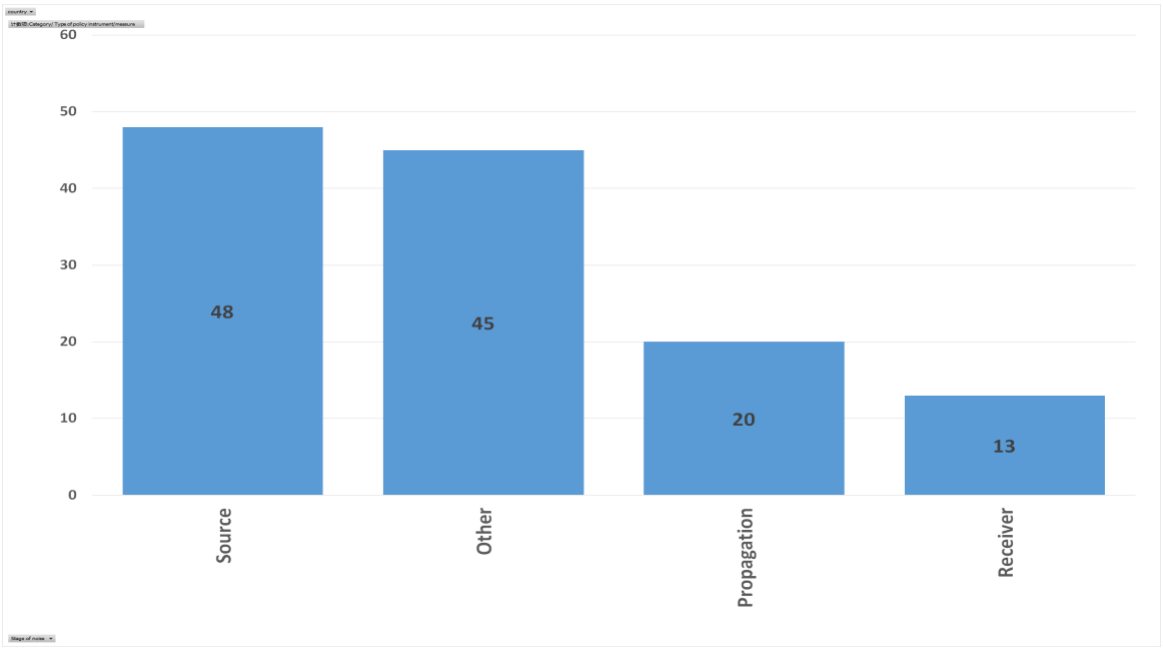


Figure 11: Ranking of initiatives according to noise stages

Source: own elaboration

Among 126 actions, 48 fall into “Source”, 20 “Propagation”, 13 “Receiver” and 45 “Other”. In other words, 38% of all implementations take place at the noise origins, 16% in the transmission path, 10% at the receptors and 36% at any point or along the way. It is clear to tell that the initiatives are most well-received addressing the very culprits

of this discomfort partly in that stage is enlarged resulted the by broader definition of machinery in this research. Alternatively, the priority of Source is attributed to it helping relieve noise discomfort at the origins (Neptunes, n.d.). Particularly sought-after of Source is "Machinery" (27) amongst all sorts. Lessening noise in the propagation path is moderately opted by ports, in which noise is not tackled at the sources and less effective but diminished when arriving in residential areas. Receiver is the least popular one, with 2 out of 4 sorts bottoming the list. One explanation is this is not a radical solution to the noise issue but more a cure of the symptoms. Or it is because then inhabitants are more than bystanders, leading to ports being restricted. Although still passive inhabitants are more deeply involved and have power to make decisions instead of simply seeing what ports do. Ports cannot act at will, having to converse with inhabitants or solicit inhabitants' consent. Often government bodies need to cooperate as well. It is not easily achievable for several parties to reach an agreement.

## 4.5 Port segmentation according to number and diversity of initiatives

As shown in Figure 11, there are remarkable differences among the cases on the quantity of initiatives taken. Outstanding are the cases with over 5 measures, two of which are located in Oceania, two of which is located in North America and one of which is located in Europe. Port of Dalian (China) has most implementations (5) in Asia. It is fair to say all the continents but South America are home to seriously noise-concerned ports, with Oceania and North America in the lead.

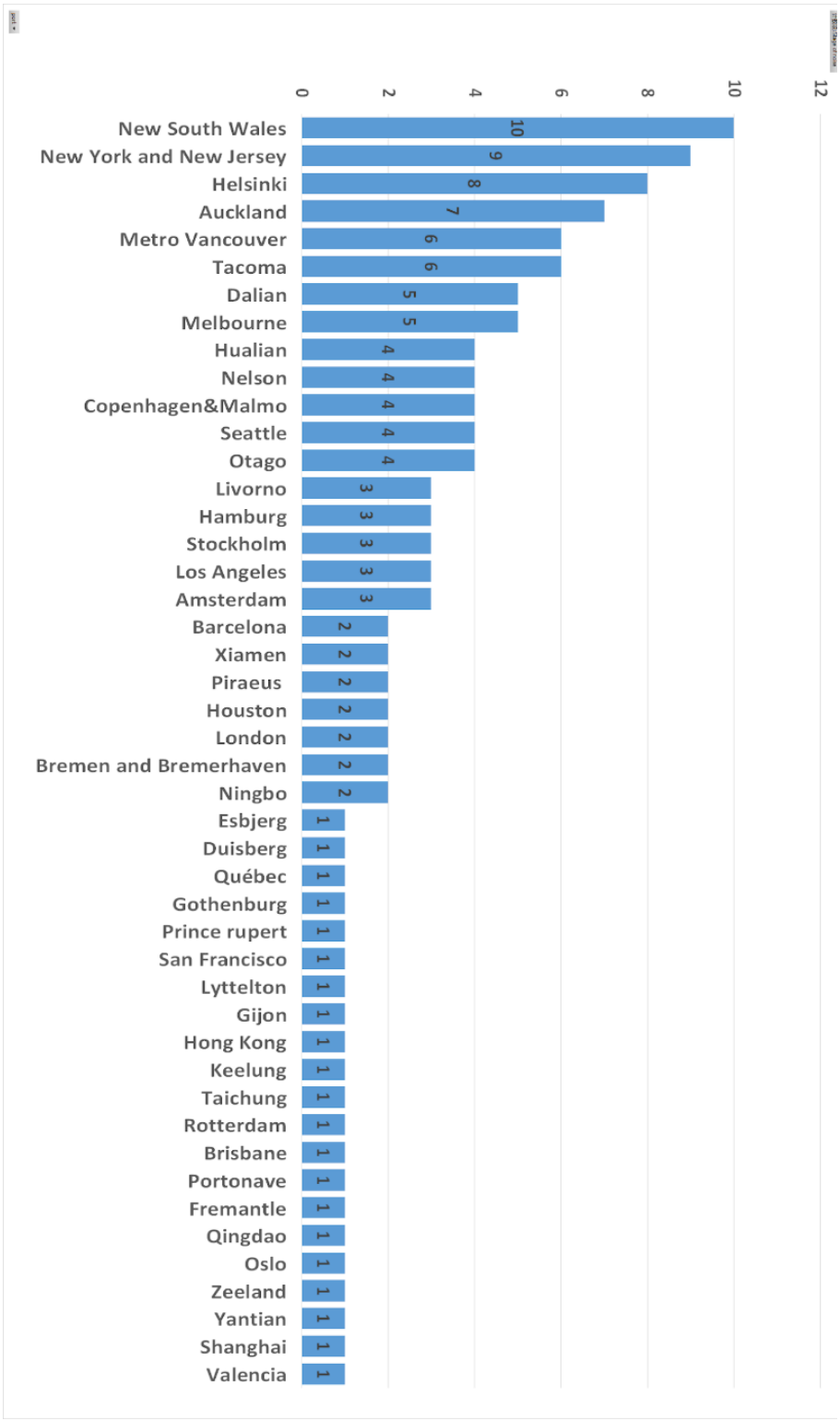


Figure 12: Ranking of ports according to number of initiatives

Source: own elaboration

The next step is to look to the distribution of the cases according to initiatives and noise stages. Ports are segmented into 4 groups as illustrated in Figure 8. Some ports with plenty implementations involve multiple noise stages while others tend to focus on only

1 or 2. Although the upper left group launches fewer initiatives, it has a wide variety in terms of noise stages. Bottom left is a cluster of ports with a low diversity in both variables. Furthering the finding, Figure 11 shows how cases are distributed according to initiatives and initiative categories to illustrate the variety of initiatives. The cases are basically divided in the same way, four combinations of quantity of initiatives and quantity of categories.

Port of New South Wales (Australia) has most implementations (10), which target at 2 stages and 4 categories. Despite more than one stages and categories involved, it can hardly be viewed as a diverse port given the quantity of initiatives it takes. Similar are Port of Metro Vancouver (Canada) and Port of Tacoma (America) where the stages and the categories are less than diverse given the quantity of initiatives taken. Port of Melbourne, with 3 stages and 4 categories against 5 initiatives, is no doubt a port with initiative breadth. The upper left group is larger in Figure 12 than in Figure 13, which means cases with fewer measures are more likely to diversify in noise stage than in category. What is interesting is 2 cases have all 4 noise stages while none has all 6 categories.

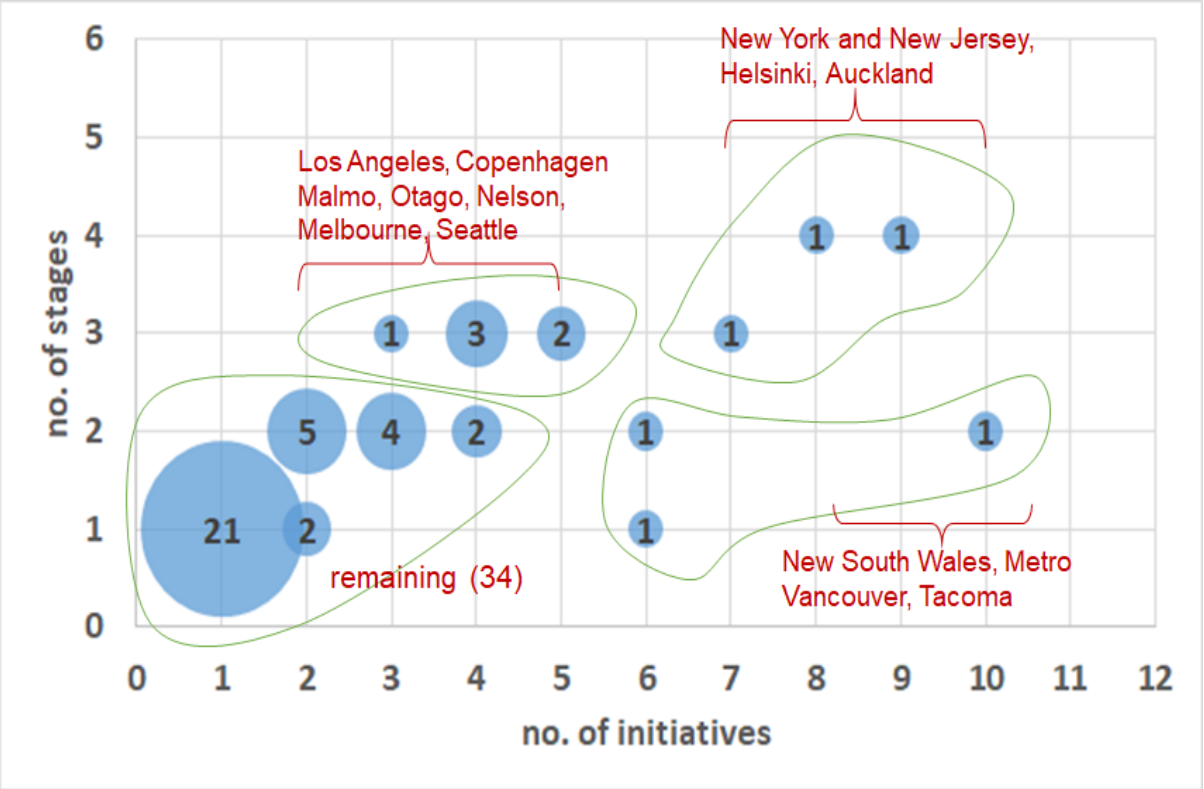


Figure 13: Cases plotted against number. of initiatives and number of noise stages

Source: own elaboration

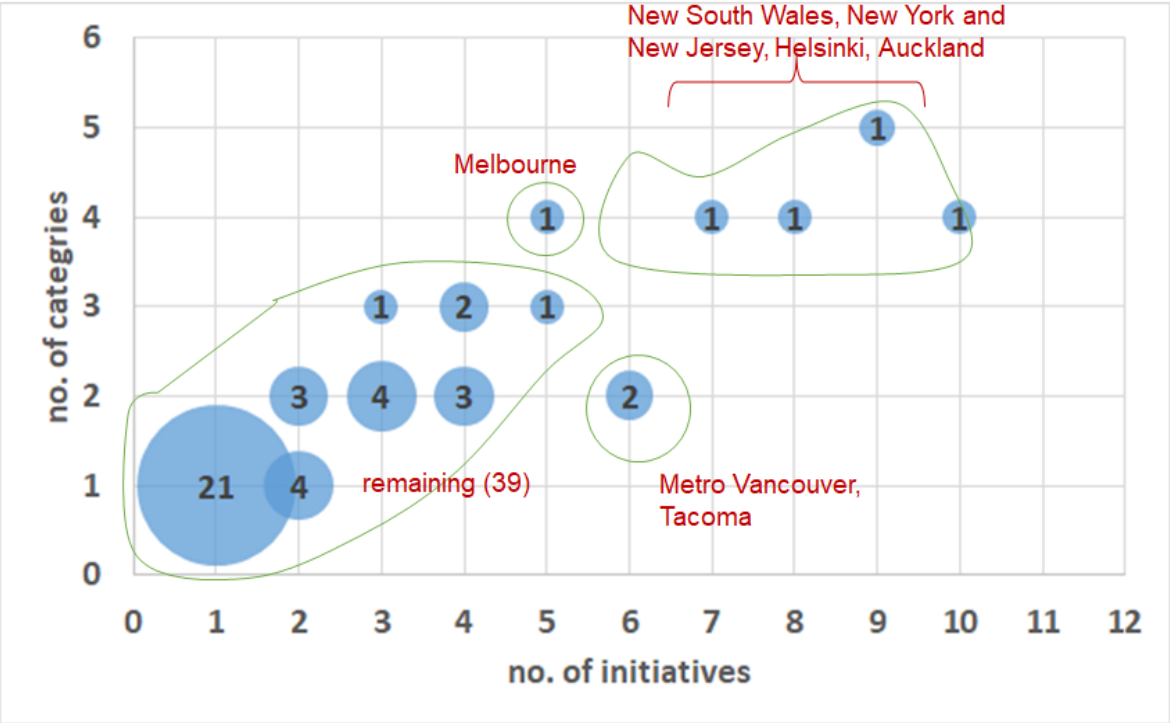


Figure 14: Cases plotted against number of initiatives and number of categories

Source: own elaboration

## 4.6 Port governance ownership

Port governance ownership has impacted through different forms during port-city interaction not only including port noise management. Take City of Kaohsiung in Taiwan as an example, Chia-Hong (2013) finds that lacking precedent management system, both city and port authority had to confront resistances and coordination issues occurred internally, externally and crossing. Such as the waterfront development, it reflects the constraints of various kinds within which decision-makers operate (Hoyle,1989), and could be complicated when more parties or stakeholders get involved in the process. Also, in the case of four European port cities: Marseille, Barcelona, Hamburg, and Rotterdam that Daamen and Vries (2013) find that except for Hamburg, all projects are executed by their own port authorities, and approved or supported by municipal governance ownership leading to difference of their interfaces. During the process of studying port noise management around the world, the authors also have found a similar rule shaped by this factor.

As discussed before, the combined model (see Figure 14) also indicates that governance ownership in the port organization mainly presents in three ways as private ownership,

public ownership, and mixture of private and public ownership. However, in order to differentiate the level of port-city interaction, with the result of 46 port cities who have different governance ownerships (see Figure 10), the authors have listed private ownership (3), mixed ownership (7), and public ownership (35) that is further grouped by various forms. In term of public ownership, the authors find it obvious that municipal ownership (17) is most commonly applied and followed by the type of state ownership (12). And the type of mixed public ownership mainly referring to joint ownership of city government, regional government or central government accounts for 4, while there are 3 ports adopting central/federal government ownerships.

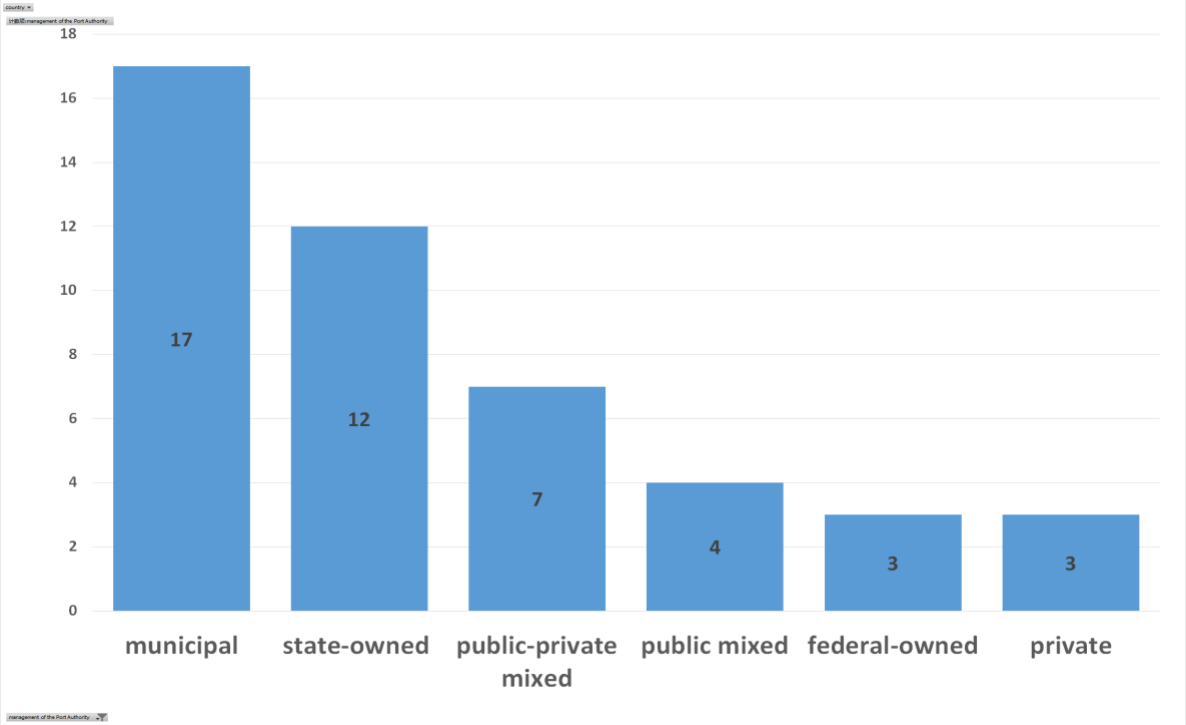


Figure 15: Bar chart of governance ownership in 46 port cities

Source: own elaboration

Municipal and state-owned ports are widely set up both in the developed countries and few developing countries. Even though the role played by government is controversial, it is not doubt that local and regional government knows more macro-level information in relatively comprehensive aspects to design the development plan for port, regarding to the fact that most local governments have the appropriate freedom to enact regulations and administrative decrees to facilitate port activities. In the case of port noise, increasing industrial activities within port area that continues to expand and get closer to residential areas, also with the increasing two-way traffic destined for the port

and from the port could directly and indirectly lead to more noise emission. Combining with the result found, the author estimate that public ports perform more actively to deal with port noise and prefer to take initiatives for overall sustainability and humanity development. And Figure 15 shows the comparison among ports adopting public ownership, mixed ownership and private ownership taking noise initiatives. It is quite obvious that overall public ports are taking more types of mitigation measures than private ports, but the ports with public-private mixed ownership have a good performance. Relatively speaking, within the group of public ports, the poor performance of mixed public owned ports could result from the effective distribution of responsibilities and excessive system since the inevitable compromises or political wrangling between local governments and provincial/regional governments. But the discussion shall be further studied to gather more information and deepen this research direction of organizational governance in port management.

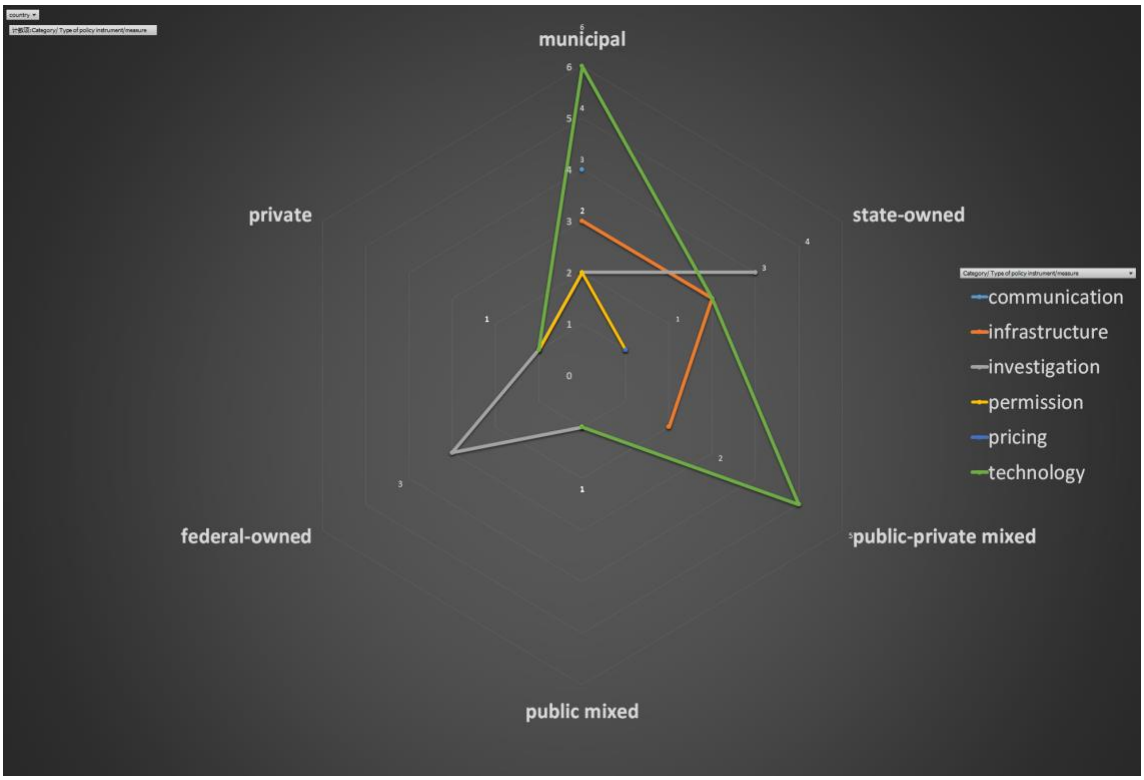


Figure 16: Radar chart of categories of initiatives in different governance ownership ports

Source: own elaboration

## 4.7 Discussion

### 4.7.1 factors influencing popularity of initiatives

Table 13: Summary of example initiatives

| No. | Category | Subcategory | Stage | Through | Reduction | Costs |
|---|---|---|---|---|---|---|
| 1 | Communication | External | Receiver | MGA | Acceptance/perception/ compensation | cost savings |
| 2 | Communication | External | Receiver | Expectation | Acceptance/perception | cost savings |
| 3 | Infrastructure | Resident | Receiver | Insulation | 1-30 dB at receptor | Low-high |
| 4 | Technology | Direct | Source | Machinery | 1-20 dB; N/A | Low-high |
| 5 | Technology | Indirect | Source | Silencer | 1-30 dB | Low-high |
| 6 | Technology | Indirect | Source | EPS | 1-10 dB | High |
| 7 | Investigation | Monitoring | Other | Monitoring | n/a | n/a |

Source: adapted from Neptunes

Based on available information, neither costs nor reduction is the very sole criterion for ports to decide on measures to battle noise. Table 12 summarizes the example initiatives to be discussed. For instance, such cost-saving measures as new terminal construction (no. 1) and advising local community (no. 2) are adopted only once each, which is not surprising given the effects of no noise level abatement at all. Installing soundproofing windows or roofs (no. 3) is one of the initiatives claimed with remarkable effects and applied in 6 cases. None of the three is what most ports resort to in the first place. By contrast, Source and Technology are favorite options in their respective circles. The two circles are in fact overlapping to a large degree, containing improved machinery elements or equipment that helps improve machinery elements (no. 4-6). PoN and Infrastructure are what ports also are inclined to. The two groups are not optimal in terms of either costs or effects. Monitoring is also well-received, but it is a means to

prevent rather than sort out the issue, demonstrating that ports have realised port noise should not be an ignorable issue.

Then what it is other than reduction and costs that influences the popularity of these instruments. The first can be where noise is emitted. As shown in Table 2, industrial noise is the main culprit. After the sources are identified, the solutions are designed aligned with the noise sources. In these 46 cases industrial noise is principally composed of ship and cargo handling and majorly associated with technological solutions. The second may lie in the feature of the current era and the future trending, technology. As Holye states (1992) that technology plays an undisputable role in maritime environmental development. Or it possibly lies in port authorities' pursuit of freedom. Technology targeting at sources is easier to implement in a non-technical sense. Except necessity of purchasing and maintaining, a port barely needs to reach out to manufacturers or any other party, enjoying greater freedom instead of being restrained and susceptible. While those measures featured by dweller involvement are less welcome. Apart from that such measures are not able to fundamentally solve noise problem but scratch the surface, ports being reluctant to cooperate with residents can lead to the situation. It is probably the difficulty to get residents' understanding or approval that impedes sizable application of these initiatives. Residents are likely to complain or refuse to cooperation, complexifying the process. The necessity of reaching out to inhabitants is presumably what ports try to avert. However, these are authors' speculations. What exactly results in popularity of the measures needs further research.

On acoustic emission the long-term interaction is needed to reverse the negative externalities, which should be formed as a shared value between a port and the host city. On the other hand, measures under the category of Communication (both internal and external) and Infrastructure (in urban area) require high extent of port-city interaction since there are stakeholders not subject to port authorities. The measures involving residents may not be the most useful, and could be time-consuming due to negotiation, but the attitudes to work jointly is not supposed to be compromised.

### 4.7.2 governance ownership

The smooth running of port-city cooperation largely depends on the governance ownership, based on the findings and primary analysis, most advanced ports are with

municipal ownership are likely to proactively perform and emphasize on communicating with the local community. Also, it is well known that many UK ports and port of Hong Kong are fully privately owned, managed and controlled (Baltazar and Brooks, 2006), so that the private ownership only has a small part in practice, which could explain the result found in the research that only three private ports are taking initiatives on port noise. But on the other hand, it might illustrate the inaction of the private port in managing to mitigate port noise, which is worthy of further research in the future. And Brooks and Pallis (2012) suggest that the majority of the largest ports have commercialized or corporatized governance structures, as a result, the increasing participation of the private sector would add the complexity of participants and stakeholders would bring more challenges also chances during port-city interaction.

# 5 Case study

This section of case study mainly focuses on the Port of Los Angeles with effective initiatives on port noise and the object of proposal as Port of Gothenburg. During the selection, the three ports located on the western USA with the same municipal ownership as Port of Gothenburg are all good options to be further studied, which are port of San Francisco, Port of Tacoma and Port of Los Angeles. But in terms of the data availability, Port of Tacoma and Port of San Francisco do not have enough data to prove the effectiveness. Thus Port of Los Angeles with project reports and noise screening analysis from consultants enables the authors to make a comparison with Port of Gothenburg and learn some lessons from each side.

## 5.1 Background

### 5.1.1 Geographical location

According to the world's major shipping routes (see in Figure 16) generalized by Stopford (2009), West Coast of the whole American continent plays an important role in trade of the Pacific Ocean. Moreover, Southern California has few maritime logistics centers which have great advantages in geography, and Europe takes the leading position in the Atlantic.

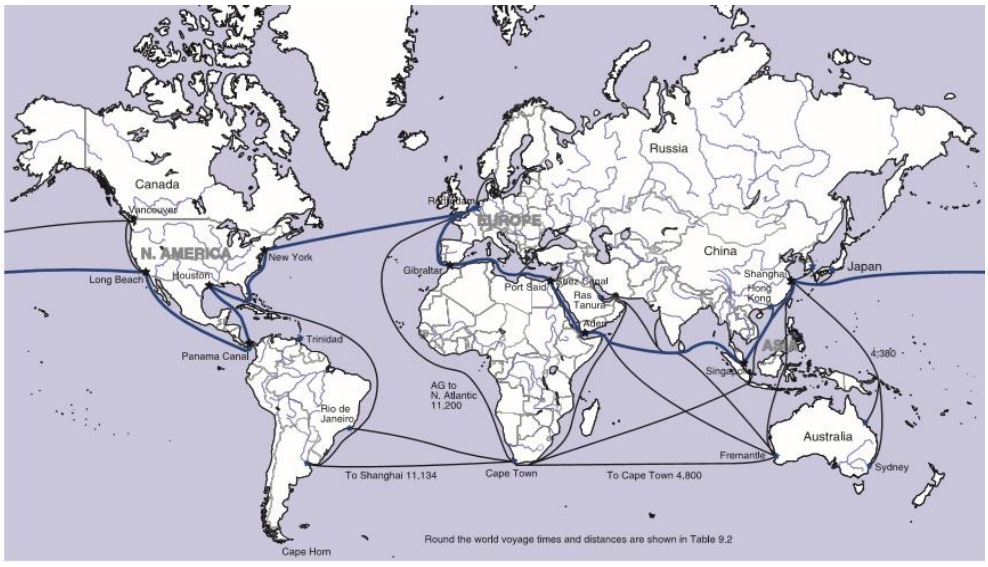


Figure 17: Main routes in global shipping industry

Source: Stopford, M. (2009)

Moreover, Southern California has few maritime logistics centers which have great advantages in geography. Meanwhile, many countries in Western and Northern Europe make up the regional logistics network.

(1) Port of Los Angeles

The Ports of Los Angeles and Long Beach combine to form the largest container shipping facility in the US (Giuliano & O'Brien, 2007), the whole capacity of both parties would be fully utilized and transformed into sustainable competitive advantage. In addition, learning from the map (see Figure 17), Port of Los Angeles (henceforth referred to as PoLA) is located in west-southern California. It is about nine kilometers west-southwest of the Port of San Diego and almost 390 nautical miles south-southeast of the Port of San Francisco (World Port Source, n.d.b). Specifically, located in San Pedro Bay, 20 miles south of downtown Los Angeles, the Port encompasses 7,500 acres of land and water along 43 miles of waterfront (The Port of Los Angeles, n.d.).

To sum up, whether to consider the severe competition among nearby large ports or to think about closing distance to residential area, PoLA must pay great attention on the port noise with a well-designed management.

(2) Port of Gothenburg

The Port of Gothenburg is the largest port in Scandinavia with the centralization of nearly 70 percent of industry, around half of which to join in the global market through the port (Port of Gothenburg, n.d.d.). From the map (see Figure XX) with clear location, the port is also close to three capital cities – Oslo, Copenhagen and Stockholm. Hence, it indicates the advantage of geography to develop regional and national economy while the competition among the nearby ports from developed European countries is still fierce. With such external trend of the leading role played by EU on Environmental Protection, Port of Gothenburg could enhance more aspects of environment management like targeted or standard noise initiatives.


Figure 18: Satellite view and map of PoLA and PoG

Source: authors' own modification from Google Map

### 5.1.2 Economic status

(1) Port of Los Angeles

Port of Los Angeles is one of the world's busiest seaports in the Western Hemisphere, and has developed as a crucial West Gate for the US together with the expansion of local famous electronics industry and tourism industry. It has ranked as the number one container port in the United States each year since 2000 (The Port of Los Angeles, n.d.). On the other hand, the PoLA also works on becoming a world cruise center, since each time a cruise ship calls at the Port of Los Angeles, it adds an estimated $1 million into the local economy (ibid). Thus in 2017, the Port of Los Angeles (2018a, and 2018b) had achieved the operation of cargo (9,343,192.95 TEUs) and passengers (109 vessel calls and 498,848 people), which again proves that the PoLA have made a huge contribution to local even regional economy.

(2) Port of Gothenburg

Till 2018, PoG had operated 753,000 TEU (compared to 2017 as 644,000 TEU) and served 1,680,000 passengers (1,733,000 passengers in 2017) (Gothenburg Port

Authority, 2019). Due to the structure of local and national economies, the port also has become a freight hub for ro-ro, ferries and cars, as well as energy (ibid).

Although there exist some differences between Sweden and the USA, and it seems unable to compare the two ports through qualitative data, the significance of the port from the city to the nation is similarly great. The authors just want to show the economic status of the ports so that with the increasing port activities, it must lead to some concerning environmental problems. Hence, from this perspective, it shall not be underestimated that potential health effects could be caused by both short- and long-term exposure to very loud noises and long-term exposure to lower levels of sound (Los Angeles Harbor Department, 2008). And port authorities are ought to take leading initiatives on port noise.

### 5.1.3 Organization

The Port of Los Angeles is a department of the City of Los Angeles operating as a landlord port, gaining its revenues from leasing and shipping service fees (The Port of Los Angeles, n.d.). In term of governance ownership, PoLA is a municipal ownership and mainly adopts City of Los Angeles Code and city general plan, and sometimes cooperates with nearby cities when proposed project would involve their interests. Since Port of Gothenburg is locally authorized too and shares same interests with the City of Gothenburg, thus PoLA with similarities in organization and economic function in region is priority to take into consideration as to learn some lessons for making the proposal for the ACT in Gothenburg.

## 5.2 Port Noise Management in Los Angeles

PoLA has implemented a unique way to mitigate noise corresponding to different sources, that is, each proposed projects of construction and other port activities within the port area would be formulated with a particular noise mitigation plan. The authors choose the “Berth 97-109 Container Terminal Project – Recirculated Draft” as an example to study the initiatives taken by PoLA, thus in the following words, specific measures and their evaluation are only applied on this project.

### 5.2.1 Measures and policy applied to port

PoLA has defined the types of nearby noise sources, which are from (Los Angeles Harbor Department, 2008):

1) vehicular traffic on the local arterials;
2) vehicular traffic on the freeways;
3) railroad activity;
4) port activity;
5) existing industrial operations;
6) aircraft;
7) community and wildlife activity.

Considering the noise conditions closing to the residential area both at the current time and in the future, PoLA (officially operated by "Los Angeles Harbor Department") has a considerably complete pre-assessment to get an overview of the noise emission in the port area, based on the federal, state and local regulations (ibid), then developed different mitigation measures. In practice, through analysis of environmental impacts caused by port noise, PoLA (ibid) has majorly address three mitigation measures applied to construction and operation of the port project of Berth 97-109 (also discussed later in same section), but essentially referring to the definition of phases of mitigation and approach to play roles, they are basically focusing on the construction of sound wall/barrier and construction of future project:

1) MM NOI-1: construction of 12-foot sound walls; MM NOI-3: construction of 24-foot sound wall
2) MM NOI-2: construction noise measures, which contains
    a) Clear rules about construction hours, construction days, notification, pile driving hours, and temporary noise barriers if it is operating within 500 feet of residential area;
    b) Equipment related control including equipment selection, idling prohibitions, equipment location, and avoidance of portable generators;
    c) Noise complaints management;
    d) Noise monitoring and management plan.

Since the authors have checked other noise mitigation plan for different projects in port and found that the noise complaint management is not widely used by other projects,

thus it is not further analyzed because the authors should consider the universality. Under the categorization used by the authors in this research, major mitigation measures taken by PoLA could be sorted into three groups as" infrastructure-port", "permission-construction" and "investigation-monitoring".

### 5.2.2 Existing situation and records of mitigation effectiveness

As mentioned before, PoLA had discussed the thresholds of significance from possible noise initiatives in total thirteen impacts, then the three mitigation measures are proved that they could be less than significant for construction and for daytime operations, but significant and unavoidable for nighttime operations ((Los Angeles Harbor Department, 2008).

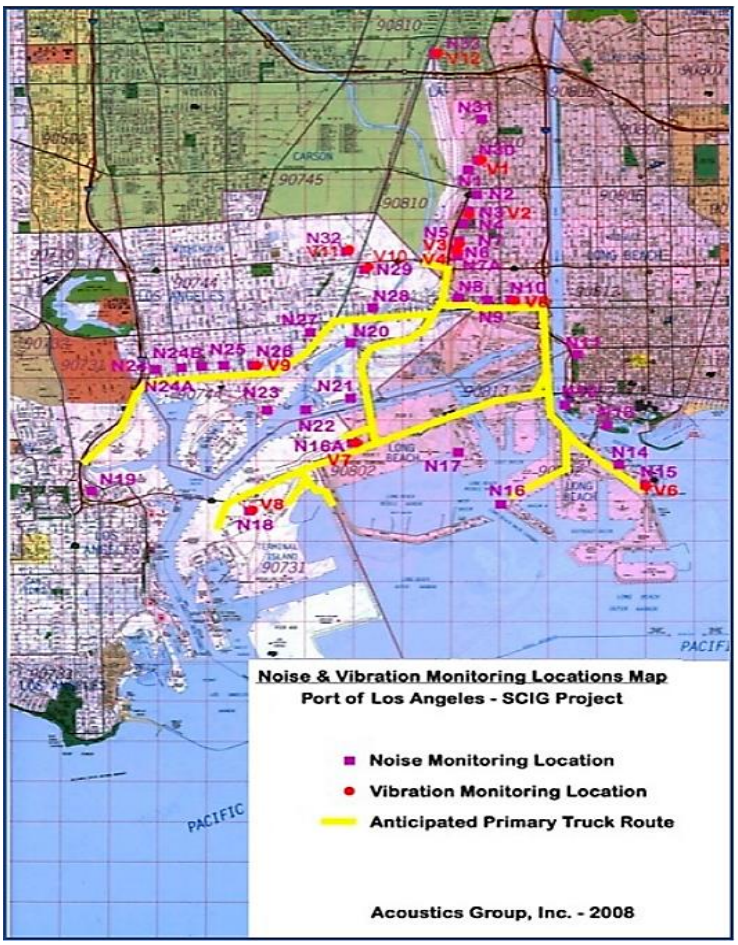


Figure 19: Location of the noise and vibration Measurements

Source: Southern California International Gateway Draft EIR, Los Angeles Harbor Department (September, 2011)

And in term of noise-sensitive receivers are the residents both living within industrial area and close to port activities area and traffic routes connecting port and city. As a baseline noise survey made between January 2008 and September 2009 (see Figure 19) since land uses and activity levels did not change substantially between 2005 and 2008 ((Los Angeles Harbor Department, 2011), and according to their testing short-term noise levels of sensitive receivers in Long Beach, San Pedro & Wilmington, and Carson (ibid), without discussing regional and personal difference, the Leq ranged from 56.0 to 83.3 dBA. In the previous literature review, common baseline of the acceptable noise level is 55 dBA for human health concerns. It is obvious that port noise would affect healthy conditions of residents without effective mitigation.

Port of Los Angeles has hired a third party to test the effectiveness of the noise mitigation plan for the project, and this professional consultant company in acoustics, noise and vibration have made the noise screening analysis for Berths 97-109 container terminal project (China Shipping, see in Figure 20) twice. One was done in May, 2017 and the other was completed in August, 2018. In order to learn the existing situation happening recently, the authors have read through the two reports and summarized relevant information reflecting the overall effectiveness of mitigation.

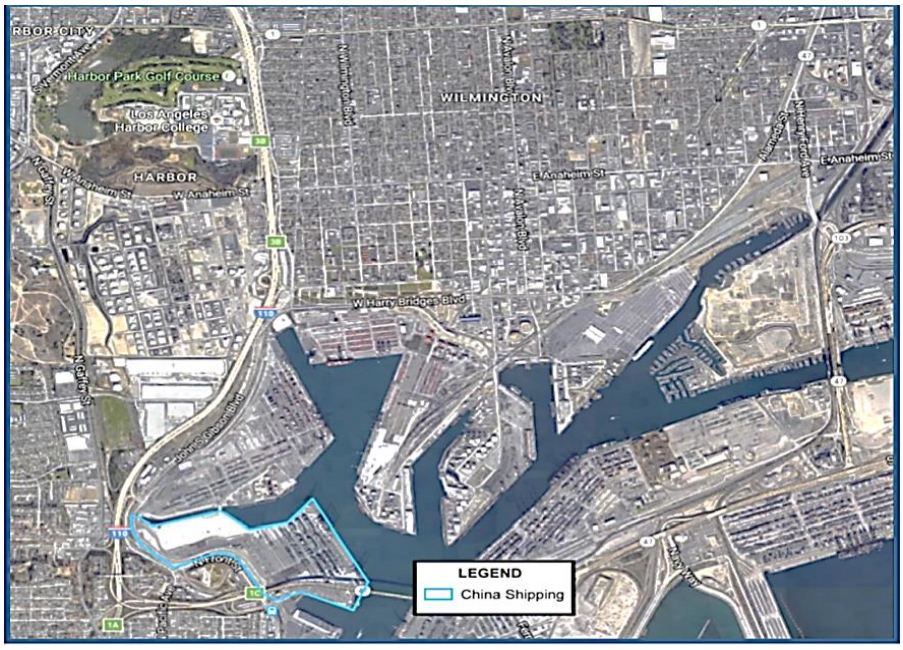


Figure 20: Location of the Project Site and Vicinity Map

Source: Woo & Nguyen, "Noise Screening Analysis For Berths 97-109 Container Terminal Project (China Shipping)", 2018

Within the site, Acoustics Group, Inc. (2017 and 2018) has listed the sensitive receivers include single- and multi-family residences (LT-1, LT-2, LT-3, LT-4, LT-5, LT-6, LT-7, LT8, ST-4), apartments (ST-1, ST-8), community centers (ST-3, ST-7), and parks (ST-2, ST-5, ST-6), which shown in Figure 21. "LT" here means long term measurement and "ST" means short term measurement. They have analysed the noise levels from 1.55M TEUs and 1.7M TEUs then indicated that the incremental change in noise level would range from 0.0 to 0.4 dB at the noise sensitive receptors that border the China Shipping Terminal and the Truck Haul Routes (Woo & Nguyen, 2018). The 2008 EIS/EIR also mentioned the assumption of "full-capacity" China Shipping Terminal throughput at 1.55 million TEUs, thus later in 2017 and 2018, the noise screening analysis prove that noise mitigation measures do help control noise impacts. Moreover, even with increasing capacity to 1.7 million TEUs, the operational noise still meets the requirements of City of Los Angeles.

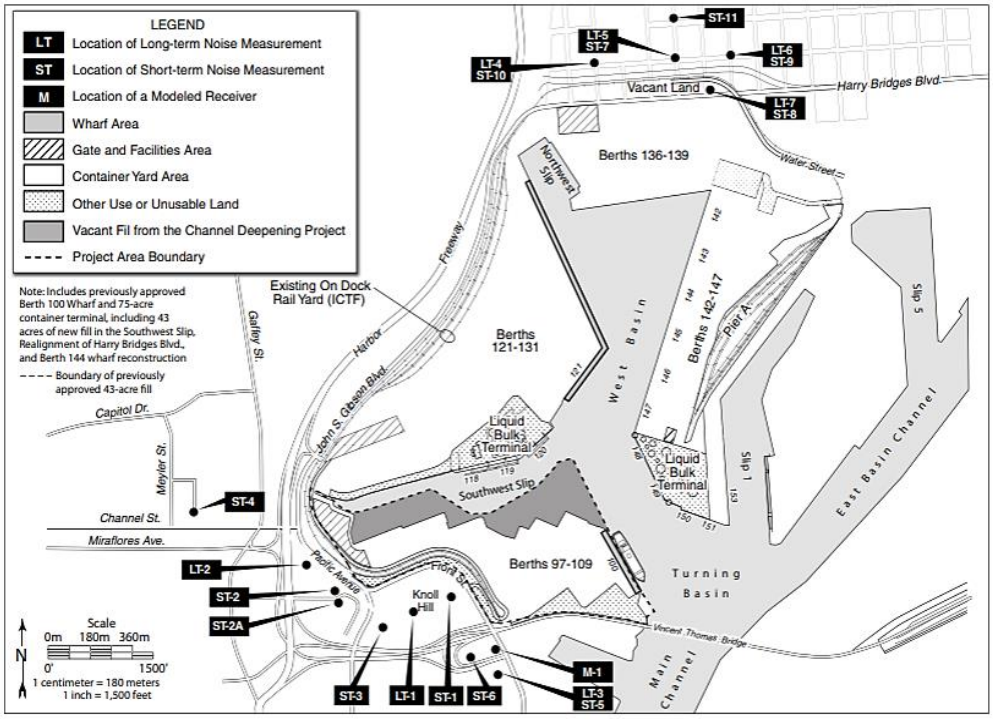


Figure 21: Noise Sensitive Receptor Locations in China Shipping Project

Source: Berth 97-109 Container Terminal Project – Recirculated Draft (Los Angeles Harbor Department, 2008)

## 5.3 Port Noise Management in Gothenburg

Before the relocation of the America Cruise Terminal, the noise issue mainly is considered within the spatial area of port cargo operation. In the case of noise from port operations, as mentioned before, lacking specific noise mitigation measure with only one general rule declaring that Noise and Smell from vessels, e.g. machinery, fans etc., and cargo must be kept to a minimum when a vessel is within the Gothenburg port and marine traffic area (Port of Gothenburg, 2017). However, the positive impact of the regulation still help the PoG receives fewer noise-related complaints below the average level of world ports (Gothenburg Port Authority, 2018).

From the latest released Sustainable Report in 2018 (Gothenburg Port Authority, 2019), there were two times of the day time noise measurements on the cruise ship separately in June and September at the America Cruise Terminal, which resulted in meeting the noise regulations stated by port of Gothenburg as 55 dB during the day from 07:00-22:00 and 50 dB during night from 22:00-07:00 (26 Feb 2019, email from Martin Eskelinen, see Appendix).

And as mentioned before, the occasional complaint about an older cruise ship staying overnight, Gothenburg Port Authority (2019) states that this ship would not operate in the terminal again. So far ACT is having a material for minimizing noise, thus the authors believe that it is likely for them to consider more measures to mitigate noise in the future since Gothenburg Port Authority has been participating in project NEPTUNES for two years (ibid).

## 5.4 Proposal for Port of Gothenburg

As learn from the port noise management taken by PoLA and PoG, first of all, the authors think that there is a need for the Gothenburg port authority to consider taking targeted initiatives and City of Gothenburg shall add port noise into urban plan, just like City of Los Angeles (1999) announcing one of objectives is to “reduce airport and harbour related noise impacts”. Although Port of Gothenburg is ‘the forerunner in investing in onshore power for ships at the quayside to not only reduces sulphur and particle emissions but also noise levels’ (Edvard Molitor, Senior Manager Environment at the Port of Gothenburg, 2014), onshore power so far has not been used by cruise vessels. The closer distance between America Cruise Terminal and residential area than

other passenger and cargo terminals makes it necessary for port and city to take initiatives. With the expansion of urban plan and development of cruise tourism, both port operation and connected public traffic must increase leading to more noise emission.

Therefore, as for Port of Gothenburg, EPS like onshore power should be available for both cargo and passenger terminal. One possibility is the LNG Power Barge (Figure 22) that is a floating power plant and customized for cruise ships. It is a green and mobile power supplier that can serve several customers in parallel. It can work smoothly with its own heating even in winter. Encouragement on direct technological measures to mitigate noise is necessary as well.


Figure 22: LNG Power Barge picture © HPE Hybrid Port Energy
Source: HPE Hybrid Port Energy LNG Power Barge

In term of the infrastructure, the short distances from residential areas, combined with the influence of intermediate traffic roads, make it possibly necessary to take some measures during the propagation of noise like buffer, barrier and absorbing materials. Last but not least, so far there is no unified noise monitoring with complete network, thus noise sensors or monitors should be installed around port area where construction work is going on, mass cargo handling operation is frequent and continuous, and traffic

flow of truck and train is huge; also must near the residential area especially housing, education and hospital facilities close to the port activities.

To sum up, from the previous findings to the global review, it is a priority to consider the initiatives of technology (indirect), infrastructure (port), and investigation (monitoring) that are commonly taken by these 46 port cities. In the case of Gothenburg, PoG has adopted environmentally differentiated port tariff (Port of Gothenburg, March 2018) and is currently constructing a permanent LNG facility by Swedegas (Port of Gothenburg, June 2018), which all indicate that PoG encourages the usage of LNG and LNG is more available for ACT to mitigate noise. Also besides, the short distance between ACT and residential area is another consideration while making the proposal, because the noise measurement that only had been taken twice ever since the relocation is not enough to well control the noise emission from ACT. In one word, the feasible proposal for the current situation is to install the noise monitoring system and promote the LNG Power Barge, in addition to the increasing interaction with the city on the shared consciousness and supportive regulations of port noise.

# 6 Conclusion

In this section the conclusions drawn from this research will be presented, together with which future research as well as limitation regarding the study is to be discussed.

## 6.1 Conclusion

*Research Question 1: "What initiatives are taken by port cities around the world to manage noise"*

As a result, a global review of measures taken worldwide was conducted. The review started with combing database to create a full port list since there is no such a list so far. 9 pertinent databases are combined in pursuit of list completeness. After a full port list of 204 ports was created and a review was performed, an overview was produced of 46 ports that act on noise issue with in total 126 measures. 46 ports are identified dealing with the issue to different extent. Parameters were then extracted from the review. The parameter table is composed of common and specific ones. Afterwards the ports and initiatives were analyzed. These initiatives are classified in two different ways. The first classification criterion is what these tools deal with, while the second one adapted from literature is noise stage, which is less commonly used compared to the first one. It turns out that Technology and Source are prevailing while Pricing and Receiver are not. Specifically, Direct Technology and Machinery are most popular in their own circle. Neither costs nor effects alone is what contributes to the popularity. What exactly those criteria are unclear. In the authors' opinion, possible explanations relate to noise sources, technology booming and ports' inclination to freedom. Then 46 ports are grouped according to initiative quantity against initiative category and initiative quantity against noise stage. No particular relationship is discovered between the number of initiatives and diversity of initiatives.

*Research Question 2: "What are the possible initiatives that can be applied to Port of Gothenburg, specifically to the America Cruise Terminal?"*

After a global review comes to a specific case study of PoLA before proposals are put forward for PoG, particularly ACT. There are 46 ports to choose from, PoLA is not remarkable from the aspect of initiatives. Nonetheless, it is the most suitable one to study considering data availability and similarity to PoG. PoG and PoLA are compared in terms of geographical location, economic status along organisation before the

proposals are put forward to help PoG and ACT advance approaching noise issue and boost port-city relationship. Based on the popularity of the initiatives summarised, the lessons of PoLA and the situation of PoG, the following suggestions in term of direct mitigation measures are offered, LNG Power Barge as EPS for ACT and systematic noise monitoring, as well as some optional solutions to machinery elements from source or to the addition of absorbing and buffering material during noise propagation.

## 6.2 Contribution and future research

Port noise is a topic that has not been studied a lot, hence there are plenty of aspects to be explored. A list of noise-concerned ports is produced for the first time, offering an overview of how worldwide ports are performing on acoustic pollution. Noise source is a key for ports to tackle noise problem. There are a few sources missing in the table in the appendix, which can be supplemented to make the outcomes more convincing by reaching out to the ports. The thesis has identified the most and least popular measures practically based on secondary data, leading to flexibility being compromised. The research can be furthered by surveying or interviewing ports to obtain a sense of what makes them opt for certain instruments while abandon others. It is also interesting to figure out why some ports take multiple actions while others take much fewer, and why some ports diversify measures while others not. This does not necessarily mean that the more actions or the more diversified actions a port takes, the more successful it is. Afterwards the answers are analyzed to see whether or not they confirm the speculations aforementioned. At last PoG and ACT are given some pieces of advice in consideration of the lessons from PoLA who are similar, and the initiatives PoLA take are proven effective. Nevertheless, it remains unknown whether the applications are applicable and helpful for PoG and ACT as well, which needs to be studied further. This research can provide implications for those ports who want to enhance their devotion to noise nuisance or those who cluelessly intend to work on it.

## 6.3 Limitation

The authors of research plan to set up a global review of port noise instruments, with two major challenges in the process of collecting data. One is the incompleteness of the full list. There is no existing list of all ports around the world, hence the authors have to create one one our own by combining as many pertinent databases as possible to create the full port list. Nevertheless, there could be some ports still missing. The other

one is that some ports are implementing certain policies to manage noise without telling the public, which is less likely to happen though in that sustainability is normally taken as an attractiveness embellishing public images of ports (Schipper, Vreugdenhil & De Jong, 2017; Aregall et al., 2018). This can affect the findings.

# 7 References


Adams, J., Khan, H. T., Raeside, R., & White, D. I. (2007). *Research methods for graduate business and social science students*. SAGE publications India.

Amato, D. (1999). Port planning and port-city relations. The Dock and Harbour Authority, 80(896-900), 45-48.

America Tinnitus Association. (2016). Tinnitus Today: Committed to a cure [PDF]. Portland: OR 97207-0005. vol. 41, Number 2. Retrieved from https://www.ata.org/sites/default/files/ATA-Tinnitus-Today-Fall-2016.pdf

Arain, M., Campbell, M. J., Cooper, C. L., & Lancaster, G. A. (2010). What is a pilot or feasibility study? A review of current practice and editorial policy. *BMC medical research methodology*, 10(1), 67.

Aregall, M. G., Bergqvist, R., & Monios, J. (2018). A global review of the hinterland dimension of green port strategies. *Transportation Research Part D: Transport and Environment*, 59, 23-34.

Arnold, D. M., Burns, K. E., Adhikari, N. K., Kho, M. E., Meade, M. O., & Cook, D. J. (2009). The design and interpretation of pilot trials in clinical research in critical care. *Critical care medicine*, 37(1), S69-S74.

Axell, N., Bolin, H., Svedin, M. (2004). Noise as an environmental challenge for ports. Stockholm: TFK - Institutet för transportforskning

Axel, B. N. (Ed.). (2011). Environmental Impacts of International Shipping The Role of Ports: The Role of Ports (Vol. 2011). OECD Publishing.

Baird, A. J. (2000). Port privatisation: objectives, extent, process, and the UK experience. *International Journal of Maritime Economics*, 2(3), 177-194.

Baltazar, R., & Brooks, M. R. (2006). Port governance, devolution and the matching framework: a configuration theory approach. *Research in Transportation Economics*, *17*, 379-403.

Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., & Stansfeld, S. (2014). Auditory and non-auditory effects of noise on health. *The lancet*, *383*(9925), 1325-1332.

Bell, E., Bryman, A., & Harley, B. (2018). *Business research methods*. Oxford university press.

Beresford, A. K. C., Gardner, B. M., Pettit, S. J., Naniopoulos, A., & Wooldridge, C. F. (2004). The UNCTAD and WORKPORT models of port development: evolution or revolution?. *Maritime Policy & Management*, 31(2), 93-107.

Berger, E. H. (Ed.). (2003). *The noise manual*. Aiha.

Berglund, B., Lindvall, T., Schwela, D. H., & World Health Organization. (1999). Guidelines for community noise.

Bienfait, P., & Delsalle, B. (1989). Les enjeux internationaux d'un grand port urbain: 11 exemples européens. In *2nd International Conference Cities and Ports, Le Havre: IACP*.

Börjesson, M., & Kristoffersson, I. (2015). The Gothenburg congestion charge. Effects, design and politics. *Transportation Research Part A: Policy and Practice*, 75, 134-146.

Bottasso, A., Conti, M., Ferrari, C., Merk, O., & Tei, A. (2013). The impact of port throughput on local employment: Evidence from a panel of European regions. *Transport Policy*, 27, 32-38.

Bryman, A. & Bell, E. (2015), *Business research methods, 4th edn.*, Oxford University Press, Oxford.

Brooks, M. R. (2004). The governance structure of ports. *Review of Network Economics*, *3*(2).

Brooks, M. R., & Cullinane, K. (Eds.). (2006). *Devolution, port governance and port performance* (Vol. 17). Elsevier.

Brooks, M. R., & Pallis, A. A. (2012). Port governance. *The Blackwell companion to maritime economics*, 491-516.

Buxton, R. T., McKenna, M. F., Mennitt, D., Fristrup, K., Crooks, K., Angeloni, L., & Wittemyer, G. (2017). Noise pollution is pervasive in US protected areas. *Science*, *356*(6337), 531-533.

Caramuta, C., Giacomini, C., Longo, G., Padoano, E., & Zornada, M. (2018). Integrated evaluation methodology and its application to freight transport policies in the port of Trieste. *Transportation research procedia*, *30*, 119-126.

Chia-Hong, L. L. (2013). The interaction between the port and Kaohsiung city: Economy, institution and power. *City, Culture and Society*, *4*(1), 21-35.

City of Los Angeles. (1999). Noise Element of the Los Angeles City General Plan[PDF]. Los Angeles. City Plan Case No. 97-0085; Council File No. 96-1357. Retrieved from https://planning.lacity.org/cwd/gnlpln/noiseElt.pdf

Collis, J., & Hussey, R. (2013). *Business research: A practical guide for undergraduate and postgraduate students*. Macmillan International Higher Education.

Daamen, T. A., & Vries, I. (2013). Governing the European port–city interface: institutional impacts on spatial projects between city and port. *Journal of Transport Geography*, *27*, 4-13.

Dangerous Decibels. (n.d.). Dangerous Decibels - A public health partnership for prevention of noise-induced hearing loss and tinnitus. Retrieved April 4, 2019 from http://dangerousdecibels.org/education/information-center/noise-induced-hearing-loss/

de Kluijver, H., & Stoter, J. (2003). Noise mapping and GIS: optimising quality and efficiency of noise effect studies. *Computers, Environment and Urban Systems*, *27*(1), 85-102.

de Langen, P., Nidjam, M., & van der Horst, M. (2007). New indicators to measure port performance. *Journal of Maritime Research*, 4(1), 23-36.

DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. *Medical education*, 40(4), 314-321.

Dooms, M., Haezendonck, E., & Verbeke, A. (2015). Towards a meta-analysis and toolkit for port-related socio-economic impacts: a review of socio-economic impact studies conducted for seaports. *Maritime Policy & Management*, 42(5), 459-480.

Dromey, C., & Ramig, L. O. (1998). Intentional changes in sound pressure level and rate: Their impact on measures of respiration, phonation, and articulation. *Journal of Speech, Language, and Hearing Research*, *41*(5), 1003-1018.

Ducruet, C., & Jeong, O. J. (2005). European port-city interface and its Asian application.

Ducruet, C. (2005). Approche comparée du développement des villes-ports à l'échelle mondiale: problèmes conceptuels et méthodologiques. *Les Cahiers scientifiques du transport, 48*, 59-79.

Ducruet, C. (2011). The port city in multidisciplinary analysis.

EPA Victoria. (1991). A guide to the measurement and analysis of noise[PDF]. Victoria: EPA Victoria. EPA Publication 280. Retrieved from https://www.epa.vic.gov.au/~/media/Publications/280.pdf

ESPO, G. G., & Guide, G. (2012). Towards excellence in port environmental management and sustainability. *European Sea Ports Organisation (ESPO), Brussels*.

ESPO. (2013) Top Environmental Priorities of European Ports for 2013. An Analysis Taking Port Size and Geography into Consideration, *European Sea Ports Organisation (ESPO), Brussels*.

ESPO. (2018). *ESPO Environmental Report 2018 - EcoPortsinSights 2018*[PDF]. Brussels: European Sea Ports Organisation. Retrieved from https://www.espo.be/media/ESPO%20Environmental%20Report%202018.pdf

European Commission. (1996, November 04). *Future Noise Policy - European Commission Green Paper*[PDF]. Brussels. Retrieved from https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:1996:0540:FIN:EN:PDF

European Commission. (n.d.). Noise. Retrieved March 5, 2019, from http://ec.europa.eu/environment/noise/health_effects_en.htm

European Commission. (2015, October 14). Noise pollution in the EU. Retrieved April 4, 2019, from http://ec.europa.eu/environment/basics/health-wellbeing/noise/index_en.htm

European Commission. (2016). Noise – Environment. Retrieved 4 March, 2019, from http://ec.europa.eu/environment/noise/europe_en.htm

European Environment Agency. (2016, August 25). Noise in Europe 2014. Retrieved February 4, 2019, from https://www.eea.europa.eu/publications/noise-in-europe-2014#tab-figures-used

Finegold, L. S., Harris, C. S., & von Gierke, H. E. (1994). Community annoyance and sleep disturbance: Updated criteria for assessing the impacts of general transportation noise on people. *Noise Control Engineering Journal, 42*(1).

Francis, C. D., Kleist, N. J., Ortega, C. P., & Cruz, A. (2012). Noise pollution alters ecological services: enhanced pollination and disrupted seed dispersal. *Proceedings of the Royal Society B: Biological Sciences*, *279*(1739), 2727-2735.

Fleming, D. K., & Hayuth, Y. (1994). Spatial characteristics of transportation hubs: centrality and intermediacy. *Journal of transport geography*, *2*(1), 3-18.

Giuliano, G., & O'Brien, T. (2007). Reducing port-related truck emissions: The terminal gate appointment system at the Ports of Los Angeles and Long Beach. *Transportation Research Part D: Transport and Environment*, *12*(7), 460-473.

Gleave, M. B. (1997). Port activities and the spatial structure of cities: the case of Freetown, Sierra Leone. *Journal of Transport Geography*, 5(4), 257-275.

Goines, L., & Hagler, L. (2007). Noise pollution: a modern plague. *SOUTHERN MEDICAL JOURNAL-BIRMINGHAM ALABAMA-*, *100*(3), 287.

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The qualitative report*, *8*(4), 597-606.

Gothenburg Port Authority. (2018). *Sustainable Port - Sustainability report of the Gothenburg Port Authority 2017*[PDF]. Gothenburg: Port of Gothenburg. Retrieved from https://www.portofgothenburg.com/globalassets/dokumentbank/sustainable-port-2017.pdf

Göteburg Stad. (2015). *Noise Action Plan.* [Ebook] (p. 3). Goteborg. Retrieved from https://goteborg.se/wps/wcm/connect/329f7997-14fe-4261-a8dc-25efcbd1d2e8/Noise+Action+Plan_2014_2018+%28mindre%29.pdf?MOD=AJPERES

Gothenburg & Co. (n.d.) *Gothenburg 2021. Opportunities on the way to Gothenburg's 400th anniversary*. [Ebook] (pp. 145-160). Gothenburg. Retrieved from http://www.goteborg2021.com/uploads/2016/10/Proposed-work-plan-goteborg2021_120530-1.pdf

Greenberg, G. Z., & Larkin, W. D. (1968). Frequency-Response Characteristic of Auditory Observers Detecting Signals of a Single Frequency in Noise: The Probe-Signal Method. *The Journal of the Acoustical Society of America*, *44*(6), 1513-1523.

Green Cruise Port. (2018). HPA Hamburg Port Authortity and DW-Ship-Consult GmbH: Emission sources and possible mitigation measures of cruise terminals.

Griffin, T., & Hayllar, B. (2006). Historic waterfronts as tourism precincts: An experiential perspective. *Tourism and Hospitality Research*, *7*(1), 3-16.

Gupta, A. K., Gupta, S. K., & Patil, R. S. (2005). Environmental management plan for port and harbour projects. *Clean Technologies and Environmental Policy*, *7*(2), 133-141.

Hayuth, Y. (1982). The port-urban interface: an area in transition. *Area*, 219-224.

Hellmuth, T., Classen, T., Kim, R., & Kephalopoulos, S. (2012). Methodological guidance for estimating the burden of disease from environmental noise. *WHO Regional Office for Europe*.

Hildebrand, J. A. (2009). Anthropogenic and natural sources of ambient noise in the ocean. *Marine Ecology Progress Series*, *395*, 5-20.

Hogan, C. A., & Turner, C. W. (1998). High-frequency audibility: Benefits for hearing-impaired listeners. *The Journal of the Acoustical Society of America*, *104*(1), 432-441.

Horton, J. W. (1954). The bewildering decibel. *Electrical Engineering*, *73*(6), 550-555.

Hoyle, B. S. (1989). The port—City interface: Trends, problems and examples. *Geoforum*, *20*(4), 429-435.

Hoyle, B. (1999). Scale and sustainability: the role of community groups in Canadian port-city waterfront change. *Journal of Transport Geography*, *7*(1), 65-78.

Hoyle, B. (2000). Global and local change on the port-city waterfront. *Geographical Review*, 90(3), 395-417.

HPE Hybrid Port Energy. (n.d.). Becker LNG Power Barge- "Hummel" in Hamburg [Digital image]. Retrieved April 15, 2019, from https://www.hybrid-port-energy.com/files/content/pics/media_files/Becker_LNG_Power_Barge_01.jpg

IMO. (n.d.a). Default About IMO //. Retrieved March 4, 2019, from http://www.imo.org/en/About/Pages/Default.aspx

IMO. (n.d.b). Default Marine Environment //. Retrieved March 4, 2019, from http://www.imo.org/en/OurWork/Environment/Pages/Default.aspx

IMO. (n.d.c). Default Major Projects //. Retrieved May 4, 2019, from http://www.imo.org/en/OurWork/Environment/MajorProjects/Pages/default.aspx

IMO. (2014). *Code On Noise Levels On Board Ships (2014 Edition)* [PDF]. London: IMO. ISBN: 978-92-801-1578-9. Retrieved from http://www.imo.org/en/Publications/Documents/Newsletters%20and%20Mailers/Mailers/I817E.PDF

International Organization for Standardization. (1990). International standard ISO 1999 Acoustics: determination of occupational noise exposure and estimation of noise-induced hearing impairment. Geneva: International Organization for Standardization.

Kahn, D. M., Cook, T. E., Carlisle, C. C., Nelson, D. L., Kramer, N. R., & Millman, R. P. (1998). Identification and modification of environmental noise in an ICU setting. *Chest*, *114*(2), 535-540.

Kalmykova, Y., Rosado, L., & Patrício, J. (2015). Urban economies resource productivity and decoupling: metabolism trends of 1996–2011 in Sweden, Stockholm, and Gothenburg. *Environmental science & technology*, 49(14), 8815-8823.

Kolko, J. (2011). *Exposing the magic of design: A practitioner's guide to the methods and theory of synthesis.* Oxford University Press.

Lee, S. W., Song, D. W., & Ducruet, C. (2008). A tale of Asia's world ports: the spatial evolution in global hub port cities. *Geoforum*, *39*(1), 372-385.

Lee, T., Yeo, G. T., & Thai, V. V. (2014). Environmental efficiency analysis of port cities: Slacks-based measure data envelopment analysis approach. *Transport Policy*, *33*, 82-88.

Litvin, S. W., Luce, N. E., & Smith, W. W. (2013). A case study of cruise ships and resident attitudes—Research gone wild. *Tourism Recreation Research*, *38*(2), 243-248.

Los Angeles Harbor Department. (2008, April). Berth 97-109 Container Terminal Project – Recirculated Draft: Section 3.11 2 Noise[PDF]. Los Angeles. Retrieved from https://www.portoflosangeles.org/getmedia/f60b81ef-6d26-4a52-8b4e-c2b50c57ea2a/3-11_noise

Los Angeles Harbor Department. (2011). Southern California International Gateway Draft EIR: Chapter 3.9 Noise[PDF]. Los Angeles. Retrieved from https://www.portoflosangeles.org/getmedia/4d3e5abf-14d4-4862-a63f-dcbdfd28a450/03-09-noise

Mangan, J., Lalwani, C., & Fynes, B. (2008). Port-centric logistics. *The International Journal of Logistics Management*, 19(1), 29-41.

Martin, W. H. (1929). Decibel-The name for the transmission unit. *Journal of the AIEE*, *48*(3), 223-223.

Merk, O. (2013). The competitiveness of global port-cities: synthesis report.

Morretta, M., Iacoponi, A., & Dolinich, F. (2008). The port of Livorno noise mapping experience. *Journal of the Acoustical Society of America*, *123*(5), 3137.

Morris, R. K., & Gibson, C. (2007). Port development and nature conservation—Experiences in England between 1994 and 2005. *Ocean & coastal management*, 50(5-6), 443-462.

Morvan, M. (1999). *Villes portuaires: les moyens d'un développement solidaire dans une Europe ouverte*.

Murphy, E., & King, E. A. (2014). An assessment of residential exposure to environmental noise at a shipping port. *Environment international*, *63*, 207-215.

Namba, M. (1977). Three-dimensional analysis of blade force and sound generation for an annular cascade in distorted flows. *Journal of Sound and Vibration*, *50*(4), 479-508.

NEPTUNES - Noise Exploration Program To Understand Noise Emitted by Seagoing ships. (n.d.). Best Practice Guide Version 1.0 - Mitigation of Noise From Ships At Berth [PDF]. Neptunes. Retrieved from: https://www.neptunes.pro/wp-content/uploads/2019/03/19.0043_BestPracticeReport_Geheel.pdf

Nicholls, R. J., Hanson, S., Herweijer, C., Patmore, N., Hallegatte, S., Corfee-Morlot, J., ... & Muir-Wood, R. (2008). Ranking port cities with high exposure and vulnerability to climate extremes.

Nilsson, M. E. (2007). A-weighted sound pressure level as an indicator of short-term loudness or annoyance of road-traffic sound. *Journal of Sound and Vibration*, *302*(1-2), 197-207.

NoMEPorts. (2008, April). *Good Practice Guide on Port Area Noise Mapping and Management*[PDF]. Amsterdam: Port of Amsterdam. Retrieved from http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=NoMEports_GPG_PANMM1.pdf

OECD. (n.d.). What we do and how. Retrieved May 5, 2019, from https://www.oecd.org/about/whatwedoandhow/

Ogren, M., & Barregard, L. (2016). Road Traffic Noise Exposure in Gothenburg 1975-2010. 11(5), E0155328.

Omubo-Pepple, V. B., Briggs-Kamara, M. A., & Tamunobereton-ari, I. (2010). Noise pollution in Port Harcourt Metropolis: Sources, effects, and control. *Pacific Journal of Science and Technology*, *11*(2), 592-600.

Parmanen, J. (2007). A-weighted sound pressure level as a loudness/annoyance indicator for environmental sounds–Could it be improved? *Applied Acoustics*, *68*(1), 58-70.

Peris-Mora, E., Orejas, J. D., Subirats, A., Ibáñez, S., & Alvarez, P. (2005). Development of a system of indicators for sustainable port management. *Marine Pollution Bulletin*, *50*(12), 1649-1660.

Popper, A. N., & Hastings, M. C. (2009). The effects of human-generated sound on fish. *Integrative Zoology*, *4*(1), 43-52.

Port of Gothenburg. (n.d.a). America Cruise Terminal. Retrieved February 27, 2019, from https://www.portofgothenburg.com/about-the-port/the-port-is-growing2/america-cruise-terminal/

Port of Gothenburg. (n.d.b). America Cruise Terminal. Retrieved February 27, 2019, from https://www.portofgothenburg.com/cruise-and-visits/cruise/cruise-terminals/america-cruise-terminal/

Port of Gothenburg. (n.d.c). The Port of Gothenburg. Retrieved March 5, 2019, from https://www.portofgothenburg.com/about-the-port/the-port-of-gothenburg/

Port of Gothenburg. (n.d.d). The Port of Gothenburg. Retrieved May 20, 2019, from https://www.portofgothenburg.com/about-the-port/the-port-of-gothenburg/

Port of Gothenburg. (2014, October 23). Establishing A Climate-Smart Transport Chain[Press release]. Retrieved March 4, 2019, from https://www.portofgothenburg.com/news-room/news/establishing-a-climate-smart-transport-chain/

Port of Gothenburg. (2017, October 01). Port of Gothenburg General Port Regulation[PDF]. Goteborg. Chapter 8 Vessel arrival, departure and time in port in the port of Gothenburg area. Retrieved from https://www.portofgothenburg.com/FileDownload/?contentReferenceID=12723

Port of Gothenburg. (2018, March 14). OECD: Sweden – a pioneering nation in green shipping. Retrieved May 20, 2019, from https://www.portofgothenburg.com/news-room/news/oecd-sweden--a-pioneering-nation-in-green-shipping/

Port of Gothenburg. (2018, June 01). Gas supplier named for new LNG facility at the Port of Gothenburg. Retrieved May 20, 2019, from https://www.portofgothenburg.com/news-room/press-releases/gas-supplier-named-for-new-lng-facility-at-the-port-of-gothenburg/

Port of Gothenburg. (2019). *Sustainable Port - Sustainability report of the Gothenburg Port Authority 2018* [PDF]. Goteborg: Port of Gothenburg. Retrieved from https://www.portofgothenburg.com/FileDownload/?contentReferenceID=14781

Puig, M., Wooldridge, C., Michail, A., & Darbra, R. M. (2015). Current status and trends of the environmental performance in European ports. *Environmental Science & Policy*, *48*, 57-66.

Reeves, P., Broeze, F., & McPherson, K. (1989). Studying the Asian port city. *Brides of the sea: port cities of Asia from the*, *16*, 29-53.

Ros Chaos, S., Pino Roca, D., Saurí Marchán, S., & Sánchez-Arcilla Conejo, A. (2018). Cruise passenger impacts on mobility within a port area: Case of the Port of Barcelona. *International Journal of Tourism Research*, 20(2), 147-157.

Rowe, J., & Fudge, C. (2003). Linking national sustainable development strategy and local implementation: A case study in Sweden. *Local Environment*, *8*(2), 125-140.

Saunders, M., Lewis, P., & Thornhill, A. (2007). Research methods. *Business Students 4th edition Pearson Education Limited, England*.

Schenone, C., Pittaluga, I., Repetto, S., & Borelli, D. (2014, July). Noise pollution management in ports: a brief review and the EU MESP project experience. In *Proceedings of the 21st International Congress on Sound and Vibration, Beijing, China*(pp. 13-17).

Schipper, C. A., Vreugdenhil, H., & De Jong, M. P. C. (2017). A sustainability assessment of ports and port-city plans: Comparing ambitions with achievements. *Transportation Research Part D: Transport and Environment*, *57*, 84-111.

Schmidt, J., Dr., Steenbeck, M., Borsch, M., Hofmann, S., Dr., & Kroh, M., Dr. (2019, February 04). Green Cruise Port Action Plan 2030 [PDF]. Hamburg: HPC Hamburg Port Consulting GmbH. Retrieved from http://www.greencruiseport.eu/files/public/download/GCP%20Action%20Plan%202030_Final%20Report%2004Feb2019.pdf

Selwyn, B. (2010). Noise Measurement & Control. *Professional Safety*, *55*(5), 16.

Shannon, G., McKenna, M. F., Angeloni, L. M., Crooks, K. R., Fristrup, K. M., Brown, E., ... & McFarland, S. (2016). A synthesis of two decades of research documenting the effects of noise on wildlife. *Biological Reviews*, *91*(4), 982-1005.

Shaw, E. A. (1974). Transformation of sound pressure level from the free field to the eardrum in the horizontal plane. *The Journal of the Acoustical Society of America*, *56*(6), 1848-1861.

Shepherd, D., McBride, D., Welch, D., Dirks, K. N., & Hill, E. M. (2011). Evaluating the impact of wind turbine noise on health-related quality of life. *Noise and Health*, 13(54), 333.

Slabbekoorn, H., Bouton, N., van Opzeeland, I., Coers, A., ten Cate, C., & Popper, A. N. (2010). A noisy spring: the impact of globally rising underwater sound levels on fish. *Trends in ecology & evolution*, *25*(7), 419-427.

Starcrest Consulting Group, LLC, CE Delft, & Civic Exchange. (2015, February). *Study of Emission Control and Energy Efficiency Measures for Ships in the Port Area*[PDF]. London: IMO. Retrieved from http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Air%20pollution/Port%20Area.pdf

Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. *Management decision*, *39*(7), 551-556.

Stojanovic, T. A., Smith, H. D. O., & Wooldridge, C. F. (2006). The impact of the Habitats Directive on European port operations and management. *GeoJournal*, 65(3), 165-176.

Stopford, M. (2009). *Maritime economics 3e*. Routledge.

Suykens, F. (1989). The city and its port—an economic appraisal. *Geoforum*, *20*(4), 437-445.

Trozzi, C., & Vaccaro, R. (2000). Environmental impact of port activities. *WIT Transactions on The Built Environment*, 51.

The Port of Los Angeles. (n.d.). About. Retrieved April 4, 2019, from https://www.portoflosangeles.org/about

The Port of Los Angeles. (2018a). Container Statistics. Retrieved April 4, 2019, from https://www.portoflosangeles.org/business/statistics/container-statistics

The Port of Los Angeles. (2018b). Cruise Statistics. Retrieved April 4, 2019, from https://www.portoflosangeles.org/business/statistics/cruise-statistics

Tsai, K. T., Lin, M. D., & Chen, Y. H. (2009). Noise mapping in urban environments: A Taiwan study. *Applied Acoustics*, *70*(7), 964-972.

Tzannatos, E. (2010). Ship emissions and their externalities for the port of Piraeus–Greece. *Atmospheric Environment*, 44(3), 400-407.

UNCTAD. (2008). *Review of Maritime Transport 2008*. New York and Geneva: United Nations.

Verhetsel, A., & Sel, S. (2009). World maritime cities: From which cities do container shipping companies make decisions?. *Transport Policy*, 16(5), 240-250.

Walliman, N. (2011). Research Methods The Basics. 2011.

Weber, R. (2004). Editor's comments: the rhetoric of positivism versus interpretivism: a personal view. *MIS quarterly*, iii-xii.

World Bank Port Reform Toolkit. (2007). Module 3: Alternative port management structures and ownership models. [PDF]. Retrieved from https://ppiaf.org/sites/ppiaf.org/files/documents/toolkits/Portoolkit/Toolkit/pdf/modules/03_TOOLKIT_Module3.pdf

World Health Organization Regional Office for Europe. (2009). Night noise guidelines for Europe [PDF]. Copenhagen. ISBN 978 92 890 4173 7.Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf

World Port Source. (n.d.a). WPS - Home Page. Retrieved May 4, 2019, from http://www.worldportsource.com/index.php

World Port Source. (n.d.b). Port of Los Angeles. Retrieved April 14, 2019, from http://www.worldportsource.com/ports/review/USA_CA_Port_of_Los_Angeles_229.php

Woo, R., Principal Acoustical Consultant, INCE, & Nguyen, A., Associate Acoustical Consultant. (2017, May 05). Noise Screening Analysis For Berths 97-109 Container Terminal Project (China Shipping) [PDF]. Los Angeles: Acoustics Group, Inc. Retrieved from https://www.portoflosangeles.org/getmedia/761effa6-57fd-40b3-b527-da5dcb2a5fb2/e2_cs_appendix_e2_noisescreening_dseir

Woo, R., Principal Acoustical Consultant, INCE, & Nguyen, A., Associate Acoustical Consultant. (2018, August 14). Noise Screening Analysis For Berths 97-109 Container Terminal Project

(China Shipping) [PDF]. Los Angeles: Acoustics Group, Inc. Retrieved from https://www.portoflosangeles.org/getmedia/a8c47044-e7ed-44c0-9300-880472b89320/appendix_d2_noisescreeninganalysis_cs_drseir

Zannin, P. H. T., Ferreira, A. M. C., & Szeremetta, B. (2006). Evaluation of noise pollution in urban parks. *Environmental Monitoring and Assessment*, *118*(1-3), 423-433.

Zito, A. R. (2005). The European Union as an environmental leader in a global environment. *Globalizations*, 2(3), 363-375.

# 8 Appendix

Table A1

Full list of port cities being investigated whether to take initiative(s) against port noise

Source: Own collection and modification

Notes: port cities identified with port noise initiatives are highlighted in red

| continent | nation | port city |
|---|---|---|
| EU (70) | Ireland | Dublin |
| | Latvia | Riga |
| | Lithuania | Klaipeda |
| | Norway | Oslo |
| | Svalbard | Longyearbyen |
| | Sweden | Stockholm |
| | Sweden | Gothenburg |
| | Sweden | Copenhagen malmo |
| | UK | Scapa flow |
| | UK | Leith |
| | UK | Liverpool |
| | UK | Immingham |
| | UK | Felixstowe |
| | UK | London |
| | UK | Southampton |
| | Austria | Vienna |
| | Belgium | Antwerp |
| | France | Dunkerque |
| | France | Le havre |
| | France | Brest |
| | France | Dijon |
| | France | Marseille |
| | Germany | Hamburg |

| | | |
|---|---|---|
| | Germany | Lubeck |
| | Germany | Bremerhaven |
| | Germany | Duisberg |
| | Monaco | Hercules |
| | Netherlands | Amsterdam |
| | Netherlands | Rotterdam |
| | Netherlands | Zeeland |
| | Switzerland | Basel |
| | Albania | Durres |
| | Croatia | Rijeka |
| | Gibraltar | Gibraltar |
| | Greece | Piraeus |
| | Italy | Venice |
| | Italy | Napoli |
| | Italy | Livorno |
| | Italy | Genoa |
| | Italy | La spezia |
| | Italy | Marghera |
| | Malta | Valletta |
| | Portugal | Sines |
| | Portugal | Leixões |
| | Serbia | Belgrade |
| | Slovenia | Koper |
| | Spain | Barcelona |
| | Spain | Ferrol |
| | Spain | Bay of cadiz |
| | Spain | Valencia |
| | Spain | Gijon |
| | Spain | Tarragona |

| | | |
|---|---|---|
| | Belarus | Mazyr |
| | Bulgaria | Varna |
| | Czech Republic | Prague |
| | Hungary | Csepel |
| | Poland | Gdynia |
| | Poland | Gdansk |
| | Romania | Constantza |
| | Russia | Petersburg |
| | Russia | Arkhangelsk |
| | Russia | Kaliningrad |
| | Russia | Novorossiysk |
| | Russia | Vladivostok |
| | Slovakia (Slovak Republic) | Bratislava |
| | Ukraine | Nikolaev |
| | Ukraine | Sevastopol |
| | Denmark | Esbjerg |
| | Estonia | Tallinn |
| | Faroe Islands | Thorshavn |
| | Finland | Helsinki |
| Africa (21) | Djibouti | Djibouti |
| | Kenya | Mombasa |
| | Sudan | Sudan |
| | Tanzania | Dar es Salaam |
| | Algeria | Algiers |
| | Algeria | Bejaja |
| | Egypt | Alexandria |
| | Egypt | Suez |
| | Morocco | Safi |

| | | |
|---|---|---|
| | Morocco | Nador |
| | Morocco | Casablanca |
| | Morocco | Agadir |
| | Tunisia | Bizerte |
| | Angola | de Luanda |
| | Angola | Lobito |
| | Madagascar | Toamasina |
| | South Africa | Cape Town |
| | South Africa | Port Elizabeth |
| | South Africa | Durban |
| | Nigeria | Tin Can Island Port |
| | Nigeria | Escravos Oil Terminal |
| Caribbean (2) | Jamaica | Kingston |
| | Cuba | Havana |
| Oceania (22) | Australia | Fremantle |
| | Australia | Finucane Island |
| | Australia | Darwin |
| | Australia | Gladstone |
| | Australia | Brisbane |
| | Australia | Sydney |
| | Australia | Newcastle |
| | Australia | Brisbane |
| | Australia | Port Kembla |
| | Australia | Melbourne |
| | Australia | Geelong |
| | Australia | Adelaide |
| | Australia | South Wales |
| | New Zealand | Auckland |
| | New Zealand | Marsden Point |

| | | |
|---|---|---|
| | New Zealand | Tauranga |
| | New Zealand | Napier |
| | New Zealand | Wellington |
| | New Zealand | Westport |
| | New Zealand | Lyttelton |
| | New Zealand | Otago |
| | New Zealand | Nelson |
| America (31) | Mexico | Manzanillo |
| | Mexico | Lazaro Cardenas |
| | Mexico | Veracruz |
| | Panama | Cristobal |
| | Panama | Balboa |
| | Brazil | Portonave |
| | Canada | Montreal |
| | Canada | Vancouver |
| | Canada | Victoria |
| | Canada | Chemainus |
| | Canada | Toronto |
| | Canada | St Lawrence Seaway |
| | Canada | Prince Rupert |
| | Canada | Halifax |
| | Canada | Quebec |
| | USA | Tacoma |
| | USA | Seattle |
| | USA | Portland |
| | USA | San Francisco |
| | USA | Los Angeles |
| | USA | San Diego |
| | USA | Houston |

| | | |
|---|---|---|
| | USA | New Orleans |
| | USA | Mobile |
| | USA | Charleston |
| | USA | Norfolk |
| | USA | Baltimore |
| | USA | Philadelphia |
| | USA | New York |
| | USA | Newark |
| | USA | Boston |
| Asia (57) | China | Haikou |
| | China | Beihai |
| | China | Zhanjiang |
| | China | Hong Kong |
| | China | Macau |
| | China | Shekou |
| | China | Yantian |
| | China | Guangzhou |
| | China | Shantou |
| | China | Xiamen |
| | China | Fuzhou |
| | China | Wenzhou |
| | China | Taizhou |
| | China | Ningbo-Zhoushan |
| | China | Shanghai |
| | China | Lianyungang |
| | China | Qingdao |
| | China | Weihai |
| | China | Yantai |
| | China | Dalian |

| | | |
|---|---|---|
| | China | Qinhuangdao |
| | China | Tianjin |
| | China | Dandong |
| | China | Keelung |
| | China | Taipei |
| | China | Taichung |
| | China | Hualian |
| | China | Kaohsiung |
| | Japan | Nagasaki |
| | Japan | Hakata |
| | Japan | Kokura |
| | Japan | Kochi |
| | Japan | Niihama |
| | Japan | Osaka |
| | Japan | Nagoya |
| | Japan | Yokohama |
| | Japan | Chiba |
| | Japan | Tokyo |
| | Japan | Niigata |
| | South Korea | Ulsan |
| | South Korea | Gunsan (Kunsan) |
| | South Korea | Masan |
| | Malaysia | Klang |
| | Malaysia | Penang |
| | Indonesia | Tanjung Priok |
| | Philippines | Manila |
| | Philippines | Iloilo |
| | Philippines | Batangas |
| | Philippines | Davao |

| | | |
|---|---|---|
| | Singapore | Singapore |
| | Thailand | Laem Chabang |
| | Vietnam | Da Nang |
| | Vietnam | Saigon |
| | India | Mumbai |
| | United Arab Emirates | Khor Fakkan |
| | United Arab Emirates | Jebel Ali |
| | United Arab Emirates | Hamriyah |
| | **Total** | **204** |

Table A2

The Global Review of world major ports with port initiatives on noise issue

Source: Own collection and modification; Port authorities' official websites

Notes: due to the limited space in the document, the table of global review only represents the most important contents like basic information about ports and the details directly related to noise initiatives .

| *port* | *country* | *management of Port Authority* | *Name* | *Brief description* | *Category of policy instrument/measure* | *Subcategory of policy instrument/measure* | *Stage of noise* | *Through* |
|---|---|---|---|---|---|---|---|---|
| ***Esbjerg*** | Denmark | municipal | activity relocation | Port activities are located farther from residential areas. | infrastructure | port | Propagation | Propagation of Noise |
| ***Oslo*** | Norway | municipal | complaint registration | Residents can register complaints and will be dealt with ASAP. | communication | external | Other | Complaint Management System |
| ***Copenhagen &Malmo*** | Denmark &Sweden | CMP is a Swedish-registered limited liability company, owned by City & Port Development I/S (50 %), City of Malmö (27 %) and various private owners with 23 % of the shares in total. | terminal relocation | Operations move further out from the city centre | infrastructure | port | Propagation | PoN |
| | | | green roof | Terminal buildings are equipped with roofs reducing noise | infrastructure | resident | Receiver | Insulation |
| | | | rubber mat | Rubber mats are placed on ramps to muffle sound within Ro-Ro. | technology | indirect | Source | Machinery |
| | | | quieter vehicle | Electric cars replace traditional cars. | technology | direct | Source | Machinery |
| ***Stockholm*** | Sweden | municipal | ramp | Noise reduction ramps are used for vehicles driving onto and off vessels. | technology | indirect | Source | Machinery |
| | | | onshore power | Onshore power supply is preferred. | technology | indirect | Source | External Power Supply |
| | | | berth relocation | A vessel is moved to another quay. | infrastructure | port | Propagation | PoN |
| ***Helsinki*** | Finland | municipal | onshore power | vessels do not need to use their auxiliary engines to generate electricity whilst moored. | technology | indirect | Source | External Power Supply |
| | | | ramp | technical guidance is used to reduce rattling of ramp. | technology | indirect | Source | Machinery |
| | | | buffering wall | A massive noise buffering wall is located at the Eastern border of the Vuosaari Terminal. | infrastructure | port | Propagation | PoN |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | golf course | The South Western part of Vuosaari is bordered by a golf course. | infrastructure | interface | Receiver | UP |
| | | | discount | shipping companies apply for and receive a discount on their vessel charges if they implement measures that reduce noise in the port. | pricing | pricing | Other | Awareness |
| | | | silencer | Many vessels also use their own sound attenuators. | technology | indirect | Source | Silencer |
| | | | new terminal construction | moving terminal operations from North and West Harbour to Vuosaari, | infrastructure | port | Propagation | PoN |
| | | | monitor program | Noise levels in the harbors are monitored, which examine the noise emissions of port operations in various situations and compare these values to what specified in the harbour's permits. | investigation | monitoring | Other | Monitoring |
| ***London*** | UK | Private | tug | New tug is christened. | technology | indirect | Other | Tug |
| | | | quiet propulsion | new propulsion for vessel | technology | direct | Source | Machinery |
| ***Hamburg*** | Germany | municipal | noise phone | People can call to register complaints 24 hours a day. | communication | external | Other | Complaint Management System |
| | | | soundproofing windows | a set-up of building license for residential buildings with the obligation for noise protection at window area and the location of sleeping rooms | infrastructure | resident | Receiver | Insulation |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | noise cap | most of the area have a noise cap of maximum 55 dB(A) during the night, but some have the concession of 63 dB(A). | infrastructure | interface | Receiver | UP |
| ***Bremen and Bremerhaven*** | Germany | municipal | activity relocation | the existing residential buildings were modernized with noise absorbing windows, doors and roofs. | infrastructure | port | Propagation | PoN |
| | | | noise absorbing material | the terminal is relocated so that container handling is performed as far as possible from residential area. | infrastructure | resident | Receiver | Insulation |
| ***Duisberg*** | Germany | municipal | LNG | LNG replace traditional engines | technology | indirect | Source | External Power Supply |
| ***Amsterdam*** | Netherlands | municipal | vehicle alarm sound | The beeps from reversing vehicles are replaced. | technology | direct | Source | Machinery |
| | | | electric crane | Electric crane replace diesel one. | technology | direct | Source | Machinery |
| | | | sound-insulating ventilation | installing sound-insulating ventilation | infrastructure | resident | Receiver | Insulation |
| ***Rotterdam*** | Netherlands | mixed public: the Rotterdam government and the Dutch central government. | onshore power | The use of shore-based power by inland vessels | technology | indirect | Source | External Power Supply |
| ***Zeeland*** | Netherlands | managed by government public company | onshore power | shore power facilities for inland shipping | technology | indirect | Source | External Power Supply |
| ***Livorno*** | Italy | municipal | noise mapping | mapping noise levels caused by various sources | investigation | mapping | Other | NP |
| | | | new access to tourist terminal | a new access for the tourist terminal to not mix up anymore with the urban traffic | infrastructure | port | Propagation | PoN |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | terminal relocation | put away the solid bulk terminal from the city | infrastructure | port | Propagation | PoN |
| ***Gijon*** | Spain | municipal | monitor program | The APG monitors and controls the sound levels generated in the port's service area following the methodology established in the current state regulations | investigation | monitoring | Other | Monitoring |
| ***Barcelona*** | Spain | municipal | new terminal construction | Development of a new terminal in Moll Costa | communication | external | Receiver | MGA |
| | | | LNG for trucks | LNG as an alternative fuel for trucks | technology | direct | Source | Machinery |
| ***Valencia*** | Spain | state-owned, and reports to the Ministry of Development | electric terminal tractor at the facilities of the Noatum Container Terminal | 100% electric terminal tractor | technology | direct | Source | Machinery |
| ***Piraeus*** | Greece | state-owned | monitor program | PPA SA implements an acoustic environment quality monitoring program for its entire port area. | investigation | monitoring | Other | Monitoring |
| | | | plantation | plantation surrounding port area | infrastructure | port | Propagation | PoN |
| ***Prince Rupert*** | Canada | a local port authority constituted under the Canada Marine Act | noise monitoring | PRPA has adopted 55 decibels as a baseline towards terminal activities and their impact on residential areas. | investigation | monitoring | other | Monitoring |
| ***Metro Vancouver (PMV)*** | Canada | established by the Government of Canada pursuant to the Canada Marine Act, and accountable to the | Noise screening procedure | to determine whether a proposed project has sufficient | investigation | mapping | Other | NP |
| | | | Identification of prominent noise sources | to identify and rank noise generated by activities | investigation | identification | Other | CMS |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | federal minister of transport. | Quantification of noise | to assemble the necessary information | investigation | identification | Other | NI |
| | | | Assessment of potential noise impact | to assess the impacts with noise guidance documents | investigation | mapping | Other | Monitoring |
| | | | Post-project noise monitoring | to verify prediction and confirm the effectiveness | investigation | monitoring | Other | Monitoring |
| | | | Record of community interaction | to consider potential noise impacts for surrounding community | communication | external | Other | Monitoring |
| ***Québec (QPA)*** | Canada | . With the administrative change of the Canada Ports Corporation (Ports Canada), the Port of Québec becomes the Québec Port Corporation and more independent on decision making | This state-of-the-art monitoring system | to monitor port operation noise in Anse au Foulon sector | investigation | monitoring | Other | Monitoring |
| ***san Francisco*** | USA | The Port of San Francisco is a public enterprise agency of the City and County of San Francisco | traffic control | no work on the embarcadero between the hours of 7am to 7pm | permission | traffic | other | Port traffic |
| ***Los Angeles*** | USA | municipal | noise reduction during pile diving | specific requirement of daytime construction noise level and nighttime construction-5 dBA during specific time | technology | direct | Source | Machinery |
| | | | temporary noise attenuation barriers adjacent to pile driving | to reduce noise impact of expansion as increasing container-handling capacities at the project site | infrastructure | port | Propagation | PoN |
| | | | noise monitoring | monitoring during the daytime, evening and nighttime in consecutive hourly intervals | investigation | monitoring | Other | Monitoring |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Tacoma*** | USA | municipal | the time window | to control the loading of rail cars between 6:30am and 3:30pm Monday through Friday, with train movements and no construction activities outside of the time window set forth by the City. | permission | traffic | Other | Regulation |
| | | | motorized equipment operation | to replace some noisy equipment by motorization | technology | direct | Source | Machinery |
| | | | turning-off unused construction engines | to educate workers with awareness of the applicable exterior which is 72 dB(A) | permission | construction | Other | Awareness |
| | | | objectionable sound from Back up alarms | to deal with the annoying noise generated by alarms | technology | indirect | Source | Machinery |
| | | | Substitute hydraulic or electric models such as rock drills | new energy engine equipment | technology | direct | Source | Machinery |
| | | | onshore power supply | alternative power to shut down engine of vessel in berth | technology | indirect | Source | External Power Supply |
| ***Seattle (terminal 5)*** | USA | municipal | construction noise on pile driving | Impact pile driving is between 8 AM and 5 PM weekdays and between 9 AM and 5 PM weekends and holidays. | permission | construction | Source | Public Address System |
| | | | ambient-sensing, broadband safety alarms | sensor to control noise from safety alarms | technology | indirect | Source | Machinery |
| | | | Addition of safety measures | to reduce usage of train alarms between the bridge across the | permission | traffic | Other | PTC |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | to the rail corridor | Duwamish and the terminal | | | | |
| | | | the provision of shore power | alternative power to shut down engine of vessel in berth | technology | indirect | Source | External Power Supply |
| ***Houston*** | USA | The Port of Houston Authority is governed by a seven-member Port Commission, established as a navigation district under the Texas laws | Vegetarian berm | 50 acres, > 3 miles, 150 feet wide, 20 feet tall, > 12,000 native trees and shrubs | communication | external | Propagation | PoN |
| | | | NASA-cooperation: control sound from flight off the coast | cooperation with local industry who generate noise in port | infrastructure | port | Other | New |
| ***New York and New Jersey*** | USA | state-governed | sound absorbing materials | sound waves are absorbed into this type of material | infrastructure | port | Propagation | PoN |
| | | | equipment in taking and exhausting mufflers | installation of mufflers within the exhaust system of internal engines. | technology | indirect | Source | Silencer |
| | | | devices with acoustically attenuating shields or shrouds | installation for devices in a structure | technology | indirect | Source | Machinery |
| | | | Max idling time for equipment and vehicles | Idling time for both on-road and off-road equipment and vehicles shall be limited to 3 minutes | permission | operation | Source | Machinery |
| | | | advertising | advising the local community via notices, mailers, street postings, etc. | communication | external | Receiver | Expectation |
| | | | Limit vibration of construction equipment | Limit vibration resulting from construction equipment close to tunnels, utilities or other sensitive structures and | investigation | monitoring | Other | Monitoring |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | closely monitor peak particle velocity (PPV) | | | | |
| | | | Minimize use of equipment | Minimize use of equipment that generates more than 80 dB(A) of noise, and use such equipment only during daylight hours. | permission | operation | Other | Awareness |
| | | | machinery innovation | self-monitoring and proactively correct conditions | investigation | monitoring | Source | Machinery |
| | | | noise barriers | barriers built between noise sources and receivers | infrastructure | port | Propagation | PoN |
| ***Portonave*** | Brazil | private | monitor program | An environmental technician monitors the noise in Portonave's entire area monthly and Port equipment is also evaluated weekly. | investigation | monitoring | Other | Monitoring |
| ***Dalian*** | China | mixed | Plant barrier | propagation mitigation using plant material | infrastructure | port | Propagation | PoN |
| | | | On-shore power charge supply | alternative power to shut down engine of vessel in berth | technology | indirect | Source | External Power Supply |
| | | | silencers for noise-hungry equipment | installation of silencers to equipment | technology | indirect | Source | Silencer |
| | | | construction transport control | forbidden transport of stone for construction and electric welding at night | permission | traffic | Other | Regulation |
| | | | nighttime construction limit | reducing the nighttime construction time close to the residential area in addition to the soundproof baffle in the safety net. | permission | construction | Other | Regulation |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Ningbo*** | China | mixed | Onshore power charge | alternative power to shut down engine of vessel in berth | technology | indirect | Source | External Power Supply |
| | | | automatic operation | Eco driving, automatic berth operation | technology | direct | Source | Machinery |
| ***Shanghai*** | China | mixed | Onshore power supply | alternative power to shut down engine of vessel in berth | technology | indirect | Source | External Power Supply |
| ***Qingdao*** | China | state-owned | automatic operation | Automated unmanned container terminal for electric drive | technology | direct | Source | Machinery |
| ***Xiamen*** | China | mixed | automatic operation | Automated unmanned container terminal for electric drive | technology | direct | Source | Machinery |
| | | | Onshore charge for cruise | alternative power to shut down engine of vessel in berth | technology | indirect | Source | External Power Supply |
| ***Yantian*** | China | mixed | Cranes using green energy | Gantry cranes use electric or hybrid drives | technology | direct | Source | Machinery |
| ***Hong Kong*** | China-Hong Kong | private enterprise | City Noise Control Ordinance (Cap.400) | City set time limit of industrial activities during specific time of 7pm and 7am or at any time on general holidays | permission | operation | Other | Regulation |
| ***Keelung*** | China-Taiwan | State-owned | 24-hour automatic monitoring of noise | setting up 6 spots around the port area to monitor noise emission | investigation | monitoring | Other | Monitoring |
| ***Hualian*** | China-Taiwan | State-owned | leaving of the vehicles | the vehicles leaving the port will be converted to underground | infrastructure | interface | Receiver | UP |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Isolation zones | Isolation green belt, guardrail and bicycle lane, walkway | infrastructure | resident | Receiver | Insulation |
| | | | green belt | 4.6 Buffer green belt between Hualien Port Area and adjacent urban housing | infrastructure | interface | Receiver | UP |
| | | | 24-h monitoring | 4 set-ups of monitoring spots | investigation | monitoring | Other | Monitoring |
| ***Taichung*** | China-Taiwan | State-owned | noise monitoring | monitoring with standard of 20Hz to 20kHz, closing to 8-ft away road | investigation | monitoring | Other | Monitoring |
| ***New south Wales*** | Australia | State-owned | equipment fitted with alarms | Equipment permanently on site will be fitted with alternatives to standard reversing alarms (such as "squawker" alarms, flashing lights, video cameras, or equivalent) | technology | indirect | Source | Machinery |
| | | | Regular and effective maintenance | equipment with 6-month inspection and effective maintenance | technology | direct | Source | Machinery |
| | | | training turning-offs not in use | Machinery not in use will be turned off. | communication | internal | Other | Awareness |
| | | | noise control for forklifts | Large forklifts will be fitted with noise control kits where necessary (appropriate sound power level is 95 dBA). | technology | direct | Source | Machinery |
| | | | large forklift operation limit | no large forklift operation in Berth WB4 and WB5 | technology | direct | Source | Machinery |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | operating garbage truck | Garbage trucks are not permitted to access the site prior to 7am. | permission | operation | Other | Regulation |
| | | | ground service equipment | Ground service equipment are to be moved and prepared the evening before rather than in the early morning hours before the arrival | permission | operation | Other | Regulation |
| | | | Continuous noise monitoring | Noise monitoring and reporting will be undertaken in accordance with the program and procedures | investigation | monitoring | Other | Monitoring |
| | | | cruise activities noise | Policy- on-deck music and public announcement | communication | external | Source | Public Address System |
| | | | 24-hour Complaints Handling | to deal with public complaints without breaking | communication | external | Other | CMS |
| ***Brisbane*** | Australia | PBPL is owned by the APH Consortium (formerly known as Q Port Holdings consortium) | Noise vibration | Noise vibration around the work site, associated with the use of construction equipment | investigation | monitoring | Other | Monitoring |
| ***Melbourne*** | Australia | The Port of Melbourne (PoM) Group is the private leaseholder and strategic manager of the Port of Melbourne's commercial operations and assets | construction of noise walls | mitigate the noise from the Port Capacity Project that will reconfigure and redevelop Webb Dock | infrastructure | port | Propagation | PoN |
| | | | An automotive facility | The works will expand the automotive capacity to handle in excess of 600,000 vehicles annually | technology | direct | Source | External Power Supply |
| | | | pile driving noise | limitation of pile driving noise below 140dB | permission | construction | Source | Machinery |
| | | | Airborne Noise monitoring | involves land-based and marine-based activities with the potential to generate noise levels | investigation | monitoring | Other | Monitoring |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | newly developed port area | open spaces and improving buffering around the working port | infrastructure | port | Propagation | PoN |
| ***Fremantle*** | Australia | The port is a mix of facilities and services managed by Fremantle Ports and private operators. | freight rail noise project | Addressing rail noise due to growing community complaints and political concern | permission | traffic | Other | PTC |
| ***Auckland*** | New Zealand | POAL has an independent board of directors, responsible for directing POAL | soundproofing | adding soundproofing and reduction features | infrastructure | port | Propagation | PoN |
| | | | heavy machinery | elimination of or reduction on heavy machinery | technology | direct | Source | Machinery |
| | | | rail alarms | elimination of rail crossing alarms | communication | internal | Source | Public Address System |
| | | | rail shunt moves | minimization of rail shunt moves | permission | traffic | Other | PTC |
| | | | gantry cranes | alarm mufflers to two gantry cranes | technology | indirect | Source | Silencer |
| | | | container ships movement | container ships to berth bow south | infrastructure | port | Propagation | PoN |
| | | | requirement for new development | new development with adequate soundproofing | infrastructure | port | Propagation | PoN |
| ***Lyttelton*** | New Zealand | municipal | driver education | education for drivers to be aware of noise impact | communication | internal | Other | Awareness |
| ***Otago*** | New Zealand | provincial regional ownership | The levels of contribution by various noise zones | Red Zone (Above 65 dBA (5 day Ldn)-50%; Blue Zone (60 – 65 dBA (5 day Ldn); Yellow Zone (55 – 60 dBA (5 day Ldn) | pricing | pricing | Other | Awareness |
| | | | buildings | Airtightness of Building- windows, wall, roof...Consider and assess ALL elements of the building | infrastructure | resident | Receiver | Insulation |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | absorb material | Adding Mass to absorb energy of noise | infrastructure | port | Propagation | PoN |
| | | | location consideration | testing considering location of outside noise level for noise sensitive rooms | investigation | identification | Other | NI |
| ***Nelson*** | New Zealand | Port Nelson Ltd is jointly owned by the Nelson City Council and the Tasman District Council | A noise contour map | with a standard as: <65 dBA Ldn, indoor < 40 dbA Ldn , 60-50 dBA | investigation | mapping | Other | NP |
| | | | houses in residential area | Company buys the worst affected houses, insulate and resell | communication | external | Receiver | UP |
| | | | cooperation with port plants | awareness campaign with plant operators to modify operating systems | communication | internal | Other | Awareness |
| | | | Technical modification | development or improvement in a technical way to mitigate noise emission from sources | technology | direct | Source | Machinery |