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Noise as an environmental challenge for ports

TFK Transport Research Institute
Warfvinges Väg 29
112 51 Stockholm
Sweden
Tel: +46 8 652 41 30
Fax: +46 8 652 54 98
Email: info@tfk.se
Internet: www.tfk.se

Maria Mustonen

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Cover photo: The noise wall in Vuosaari Harbour. Port of Helsinki/ Mikael Kaplar, Studio POiNT

Foreword

This report is a result of the environmental work package of the European Union Central Baltic Interreg IV A Programme 2007-2013 project *Pentathlon – Ports of Stockholm, Helsinki, Tallinn, Turku and Naantali – together*, alias PENTA. The project has been cooperation between the five Central Baltic ports and three research institutes: Centre for Maritime Studies at University of Turku (lead partner), TFK Transport Research Institute and Estonian Maritime Academy. The main purpose of the project has been to explore the alternatives of how the five ports together can face the challenges of today and in the future. TFK's responsibility in the project has been the work package concerning environmental actions, whereof noise handling was chosen as the focus area.

The writer of the report is Maria Mustonen at TFK, who has also been project manager for the work package and responsible for the research. Janni Jensen, formerly TFK, was project manager in the start-up phase of study and conducted interviews. Anssi Lappalainen, Centre for Maritime Studies conducted interviews in Finland and Tõnis Hunt, Estonian Maritime Academy, conducted preliminary interviews in Estonia. The research team for the whole project has consisted of Johanna Yliskylä-Peuralahti (project coordinator), Anssi Lappalainen, Reima Helminen and Elisa Holma at Centre for Maritime Studies, Maria Mustonen and Janni Jensen at TFK and Raivo Portsmuth, Tõnis Hunt and Kaidi Nõmmela at Estonian Maritime Academy. At TFK, Sumile Segerdahl has supported the work package administratively.

The steering group of the study had the following representatives:

Jan Valeskog	Ports of Stockholm (chairman)
Marita Anstead	Port of Turku
Jukka Kallio	Port of Helsinki
Siiri Lõhmus	Port of Tallinn
Maria Mustonen	TFK
Raivo Portsmuth	Estonian Maritime Academy
Yrjö Vainiala	Port of Naantali
Johanna Yliskylä-Peuralahti	Centre for Maritime Studies

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Stockholm in June 2013

Peter Bark

Managing Director, TFK Transport Research Institute

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Summary

Noise has during the recent years become a prioritised environmental issue for sea ports. This is due to tightening regulations reflecting the raising consciousness of the health effects of noise on the one hand, and the international trend of exploiting waterfront areas in port vicinities to housing purposes. The noise question implies several technical, juridical and financial challenges to the ports.

Noise as an environmental and societal problem is discussed. Research regarding noise from a technical, social and cultural perspective is reviewed. Questions about good sonic environment and soundscape are discussed. The main challenges of port noise are presented and the most common noise sources in the port environment are presented. Ways for reducing noise in ports are listed.

The noise regulations in Finland, Sweden and Estonia are compared. Ports are obliged to do an environmental impact assessment in all of the three countries. In Estonia, limit values for noise are set in the legislation. In Finland and Sweden guideline values are given, and the noise conditions are issued for each port individually by environmental permits. Port noise is classified as industrial noise, which is handled by environmental permits. Traffic noise, on the contrary is handled by urban planning. Especially in Sweden, this complicates the ambitions of building residential areas in the port vicinities.

The status of noise handling in the participating ports is analysed. The vessels and the land-based traffic the RoPax operations generating showed to be the most important noise sources in these ports. The ports have taken a wide variety of actions to abate noise, including bigger investments such as noise walls and installing onshore power supply for berthed vessels, and operational measures such as amending traffic arrangements and allotting berths according to the noise levels. Keeping the noise within the required levels is perceived as a challenge in the PENTA ports.

The relationship between the port noise and the urban planning is studied. The pursuit of mixing different functions, such as residential buildings and port operations, in the same areas is challenging from the noise perspective. The environmental permit processes and the urban planning are two separate processes, and the lack of institutionalised forms of cooperation creates situations where a conflict between the urban development and the port development can easily occur. Taking the sonic environment into account from an early stage of planning, better cooperation and proactivity from all the involved parts can be ways to stop the unwanted development.

The polluter pays principle is widely accepted in the environmental justice. When allocating the costs for noise reduction, the first question is to define the polluter. Today, the ports are responsible even for noise they cannot directly impact. At the moment, vessel noise is not regulated internationally, and it raises questions regarding the liability of the ports. The polluter pays principle is a good starting point for cost allocation, but sometimes it can be justified to consider co-investments to make noise reduction possible.

The question is so complex that the ports need to handle it more systematically and proactively in the future. Due to this, even the collaborative networks should be enhanced. A systematic noise management model is proposed to the ports. It should be an integrated part of the ports' work for sustainability and social responsibility.

Sammanfattning

Tiivistelmä

1 Introduction

When you think about a seaport, noise is hardly the first thing that comes to your mind. The very first ideas are probably more of a visual character: vessels berthing, passengers arriving, big cranes loading and unloading vessels lying by the quay. There is activity everywhere; a port should not be still. All this activity produces, of course, some sounds. A completely quiet port is nothing to strive for.

But, how does a port actually sound? Should you anticipate the sounds of the sea like the buzzing wind, waves washing against the pier, accompanied with some seagull cries? Or are you about to hear deafening jar from the working machinery, pounding bass tunes from the enormous diesel engines and whining and rattling from the unloading bulk vessels? The reality might roam somewhere between these two extremes, and we can state some questions like: how should a port sound like? How is a good port sound environment like? And why are these questions important to ask in the first place?

The motive for this report is that many ports both in the Baltic Sea countries and internationally experience noise and in particular the noise requirements from the authorities as a growing challenge. That is why the five Central Baltic ports which formed the PENTA project wanted to take a closer look at the port noise situation. PENTA has been a cooperation and development project between the ports of Stockholm, Helsinki, Tallinn, Turku and Naantali. Three research institutes, Centre for Maritime Studies at Turku University (lead partner), TFK in Sweden and Estonian Maritime Academy have been responsible for carrying through the research. The overall aim of the project has been to explore how the five Central Baltic ports together can face and better comprehend the challenges of today and the future. PENTA has been financed by the European Union Central Baltic Interreg IV A Programme 2007-2013, the five ports and the state of Estonia. TFK has been responsible for the work package regarding the port noise.

The noise question is much more complex than just decibel levels and acoustic measurements, which are already a whole science of their own. When you start to investigate noise, you will be cast onto different juridical, economical, medical, psychological, ecological, technical, architectural, social and societal as well as aesthetical issues which all can be relevant even from a port's perspective.

The image of sea ports has changed remarkably during the past few decades. In the old days, the word dockland could evoke quite dubious associations, and ports were often located outside the inner-city areas. Now, many port cities have grown so that ports have been encircled by the city settlements, often with residential areas close-by. The ports themselves have been modernized and become efficient logistic hubs with less manpower and more technology. This has been a big change, also from the image point of view. In many European port cities, flashy and dynamic inner-city residential areas are being built close to the port areas, and the main target group for these housing projects is the economically privileged upper middle-class. The dominant city planning philosophy is to mix different functions in the same area, and this can, at least in some cases, lead to conflict of interest. The city planners' visions don't meet the ports' reality entirely smoothly in all cases.

When it comes to legislation regarding noise and other environmental impacts, the ports are handled the same way as industrial establishments in all the three countries. In many respects, this is justified due to the several parallels ports have with different industries. Alike many

industries, there are multiple environmental impacts and several emission sources in a port. But at the same time, this leads to more strict noise regulations for ports than other modes of transport. Of the studied countries, the juridical situation is most complex in Sweden, and many of the questions regarding the ports' condition remain unanswered. When we discuss port noise, it is important to keep in mind that ports in general are not particularly noisy places compared with an average city street where the sounds of car and truck traffic dominate the soundscape. The port noise is only a little addition to the sound carpet that embraces the city from every direction.

Even though ports stand only for a little fraction of all environmental noise our society, the noise issue cannot be ignored by ports. The noise abatement requirements from the environmental authorities will not be less strict in the future, and at the same time, minimizing the environmental impact and being a good neighbour will be crucial for the ports' social responsibility and public relations. Due to the rising environmental awareness, all companies, and therefore ports as well, will be scrutinized even more carefully by the authorities, the media and the public in the future. That is why a systematic noise abatement work is an important issue for the ports' future development.

1.1 Research questions

In this report the port noise issues in the three countries will be mapped. Five research questions will be answered:

1. Which noise abatement requirements are set by the authorities and in which way noise is defined as a problem in Sweden, Finland and Estonia?
2. How do the PENTA ports work with noise issues at the moment?
3. How can noise be analysed as a potential risk factor for the port development, especially in relation to waterfront housing projects?
4. How should the cost for noise abatement measures be allocated between the different parts which cause and suffer from noise?
5. How can noise management be developed as a part of the ports' social responsibility and stakeholder management?

1.2 Purpose and delimitations of the study

The aim of this report is to gain more understanding about the port noise questions in the three countries. The purpose is that the ports will find the contributed information useful, so that they can face the noise issues in a systematic and a proactive way. The aim is to give recommendations for the future noise abatement work in the ports.

The report focuses on the environmental noise from the ports, and consequently, noise as an occupational health problem is outside the range of the study. The noise emissions to the water are not regulated in the environmental permits of the ports, and therefore they are outside of the scope of the study as well. The report will give recommendations to the ports, but not directly to other parts involved in the noise issues, such as authorities and other enterprises.

1.3 Disposition of the report

The report is divided into ten chapters, including this introductory chapter. Chapters 2 to 4 are theoretical and methodological. In chapter 2, noise as an environmental problem is discussed. The material and the methods of the study are presented in chapter 3. Chapter 4 gives theoretical background on the soundscape question and port noise abatement in general.

The research question number 1 is answered in chapter 5 about noise regulation in the PENTA countries. The research question number 2 is answered in chapter 6 discussing the noise situation and the noise abatement measures in the studied ports. In chapter 7, the research question 3 regarding the relationship between port noise and waterfront housing projects is discussed both generally and in the PENTA ports. The research question number 4 about the cost allocation is handled in chapter 8. In chapter 9, noise management and the ports' social responsibility are discussed and recommendations to the PENTA ports are given. Finally, in chapter 10 the conclusions are summarised and further research questions within the topic are given.

2 Noise as an environmental problem

It is widely agreed that environmental noise is a severe public health problem. At the same time as the society is becoming noisier and quiet places are becoming rarer, new research results about the health effects of noise are shown. The noise question is getting a growing attention from the environmental and health authorities both internationally and nationally. The European Union issued the Environmental Noise Directive in 2002 (EC, 2002), and investigations, authority reports and action plans are produced frequently on the national level.

Paradoxically, Lyytimäki (2006) characterizes noise as a forgotten environmental problem. With this he points out that, unlike the growing awareness of noise's hazardous effects on human health, very little is known about noise's impact on other species. Noise is defined as a problem mostly from a human point of view. You could say that the authorities are so busy with the growing burden of environmental noise and its negative effects to the public health that that there is no time and resources to pay attention to its harmful effects to the wildlife.

Noise is many times found as a fuzzy concept. In his classic study The Tuning of the Word, R. Murray Schafer (1977, 182-183) finds four definitions for noise:

1. Unwanted sound.
2. Unmusical sound.
3. Any loud sound.
4. Disturbance in any signalling system.

The first two definitions show that noise is a relative matter. Music, chat and laughter from a party next-door can be experienced as noise by a sleepless neighbour, but guests attending the party wouldn't certainly hear these cheerful sounds the same way. What is music to one's ears can be noise to other's. One of the uses of music is to make identifications and draw boundaries between different subcultures, generations, ethnical groups etc. That is why the "unmusicality" of a sound is always a social matter. The third definition is close to the modern use of the concept where different limit values for noise exposure are determined. It pays attention to the mere volume of the sound, regardless if it is wanted and pleasant or unwanted and annoying. The fourth definition is of a technical character.

The vagueness of the two first definitions is, in fact, capturing one of the main features of noise, its subjectivity. Sounds are experienced differently in different contexts and situations, and the variation between individuals is great. The Western culture is strongly oriented to the visual, and we are taught to see the world rather than to hear it (Schafer, 1977). Nevertheless, some people use their ears more than others, and it is likely that these people are more sensitive to noise as well. In the worst case, these individuals are labelled as "difficult persons" or trouble-makers when they complain about noise pollution in their environment (see Ampuja, 2008).

It is obvious that an operational definition of noise is needed for the purposes of the study. For this Lahti's (cited in Ahonen, 2009) definition is useful: noise is a meaningless or disturbing sound, is hazardous to the physical or psychical health. This twofold definition is useful because, firstly, noise can have health effects even though it is not experienced as annoying, and secondly, noise can be experienced as disturbing even though limit values for noise are not exceeded (see Socialstyrelsen 2009, 170-172). Consequently, this definition covers both

the quantitative (decibel levels) and the qualitative (experienced annoyance) scope of noise. It is also equivalent with the definition of environmental noise in the Environmental Noise Directive, which reads: "unwanted or harmful outdoor sound created by human activities, including noise emitted by means of transport, road traffic, rail traffic, air traffic, and from sites of industrial activity" (EC, 2002).

2.1 Noise in the society

In densely populated urban areas, it is hard to find quiet, noise-free places. Noise is surrounding us everywhere and has multiple sources. Noise is one of the most widely spread environmental problems in Europe (WHO 2011, 1). It is quite hard to estimate the number of people exposed to noise, and due to the different criteria and measuring methods, it is even harder to make reliable comparisons between different countries. On the European level, the approximated number of people exposed to noise is 120 million, or 30 per cent of the population. (Ympäristöministeriö 2004, 16). In Sweden, with a population of ca. 9,4 million, approximately two million people are exposed to noise in their living environment (Socialstyrelsen 2009, 164). In Finland, with a population of ca. 5,4 million, the approximated number of people is up to one million. (Ampuja 2007, 13; Liikonen & Leppänen 2005). Therefore, in these two countries, the number of noise-exposed people is somewhat less than in the rest of the EU countries. In Estonia, the noise exposure lies on the average European level, but only 13 per cent of the population report noise as a problem (Estonian Review 2011).

The birth of noise pollution can be dated to the industrial revolution and the invention of the steam engine. The noise pollution of today is to an overwhelming extent caused by the internal combustion engine which has not only made our modern society possible, but also shaped our affluent life-style as a whole. The noise problem is one of the downsides of the economic growth and can only partly be eliminated by new, quieter techniques. Roughly, you can state that the more goods and transports we require, the more noise will be created. (See Ampuja 2007; Schafer, 1977).

In the beginning of the industrial revolution, noisy machines were seen as symbols of efficiency and progress. Never before in its history had the mankind been able to produce such deafening sounds. As we know from the history books, the rights of the workers were somewhat non-existent in the beginning of the industrial revolution, but still, it was in the occupational health context noise was first defined as a problem. It was not until in the latter half of the 20th century noise was defined as an environmental problem and noise abatement legislation started to develop. (Ampuja 2007, 57-102; Schafer 1977, 181-202.)

Access to silence is becoming a rarity in our society. Like other resources, it is not evenly distributed among the citizens. In the USA, the concept of "noise ghetto" refers to an unattractive, noise-exposed area where only people who cannot afford to live somewhere else end up to. It remains unknown if there are such areas in the PENTA countries, but there are implications that real estate prices and the inhabitants' incomes are lower in areas heavily exposed to noise. People with the privilege of choice tend to ensure themselves a quiet and private living environment in any country. (See Ampuja 2007, 154; Puttonen 1998.)

Noise and urban planning are intimately related to each other. Ampuja (2007, 125-127) discusses the urban landscape and "non-places" which people are avoiding due to their noisiness. These no-places are created by city planning unintended, but also with the purpose

to isolate noise to certain places to be able to secure a somewhat noise-free environment elsewhere. Industrial sites such as ports can be seen as this kind of non-places that are unpleasant to be at, partly due to the noise impact.

In city planning, the general development during the past decades has been the shift from a zoning to a mixing philosophy. The main advantages of mixing are to be able to densify the urban structure, create more living urban environments and to avoid the phenomenon of urban sprawl. The main disadvantage with mixing is that it can be difficult to combine different interests, such as industrial and recreational functions, in the same area. (See Bellander 2005; Hedman & Möller 2011, 82.)

Road and street traffic is by far the most important source of noise pollution, followed by rail and air traffic. The noise from cars and trucks dominates the urban soundscape and therefore also the noise abatement literature and measures. In Sweden, the number of people exposed to road and street traffic noise is up to 1,8 million, in Finland circa 0,8 million (Liikonen & Leppänen 2005, 39; Socialstyrelsen 2009, 165). In Estonia, the situation is similar and the noise abatement measures are mainly focused on road and street traffic noise.

There are only a few estimations of the number of people suffering of port related noise available. In Finland, it was estimated in the mid-2000s that ports exposed between 100 and 500 people to noise levels higher than 55 decibels (day equivalent level, for more information about measuring noise levels, see chapter 2.3), excluding car and truck traffic to and from ports (Liikonen & Leppänen 2005, 33). These figures should be seen only as a rough estimate, and they do not take into account the possible annoyance resulted by port noise. From Sweden and Estonia, there are no comparable figures available. Overall, there are no reliable statistics on the scope of the port noise.

Legally, port noise is classified as industrial noise. Unfortunately, there are no statistics available about the exposure for industrial noise in European Union. In World Health Organization's summary of exposure figures and estimation of health lost due to noise, less than two per cent of the population in Netherlands reported severe sleep disturbance due to industrial noise (WHO 2011, 65). In Sweden, less than one per cent of the population reports noise disturbance due to industries (Socialstyrelsen 2009, 169). These figures might be indicative for the scope of the problem of industrial noise in European Union.

Overall, the knowledge of the scope of the port noise is limited to the noise mappings and annoyance surveys of each individual port. On the population level, port noise cannot be seen as a problem of great importance. Noise impacts generated by port operations are local, usually limited to a couple hundred meters from the port area.

Considering this, port noise might seem a marginal problem contributing only to a little fraction of the whole burden of environmental noise. The figures could be interpreted that maritime traffic is the quiet traffic mode compared with road, air and rail traffic. Nevertheless, the situation is not that simple. As a matter of fact, many European seaports are struggling with the noise problem, and noise is topping European Sea Ports Association's and EcoPorts' latest list of prioritized environmental issues (ESPO / EcoPorts, 2010, 4).

Reasons to this discrepancy are several. The ESPO / EcoPorts report (2010, 4) names the Environmental Noise Directive (EC, 2002), with its obligations to create strategic noise maps and action plans for noise abatement, as the most important factor contributing to the ports'

increased focus on noise issues. On the other hand, the European Union initiative can be seen as a part of a bigger international trend to pay more attention to noise pollution. The definition of noise as an environmental problem has gone hand in hand with the growing knowledge of the health hazards caused by noise. National legislators and environmental authorities have been working with noise abatement even before END was adopted. In Finland and Sweden, noise issues have been a part of ports' environmental permits already since the 1990s.

One important ingredient in port noise question is that maritime traffic is regulated internationally, mainly by the United Nations organ International Maritime Organization, IMO. Therefore, national authorities' means to regulate environmental issues regarding the maritime traffic is limited. One way to do it is by regulating ports, instead of regulating the shipping industry.

Moreover, the growing environmental consciousness, the emergence of corporate social responsibility and the pursuit for sustainability have not left the seaport business intact. Altogether, we have ended up in a situation where ports are experiencing an increasing pressure to take noise abatement measures. At the same time, delimiting noise levels in port environment is a big technical challenge. The specific character of port noise and the problems of port noise abatement will be discussed in chapter 3.

2.2 The health effects of noise

For a long time, noise was primarily seen as a question of comfort, and noise annoyance was more or less seen as the annoyed individual's private attitude problem. It was argued that noise is an integral part of the urban environment and urban inhabitants are supposed to tolerate the necessary evil of noise. In this ethos noise can be seen as a symbol of progress, effectiveness and modernity and a low price for the comforts and improvements that the modern machinery has to offer. (See Ampuja 2007.)

The more research about the health effects of noise is done, the more hazards are shown. According to WHO (2011, 101-102), at least one million healthy life years are lost annually due to noise pollution in Europe.

The most widely known effects of noise are the effects on the hearing. One single loud sound can damage the hearing permanently, but even a long-time exposure to sounds on a lower decibel level can lead to permanent changes in ears and cause hearing disabilities like tinnitus. (Socialstyrelsen 2009, 166-168; WHO 2011, 71-85.)

Besides annoyance, a long-time exposure to noise has several health effects. Noise exposure is related at least to cardiovascular diseases, sleep disturbance, and cognitive impairment in children. (WHO 2011.) Hearing is the one of our senses that is always open for sensations; it is not "switched off" even during the sleep. This is due to the hearing's role as an important warning system. Hearing sensations have effects both on the autonomous nervous system and on the hormonal system. Exposure to a high level of noise triggers a stress reaction which can be for instance measured in high levels of stress hormones. A long-time noise exposure can lead to a more permanent unbalance in the stress regulating system of the body. These physiological effects can be measured regardless of the experienced annoyance or sleep disturbance. (Socialstyrelsen 2009, 171-172.)

The health effects of noise can be summarized with this picture showing the severity of the effects and the number of people affected. The picture shows, on the top of the iceberg, that noise is a risk factor to premature death cases. (WHO 2011, 100.)

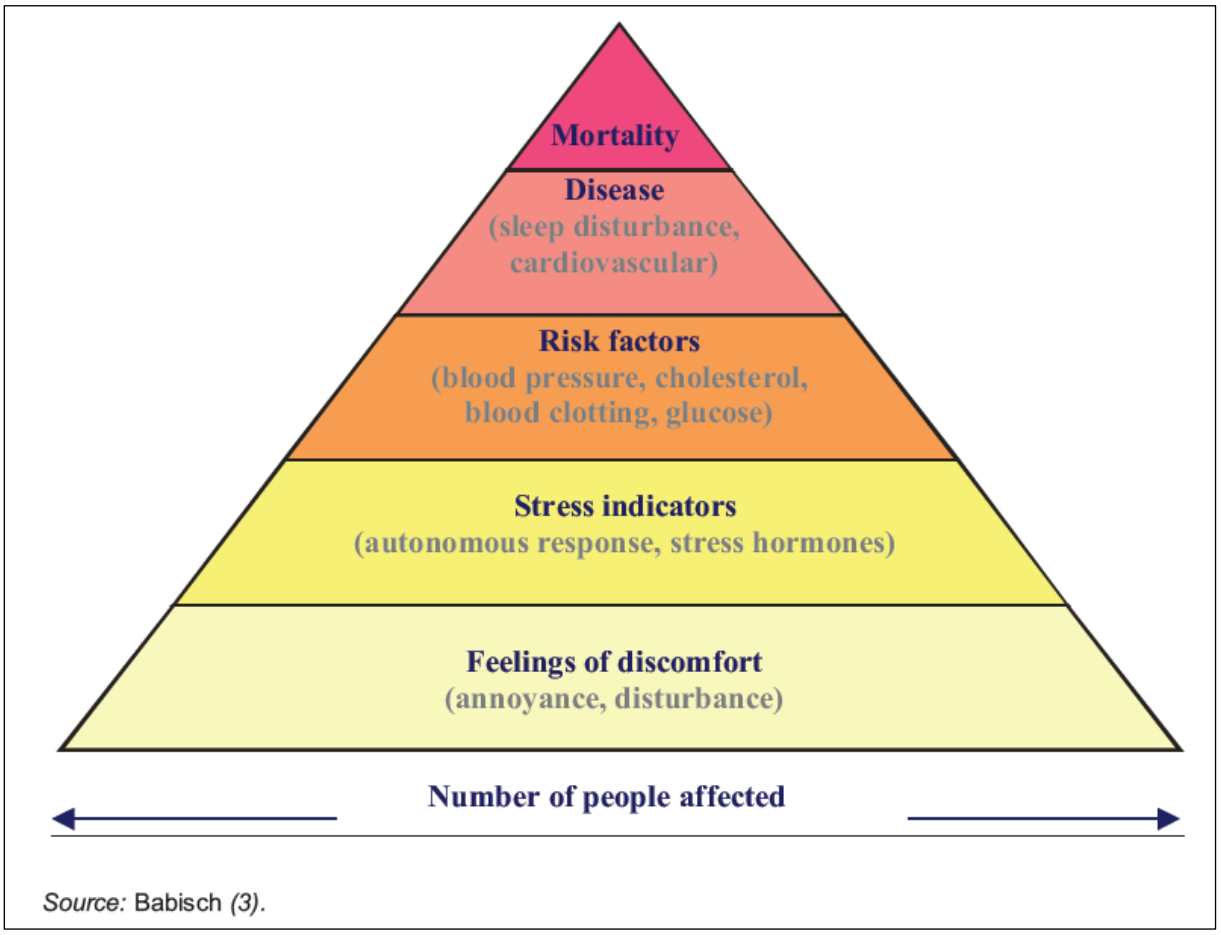

Figure 1: Severity of health effects of noise and number of people affected. Source: WHO 2011, 100.

The variation between the individual's reactions to noise is great. The mere loudness of a noise cannot explain why some individuals develop noise-related symptoms and others do not. The noise source, its meaning to the individual, qualities, occurrence over time, familiarity, controllability and predictability affect the these reactions. (Jauhiainen, Vuorinen & Heinonen-Guzejev 2007, 55). Noise sensibility is a personality attribute independent from noise exposure, and 25-43 per cent of the population has been classified as noise sensible in different studies. That is why noise annoyance cannot be measured only by noise mappings. (Heinonen-Guzejev & Vuorinen 2001, 22-23.)

Based on medical research on the health effects of noise, WHO has issued guidelines for community noise (WHO 1999, 55-65) and specific night noise guidelines for Europe (WHO 2009). They are meant to be guidance for legislators and policy-makers who are to protect the public health. WHO also gives guidelines for noise management in general. WHO's set of guideline values is quite complicated and includes values for several kinds of situations and population groups. These values are then stipulated to the national legislations and national

guideline values to a varying degree. The environmental and health authorities handling of noise in PENTA countries will be discussed in chapter 5.

2.3 Measuring noise

The science of sounds and vibrations is called acoustics. The phenomenon of sound consists of changes in air pressure, which induces hearing sensations. Sounds are carried in the air as a mechanical wave movement. Sounds audible to the human ear, but also of low-frequent (infra) and high-frequent (ultra) sounds which cannot be sensed by humans are counted as sounds. In solid materials the sound waves can be observed as vibrations. The unit of sound pressure is pascal, but as the hearing functions logarithmically, the logarithmical scale with the unit decibel, dB, is widely used to describe the sound pressure or the loudness of a sound. The lowest theoretically audible sound level, hearing threshold, is 0 dB, while the loudest sound the human ear can sense without damages is between 120-130 decibels. (Bodén et al 2001, i; Boverket 2008, 47.)

The frequency of a sound is measured in hertz (Hz), a unit of vibration cycles per second. A young and healthy person can hear sounds between 20 and 20 000 Hz. The variation of the frequency is experienced as pitch; bas tones have a low frequency and high-frequency sounds are experienced as a higher pitch. Sounds with a frequency lower than 20 Hz can be sensed as vibrations. (Bodén et al 2001, 43.) Many other species of animals can sense and communicate with sounds beyond the human scope of hearing (Lyytimäki 2006, 115-117).

The human hearing sensation does not correspond directly to the measured sound pressure, and different frequencies are experienced in different loudness. To make the measurements correspond better to the sound experience, weighting scales have been developed. The most common of the scales the A-weighted scale (dBA) which is used to measure for instance traffic noise. Guidelines for noise levels are usually given in dBA. C-scale (dBC) is used to measure low-frequent or short-term impulse sounds. (Bodén et al 2011,43-48; Boverket 2008, 48.)

Noise guidelines and limit values are usually given in equivalent sound pressure levels, as an average noise level where the maximum sound pressure levels have been weighted, during a period of time. An equivalent level during the whole 24-hour period is $L_{day,}$ and equivalent level for night-time is L_{night}. L_{den} (day-evening-night) is a day equivalent level where the different times of the day are measured separately. Sometimes even maximal allowed sound pressure levels are given to regulate impulse sounds, especially for noise events during the night-time. (Bodén et all 2001, 47-48, WHO 2011, xiv.)

Noise annoyance is not directly dependent on the decibel level. Momentary or impulse sounds, sounds with tonal elements and low-frequent sounds are often experienced as more disturbing than broadband sounds with a low variation, such as noise from rod traffic.

Measuring noise in an outdoor environment such as ports is rather complicated. The weather, as wind, temperature, air pressure and the presence or absence of snow has impact on the measurements. Sometimes the background noise makes it problematic to distinguish the noise level from the measured noise source. The latter problem is nowadays solved with computer-assisted modelling. The noise source is measured on a close distance, and a map with the

detailed topography of the site is used to calculate the dispersion of the sound to the surroundings. The available acoustic software for noise mapping is advanced today, and professionally made noise models respond control measurements well. In more complicated situations, the models can be complemented by detailed long-term measurements. The advantage of this method is that it captures the variation of the noise level during the measured time period.

There are ISO-standards for noise measurements, which leads to a high level of reliability of the results. Nevertheless, it is quite common that the results become a subject of disputes. The explanation to this is simply the subjectivity of the noise experience. After all, it is only the individual him or herself who can tell if he or she is disturbed by a sound or not.

3 Material and methods

The study has been carried out using qualitative research methods, and it is of an explorative character. In the first phase of the study, an interview round with the environmental managers at PENTA ports was made to map the scope of the research problems and to formulate the research questions. The problem formulation period was relatively long, and during this period the researcher who started the project was replaced by the writer of this report.

3.1 Literature study

As the noise question is comprehensive and can be approached from the perspective of several disciplines, an expensive literature study was made. To map the different approaches to the question of noise, the emphasis was rather to catch these different perspectives than to get in-deep to any of them. The initial literature study was made in the problem formulating phase, and it has been complemented during the whole research period.

The literature study has included authority reports, academic research, consultant reports, newspaper and periodical articles, textbooks, and internet sources. The literature study included an overview of the legislative framework on the European Union and national level, the health effects of noise, the acoustics of noise, reports regarding technical noise abatement, soundscape studies, and research on noise from a societal and cultural perspective. Only the literature directly used in the report is found in the list of references.

3.2 Interviews and other material

The primary material of this study was collected in qualitative, open-ended interviews made both face-to-face, by telephone and by email. The interviews in Sweden were conducted in Swedish and the ones in Finland in Finnish. The Estonian interviews were done in English. Totally 31 interviews were made. The face-to-face and telephone interviews were recorded and transcribed to written format. The questions stated varied greatly depending on who the interviewee was, but their purpose was to map and comprehend how the authorities and the companies in the port communities handle the noise question. Also an acoustic expert and two residents' associations were included in the interviews. The duration of the interviews varied from approximately 15 to 90 minutes. During the interviews, the atmosphere was generally open and cooperative despite the fact that noise is sometimes seen as a sensitive issue. The list of interviews can be found in Annex 1.

In Sweden and Finland, all the people who were asked for an interview agreed to participate in the study. In Estonia, contact efforts with one authority representative ended up without results. Conducting additional interviews was ended when a point of saturation was achieved, resulting a situation where new interviews would not have given a deeper understanding of the question.

In addition to the interviews, a number of shorter expert consultations were made by telephone. The telephone consultations were a complement to the interview material and were used to double-check missing facts. The consultations are listed in Annex 2.

During the whole research process, a continuous dialogue with the project's steering group, the environmental managers of the PENTA ports and the PENTA research partners was held. On these occasions, facts were updated and the research questions were discussed.

The researcher participated in a number of workshops, seminars and conferences during the research period, and presentations and discussions from these events were used as background material for the analysis. In some of the events, preliminary results from this study were presented. The list of these events can be found in Annex 3.

3.3 Analysis methods

The use of the research material was twofold: Firstly, it was used to gather facts about the research questions. Secondly, the material was used to create a synthesis about the state of and general attitudes towards noise handling by the authorities, the ports and other parties involved in the question. Speaking to several people who work with and are involved in the noise question and behold it from different perspectives helped to triangulate the ideas and to form a more objective picture of the research questions.

For research question one about the noise regulation, a description of the environmental permit process in Sweden and Finland was made. For research question two about the noise handling in PENTA ports, the interviews were analysed using a thematic classification method. For research question three, the arguments of the ports, the urban planners and construction companies were put against each other and analysed. Analysis of research question four about the cost allocation is of descriptive and summarising nature. Research question five, the recommendations, is based on the synthesis of the entire material.

3.4 Limitations of the study

There is no reason to suspect that the informants would deliberately have given false information in the interviews. Nevertheless, they might have, consciously or unconsciously, presented the facts in a way that casts a favourable light to the organisation they represent. To counteract this effect, several people have been interviewed regarding the same questions.

The fact that the ports have in a way acted both as informants and as assigners is no easy situation for a researcher. To be conscious about the situation is one way of keeping a critical distance to the research object. Another way is the triangulation mentioned before.

As the material from Sweden and Finland is both broad and rich, the material from Estonia is much thinner. It consists mainly of interviews, and written material has been used only when it has been available in English. The language barrier is a fact even though neither the informants nor the researcher have problems speaking English. The lack of access to material in the language of the country makes it more difficult to gain a deep understanding about how the noise problems are defined and handled in Estonia. The researcher is not either personally familiar with the Estonian administrative culture, unlike the Finnish and Swedish ones. For the same reasons, she has not been able to follow the public debate about noise in Estonia. That is why there is a reason to be careful with the conclusions regarding Estonia. Some conclusions will nevertheless be made, but the reader should be conscious of the limitations of the Estonian material in this study.

4 Hushing the docklands – soundscape and noise abatement in ports

The concept of noise was discussed in the previous chapter. As noise, by definition, is always something unwanted and negative, the more neutral concept of soundscape is useful when discussing the sonic environment. The father of both the concept and the research field of soundscape studies is the Canadian composer, researcher and activist R. Murray Schafer. The word soundscape is a combination of words sound and landscape, and it is used to describe how the world sounds like. In the World Soundscape Project, Schafer's research team developed a method of describing and studying the soundscape back in the 1970s, and his book *The Tuning of the World* (Schafer 1977) is considered to be a classic.

In The Tuning of the World, Schafer criticises the visual dominance of the Western culture and points the attention to the sonic environment. He uses the concept pair *hi-fi vs. lo-fi soundscape* to describe the shift from a pure and original soundscape where places had their own sonic identities to the blurred and anonymous modern soundscape which is dominated by the ever-present noise pollution caused both by the mechanical (machines, traffic) and the electrical (radio, TV, sound amplifying systems) revolution. The amount of noise pollution is today even bigger than when Schafer was writing his study. The loss of the sonic identities is escalated by the globalisation and the development of the ITC technology.

The soundscape concept is useful when the qualitative properties of the sonic environment are studied and discussed. Psychological, social scientific and humanistic research can give us clues on how people experience sounds and what characteristics of the soundscape are preferred. Even though the societal planning is dominated by the visual, the sonic environment has impact on the people's well-being and the qualities of a soundscape cannot be wholly described by decibel levels and other acoustically measurable parameters.

The Finnish environmental historian Outi Ampuja (2007) uses the term *artificial soundscape* to describe the sonic environment born of and controlled by human activities. The control of our sonic environment is, however, no straightforward and wholly conscious process, but a result of contradictory intentions and struggles of interests. Noise abatement measures are used to hit the most urgent noise hot spots, but an overall vision on how our society should sound like is missing. The efforts for noise abatement are easily knocked out by the increasing amount of new machines and devices that create new forms of noise.

It is known that sonic environments with "natural" sounds are preferred to "artificial" or mechanical ones, even in urban environments. Research results stress the importance of *restorative environments* as a refuge from the stressful, noise-polluted urban environments. Typically, these restorative environments are more silent than the average urban environment and include visual and sonic elements of the nature. In the urban environment, parks, fragments of forest and waterfronts are very important restorative environments where the inhabitants can rest their ears and minds. (Ampuja 2012; Grahn 2010; Nilsson 2007.)

Altogether, we can state that a good soundscape is more than just decibel levels. The qualitative characteristics of the sonic environment and the meaningfulness of the ambient sounds have a great impact on how the soundscape is experienced. (Naturvårdsverket 2007a; Nilsson 2007.) These qualitative considerations are good to bear in mind when we now discuss the decibel levels, noise abatement and noise control in ports.

When it comes to the handling of noise, there are different views on how it should be done. The terms of noise abatement, noise control and noise management are different perspectives to the same questions. The noise abatement approach is the dominating view of protecting the public from noise, and it is mostly concerned of technical ways of noise reduction. Nowadays, the concept of noise control is seen often in the noise debate. The difference between the two is a thin line, but the term noise control stresses an active handling of noise instead of a passive protection approach. The concept of noise management is defined as "an ongoing, systematic and documented way to handle the impacts of noise on people and the environment in or around a company or a geographic area" (NoMEPorts 2008, 39), and is thus a process description for noise control. Noise management will be discussed closer in chapter 9.

The concepts of noise abatement and noise control can be related to the Swiss researcher Pascal Amphoux's (summarised in Hellström 2002, 77-80) terminology. He has described three different attitudes we can have to the sonic environment. The first attitude, which is the dominating today, is *defensive* and consists of defending the sonic environment from acoustic pollution. The mainstream noise abatement is dictated by this attitude. The second attitude is *offensive* and aims at consolidating the sonic milieu, active control of the soundscape, handling the conflicts arisen from the soundscape question and engaging people to regulating and controlling their own sonic environment. It takes the step even further than the noise control approach, because the controlling includes even the qualitative aspects of the soundscape. The third attitude is *creative* and consists of composing the landscape. It is both about taking the step further towards urban sonic design and stimulating the citizens' consciousness of the sonic environment. The creative attitude is the opposite of the technocratic ethos of the mainstream noise abatement thinking.

4.1 Noise sources in the port environment

The significance of the noise question varies greatly from port to port. Both the location of the port, its topography and the characteristics of the port operations influence the noise situation greatly. Measured in decibels, ports dominated by cargo traffic are typically noisier than ports dominated by passenger traffic. However, passenger-oriented ports located in inner-cities are more often struggling with the noise issue. This is simply due to the fact that cargo-oriented ports are usually located further away from residential areas.

A port environment has typically several noise sources. The presence and the significance of the sources vary depending on the type of traffic in the port. The following noise sources are the most common ones:

1. **Working machines.** Cargo handling equipment is a significant noise source in ports. Examples of these machines are cranes, reach stackers, straddle carriers, terminal tractors and trucks. Noise sources on these are engines, exhaust systems, tyres and alarm signals. The cargo handling equipment is usually driven by diesel engines, and noise is generated both by driving and cargo handling events. (See Hyrynen et al 2009.) The engine solutions are more or less the same as the ones used for road vehicles, but unlike road vehicles, noise reducing solutions for this kind of machines have not been required by legislation. Nevertheless, newer equipment is generally more silent than older. Some of the improvements have been achieved through a conscious development work, but sometimes improvements have been resulted by other requirements. An example of this is the requirement of catalytic converters in the

exhaust systems of the terminal tractors, which has reduced the noise levels as a bi-product.

2. **In and out truck and car traffic.** As ports are hubs where different traffic modes meet, the in and out road traffic to ports is extensive. This creates problems both with air pollution and noise in the port areas and their vicinities. Even passenger vessels generate car traffic to the ports, because many passengers arrive to the ports by car or have their cars with them during the boat trip on RoPax vessels typical to PENTA ports. Creating functional road and street traffic solutions and eliminating the nuisances caused by this traffic at ports is a big challenge to both the ports and the urban planning. For ports dominated by heavy truck traffic this is even a bigger challenge.
3. **Railway.** The ports with a railway connection have special noise questions related to the rail operations to handle. The most problematic of these sounds is the impulse noise generated when the railway wagons are shunted.
4. **Vessel-quay interface: ramps.** The ramps between the vessels and the quay which vehicles enter and leave the vessels are usually made of concrete and metal. Driving on the ramps can create loud impulse sounds.
5. **Cargo handling: containers, bulk cargo.** Cargo handling sounds in ports are many and diverse. Generally, unitised traffic generates less noise than loading and loading bulk cargo. This noted, even container handling creates impulse noise when the containers are dropped to the ground, to the vehicle or are clashing into each other. Unloading liquid bulk can create tonal, whining sounds. Maybe the most problematic noises in the port environment are created by loading and unloading some types of dry bulk, which creates loud impulse sounds that are quite difficult to abate.
6. **Vessels.** Last but not least, the vessels themselves are maybe the most significant noise source in ports. There are several noise sources on vessels: engines, auxiliary engines and their funnels and exhaust systems, different kind of ventilation and air conditioning systems, hydraulics, pumps and on-board ramps (Hyrynen et al 2009). For several reasons, the vessel noise is a real dilemma. The challenge of vessel noise for ports is discussed in more detail in chapter 4.4.

Figure 2: Ramps are a significant noise source in the vessel-quay interface. Photo: Per-Erik Adamsson/Ports of Stockholm.

Within the EU project EFFORTS acoustical properties of the different noise sources in the port environment were measured and psychoacoustic descriptors were used to approximate the annoyance caused by the different noise sources. In the study, the sounds with highest decibel levels were not the same as the most annoying ones. The most annoying port sounds were alarm signals, gantry cranes and vessel exhaust stack ventilation. (Hyrynen et al 2009.)

4.2 Technical challenges

The noise abatement efforts in ports are constrained by several challenges, both of technical, legal, financial and organisational character. The most important technical challenges are:

1. **Outdoors environment.** Port operations take usually place in a wide outdoors area, where noise easily can spread to neighbouring areas. Abatement measures, such as noise walls and barriers are not always possible to build due to for instance lack of space. Especially propagation towards water is difficult to hinder with this kind of methods. The weather, as wind, temperature and air pressure, can also greatly impact the propagation of noise in outdoors environment. In addition, the outdoors environment can complicate the noise measurements and make it difficult to determine if a noise disturbance is caused by the port or some other source. In city areas, the background noise levels are high, and the proportion of the port to the overall noise levels can be difficult to show.
2. **Acoustically hard materials.** Acoustically, there are hard and soft materials. Generally, hard materials conduct sounds, and soft materials muffle them. In port environment, hard materials such as concrete, asphalt and metal surfaces are common.
3. **Closeness to water.** Water, which ports are by nature surrounded by, is the acoustically hardest of all materials. It conducts noise easily to opposite shores and nearby islands. Isolating the port from the surrounding areas by noise walls or barriers is complicated, and often impossible.
4. **Several different noise sources.** As port noise consists of sounds emitting from several different sources, to cut down one of the sources does not necessarily have any impact on the overall noise level.
5. **Scattered noise sources on different heights.** Noise from different positions in the area complicates mitigation measures. Propagation from sources on the ground level, like tyres, is easier to hinder than from sources higher up, such as the funnels of the vessels. Moreover, some of the noise sources, as working machines and vessels are moving, which makes stationary mitigation measures inefficient.
6. **Low-frequent, tonal and impulse noise.** Compared to average traffic noise, which is quite monotonic in character, port noise is, due to the different sources, more diverse. The acoustic properties of port noise make it more annoying to hear and more complicated to abate. Low-frequent noise is typical for vessel engines, and to muffle it requires big silencers or thick noise barriers. Impulse noise is typical for cargo handling operations and driving on vessel-quay ramps. Noise with tonal elements is typically emitted from fans of the vessels and beacons of the working machines. Common to these three types of noise is that they all are experienced as more annoying than the average traffic noise. (Of noise annoyance in ports, see Hyrynen et al 2009.)
7. **Best Available Technology principle not generally applicable.** The location and the nature of operations are of great importance for a port's noise situation. Together with the topography and the layout of the port area these factors make every port unique when it comes to the noise propagation situation. In environmental justice, the principle

of Best Available Technology (BAT) is widely used to benchmark the best technical standards to prevent hazards to the environment. The operators are required to use BAT whenever it is economically feasible. (See Länsstyrelsen i Stockholms län 2010, 6.) Since the variation between ports regarding the noise question is great, all noise abatement measures have to be tailor-made to fit each port. Therefore, the BAT principle cannot be directly applied to port noise.

4.3 Legal challenges

In Sweden and Finland, the noise limits of the ports are set through the environmental permits. The environmental permit practice for ports was adopted in Finland in 1995 and in Sweden in 1999. An environmental impact assessment with noise measurements, maps, models and action plans is an obligatory part of the environmental permit process. In Estonia, no environmental permit is required, but ports are obliged, just like in the other PENTA countries, to do an environmental impact assessment, including a noise map and action plan for noise abatement. The permit practises will be discussed in more detail in chapter 5. Here we discuss the challenges that are created applying the regulations in the environmental permits.

The environmental permit process and the environmental impact assessments have made the noise impacts of the ports more concrete, which is after all a positive thing because it helps the ports to work more systematically with the noise question. Especially in Sweden, the issuing of the permits has, however, been postponed due to protracted appeal processes. This has led to a situation where several ports still remain without valid, legally binding environmental permits. The unsolved issues are about setting the boundaries of the responsibility of the ports.

In Finland and Sweden, the noise limits, noise abatement measures and other conditions are set to each port individually by the environmental permits. This means that the conditions can vary remarkably depending on the location and the nature of the port operations. As the permits are issued by local authorities, they can interpret the regulations in varying ways. The fact that different ports have different noise conditions can be difficult to understand to customers, sub-contractors, other partners and the general public.

There are efficient noise abatement techniques available for the most noise sources, but their feasibility is always a financial question. In environmental justice, the “polluter pays” (PP) principle is widely accepted, and it is also written in the European Union Liability Directive (EC 2004; EU 2007). To be a noise polluter means a responsibility to pay for the needed noise abatement measures. In the environmental permits of the ports, the port authority or the port company is considered to be the “polluter”, regardless if the authority has the control of the polluting activities or not. In some cases, the definition of the polluter is not too clear. This is the case especially regarding the noise from vessels, which will be discussed in more detail in chapter 4.4. All the PENTA ports are using external stevedoring companies for the cargo handling operations. Therefore, the port authority is obliged to monitor the environmental performance of the port operators and other port-related businesses within the port premises, and also to take measures to secure that the conditions of the environmental permit are followed.

Similar questions are relevant regarding the noise impact from in and out truck and car traffic. In Sweden and Estonia, industrial noise is regulated more strictly than noise from road and

street traffic. Generally, ports are responsible for noise emitted from within the port boundaries, both on shore and within the water area of the port. Nevertheless, there are court cases where ports have been held responsible for noise from traffic coming to and from the port, even outside the port premises. In this respect, the situation of the ports is comparable to the situation of the airports, which are held responsible for the noise from the landing and take-off of the airplanes using the airport.

The international trend to transform waterfront areas near the docklands to residential areas brings not only new neighbours to ports, but also creates new, legally problematic situations. For environmental permits, the noise levels are measured outside the closest dwellings. The practical consequence of the new neighbours on a closer proximity is a tightening of the permit conditions, because the noise has to stay below the limit values. The ports risk even paying the noise abatement measures that are required to make the new homes habitable. The noise regulations with lower night-time decibel levels that are set to secure the inhabitants' undisturbed sleep can limit even the ports' possibilities to be open 24/7.

The more stringent regulation of industrial noise compared to road traffic noise is making it practically impossible to build residential areas close to the ports in Sweden, despite the fact that the political pressure to do so is high. The guideline values for traffic noise are higher to begin with, and there is also a practice of exemptions from the traffic noise guidelines in densely populated urban areas with high demand of housing. There are no corresponding practices for industrial noise. This is noted politically, and the Swedish government is letting the question to be investigated. The practical implication is that stricter noise regulations are applied to ports and maritime transports than to other modes of traffic. (See Boverket 2008; Hedman & Möller 2011, 83-84; Prop. 2012/13:25, 79-83.)

The regulation of noise through the environmental permits is discussed in chapter 5, and the relationship between the port noise and urban planning is discussed in more detail in chapter 7.

4.4 The dilemma of vessel noise

Vessels are in many ways the most challenging noise source in ports. Firstly, the technical and acoustical features of vessel noise make it problematic as such. Vessels are, as a rule, running their auxiliary engines to produce electricity they need during the time they are berthed. The sound from the engines is low-frequent, which makes it more annoying to hear. Low-frequent noise has a long wave length, and this means that muffling it requires big, space-consuming silencers on the vessel. If the noise is not muffled on the vessel, standard noise walls, sound-proof windows and like are insufficient to mitigate it from penetrating the nearby buildings.

Moreover, the engines are not the only noise source on a vessel. For the RoPax vessels typical for PENTA ports, the ventilation systems of the car decks, including fans and compressors, are at least as important noise source as the engines themselves. Also the engine rooms and hydraulics equipment need to be ventilated, which generates sounds. Car ramps and alike are also a noise source on RoRo and RoPax vessels. On vessels in passenger traffic, the ventilation and air conditioning systems are also a significant noise source. These noise sources are located on different heights on the vessel. (Of acoustical characteristics of vessel noise, see Hyrynen et al 2009.) The auxiliary engine noise can be eliminated by onshore power supply (OPS), but it does not impact the other noise sources on a vessel. OPS will be discussed in chapter 4.5.1.

Noise emitting from vessels is not regulated internationally. For International Maritime Organization, IMO, vessel noise is primarily an occupational health question, and they are also working on recommendations for noise emitting to the water to protect the marine fauna. Noise emissions to the air are not on agenda for IMO at the moment, so there is no regulation in sight in the nearest future. Therefore, noise emissions from maritime traffic are only regulated on the national level through the environmental permits of ports.

In Baltic Sea Region, the upcoming SECA regulations are a big challenge to the maritime business. The sulphur question is the number one environmental question for the ship owners at the moment, because it has drastic effects on the fuel prices and requires investments on alternative fuel technologies. As the list of upcoming environmental regulations for maritime traffic is quite long, it is understandable that the noise question, which is not even sanctioned in any way, does not end up on the top of the list of ship owners' environmental agenda.

Noise reducing improvements on existing vessels are relatively expensive. An investment of 200 000 Euro on silencers is estimated to reduce the noise levels with a couple of decibels. It is an investment which does not pay back direct revenues and is therefore hard to motivate. The situation is different when new vessels are constructed. If the noise question is taken into account already on the drawing board, a good sound level can be obtained. However, the life cycle of a vessel is up to 30 years or more, so it will take a long time before a change in the noise situation due to the renewal of the fleet. Noise reducing solutions on-board require space, which could be used to revenue-producing functions as cargo or passengers instead. Moreover, they increase the weight of the vessel.

As port noise is classified as industrial noise, the noise emissions from a vessel become industrial noise as soon the vessel enters the water area of the port. From the ports point of view, the situation is very problematic. The maritime traffic is per definition international, but the noise requirements vary from country to country and from port to port. In this situation, it is not all too simple to implement requirements. A strict noise policy is also seen as a competitive disadvantage by the ports.

Finding solutions to the dilemma of vessel noise requires a good collaboration between the ports and the ship owners. In liner-traffic, long-term customer relationships between the ports and the ship owners are created, and it is uncomplicated to bring the environmental issues, such as noise, to the agenda. The situation is more challenging with irregular customers such as cruising vessels which may only visit a port once or twice a season or cargo vessels using the port occasionally. In the cargo segment, the transport and logistics chains are so complex that the transport buyers usually do not even know how the goods are transported. The vessel noise is a quite abstract question to a transport buyer who, if environmentally oriented, is more interested of carbon dioxide emissions and the climate impact of the transport.

In the passenger segment, the general environmental consciousness creates some customer pressure to environmental friendly solutions. In addition, a vessel with low external noise emissions has also a higher customer comfort. Therefore, incentives to find silent solutions exist in a way which is non-existent in the cargo segment. The ways of reducing the noise impact of the vessels are discussed in chapter 4.5.3.

4.5 Noise abatement in ports

After the previous review of the challenges of port noise, it is quite obvious that the ports are facing a very complex question. As the port noise is diverse, a whole toolbox is needed to reduce the noise impact. Below, the ways to reduce noise are divided into technical-operational and cooperative-financial. The former are different technical and physical measures that reduce noise. The latter are instruments the ports can use to encourage or enforce their customers, subcontractors and other stakeholders to adopt noise reducing solutions.

It has to be noted that the best way of noise abatement is to prevent it from occurring in the first place, that is, different proactive measures when ports are planned either physically or operationally should be preferred. In real life, some noise will always be generated from port operations, and different kinds of noise abatement measures are needed.

4.5.1 Technical and operational solutions

It is generally most effective to reduce or eliminate noise directly at the source. Propagation measures which reduce the impact of noise during its path from source to the receiver are the second alternative. Receiver methods reducing the noise in the dwellings are the last alternative and should only be carried out if source and propagation measures are not sufficient (See (NoMEPorts 2008, 43-47.) Below, the most common ways of noise reduction in ports are listed. Because ports are diverse, the measures are not universally applicable in every port, but each port has to find its own mix of ways of noise reduction. It should be based on an analysis of the noise sources and their significance in the particular port.

1. **Port layout.** The port layout has a great importance for noise mitigation. Location of different port functions in the port area, traffic arrangements, choice of materials, architectural and landscaping solutions, vegetation, using natural topographical formations such as rocks and hills as noise barriers are examples of taking the noise question into account in the planning phase of a new port. Amending the layout of an existing port can also reduce the noise impact, and sometimes simple measures, such as building “noise-walls” of containers towards areas to be protected from noise can give good results.
2. **Traffic arrangements.** As previously mentioned, a significant part of the noise impact of the ports is coming from shore side traffic coming to and going from the ports. There are a lot of ways reducing this impact. Directing the traffic to the port area in less sensitive areas or via tunnels, installing physical obstacles forcing to lower speeds and arranging the queuing and parking areas for trucks and cars going to ships in a less disturbing way are examples of this. Also silent asphalts are available and can in some conditions give remarkable reductions in noise levels.
3. **Ramp design.** The loud impulse noises generated in the vessel-quay interface can effectively be reduced by ramp design. Both the form and the materials of the ramps impact the noise levels. Relatively simple and inexpensive measures such as putting rubber linings and insulations onto the ramps can practically eliminate this type of noise, and it can be done without compromising the functionality of the ramps in all weather conditions present in the Baltic Sea climate, where rain, snow and ice, but also hot sun are common weather conditions.
4. **More silent cargo handling methods.** Noise from the cargo handling operations can be reduced by “soft” driving. A lower driving speed gives lower engine and tyre noise

from the cargo handling equipment, and can also help to reduce the fuel consumption. Soft working methods for instance in container handling can reduce the impulse noise significantly. This requires awareness and might in some cases be a small culture revolution in stevedoring, where a "masculine" working culture is deeply rooted. (On noise and masculinity, see Mildner 2012, 143-145.) This kind of changes cannot be implemented without engaging and involving the personnel to the improvement work.

5. **More silent machine fleet.** Ports can, regardless of if they are landlord port authorities or are operating in-house stevedoring, have influence on the noise from the port machine fleet. The cargo handling machinery is getting more silent over the years, especially when new electrically-driven and hybrid machinery is introduced. This change is nevertheless quite slow as the life-cycle for the machines is long. Whenever the port or the port operator is investing in new machines, noise features can be taken into account in the purchasing process. This should also be a requirement the ports set when contracting terminal operators.
6. **Onshore Power Supply,** OPS, can be used instead of auxiliary engines to produce electricity to berthed vessels. It is a partial solution to the vessel noise question, because it eliminates the low-frequent engine noise but is powerless against other noise sources on vessels. OPS will be discussed in more detail in chapter 4.5.3.
7. **Noise walls and barriers** are the most visible noise abatement measures in ports. In some cases they are necessary to keep the noise under the limit values outside the port area.
8. **Measuring noise levels of the vessels** using the port regularly helps the port authority to plan how the vessel will be received in the port and which berth it will be allowed to moor into.
9. **Allotting berths.** In bigger ports with several alternative berths noisier vessels can be placed further away from the residential areas. In acute situations, vessels can be ordered to turn the noise source away from the residents or to use auxiliary engines on the more favourable side of the vessel.

4.5.2 *Cooperative and financial ways to reduce noise*

1. **Noise maps and models** are today an obligatory part of the environmental impact assessments of the ports. They can be used to planning of noise abatement measures both strategically and operationally.
2. **Timetables.** The port authority can use timetables to regulate the stays of the vessels in favourable times of the day.
3. **Opening hours** can be used to minimise noise disturbances during the night-time hours.
4. **Speed limits.** Lower speeds within the port area and its vicinity can be used to reduce the noise impact of the in and out car and truck traffic.
5. **Differentiated port fees** are sometimes proposed to be used against vessel noise. They could be set either as a discount which favours low-noise vessels or as a "fine" for high-noise vessels. Setting port fees is a quite complex question, and its feasibility to environmental governance depends also on the market situation of each port. Environmentally differentiated port fees are not often used to regulate noise, but this is one of the possible noise management solutions the ports have to take into consideration in the future.
6. **Negotiations with "noise polluters".** Even though the port authority is through the environmental permit responsible for all port-related noise in the port area, it cannot directly impact all noise-generating operations within the port area. Due to this,

negotiations with customers, subcontractors, terminal operators, logistic companies, hauliers, railway companies and other possible noise polluters operating within the port premises are needed. Collaborative solutions to the noise questions can be found in this way. In the most cases, the port and the stakeholders have a common interest in making the future operations possible by different noise abatement measures.

7. **Cooperation with the port city.** It is in the port's interests to collaborate with the city or municipality it is located in. Being a part of the urban planning process from an early phase can help the planners to understand the points of views of the port and give a possibility to impact the planning in a favourable way. Collaboration with the traffic planning is essential to find functioning solutions for the land-based traffic into the ports.
8. **Cooperation with other ports.** Ports have a lot to gain from cooperation with other ports regarding the noise question. The cooperation can take different forms such as information exchange, collaborative projects, lobbying for the common cause and adopting similar noise policies towards the customers.
9. **Stakeholder cooperation.** Ports can help its stakeholders and the general public to gain a better understanding of the port specific noise questions by collaboration and communication. This may not help to reduce the noise levels themselves, but it can help to explain why noise is sometimes unavoidable and how the port is working with the question. In this way, a better acceptance for some reasonable level of nuisance can be obtained.

4.5.3 Tackling vessel noise

As noted in chapter 4.4, the dilemma of vessel noise is in many ways out of the hands of the port authorities. At the same time, vessels remain the most significant noise source in ports, and ports are held responsible for this time of noise emitting from the port area. That is why ports have to find ways to handle the dilemma. The most obvious way to do it is by collaboration with the ship owners. Fortunately, the interests of the ports and the maritime industry are not, in the most cases, contradictory, but limiting the negative environmental impact is a common cause. In liner traffic, long-term customer relationships between the ports and the shipping companies are created, which is a favourable situation for finding solutions together.

Some of the solutions mentioned above are applicable to vessel noise. Measuring the noise levels of the vessels using the port regularly and planning the port operations, such as allotting berths according to the noise levels are measures the port can take independently. Port fees can be used as a financial steering instrument.

OPS is primarily a way to improve the air quality in the ports, but great expectations are directed towards it as a noise abatement measure as well. The real possibilities of OPS in noise reduction will be a disappointment for the most optimistic enthusiasts, but is doubtlessly a useful method that can bring about remarkable improvements. Nevertheless, OPS has some limitations.

The first limitation of OPS is that it is a partial solution eliminating only the noise from the auxiliary engines. The second limitation is that the international standard for OPS (ISO 2012) does not solve all the technical questions regarding the implementation. Therefore, OPS is still best applicable for liner traffic with the same vessels using the ports regularly, where the port and the ship owner can get together and find the most feasible solution for OPS

installation. The third limitation is that the suitability of OPS varies from case to case. The vessel has to stay berthed some time before connecting to OPS is feasible. The time varies from case to case, but a guideline value is two to four hours' stay in the port (Klingström 2013, 1; Ramböll 2009, 29). The fourth limitation is the costs; OPS requires investments both on-board and on the shore-side. An approximated cost of installing transformers and other equipment on vessels is 500 000 Euro, and doing corresponding installations on the shore-side costs at least as much.

Despite its limitations, OPS is an upcoming technical solution, and OPS systems are being installed in ports around the world. OPS solutions will doubtlessly become more common during the next couple of years, and the tax reliefs already implemented in Sweden and some other countries will advance the development. Today, the ports and ship owners are both waiting for the other part to take the first step initiating the installation. It might be the ports taking the first steps, because OPS systems are required from them by the environmental authorities in a growing extent.

Of course, OPS is only one of the technical solutions which can be used to reduce vessel noise. Obviously, the most effective ways to reduce the noise impact of the vessels are in the hands of the ship owners. Even though it is technically more challenging to do improvements on existing vessels, it is possible to install silencers to the exhaust funnels, on machine room ventilation and air vents. This is costly, but sometimes it is necessary to find this kind of solutions to make it possible for a vessel to use a port. Catalytic converters on funnels function as silencers as well (Klingström 2013, 3).

The situation is quite different when completely new vessels are being constructed and built. If the noise question is taken into account already on the drawing board, a good sound level can be obtained. An example of this is Viking Lines' new RoPax vessel M/S Viking Grace which started to operate the route Turku – Stockholm in January 2013. The vessel has a high environmental profile, and runs on LNG and marine diesel. When the ship was ordered from the STX shipyard in Turku, a maximum noise level of 50 dB on a distance of 100 metres was specified. Wärtsilä, the supplier of the engines, was also involved in the noise question from the beginning, and it was taken into account in the construction on a detail level. For instance, the exhaust pipes of M/S Viking Grace are equipped with resonators which eliminate the low-frequent noise, and her ventilation systems are also equipped with noise reducing solutions. The engines are mounted elastically to minimize the vibrations conducted by the hull, and this lowers also the noise levels. The noise reducing solutions increase the passenger and crew comfort as well. M/S Viking Grace is a best practice example showing that building vessels is fully possible. (About M/S Viking Grace, see Sjöström 2013.)

Figure 3: M/S Viking Grace is a best practice example on a low-noise vessel. Photo: Viking Line.

Altogether, even though tackling vessel noise is a real challenge for the ports, it is by no means impossible. In this area, the ports cannot achieve results alone, but have to find solutions together with the customers.

5 Rules and regulations in the PENTA countries

There is no shortage on legislation, regulations and recommendations regarding environmental noise. The driver for this regulation is, obviously, the rising awareness of noise as a serious health risk. Legislation and guidelines have been issued on international level, but it is up to each state to interpret and implement them in the national legislation. The principal difficulty issuing guidelines is to find a balance between the public health and the conditions of running businesses, industries and transports that make the society as we know it possible.

The noise nuisances from individual industries or businesses located on a definable geographical area, such as from ports, is handled by the environmental permits in the Nordic countries. This is due to that a "noise polluter" which can be held responsible for the noise impact, can be shown. The situation is more complicated when it comes to the biggest noise polluter, road and street traffic, where no individual "polluter" can be shown. Its health effects are handled mainly by societal and urban planning.

5.1 Noise legislation and guidelines

On international level, environmental noise is regulated by the European Union Environmental Noise Directive, END, which was issued in 2002 (EC 2002). The directive is in the first place a tool for policy makers to grab the environmental noise problem. It makes noise maps and action plans against noise obligatory in bigger cities. However, it does not give guideline values for noise. Another EU directive which has relevance to the ports is the equipment noise directive (EC 2000), which regulates the noise emissions from for instance certain types of cargo handling equipment.

World Health Organization, WHO (1999), has issued guidelines for community noise, and specific night noise guidelines for Europe (WHO 2009). The WHO (1999, 55-65) guidelines are based on thorough epidemiological studies and define values for community noise in special environments, such as dwellings, schools, hospitals and outdoors in parkland. Due to this, they are quite complicated to apply when limit values are to be set in the environmental permits. As END does not either define guideline values, the practical application of WHO guidelines takes place in each member state.

In Finland, environmental noise is regulated mainly by two laws; Environmental Protection Act (Ympäristönsuojelulaki 2000) and Land Use and Building Act. (Maankäyttö- ja rakennuslaki 1999). Of these, Environmental Protection Act regulates operations hazardous to the environment and defines when an environmental permit is required and how it is applied and issued. Land Use and Building Act regulates for instance building residential areas in noise-exposed areas. The guideline values for noise are given in the Decision of the Council of State Concerning the Guideline Values for Noise Level (Valtioneuvosto 1992). Originally, the values were issued to guide the society planning, but they are used as they are also for guideline values in environmental permits for operations hazardous to the environment (see Kanerva et al 2009, 26). Thus, no difference is made between noise sources, and same guideline values are valid both for industrial and for traffic noise.

In Sweden, the legislative framework for environmental noise is alike the Finnish one, but there are several sets of guideline values for noise. The operations hazardous to the environment and the environmental permit process are regulated in Swedish Environmental Code (Miljöbalk 1998), and building and society planning in noise-exposed areas is regulated in Planning and Building Act (Plan- och bygglag 2010). Guideline values for noise are issued by three governmental authorities; Swedish Environmental Protection Agency is responsible for the guidelines for external industrial noise (Naturvårdsverket 1983), The Swedish National Board of Housing, Building and Planning is responsible for the guidelines regarding building new dwellings in areas exposed to street, road and railway traffic noise (Boverket 2008), and The National Board of Health and Welfare has issued recommendations for noise levels inside dwellings (Socialstyrelsen 2005). Unlike Finland, different noise sources are treated differently. The guideline values for external industrial noise are used in issuing environmental permits, and they are thus the most relevant regulations concerning port noise in Sweden.

The regulation of industrial noise has highly relevant implications for the urban planning. Building residential areas in the near proximity of the ports has become a big question due to the different ways noise from different sources is regulated. Road and street traffic noise is not handled by environmental permits but by urban planning. According to the guidelines from The Swedish National Board of Housing, Building and Planning (Boverket 2008, 29-46), it is today possible to build dwellings in areas exposed to quite high levels of street and road traffic noise, and it is also possible to make exemptions from the general guidelines in densely populated urban areas with a high demand of new housing. They include higher acceptable noise levels outdoors if the indoors space is made silent through technical solutions, and for instance a “silent side” where at least 50 per cent of the rooms are placed on the other side of the building than the noise source, is used.

The practical implication of the state of noise regulation in Sweden is that it is nearly impossible to build residential areas in near proximity of ports and other industries. There have been peculiar situations where the noise levels from a port have stopped the planning of new residential areas even tough noise from road and street traffic have been higher on the actual site. As the political pressure to exploit waterfront areas in port vicinities to housing is high, the Swedish government is now letting the question to be investigated by the two government authorities issuing the guidelines, The Swedish National Board of Housing, Building and Planning and Swedish Environmental Protection Agency. The goal of the actual investigations is to harmonise the regulations and to make the exploitation possible. (Regeringens proposition 2012.) The regulation of noise is a remarkable factor impacting the future conditions of operation for the ports in Sweden.

In Estonia, the situation is somewhat different. Limit values for environmental noise are given in “Regulation No 42 of 4 March 2002; Standard noise exposure limits in residential and recreational areas, in residential and public/commercial buildings; and the methods for noise level measurement” issued by the Minister of Social Affairs. Unlike Finland and Sweden, two sets of values, target and limit values, are given, and the target values being 5 dB lower than the limit values. Practically, only the limit values are legally binding for businesses and organisations with operations hazardous to the environment, and the target values are just a goal that should be pursued. Different values are given for different kind of areas; nature and recreational areas have the lowest and industrial sites the highest limit levels. As in Sweden, traffic noise and industrial noise are treated differently, and industrial noise is given lower allowed decibel levels. (See Justice and Environment 2009, 66-69.)

Table 5.1 shows the guideline values for industrial noise in residential areas in PENTA countries. In addition, a maximum level of 55 dBA for impulse sounds during the night-time hours is given in Sweden. The Swedish guideline values are given separately for existing industries and new industries about to be established. In Finland, guideline values 5 dBA lower are to be used when the sound is impulsive or narrowband (tonal) in character. In Estonia, +5 dB shall be added for evening period (19-23) noise level when equivalent level for the time period 07-23 is calculated. (Naturvårdsverket 1983, 4; Valtioneuvosto 1992.)

Table 5.1 Guideline values for outdoors industrial noise in residential areas in PENTA countries (dBL$_{Aeq,}$ A-weighted equivalent levels).

	Day	Evening & weekends	Night
Sweden	(07-18) 55 dB, old industries 50 dB, new industries	(18-22) 50 dB, old industries 45 dB, new industries	(22-07) 45 dB, old industries 40 dB, new industries
Finland	55 dB (07-22)	-	(22-07) 45 dB, new areas 50 dB, old areas
Estonia	60 dB (07-23)	-	45 dB(23-07)

(Naturvårdsverket 1983,4-5; Valtioneuvosto 1992.)

Guideline values for recreational housing (summer cottages) and nature areas used for outdoor life are summarised in table 5.2. A maximum level of 50 dBA for impulse sounds during the night-time hours is given in Sweden. As for residential areas, 5 dBA lower levels are applied for impulse and narrowband sounds in Finland. In Estonia, 5 dB shall be added to the evening period (19-23) noise level when a day equivalent level is calculated.

The guideline values for indoors in dwellings, schools or hospitals are not directly relevant for port noise, because the noise levels outside are defined as limits in the environmental permits in Sweden and Finland and the limit values applied in Estonia. The indoors sound levels are solved by construction techniques for sound isolation in the first place. It is nevertheless possible that ports can be responsible to finance such solutions in dwellings near-by, if the needed sound isolation is not properly defined in the city plan and the building permit. Also the occurrence of low-frequent noise requiring special sound isolation solutions in the port vicinities can make the indoors values relevant to the port authorities.

Table 5.2 Guideline values for industrial noise in nature areas used for recreational activities in PENTA countries ($dBL_{Aeq,}$ A-weighted equivalent levels).

	Day	Evening, weekends	Night
Sweden	(07-18)	(18-22)	(22-07)
	45 dB, old industries	40 dB, old industries	40 dB, old industries
	40 dB, new industries	35 dB, new industries	35 dB, new industries
Finland	45 dB (07-22)	-	40 dB (22-07)
Estonia	55 dB (07-23)	-	40 dB (23-07)

(Naturvårdsverket 1983,4-5; Valtioneuvosto 1992.)

It has to be noted that the legislation is issued to protect the human health and needs for rest and recreation in the nature. No legislation protecting the wildlife from noise emissions exists at the moment. There are no given guideline values for noise emissions from ports to the water either. Noise from the underwater operations of the ports, such as dredging, underwater construction operations or the maritime traffic coming to the ports, is regulated separately, and is outside the scope of this study.

5.2 Noise regulations in environmental permits

In Finland limit values for noise are confirmed for each port individually as a part of the environmental permit. After a reform of the governmental administration a few years ago, Regional State Administrative Agencies are nowadays the government authorities issuing the environmental permits to ports. Ports are required to have an environmental permit since 1995. An environmental impact assessment including noise mapping is required as a part of the application.

During the permit process, the concerned parties such as neighbours, environmental organisations, the concerned authorities and others who can be affected by the port operations are consulted. If the port or some of the concerned parties is dissatisfied with the permit issued by the Regional State Administrative Agency, an appeal to Vaasa Administrative Court can be made. The highest court making the final decisions regarding environmental permits is The Supreme Administrative Court.

The environmental permits are valid until further notice, but they have to be are updated regularly so that they correspond the conditions in the port. The usual interval for updating the permit is 6-8 years. An update is also required when big amendments in the port operations are made.

The guideline values for noise are usually applied directly in the environmental permits, even though they are originally meant to be just guidelines and the legislation gives space to consider the limits case by case. In addition to setting the limit values for noise, limitations of the operational hours and different noise abatement measures can be ordered in the environmental permit.

Altogether, issuing limit values and noise abatement measures in the permits is perceived as a problematic question by the Finnish authorities. As the guideline values are originally issued to guide the society planning, it is not uncomplicated to apply them in the permits. It is also complicated to judge how to formulate the permit conditions so that the public health and reasonable conditions to the operations can be secured. For instance the choice between using equivalent or maximum sound pressure levels, or a combination of these two, has a big impact on the operations and their noise impact. (Ahonen 2009.)

Ports existing since a long time with dwellings either inside or in the immediate proximity of the port area are creating problematic situations. The same applies to noise emitting through the water to the opposite shore or nearby islands. In cases where the port is surrounded both by city settlements and nature reservation areas setting reasonable conditions is very problematic. Drawing limits to the port's responsibility for the in and out truck, car and vessel traffic is not too simple either. The biggest challenges the permit authorities are facing are the new residential areas planned in near proximity of ports. As an interviewed permit officer expressed it: "The city planners are planning, and we are trying to patch up the damage made". Practically, new neighbours in the port vicinities mean a tightening of the permit conditions.

The Swedish system of environmental permits is similar to the Finnish one. Environmental permits have been required from the ports since 1999 and the Swedish Environmental Code. The County Administrative Boards are the government authorities usually issuing environmental permits for ports. The permit process is started with a public consultation where everybody concerned can speak up his or her mind regarding the environmental impact of the operations. The applier is responsible to make an environmental impact assessment including noise measurements and mappings as a part of the application.

The issued permits are valid until further notice, and the port authorities are obliged to follow up how the requirements have been fulfilled and report it to the monitoring authority. With remarkable amendments in the operation, a new permit has to be applied. Like in Finland, both decibel limits, limitations for the operation hours and different noise abatement measures can be issued in the permit.

The environmental permit can be appealed against in higher courts: Land and Environment Court, Land and Environment Court of Appeal, and sometimes in most complicated cases, an appeal to the Supreme Court can be made. Almost all the environmental permits of ports in Sweden have been appealed against either by the port authorities or other parties concerned. The result of these protracted appeal processes is that several ports still are without valid environmental permits, and there is considerable uncertainty of the conditions of the permits. Regarding noise, it is quite common that the conditions are set on a trial period with an obligation for the port authority to make further investigations about how to reduce noise. Also investigations regarding various noise reducing measures such as OPS or differentiated port fees have been issued.

Since valid environmental permits are delayed, there are several open questions regarding the boundaries of the port's responsibility for noise nuisances caused by and related to the port operations. They include the traffic into and out of the ports, noise from the vessels using the port, the geographical borders where the responsibility starts and ends. The answer to these questions will vary from port to port.

Both in Finland and Sweden, it does not matter if the port existed on the location before the other functions possibly disturbed by the port operation moved in. The practice of environmental permits makes the ports responsible to keep the nuisances caused by the operations on a level that is defined in the permit conditions in any case.

Estonia differs from the two other PENTA countries in that no environmental permits are required from the ports. Like in Finland and Sweden, the ports are obliged to do an environmental impact assessment. Ministry of Environment is the authority approving the environmental impact assessments. Like for the Nordic environmental permits, negotiations and consultations with different concerned parties are included in the approval processes of environmental impact assessments. Noise measurements and mappings are a part of the process. A noise mapping was made in the Old City Harbour in Tallinn as a part of the END obligations of city of Tallinn.

5.3. Monitoring of the permits

In Finland and Sweden, the ports are responsible to report their environmental performance, including noise, to the controlling authorities. The regional Centres for Economic Development, Transport and the Environment are the controlling authorities in Finland. In Sweden, the controlling authorities are usually the County Administrative Boards, but in some municipalities, like in the city of Stockholm, the controlling has been delegated to the environmental and health administration of the city.

In both countries, the controlling of the environmental permits is done primarily by a self-control program which is confirmed in the environmental permit. The permit defines how and how often noise measurements have to be made and how the environmental performance is to be reported. Regular meetings and on-site inspections are included in the control programmes as well. They are often done in cooperation with the port municipality's environmental and health administration.

The public can leave complaints regarding port noise directly to the port, to the municipality or the controlling authority. The controlling authority's task is then to investigate if the conditions of the environmental permit have been followed. The first step is to request the port to provide a statement of what has happened and to respond to the complaint. Concerning noise, the port will usually be ordered to provide new measurements. If it is clear that the conditions of the permit have been broken, the first step is that the port provides an action plan to correct the situation. In the most cases, there is no need to use other sanctions to make the things right.

The controlling authorities have also more severe sanctions to make the holders of the environmental permits to follow the permit conditions. Acute noise abatement measures can be ordered, and they can be reinforced by penalties. Theoretically, it is possible to interrupt the operations. Finally, the controlling authorities are obliged to report to the police if an environmental offense is suspected. In reality, the most situations concerning port noise don't require such far-reaching measures, but are solved with negotiations in cooperation between the controlling authority and the port.

As the environmental permits of the ports are delayed in Sweden, the role of the controlling authority is to see that the complaints regarding noise are handled correctly, to discuss the

state of the noise abatement with the port in the regular meetings and interfere in acute situations. The arrangement that the municipality is both the owner and the controlling authority of the port has sometimes been criticised, and the objectivity of the municipality as the controlling authority has been questioned. Actually, in the case of city of Stockholm, the municipality has three roles regarding the port noise question: the city owns the port company, the city environmental administration is the controlling authority and the city planning administration is planning residential areas near to the port.

Since no environmental permit is required from the ports in Estonia, no monitoring of the permit conditions is done either. The government authority monitoring the noise situation and handling complaints regarding noise is the Health Board, which is a unit within the Ministry of Social Affairs. If a complaint is received the Health Board investigates the situation, makes measurements and consults with the port. Letters of notice and penalty fines can be used to make the port to follow the limit values given in the legislation. In real life, this is seldom applied. Firstly, complaints are not received very often. Secondly, it has to be shown that the port has exceeded the limit values before any such measures will be taken by the Health Board.

5.4 Conclusions

Generally, it can be stated that the regulation of port noise in the PENTA countries is thorough, especially in Sweden and Finland where a system for systematic monitoring of the environmental permits has been established. Some criticism has been directed to the controlling system of environmental permits in general both in Sweden and Finland, but the material of this study does not give possibility to assess how well the systems are working and how objective the controlling of the permits is. The controlling authorities interviewed for this study stress cooperation and trust between the controlling authority and the port as the best prerequisite to solve problems together with the ports.

In environmental permits, the guideline values are, in most cases, applied directly. The possibility to individual consideration in the legislation is thereby left unused. It is however not possible to know how a more individual consideration would affect the noise regulation and the conditions of operation of ports.

Of PENTA countries, industrial noise is somewhat more stringently regulated in Sweden than the other countries. This is due to the guideline values applied for the evenings and weekends which are absent in the Finnish and Estonian regulations and the ambitious guideline values for new industries to be established. As the environmental permit processes have been delayed, there is a great deal of uncertainty regarding the responsibilities of the ports. Moreover, In the situation where exploiting the areas close to ports is near to impossible when other areas exposed to even higher noise levels are made available for residential building through higher guideline values and possibilities to exemptions, all involved parties feel that their interests are threatened. The ports see, with all right, that the new and close neighbours are another tightening of the noise regulation and can lead to unwanted and unfavourable limitations to the conditions of operation. The port cities see that the regulations limit the possibilities to exploit the most attractive waterfront areas. The investigations in progress by The Swedish National Board of Housing, Building and Planning and Swedish Environmental Protection Agency will probably clarify the current deadlock situation.

In Finland, port noise is seen as a problematic question. Sometimes, setting well-functioning and reasonable limit values in the environmental permits is experienced to be a real challenge. Nevertheless, the question is not as infected as in Sweden. As the Finnish ports already have valid environmental permits, the turbulent situation after the introduction of the permit practice has been generally stabilised, even though there still are some problematic cases to be solved. All the involved parties are aware of the technical and financial challenges of port noise and are trying to make the best out of the situation.

According to the material of this study, port noise is not defined as a major problem by the authorities in Estonia. Both Port of Tallinn and the Ministry of Environment see that the cooperation about the environmental impact assessment is working well. The noise abatement efforts of the Estonian authorities are concentrating mostly on traffic noise. Remembering the scarce Estonian material in this study, we can only speculate why noise has not been politicised as a societal problem in Estonia in the same way as in Finland and Sweden. Alongside the Irish, Estonians report least noise disturbances the European Union (Estonian Review 2011). On the other hand, a NGO (Justice and Environment 2009) report criticises the Estonian authorities for the poor implementation of the END obligations, insufficient action plans, low public involvement and inadequate protection of the citizens from noise.

Generally, the existence of two different ways of protecting the population from noise, planning and environmental permits, makes the situation quite complicated. The planning approach applied to road and street traffic noise defines under which circumstances and how residential areas can be built. The permit approach defines the conditions under which certain kind of operations can be run. These two different logics can be difficult to apply together to the same areas. Moreover, this leads easily to misunderstandings which erode the legitimacy of the authority decisions. The discrepancies created by the two different logics can seem “unfair” from the perspective of the different parties involved in the noise question.

6 Noise handling in the PENTA ports today

Several types of port operations are presented in the five PENTA ports. As a matter of fact, it is more appropriate to talk about port companies than of ports, because all the port companies except for Port of Naantali are running several harbours.

Figure 4: The PENTA ports. Picture: Elisa Holma/Centre for Maritime Studies.

The city of Stockholm owns the **Ports of Stockholm** company, which is running ports in three different municipalities in the Stockholm area. Värtahamnen, Frihamnen and Stadsgården are RoPax harbours in the city of Stockholm, and in Frihamnen there is also a container terminal. Loudden's energy harbour, several cruising quays, some smaller industry ports, quays for the passenger boats used for archipelago traffic and some bascule bridges and two locks between the Mälaren lake and the Baltic Sea are all managed by the port company in Stockholm. There is regular liner traffic to Helsinki, Turku, and the Åland islands, Tallinn, Riga and St. Petersburg.

In addition, the company has a RoPax and cruising harbour in Nynäshamn municipality ca. 60 with kilometres south of Stockholm with regular traffic to the island of Gotland and to Poland and Latvia. The Kapellskär RoPax harbour in Norrtälje municipality ca. 90 kilometres north Stockholm with regular liner traffic to Åland, Naantali and Paldiski harbour is operated by the port company as well. Moreover, the port company is planning a build a whole new cargo port for container and RoRo operations in Norviksudden in Nynäshamn. The company is also planning of re-building the existing ports in Värtahamnen/Frihamnen and Kapellskär.

In 2011, totally 12,3 million passengers travelled through the Ports of Stockholm. The ports received 9170 ship calls, whereof 262 were international cruises. Nearly 6,5 million tons of goods, or 425 000 trucks or trailers, and nearly 750 000 cars and buses were transported via the ports within the regular liner traffic. The container volume was nearly 28 000 TEU, and the volume of transported bulk consisting of energy bulk (oil products and coal), agricultural

products and construction materials was 1,9 million tons. (Holma et al 2012, 166-167; Stockholms Hamnar 2012, 3-5.) The port company is using both in-house stevedoring and external terminal operators to do the stevedoring.

As the Ports of Stockholm are located in the inner-city area, they are surrounded by residential areas. Moreover, there are areas for recreational housing within a hearing distance from the Kapellskär harbour.

Port of Helsinki is owned by the city of Helsinki. The company runs two inner-city ports for RoPax and cruising traffic and quays for icebreakers, South Harbour and West Harbour, and in 2008 it opened a whole new cargo port in Vuosaari in eastern Helsinki. There are regular RoPax lines to Tallinn, Stockholm, Åland, Travemünde, St. Petersburg, Rostock and Gdynia. The port is specialised in unitised traffic, and both RoRo and LoLo, but it also handles some bulk cargo. The port is functioning as a landlord port authority to the external port operators. (Port of Helsinki 2013.)

In 2011, the port received 8780 ship calls, and more than 10 million passengers travelled through the port. The total cargo volume was more than 11 million tons. The container volume was 394 000 TEU, and nearly 1,2 million cars and buses and 514 000 trucks and trailers were transported through the port. The total volume of the bulk cargo was about 1,5 million tonnes. The traffic between Helsinki and Tallinn is by far the busiest one, measured in cargo volumes and number of passengers (Holma et al 2012, 89; Port of Helsinki 2012, 23-35.)

The South and West Harbours in Helsinki are surrounded by residential areas. The Vuosaari Harbour has no permanent residents in a close proximity, but it is located beside a Natura 2000 area and has recreational housing on islands close to the port.

Unlike its municipality-owned PENTA partner ports, **Port of Tallinn** is owned by the Estonian state. The port company is running port operations on five different sites, and is functioning as a landlord port authority to the external terminal operators. The Old City Harbour is a busy RoPax port with regular liner traffic to Helsinki, Stockholm, Åland and St. Petersburg, cruising terminal and even a marina for leisure boats. The Muuga harbour 17 kilometres east of Tallinn is the biggest cargo port in Estonia, and its main types of cargo are oil products, coal, fertilisers, grain, and unitised traffic in containers. Paldiski South Harbour located 45 kilometres southwest of Tallinn is the second cargo port within the Port of Tallinn. It has regular liner traffic to the Kapellskär. It handles mostly RoRo, scrap metal, timber, peat and oil products. The little port of Paljassaare 6 kilometres from the city centre of Tallinn is a cargo port, which primarily specialises in handling coal and oil products, as well as timber and perishables. Moreover, the port of Tallinn has a small cruising harbour on the island of Saaremaa. The traffic between the Old City Harbour and Port of Helsinki is the busiest one for Port of Tallinn. (Port of Tallinn 2013.)

In 2011, the port received totally 7210 ship calls, and ca. 8,5 million passengers travelled through it. Port of Tallinn is the busiest international cruise port of the PENTA ports and received 443 000 international cruise passengers. The total cargo volume was 36,5 million tons, consisting of ca. 198 000 TEU containers, ca. 310 000 trucks and trailers, more than 1,1 million cars and buses and 10 million tons of liquid cargo. (AS Tallinna Sadam 2012, 7-8; Holma et al 2012, 75-77.)

The Old City Harbour is located in the inner-city and has residential areas close by. In Muuga, the distance to the closest neighbours is short as well.

Port of Turku is owned by the city of Turku and has two harbours, Kantasatama and Pansio. It is a landlord port authority for external terminal operators. There is regular RoPax, RoRo and LoLo traffic to Stockholm, Åland, Germany, Norway, France and Spain. The lines to Stockholm via Åland are the most important to the port. In 2011, the port received 2300 ship calls and 3,4 million passengers and ca. 250 000 cars and buses travelled through the port. The total cargo traffic was 2,8 million tons. 109 000 trucks and trailers and ca. 12 000 TEU containers were transported through the port. (Holma et al 2012, 93; Port of Turku 2013; Port of Turku 2012, 8-11.)

Since the ports are located a couple of kilometres outside of the city centre, there are no residential areas in the immediate proximity of the harbours in Turku at the moment. However, the Ruissalo island with recreational housing is located on the opposite shore and very close to the Pansio harbour.

Port of Naantali is owned by the town of Naantali and is the most cargo-oriented port of the PENTA ports. It has regular liner traffic to Kapellskär and Åland. Approximately two thirds of the total traffic volume is dry and liquid bulk, and the rest is goods transported in trucks and trailers. In 2011, the port received 1925 ship calls, and the total cargo volume was 8 million tons. 166 000 passengers, 22 000 cars and 125 000 truck and trailers travelled through the port. (Holma et al 93; Naantalin Satama 2013.) As the most PENTA ports, the Port of Naantali uses external terminal operators for stevedoring. There are no neighbours in the immediate proximity of the port.

6.1 Noise as challenge in the PENTA ports

All the PENTA ports perceive noise as a problem complicating the operations, but as the operations and the operational environments are diverse, the severity and actuality of the problem varies between the ports from a threat to a question that has to be tackled in the every-day work. The Port of Tallinn perceives noise as a minor problem compared to the other environmental impacts of the port. For Ports of Stockholm, noise is one of the prioritised environmental challenges. The noise situation in the Port of Helsinki has become better during the past ten years through the new Vuosaari Harbour where the cargo operations were moved to from the West Harbour, and through the renewal of the vessel fleet using the port. For Port of Turku, the closeness of Ruissalo area opposite to Pansio Harbour is the main factor causing noise problems. For Port of Naantali, the noise question can, at the moment, be characterised as a future threat. In general, there are relatively few complaints concerning noise coming to the PENTA ports from the public.

The Finnish and Swedish PENTA ports see that noise is at least a potential issue influencing the port's stakeholder and public relations. The ports of Stockholm and Helsinki have an active cooperation with their neighbours, and noise is one of the issues discussed in the meetings with the local communities.

The PENTA ports in Finland and Estonia see that the cooperation with the environmental authorities is working well. For Ports of Stockholm, however, the unclear situation regarding the regulation of noise has made the cooperation more challenging. All the municipality-owned PENTA ports have intensive cooperation with the port cities regarding the

environment and urban and traffic planning. However, there is no established cooperation between the Port of Tallinn and the city of Tallinn.

The biggest challenges for noise handling the ports mentioned in the interviews were, both today and in the future, the high costs and financing of the noise abatement measures, the technical complexity of the port noise abatement, the dilemma of vessel noise, and the waterfront housing projects in the vicinities of the ports.

6.2 The sources of noise

Vessels are by far the most important noise source for the PENTA ports, and the vessel noise was mentioned as an issue in all the interviews with the ports. The most problematic cases are the vessels staying berthed overnight or entering the port premises during the night-time hours. In Stockholm and Helsinki, the ports are located so close to the residential buildings that berthed vessels have caused noise disturbances even during the daytime hours.

The truck and car traffic into and from the port is another common concern causing noise in the PENTA ports and their vicinities. Even though the inner-city ports in Stockholm, Helsinki and Tallinn have a passenger port profile, the RoPax vessels using the ports generate a remarkable amount of car and truck traffic. This traffic is a question for both the ports and the urban and traffic planners of the port cities.

Cargo handling equipment is a remarkable noise source as well. It has been an issue both in Vuosaari and Turku harbours. The fact that the machine fleet is owned by the stevedoring companies and not the port authorities adds an ingredient to the noise reduction question.

Cargo handling is causing noise, and has been noted mainly in Vuosaari and Naantali. In Vuosaari, the noise is mainly generated in container handling, and in Naantali, it originates from loading and unloading bulk cargo. The latter one is very complicated to hush with any existing feasible techniques.

Figure 5: Cargo handling in Vuosaari Harbour. Picture: Port of Helsinki/Mikael Kaplar, Studio POiNT.

Finally, the ports with railway connection are troubled by the sounds caused by the trains and train wagons. The question is most acute in Muuga harbour with intensive rail traffic. The impulse sounds from the shunting and the tonal sounds of braking are the most problematic ones (ESPO 2012b, 63-64).

6.3 Noise measurements, maps and models

Noise measurements and assessments of the noise situation are nowadays an obligatory part of the environmental impact assessments of the ports in the PENTA countries. Therefore, the PENTA ports have noise maps and an overall view on the noise situation. The environmental permits in Finland and Sweden require regular monitoring and measurements. External acoustics consultants are hired to do the measurements, maps and models. Both short-term and long-term measuring and modelling are used to do the noise maps.

The noise levels of the vessels in regular traffic are measured to be able to allot a berth to them and to make sure that the noise stays below the limit values. The ports are also exchanging information of these measurements with each other.

When Vuosaari port was constructed, thorough noise models were made to forecast the noise situation. The models were also used in the physical planning of the port so that the noise impact would be as small as possible. Certain noise reducing actions were a condition for the port to be located in the actual site. Ports of Stockholm are working in a similar way now when the new port in Norviksudden and reconstructions of Värtahamnen, Frihamnen and Kapellskär are planned.

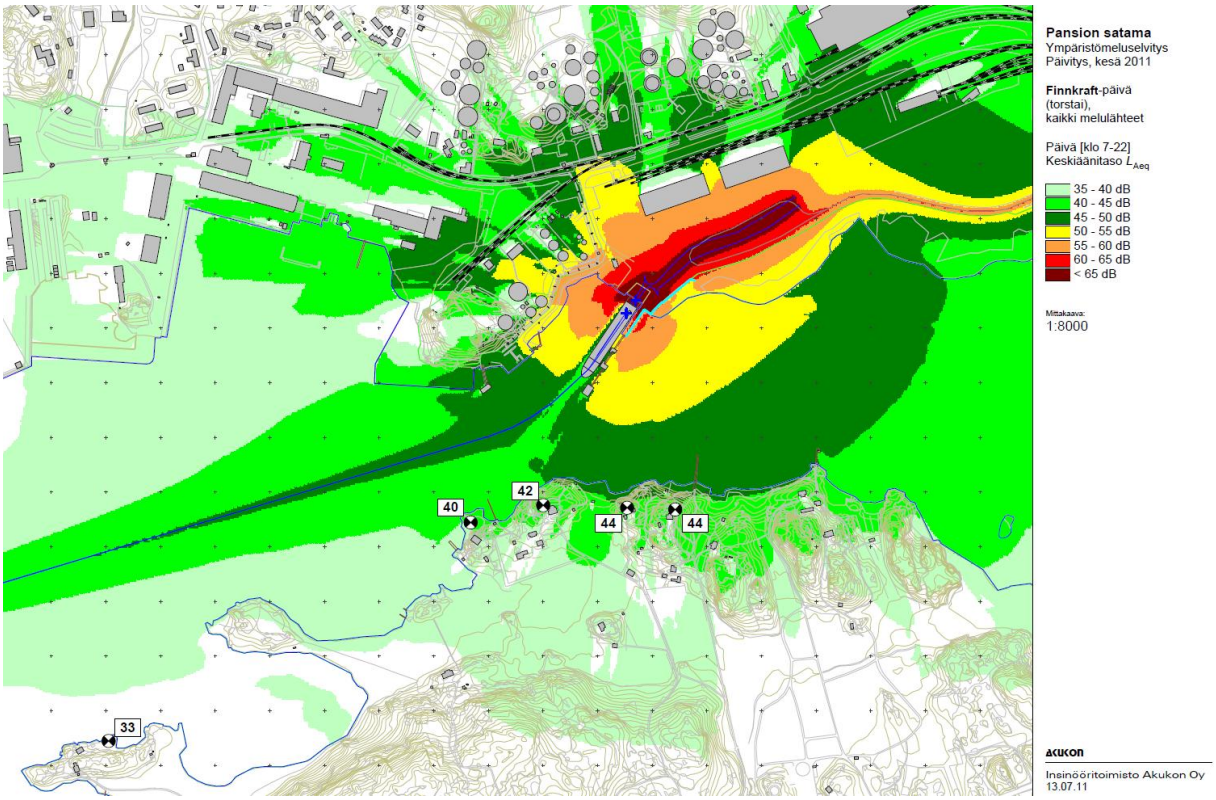

Figure 6: Noise map of Pansio Harbour. Picture: Port of Turku/Akukon Oy.

6.4 Noise reducing actions

Port layout. When Vuosaari Harbour was planned and constructed, noise prevention was taken into account from the beginning. The port's location next to a Natura 2000 area set high requirements to minimising the environmental impacts, and several solutions had to be found before the construction of the port on the actual site was allowed. When the port layout was made, a man-made hill was built of polluted soil. The location, the size and the soft material of the vegetation all function as noise reduction. The heavy traffic is directed to the port through a tunnel to minimise the nuisances caused to the neighbouring areas. Finally, a kilometre long and more than 10 metres high concrete noise barrier was built between the port and the nature protection area. The Vuosaari wall is the most spectacular of all noise abatement measures taken in the PENTA ports.

Traffic arrangements. All PENTA ports and the cities they are located in have amended the traffic arrangements to secure a smooth traffic flow, but also to minimise the noise and other nuisances from the truck and car traffic. City of Tallinn re-directed the heavy traffic to the Old City Harbour and Port of Tallinn built a new parking lot for trucks waiting for their turn to drive aboard. Vuosaari Harbour's tunnel solution is also a noise-reducing traffic solution. In Kapellskär, Ports of Stockholm amended the traffic arrangements so that speeding was made impossible, which reduced noise (ESPO 2012b, 68-69). Also the ports of Turku and Naantali have amended the traffic arrangements together with the municipal traffic planning.

Ramp design has been used in several PENTA ports to reduce noise. In Vuosaari, some of the on-quay ramps were equipped with rubber insulations already when they were first built. In Kapellskär, a reduction of impulse noise up to 10-15 decibels was reached through a re-

construction of the ramps (ESPO 2012b, 68-69). Ramps have been looked into in the ports of Turku and Naantali as well.

More silent machine fleet. Investments in more silent cargo handling equipment have been done in the ports of Stockholm and Helsinki. In Helsinki, it was the terminal operators who took the initiative to this.

Onshore Power Supply is in use in the ports of Stockholm and Helsinki. In Helsinki, the Viking Line's two vessels on the Stockholm route have been connected to OPS since the fall of 2012. In Stockholm, the very same vessels have been connected since the 1980s. It is a low-voltage solution tailor-made to these two vessels, as the more common OPS systems are high-voltage solutions. Moreover, Ports of Stockholm is providing shore side electricity to some vessels on the routes to St. Petersburg, Riga and Åland. During the upcoming reconstruction of Värtahamnen and Frihamnen a further installation of OPS will be made. All regular vessels using the port will be provided a possibility to use onshore power supply when the renovation is ready.

Figure 7: The spectacular noise wall in Vuosaaari Harbour is one kilometre long and more than 10 metres high. It separates the port area from the Natura 2000 area. Photo: Port of Helsinki/Mikael Kaplar, Studio POiNT

Noise walls and barriers. In addition to the Vuosaari noise wall, some smaller noise walls have been built in Muuga (ESPO 2012b, 63-64) and Pansio harbours. In Muuga, two walls were needed to mitigate the railway noise, and they were financed by the Estonian Railways. In Pansio, a noise wall was built to mitigate the noise emitting towards Ruissalo. First, an about three metres high wall was built. At the moment, an extension of the wall to five metres suggested by the monitoring authority is investigated by the Vaasa Administrative Court, due to an appeal process against the environmental permit.

Allocating berths and other operational measures. The ports of Stockholm and Helsinki are using the noise measurements done on the vessels when they are allotting berths to them. In acute situations, vessels have also been ask to use an auxiliary engine further away from

the residential buildings or turn around to reduce the noise reaching the residential areas. This measure is only suitable for bigger ports with alternative berths available. In ports of Turku and Naantali, there are no extra berths, and in Port of Tallinn there has been no need for this measure.

Timetables have actively been used by Port of Helsinki for noise reduction. The port applies a reluctant policy for overnight berthing of noisy vessels, and is regulating the traffic to more favourable hours.

Speed limits for land-based traffic have been issued in several PENTA ports, partly to minimise noise nuisances, partly for safety reasons. Together with amended traffic arrangements, they had a good impact on noise for instance in Port of Kapellskär.

Cooperation with customers and other "noise polluters". Since the port authorities do not have direct control over all the operations causing noise in the port areas, cooperation with the customers and external operators is necessary. All the PENTA ports discuss the noise question with their customers, and it has led to concrete measures. Customers have for instance installed silencers aboard. Ports have, in general, ended up in a situation where they have to communicate the noise regulations to the maritime industry and invite it to noise-reducing measures. The results of this work can already be seen when ship owners are launching new, low-noise vessels, partly due to the press from the ports they are using. Another example of this cooperation with the customers is tailor-made OPS systems for the Viking Lines vessels sailing between Helsinki and Stockholm.

Cooperation with the port city. The Finnish and Swedish PENTA ports are municipality-owned and have thus a natural cooperation both with the political decision-making and with other administrations in the respective municipalities. The environmental, traffic and city planning administrations are the most relevant for the ports. It is important for the ports to look after their interests and influence the decisions impacting the conditions of operation in an early phase. In some situations, the contradictory interests of different city administrations can even lead to conflicts. For instance, the interests of the ports are not always the same as the city planners, and this has been noted in several PENTA ports. In the case of city of Stockholm, the city's environmental administration is also the controlling authority of the port's environmental permit. When the municipal party politics are added to this, the situation can become quite complex. This said, the cooperation is working however quite well and is perceived to be a necessary part of the ports' societal integration. In Tallinn, there are no established forms of cooperation with the city and the state-owned port, and the relationship has not always been warm. This is due to historical, cultural and ownership reasons.

Cooperation with other ports. All PENTA ports have an established cooperation with other ports. Much of the cooperation takes place within the frame of the national port associations, ESPO and Baltic Ports Organization, but also in other constellations such as EU projects and like. Regarding environmental cooperation, the ports apply an open information exchange policy. For instance noise measurements on vessels are exchanged with each other. The openness has also helped the ports to notice that it is often the very same vessels causing noise nuisances in different ports. Knowing this, ports have been able to discuss the issue with the customers as a united front.

Stakeholder cooperation. The ports of Helsinki and Stockholm have an active cooperation with the neighbours, and the noise question is discussed with them. As the stakeholder

cooperation is a very wide concept, all PENTA ports are doing it in some extent. It can vary from information, communication, marketing, PR and lobbying to and participating in projects, discussing practical noise-reducing solutions with the stakeholders, organising events and stakeholder meetings. The stakeholder cooperation does not reduce the decibel levels themselves, but can contribute to better understanding between the ports and their stakeholders, even regarding the noise question.

6.5 Conclusions

To summarise the general attitudes of the PENTA ports regarding the noise question, it can be concluded: For Port of Tallinn, noise is no big issue or an area of focus at the moment. For ports of Stockholm and Helsinki, on the contrary, it is a major concern, and they work in many ways with the noise question. The ports of Turku and Naantali regard that they have complied with the requirements of the environmental permits and made everything they can to keep the noise levels within the allowed limits.

In general, the PENTA ports are sceptical to prohibitions, sanctions and measures that risk the competitiveness of the ports in noise reduction. The ports do not directly welcome such suggested measures as for instance noise-differentiated port fees or OPS for cargo vessels. In general, the PENTA ports propagate voluntary self-regulation and dismiss regulations on national or EU level. The question of public financing for noise-reducing solutions is welcomed by some of the ports, while others are sceptical to these kinds of arrangements.

None of the PENTA ports has a budget for noise abatement as such. Noise mapping and modelling and some minor changes in the port operations are the operational costs of the noise reduction. Bigger investments such as rebuilding ramps, building of noise walls and installing OPS are financed separately. When measures preventing or abating noise are a part of a bigger port construction project, the costs are covered by the project budget.

The main driver of the noise abatement work in the PENTA ports is the pressure from the environmental authorities. The requirements set by environmental impact assessments and environmental permits have made the requirements more concrete. The result of the obligatory noise maps and models is that the PENTA ports have a good overview of the noise situation and can evaluate the effect of the noise abatement measures taken. The requirements from the authorities have a relatively high standard of noise abatement in the PENTA ports as a result.

However, even though the PENTA ports are complying with the minimum requirements for noise abatement, they have been less successful in working with the noise question in a more proactive way and finding solutions on their own initiative. Cases where the port companies have appealed in court against new requirements set in the environmental permits confirm the impression of trying to avoid new noise abatement obligations and costs. Moreover, for Port of Tallinn, the lack of cooperation with the city can complicate the noise abatement and the societal integration of the port company.

On the other hand, especially the ports of Helsinki and Stockholm are working with the noise question systematically and in several ways. There are signs of the noise question to be a rising focus area in the social and environmental responsibility in the PENTA ports. The matter of noise management as a part of the ports' social responsibility work will be discussed in more detail in chapter 9.

7 Living by the sea – waterfront housing projects and port development

To build new waterfront residential areas is an international trend which has a great influence on the operation conditions of many sea ports. Apartments in the waterfront areas are marketed with a view to the sea and a marine atmosphere, and beautiful vessels are decorating the drafts of the urban planners. Unfortunately, ships, cranes and other port functions are not always as beautiful to listen to as they are to look at. Many times, the new neighbours moving right next door to ports are totally unaware of the noise and other environmental impacts the port operations are generating.

To put this in a broader perspective, it can be stated that our society sounds like it does because the sonic has been subordinated to the visual in the Western culture for centuries. This applies even to urban planning. Its basic approach and the whole tradition are visual to begin with, and the people working with the planning are visually educated architects and landscape architects. Although Schafer (1977) launched the concept of soundscape already back in the 1970s, the acoustic perspective is still new and upcoming in urban planning (Hellström 2010).

7.1 Cities and ports are growing together

In growing cities, available land is scarce and the political pressure to build housing is high. As noise pollution is widely present, places which were previously seen as unsuitable for residential areas are now being exploited for housing projects. The development of construction techniques and the allowed exemptions from the general guideline values for traffic noise have now made possible to build noise-isolated residential buildings for instance right next to highways.

Sea ports are not the only industries getting new neighbours within a hearing distance. But, ports are at the same time special because of their natural location by the water. Waterfronts are particularly attractive for residential projects; living by the sea has a high status, and people are willing to pay for a marine view. Even more attractive are the waterfront areas in the inner-cities. There are big housing projects by the port areas in progress in Stockholm and Helsinki, and also in Tallinn the exploitation of the waterfront area is planned.

During the recent decades, the idea of safety zoning has been replaced by a mixing philosophy in urban planning. This means that different functions such as living, shopping, recreation, schools, industrial operations and traffic are located in the same areas. The main idea of mixing is the pursuit to create living neighbourhoods instead of boring sleeping suburbs without service in some areas, and working zones which are dead in the evenings and weekends in others. Another reason to mixing and is to avoid the phenomenon of urban sprawl, which is creating big problems in the urban structure. (Bellander 2005; Hedman & Möller 2011, 82.)

In Stockholm, the project Stockholm Royal Seaport is under construction. 12 000 apartments and 35 000 workplaces are planned to the area right next to and partially instead of the current

port premises. The first inhabitants have already moved in, and the whole project is estimated to be ready in 2030. The areas closest to the port premises are still on the drawing board in spring 2013. The new city quarters have a high environmental profile. (City of Stockholm 2013.)

The Stockholm Royal Seaport project brings about remarkable changes in the operations of Ports of Stockholm's Värtahamnen, Frihamnen and Loudden areas. Only the passenger-related traffic will be presented in the inner-city harbours in the future. The RoPax and cruising port in Värtahamnen will be moved out towards the sea and give space to the city settlements when a new pier with a new passenger terminal is being built. The container terminal in Frihamnen is about to be moved out to the Norvikudden port planned in Nynäshamn's municipality. According to the plans, the energy port of Loudden is going to be moved out of the inner-city as well and replaced by residential and office buildings.

Figure 8: The draft from Stockholm Royal Seaport illustrates how close to each other ports and cities will be in the future. Picture: City of Stockholm/Aaro Designsystem.

In Helsinki, the Jätkäsaari area where the West Harbour is located is a big city development project. It was made possible by the move of the cargo-related port operations to the Vuosaari Harbour in 2008. Homes for 17 000 inhabitants and 6 000 new workplaces are planned to the area, and the project is estimated to be finished in 2025. A major part of the Tallinn traffic and cruising quays are located in the area, and according to the plans they will remain there next to the new neighbours. A new passenger terminal is a part of the plans. (City of Helsinki 2013.)

The situation of the Port of Tallinn differs from its neighbours, because it is the port company which is the owner of the land closest to the port premises. It is also the port company which

is planning to exploit the area for commercial and residential purposes. At the writing moment, the plans are on a vision stage so far. In Turku, there is a workplace zone planned closest to the port premises at the moment. Nevertheless, even residential buildings close to the port have now been proposed. In Naantali, the municipality planned residential buildings closer to the port. After an intensive debate between the port and the municipal planning, the plans were revised to secure the possibilities for further port development.

The urban development projects in Stockholm and Helsinki are good examples on the trend where ports and cities are growing together according to the mixing philosophy. The vision is to integrate the ports to the rest of the city and even open the port areas to the inhabitants and the general public. At the same time, cargo operations are moved away from the inner-city harbours which are concentrating on the passenger traffic.

The idea of solving the concerns created by the port operations by moving the cargo operations further away from the city centres is not fully developed because of two reasons. Firstly, the traffic between the PENTA ports is based on the RoPax arrangement. The liner traffic is conducted either on passenger vessels serving even the cargo segment or on truck ferries that also serve passengers. The both are necessary for the competitiveness of the traffic and make the frequent traffic on these routes possible. Using ports located far away from the city centres is not attractive to the ship owners oriented in the passenger traffic, and with the passengers comes also the truck and car traffic.

The RoPax arrangement is a big concern for the urban planners. In Helsinki, the growth of the passenger traffic has been a surprise to the urban planning, and many of the passengers on the Tallinn route arrive to the port by their own cars or have them with them during the trip. The amount of heavy traffic has also been bigger than forecasted. The urban and traffic planning is now considering a tunnel solution to stop the port-related street traffic from causing congestion in the new residential areas. In Stockholm, Norra Länken tunnel is under construction and it will connect the port and the neighbouring residential areas to the Swedish highway network.

Figure 9: The RoPax arrangement brings the trucks to the city centres. Picture: Per-Erik Adamsson/Ports of Stockholm

Secondly, the vessels themselves, together with the car and truck traffic, are the most important noise source in the inner-city harbours. Image-wise, cargo traffic is experienced as dirty, noisy and disturbing, whereas passenger traffic is seen to be clean and silent. Knowing the dilemmas caused by the vessel noise, this is not necessarily true. International cruising vessels transporting passengers only are among the most problematic noise sources from the port perspective. For instance the air conditioning systems can generate high decibel levels. As cruising vessels are using each port only occasionally, discussing the noise question and finding tailor-made solutions is together with the ship owners is quite a challenge.

As there are people willing to pay a little extra for flashy apartments with a view to the sea in the inner-city area, the new urban development projects have quite a high profile and can be characterised as prestige projects. The target group is the economically privileged upper middle-class, and buying or renting an apartment in these areas requires a good financial status. The cities are aiming for a mix of rental and owned apartments to make the areas available for different socio-economical groups, but the price levels set by the housing market make sure that they mostly will be inhabited by the more privileged groups. From the sustainability perspective, housing projects with high ecological sustainability profile, such as Stockholm Royal Seaport, have been criticised for the low social sustainability, but also for a low ambition level for the ecological sustainability. (Wangel 2012, 91).

In the old days, the image of sea ports was dubious, and they were seen as “havens of sin, poverty, crime and disease” (van Hooydonk 2007, 23). The current trend is quite the contrary; trendy residential areas with “hip” middle class inhabitants, houses with experimental architecture (see Salmela 2012) and good shopping opportunities are emerging in these areas that previously were seen as ugly, noisy and dirty industrial sites.

This is interesting towards the background that noise exposure is matter of class and social status. The more privileged groups can buy themselves silence by moving to areas with a pleasant soundscape, whereas the less privileged end up living in noise-exposed areas such as close to highways or airports. (Ampuja 2008, 127-130; Mildner 2012, 174-177.) The privileged are also used to look after their interests and know how to make their voices heard in the society. It is easier for people with know-how and contacts to build protest groups, get media exposure to their cause and formulate court appeals than for people usually living in noise-exposed areas. This means that the new neighbours of the ports are less likely to tolerate the nuisances caused by the port operations.

It should not be forgotten that there are big economic interests influencing the exploitation of the land in port proximities. As there are people ready to invest in apartments by the sea, there is money to be made out of the exploitation. Selling the right to build on this land is a big revenue for the municipality and a business opportunity for the construction companies building and selling the apartments to the future inhabitants. It has to be noted that no indication of noise or other downsizes of living next to ports can be found in the marketing materials of the residential projects mentioned above.

7.2 The consequences of the development

Ports are facing a new situation where the “no man’s land” they previously had at their disposal has suddenly become attractive for other functions. As a consequence, the ports have to be more effective in the land use and in the operations. The competition for space with other functions can also become a hinder for a further development of the ports and create

bottlenecks for growing traffic flows. The inevitable environmental impacts, such as noise, can further be an obstacle for the development of port operations, and make the ports delimit even the operations they have today.

Because the limit values for noise are set and measured outside of the closest dwellings, building new residential buildings in a closer proximity is practically a tightening of the noise regulations of the ports. This is why the mixing philosophy is problematic for ports or any other operations that require an environmental permit.

The situation today, as an interviewed permit authority put it, is that the urban planners are planning and the permit authorities are trying to patch up the damage caused. The tool for the permit authorities is to stipulate new requirements for the port or the industry to secure a good living environment for the inhabitants in the neighbourhood. The system of urban planning on one hand, and environmental permit process on the other, is not built in a way favouring cooperation. There are no forums where the parties could meet and negotiate so that the conflicts of interests could be solved in a proactive way. Instead of a proactivity and cooperation, court appeals which can lead to processes lasting for several years are used to solve the dilemmas. There is a risk that the court processes lead to compromises that are not satisfactory to any of the parties.

Applying the mixing philosophy in a negligent way can lead to dysfunctional areas where neither a good living environment for the inhabitants nor the conditions of operation for the companies are secured in a satisfying way. To tackle the noise question in residential areas next to the ports requires acoustical competence. Urban planners are used to work with areas exposed to traffic noise, but it is not self-evident if the special acoustical characteristics and the consequences of the industrial noise in general and port noise in particular are thoroughly understood by all urban planning professionals.

The worst case scenario for the ports is an unpleasant and actually unhealthy living environment, which has unhappy inhabitants as a consequence. Dissatisfied citizens start complaining, and as a result, ports are forced to delimit their operations. The pressure to limit the opening hours and eventually move out further away from the cities is rising. There is also a risk that ports have to pay for noise abatement measures which are needed due to bad planning. The unsuspecting inhabitants are risking their health and investing their money in apartments in dysfunctional areas. It is quite obvious that this is a situation nobody wants to have.

Many of these problems can either be amplified of muffled by the decisions made during the planning process. The urban planning can create a lot of problems, but it has also the keys to the solutions.

7.3 A good living environment

We know that environmental noise is a serious risk for the public health. Therefore, a noise-free living environment is not only a matter of comfort, but a matter of health, and it should not be seen as a luxury but as a necessity.

Securing a good sonic environment in the growing cities is an enormous challenge for everyone involved in the question. With the current construction techniques it is possible to obtain a quiet indoors environment in heavily noise-exposed areas. Obtaining a good outdoors

environment is a question that is relevant from the health perspective, and has practical implications for issuing environmental permits. The traditional noise-reducing solutions for outdoors space such as noise walls and barriers create both visual and physical obstacles between the noise source and the areas protected from the noise, and they are not so suitable in the idea of integrating areas with different functions. Other solutions such as green facades with noise-reducing materials, for instance perforated metals, behind the vegetation are still on an experimental phase (Forssén 2012). They are developed to abate noise from road and street traffic and their effectiveness against the most problematic types of port noise such as the low-frequent noise from the vessels is an open question.

Nevertheless, there is a lot that can be done if the sonic environment is taken into account from an early phase of the planning process. The acoustic planning approach is simply about bringing the sonic element to the planning process besides the visual one. This requires new cooperation and working methods between the professionals, for instance urban planners, architects, acousticians and designers involved in the planning process (Hellström 2010).

We know that a good sonic environment is more than low decibel levels, and that the qualitative characteristics of the soundscape have a big influence on people and their experiment of the ambience. It is nevertheless difficult to apply these qualitative experiences in the planning practice, and is even more difficult to apply them in the issuing of the environmental permits where measurable conditions have to be given. So far, there is no research about how the people living in well sound-isolated apartments in noise-exposed areas experience their sonic environment. Can this sound-proof living milieu where windows cannot be opened be called a good living environment? The requirement of low decibel levels is met, but the qualitative properties of a good soundscape, for instance the presence of sounds of nature, will probably not be fulfilled with this kind of solutions.

Of PENTA countries, the public debate about exploiting noise-exposed areas to residential projects is hottest in Sweden. Especially in Stockholm, the housing shortage is a fact and the population growth is high. In the political rhetoric, the noise regulations, not the noise itself, has turned to be an obstacle for new housing projects and the economic growth. In the debate, the complexity of the port noise question is easily forgotten, and highly placed decision-makers are proposing simplified solutions such as OPS to move their visions from the drawing board to the reality (see Sundström 2012). In Finland, the city of Helsinki and the Uusimaa region have a similar situation with high pressure to exploit new areas to residential uses.

Even though the focus of this study has mainly been on the on-going development with new neighbours moving to the ports' proximity, the old residential areas by the ports should not be forgotten either. The ports located in inner-cities are a result of a long development. In the most cases, the ports were there first, and the port cities have grown around the ports. In Stockholm, Helsinki and Tallinn, the ports are a part of the inner-cities since hundreds of years, and there are well-established and reputable residential areas within the hearing distance from the ports. The expansion of the maritime traffic and the street and road transports it generates on the one hand, and the higher requirements for the good living environment on the other hand, have changed the relationship between the ports and their old neighbours as well, and most of the issues discussed regarding the new residential areas are relevant also to the old areas. The only difference is that the new areas will be build, if possible, even closer to the ports than the old ones.

7.4 Conclusions

The urban planning and the issuing of environmental permits are about balancing different interests. Creating functional cities with a well-working transport system and a good living environment is no easy task. In the end, the decisions about the urban planning and the land use are a matter of politics. The decisions made today have far-reaching consequences; the areas planned now will probably exist a hundred years ahead or even longer. That is why the sustainability questions should be on the top of the agenda in the planning process instead of the interests for short-term profits.

As the acoustical properties of the port and industrial noise are more challenging than the ones of traffic noise, there can be reason to apply different limits for the different kinds of noise. This is a question which the environmental and public health authorities are weighing when general guideline values are issued and limit values are stipulated through the environmental permits. The aim of this study is not to assess how well the existing regulations are set.

There is no turning back in sight regarding the exploitation of the land near the ports. Therefore, the ports have to find ways to meet the new requirements set by the development. They have to take their responsibility and take all available measures for noise reduction, but the urban planners have to do their part as well. If housing is deliberately planned close to the port areas, the ports should not be alone responsible for the consequences. The current situation where the noise from the road and street traffic is handled by planning and the noise from ports is handled by the environmental permits creates situations where the ports have to bear the responsibility for the problems created by the planning.

If the noise and the soundscape questions are not taken into account from an early phase of the planning process, risk of creating an uncontrolled cacophony of sounds is high. A broad cooperation is needed to avoid this situation, and a proactive approach is needed from all the involved parties. There are no easy, ready-made solutions to create a good soundscape in ports and their proximities. Adopting an acoustic planning approach is a good starting point to solve these questions.

The urban planning should bear the main responsibility for the sonic environment in the residential areas in port vicinities, but the acoustic planning approach is interesting to inner-city ports as well. A completely silent port is, of course, impossible and nothing to strive for. Thus: which sounds do we wish to hear in ports and which sounds do we want to eliminate as well as possible? Are there port sounds that are worth preserving? What kind of soundscape is desirable in the port environment, or how should a port sound like? These questions remain unanswered so far, but might be interesting to address.

Obviously, ports have the responsibility as employers to secure a good occupational environment to their employees. They have also the responsibility to stay within the given decibel levels to secure a noise-free environment for the surrounding community and its inhabitants. These two things are naturally the first priority to ports. In the new situation the ports are facing, they have an opportunity to take a step further and explore the possibilities of creating port-specific soundscapes together with urban planners, acoustic designers and sound artists, refining the sounds of the ports and making something positive out of them. This could help the social and cultural integration of the ports and the cities. The societal integration of ports will be discussed further in chapter 9.

Towards this background, the partially inevitable noise port operations cause can be characterised as a risk factor for the development and even the survival of the inner-city ports. If the urban development on the one hand, and the port development on the other, are done in a negligent way, there is a big risk for conflicting interests. This is why a deeper cooperation between the two should be the interest of the both parties.

8 Payin' the dues – allocation of the costs of noise reduction

As noted in chapter 4, there is a wide variety of noise abatement measures available for ports. In applying them, the liability, who is going to pay the bill, is the big question. In environmental permits, the port company is held responsible for all the noise generated by the port operations regardless of who is causing the noise. In this sense, the juridical status of ports is similar to the situation of airports. Regarding the liability, there are several open questions and grey zones.

In addition to the financing of the noise abatement, noise creates costs that are more difficult to value in money. It is complicated, but not impossible, to value the measurable health effects of noise in money. But to estimate the cost of unpleasant living environment or calculate the costs of noise disturbance cannot be measured in monetary terms. In any case, the inhabitants risk paying these hidden costs of noise.

8.1 Applying the Polluter Pays Principle

The Polluter Pays principle is widely accepted. The question is the definition of the polluter, and there are no self-evident answers to it. The starting point of the environmental permits is that the ports are responsible, but drawing the limits of the liability is no easy task for the permit authorities. The main problem points are noise from the vessels, from the road and street traffic, from the stevedoring activities and noise-isolation of the nearby buildings.

The dilemma of vessel noise and the ways to tackle it are discussed in chapter 4. In the court praxis, there is no self-evident border between the port premises and the public fairways, and the liability of the port for the vessel noise the port operations generate is an open question. There are several possible principles to solve the question. Regarding the maritime traffic outside the dock area, it has been proposed that the ports should have the same liability as the airports have for the air traffic. On the other hand, it has been even proposed that the shipping companies, not the ports, should be responsible for the noise. The current situation is somewhere in between these two extremes; the ports are held responsible for the vessel noise within the port area, but not on the fairways. The lack of international regulation of the vessel noise has put the legal responsibility to the ports.

Similar questions are actual regarding the land-based traffic the ports are generating, with a difference that traffic noise is handled by environmental permits in port and industrial areas only. Normally, it is a question for the urban planning. The practical consequence has been that the investments needed to limit the noise from trucks and cars in the port area have been financed by the ports, and amendments in the traffic arrangements outside the port premises have been the responsibility of the municipalities. In Muuga harbour, where the noise from railway wagons was disturbing the neighbours, noise walls were needed. They funded by Estonian Railways.

The definition of the polluter is somewhat different when it comes to terminal operations and stevedoring. In the cases when the port company is running in-house terminal operations, the situation is quite simple. But, even in cases when external terminal operator and stevedoring companies are used, the port authority has a contract relationship to the companies and can set

different conditions for the operations. Even though the port company does not directly cause the noise, it has possibility to directly impact it through the contract.

Defining the polluter in relationship to the nearby residential buildings is a big question. As the situation is today, the ports are responsible to keep the noise within the given decibel levels despite the fact that they have been operating in the areas long before the residential buildings were built. Following this logic, it can be argued that ports should pay for the noise isolation of nearby dwellings. If the noise isolation requirements are not properly written in the city plan and the building permits of new housing projects near the port, this can be the result. If sound isolation of the new buildings is required in the building permit, the responsibility lies on the construction company instead of the port. This fact sets a great responsibility to city planners, and requires a lot of know-how and awareness of the noise in the city bureaucracies.

The definition of the polluter could be put the other way around as well: if the port has been operating in the area since a long time, the exploiters of the area could be held responsible for all the measures required to make the port operations possible even after the new residential areas have emerged.

To build in the areas near to ports is more expensive due to decontamination costs of the old industrial land. If the new housing area is exposed to port-related noise as well, the building costs are even higher due to the higher sound isolation standards. The inner-city waterfront areas are already valuable as such. These factors are increasing the price of the apartments in the old port areas and steering the social selection of the future inhabitants. However, the final prices of the apartments are in the most cases determined by the housing market, and the cost for the extra noise isolation needed is not directly visible in the price the inhabitants pay for their living. It is nevertheless included in the price of the apartments, and in this way the inhabitants become payers of the noise reducing measures.

Defining the polluter through the environmental permits is a juridical question. The practical applications are another. In PENTA ports the general policy has however been that each party pays for its own investments. For instance, when on-shore power supply has been installed in the ports of Stockholm and Helsinki, the ports have been responsible for the installation cost on the shore side, and the shipping companies have paid for the investments aboard. In cases when vessels have been causing disturbing noise, the ship owners have installed and funded silencers on the vessels.

There can be cases when exceptions from this general rule have to be made to make noise reduction possible. Port of Turku has in the past co-financed noise-reducing measures for one customer in order to enable rail-ferry traffic to Germany. An opposite example is Port of Gothenburg which has an investment limit by berth when OPS is installed. If the vessel requires more complicated solutions than the standard one to connect the vessels to the shore-side electricity, the shipping company pays for the extra investments needed even on the shore-side.

Of course, making exceptions from the principle depends always on the market situation and is in a way a strategic decision. The port authorities have different ways of steering the development to a more environmental-friendly and more silent direction. Co-investing in noise reduction can in some cases be worth considering.

8.2 Conclusions

The Polluter Pays principle is a good starting point when the allocation of noise abatement costs is discussed. But first, the polluter has to be defined. At the moment, the responsibility lies on the port authorities. In practise, the external polluters, as the customers of the ports, have in the mot cases financed the noise reduction measures needed to be able to use the ports. Collaborative financing of noise reduction might be a solution in some cases.

The biggest open question is the liability for the noise reduction of the new residential areas in port proximities. The current situation does not favour the ports, especially because the noise measurements are made outside the closest dwellings. The inhabitants become payers of the costs for noise isolation of the houses, but also the hidden, immeasurable cost of noise.

9 Being a good neighbour – towards port noise management

It is quite obvious that noise and other environmental impacts port operations are generating complicate the port's ambitions to be good neighbours. That is why handling the noise question in a systematic way can not only help the ports to stay within the allowed decibel levels, but also to take care of the neighbour relations.

The European port sector has developed guidelines both to the societal integration and the environmental management, including noise management, of the ports (ESPO 2012a; ESPO 2010). Moreover, the European Union Life programme project Noise Management in European Ports has published its Good Practice Guide on Port Area Noise Mapping and Management (NoMEPorts 2008). Therefore, there are guidelines and lot information and good examples available for ports to handle the questions of noise and being a good neighbour.

The possibilities of integrating a systematic noise management in the social responsibility work in ports will be outlined in this chapter. Moreover, the model for noise management in ports developed in the NoMEPorts project will be revised so that it corresponds better to the situation of the PENTA ports.

9.1 Environmental management in ports

ESPO's (2012a, 7) view of environmental management in ports is based on five principles: 1. Voluntary self-regulation, 2. Cooperation and sharing of knowledge between port authorities, 3. Serving in parallel interests of the businesses and local communities aiming towards sustainability, 4. Applying a systematic approach to the environmental management, and 5. Transparency in communication regarding the environmental efforts. Five different approaches, the five E's, for reaching the desired results are launched: 1. Exemplifying; setting the good example when managing own operations, 2. Enabling; providing conditions that facilitate and enhance improved performance, 3. Encouraging; providing incentives for greener ports, 4. Engaging; with users and/or authorities in sharing knowledge and skills, and 5. Enforcing; setting rules and ensuring compliance.

Applied to noise management, several examples of these five approaches can be given. Some of them are: 1. Exemplifying; sourcing best available silent techniques for own machine fleet and infrastructure. 2. Enabling; installing onshore power supply facilities which the vessels using the port can connect to. 3; providing incentives for using silent solutions, for instance more favourable berths or discounted fees for more silent vessels. 4. Engaging; developing relationships with the customers and the suppliers to support the development of silent technology and processes. 5. Enforcing; setting speed limits within the port premises.

ESPO and EcoPorts offer their members on-line tools to get started with the environmental management. Self Diagnosis Method, SMD, can be used for identifying environmental risks and establishing priorities for action and compliance. Port Environmental Review System PERS, is an environmental management standard for the port sector, and its implementation can be independently certified by Lloyd's Register. ESPO strongly recommends its members to use these tools and to aim towards ISO 14001 or EMAS certification to as a part of the

systematic environmental management. (ESPO 2012a 16-19.) Several PENTA ports have already been certified according to the ISO 14001 standard.

9.2 Social responsibility and sustainability in ports

The concept of corporate social responsibility (CSR) is wide and has many meanings depending on who is using it. CRS was first used to stress that enterprises should not be responsible to shareholders only, but to other stakeholders as well. Shareholder responsibility covers only the financial aspects, and then, profitability is the only leading value in running a business. CSR was raised because there was a need for ethical guidelines in business, and shareholder responsibility was not able to provide them. Depending on the line of business, CSR can include a wide variety of subjects such as employee democracy, equality between the sexes, anti-discrimination issues, community engagement, anti-corruption, human rights issues, fair trade, anti-child labour, responsible sourcing etc. The environmental issues are nowadays an important part of CSR, and the concept of corporate social and environmental responsibility is commonly used. (Blowfield & Murray 2011.)

Another relevant and commonly used concept is sustainability, which was originally launched in 1987 by the Brundtland Commission by assignment of The United Nations. The main point of the concept is to meet the needs of the people living today without compromising the needs of the future generations, which sets focus on the use of the nature resources. The concept contains three parts, environmental, economic and social sustainability, even though the environmental sustainability has gotten most attention. (Ammenberg 2008, 30-31; 41-43.) The sustainability concept is widely adopted both in the private and the public sector, and it is used in the pursuit of more ethical codes of conduct in doing business and in governing the societal development as a whole.

As the CSR concept is above all about self-regulation, the sustainability concept emphasises the importance of measuring and reporting the environmental performance. The three bottom line reporting focuses on the reporting of the financial, social and environmental aspects of an organisation. There are a several environmental management and certifying tools such as ISO 14001 and EMAS available for organisations wishing to systematise their environmental management. (Ammenberg 2008, 155-160; Cummings 2009, 244-247.)

As the name implies, corporate social responsibility has been a private-sector endeavour in the first place. The principles of creating ethical codes of conduct are, however, applicable to public-owned companies well. As matter of fact, for instance the social responsibility the public procurement is a frequently discussed topic (See Lann & Thorsell 2005). All the PENTA ports are public-owned; in Finland and Sweden, they are owned by the municipalities, and in Estonia, Port of Tallinn is owned by the Estonian state. This makes the citizens, as taxpayers, shareholders of the port companies. This means also that the port companies are more or less directly controlled by the democratic institutions. Moreover, PENTA ports have a double mandate as port authorities obliged to secure that laws and regulations are followed by the whole port community on the one hand, and as port companies to be driven by business principles, on the other hand. In Sweden and Finland, a public-owned port company is exposed to a more stringent public scrutiny than a private one - at least due to the principle of public access to public records.

In ESPO's (2010) Code of Practice on Societal Integration of Ports, the societal integration is seen as a part of the broader CSR. It is defined as following: "Societal integration of ports…

concerns actions by port authorities that aim to optimise relations between the port and its surrounding societal environment and it focuses on the human factor in ports, i.e. (future) employees, people living in and around port areas and the general public." Societal integration of ports has an environmental aspect and covers especially pollution problems such as noise (ibid. 11). ESPO's code of conduct includes guidelines for general public support and image, education and labour market and port-city relationships. When it comes to noise and other pollution, ports have an important task in limiting negative extremities to be able to maintain good neighbour relations (ibid. 25).

9.3 Proactive measures and recommendations

The previous chapters have shown that the question of port noise is very complex. The changes in the operational environment such as the waterfront housing projects and tightening environmental regulations imply big challenges to ports, and at the same time their possibilities to impact this development are limited. In many cases, the ports cannot take direct measures against all noise they are held responsible for. Because of this, complying reactively with the minimum requirements of the authorities will probably be difficult. The ports will have to work with the noise question more systematically and more proactively, and enhance their collaborative networks to be able to tackle the challenges.

There are no shortcuts to a better sonic environment in ports and their vicinities. The regulations have led to a relatively high standard of noise abatement in the PENTA ports, and obtaining big improvements in something that already is quite good is naturally more difficult than getting big results when the starting point is on a lower level.

It has to be pointed out that PENTA ports, as ports in general, are diverse. All the ideas presented below will not be directly relevant for every port. The purpose of the recommendations is that each port can pick up the ideas they find useful and apply them in their particular situations. The recommendations outline an ideal case of noise handling in ports.

9.3.1 Noise management – a systematic working method

Noise management is an ongoing, systematic and documented way to handle the impacts of noise on people and the environment in or around a company or a geographic area" (NoMEPorts 2008, 39). According to WHO (1999, 66-89), the goal of noise management is to maintain low noise exposures, such that human health and well-being are protected. For WHO, noise management is mainly a macro-level planning and policy-making tool, including legislation, noise exposure mapping and modelling, mitigation measures such as noise walls, precautionary measures such as planning the land use and building design, priority setting, and enforcement of noise standards. As the definition of noise management implies, it can be practiced from a macro-societal level to regional and municipal authorities, down to company and unit levels. There are noise management handbooks available to environmental authorities on a local level (See for example Silence 2008).

Several advantages of noise management for ports are listed in the NoMEPorts (2008, 39) report. They include cost savings through the prevention of negative environmental influence from the planning of the port functions and port development, better control of production, enhanced environmental quality of the port surroundings, greater transparency and improved working environment. It should be added that noise management is an essential tool both for

living up to the requirements from the environmental authorities and for being a good neighbour.

This suggestion of noise management in ports is a revised version of the guidelines given in the NoMEPorts report, applied to the current situation in PENTA ports. The goal is that other ports can find it useful as well. The following steps should be included in the noise management:

1. **Noise measurements, mapping and modelling.** The starting point of noise management is mapping and modelling of the noise situation within the port premises and in the vicinity. This makes it possible to see if the port can manage to stay within the required limit values. This work is most suitably done by external acoustics experts who have the right competence and equipment.
2. **Identifying noise sources and hot spots.** With the help of the noise maps and models, a detailed analysis of the noise sources can be done. The hot spots with the heaviest noise exposure can be pointed out.
3. **Evaluation of the impact of current noise abatement measures.** Nowadays, no port starts its noise management from zero, but there are already a number of measures in use. With the help of the noise maps and models, the effect of the current noise abatement can be estimated.
4. **Action plan.** By the identification of the noise sources and evaluation of the current abatement measures, new measures can be planned and prioritised. Action plan can include investments (such as noise walls), policy changes (such as setting the port fees), smaller changes in the port layout or working methods (such as more silent driving in cargo handling) and working methods for handling acute situations (such as allotting berths to vessels according to their noise levels).
5. **New noise abatement measures.** Implementing the action plans is the next step. This step will probably include several different time spans depending on how comprehensive the planned actions are. It has to be pointed out that even though noise management is primarily responsibility of the top management, the concerned parts of the personnel and the whole port community should be engaged in the implementation of the action plan.
6. **Complaint handling.** Even though every thinkable noise abatement measure is taken, it is probable that the port will receive complaints about noise at least every now and then. It is of great importance to have a procedure for receiving complaints. The time and the details of the noise disturbance should be documented for further analysis. The complaints should be forwarded to the highest level needed, and immediate actions should be taken if it is possible. Feedback routines should be developed so that the people complaining can get an explanation for the noise event, what was done to it in the acute situation, and what the port intends to do to prevent similar noise disturbances in the future. Sometimes the only thing the port can do is to give an explanation and an apology, but it is still important for the maintenance of the good neighbour relations that the people complaining can feel that their cause is taken seriously by the port authority.
7. **Follow-up.** The taken measures and their impacts should be evaluated continuously. This should include both the impact of short-term operational measures and strategic decisions.
8. **Documentation, reporting and communicating.** The whole noise management process should be documented, reported and communicated to the stakeholders and

the general public. This serves two aims: transparency, and the ports obligations of reporting the environmental status to the authorities.

Even though the noise management is presented in eight steps, it should be stressed that it is a continuous process with no given beginning or end. The most essential part in formulating a noise management policy is to establish a systematic, documented and transparent working method against noise disturbances.

The formulating of the noise management guidelines and procedures is a concern for the port's top management, but the implementation involves the whole personnel and the port community. The operational personnel should be given the necessary authorities so that they can take measures in acute situations, prevent unnecessary noise events and communicate with the public in an appropriate way.

Adopting the noise management approach helps to handle the noise question more proactively than just passively complying with the requirements from the authorities. It can be also be a starting point in taking the step from a defensive noise abatement approach to a more offensive approach of noise control, or even controlling of the port soundscape.

A successful noise management has a high potential to be a key factor in maintaining good neighbour relations in several ways. Firstly, a systematic and transparent noise handling helps the port to minimize the noise nuisances. Secondly, a systematic complaint handling is of great help when problems occur. It should also be seen as a valuable source of information; by analysing the complaints the port management will know which ports sounds are actually disturbing the public. There is no direct correlation between the decibel levels and the experienced noise annoyance, and the question is very subjective to begin with. Thirdly, it can help to objectively assess the noise situation and the effectiveness of the measures taken. Fourthly, adopting a noise management approach can help using the whole toolbox of noise reducing measures. All noise reducing measures have to be tailor-made for each port individually. The noise management approach can help to concentrate the efforts there where they give the best effect.

A successful noise management can enhance the societal integration of ports; become an integral part of their social responsibility and essential building block in their pursuit to sustainability.

9.3.2 The approach of continuous improvements

Even though much has already been done with the noise question, there are still a few things the PENTA ports can do about it. An approach of continuous improvements, inspired by the lean production (see Womack et al 2007), could be worth trying. The idea of continuous improvements is about that even small things matter because they can, counted together, lead to remarkable improvements as a whole over a longer time period. This idea is applicable especially to the more silent working methods, where the operational personnel and their attitudes are the key to improvements.

The strength of the idea is that applying it can help to capture the ideas from the operative personnel who know the practical realities better than anyone sitting in the office for the most of the time. The challenge is to involve and engage the relevant personnel to the improvement work. As the giant leaps already are taken, there are still small steps left towards a better sonic

environment in ports. This complies also with the idea of noise management as a continuous process.

9.3.3 Collaboration against noise

Tackling the noise question alone may be overwhelming to an individual port. The complexity of it makes it necessary for the ports to enhance their collaborative networks. Collaboration should involve the whole port community, customers, suppliers, neighbours, other ports, and authorities working with environment and urban planning. The collaborations can take different forms depending on the needs of the situation. It can vary from information exchange with the colleagues from other ports to concrete measures such as co-investments in noise-reducing solutions, and from one-off events to strategic alliances.

In many cases, it is no easy task to overcome the obstacles for a better collaboration and to engage new parties to the noise reduction work. It can require a lot of efforts to make everyone involved see that noise reduction is actually a common cause and that only looking after one's own interests can lead to deadlock situations where no progress can be made.

9.3.4 Communication and stakeholder management

Adopting a noise management approach can make a big difference on how the port is perceived by its stakeholders and the general public. That is why noise management is as much managing the stakeholder relations as managing the noise itself. Communicating to and with the stakeholders, as neighbours, about the noise abatement efforts is of essential importance. The technical measures can reduce the decibel levels, but if the public does not know about them, the image of the port is not improved.

Since noise can in the worst case infect neighbour relations, it is probably very challenging to involve the neighbours who already have a negative attitude to the port. That is why the importance of the proactive work cannot be overestimated. Initiating a genuine dialogue with the neighbours and the other stakeholders should be the goal. It can build bridges between the port and the stakeholders and contribute to a better understanding of each other's concerns. If the people feel that their opinions are taken seriously by the port and can trust that the port is doing its best to prevent the noise from happening they are also more likely to accept a reasonable level of nuisances.

Noise reducing improvements can also be used in green marketing. Doing this, it is important to avoid the pitfalls of "green wash", marketing with meaningless environmental claims (Polonsky 2009, 134). A trustworthy environmental marketing is based on serious environmental work, it is well-communicated and the marketed products or services contribute to real environmental improvements (see Ammenberg 2008, 311-314). Knowing this, it is more advisable to communicate concrete improvements such as building new ramps that lowered the decibel levels than more abstract issues like making a noise map, which is obligatory in any case.

9.4 Conclusions: noise management as a tool for social responsibility and stakeholder relations in ports

A systematic and proactive noise handling, or noise management, can become a tool which can be used in the social responsibility work of the ports. As argued above, the complexity of the noise question requires new working methods and new cooperative constellations from the ports. The complexity requires also that the question is handled systematically, and adopting a noise management approach is a way to do it. The noise management approach helps the ports to get control of the noise situation. All problematic sounds cannot be removed from the ports as once, but to be conscious of the situation and to have an action plan is already a big step forward. As the noise maps are already obligatory in the PENTA countries, the ports have a good starting point to go further in the noise management process.

The next step is to engage the concerned parties to the process. This engagement creates preconditions to the integration of the noise management to the social responsibility work, and is a way of the societal integration of ports as such.

Of course, every port is free to choose which level of ambition it desires to have regarding the noise question. Sometimes it might be sufficient to comply with the minimum requirements, but using noise management as a tool in the stakeholder management it is possible to make something positive out of the noise issue which is perceived as negative in the beginning. The ports and their stakeholders will benefit most if the noise management is a fully integrated part of the social responsibility work.

The money and efforts invested in noise management might not always pay back in financial terms, but they are the necessary ingredients for a better environmental performance, an improved image and good public and neighbour relations. Noise management should rather be seen as an opportunity than a thread in the port industry.

10 Discussion

This study has enlightened the complexity of the port noise question from different perspectives. Port noise is only a small fraction of the total noise the urban inhabitants are exposed to, but at the same time it can be a factor that jeopardises both the port's future development and the good living environment of their neighbours.

The port noise question cannot be solved by the port communities, the urban planning, or the environmental authorities alone. That is why a better cooperation between all the parties is necessary. In some cases, there is no available technology to solve all the problem points. That is why new innovations are needed to tackle the questions. It might be necessary to ease the noise regulations to make the co-existence of the new housing projects and the old inner-city ports possible, but it should be kept in mind that the regulations are issued to protect the public health, not to complicate the exploitation. That is why preventing and reducing noise should be given the first priority.

The goal should be to practice noise control instead of noise abatement, to work with the question proactively instead of reactively. That is why the question should be taken into account from an early phase of the planning process. Many of the problems created depend on the lack of cooperation and a proactive attitude.

This study has given only a quick look at the different perspectives from which the port noise question can be viewed. Any of the research questions could be examined more deeply. The juridical questions regarding the liability questions, the regulating of noise, the environmental permit process and the monitoring it would deserve a deeper look.

The relationship of the urban planning and port noise should involve specialists from several disciplines: acousticians, architects, psychologists, social scientists, engineers, landscape architects, designers, sound designers, sound artists, geographers, biologists, medical experts, environmental scientists, cultural scientists et cetera. For example, very little is known of the actual annoyance the noise from this type of operations is causing. There are neither reliable statistics available on the exposure to this kind of noise on population level.

Also the development of social responsibility work in the public sector in general and in ports in particular is worth further research. Developing the neighbour cooperation as a part of the port's societal integration is an interesting idea for a more applied research. The soundscape question in port environment is another interesting path to follow.

The whole maritime sector could combine its forces to tackle the dilemma of vessel noise. The effects of noise on the (marine) fauna are also a quite unexplored, if not forgotten, question.

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Annex 1: List of interviews

Magnus Lindqvist, The Swedish National Board of Housing, Building and Planning / Stockholm City Environmental and Health Administration. Face-to-face interview conducted by Janni Jensen at TFK on 14.11.2011.

Åke Mauritzson, Swedish Environmental Protection Agency. Face-to-face interview conducted by Janni Jensen at TFK on 16.11.2011.

Ari Saarinen, Finnish Ministry of the Environment. Face-to-face interview conducted by Anssi Lappalainen at Centre for Maritime Studies on 7.12.2011.

Anders Klingström, Swedish Ports Association. Face-to-face interview conducted by Janni Jensen and Maria Mustonen at TFK on 8.12.2012

Johanna Bengtsson Rydberg & Moa Ek, Swedish Environmental Protection Agency. Face-to-face interview conducted by Janni Jensen & Maria Mustonen at TFK on 20.12.2012.

Kaarina Vuorivirta, Port of Helsinki. Face-to-face interview 3.1.2012.

Tapio Lahti, TL Akustiikka. Face-to-face interview in Helsinki 3.1.2012.

Kaija Santaholma, Eteläiset kaupunginosat ry. residents' association. Face-to-face interview 3.1.2012.

Staffan Lorenz & Ann-Christine Nyberg, Stockholm City Development Administration and Klas Groth & Stefan Modig, Stockholm City Planning Administration. Face-to-face interview 10.1.2012.

Gun Rudeberg & Anne Wallinder, Ports of Stockholm. Face-to-face interview 18.1.2012.

Yrjö Vainiala, Port of Naantali. Telephone interview 23.1.2012.

Markku Alahäme, Port of Turku. Telephone interview 24.1.2012.

Bo Araskog, Logent AB. Face-to-face interview 2.2.2012.

Anna-Liisa Perttilä, Finnlines Plc, Ship Management. Email interview 6.2.2012.

Anette Broman & Sven Bomark, Stockholm County Administrative Board. Face-to-face interview 17.2.2012.

Pekka Häkkinen, Regional State Administrative Agency in Southern Finland. Telephone interview 20.2.2012.

Tony Öhman, Viking Line Abp. Email interview 23.2.2012.

Jari Huhtaniemi, City of Helsinki, City Planning Department. Telephone interview 12.3.2012.

Ellen Kaasik, Port of Tallinn. Telephone interview 14.3.2012.

Marjo Vuola, Centre for Economic Development, Transport and the Environment in Uusimaa. Email interview 27.3.2012.

Mikael Jimmerfors, TTS Port Equipment AB. Email interview 28.3.2013.

Reet Pruul, Estonian Ministry of the Environment. Email interview 2.4.2012.

Ramon Nahkur, Estonian Ministry of Social Affairs. Email interview 13.4.2012.

Peep Pobbul, Tallinn City Government, Environment Protection Department. Face-to-face interview 18.4.2012.

Björn I M Svensson, NCC. Face-to-face interview 25.4.2012.

Per Persson, Wallenstam AB. Telephone interview 4.5.2012.

Anna Mroz, Stockholm City Environmental and Health Administration. Email interview 14.5.2012.

Malin Aarsrud, Swedish Agency for Marine and Water Management. Email interview 23.5.2012.

Kimmo Hyvärinen, Katajanokkaseura residents' association. Email interview 27.8.2012.

Timo Hakala, Lloyd's Register Turku, telephone interview 14.1.2013.

Berndt Lönnberg, STX Finland Oy. Email interview 4.2.2013.

The interviews were conducted by Maria Mustonen at TFK, unless otherwise stated.

Annex 2: Expert consultations

Satu Lehtonen, Port of Helsinki, 14.5.2012.

Susann Dutt, Port of Gothenburg, 30.5.2012.

Christina Östberg, Swedish Transport Agency, 30.5.2012.

Anders Jansson, The Finnish Transport Agency, 4.8.2012.

Kirsti Tarnanen-Sariola, Finnish Port Association, 4.8.2012.

Eija Kanto, Finnish Shipowners' Association, 27.8.2012.

Cecilia Ejlertson, Port of Ystad, 5.10.2012.

Annex 3: Workshops, seminars and conferences

PENTA workshop "Future challenges of cargo and passenger flows in the Baltic Sea" at Ports of Stockholm 22.11.2011

VTI Transportforum 2012 in Linköping 12.1.2012

Stadens ljud seminar "Hamn i staden – hur kan vi samexistera?" in Gothenburg 28.3.2012

PENTA workshop "Major shifts or business as usual? Implications of the sulphur regulation for maritime transport" at Muuga Harbour 18.4.2012

Stadens ljud seminar "Akustisk design och hållbar stadsplanering" in Stockholm 14.9.2012

PENTA workshop "Port related noise and city planning at Vuosaari Harbour in Helsinki 9.10.2012

Satama 12 Port conference in Tallinn 26.10.2012

HOSANNA, "HOlistic and Sustainable Abatement of Noise by optimized combinations of Natural and Artificial means" workshop in Stockholm 10.12.2012

CityHush Dissemination Seminar "Reducing Transport Noise in Cities" in Stockholm 11.12.2012

VTI Transportforum 2013 in Linköping 9.-10.1.2013

SmartComp "Towards Green and Efficient Maritime Cluster in the Central Baltic Region" Consultation Day in Tallinn 13.2.2013

National Noise Abatement Days (Meluntorjuntapäivät) 2013 in Jyväskylä 14.3.2013

TFK's annual conference at BillerudKorsnäs in Gävle 21.3.2013

PENTA final conference "Maritime Transport in the Baltic Sea – Threats and solutions" at the Port of Naantali 16.4.2013.

In the events written with bold style, results from the study have been presented.

TFK – TransportForsK AB
Warfvinges Väg 29
112 51 Stockholm
Tel: +46 8 652 41 30
Fax: +46 8 652 54 98
Email: info@tfk.se
Internet: www.tfk.se