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ENVIRONMENTAL NOISE MANAGEMENT IN LATVIA

DOCTORAL THESIS

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ABSTRACT

Environmental noise affects a large number of Europeans day-to-day. Several studies have revealed that increased noise levels cause a negative impact on human health, both physiologically and psychologically, interfering with basic activities such as sleep, rest and communication. The World Health Organization (hereinafter - WHO) has recommended limiting outdoor night noise to L_{night} 40 dBA, however, given the trend of increased transportation, expansion of business activities and infrastructure, such limitation is not expected to be an easy task.

This thesis studies the possible solutions on how to prevent and reduce environmental noise through management practices in Europe and Latvia. The aim of the research is to deal with environmental noise issues and to develop a strategic, practice-based model for environmental noise management in Latvia, which has not been done prior to this study. To achieve the aim, the study is based on several research objectives, including a comprehensive analysis of environmental noise management policies and research on established practices in Europe and Latvia for legislation, institutional systems, society feedback management and identification of the main deficiencies of existing noise management. Empirical and statistical data analysis, documentation analysis, sociological research, and case study methods have been used for this purpose, including the analysis of both acoustic and non-acoustic aspects. The results showed that environmental noise management issues in Latvia are mainly related to high subjective noise perception, a poor understanding of environmental noise, low prioritisation and ineffective implementation of the existing noise management policies. Taking into account the mentioned factors, an integrated comprehensive and multi-level practice based environmental noise management model has been proposed. The model comprises process sub-models for national and municipal levels and a coordination model, and it takes into account and proposes improvements to current management processes. The model proposals have been approved with experts and stakeholders from state and municipal levels.

The thesis provides significant scientific and practical value, and its results can be applied on a practical level, and adapted for noise management policy planning, assessment, and implementation at state and municipal levels in Latvia. It can serve as an example for the situation analysis and also shows room for further improvements in other countries that want to develop noise management at a faster pace. These results complement and update the theoretical and management practice knowledge and outline further research directions that could contribute to more effective and meaningful noise management development.

Keywords: *environnemental noise, Latvia, noise management, practice-based management model*

CONTENTS

GLOSSARY

- A-weighted decibels

The vast majority of noise measurements made are in A-weighted decibels (dBA). The A-weighting is an electronic frequency-weighting network, which is used to simulate the human perception of different frequencies into the reading indicated by a sound level meter so that it will relate to the perceived loudness of the noise.

- Agglomeration

"Agglomeration" means a part of a territory, delimited by the European Union (hereinafter – EU) Member State, having a population in excess of 100 000 people and a population density such that the Member State considers it to be an urbanised area (Directive 2002/49/EC.., 2002).

- Burden of disease

The burden of disease associated with environmental impact is commonly measured by disability-adjusted life years (DALYs). DALYs are the sum of the potential years of life lost due to premature death and the equivalent years of "healthy" life lost as a consequence of being in a state of poor health or disability (WHO, 2011).

- Decibels

The decibel (dB) is a measurement unit in acoustics. It can be used as a measure of the magnitude of sound, changes in sound level and as a measure of sound insulation. The decibel is not an absolute unit, but the ratio of two levels expressed in logarithmic form. A 1 dB increase in sound level would normally go unnoticed in everyday life. A 3 dB increase would be barely perceptible (even though it is a doubling of sound energy). A 10 dB change in sound level is perceived as a double increase in loudness.

- Environmental noise

The term "environmental noise" is applied to summarize noise emissions originating in outdoor environments. The WHO Guidelines for community noise define environmental noise as "noise emitted from all sources except for noise at the industrial workplace" (Berglund *et al.*, 1999). However, in this dissertation, the environmental noise concept is understood and investigated in the context of the Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise (hereinafter – Directive 2002/49/EC). It defines it as "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". The Directive 2002/49/EC requires to take action on the mentioned noise sources and excludes from its scope several categories of noise, such as "noise caused by the exposed person himself, noise from domestic activities, noise created by neighbours, noise at workplaces or inside means of transport or due to military activities in military areas". The dissertation excludes from its scope leisure noise and construction noise.

- Environmental noise management

Environmental noise management is a strategic and complementary set of measures comprising the development and implementation of environmental noise control policy based on the identified problems and their assessment and aiming to prevent and reduce noise-induced negative effects on human holistic health and well-being, as well as those effect in nature (Schwela *et al.*, 2011). Noise management including assessment, planning, enforcement and control of noise.

- L_{day}

The evening-time noise indicator L_{day} is the A-weighted long-term average sound level determined over all the day periods of a year. The day is 12 hours; the default values are from 07.00 to 19.00 local time (Directive 2002/49/EC, 2002).

- $L_{evening}$

The evening-time noise indicator $L_{evening}$ is the A-weighted long-term average sound level determined over all the evening periods of a year. The evening is four hours; the default values are from 19.00 to 23.00 local time (Directive 2002/49/EC, 2002).

- L_{night}

The night-time noise indicator L_{night} is the A-weighted long-term average sound level determined over all the night periods of a year. The night is 8 hours; the default values are from 23.00 to 07.00 local time (Directive 2002/49/EC, 2002).

- L_{den}

The day-evening-night level is a descriptor of noise level based on energy equivalent noise level (Leq) over a whole day with a penalty of 10 dBA for night time noise and an additional penalty of 5 dBA for evening noise (European Environmental agency, 2001). It is calculated according to Formula 0.1.

$$L_{den} = 10 \cdot log_{10}\left(\frac{1}{24}\left(12 \cdot 10^{\frac{L_{day}}{10}} + 4 \cdot 10^{\frac{L_{evening}+5}{10}} + 8 \cdot 10^{\frac{L_{night}+10}{10}}\right)\right), \quad (0.1.)$$

where L_{day}, $L_{evening,}$ and L_{night} are respectively day, evening, and night noise levels.

- Noise and sound

"Sound" refers to the harmonic pressure variations that we hear in the air and other mediums and is an important part of our everyday world. Too much sound can be annoying, even dangerous. The term "noise" usually refers to unwanted sound. Noise, in general, is made up of sounds with a wide range of frequencies.

- Noise annoyance

Noise annoyance is an individual's subjective response to noise, a negative evaluation of one's acoustic environmental conditions, which is associated with disturbance, aggravation, dissatisfaction, concern, bother, displeasure, harassment, irritation, nuisance, vexation, exasperation, discomfort, uneasiness, distress, etc. In some cases, when a more concrete definition is needed, "noise annoyance" can also be viewed as a certain degree of long-term dissatisfaction, disturbance, or bother from the acoustic environment (Guski, 1999).

- Noise mapping

"Noise mapping" is the presentation of data on an existing or predicted noise situation in terms of a noise indicator, indicating breaches of any relevant limit value in force, the number of people affected in a certain area, or the number of dwellings exposed to certain values of a noise indicator in a certain area (Directive 2002/49/EC, 2002).

- Major airport

Major airport is an airport with more than 50 000 movements a year, including small aircrafts and helicopters (Directive 2002/49/EC, 2002).

- Major railway

Major railway is railway line with more than 30 000 trains a year (Directive 2002/49/EC, 2002).

- Major road

Major road is a road with more than 3 million vehicles a year (Directive 2002/49/EC, 2002).

- Quiet area

A quiet area is an area which is not exposed to a value of L_{den} or of another appropriate noise indicator greater than a certain value set by the Member State, from any noise source (Directive 2002/49/EC, 2002). In Latvia, a quiet area in a populated area (including in an agglomeration) is a territory in a populated area, where the limit value for noise is lower than the limit values for noise indicators – L_{night} 40 dBA, $L_{evening}$ 45 dBA, and L_{day} 50 dBA (Vides trokšņa novērtēšanas un pārvaldības kārtība, 2004).

INTRODUCTION

Background

The term "environmental noise" is applied to summarize noise emissions originating in outdoor environments. Environmental noise, the main sources of which are transportation, industry, and different other community activities, is currently becoming one of the most dominant types of environmental pollution. Transportation noise according to the European Environmental agency (2019) is ranked as the second most important environmental stressor impacting public health. Further, the trend is that noise exposure is increasing in Europe compared to other stressors (e.g., exposure to second-hand smoke, dioxins, and benzene) (Kephalopoulos *et al.*, 2016).

The effects of environmental noise closely correlate with the quality of life regarding physical and psychological health, social and economic factors, as well as overall wellbeing. Noise can cause diseases, discomfort and annoyance as well as disturbance of communication. However, the most significant noise impacts are those affecting sleep patterns. For instance, in Europe at night almost 34 million people may be exposed to long-term average road noise levels exceeding 50 dB (European Commission, 2016). Because of this, the WHO has recommended the target limit of outdoor night noise levels at an annual average of L_{night} 40 dB (WHO, 2009), but the EU requires mitigation action planning in areas where the noise exceeds 50 dB at night time and 55 dB during daytime (Directive 2002/49/EC, 2002).

According to European level environmental noise mapping data Latvia and the Rīga agglomeration (EEA, 2019) is one of the noisiest areas in Europe, including number of people subjected to high noise levels (over 70 dBA daytime). There has also been negative feedback from the public regarding noise issues, and several cases on noise issues have been brought to court by residents.

Rapid urbanization, industrialization, and increased automotive/aviation travel are the main factors contributing to increasing noise impacts and their effects, especially in developing countries (Schwela *et al.*, 2011). Initially, environmental noise was considered mainly a problem associated with the urban environment. It is estimated that approximately 40% of the population living in the largest cities in the EU-27 countries may be exposed to long-term average road traffic outdoor noise levels exceeding 55 dB. However, expansion of business activities and infrastructure (such as roads and industry) are becoming critical factors contributing to increasing noise levels outside cities as well. Environmental noise mapping data shows (EEA, 2015) that more than 84 million people are exposed to L_{den} noise levels over 50 dB inside agglomerations and 38 million people - outside agglomerations. It should also be noted that smaller, suburban towns are usually places of residence for people who work daily in large urban centres and want to get away from noisy environments, and want to spend time peacefully.

Attention should be paid not only to the reduction of noise in "black spots" (where noise level exceeds the threshold) such as airports and motorways, but also on noise prevention, as well as on moderate level "grey zones" (i.e., zones where the noise level is elevated but is still below the threshold), because there might be a corresponding increase in the moderate level "grey zones" in case of tackling issues in "black spots" (Buck, 2016).

Due to the factors mentioned above, there is a need for comprehensive and integrative and appropriate approaches for the management of overall noise impacts in order to deal with them in the most effective manner. This should be done taking into account the best practice experience, along with the latest data on the social, economic, and environmental dimensions and their integration aspects, as well as planning and development perspectives. The effective noise management should involve both, acoustic and non-acoustic factors as well, because only about one-third of noise caused annoyance can be explained by acoustic properties of noise. (Suau-Sanchez *et al.*, 2011; Guski, 1999)

Adequate, sound environmental noise management policy that ensures safe and healthy acoustic conditions through preventing and reducing the negative effects of noise is essential for creating a wholesome living environment. In order to ensure that it is effective, noise policymaking must be broad and occur at different governance levels – international, national, and local (Murphy & King, 2010). Developing a coherent noise management policy at different levels and applying a cross-sectoral and interdisciplinary approach will allow better coordination of noise mitigation measures throughout the

globe and consequently establish better noise management approaches in each country (Murphy & King, 2010).

Studies on environmental noise management at the different management levels in the EU and other countries (Weber *et al.*, 2011; Schwela *et al.*, 2011; Finegold *et al.*, 2012; Schwela *et al.*, 2008) have demonstrated deficiencies in established noise management both at the municipal, and the national level. In addition, studies of noise management conditions carried out in EU member states that joined EU during the fifth and sixth enlargement or so-called "Eastern Enlargement" during the years 2004-2007 (that includes the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, Bulgaria, Romania, as well as Cyprus and Malta) (hereinafter – Eastern enlargement countries) have revealed that, in comparison to the other EU countries (where noise management policies have developed systematically and steadily since the last decades of the previous century), EU Eastern enlargement countries have developmental gaps in terms of noise assessment and its quality (Belojevic *et al.*, 2012).

The scope of the thesis

In Latvia so far there have been no comprehensive or integrative studies on the subject of noise (as a form of environmental pollution) management either at the municipal nor at the national level, including policy planning and factual problem case analysis on the development of transportation and industrial noise sources. There has been little research done on environmental noise management in towns and villages in Europe, even though these are the predominant types of settlements in Latvia (as it is also in several other countries). The situation that noise issues are becoming more topical not only in cities but also outside of them was highlighted at a high-level European Commission (hereinafter – EC) conference in April 2017.

The Author's previous research on the topic (for instance, Master thesis) has demonstrated a lack of efficient and effective noise management at both the municipal and state level. Therefore, this PhD thesis aims to develop a practice-based environmental noise management model for Latvia that could be practically adaptable and used as an environmental noise policy-making tool. The model is to be based on analysis of noise management practices in Latvia and of the best practice analysis of other EU countries, especially on the experience of those countries that have a similar background, i.e., neighbouring countries and other EU Eastern enlargement countries. These countries have been chosen for the best practice adoption study because of the need for Latvia to develop environmental noise management at a fast rate. Latvia has developed the framework around 2004 when joining EU, and the example of other countries that also have to develop their frameworks recently can show efficient ways of how noise management has developed over this short time period and the comparison with countries of similar background can lead to ascertain better management practices. These countries were chosen because of the timing of their accession to the EU in order to see how the institutional systems are constructed and what best practices have been introduced in other countries in this limited period. Meantime, the research in the theoretical part also analyses the general noise management practice in the United Kingdom and the Netherlands – countries that have developed environmental noise management already for five decades and achieved good results.

Within the scope of this doctoral research, the Author will analyse the existing legislation on environmental noise management and the institutional system for its implementation, noise policy planning practice, review practical noise management cases, as well as investigate schemes that are used for dealing with environmental noise and with the issues raised by society in this respect. These studies conducted by the Author will include analysis of Latvian and Baltic States legislation and a comparison of their institutional systems to assess compliance with EU directives, to find any possible flaws and to identify best practice examples from other countries. The Author will carry out a comparative analysis of the results obtained with the main findings of international studies on noise management institutional aspects in EU Eastern enlargement countries, and, as a result, will propose a common noise management institutional scheme for EU Eastern enlargement countries. The Author will proceed with an analysis of the existing policy planning documents at the municipal level in several Latvian municipalities in order establish the scope of functions undertaken by Latvian municipalities in the area of noise management.

The PhD research will also comprise practical investigations of specific noise management issues in Latvia through case studies of industrial, road and railway noise issues, since those sources according to environmental noise maps are the biggest noise pollution emitters in Latvia (European Commission, 2019). The research will also include an analysis of the Environmental Impact Assessment (hereinafter – EIA) efficiency and effectiveness, thus investigating the fulfilment of state functions on environmental expertise. The noise source manager activities will be studied in cooperation with the company Latvijas dzelzceļš (Latvian railway) when participating in the implementation of the EU LIFE+ program project "Innovative solutions for railway noise management".

The results of the practical and research activities the Author will use identify the main deficiencies and faults in the existing noise management framework in Latvia. The information on the existing situation and problem issues then will serve as a basis for further recommendations for improving the current noise management policies and practices as well as for developing a noise management model that could be used not only in Latvia but also could be adapted for other states with similar noise management issues.

The PhD research focuses exclusively on environmental noise as an environmental pollution management issue. In this dissertation, the environmental noise concept is understood and investigated within the context of Directive 2002/49/EC. The definition of Directive 2002/49/EC is chosen as a scope of the dissertation because it sets the mandatory legal requirements for the EU member states for noise management, and it generally focuses on the permanent noise that causes adverse health effects. The PhD thesis does not look at leisure noise in detail, except for showing the scope of municipal level noise management. It also excludes noise from siren-type alarms that are used to ensure public safety and military activities in military areas. The Thesis does not investigate indoor noise or building acoustic requirements. The dissertation also excludes research on infrasound, ultrasound, and vibrations. The doctoral research does not investigate noise-causing activities from the perspective of private businesses, technical solutions, or further research on wildlife impacts.

The Thesis shows research that were done throughout the years 2011 – 2019, thus showing the environmental noise management and its development in the medium term in Latvia. As the doctoral research is about environmental noise management, the practical situation problem-cases provide the background information where attention should be focused on environmental noise management and shows factors impacting public attitudes. The main conclusions on practices applied, planning document and legislation content, were rechecked in approbation interviews or in latest documents, thus identifying improvements within the mentioned period. Therefore, data gathered throughout the research is still valid for proposals on environmental noise management improvements in Latvia and the development of a practice-based environmental noise management model in Latvia. This approach also allows detecting in the legislation and policies to be determined, thus, making it possible to conclude on developments made so far.

Aim and objectives

This PhD thesis aims to study environmental noise management issues and to develop a strategic, practice-based model for environmental noise management in Latvia.

The objectives of this PhD thesis are as follows:

1. To justify the need for the improvements of environmental noise management at different governance levels, based on theoretical studies of environmental noise as environmental pollution.
2. To analyse the established legislative, institutional and feedback management frameworks in the area of environmental noise in Europe and Latvia.
3. To study and analyse environmental noise problem situations in Latvia in order to assess environmental noise management from empirical and non-acoustical points of view and on a multi-level approach basis.
4. To develop a practice-based model for environmental noise management in Latvia based on the research done on the subject, including proposals for improving environmental noise management processes in Latvia.

Hypothesis

Environmental noise management in Latvia can be developed by:

- Learning from and adopting the best practice used in EU countries to manage environmental noise;
- Assessing and taking into account national and local deficiencies regarding environmental noise management;
- Developing a practice-based integrative noise management model that consists of two key components – a complex process model that describes horizontal noise management at both national and municipal levels, and a coordination model for vertical integration.

Author's contribution

As the PhD thesis focuses on providing management solutions, the Author's contribution is as follows:

- The Author performs a complex, integrative analysis of environmental noise related problem situations (cases/practices) in Latvia based on engineering and other empirical data available, statistical data, information from documents, including, policy documents, legislative regulations, supplementing them with information on public attitudes (on how society perceives noise-related issues, situations, and solutions). Thus, the Author provides a complex and integrative combination of acoustical and non-acoustical data and information that allows providing solutions on how to develop noise management and, possibly, reduce public complaints;
- The Author analyses Latvia's municipal planning documents from the aspects of integrating environmental noise management;
- The Author describes environmental noise management from the institutional and legislative points of view in Latvia and other EU Eastern enlargement countries, providing comparative analysis, as well as designing a common institutional management model for EU Eastern enlargement countries;
- The Author identifies aspects of noise management in other European countries that are not used in Latvia and could be beneficial for environmental management;
- The Author performs a complex, integrative analysis of the overall situation in Latvia based on the analysed noise problem cases and practices. The Author provides systematic, systemized and integrative detection of noise management deficiencies in Latvia from all studies, as currently in Latvia there are separate case studies performed, but they are not systemized and analysed together in a complex manner.
- The Author develops a systemised, practice-based management model, including proposals for upgrading currently used management processes.

Innovation aspects

The innovative aspects of this PhD thesis are demonstrated by the following elements:

- For the first time, a comprehensive, practice-based noise management model for the European community and for Latvia has been developed and characterized in detail, taking into account national noise management issues, acoustic and non-acoustic factors, and public attitudes, as well as practice examples of other countries. The model itself could further adapted in other countries as it consists of main environmental management processes at each management level;
- For the first time, an environmental noise management institutional model for EU Eastern Enlargement countries is described;
- This is the first comprehensive and complex research done on the actual environmental noise management issues in Latvia, including a comparative analysis of the situation in the Baltic states and other EU Eastern enlargement countries.
- The Thesis proposes on how to speed up environmental noise management in European countries that joined the EU after 2004 based on the practice that other countries have already used approaches to meet the requirements of the EU Directive 2002/49/EC which applies to all EU member states in the field of environmental noise.

Approbation of results

The results are approbated through 15 publications and participation in 19 international and national conferences. The results of this PhD research are published in indexed journals "NoiseHealth" and "European Integration Studies" and in several international conference proceedings. Six publications and three abstracts are available in the scientific databases, such as Scopus, EBSCO, Web of Science. One publication is included in the EC Joint Research Centre database. Another six publications are available at international conference proceedings.

The author has been awarded a prize at the 10th International Congress on Noise as a Public Health Problem for the best student poster.

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1. ENVIRONMENTAL NOISE AND ITS EFFECTS

Environmental noise is a critical environmental stressor and exposure to it causes multi-disciplinary and cross-sectoral effects. Figure 1.1. represents the most common noise exposure effects on humans and their causative pathways. Noise can cause disturbances in sleep, activities, and communication that can cause annoyance through emotional and cognitive responses and psychological stress reactions, as well as increase health effects of certain disease risk factors (for instance, blood pressure, cardiac outputs) and could be as a catalyst of cardiovascular diseases (for example, ischemic heart disease, hypertension, stroke, etc.) (Babish, 2012).

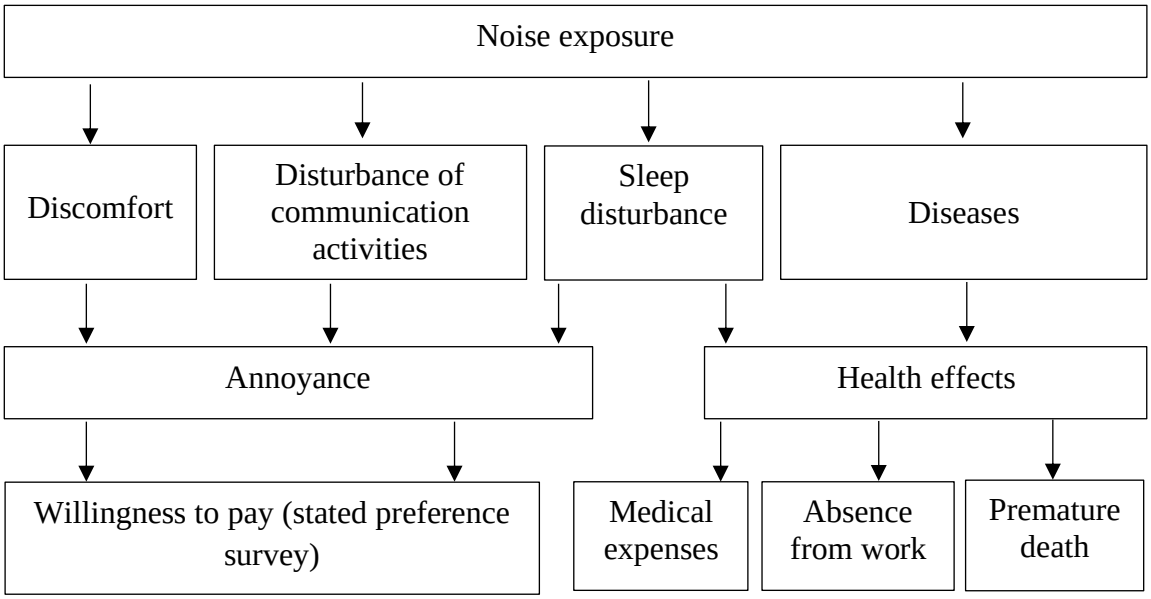

Figure 1.1. Effects of noise exposure (Gerike *et al.*, 2012)

Figure 1.1. illustrates that noise causes physical and psychological discomfort and disturbance, sleep disorders and diseases, that further lead holistic health effects and annoyance that has diverse socio-economic impacts. For some of the noise associated diseases, sufficient evidence is already available. However, some should be taken into account under the precautionary principle and be studied further.

1.1. Health impacts

Environmental noise, as an important environmental stressor, has diverse holistic health effects on humans. The most frequent noise-induced effects are noise annoyance and disturbance, followed by the stress responses of the neuroendocrine system, changes of physiological functions, and the diseases associated with these factors. This is illustrated in Figure 1.2.

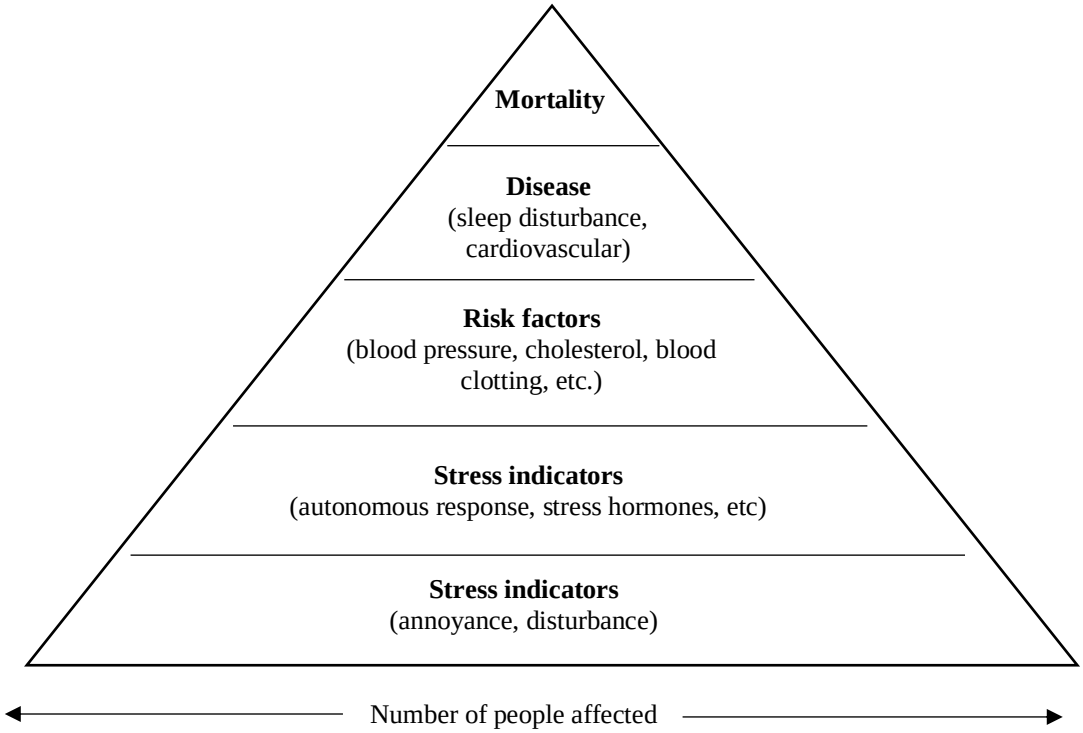

Figure 1.2. Severity of health effects of noise and number of people affected (WHO Regional office for Europe, 2011)

Many studies carried out all over the world have found evidence of noise-related annoyance, sleep disturbance, cardiovascular disease and increased blood pressure (WHO Regional office for Europe, 2011; Ndrepepa & Twardella, 2011).

1.1.1. Diseases and risk factors

Studies carried out in the United Kingdom give some evidence on the association between environmental noise exposure and hypertension and ischemic heart diseases, however further studies are required to explore gender differences and the effects of day and night time exposure (Stansfeld & Crombie, 2011). Recent estimation of the total burden of disease from road traffic noise exposure in the Netherlands has shown a clear link between it and myocardial infarction, though it is applicable just for a small proportion of the total research group (Ndrepepa & Twardella, 2011).

Research on traffic noise-induced health effects in the Czech Republic, Serbia, Slovenia and Lithuania show an indication of the relationship between noise and hypo-dynamic effects (Argalášová-Sobotová *et al.*, 2013), as well as between noise annoyance and increased hypertension (Bendokiene *et al.*, 2012; Argalášová-Sobotová *et al.*, 2013). Data from other traffic noise studies shows that noise may be related to increased heart rate (Zijlema *et al.*, 2016) as well as increased hypertension (Bendokiene *et al.*, 2012; Argalášová-Sobotová *et al.*, 2013; Zeeba *et al.*, 2017). Another cross-sectional study of road traffic noise impact on pregnant women in Lithuania has proven that high hypertension risk exists already at noise levels of 51-60 dB (Argalášová-Sobotová *et al.*, 2013). Due to this, the WHO has advised a target limit of outdoor night noise levels at an annual average of 40 dB (WHO, 2009). However, the EU requires the minimization of the noise level in areas where levels exceeds 50 dBA at night time and 55 dBA during daytime (Directive 2002/49/EC, 2002).

Researches also showed an increased risk of stroke and coronary heart disease for people being exposed to aircraft noise and road traffic noise with L_{den} in the range of approximately 52-77 dBA (Babich, 2014; Mūnzel *et al.*, 2014).

Other research shows that environmental noise can cause migraine headaches (Kutlu *et al.*, 2010), peptic ulcer disease, irritable bowel syndrome, cognitive effects and speech impediments (Eglīte *et al.*, 2008; King & Davis, 2003).

1.1.2. Feelings of discomfort

Another important issue regarding noise is an annoyance that can be viewed as an indicator of negative reactions to noise or interfered well-being, and may also contribute to the occurrence of health issues mentioned above. People annoyed by noise may experience a variety of negative responses, such as anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation, stress-related psychosocial symptoms such as tiredness, stomach discomfort and stress (WHO Regional office for Europe, 2011). In a study conducted in Macedonia (Ritkovska *et al.*, 2009), 13% of respondents reported a high and 33.5% moderate level of annoyance at noise exposure levels L_{day} more than 60 dB. Another research on the topic (Bluhm *et al.*, 2004) reveals that 13% of respondents are frequently annoyed by road traffic noise if L_{eq} 24 hours a day are over 50 dB. The research on noise disturbance (Hume *et al.*, 2012) demonstrated that the prevalence of both annoyance and sleep problems is higher when bedroom windows are street facing and that people living in apartments have more sleep problems compared to people living in detached or semi-detached houses. During the night-time, annoyance was reported with exposure to L_{night} above 46 dB (Ritkovska *et al.*, 2009).

People classify construction activities (34% of answers), road traffic (24%), and leisure/entertainment activities (18%) as the most annoying noise sources (Ritkovska *et al.*, 2009). However, noise annoyance ratings do not depend only on acoustical factors. Noise level itself accounts only for 10–25% of an individual's reaction to noise (Job, 1996). The other non–acoustical factors can be viewed as demographical (satisfaction with the place of residence, type of transportation used, number of people in the household, possibly also age, etc.), personal (noise sensitivity, attitude toward the noise source, etc.), social (trust of authorities, general evaluation of noise source, possibly also previous noise experience, etc.) and situational (house orientation, meteorological conditions, time of the day, building insulation, possibly also media coverage and distance from the noise source, etc.) (Laszlo *et al.*, 2011).

1.1.3. Sleep disturbance

One of the most important effects often caused by environmental noise is sleep disturbance. This includes arousals, awakenings, longer falling-asleep periods, insomnia, and other effects. A study conducted in Oslo showed significant relationships between noise annoyance at night and sleeping problems, as well as strong links between these factors and pseudo neurological complaints (Fyhri *et al.*, 2010). Studies on the subject confirm noise-induced arousals even at relatively low noise levels (Hume *et al.*, 2012). According to WHO (WHO, 2009), also other adverse health effects are detected already at the levels above 40 dBA L_{night}. This includes self-reported sleep disturbance, insomnia, and increased use of medication. Research carried out in Sweden (Bluhm *et al.*, 2004) has shown frequently occurring sleep disturbance for 23% of respondents at L_{eq} 24 h level over 50 dBA and 13% sleep disturbance complaints from respondents living in areas with at levels L_{eq} 24 h level less than 50 dBA. The researchers also found a positive exposure-response relation for sleep disturbances in different exposure categories. In cases when noise levels exceed 55 dBA during the night time, this exposure can cause not only sleep disturbances but also cardiovascular effects and also may increase stroke risk in the elderly (Hume *et al.*, 2012). However, there is a lack of studies that demonstrate a long-term causal linkage for noise-induced sleep disturbance with cardiovascular disease or other long-term health effects.

In addition to the most common noise exposure effects as mentioned above, it is of utmost importance to assess the noise in combination with other environmental stressors such as air pollution and chemicals that can cause complex impacts and that still are rarely considered in epidemiological studies (WHO Regional office for Europe, 2011). For example, it is assumed (however, it is not proven with certainty) that noise increases cardiovascular morbidity, but it is well known that air pollution of certain compounds is well established to influence cardiovascular diseases. As air pollution and noise usually occur in urban areas, studies on noise impacts on cardiovascular health should consider air pollution exposure as a possible confounding factor (Schwela *et al.*, 2005). Moreover, there may be co-benefits of integrated noise and air pollution (including greenhouse gases) reduction, especially taking into account that air and noise pollution sources can often be the same (Schwela *et al.*, 2008).

1.2. Socio-economic impacts

Environmental noise causes significant socio-economic effects. These are related to increased amounts of medical expenses, productivity loss, absence from work, decrease in property value, as well as the costs associated with different noise control measures.

Figure 1.1. (see above) graphically illustrates the main noise exposure effects and potential associated expenses that can affect individuals, businesses, and even the national economy. It shows that the economic impact of noise annoyance could be expressed as a willingness to pay for better environmental quality to avoid the nuisance. Noise-related diseases, stress, and risk factors increase the level of expenses for medicine and medical services. The costs of noise caused absence from work, and premature death has significant impacts on businesses and the global economy. Together they express the potential years of life lost or DALYs.

According to the WHO (WHO Regional office for Europe, 2011), the estimated DALYs from environmental noise in the EU countries are 60 000 years for ischemic heart disease, 45 000 years for cognitive impairment of children, 903 000 years for sleep disturbance, 21 000 years for tinnitus and 587 000 years for annoyance. The sum of all impacts is considered 1.0 – 1.6 million DALYs, which can significantly influence the global economy.

In Latvia, the only agglomeration in the context of EU legislation is Rīga. It is evaluated that in total, 74 552 residents have noise caused sleep disturbances, and 147 236 residents are committed to acoustical discomfort that is mostly caused by motorized auto transport (ELLE, 2017). The total DALY index sums up to 3 876 years of annoyance in Rīga agglomeration or on average each resident loses two healthy days per year (see Table 1.1.). The biggest impacts are created by road noise; however, some parts of the agglomeration are also impacted by railway and air traffic noise. (ELLE, 2017)

Table 1.1. Noise discomfort and sleep disturbances in Rīga agglomeration (created by the Author, 2017 using data from ELLE, 2017)

Parameter	Noise source		
	Road traffic	Rail traffic	Air traffic
Number of people that are subjected to noise discomfort (A)	137758	3533	5945
Number of people that are subjected to serious noise discomfort (HA)	56957	1799	514
Number of people that are subjected to sleep disturbances (SD)	70275	4046	231
Number of people that are subjected to serious sleep disturbances (HSD)	30219	1499	37
DALY HA	1139	36	10
DALY HSD	2155	105	10
DALY coronary heart disease	445	15	1
The total sum of DALY index	3699	156	21

The studies on how people value environmental conditions through the willingness-to-pay assessment show that willingness to pay (hereinafter – WTP) for the reduction of 1 dBA noise between 2-34 EUR per every dBA. However, most of the studies show the WTP to be in the range between 2-9 EUR, which is approximately 0.27% – 0.31% of the total household annual income (Barreiroa *et al.*, 2005). Research on the effects of airport noise exposure on housing prices shows that the average noise depreciation index (hereinafter – NDI), which is defined as a loss in property value per one-decibel change in noise exposure, is on average between 0.45 % and 0.67% (Nelson, 2004; Bristow *et al.*, 2011). Up to date researches also confirm that transport noise levels can significantly impact rent prices – the calculated apartment rent discount (using hedonic pricing method) can be from 0.4% per dBA up to 9.6% per dBA for especially noisy areas if noise is a categorical factor (Kuehnel & Moeckel, 2020).

1.3. A brief summary of Chapter 1

Environmental noise is pollution and a critical environmental stressor. Exposure to it causes multi-disciplinary and cross-sectoral effects. Many studies carried out all over the world have found evidence of noise-related annoyance, sleep disturbance, risk factors, and cardiovascular diseases. The most important noise induced effect is sleep disturbance. This includes arousals, awakenings, longer falling-asleep periods, insomnia, and other effects. According to WHO (WHO, 2009), adverse health effects are detected already at the levels above 40 dBA L_{night}. 13% of respondents reported a high and 33.5% moderate level of annoyance at noise exposure level L_{day} more than 60 dB, but during night-time, annoyance was reported with exposure to L_{night} above 46 dB (Ritkovska *et al.*, 2009). However, noise annoyance rating does not depend only on acoustical factors as it only explains for 10–25% of an individual's reaction (Job, 1996). Also, noise pollution, in combination with other environmental stressors such as air pollution and chemicals, can cause complex impacts that are needed to be further studied in epidemiological studies. Noise also causes socio-economic impacts that can be characterized through the willingness to pay for better environmental quality to avoid the nuisance, increased expenses for medicine and medical services, losses caused by absence from work and premature death (potential years of life lost), etc.

2. ENVIRONMENTAL NOISE POLICY AND MANAGEMENT

2.1. The topicality of environmental noise pollution in Europe and Latvia – a need for pollution management

2.1.1. Exposure

An assessment of the exposure of European citizens to noise is carried out regularly in the EU Member States, covering 467 agglomerations (where roads, railways, airports and industrial installations are considered), 86 major airports, as well as 186 600 km of major roads and 44 320 km of major railways outside agglomerations. These numbers, though, may are subjected to change, due to socio-economical and demographical changes in EU member states.

Road traffic noise, both inside and outside agglomerations, remains the most dominant source affecting human exposure above the reporting noise levels defined by Directive 2002/49/EC, with an estimated total (inside and outside agglomerations) of around 100 million people (nearly 70 million inside and 30 million outside agglomerations) being exposed to road traffic noise above 55 dB L_{den}. Railways are the second most important noise source with a total of more than 18 million people (around 10 million inside and 8 million outside agglomerations) exposed above 55 dB L_{den}, followed by aircraft noise with a total of nearly 4 million people (nearly 3 million inside and 1 million outside agglomerations) exposed above 55 dB L_{den}. Industrial noise within urban areas exposes around 1 million people to noise levels above 55 dB L_{den} (European Commission, 2017). This is illustrated in Figure 2.1. This shows that expansion of business activities and infrastructure (such as roads or industry) is becoming a critical factor contributing to increased noise levels both inside and outside cities, thus showing that noise is not only a problem of big, urban agglomerations. It should also be noted that small, suburban towns are usually places of residence for people who work daily in large urban centres and have chosen to live away from all the noisy environments, and want to spend time peacefully.

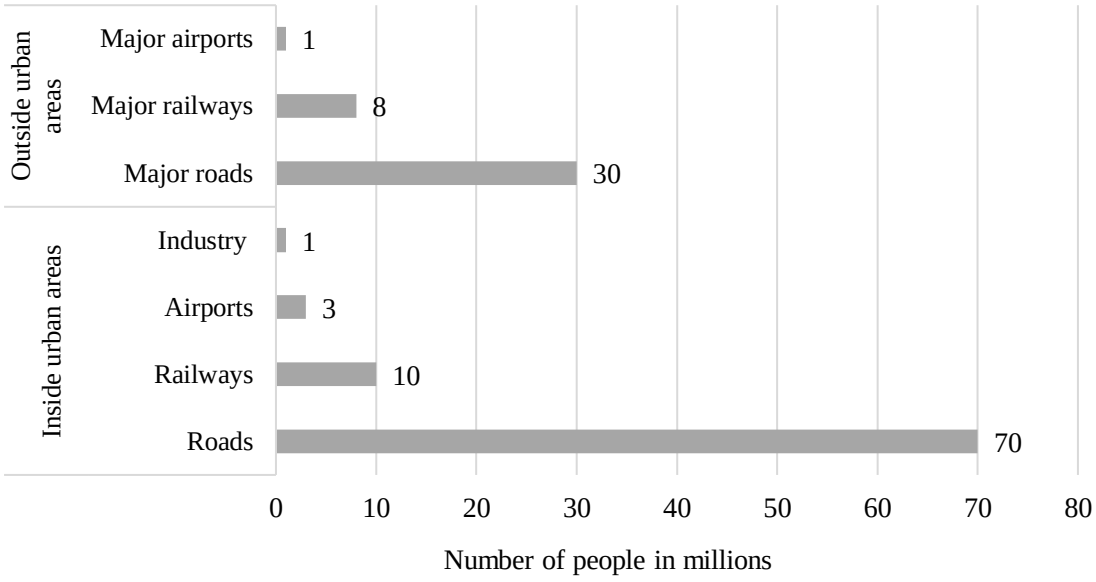

Figure 2.1. Noise mapping data - estimated number of people exposed to L_{den} above 55 dBA inside and outside agglomerations categorized by noise sources (European Commission, 2017)

Exposure data implies that 14.1 million adults are severely annoyed by environmental noise, 5.9 million adults are highly sleep disturbed, 69 000 hospital admissions and 15 900 cases of premature mortality that occur annually are caused by environmental noise. This data is limited to agglomerations, roads, railways, and airports falling under the scope of Directive 2002/49/EC. The total exposure and health impacts are, therefore, even higher. (European Commission, 2017)

The mapping results show that L_{den} and L_{night} noise levels that exceed 55 dBA, show that in five countries - Latvia, Lithuania, Bulgaria, Spain, Iceland, and Cyprus – road noise over 55 dBA impacts more than 29.5% of the total population, thus showing the highest noise levels in Europe in this aspect (see Figure 2.1.). The data might be related to the small number of agglomerations and the globalization tendencies (biggest amount of population living in these few agglomerations), as well as it may relate to the national methods used for noise pollution measurements (European Commission, 2017).

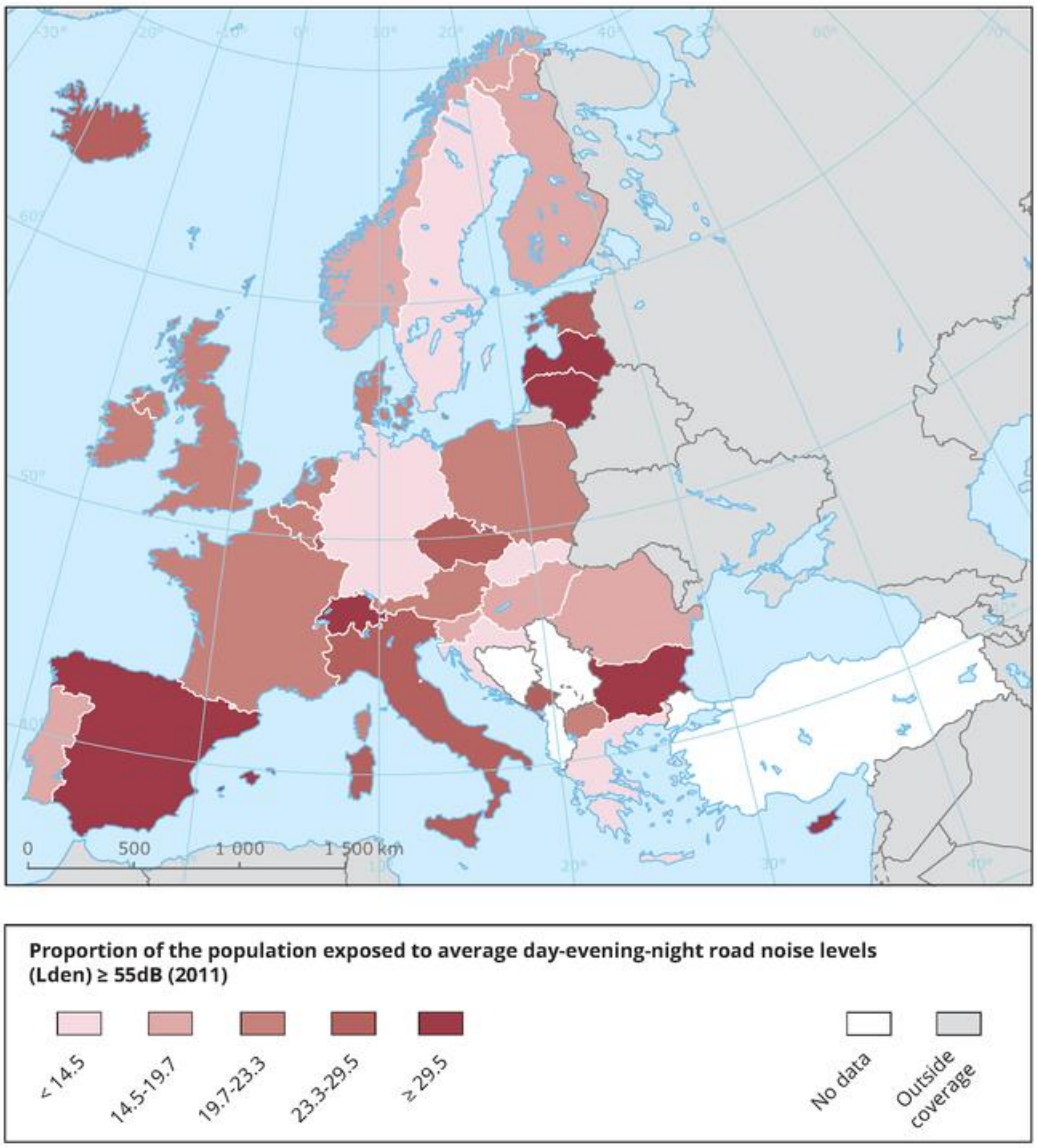

Figure 2.2. Proportion of population exposed to noise (L_{den}) >55 dBA according to 2012 noise mapping exercise (EEA, 2018)

The data above is gathered from a 2012 noise mapping exercise, even though not all countries submitted their data. The situation is even worse regarding 2017 data – only 18 member states (up to 2019) have submitted data. Therefore, these data cannot be used for comparison with previous environmental noise mapping. Data on countries that have submitted the latest noise mapping data are illustrated in Figure 2.3.; however, they represent the shares of exposed inhabitants only in agglomerations. Figure 2.3. shows that Latvian, Austrian, Bulgarian agglomerations have the highest shares of exposed inhabitants.

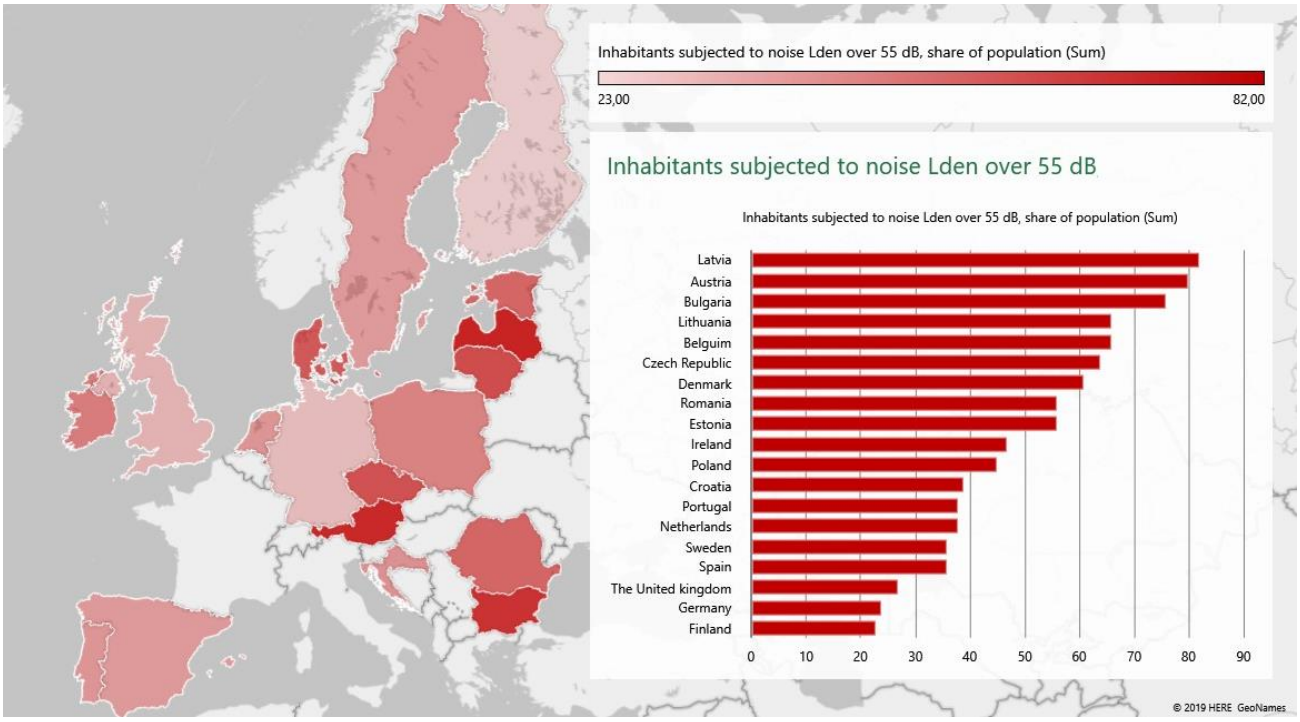

Figure 2.3. Data representation on the proportion of the population exposed to average day-evening night road noise levels (L_{den}) over 55 dBA in noise agglomerations in 2017 (in countries which have submitted data) (created by the Author using EEA, 2019)

Analysis of the noise mapping data array also allows showing the distribution of the total share of noise-exposed inhabitants in noise agglomerations per country on L_{den} and L_{night} that are illustrated in graphic form in the Annex I of the thesis.

In order to see which are the noisiest agglomerations in Europe, top 10 lists (according to available EEA data) have been developed (see Figure 2.4. and Annex II). These lists show that Rīga (Latvia), along with Plovdiv (Bulgaria), Pitesti (Bulgaria), Siauliai (Lithuania), Vienna (Austria), etc. is one of the top 10 agglomerations regarding the largest environmental road noise exposure in EU L_{den} and L_{night} (over 55 dBA and 50 dBA, respectively). In order to see if these data show rather low, but permanent noise levels in these agglomerations or the agglomerations are very noisy in terms of environment noise, data on L_{den} and L_{night} noise levels over >70 dBA and >60 dBA, respectively, were also analysed. The data showed that Rīga, Vienna, Pitesti are also on the top 10 loudest road noise agglomerations in respect of population subjected to mentioned noise levels. Rīga agglomeration is also in the list of top 10 agglomerations regarding L_{den} and L_{night} in terms of industrial noise. However, industrial noise exposure in the EU, in general, is much lower. All the top 10 agglomerations in terms of railway noise are located in Germany.

According to the environmental noise mapping data in 2017 (EEA, 2019), the main noise sources in Latvia in priority order (taking into account their exposure) are road, rail and industry. Aircraft noise has the least exposure.

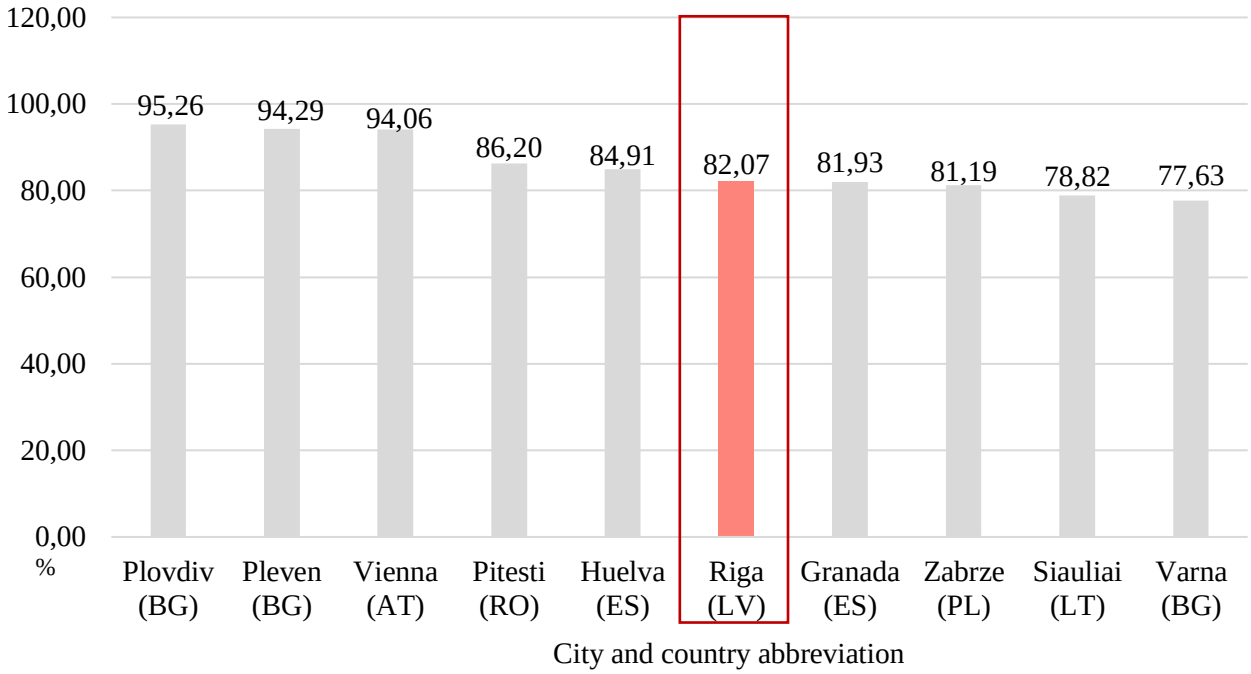

Figure 2.4. Environmental noise agglomerations with the largest share of impacted inhabitants regarding road noise (top 10) by L_{den} values over 55 dBA in EU counties according to EU noise mapping data (created by the Author, using EEA, 2019)

In order to see if noise mapping data reflects the real situation in Rīga agglomeration, Rīga Stradiņš University (Skreitule *et al.*, 2016) have performed a study. Noise level data obtained during environmental noise measurements in several Rīga neighbourhoods were compared with the data of the Rīga noise map. It was found that the average noise levels obtained during the measurements are generally equal to or lower than the ones shown in the noise map (by 5 dBA or 10 dBA in a few cases). The differences between measurement results and noise maps could be explained by the fact that the so-called "worst case scenario" was taken into account, for instance, higher possible traffic flow, the maximum number of vehicles, etc. Measurements may have been made on days when this "worst case scenario" conditions were not fulfilled. It is also important to note that in the study noise measurements were only made on one day, but the noise map shows the noise level for the whole year regardless of the season, weather, etc.

G. Licitra and E. Ascari (2014) conducted a study on noise levels and noise annoyance in European countries and agglomerations, using an indicator G_{den} (that shows noise levels in energy equivalent level of day, evening and night (L_{den}) when normalized for the proportion of the population exposed) revealing that the highest values, are found in Slovakia, Hungary, Ireland, Latvia, Czech Republic, Norway and Bulgaria and that "a large part of higher values are detected in South and Eastern Europe." These values also correlate to highly annoyed and highly sleep disturbed percentages of inhabitants (see Figure 2.5.).

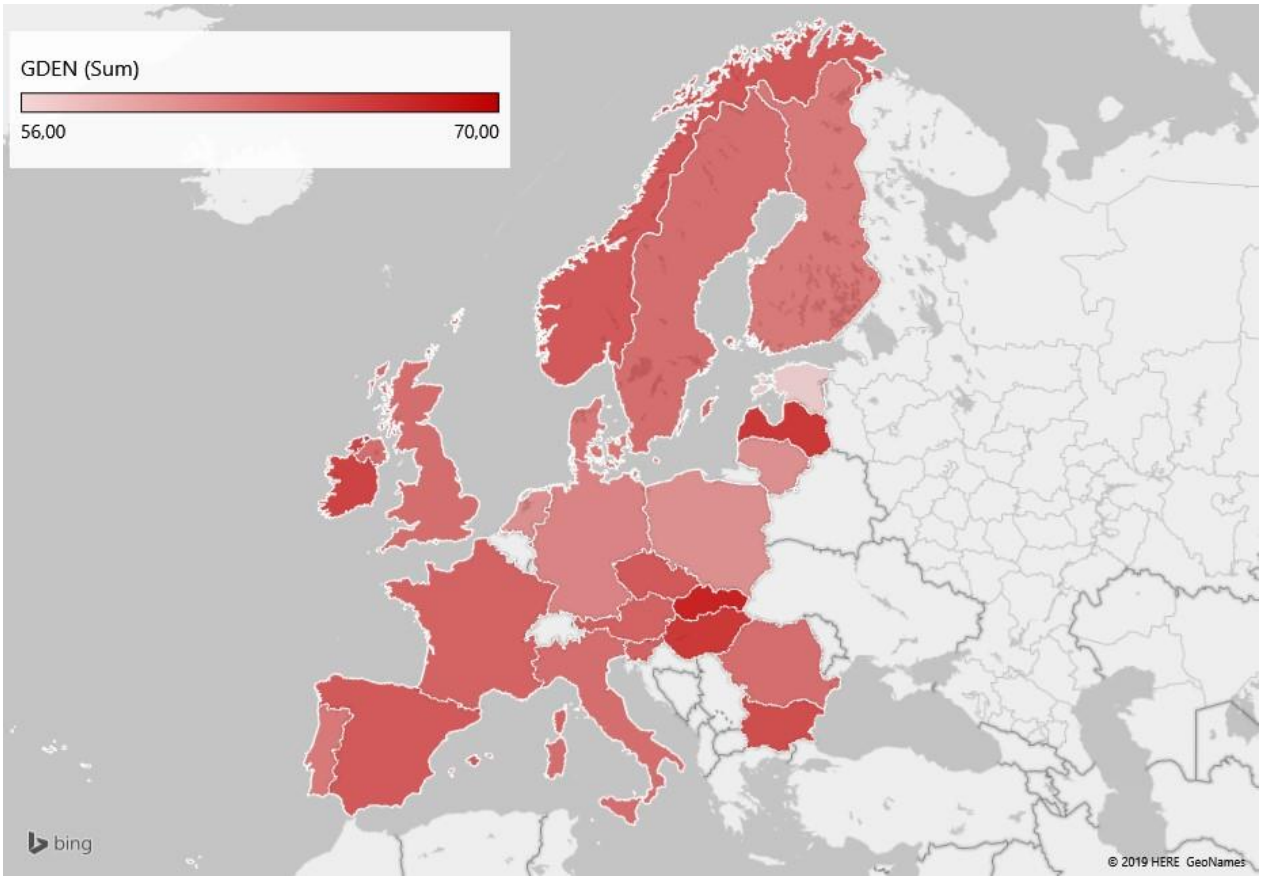

Figure 2.5. Data representation on average G_{den} values in Europe (created by the Author using Licitra & Ascari, 2014)

The authors (Licitra & Ascari, 2014) show that much of this annoyance is related to insufficient noise management and that countries could provide improvements through raising awareness on noise and health issues, and improving national legislation, for instance, including limits for traffic noise, especially for old infrastructure.

2.1.2. Europeans' views on noise issues

"The European quality-of-life surveys, carried out every four years, are unique, pan-European surveys examining both the objective circumstances of the lives of European citizens and how they feel about those circumstances and their lives in general. The last (fourth) survey was conducted in 2016–2017, involving nearly 37 000 citizens from all EU Member States and the five candidate countries (Albania, Montenegro, Serbia, North Macedonia and Turkey). Respondents were asked whether they had major, moderate, or no problems with noise. Almost one third (32%) reported problems with noise (ranging from 14% to 51% in individual countries), mainly in cities or city suburbs (49%). A 2010 survey of the then 27 countries in the EU, requested by the EC, showed that 80% of respondents (n = 26 602) believed that noise affects their health, either to some or to a great extent. A Eurobarometer report on attitudes of European citizens towards the environment compiled opinions on various environmental risks from almost 28 000 respondents in 28 EU countries. Results showed that for 15% of respondents, noise pollution is one of the top five environmental issues they are worried about. Furthermore, 17% of respondents said that they lack information about noise pollution. Data on the perception of specific sources of environmental noise as a problem are not available for the entire WHO European Region. Nevertheless, some countries – including France, Germany, the Netherlands, Slovakia and the United Kingdom – conduct national surveys on noise annoyance, either regularly or on demand. According to these large-scale surveys, road traffic noise is the most important source of annoyance, generally followed closely by neighbour noise. Aircraft noise can also be a substantial source of annoyance. Railway noise and industrial noise are enumerated less frequently". (WHO, 2018)

Comparing these data with environmental noise mapping data (EEA, 2019), it can be concluded that road noise is the most widespread and annoying noise source; however, this is not true with other noise sources. For instance, railway is the second largest noise source in regard to number of impacted people, but its impacts are less annoying.

Comparing different environmental pressure and pollution, as well as urban quality indicators, multicriteria analysis of environmental perception in 33 European countries (that characterize attitude toward quality of urban life) also shows that for residents the most important factors for the environmental perception are noise and light pollution along with availability of green areas. (Carlsen & Bruggermann, 2020)

Meanwhile, limited information is available on the population's perception and attituded of newer noise sources, such as wind energy facilities. Currently also data on noise exposure and health outcomes are limited. Therefore, it is essential to collect data on people's preferences, attitudes, opinions and values regarding environmental noise also from these noise sources. However, despite impediments and a fragmented knowledge, the available data on noise pollution show growing concerns in Europe. Individuals are not always aware and mindful of noise impacts, particularly in the terms of long-term exposure at lower levels. Therefore, awareness should be raised on the topic. (WHO, 2018)

When it comes to Latvia, the last Eurofound survey showed that 5% of respondents think that environmental noise in their neighbourhoods is an important issue, 22% - medium, but that noise is no problem is reported by 73%. Similar results were found in Lithuania and Estonia. (Ahrendt, 2017) In Latvia, detailed nationwide studies that would concentrate exclusively on environmental noise have not been conducted. However, the Central Statistical Bureau conducts annual surveys on households pointing to noise problems with their home environment (see Figure 2.6.).

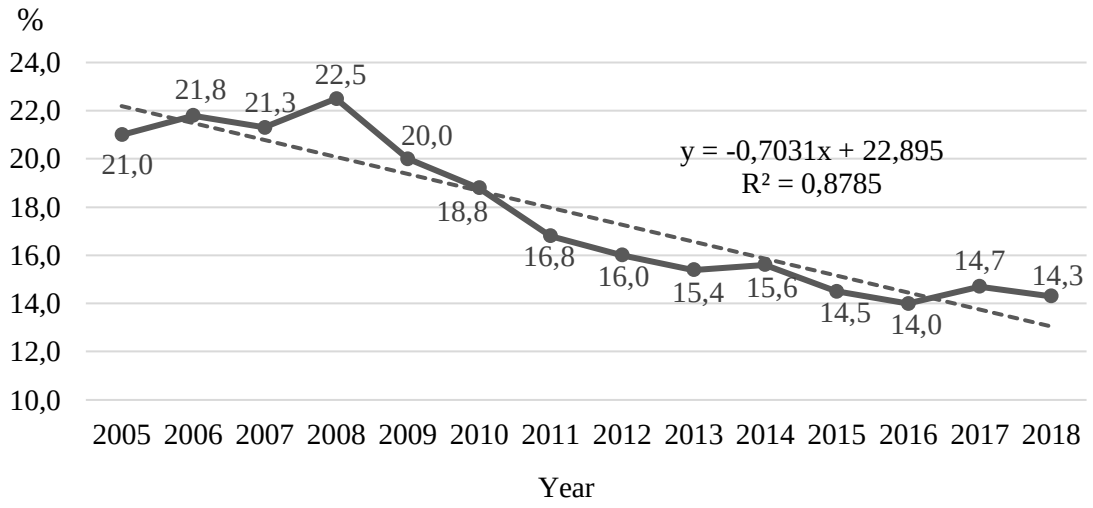

Figure 2.6. Share (% of respondents) of Latvian households reporting noise problems with their home environment (created by the Author, using Central Statistical Bureau, 2019)

Data in Figure 2.6. show negative, strong effect trend (R^2 = 0,8785) in reported noise problems, which leads to the conclusion that there is a decline in the proportion of households affected by noise.

2.2. The topicality of environmental noise management

Urbanization, industrialization, and growing motorized travel and transportation are the most important causes of environmental noise and the increase of its impact. In particular, it is crucial in countries where the management of these issues have also begun recently and in countries and cities ongoing economic and industrial development (Schwela *et al.*, 2011; Schwela *et al.*, 2008).

In order to tackle environmental noise pollution issues, a comprehensive and strategic approach has to be used. Environmental noise management as a strategic and complementary set of measures comprising the development and implementation of outdoor noise control policy based on the identified

problems and assessment, therefore aims to prevent and reduce noise-induced negative effects on human holistic health and well-being, as well as those effect in nature (Schwela *et al.*, 2011).

A worldwide expert panel formulated the main environmental noise management principles that could help to implement strategic environmental noise management with a clear vision (see Table 2.1.) These derive mainly from general environmental protection principles (for instance, the polluter pays or sustainability principle), but are adapted to the sector and its main issues.

Table 2.1. Environmental noise management principles (Schwela *et al.*, 2011)

Environmental noise management principles	Environmental noise management principles
Access to environmental information: All stakeholders should have access to information regarding noise	Co-benefits: Consideration of the benefits of integrated environmental noise management, air pollution management including greenhouse gas reduction
Awareness: Provision of information to all stakeholders	Integrated approach: Development of integrated environmental noise management (prevention, monitoring of adverse impacts, control of sources, and education)
Best practice: Application of state of art technologies	Opportunity: Sound solutions to noise problems at the suitable moment
Coherence: Orientation of the efforts of all stakeholders including different neighbouring jurisdictions towards a common objective	Participation: Active participation of the population in the development and implementation of the plans to minimize noise pollution and prevent increase in noise levels
Concerted effort: Discussion and co-operation among all parties involved	Polluter pays principle: Individuals responsible for noise pollution should bear the cost of its consequential impacts
Decentralization: Implementation of decentralized noise management with national and local components with due consideration to local capacity	Precautionary principle: Where there are threats of serious or irreversible health damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent high noise levels
Equity: Fair and equal protection of all people from noise exposure and consideration of individual vulnerability	Stepwise approach: Environmental noise management following a target and milestone approach
Compatibility: Development of environmental noise management compatible with national and local needs	Stakeholder: Commitment of all stakeholders to noise management
Continual improvement: To promote and implement continual improvement of environmental noise management and reduction of noise itself	Sustainability: Development of economically and socially compatible environmental noise management which is sustainable in the long term and for next generations
Cost-effectiveness: Environmental noise management measured at least cost and highest effectiveness	Universality: Comprehensive environmental noise management including human health

Also, there is a set of noise management measures – planning, technical, administrative and institutional, economic and financial, communication, political, and legislative ones that can be used for environmental noise management (Ernšteins *et al.*, 2014):

- Political and legislative instruments include sectorial and integrative international, national, regional and local regulations and multilateral and bilateral cooperation agreements, standards, as well as regulations and decisions of the municipalities, for example, restrictive regulations on public order, territorial usage, and building regulations, etc. Various countries have set standards for maximum noise levels, the maximum sound pressure levels in front of buildings and for the minimum sound insulation values required for façades.
- Planning instruments include, for example, sustainable development and transportation strategies, environmental reviews, development programs and spatial planning. With thought wise planning, noise exposure can be avoided or reduced. For instance, a sufficient distance between residential areas and an airport will make noise exposure minimal, although the realization of such a situation is not always possible. For new buildings, standards or building codes should describe the positions of houses, as well as the ground plans of houses with respect to noise sources. (WHO, 1999)
- Economic and financial instruments include municipal budget, charges, fees, fares, projects etc.
- Administrative and institutional instruments are working groups, cooperation projects, administrative fines, environmental requirements, inspection checks, work of environmental specialist/inspector, municipal regulations, etc. For instance, actions can be taken to ensure that access to some areas of the city is restricted to those vehicles that are seen to be environmentally cleaner than other vehicles or driving prohibited (WHO, 1999).
- Infrastructural and technology instruments, including development and reconstruction of different technical and social infrastructure, noise barriers, rail grinding, etc. Additional insulation of houses can help to reduce noise exposure from railroad and road traffic (WHO, 1999).
- Communication instruments, including raising of public awareness - environmental information and education, public participation and environmentally friendly behaviour. This, for, instance, may include noise awareness day, "buy quiet" initiative where costumers are urged to choose goods with lower noise levels, such as quieter tires or work tools, etc.

Implementation of a single management measure is unlikely to work; therefore, a whole set of instruments has to be used. Priority should be given to precautionary measures that prevent noise, but also measures to mitigate existing noise problems must be used. The most effective mitigation measure is to reduce noise emissions at the source, followed by noise control within the sound transmission path and protection at the receiver's site. (WHO, 1999)

However, analysis of the practical situation shows a need for significant improvements in the appliance more effective noise control and prevention (see subchapter 2.2.1).

2.2.1. Environmental noise management issues

A wide range of activities to tackle noise issues have been developed and implemented in the last few decades of the last century in several countries, including Japan, Germany, France, Switzerland, the United States of America, the United Kingdom, and the Netherlands. In the EU Eastern enlargement countries, environmental noise management has started to develop mostly only around the time of joining the EU and integrating the requirements of the EU Directives in the national systems. Compared to the other EU countries where noise management policies and schemes have developed steadily over the last decades of the previous century, developmental gaps in terms of approaches can still be identified (Belojevic *et al.*, 2012). It is so that countries have developed environmental noise policies, but they are rather theoretical as the efficient implementation is poor. This situation might have partly developed because of the lack of political will and the associated expenses (Schwela *et al.*, 2008).

It is presumably somewhat unrealistic to anticipate a fast improvement in implementation. Therefore, a gradual, step-by-step approach would be more pragmatic. However, a step-by-step program must have a clear and strategic approach. Many developed countries lack this as do most developing countries. (Schwela *et al.*, 2008)

Challenges in environmental noise management include the implementation of the strategic approach. In particular, key barriers include: low government commitment and political will, insufficient public awareness, low stakeholder participation, inadequate infrastructure, weakness in policies,

standards, and regulations, deficiencies in data for emissions and health impacts. (Schwela *et al.*, 2008) The summary of environmental noise management issues found in the literature is given in Table 2.2.

Table 2.2. Summary on environmental noise management issues (created by the Author using (Jeram *et al.*, 2013; Schwela *et al.*, 2008; Schwela *et al.*, 2011; Basner *et al.*, 2015; Licitra *et al*., 2014; Moudon, 2009))

Group	Noise management issues
Knowledge, data and information	Precise knowledge on noise emissions, levels are often missing, incomplete or inaccurate
	Poor surveillance of health impacts due to noise
	Little information exists in many countries on health and economic impacts of environmental noise
Policies, standards, and regulations	Noise emission standards are sometimes obsolete and do not reflect the best technical practice
	Weakness in policies, standards, and regulations; the need for improving national legislation, for instance, including limits for traffic noise, especially for old infrastructure
Noise reduction	Measures to prevent and reduce noise are often hampered by lack of source apportionment
	Low cost and effective alternative technologies are rarely available
	Adequate infrastructure is missing
	There is still little done regarding retrofitting existing infrastructure
Monitoring and control	Noise monitoring is often limited in spatial coverage, not harmonized to each other, or are absent altogether
	There is a lack in, or absence of, quality assurance/quality control plans; data quality is unknown or poor
	Technical control tools are taken into account mostly for new, large infrastructure projects
Awareness, communication, stakeholder involvement	Low stakeholder participation (including initiatives like “buy quiet”)
	Residents and policymakers lack knowledge on the issue
	Risk perception, risk communication, information dissemination, and awareness raising are issues to be addressed
Funding	A major challenge is the availability of funding with good governance missing and low priority funding for environmental noise management
Political will	Lack of sufficient political will and government commitment
	Profits and other economic considerations of noise causing activities are often weighed against environmental and health protection
Noise administration	General need for better administration

In addition to this, there is a general need for better administration. This includes guidance for dealing with feedback from the public about environmental noise, as well as an establishment of a better data collection and assessment. Improvement of information policy would reduce annoyance and improve public well-being and health. An increased role of the public in consultancy on noise actions plans, on land-use planning and environmental health impact assessment would also be a step forward in improving public collaboration and awareness. (Jeram *et al.*, 2013)

Despite the topicality of the issue, the public, in general, is not sufficiently aware of the noise hazards to their health and well-being. There is a lack of deeper understanding of the impacts of environmental noise amongst both politicians and the public (Schwela *et al.*, 2008; Hays *et al.*, 2017; Jarem *et al.*, 2013). This could be due to several reasons. Noise is invisible; it does not provoke strong images and is perceived to be less hazardous than air or water pollution. Noise is often labelled as a subjective issue, and might not fully be accepted as an environmental problem, therefore people do not often clearly understand the scientific data on the connection between noise and health. People may also

lack trust in authorities dealing with environmental or other public issues. Finally, the public, in general, considers that financial matters prevail over environmental problems (Jeram *et al.,* 2013). A similar conclusion was made by another author (Hays *et al.*, 2017), stating that profits and other economic considerations of noise causing activities are often weighed against environmental and health protection and other community concerns (e.g., nuisance, aesthetics, etc.). Therefore, in order to estimate the effects and solve the issues related to environmental noise, the management of it should become a concern for policymakers, their technical and staff from supporting agencies (WHO, 2011). It is only when these impacts are better understood that governments will be motivated to tackle environmental noise and that citizens will demand that noise be taken seriously (Schwela *et al.,* 2008). Other authors (King & Murphy, 2016), though, consider that environmental noise has already become a recognized issue; however, the data submitted to the EU environmental noise mapping show that noise control remains on its current course, it may become more appropriate to refer to noise as "the ignored pollutant."

Due to the factors mentioned above, national environmental management need to be developed in a comprehensive, integrative and cross-sectoral way and appropriate methods and approaches for the management of overall noise impacts need to be found to deal with these issues in a most effective and sustainable manner. This should be done taking into account the best practice experience, along with the latest data on the social, economic, and environmental dimensions and their integration aspects, as well as planning and development perspectives.

2.2.2. Public feedback on environmental noise – a signal for the need for better management

Noise is largely an issue of sensory perception and personal preference, particularly at levels where direct health hazards are not a major factor. Therefore, psychological, social factors and sensitivity are very important in noise annoyance assessment (Fields *et al.,* 1997; Collette, 2011; Job, 1997). Only about one-third of the variance of annoyance reactions can be explained by the variance of acoustic properties of noise (Guski, 1999). Even when a large number of residents are annoyed by noise, not many of them submit feedback or complain, because they feel that nothing can be done about the noise (Maziul, 2002). Older people, people who are better-educated, have higher incomes or have a higher social status provide feedback more often than other annoyed persons, probably because they are more likely to feel that they will be listened to due to their verbal and organizational skills to take action against noise (Collette, 2011). Even if public feedback or complaints cannot be accepted as an accurate measure of public annoyance, it is the most frequent form of opposition as it is an easy way to express one's concerns (Vogt *et al.,* 2000). The importance of having the possibility to provide feedback and express opinions was highlighted in a study that showed a reduction in blood pressure after the usage of a noise-complaint line (Vogt *et al.,* 2000). On the other hand, unsuccessful complaining might even increase the annoyance (Botteldooren, 2003). It is important to know that people who give feedback frequently belong to vulnerable groups demonstrating high noise sensitivity, poor sleep, chronic diseases, or neuroticism (Hume *et al.,* 2002). These analyses highlight the importance of precise and immediate response to public feedback. First-time complainants are generally courteous and reasonable, whereas they become unreasonable after having been ignored. Therefore, it is important to plan the procedures on how to deal with feedback very carefully so that residents and authorities benefit from the procedure (Luz *et al.,* 1983). Previously, Borsky (1979) defined complaining as a function of several factors such as the belief that the complaint might be effective, knowing where to complain, confidence in one's ability to deal with authorities, and past experience. It is important when operating noise complaint lines to respond to the feedback at once and to be precise at all times, especially if it is the first time the person submits the feedback. Feedback can be useful to identify important noise problems and to enable the residents to participate in the development of their environment and improve noise management. Apart from the possibility to reduce the level of noise, filing complaints has an important psychological benefit for individuals (Maziul, 2005). Authorities should address the issue of the success and efficiency of noise complaint lines by the means of transparency and an open information policy (Vogt *et al.,* 1999; Vogt *et al.,* 2000). Many major airports operate public feedback services to gather information about the disturbances caused by their activities in the neighbouring communities. This information related to the noise monitoring can be applied to improve operations and to minimize the disturbance. Levels of feedback would be different from different regions or countries because of diverse

approaches used to collect feedback, cultural and socioeconomic variability, different levels of public awareness, and other factors. However, community feedback data should be better assessed, as they can be valuable in supporting the decision of the planning authorities, thus improving noise management (Hume, 2002).

2.2.3. Environmental noise management influencing factors and management levels

Environmental noise management and the course of its development in a country is influenced by diverse and cross-sectorial internal and external factors. These conditions and changes over time, determine the current management model. These factors include policies and legislation, collaboration and networking, resource capacity, economics, modes of governance, etc. (Schwela *et al.,* 2011; Finegold *et al.,* 2012; Janssen *et al.,* 2000; Cvetković *et al.,* 2006), and their influences can be either positive, allowing the further development of noise management issues or negative, precluding further progress.

Environmental noise management includes the development, implementation, and assessment of noise policy that aims to prevent and reduce the negative effects of noise. In order to ensure noise management efficiency, noise policy-making and its implementation must be broad and occur at different spatial scales – international, national, and local. As every one of those different noise management levels has a specific focus, developing a coherent noise management covering various levels would allow for better coordination of noise mitigation measures throughout the country and establishing consequent, solid approaches in each state.

In countries with a comprehensive legislative approach, noise management is typically organized in such a way that different authorities tackle different parts of the problem. The sharing of the responsibilities varies from country to country; however, different authors use different noise management focuses - some authors stress the growing importance of the international level (Adams *et al.,* 2006), whereas others consider noise policy as focussed too much on a top-down approach and mainly based on metrics than rather local needs (Weber *et al.,* 2011). The latter believe that, due to the noise source, its impact and perception, localization is essential to build noise development policy based on this local knowledge, thus also highlighting the role of local authorities in ensuring effective noise management at the municipal level.

The responsibility at international and national levels is to provide the regulation and policy of noise issues for the organization of environmental noise management processes at lower governance levels. The regulative policy of those levels should be based on an assessment of noise impacts on health and other general social and economic aspects. EU legislation focuses on noise management for agglomerations and the largest noise emitting facilities and promotes noise mapping and action planning. National legislation regulates general and practical management aspects according to the general factual situation in a state and its specifics. This includes the establishment of the main procedures and orders for overall noise management, as well as the setting of specific parameters and methods for noise control. Besides that, the responsibility of the state level is also the development of infrastructure objects of national significance and control of noise level emissions (Figure 2.7).

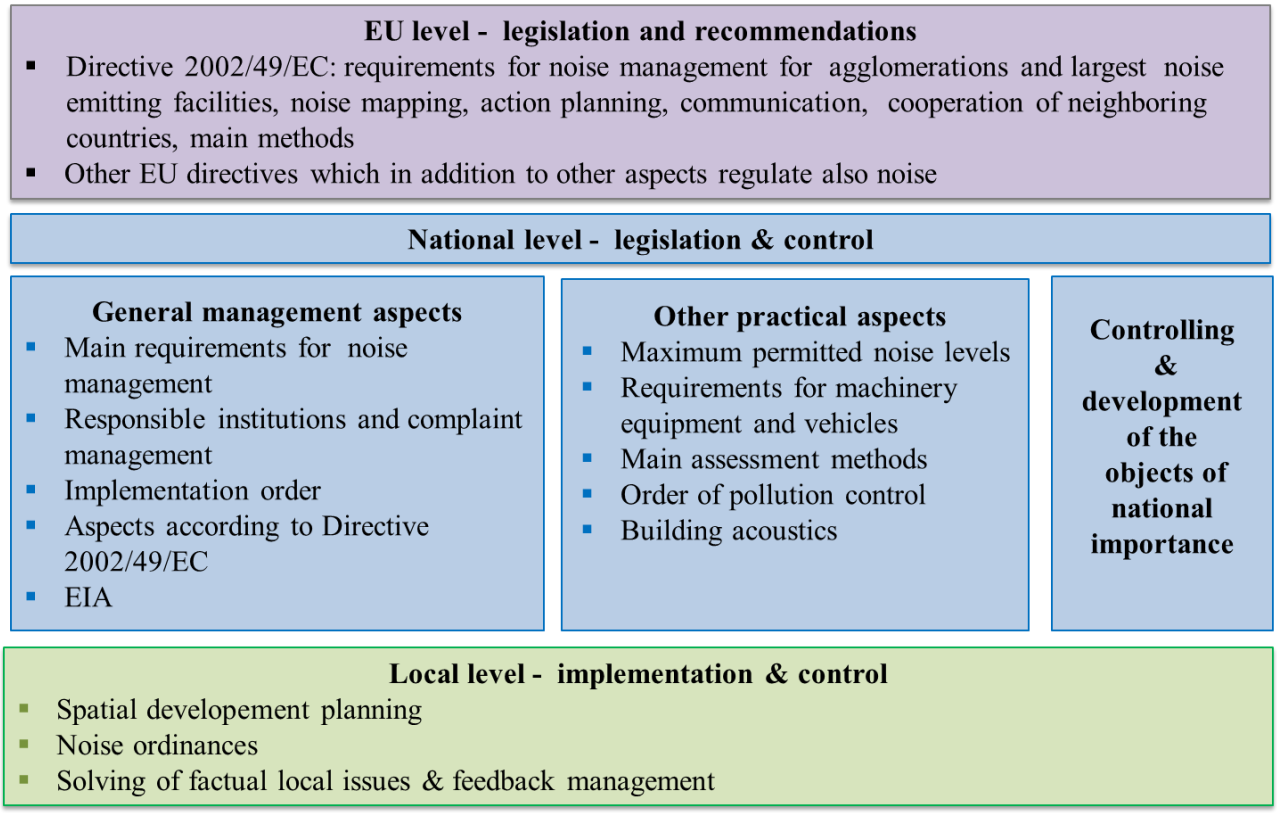

Figure 2.7. Noise management levels and their main functions (created by the Author)

Meanwhile, municipalities have obligations to observe national legislation and ensure that their delegated obligations are discharged. Municipalities have a dual role in environmental management – on the one hand they are a tool for the implementation of state noise management policy, but on the other – they attempt to satisfy the needs of local society (Sørensen, 2008), which mostly considers the municipality to be responsible for solving noise issues (Brebbia, 2010).

Top-down noise policy requirements are usually focused on physical noise levels, whereas effective noise management usually involves non-acoustic factors as well (Suau-Sanchez *et al.*, 2011). Avoiding proper consideration of the local situation and the needs of the community will shape adverse effects and annoyance, because "the protection of one's own backyard is radicalized and fostered" (Suau-Sanchez *et al.*, 2011).

The focus of community-based environmental noise management should also include the assessment of local health, environmental, economic, and social aspects and collaboration between residents and upper management and government levels in order to improve the sonic environment (Finegold *et al.*, 2004). This also means that municipalities should be as moderators between residents and upper government levels.

As the municipalities are the closest governance level both to noise producers and residents, their noise policy should be based on both residential and entrepreneurship and socio-economic development paradigms. Meanwhile, as the socio-economic development includes all economic sectors, including industry and transportation, which, as mentioned above, are considered to be the main sources of noise with the most profound effects on local residents, the conflicting problem of territories' development and the associated environmental degradation due to noise becomes apparent (Paslawski, 2009). In order to avoid these issues and to strike a balance between business and infrastructural development and environmental issues, municipalities have to develop methods of permitting development while preserving an acoustically favourable living environment for the whole territory of the municipality. In order to do that, local governments have a set of noise policy instruments, such as regulations, fines, land-use planning, infrastructure planning, marketing and provision of information, and organization (Nijland & van Wee, 2005). In most cases, it is necessary to implement more than one measure to solve environmental noise problems properly (Murphy & King, 2011). However, due to the limitation of the

resource capacity, particular noise policy measures should be selected based on the cost-benefit analysis of the social and economic factors. Measures to reduce noise at its source rather the ones that limit its propagation or abate noise levels at the receiver are preferable for noise abatement, due to their cost-effectiveness (Nijland & van Wee, 2005).

However, in practice noise management studies in EU countries (Weber *et al.*, 2011; Schwela *et al.*, 2011; Jarem *et al.*, 2013) have provided evidence that municipalities lack knowledge and competencies relating to environmental noise problems and mitigating measures, as well as that they face challenges related to the lack of resources and inadequately developed management tools. They also face the issues of balancing the noise emission intensity with residents' interests, as well as have difficulties related to spatial planning. There is also a need for targeted policies and practices at lower governance levels and funding, and these policies should be aimed not only at the affected populations but also at those who are the most receptive to implementing changes (Moudon, 2009).

Based on the findings outlined above, it can be summarized that, planning, and implementation at each of the different territorial and governance levels need to be done diligently in order to make noise management policies effective. However, nowadays in the field of noise management, a tendency for differentiating approaches to noise management is becoming more apparent, and this emphasis on top-down or bottom-up approach impacts the developed noise management and for creating noise management model in a country (Table 2.3.).

Table 2.3. Differentiation of noise management approaches (created by the Author)

Top down approach	• Legislation and regulation, including noise limit values • General health and well-being impact assessment • Permits • Control
Bottom up approach	• Local issues • Human perception, needs, and soundscape (i.e. environment of sound where the emphasis is on the way the sound is perceived and understood by an individual, or by a society (Adams *et al.*, 2006)) approach • Local well-being and development aspects • Particularly subjective impacts and solutions

In practice, in western EU countries, the shift of the noise management paradigm from the top-down to the bottom-up has occurred in the last decade, especially by developing the soundscape approach, which considers environmental sound to be a resource.

2.3. Legislation and policy: framework and EU requirements

One of the most important factors influencing environmental noise management is legislation and policy framework. The policy framework is the basis of noise management. Without an adequate policy framework and legislation, it is difficult to maintain active or successful noise management programs (Cvetković *et al.*, 2006). At the level of county alliances, the legislation and policy on environmental noise management are developed based on an analysis of the main environmental problems in the member states and scientific data on the noise impacts and possible solutions.

According to the 7th Environment Action Programme to 2020 (Decision No.1386/2013/EU), environmental noise is perceived as EU resident's health and urban sustainability issue, and foresees implementing EU requirements and goals, measures for abating noise at source and improvements in city planning and design, as well as took into account other environmental stressors.

As stated in Article 2 of the European Community Treaty, environmental protection was referred to as one of the Community's tasks. This task was specified in more detail in Article 174 of the European Community Treaty (section on the environment). In June 1990 the Declaration on the environment was adopted which proclaimed the right to a healthy and clean environment, which included the air, rivers, lakes, coastal and marine water quality, food and potable water quality, protection against noise, protection against soil pollution, soil erosion and other factors (Krämer,

2016). Due to different environmental noise sources, environmental noise is regulated both, in a complex, wholesome manner as well as also through sub-sectoral requirements.

Road transportation noise

For vehicles that are sold within the EU, their noise level must comply with the European Parliament and Council Directive 70/157/EEC on permissible sound level and the exhaust system of motor vehicles and its amendments (hereinafter – Directive 70/157/EEC). Directive 70/157/EEC regulates vehicle noise levels and measurement conditions and requires Member States to grant national technical examination approval for this equipment conforming that it corresponds to the specified parameters defined in the mentioned normative act. The Directive 70/157/EEC has been amended several times in order to take into account the latest developments in engine technology, reducing the permissible noise limits and defining new requirements for the Member States. In order to enforce the road traffic noise limitations, the EC, Parliament, and Council in 2001 adopted the Directive 2001/43/EC which controls tire noise and the Regulation No.1222/2009 on the labelling of tyres with respect fuel efficiency and other essential parameters that, among others, aims to reduce tire noise. This regulation sets the standards for the market to gradually exclude models with the worst performance, while the directive on labelling issues promotes innovation and rapid market development towards more fuel efficient, safer and quieter tires.

Aircraft noise

Legislation related to aircraft noise and its limitation has been developed in the European Community since 1978. For example, the Council Directive 89/629/EEC from 1978 restricts the passenger subsonic jet aircraft noise based on the Chicago Convention on International Civil Aviation signed in 1944. The European Parliament and Council Directive 2002/30/EC set the rules and procedures about the restriction of noise-related operations in the EU airports. This Directive requires all Member States of the European Community to fulfil specific procedures before introducing operating restrictions, thus protecting the internal market requirements and finding similar solutions for similar noise-related problems. Also, it defines aircraft noise and defines the rules to be applied, introducing operation restrictions. Since 2006, the European Parliament and Council Directive 2006/93/EC on the regulation of the operation of airplanes is also in effect. It regulates the application of noise emission standards for civil subsonic jet airplanes. There is also EC Regulation No.748/2012 that lays down rules for the airworthiness and environmental certification of aircraft and related products, parts, and appliances, as well as for the certification of design and production organizations.

Railway noise

In 1983 the EC, the Parliament, and the Council first proposed a directive on rail rolling stock noise. Currently, the European legislation concerning railways and noise is further specified in Technical Specifications for Interoperability (Peris *et al.*, 2016). They are described in Directive 2008/57/EC on the interoperability of the rail system within the Community and EC Regulation 1304/2014 on the technical specification for interoperability relating to the subsystem "rolling stock — noise". They establish the conditions to be met to achieve interoperability within the Community rail system concerning the design, construction, placing in service, upgrading, renewal, operation, and maintenance, including noise limit values. EC Regulation 2015/429 sets out the modalities to be followed for the application of the charging for the cost of noise effects is aimed at stimulating progress with the retrofitting of wagons.

Equipment used outdoors

In 2000, Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors (hereinafter – Directive 2000/14/EC) was adopted. It lists approximately 60 types of equipment that must comply with the guaranteed sound power level and CE marking (i.e., manufacturer certification that the goods meet the requirements of the applicable directives). Directive

2000/14/EC also sets limits on the noise levels permissible for about 20 types of equipment that will go on sale the first time operating in the EU.

Framework legislation

The European Parliament in its resolution 1997 Nr. OVC200 called for concrete measures and legislative initiatives for the reduction of environmental noise, and noted the lack of reliable, comparable data on the different sources of noise and supported the EC's Green Paper (EC, 1997). The Green paper aimed at giving noise issues higher priority in policymaking at the EU level and proposing an overall framework for actions, as well as stimulating public discussion on the future approach to noise policy. It reviewed the overall noise situation and national actions taken to abate noise and, as a result, outlined a framework for actions covering the improvement of information and its comparability and future options for the reduction of noise from different sources. Therefore, in order to ensure the collection of the data on environmental noise and comparison with comparable criteria across all Member States, using harmonized indicators and evaluation methods, as well as common criteria for noise mapping, Directive 2002/49/EC determining environmental noise assessment and management was developed and passed. Article 2 of Directive 2002/49/EC declares that: "This Directive shall apply to environmental noise to which humans are exposed in particular in built-up areas, in public parks or other quiet areas in an agglomeration, in quiet areas in open country, near schools, hospitals, and other noise-sensitive buildings and areas." The Directive 2002/49/EC requires monitoring the environmental problem and lays down the need for the development of strategic noise maps for major roads, railways, airports, and agglomerations, in order to forecast noise levels using harmonized noise indicators. It sets obligation for the Member states to collect data and compile it in the relevant reports. Directive 2002/49/EC requires mapping of the noise exceeding 55 dB. However, health and wellbeing can also be affected at lower noise levels than specified by Directive 2002/49/EC. Reporting on these lower levels is not required under Directive 2002/49/EC, but there is a scarcity of data on numbers of the population exposed below L_{den} 55 dBA as concluded in a recent WHO study on developing updated Environmental Noise Guidelines for the European Region (WHO, 2018). An extension of the mapping of noise exposure to the levels below L_{den} 55 dB would expand the knowledge base and facilitate the evaluation of progress in preventing adverse health effects (WHO, 2018).

The Directive 2002/49/EC regulates the development of noise action plans for the reduction of noise where it might be harmful and maintaining acoustical quality where it is good. It also requires informing and consulting the public about noise and activities for noise abatement or prevention. However, although the Member states are obligated to develop action plans, there is no legal responsibility to practically implement them, and therefore can sometimes make the noise mapping meaningless. Setting a legal obligation to implement action plans, would stimulate the implementation of noise reduction measures by national governments and regional administrations, thus also decreasing numbers of people subjected to elevated noise levels (Murpy *et al.*, 2020).

Despite substantial progress over the last fifteen years in data mapping and development of noise action plans, there is room for further improvement. In 2019 (two years after the reporting term), only 18 countries have submitted their noise maps. In particular, noise exposure data from the eastern part of the European Region is lacking, and inconsistencies in quality and quantity of reported data make the discernment of noise exposure patterns difficult (WHO, 2018).

Directive 2002/49/EC also helps to develop a long-term EU strategy, which aims to reduce harmful health effects and the number of people affected by noise in the longer term and provides a framework for developing existing environmental noise policy.

Transposition and noise levels

In order to implement these activities, countries have to develop subordinate legislation, i.e., to adopt the requirements, detect suitable technical methods, noise levels, etc. EC regulations are applied directly, but directives are not directly applicable and must first be transposed into national legislation before it is applicable in each EU country. Thus, the external regulation is one of the factors which require the development of national noise management approach and the implementation of the particular tasks.

However, each country can take its own approach to the transposition of requirements of EU directives in its national legislative acts. Factors such as social behaviour due to cultural differences, meteorological conditions, legislative backgrounds, etc. are taken into account in determining different legislative approaches in the transposition of the directives (Lictra *et al.*, 2015; Basner *et al.*, 2015). For example, Directive 2002/49/EC does not set a single approach for setting environmental noise levels. Therefore, Member states, taking into account the factors mentioned above along with other factors, such as spatial planning paradigms and the particular tailor-made evaluation on noise sources, choose their own approach to the legislation. When comparing the environmental noise levels in different EU member states, three main concepts on how the environmental noise levels can be identified – first, maximum noise levels are set for a particular territorial zone according to a spatial plan, for example, for multi-story buildings, industrial areas or hospital zones different noise limits can be set. This concept is used in Latvia, Lithuania, and other countries. Second, maximum noise levels are source dependent. This means that different noise levels can be set for noise coming from transportation or industrial sites. The particular paradigm is used in Estonia, Spain, and other countries. The third alternative is the generic approach that refuses noise limits, but sets an ambitious policy aim on the matter, for example, to reduce the number of inhabitants affected by of noise. This approach is used, for instance, in Finland that has a goal of 20% reduction of daytime noise over 55 dB compared to 2003. Every approach has its advantages, and every country should have a tailor-made way for the determination of noise limits so that they best suit the actual situation, most probably, based on the country's economic and urban structures. The first approach is mostly based on urban structures (population and economic activity concentration areas) and focuses on the possible vulnerability of the dwellers of residential parts of the area. This is well shown by the research of King & Murphy (2012) that proves that noise disturbance significantly impacts areas with a high population density and affects the inhabitants in their daily life and that in residential areas noise levels tend to be lower than in mixed-used areas. The second approach could be based on the correlation between annoyance and noise sources (Hume *et al.*, 2012; Perron *et al.*, 2016) and foresees protection of all inhabitants. The third approach is usually used for environmentally aware countries that are more ambitious in reaching sustainability goals. This approach requires very good coordination and impact assessment on a case-to-case basis.

Currently, in EC reports for the evaluation of noise policies, the WHO guideline targets are used. As shown in Table 2.4., the WHO guidelines for the European Region (WHO, 2018) cover L_{den} and L_{night} road, railway, aircraft, wind turbine, as well as leisure noise limit value recommendations.

Table 2.4. WHO Environmental noise guidelines for the European Region - outdoor exposure to environmental noise (WHO, 2018)

Specific environment / noise source	Day-evening-night dBA L_{den}	Night-time noise dBA L_{night}
Road traffic	53	45
Railway	54	44
Aircraft	45	40
Wind turbine	45	Not applicable (n/a)
Leisure	70	n/a

Meantime, in some EC reports, it is mentioned that a common target value for all EU countries should be introduced (European Commission, 2017).

2.4. Environmental Noise Management Practice in European countries

Legislation dealing with environmental noise and methods for its control as a part of environmental pollution regulations were first developed in the the United Kingdom in 1960s and the United States of America in 1972. The practice was then introduced in other European countries as well, such as in the Netherlands in 1979. The United Kingdom and the Netherlands, therefore, are the first European countries that started to manage environmental noise pollution and its effect and, they can be viewed as examples for noise management development.

2.4.1. The United Kingdom

In 2012, the United Kingdom examined the effectiveness of its noise policy actions carried out since 1960 in reducing the impact of noise emissions and noise annoyance and improvements in legislation and control. The study showed that road transportation noise had fallen by 2 dBA on motorways and by 5 dBA for minor roads between 1971 and 2010 despite tremendous traffic increases. Concerning aircraft noise, the research found a remarkable change in the area where noise levels are above 57 dB $L_{eq,16h}$ had reduced by over 78% around major airports (between years 1972 and 2009) despite a significant increase in aircraft operations. This shows that it is possible that the improvements in policy and legislation have enabled such intervention results, and it could be a practice to apply more widely (Basner *et al.*, 2015).

According to Murley's (2012) the noise policy statement for the United Kingdom sets out a long-term vision to promote good health and good quality of life through the effective management of environmental, neighbour and neighbourhood noise within the context of sustainable development. Noise policies aim to avoid, mitigate and minimize significant adverse impacts on health and quality of life, and, where possible, even contribute to the improvement of them using the best available practices and technology available within a sustainable development framework. The emphases are placed on noise management in the largest agglomerations. The benefits of implementing noise management should be weighed against costs to the wider community (Murley, 2012).

Environmental noise is controlled to some extent by planning guidance, noise nuisance and compensation legislation, and EU directives on transport noise. Effective use of planning controls and related guidance is considered to be one of the most important tools for preventing many noise-related problems. Each region of the United Kingdom has adopted guidance on planning and preparation of development plans regarding noise issues, development control, information on noise exposure categories with overarching guidance on land use policy. The city of Manchester has prepared the Planning & Noise Technical Guidance to advise developers, acoustic consultants and other companies about noise in a planning context to ensure the good acoustic design of the city (Manchester City Council, 2015).

Before any development can take place, planning permission must be obtained. In some cases, an environmental impact assessment may be required. In either case, the noise will be one of the criteria to be considered. England's National Planning Policy Framework makes that planning policies and decisions should aim to prevent, mitigate, and reduce significant adverse health effects and quality of life, as well as to protect areas of tranquillity, which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason. It also suggests recognizing that development will often create some noise and existing businesses wanting to develop should not have unreasonable restrictions put on them. England's National Planning Policy Framework also sets criteria for noise mitigation and prevention measures – the mitigation should start when noise is noise is noticeable and intrusive – i.e. it can be heard and causes small changes in behaviour and/or attitude. The legislators have also explained that "all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur." Therefore, taking an overview of national policy it is clear that when considering the impact of noise, one must consider the significance of any impact. When evaluating planned development, the assessment of sound impact includes: the absolute level of sound, the character and level of the specific sound compared to the existing noise climate, the sensitivity of the receptors, the time and duration that the specific sound occurs, the ability to mitigate the specific sound through various methods, the form and scale of a development. In regard to noise levels, British Standard 8233:2014 "Guidance on Sound Insulation and Noise Reduction for Buildings" and World Health Organisation document "Guidelines for Community Noise" are used. The standard and WHO guidelines advices that environmental noise level in outdoor living areas such as gardens and balconies should not exceed 55 dBA, in case of permanent, steady noise and should aim to be lower than 50 dBA. Also, background noise levels and impact on perception is taken into account, for instance, changes in noise levels of less than 3 dBA are not perceptible under

normal conditions and changes of 10 dBA are equivalent to a doubling of loudness. (Ministry of Housing .., 2019)

At the central government level, environmental noise and noise nuisance is the responsibility of the devolved administrations, with the United Kingdom Government ultimately responsible for ensuring compliance with EU Directives and reporting to the EC. The Secretary of State, Department for Environment, Food and Rural Affairs (hereinafter - DEFRA) is responsible for the preparation of noise maps and action plans in England arising from the implementation of the Directive 2002/49/EC, and for policy on the control of noise from fixed sources and statutory noise nuisance. Similar arrangements apply in Scotland and Wales, with Scottish Ministers and the Welsh Government, as appropriate, designated as the competent Authorities. In Northern Ireland, responsibilities are split between several departments, including the Department of Environment. The Department for Communities and Local Government is responsible for the preparation of guidance on the use of planning controls to prevent noise problems; the Department for Transport deals with legislation and policy on road traffic noise and noise from civilian aircraft. (Murley, 2012)

In England and Wales, the police, while having no specific powers to deal with noise nuisance, provide some support to environmental health officers and other officials in carrying out their duties, they also have powers to noise-test road vehicles. In Scotland, the police have powers to deal with noise related to anti-social behaviour guidance in accordance to "Good practice guidance for police and local authority cooperation" that provides guidelines on what is considered to be a minimum standard of cooperation between the police and local authorities when dealing with noise feedback. It sets out the roles and responsibilities of each, giving examples of effective local liaison arrangements, and suggests that both local authorities and the police in each area should draw up an agreement covering how they will cooperate. The "Neighbourhood Noise Policies and Practice for Local Authorities – a Management Guide" encourages consistency in the way local authorities deliver noise control services, while still enabling them to respond to local circumstances and needs. (Murley, 2012)

According to the requirements of the EU, the United Kingdom has produced noise maps and developed noise action plans. As the EU regulations do not set criteria for quiet areas in agglomerations, the responsible institutions for noise maps in each region published technical guidance on determining whether a Candidate Quiet Area should be declared a Quiet Area in each region. The Welsh Government has also published guidance on procedures for designation of quiet areas in agglomerations, and the conditions which such areas must meet if they are to have an official designation and thus receive more protection under statutory planning guidance. A proposal for an area to be officially designated as a quiet area should be submitted to Welsh Ministers and should describe its soundscape, nature and what it looks like – a candidate quiet area should not be one that is already identified as being excessively noisy on a strategic noise map. Guidance on Noise Action Plans suggests several possible noise management measures but leaves the identification of the most appropriate option to the competent authorities. (Murley, 2012)

DEFRA has also identified Important Areas and First Priority Locations for each of the noise action plans. The noise action plans set criteria for areas for investigation, to assess if any further noise mitigation measures might be carried out, in the context of sustainable development. Priority areas for noise management in agglomerations are those where 1% of the population is affected by the highest noise levels, according to the strategic noise maps. In practice, among the other proposals for achieving the general aim of noise pollution management, the London Noise Strategy proposed improvements in traffic noise management (through the use of quieter vehicles and trains, better street repairs and the use of low-noise road surfaces, improved traffic management and encouraging better driving, improved railway track maintenance and control of noise and vibration; better trackside screening, a ban on night flights, financial incentives to operators to phase out noisier aircrafts, and for aviation to pay its environmental costs, planning building design, creation of new quiet outdoor spaces. (Murley, 2012)

According to the Control of Pollution Act, a local Authority may designate all or part of its area as a noise abatement zone (hereinafter – NAZ). The purpose of a NAZ is the long-term control of noise from fixed premises in order to prevent any further increases in existing levels of neighbourhood or community noise levels and to achieve a reduction of those levels wherever possible. Following the implementation of a noise abatement zone order, the Local Authority measures noise levels from those

types of premises (specified in the order) within the zone. These are recorded in a register kept by the Local Authority for this purpose and open to public inspection. In Scotland, noise levels are recorded in a noise level register. Once the noise level has been registered, it may not be exceeded except with the Local Authority's consent. Over a period of time, the Local Authority may seek to achieve a reduction in the initially registered levels of noise by serving a reduction notice, but only if reduction is practicable at a reasonable cost and would afford a public benefit. The Local Authority can also determine the acceptable level of noise for a proposed new building, which, when constructed, will be subject to a noise abatement order. The legislation allows the Secretary of State to make regulations for the reduction of noise caused by plant or machinery, whether or not in a noise abatement zone, and give the Local Authority default powers in the case of failure to comply with a noise abatement or noise reduction notice. There is a right of appeal to the Magistrates' Court for three months from the date on which a Noise Reduction Notice is served. It is the burden of the defence to prove the best practicable means were used to prevent or counteract the effects of the noise. (Murley, 2012)

The legislation gives the Secretary of State the power to prepare and approve, and issue codes of practice for minimising noise, or to approve such codes issued by non-government bodies (for instance, the Code of Practice on the control of noise on construction and demolition sites, noise from organised off-road motorcycle sports, clay pigeon shooting facilities, environmental noise control at concerts, etc.). Such codes, although having statutory recognition, do not have the force of regulations, and infringement does not constitute an offense. Non-compliance, however, will usually be taken into account in any proceedings for noise nuisance. (Murley, 2012)

2.4.2. The Netherlands

The noise policy goals in the Netherlands, as well as the consequent management choices, are exemplary for many western European environmental policy domains that matured since the late 1970s. Similarly, to the United Kingdom, three principles were defined by the central government that included: (i) prevention of noise pollution; (ii) solving existing problems of noise pollution; and (iii) reduction of noise emissions from traffic and other sources. Prevention of noise pollution and the detrimental health effects was implemented through the instrument of spatial zoning (set in the Noise Abatement Act), as well as separating noise sources from noise sensitive areas and dwellings. These actions were expected to stabilize the noise problem at a maximum of 40% of the annoyed residents. Though, the next years showed that the "noise problem is far more complex and resistant", and therefore the noise policy had to be corrected.) In 1980s a new goal of no highly annoyed people in 2010 was set. This goal has also been changed to more pragmatic targets – to have no house with road noise exposure over 65 dB and rail noise - over 70 dB by 2020, as well as to reduce road transport noise by 2 dB. (Weber, 2013)

In 2012, new noise legislation came into force, to ensure that there will be no increase in noise emissions on national road and rail infrastructure. This included the setting new noise reduction policy principles - (1) controlling the growth of noise; (2) solving the existing problems of noise pollution, as well as (3) development of measures to control noise at source (Hobma *et al.*, 2016). Nevertheless, the policy style remained mainly hierarchical, steered as a top-down regulation (Glasbergen, 2005) with the national government defining the limits to which regional and local authorities had to adhere to physical planning. (Glasbergen, 2005).

The new noise legislation introduced a new tool for the reduction of noise growth – the execution of noise production limits. This means that the limit for the noise of national infrastructure should not be exceeded and the protection activities have to be performed by the responsible authority. The noise limits are defined based on the calculation using the noise model as regulated in the normative acts on noise nuisance calculation and measurements, as well as on performing on-site testing. Noise production limits mean that even if the characteristic of the object changes (for example, traffic increases), the measures must be taken in order to ensure compliance with the noise limit regulation (Hobma *et al.*, 2016). The new system also defined an efficiency criterion for noise abatement measures – measures should be taken only if their costs are in proportion and comparable with the benefits of their implementation. If measures are too ineffective, a decision to decrease the noise production limit can be taken, though interested parties can appeal the decision to the administrative court (Hobma *et al.*, 2016).

According to evaluation of the Organisation for Economic Co-operation and Development (hereinafter – OECD), in the Netherlands there are situations where noise levels are not increasing, but are already very high. For such situations, the legislation included a single, large-scale measure to ensure that noise abatement operations continue and noise levels reduce. (OECD, 2015)

In 2018, according to the EC Environmental impact review, environmental noise caused around 200 premature deaths and 1 400 hospital admissions per year in the Netherlands, and 390,000 people experienced disturbance. (European Commission, 2019)

The implementation of the measures has helped to reduce noise pollution from transport – the number of houses exposed to "high noise levels" (over 65 dBA) along national roads reduced by over one-third in five years. The country had an ambitious plan to continue reducing noise levels of road, rail, and air transport in line with the rising sensitivity and attention of the population to noise issues. A noise innovation program resulted in cheaper solutions to reduce noise at the source. As the main airport is in a densely populated area, the Netherlands faces a challenge in managing noise levels around airports at acceptable levels for residents. (OECD, 2015)

In Schiphol, the noise has been regulated principally by limiting the total number of flights. Further refinement of the noise regulation by a system of ambient noise maxima is expected. As aircrafts get quieter and land-use planning and isolation programs reduce noise impacts on residents, an absolute cap on flight movements or noise levels becomes suboptimal. A finer instrument is needed to measure real noise damage (residents multiplied by scaled noise damage). An ambient noise tax or an ambient tradable noise scheme can be a more efficient solution based on noise emissions, but also on the local impact of the noise (which depends on time and place). A tradable ambient noise scheme achieves the same objective but gives property rights for noise emissions to the existing carriers. This would allow a more balanced approach to the airport noise problem in Schiphol as the most valuable flights can buy rights to fly at certain times and in certain places. This could make airlines account for the real noise costs associated with their activity. (OECD, 2015)

In order to complementarily address various pollution issues, the Netherlands has also developed the "Atlas of our Living Environment" – an innovative online platform to integrate spatial information about the quality of the living environment and make it publicly accessible. The Atlas makes it possible to view various environmental aspects at a certain location or to compare various locations. It uses maps and background information about noise, air pollution, green spaces, external safety, soil, asbestos, cultural heritage, perception of the living environment, and regional planning programs. (OECD, 2015)

Regarding the institutional system, there are several main actors developing noise policy in the Netherlands. The national government in the noise policy domain primarily represents the main actor, i.e., the decision-maker which, since 2010, is the Ministry of Infrastructure and the Water management. The national government depends on other authorities, that is, the provinces that own the main roads and the municipalities that are responsible for spatial planning and municipal roads. This is exemplary for the combination of centralized and decentralized governance modes; the national government is the main owner of the noise pollution problem and partially involves decentralized governmental bodies in the implementation of noise policy. This shows the multi-level character of noise governance. The second category of actors is comprised of 'governmental bodies as a physical planner,' which mainly concerns regional and local authorities. There is a dilemma of conflicting interests and priorities, as decentralized authorities also hold responsibilities for many other policy domains, therefore the integration of noise into spatial or traffic policy domains seems sometimes to be weak. (Weber, 2013)

Though the years of learning and new integrative and strategic noise policy, the Netherlands has achieved the aim - absolute noise levels from transport are decreasing. Meanwhile the sensitivity and attention of the population to noise issues is increasing. Sensitivity is rising because low noise hindrance is an income-elastic good and well-publicized medical research points to higher than expected damages from exposure to traffic noise, including effects on cardiovascular health and cognitive functions (OECD, 2015). Non-governmental organizations (hereinafter – NGOs) are active regarding noise policy at the national and local levels; however, the initiatives of NGOs are most active in situations where new infrastructure, such as high-speed trains or airport runways, are planned or when legislation is being discussed in the parliament. The main concern of NGOs is to influence noise policy in a more sustainable direction (Weber, 2013).

2.5. A brief summary of Chapter 2

Road traffic noise, both inside and outside agglomerations is the most dominant source of noise in the EU (around 100 million people being exposed to traffic noise above 55 dB L_{den}). Railways are the second most prominent type of noise (around 8 million people exposed), followed by aircraft noise (nearly 4 million people being exposed) and industrial noise (around 1 million people exposed). Of all European agglomerations, Rīga is one of the TOP 10 loudest agglomerations of Europe by the share of the population affected by road and industrial noise over 55 dBA L_{den}.

When it comes to Europeans' opinion on noise pollution and annoyance, it is almost one-third of the European population that reported noise problems. In Latvia, according to Latvia's Central Statistical Bureau data on households reporting noise problems, nearly 15% of residents reported noise as one of the issues impacting their household in 2018. Receiving complaints from residents is a strong signal of the need for action on environmental noise management, taking into account that only a part of noise annoyance can be explained by acoustical factors alone.

In order to tackle environmental noise pollution and its health and socio-economic impacts on people, environmental noise management as a strategic and complementary set of measures is used, including the development and implementation of the policy based on the identified problems and their assessment. Environmental noise management is being implemented at different management levels - global, national, and local level -, as each level has its own functions, also taking into account a top-down and bottom-up approach. However, there are many deficiencies in strategic implementation of environmental noise management, that in particular includes low government commitment and political will, public awareness, stakeholder participation, inadequate infrastructure, weakness in policies, standards, and regulations, deficiencies in data for emissions and health impacts, etc. (Schwela *et al.*, 2008). One of the most important factors influencing environmental noise management is legislation and policy framework because, without it, it is difficult to maintain successful noise management that reaches its goals. There is a set of comprehensive legislation regarding environmental noise management in the EU that includes sectoral requirements and framework legislation (Directive 2002/49/EK). In addition, to progress in environmental noise management, the practice from countries that implement noise management since the 1960s can be used. In the United Kingdom, for instance, has guidance for local authorities and sets criteria for construction practices, designation of quiet areas, action planning and prioritization.

3. METHODS AND METHODOLOGY

3.1. Research methodology (research design)

In order to study and analyse actual problem situations in Latvia associated with environmental noise, to identify best practices and to develop a practice-based model for environmental noise management in Latvia, and to elaborate proposals for management process improvements, the research process was organized in several main steps. These steps include: problem identification and setting of the research objectives and aims; general analysis of documentation and scientific articles on environmental noise and its management; research on legislation and institutional system in the Baltic and other European countries; scrutinization of the environmental noise policy planning and management practice case in Latvia; identification of environmental noise management deficiencies and their possible solutions in Latvia; development of a management model and elaboration of recommendations for noise management process improvements. The methodology of the research is illustrated in Figure 3.1.

Problem identification and setting of the research objectives and aims are discussed in the **Introduction** part of the Thesis. Environmental noise, its health and socio-economic impacts, topicality of noise pollution and issues of environmental noise management were analysed through the review of scientific publications, different studies and reports, policy documentation and EU legislation thereby ensuring an overview of environmental noise management topicality, its policy, used management approaches, and highlights. It also includes empirical and statistical data analysis on the topic. This is described in **Chapter 1** and **Chapter 2** of this Thesis. Chapter 2 also highlights the information of the environmental noise management in the United Kingdom and the Netherlands, describing specific practices of the noise management there. These countries are chosen for the practice analysis because they are the first European countries, where noise management started to be developed in the 1960s and 1970s. In 2012, the United Kingdom examined the effectiveness of its noise policy actions carried out since 1960 in reducing the impact of the noise emissions and noise annoyance and improvements in legislation and control. The study showed a remarkable reduction of the areas with elevated noise levels, thus allowing to consider that the developed policy and legislation have enabled such results, and it could be a practice to incorporate elsewhere (Basner *et al.*, 2015). In the Netherlands, the implementation of the policy has helped to reduce noise pollution from transport along national roads reduced by over one-third in five years (OECD, 2015).

Chapter 4 analyses information on European practices of legislation implementation, institutional frameworks, and governance of public feedbacks with the aim to show how environmental noise is managed in other countries. The analysis of environmental noise management included the investigation of national legislation in Latvia, Estonia and Lithuania, comparison with the EU legislative acts. The Baltic States have been chosen for the legislative research, because they have a similar social and economic background, and noise management can be impacted by the judicial systems, culture, behavioural patterns, settlement structure, weather and geographic conditions (Lictra *et al.*, 2015; Basner *et al.*, 2015). The environmental noise management's institutional system, as well as environmental noise control and public feedback management process, were analysed in several EU Eastern enlargement countries – Lithuania, Estonia, Poland, Slovenia, and Slovakia. These countries have been chosen for legislative and institutional research, because of the need for Latvia to develop environmental noise management at a fast rate – Latvia developed its environmental noise management framework only around the year 2004 when joining the EU. The example of other countries that also had to develop their frameworks at the same time can show the best and most efficient way how to improve noise management during a limited time period, i.e. in order to see how to speed up processes. Based on these studies, it was possible to outline a general noise management institutional model in Europe and to identify best practices in institutional and public feedback management aspects.

Chapter 5 of this PhD thesis outlines environmental noise policy planning at the municipal level in four Latvian areas - Rīga, Saulkrasti, Mārupe, Ogre, and Valmiera. This includes the analyses of policy documents at the municipal level regarding environmental noise. Policy planning of environmental noise management in other European countries was not analysed, because the range of

the different situations is too broad, and the interchangeable comparison and its application to the Latvian situation may lead to false conclusions.

Chapter 6 of this Thesis is devoted to the research of local level acute and practical environmental noise management cases. These cases describe noise problem situations from diverse noise sources, at different management levels, as well as cases raised by society in this regard. As environmental noise management should be based on acoustic (empirical) and non-acoustic aspects, the case studies take into account both of these (Suau-Sanchez *et al.*, 2011; Guski, 1999). Problem cases of environmental noise management in other European countries were not analysed, because the range of the different situations and circumstances is too broad, and the interchangeable comparison and their application to the Latvian situation may lead to false conclusions. The chapter also includes analysis of Latvian public feedback management (public reaction on acute, practical situations).

Chapter 7 summarizes conclusions from research on the policy and practical environmental noise management situations in Latvia that were conducted through several interlinked steps that allowed the studying of the national legislation and its accordance to upper-level legislative acts, noise management institutional system, local (municipal) level environmental noise policy and its planning, local level practical environmental noise management cases, as well as environmental noise control and society feedback management. This helped to establish how noise management is theoretically and practically managed in Latvia at the same time made it possible to identify the weaknesses and propose further improvements for both policies and practical implementation.

Based on the identification of environmental noise management shortcomings in Latvia and possible solutions (also based on the practice analysis of other countries), **Chapter 8** provides a description and illustration of the developed practice based environmental noise management model for Latvia that derives from the research and conclusions of the previous methodological steps of the PhD thesis and includes set of integrative processes horizontally at national and municipal level and vertically.

Chapter 9 includes the approbation of the proposed environmental management model through the expert survey and analysis of the best practices of other countries (that shows that this is already in use) and details further steps for the practical implementation and proposed suggestions to enhance future improvements and applicability.

The last part of this Thesis provides conclusions of the research.

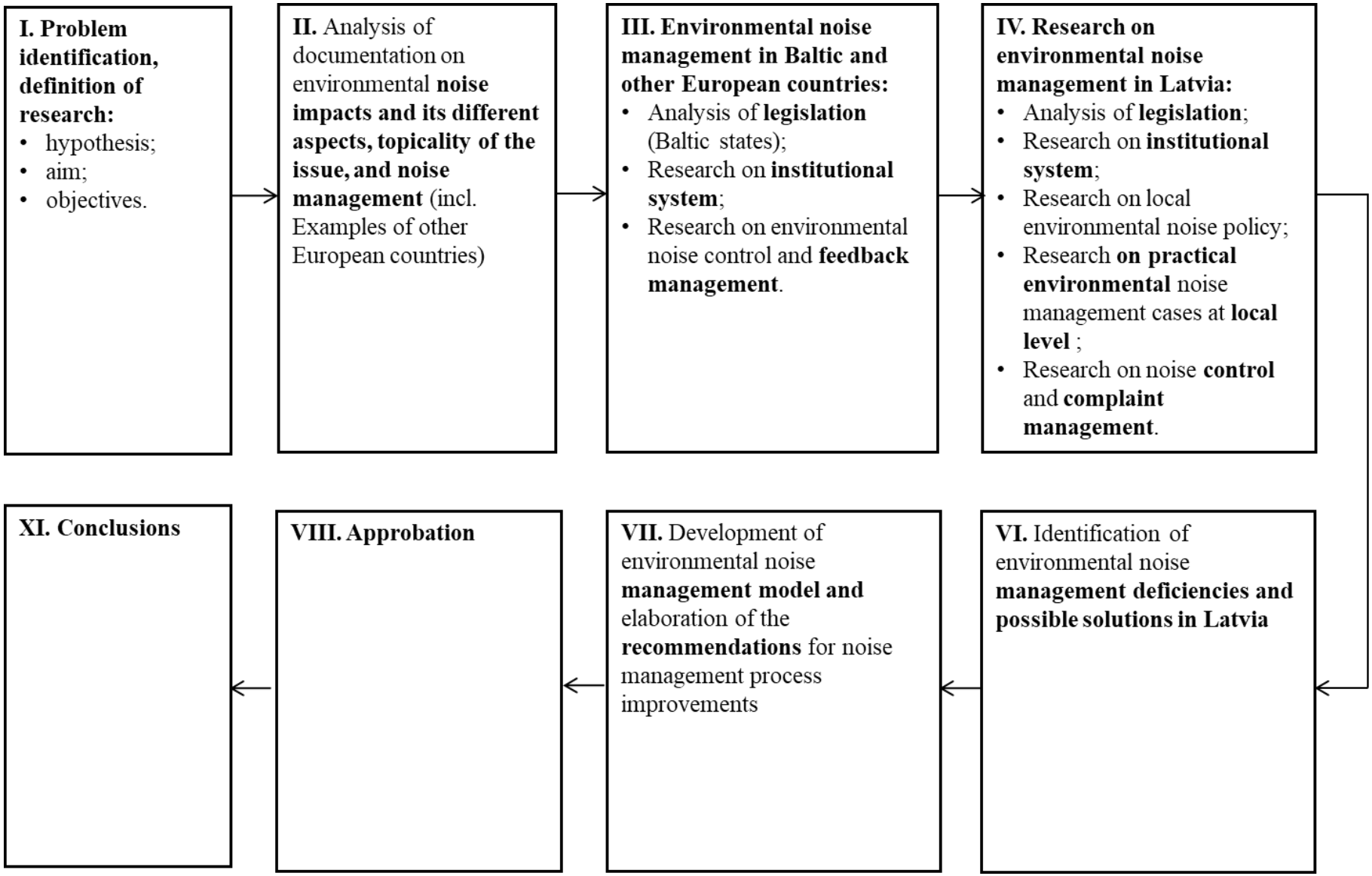

Figure 3.1. Research methodology (created by the Author)

3.2. Methods used

3.2.1. Theoretical section

Chapter 1 and Chapter 2 of the Thesis consist of the literature and documentation review, as well as the analysis of the statistical and empirical data on the subject.

3.2.1.1. Literature and documentation analysis

A literature review of related works in the field of study (i.e., environmental noise management) was done in order to gather information on noise management, impacting factors, approaches, theories, tools, as well as to characterize and analyse the problem and possible solutions and practices already described above. The document review in the field of study was done, including components of content and thematic analysis methods and involving thorough examination and interpretation. For this purpose, information from scientific publications, conference papers, legislation, and planning documentation, books, reports, statistical data, and other sources were analysed. The literature and document analysis was not only used to understand the development of empirical knowledge, but also to gather secondary empirical data and use them for further and practical studies, especially in the combination (triangulation) with data from sociological research methods, such as interviews and observations, to establish credibility of the research (Bowen, 2009).

3.2.1.2. Analysis of statistical and empirical data

In order to gain information on the topicality of the environmental noise pollution in Europe and Latvia, primary data array from EU-wide environmental noise mapping were analysed. This included data on 467 agglomerations and their L_{den}, L_{night} values in different sectors across Europe from noise mapping done in 2007, 2012 and 2017. Taking into account a large number of countries and environmental noise agglomerations and their different characteristics, in order to compare the environmental noise situation within them, the agglomerations were grouped by the country and a distributional characteristic of a group (minimum, maximum, median and quartiles) that was mathematically calculated and illustrated in boxplot charts. Also, the top ten noisiest agglomerations in each noise source group were detected and illustrated using data on L_{den} and L_{night} levels (over 55 dBA and 50 dBA, respectively, as it is the environmental noise mapping threshold and of which it is considered that health effects might arise). In order to see if the inhabitants in these agglomerations are exposed to noise levels close to the threshold or if they are subjected to loud noise levels, information on L_{den} and L_{night} levels over 70 dBA and 60 dBA, respectively, were analysed using the same approach. This allowed showing the topicality of environmental noise pollution in the EU and the situation in Latvia in comparison to other countries.

Also, long term primary statistical data from the Central Statistical Bureau annual survey ("MTG010. Percentage of households pointing to particular problems with their home environment (%)") were used in order to calculate the trend and its descriptive coefficient of determination (R^2) to show the proportion of variance in the dependent variable that can be explained by the independent variable. The strength of a relationship based on its R-squared value was detected.

Data representations are performed using the Microsoft Excel program functionalities.

3.2.2. Analysis of law and institutional system

Chapter 4 includes the analysis of the legislative acts and the institutional system using the document analysis method. It included a thorough and systematic review of documentation. The study included the analysis of the Baltic States legislation on the topic and institutional system and Latvia's municipality planning documentation in order to analyse their content and identify their common features and differences. Content and thematic analysis elements were incorporated into the research.

In order to have a more detailed and balanced view of the situation, and to minimize weaknesses and inherent biases that might arise from single method, single-observer or single-theory studies, the author uses triangulation (sociological) as an approach that foresees the application and combination of multiple sources, methods or empirical materials to investigate on the same situation or process. The triangulation approach was used in each of the cases.

3.2.2.1. Analysis of legislation

For the purposes of the research the Baltic States legislation study was conducted in order to determine the influence of this factor on noise management, the respective legislative frameworks of the Baltic States were analysed. The study demonstrates how countries plan to implement noise management duties assigned to them.

The study questions were:

1. How the countries have transposed the requirements of Directive 2002/49/EC (because directives, unlike regulations, are not directly applicable and the Directive must first be transposed into national law before it is applicable in each EU country)?
2. How is the national noise management designed at the national level in order to take into account the local specifics and reach the general aim of the Directive 2002/49/EC – to protect society against noise?

The study contains the inspection of both aspects mentioned above. The research included, in particular, the analysis of the legislation, as well as the analysis of the literature and EC reports in these aspects. The legislative acts were retrieved from the official journals of all countries at the time the particular study was done, using information from the consolidated versions. The information on documentation analysis is given in Table 3.1.

Table 3.1. Scope of the analysis of legislation (created by the Author)

<table>
<tr><td colspan="2">Documentation analysis</td></tr>
<tr><td>Documents selected</td><td>Data analysed</td></tr>
<tr><td rowspan="4">• Latvian environmental noise legislation
• Lithuanian environmental noise legislation
• Estonian environmental noise legislation</td><td>Legal requirements - conceptual and procedural frameworks</td></tr>
<tr><td>Permitted maximum noise levels</td></tr>
<tr><td>Institutional system</td></tr>
<tr><td>Transposed requirements of the Directive</td></tr>
<tr><td>EC report on noise management (Milieu Ltd., 2010)</td><td rowspan="3">Additional information on the legislation and its weaknesses or strengths for data triangulation needs</td></tr>
<tr><td>Other research articles (Runvda & Luik, 2008)</td></tr>
<tr><td>Court decisions</td></tr>
</table>

The study allowed comparison of the legal requirements, allowed maximum noise levels and institutional frameworks in the Baltic States. The data and information gathered in the investigation were described and analysed in several sections. First, the Baltic States' legal frameworks on noise management, which officially determine the management conceptual and procedural frameworks, were described. Then, the maximum allowed noise levels, and institutional structures were compared. Finally, the conclusions about legislation as noise management-influencing factors were given, and recommendations for the development of management through the adoption of practices from the neighbouring countries were proposed.

3.2.2.2. Analysis of the institutional system

In order to see how noise is institutionally managed in other countries from the sixth EU enlargement, international institutional research on Slovenia, Slovakia, Poland, Lithuania, and Latvia was carried out. In addition, information on Serbia and North Macedonia as pre-accession countries that need to implement EU regulations were also added for data triangulation. Due to the lack of publications exploring the issue of environmental noise, the information was mainly obtained through document analysis and structured interviews with experts from each mentioned country, that also provided information collection from the competent authorities.

The research questions were as follows:

1. What institutional systems are in force in several EU Eastern enlargement countries – Lithuania, Estonia, Poland, Slovenia and Slovakia – as well as of EU pre-accession countries – Serbia and Macedonia?
2. What are the needs for the improvement identified in these countries regarding institutional system?

The information on documentation analysis is given in Table 3.2.

Table 3.2. Scope of the analysis of institutional systems (created by the Author)

Documentation analysis		Other methods
Documents selected	Data analysed	
Environmental noise legislation	Institutional system and functions of each institution	• Partially structured interviews with Latvian State Health Inspectorate on the noise complaint management scheme; • Information from the complaint management order (in Slovenia, Slovakia, Poland, and Lithuania, as well as in Serbia and North Macedonia) gathered from working international working party participants from respective state (described in sub-chapter 6.4. of these Thesis).
Other research articles		

The analysis of the institutional system included the determination of institutional system and functions of each institution, and information from the complaint management order (described in sub-chapter 6.4. of these Thesis).

3.2.3. Practical research on local level noise management practice

The case study method has been used because it allowed investigation of the practical experience and offers proposals for problem-solving or development of similar systems. A case study is conducted as an empirical study, in which real-time and environment examples are investigated. The main issues on which the Author is looking for answers are “what,” “how,” “where,” and “why.” This case study method allows for extensive discovery of social, cultural, and political factors possibly associated with the phenomenon of concern that may not be known in advance. Within the scope of this Thesis, it would help to discover environmental noise management practice and understand deficiencies at a municipal and state level, its impact factors, and conclude on how noise management can be improved. The case study analysis is usually qualitative, but heavily contextualized and detailed, thus including empirical data as well. Taking into account that there is a need to establish causality and conclusions and management model, and a single case may not be immediately generalized, the Author uses a multiple case design to study practical environmental noise management in Latvia (Bhattacherjee, 2012).

Case studies were chosen in order to investigate on the most acute and topical noise management issues and noise sources. The case studies were designed so that the research could give the most detailed information on the most widespread noise source types in Latvia (according to noise mapping data), as well

as the information on state and municipal level environmental noise management from different perspectives. Therefore, the Author investigated road, railway, and industrial noise management practices from different special focuses perspectives – EIA, object construction and utilisation, wind farms and horizontal overall management, including policy implementation, - in order to gather information and analyse special topical issues in Latvia and particular management processes. All studies horizontally provided information on the state and municipal sector, noise source manager, and viewpoint of inhabitants. Figure 3.2. shows case study design scheme, including information on special focuses of each study.

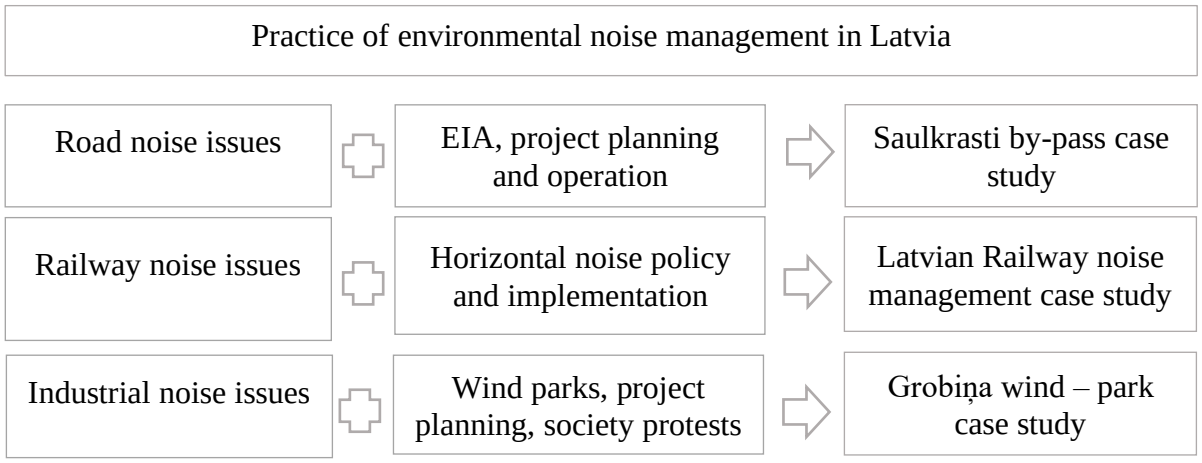

Figure 3.2. Integrative methodology of the Latvian municipal practical environmental noise management case study research (created by the Author)

During the case studies, documentation analysis and sociological research methods were combined in order to identify environmental noise management situation in Latvia, perform a comprehensive assessment of environmental noise issues and develop proposals for improvements based on the conclusions and actual noise management problems. Case studies also included a triangulation approach due to the reasons described above.

Main research questions in all of the selected case studies were:

1. How the environmental noise is managed in the particular case?
2. What is the acoustical noise climate and what are the public views on the noise situation and its management (taking into account that noise impacts on the public should be viewed as a complex of acoustical and non-acoustical factors) (Suau-Sanchez *et al.*, 2011; Fields *et al.*, 1997; Collette, 2011; Job, 1997; Guski, 1999).
3. What are noise management issues, and how can they be improved?

All case studies were conducted with a similar design and sections of research (see Table 3.3).

Case studies were designed in order to investigate not only on acoustic, but mainly non-acoustic factors impacting public noise annoyance (Suau-Sanchez *et al.*, 2011; Guski, 1999), because only about one-third of noise annoyance can be explained by acoustic properties of noise.

Table 3.3. Case study research design (created by the Author)

No.	Research part	Clarification, including on methods used, sources, etc.
1	Selection	Identification of acute situation regarding each noise source, taking into account public information from periodicals
2	Acoustical situation – empirical data	Empirical data on environmental noise levels set (gathered from documentation analysis)
3	Non-acoustical situation – data on public views	Data on the population's attitudes, views, burden, and annoyance regarding environmental noise gathered using (depending on the case study's characteristics):
		• Sociological survey provided by the author
		• Documentation analysis
		• Analysis of periodicals and website news portals (articles on noise from particular noise sources and public opinions, actions)
4	Conclusions	Conclusions and suggestions for improvements

3.2.3.1. A case study in Kurzeme – an example of industrial noise

It was decided to do a study of the wind turbine noise within the framework of industrial noise case, because only limited information is available on the population's perception of newer sources of noise, such as wind turbines. (WHO, 2018) There also have been several public initiatives against wind parks in Latvia.

The study consists of the research of Kurzemes region´s in the context of wind park developments. The case study includes an on-site inspection of the research territory (the particular area of the wind park) at the parishes of Grobiņa and Vērgale, as well as Medze (hereafter – in the text when speaking about the parishes, only the toponym will be used), analysis of documents (spatial planning document, court decision), literature and legislation analysis in order to obtain empirical data on noise situation.

The Grobiņa wind park case was selected for the study for several reasons. First, wind turbine noise is an industrial noise, and it is the third most important noise source in Latvia (European Commission, 2019). Second, the use of renewable energy and the number of wind farms is growing worldwide, and scientists and policymakers have increasingly focused on their environmental impact (Basner *et al.*, 2015). Third, the wind park development region raised public concerns, that included environmental noise issues, and the case was brought by local residents to the Constitutional court of Latvia and the Court of Human rights. In addition, to Kurzeme region was also chosen as a research territory because of the meteorological and orographic situation, the existence of wind parks and their development perspectives in it and other neighbouring regions on the sea coast, public feedback and constitutional cases brought to the courts.

Within the framework of the study, structured interviews were conducted with inhabitants of Grobiņa and Vērgale living within 500 m of the wind turbines (n = 37). The selection of interviews included 50% of Grobiņa households (in the area of the wind park) and 100% of those of Vērgale. Interviews were carried out by the Author visiting households in the areas of the mentioned wind farms, reading out the questions to the interview participants, and writing down the answers given in the blanks. The Author went to each house in these wind park areas, and met 29 people of which two refused to answer the questions and 27 respondents agreed to give an interview. The interview was carried out as semi-structured interview, including pre-prepared open questions, allowing respondents to add information and tell additional details of the situation. The interviews included questions about the respondent´s point of view regarding the acoustic discomfort created by the wind turbine noise, residents' awareness of the possible negative effects of wind energy facilities, as well as the population's participation in the processes of territorial planning. Author also made visual observation of the respondent's house and its condition (see Annex III for the interview questions and Annex VII for data on respondents).

3.2.3.2. A case study in Saulkrasti – an example of road traffic noise

Another case study was made in order to investigate the road noise issues, as well as the EIA efficiency and effectiveness of most troublesome and annoying noise source in Latvia and Europe (European Commission, 2019). EIA shows environmental noise prevention and impact reduction is evaluated and taken into account in the ex-ante assessment form. However, it is of utmost importance to understand if it has succeeded to ensure environmental and health protection. The study comprised not only of the case study about road transportation noise but also an ex-post examination of EIA relating to noise issues by the analysis of noise mitigation action efficiency and their resulting effectiveness. This approach is chosen because of the close interrelation of efficiency and effectiveness concepts, which mutually complement one another and allow for the systemic ex-post appraisal of EIA and determine whether, and how well the purpose of the process is accomplished.

For the location if case study, the Saulkrasti by-pass road was chosen. The object of the research is a 20 km long span of road of international significance, the VIA Baltica. The EIA for it was conducted through the years 2000 to 2001; the road was constructed in the period from 2005 to 2007. This project as the object of the study was chosen for the following reasons: the subject of this project is a road noise source, the project provides public benefits, the EIA for the project was concluded, noise mitigation measures were required, and the road is already operating.

The research includes empirical data analysis obtained from EIA documentation, noise level measurements done by the Rīga Technical University, and on-site observation of the project area. The research also consists of national environmental noise legislation analysis and structured interviews with nearby residents (see Annex III for the interview questions).

Interviews were held with local residents whose households are within 200 m of the motorway in places where noise abatement measures were planned (n = 85), excluding summer cottages. The interviews were chosen by random selection approach. Interviews were carried out by the Author visiting households in the mentioned areas, reading out the questions to the interview participants and writing down the answers given in the blanks. Interview questions dealt with the respondents' viewpoint regarding acoustic discomfort and other effects on their health or behaviour produced by road noise, as well as any involvement in the EIA process that they had and actions for noise impact reduction. The selection of interviews included 28% of local residents (n = 24). Surveys with owners of allotments and summer cottages were excluded from the study because maximum noise levels in these areas are not regulated by national legislation directly, people remain there for a relatively short period, and most of the dwellings are not in line with Latvian standards of building acoustics. Annex VIII provides data on respondents.

The results of the study are described and analysed in several sections. The information about noise issues and the efficiency of noise mitigation activities is provided in the EIA report is determined through the comparison of predicted and actual noise levels using data obtained by the Rīga Technical University and the EIA report. Then, the noise perception and effectiveness of the EIA is evaluated by analysing the results of the resident interviews about the effects of noise abatement actions on them and the quality of their living environment. Finally, the conclusions about EIA ex-post examination about noise issues in aspects of their efficiency and effectiveness are given.

3.2.3.3. Analysis of noise source manager activities – an example of railway noise

Another case study was made in order to investigate noise source manager activities and general railway noise management practices on Latvian railways because railway noise is the second predominant noise source in Latvia (European Commission, 2019).

The railway noise issues were analysed through the analysis of primary and secondary empirical data obtained from RMR (Reken-en Meetvoorschrift Railverkeerslawaai; hereinafter – RMR) method testing (Rīga Technical University) and environmental noise mapping data and action plans, as well as other document analysis on railway noise and its causes.

It also included in-depth, semi-structured interviews with noise and railway experts – environmental and development specialists of Latvian Railway (Māris Poikāns, Kārlis Dreimanis, Daiga Helēna Žideļūne, and Gundars Jansons) and researchers of the Rīga Technical University (dr.sc.ing. A.Baranovskis). These experts were chosen due to their knowledge on railway development, environmental aspects, or researches on railway noise in Latvia.

For analysis of the non-acoustical situation, media analysis was prepared which comprised of content analysis of periodicals and news portals from 1 January 2014 to 1 January 2019 using most descriptive keywords "railway," "noise," "complaints" (used in Latvian) and their combinations. From all articles, only those that comprised resident's views were chosen for further analysis (see Table 3.4.).

Table 3.4. Information on media articles regarding environmental noise from railway and resident complaints (created by the Author)

Media	Title	Date	Author
Latvijas Avīze	Broken houses and hopes: Rail freight vibrations in Kundzinsala are destroying buildings *(Title in original language: Brūk mājas un cerības: Dzelzceļa kravu pārvadājumu vibrācijas Kundziņsalā bojā ēkas)*	28 June, 2018	Zigfrīds Dzedulis
TVNET	Residents of Sarkandaugava want solutions to reduce rail noise *(Title in original language: Sarkandaugavas iedzīvotāji vēlas risinājumus dzelzceļa radīto trokšņu mazināšanai)*	23 September, 2016	No information
Skaties.lv	Residents of Sarkandaugava are worried about the noise generated by freight trains; calls on the public authorities to act *(Title in original language: Sarkandaugavas iedzīvotāji satraukti par kravas vilcienu radīto troksni; aicina valsts iestādes rīkoties)*	25 September, 2016	No information
Latvijas Radio	Sarkandaugava calls for reduction of rail noise; Latvian Railway pessimistic about changes *(Title in original language: Sarkandaugavā prasa mazināt dzelzceļa radīto troksni; LDz pesimistisks par izmaiņām)*	1 August, 2016	Vita Anstrate
Delfi	Citizens are fighting for freight rail noise reduction *(Title in original language: Iedzīvotāji cīnās par dzelzceļa pārvadājumu radīta trokšņa samazināšanu)*	31 July, 2016	No information
TVNET	Mārupe residents are worried about the huge wall that could divide the village *(Title in original language: Mārupieši satraukušies par milzīgo mūri, has varētu sadalīt ciemu)*	06 March 2015	Santa Kvaste

For needs of data triangulation, the case study also included a participatory approach through active involvement in the EU LIFE+ program project "Innovative Solutions for Railway Noise Management" LIFE11 ENV/LV376 ISRNM implementation (main partners: Latvian Railway and the Rīga Technical University), that included railway noise modelling and measurements, technical analysis, preparation of the surveys on noise protection walls, as well as public awareness raising.

3.2.4. Analysis of noise policy planning in Latvia's municipalities

In order to analyse environmental noise management in municipalities of different sizes comparative analysis of planning documents of municipalities in Latvia were made, and also more detailed case study was carried out regarding the development of Valmiera transport strategy.

3.2.4.1. Analysis of policy planning documents: scope and content

In order to analyse environmental noise policy planning in municipalities of different sizes, including the assessment of their obligatory and self-initiated counter-noise actions, a critical examination and content analysis of the accepted and existing regulatory and planning documentation of municipalities in Latvia were made.

First of all, an assessment of the noise management activities incorporated into regulative and planning documentation of the municipalities and their compliance with the national legislation has been conducted. This includes the investigation into activities relating to public activity, spatial planning as well as noise mapping and action planning (if applicable). Following that, the initiatives or activities over the formal fulfilment of legal requirements – the scope of the activities and their degree of detailed development, compatibility with the specifics of the local acoustic situation and best practice – were examined in order to detect whether municipalities tend to manage their actual noise issues optimally. For the assessment of the best practice, the groups of noise management measures of the SILENCE project report were employed (EC supported SILENCE project has developed an integrated methodology for an efficient reduction of urban traffic noise) (as the SILENCE project mostly describes the noise reduction measures related to road and rail noise before the decision to apply the measures was taken, the results of *Effnoise* research (EC contract relating to the effectiveness of noise mitigation measures) (Popp *et al.,* 2004) were analysed. It showed that the noise control measures used for other noise sources were compatible with those proposed by the SILENCE project. At the end of the analysis of municipality noise management actions, an evaluation is conducted, and suggestions are given.

As the objects of the study, four Latvian municipalities – Rīga, Saulkrasti, Mārupe, and Ogre – were selected. These are municipalities of different sizes (Rīga, and they are required to implement different legal requirements, as well as having different existing noise sources in their territories. Rīga municipality as a research object has been chosen, because it is the largest Latvian municipality in terms of number of inhabitants, and it is the only municipality in Latvia that has completed the process of noise mapping and action plan development, because it is the only agglomeration according to the Directive 2002/49/EC. The rest of the study's objects were selected due to the existing noise sources in their territory, as well as taking into account that these municipalities are suburban living areas, and people might want to rest from the urban noise environment. In Saulkrasti municipality, the major noise emitters are the major road and the railway line Rīga - Skulte. In Mārupe municipality there is the major airport and major road, as well are RailBaltica railway line is planned. Ogre municipality has multiple noise sources with similar noise importance, including major road and major railway line Rīga - Krustpils (according to Directive 2002/49/EC). The following municipality documentations in force have been assessed – territory and land use planning, development plans and regulations of public activities. Rīga municipality has prepared noise mapping and noise action plans. Also, the scope of review comprised strategic and regulative papers adopted by these municipalities by their own initiative, which either comprise or should contain information about noise abatement measures established in the respective municipalities. Examples of these are the environmental policy plans, transport network development programs, etc.

3.2.4.2. Valmiera case study

In order to see how the environmental noise aspects are taken into account in an integrative manner in municipal development and spatial planning, especially in regard to transport (as the main noise source), the Valmiera case study was performed (Krūkle *et al.*, 2017, Krūkle *et al.*, 2018, Krūkle *et al.*, 2019). The research highlights sustainable mobility - to have the ability of people to travel and supply goods in a way that balances environmental and socio-economic aspects and aims at reducing negative impacts on the environment, including noise pollution. The study was carried out using the research and development, case

study and participatory action research methods, as it allowed not only to provide sectoral and inter-sectoral analysis of the Valmiera mobility case, but also to provide policy suggestions to the municipality and other stakeholder groups, as well as a possibility for the author to participate in the society process and work together to review the situation and provide solutions for sustainable mobility development through participation in the transport strategy in Valmiera. The research, therefore, consisted of two main parts – the research on sustainable mobility, and the participatory action study.

Research on sustainable mobility issues in Valmiera was carried out employing the case study research method, aimed at the review of the existing situation and discovering solutions to problems in the field of sustainable mobility in Valmiera, as well as included policy recommendations for the municipality and other stakeholder groups. As the research was carried out on a long-term basis (from 2017-2019), it allowed concluding on the changes and adjust further recommendations in response to the conclusions of the study. The study included: the analysis data from a representative public pro-environmental behaviour survey (prepared by R.Ernšteins, J.Kauliņš, J.Brizga) that was carried out in 2016 within the framework of Latvia's State research program project "Vides daudzveidība un ilgtspējīga izmantošana" ("Application of environmental diversity and sustainability"; hereinafter - SUSTINNO), analysis of the main municipal level planning documents, on-site observations and cycling infrastructure testing and semi-structured in-depth interviews with representatives of eight main stakeholder groups, 112 express interviews on the street with Valmiera inhabitants, using the random selection approach and 10 in-depth, semi-structured interviews with households. The Author's contribution was the stakeholder interviews with the representatives of all eight main stakeholder groups and on-site observations, documentation, data analysis, and complementary and integrative analysis of sustainable – transport related data obtained within the project (detailed methodological scheme of can be found in Annex IV).

The participatory action research was carried during the process of the development of the transport strategy. Based on the above-described case of sustainable mobility in Valmiera, the Author provided a SWOT analysis and improvement proposals, that were sent to the municipality with an aim to support the municipality during the preparation stage of the transport strategy. The Author also participated in the public consultation of the Valmiera transport strategy, by reviewing the Valmiera transport strategy and commenting on the strategical document based on her professional knowledge and conclusions from previous case studies, taking into account the sustainable mobility concept, pollution management aspects, the complex and integrative use of governance instruments within all stages of the governance cycle and the needs of stakeholders.

3.2.5. Analysis of practical settlement of environmental noise problem situations, control and dealing with feedback from the public

In order to evaluate the practical resolution of environmental noise problem situations, noise control, and dealing with feedback from the public, a detailed analysis of the practical municipal noise-issue management is provided along with details of a collaboration mechanism between the municipalities and state institutions in Latvia. The study methodology includes studies of literature, documents, and legislation, as well as structured interviews with representatives of local administrations and responsible state institutions about the practical implementation of noise management activities. Also, international research about Slovenia, Slovakia, Poland, Lithuania, and Latvia was carried out in order to see how noise and society feedback related to noise are managed in other EU Eastern Enlargement counties. In addition, information on Serbia and North Macedonia as pre-accession countries that need to implement EU regulations were also added for data triangulation. The study included analysis on institutional aspects, the procedures for investigating public complaints, and social involvement in noise issues. Due to the lack of scientific data and reports, most of the information was gathered through personal communication with experts from each country.

Table 3.5. The scope of the analysis of feedback management and control (created by the Author)

Documentation analysis		Other methods for data triangulation
Documents selected	Data analysed	
Environmental noise legislation	Complaint management order	• Two interviews with the Latvian State Health inspectorate on the noise complaint management scheme • Work in a working party with partners of other EU Eastern enlargement countries • Information on EU pre-accession countries – Serbia and Macedonia.
Noise complaint reviews (official statistical information) 2007 - 2012	The scope and number of complaints	
Publications in Latvian periodicals and news portals (2011)	The scope and amount of complaints, petitions and public initiatives regarding environmental noise issues	
Official documents – environmental impact analysis (VIA Baltica case), petitions and court decisions (wind park case)		

For a unified approach, structured expert questionnaires were used. The questions in the questionnaires were built around a framework of themes to be explored. They included general questions on the topic - responsible institutions to deal with society feedback on traffic, industry, as well as the one responsible for awareness raising. Questions also included information on public initiatives in solving environmental noise issues. Also, information in the media and reports from governmental institutions were used.

The data on society feedback investigation mechanisms and noise control procedures was included in detailed questions on procedures how feedback from the public is investigated – a sequence of actions that are done to investigate society feedback, methods, and tools used, involved persons, mechanisms used to deal with negative results, for how follow-up inspection is organized, etc. The answers were collected using a telephone interview with a call centre operator and a face-to-face interview with the head of the regional Control division of the State Health Inspectorate of Latvia. The replies were entered into the sheets.

3.2.6. Modelling and approbation of the model

The environmental noise management model derives from the noise management practice in Latvia, including proposals for the improvements based on identified shortcomings and the best practice identified.

The model was prepared using a business process modelling technique that allows an analysis of the activities and representing the management processes, thus determining which current processes may be improved. This includes strategic management process analysis and representation using activity diagrams that graphically illustrate workflows of interrelated activities. The processes are then unified in an integrative model based on institutional and functional conformity and the relevant categorization of the levels at which these processes take place. For easier understanding of the noise model process schemes, the colour schemes are used – the green colour is used for municipal level and blue – for the national level.

As the management model (including proposed improvements in the existing processes) cannot be practically tested, because this would require institutional and functional changes at different management levels and institutions, as well as requiring political will to implement the model. However, the proposed model itself is based on the analysis of practices in Latvia and other countries, and the development suggestions derive the applied practices and are intended to solve identified problem issues, thus proving the effectiveness and practical applicability of the model. In order to prove that the chosen practices and proposals for the environmental noise management model could be functional (in Latvia's situation) and the offered processes' improvements are tailor-made, useful and efficient, the expert interviews with municipal representatives and state institution experts, scientists and acousticians were carried out.

The experts were chosen from the municipal and state levels because the proposed environmental

noise model institutionally and functionally consists of municipal and state level processes that are implemented at those levels. The choice of experts primarily (but not only) included those institutions that would have to implement the new or improved process steps of the model if they are introduced in practice. The municipal expert selection included municipal environmental specialist, head executives of Latvia's municipalities and the environmental councillor at Latvia's Association of Local Governments. Experts at the national level were from institutions working with environmental noise legislation and those responsible for issuing pollution permits, conducting noise control and monitoring. In addition to that, other practitioners, scientists, and non-governmental organizations were interviewed. The information on the experts interviewed is given in Table 3.6, but the Annex VI provides brief summary (main points) of these interviews.

The expert consultations were held through semi-structured interviews. Before each interview, the environmental noise management model proposal (full of particularly concerning the competence of the interviewee) was presented to the expert. The experts were then questioned on their opinion of the proposed model, especially regarding proposed developments of processes dealing with the environmental noise management model and its processes, the practical applicability of the model, necessity and other proposals, if such were brought forward by the respective expert. The received opinion was then evaluated and taken into account (where appropriate). According to the comments, corrections in several process schemes were made. The discussion on experts' proposals is included in Chapter 9 of this Thesis.

Table 3.6. Expert interviews for model approbation (created by the Author)

Municipal level experts	• Mayor of Ogre municipality • Councillor at the Latvian Association of Local Governments • Mayor of Valmiera municipality • Rīga Municipality Housing and Environmental department specialist
National level experts	• Deputy head of the State Environmental Service • Head of the unit of the Environment State Bureau • Head of Vidzeme region Control division of State Health Inspectorate • Head of Environmental protection department of the Ministry of Environmental protection and regional development (hereinafter – MoEPRD) • The chief specialist (in the environmental noise field) of the Lithuanian Health Ministry, Department of Public health, Health risk management unit
Other experts	• Dr.sc.eng., Member of Latvian Acoustician Association, Researcher at the Rīga Technical University, Member of the board at the LNK Aerospace group • Engineer, Member of the board of NGO Resilience that implements environmental and social projects, including on environmental noise • Head of environmental management at Latvian Railway • Public health specialist, lead researcher, at Rīga Stradiņš University, Safety, and Environmental Health Institute

Since one of the main proposals of environmental noise management process improvements includes the establishment of a Noise Prevention council which is the best practice from Lithuania and other countries, an expert consultation was carried out regarding this council. This consultation was used to clarify how the noise council works, how the expert evaluates the work of the council, what the conclusions on the council's work are through an analysis of the current practice, are there any changes planned in this respect, etc. The consultation was carried out using an expert interview with the chief specialist (in environmental noise field) of the Lithuanian Health Ministry, Department of Public health, Health risk management unit. The questions and answers are available in Annex V.

3.2.7. Additional data and triangulation

The additional data triangulation includes participation in other research projects regarding environmental noise in Latvia. These projects are not analysed as, detailed, full-scale case studies in the Thesis, but the data and information gathered thought them are used in the Thesis. Taking into account that PhD researches were carried out from 2011 – 2019, in cases where the situation might have changes, the author ensured additional data validation.

3.2.7.1. Participation action research within EC Programme "Youth in Action" project "Noise impact management in an urban environment in Ogre town"

In order to ensure additional triangulation and reduce bias, the Author also participated in several projects dealing with environmental noise. For instance, the author participated in the project *LV-12-E147-2013-R2 "Trokšņa ietekmes vadība Ogres pilsētvidē"* (*"Noise impact management in an urban environment in Ogre town";* hereinafter - ANTI-NOISE) as part of a participation action method, because participatory research is used as a scientific research method that combines social research with education and political action, and allows the researcher to work with the community in order to understand and resolve community problems. The participatory research method is described by several main characteristics: participation by the people being studied; getting to know the popular ideas; consciousness raising and education of the participants; political action. The participatory research includes discussions of personal experience through interviews, group work, and surveys, as well as analysis of public documents, etc. The participation research also allows integrating other actions that the research finds to be the most suitable in reaching the aim.

The participation research has been done through the project where four Ogre town residents conducted research on sound environment and environmental noise. The project participants were selected considering the place of their residence, gender balance, and interest in the issues. The Author was the group leader. During the project, environmental noise measurements were carried out on Ogre tourism path and near major noise sources (railway line Rīga – Aizkraukle and A4 motorway) and sound sources were identified, thus providing information on Ogre tourism path as a soundscape path.

The Author developed an express on-line questionnaire in the municipality's official web-page on resident's opinion on the topicality of environmental noise in Ogre (n = 1671) and the focus group discussion (n = 11) with Ogre residents on the results, that are used in this PhD thesis. The Author then discussed the results with the mayor of Ogre municipality E. Helmanis in semi-structured interview. Also, communication and dissemination campaigns were organized, and people from the group participated in seminars and workshops related to environmental noise (national noise awareness day, learning how to make noise measurements, etc.).

3.2.7.2. Participation in the Rīga municipality project "Promotion of New Urban Noise Management Approaches in Rīga"

The author also participated in the *project "Jaunu pilsētvides trokšņa pārvaldības pieeju veicināšana Rīgā" ("Promotion of New Urban Noise Management Approaches in Rīga").* Within the project, a "public perception environmental noise and sound map" was created according to the perception of the public, which will show places that the inhabitants consider to be noisy and unpleasant, and places which are favourable and pleasant from the point of view of sound. The data from perception maps were complemented with a cell phone-based noise measurement application data. These data on perception were then compared with the Rīga environmental noise map. The conclusions were discussed with Rīga City council (environmental specialist). The author participated in the research through designing the scope of the project, providing participants with instructions on how to do the process, and, analysing data.

These complementary activities are not described in the thesis separately or as separate case studies,

but data obtained during these activities are used in the thesis (data from questionnaires, interview data) and the author was permitted to use the obtained information for verifying the case study provided in the Thesis.

3.2.7.3. Provision of data validity

As the PhD researches that were carried out in the period of 2011 – 2019, thus allowing to show the environmental noise management and its development in the medium term in Latvia. As practical situation cases provide information on main issues and highlight factors impacting public attitudes, data are valid for using for management conclusions. In order to apply valid data and conclusions, information on management practices applied and content of planning document and legislation, the main conclusions and data were rechecked in approbation interviews or in latest documents, thus allowing conclusions on improvements within the mentioned period to be validated. This, for instance, refers to planning document analysis when both, previous and new, planning documents were analysed or additional interview questions on EIA practices during thesis approbation interviews.

3.3. A brief summary of Chapter 3

The PhD thesis uses literature, document, and statistical data analysis methods to illustrate environmental noise impacts, problematic in Latvia and Europe, the necessity for its management and its issues, as well gives an insight in practices of environmental noise management in the United Kingdom and the Netherlands. This allows to highlight the research problem and justify the necessity of this study.

The research comprises an institutional system and legislation analysis to show noise management in different countries that need to develop noise management at a fast pace, thus identifying the practices that are already approbated and can be further implemented elsewhere.

The Author employed a case study research methodology to illustrate environmental noise management practices in Latvia regarding road, railway, and industrial noise from different perspectives because these are the most topical noise sources in the country. All case studies made use of empirical data on the acoustical situation as well as complementarily show the society feedback and provides knowledge on non-acoustical factors using sociological research methods.

The research also includes analysis of environmental noise planning and general environmental noise policy and implementation in them based on an analysis of cases in 5 municipalities in Latvia.

The information and conclusions obtained through the above-mentioned analysis are used to develop an environmental noise management model for Latvia using a business process modelling technique. The model includes proposals for improvements in the management processes based on the shortcomings and practices identified. The model is then approbated through expert interviews with state and municipal level experts.

4. RESEARCH ON ENVIRONMENTAL NOISE MANAGEMENT ISSUES IN EUROPEAN COUNTRIES

Environmental noise management issues in European countries, including Latvia, are investigated from different, but closely linked and successive aspects – in terms of legislative, institutional, policy, practical noise management case aspects and dealing with society feedback. This chapter in particular analyses information on legislation, institutional systems, and society feedback management aspects in other European countries, however, information on Latvia's case (at national level) is given for reasons of better compatibility.

4.1. Legislation in the Baltic States

4.1.1. Legislation

The Baltic States have developed over a similar path in time from a similar socio-economical background, joined the EU together and transposed regulations of EU directives into their respective national legislation; their geographical and meteorological conditions are similar, but their noise management conceptual, legal and procedural frameworks differ.

The noise management legal framework in the Baltics consists of a diverse level and scope of noise sector legislative acts. The noise management procedure – the aims, methods and responsible authorities for the implementation of the requirements and its control – are set out in Estonia's "Ambient air protection act," Latvia's "Law on pollution" and Lithuania's "Law on noise control". These acts define general provisions and transpose the requirements of Directive 2002/49/EC. All countries have included in those acts the regulations relating to noise mapping, noise action planning, the application of noise indicators L_{den} and L_{night}, assignation of responsible authorities, cooperation with neighbouring countries and informing society and EC about noise management activities.

The Baltic States have also developed sectorial noise management rules that set the maximum allowed noise levels, describe control, and regulate the use of noise emitting equipment and transportation noise according to the requirements of other EU Directives.

The summary of the main noise management legislative acts in the Baltic States is given in Annex IX. The grouping of noise legislation shows that the noise management approaches in the Baltic States are similar because they transpose the direct requirements of EU Directives and fulfil the main goals within them. However, the chosen methods and the noise management rules differ due both in terms of content and in the degree of detail.

Lithuania's noise management legislation, unlike that of the other Baltic states, contains the most expanded strategic noise management descriptions. It clearly states the principles and tools for noise management, proposes the situation evaluation indicators, details the responsibility and tasks for each institution involved, and requires annual reports on noise management. Lithuania's legislation also contains the most detailed information on noise disturbance control procedures.

Estonia's noise management laws and regulations include all the necessary main information about noise management. Also, Estonia is the only country among the Baltic countries that has elaborated noise management guidelines for noise evaluation and control and disseminated them to the involved parties (Keskkonnaamet, 2018).

4.2.1. Environmental noise limits

In order to ensure acoustic quality and fulfil the tasks of Directive 2002/49/EC, all three countries have included within its legislation a regulation defining maximum allowed noise levels. The Directive 2002/49/EC avoids establishing a unified noise limit approach; each Member state has developed its own approach and set maximum allowed noise levels.

The noise limits used in the Baltic States and their range differs in each country. More detailed information about current noise limit values is contained in Table 4.1.

Table 4.1. Outdoor environmental noise limit values in the Baltic States, $L_{Aeq,T}$ (created by the Author)

<table>
<tr><th>Country</th><th>L_{Amax}</th><th>L_{night}</th><th>L_{day}</th><th>$L_{evening}$</th><th>Explanations</th></tr>
<tr><td>Latvia</td><td>+20 *</td><td>40-55</td><td>50-65</td><td>45-60</td><td rowspan="2">Limit values in Latvia and Lithuania cover all the country concerning certain residential and public areas regardless of particular noise source.
Maximum noise levels in a particular area are dependent on land use zoning.</td></tr>
<tr><td>Lithuania</td><td>+5 to +10</td><td>35-55</td><td>45-85</td><td>40-80</td></tr>
<tr><td rowspan="2">Estonia</td><td>-</td><td>40-60 (traffic noise)</td><td>50-70 (traffic noise)</td><td>-</td><td rowspan="2">Maximum levels in a particular area are dependent both on land use zoning and noise sources – traffic or industry.
Legislation determines:
• Target values for new and existing building areas, which generally do not cause annoyance and represent good acoustical conditions.
• Limit levels which characterize the maximum permissible noise level above which noise mitigation measures have to be implemented. Values of limit levels are shown in this table.
• Critical values which are calculated as +5 dB to +10 dB of the maximum permissible noise levels and the exceedance of which can cause strong annoyance and characterize the acoustic environment quality as harmful, as well as require the use of noise control measures.
In the meantime, there are no special noise level values for military and wind farm noise. Thus, experts tend to use the ones given for industrial noise (Runvda&Luik, 2008).</td></tr>
<tr><td>-</td><td>35-55 (industry noise</td><td>55-65 (industry noise)</td><td>-</td></tr>
</table>

**of indoor noise level*

As shown in Table 4.1, the maximum allowed noise levels in the Baltic States are specified with different approaches. Latvia and Lithuania have set their noise limits only in relation to land use planning, whilst the categories used for land use zoning are diverse. In Lithuania, the quietest environment both in daytime and night-time are the external areas of hospitals and sanatoriums, but the loudest environment is allowed in the areas of open-air concert halls and entertainment businesses. In Latvia, the lowest maximum noise levels both in daytime and night-time are prescribed for detached private houses and health, education and recreation areas, but the highest – for hotel, business and trading areas. The noise limits in Latvia are determined through the analysis of other countries' experience, but in Lithuania – based on resident feedback (Milieu Ltd., 2010).

A quite different approach is used in Estonia where noise levels are dependent on noise sources and the place where the noise source operates or is planned to be built, i.e., in an existing building area or a newly developed one. The noise limit values are chosen based on the assessment of health impacts, especially those relating to the strong, noise-caused annoyance (Milieu Ltd., 2010).

It must be mentioned that Estonia's permissible noise levels over time (levels at 2011 and 2019) have been reduced taking into account health effects, but in Lithuania and Latvia the permissible noise levels have been raised in some categories over the same period, that, possibly, is an indication of prevailing economic interests. The maximum permissible environmental noise values currently Latvia vary from 40 – 65 dBA (taking into account land use zoning), but previously (in 2004) they were in range from 40 to 60 dBA. The rise from +5 to +10 dBA concerns all zoning areas, including such noise sensitive areas as resorts, hospitals, child and social care facilities. In Lithuania the increase has not been so big – current maximum noise levels are 35 - 85 dBA, but previously they were up to 83 dBA. Estonian maximum permissible noise levels from 40 - 75 dBA is reduced to 30 – 70 dBA.

In 2017, in Latvia, society took the State to court on this issue of the approach applied for noise limit determination. Noise as environmental pollution affects the quality of the environment and can harm personal health; therefore, the State must protect the health of a person from environmental pollution and the person's ability to live in healthy environment that can ensure person's mental and physical development. The Court drew attention to the fact that the Cabinet of Ministers has set higher noise limits for motorbike racing (i.e., leisure noise) than for other sources. However, the development of the regulatory framework has not considered and substantiated the possible consequences of the noise concerned. Thus, the precautionary principle is not respected, and human dignity is not protected. When issuing legal norms that can have a significant impact on a person's right to health and the right to live in a favourable environment, it is necessary to consider not only economic and legal interests but also primarily holistic effects on health. It must be taken into account that noise management is an integrative set of activities, which cannot be aimed at favouring one stakeholder. Even though particular regulation that is brought to the court concerns leisure noise and does not fit in the scope of the Directive 2002/49/EC, it shows overall principles of noise limit level determination. (Latvijas Republikas Satversmes tiesa, 2017)

Taking into account above mentioned, Latvia and Estonia should consider developing the scope of strategic noise management and forming a noise action plan, which would help municipalities and state institutions to solve noise issues. Lithuania and Estonia could specify the procedural schemes similarly to Latvian legislation, but Latvia and Lithuania may use the Estonian example in order to develop noise management guidelines and evaluate the need to adopt an approach for setting maximum permitted environmental noise levels based on the assessment of health impacts.

4.2. Institutional system

Directive 2002/49/EC requires Member States to assign responsibility to relevant Authorities for the required implementation under Directive 2002/49/EC, including the Authorities which ensure data collection, development of noise maps and action plans, as well as their approval. However, each country needs an institutional system for implementing not only the requirements of Directive 2002/49/EC but also to ensure comprehensive environmental noise management in its different aspects. These aspects include legislation, policy planning, implementation, and control.

4.2.1. Institutional systems in the Baltics

The Directive requires states to assign responsibility to the relevant Authorities for the required implementation under Directive 2002/49/EC, including the Authorities which ensure data collection, development of noise maps and action plans, as well as their approval. In all Baltic States, the responsible institutions for general and sectorial noise regulation and the development of noise management regulations are ministries or their subordinated institutions (state health inspectorates). They are also responsible for data collection and informing the EC.

Responsible institutions for the practical implementation of the requirements of Directive 2002/49/EC are municipalities and noise source operators. Municipalities in Latvia and Lithuania have other functions relating to noise management – spatial and development planning, issue local level binding regulations,

coordination of building activities and public events, control of noise levels and identification of tranquil areas (in Lithuania also the monitoring of these areas). Apart from the development of noise mapping and action planning, municipalities also have the right to restrict traffic in their territories.

Noise level control from larger noise sources in the three countries is assigned to state health inspectorates, however municipalities also have the right to control community noise.

In contrast to Lithuania and Estonia, Latvia has separated its cross-border noise coordination activity and assigned this duty to the Environmental State Bureau. Although now no large noise sources exist in the border area, the legislation has been developed, taking into account future potential projects.

Lithuania

In Lithuania, in order to provide a coordinated approach, an inter-institutional consultative body - the Noise Prevention council (board) - has been established. It includes members from municipalities, scientific and health institutions, acoustic associations and public agencies. It considers issues related to noise management, helps municipalities to deal with specific noise problems, monitors implementation of Directive 2002/49/EC requirements and noise abatement measures, as well as collects data on the impact of noise on the population. A schematic summary about Lithuania is given in Figure 4.1.

The above mentioned illustrates that, in order to fulfil the requirements of Directive 2002/49/EC, similar institutional systems have been established in the Baltic states, however, the responsible institution for the fulfilment of the functions and tasks regarding strategic and practical noise management differs in aspects that are not regulated by Directive 2002/49/EC.

Due to their similar background, the Baltic States can more easily adapt those best practices introduced in the neighbouring counties, as well as communicating and cooperating on noise issues. This is important because the countries are small, and their resources are limited.

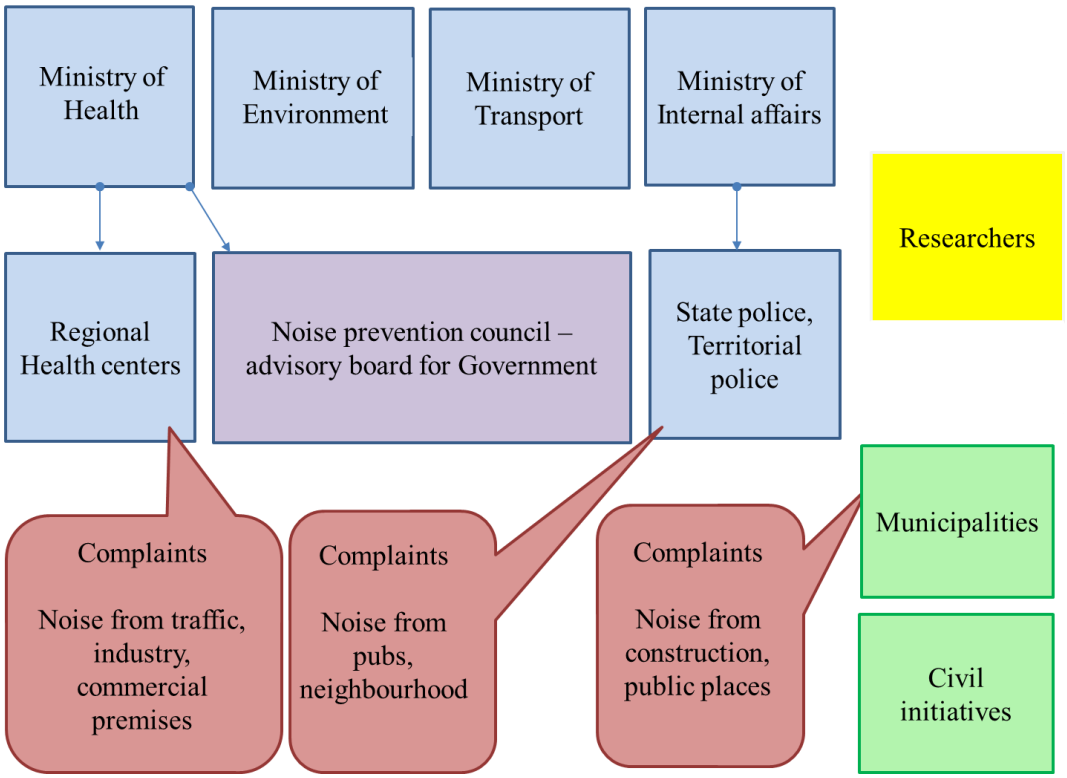

Figure 4.1. Noise management institutional scheme in Lithuania (created by the Author based on Jeram *et al.*, 2013)

Latvia

In Latvia specifically as well as in the Baltic States overall, the responsible institutions for general and sectoral noise regulations and the development of noise management regulations are ministries. The MoEPRD is responsible for the development of environmental noise legislations that regulate general management and control procedures. Other ministries – the Ministry of Transport, Ministry of the Interior and the Ministry of Health – are responsible for the development of sectorial regulations such as for transportation noise issues, noise from equipment, indoor noise, etc.

The subordinated institution – the Latvian Environmental, Geology and Meteorological Centre - is responsible for data collection and informing the EC according to the requirements of the Directive, but for EIA and cross-border impact assessment – State Environmental Bureau, but control – State Health Inspectorate (including its regional offices) and municipalities.

The national legislation determines municipal requirements for environmental noise management. These functions are mainly related to practically dealing with significant and acute noise issues when noise levels are created as a result of activity in the jurisdictions, the governing of construction activities spatial development planning, as well as noise mapping and noise action planning (if appropriate). The obligation of the municipality is to implement territory (spatial) planning and assign different function zones, thus controlling environmental noise levels within these zones. Municipalities have the right to implement lower noise limitations in administered territories using mandatory regulations in order to preserve previously designated lower noise areas.

The monitoring and control of noise emissions from economic activity (including ventilation, freezing equipment, compressors and elevators) and of the noise produced by transport vehicles is done by the State Health Inspectorate, whereas the monitoring and control of music noise and other public noise sources are controlled by the respective municipal institution to which the municipality has assigned the responsibility. These institutions are also responsible for the investigation of the respective public feedback. The public feedback process is more explicitly described in subchapter 6.4.

4.2.2. Institutional systems in other European countries

In order to understand how noise is managed in the Baltic countries in comparison to other European countries, the international research on institutional noise management models was carried out in some Eastern enlargement EU countries – in Slovenia, Slovakia, Poland, as well as in two candidate counties – Serbia and North Macedonia (Jeram *et al.*, 2013).

4.2.2.1. Analysis of EU countries

Slovenia

Figure 4.2. shows the noise management institutional scheme in Slovenia. It shows that noise issues are managed by the Ministry of Health and its agency – National Institute of Public Health and its regional branches. The latter advises in case of problems with environmental health and raises public awareness. The Ministry of the Environment is the main institution responsible for legislation in outdoor noise aspects. Its Inspectorate of Environment deals with environmental controls and investigates public feedback about noise from traffic, industry or big public events. Meanwhile, at the municipal level, the State police investigate noise from public activities such as noise from pubs and neighbourhoods (see Figure 4.2.).

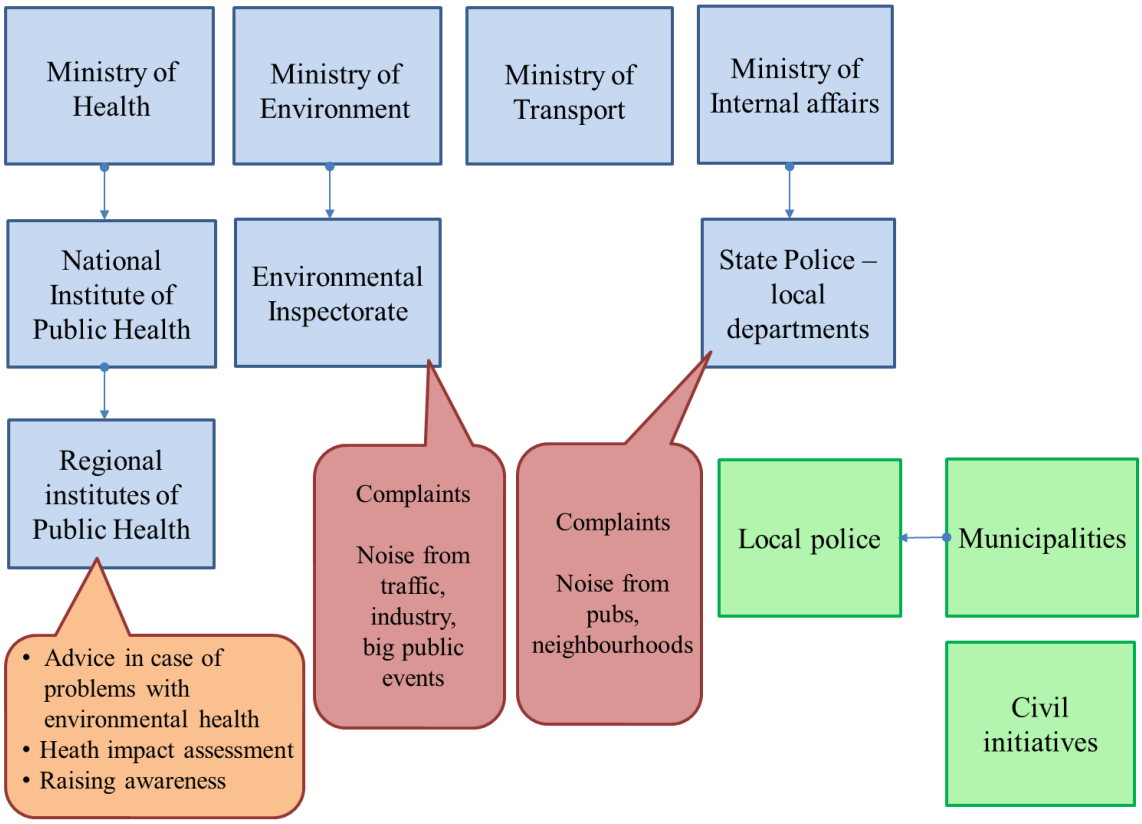

Figure 4.2. Noise management institutional scheme in Slovenia (created by the Author based on Jeram *et al.*, 2013)

Poland

Poland, the main institutions involved in addressing public feedback about environmental noise in Poland include the Ministry of Environment, Inspection for Environmental Protection, the State Sanitary Inspection, and the Ministry of Health. The activities of the Ministry of Health and the Ministry of Environment in the field of noise protection are supported by scientific and research institutes, including the Institute of Environmental Protection-National Research Institute. The main noise control activities are undertaken by the Sanitary inspection (and its regional offices) and the Inspectorate of the Environment that cooperates with municipalities or Voivodes (administrative districts) in dealing with environmental noise problem cases (see Figure 4.3.). The regional institues of Public health have a special advisory, health impact assessment and awareness raising function.

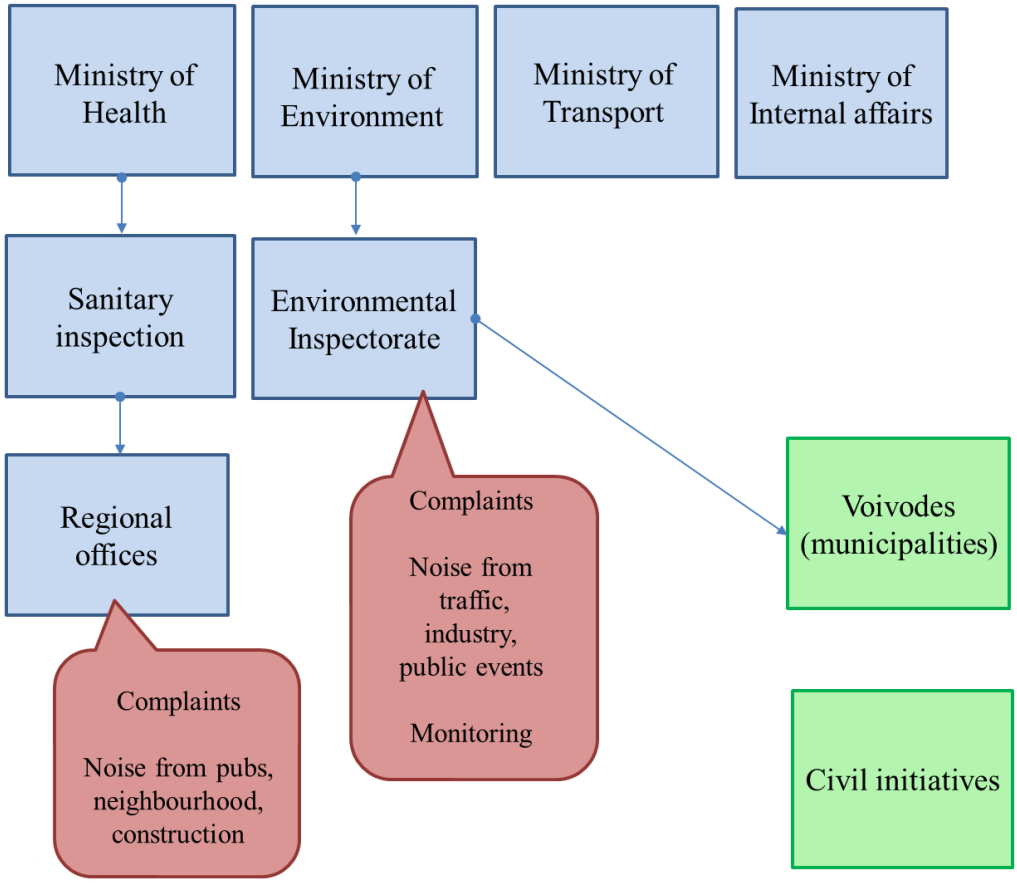

Figure 4.3. Noise management institutional scheme in Poland (created by the Author based on Jeram *et al.*, 2013)

Slovakia

In Slovakia the Ministry of Health together with the Public Health Authority including 36 regional public health units play the crucial role in dealing with problems of noise pollution. Other ministries, such as the Ministry of Agriculture, Environment and Regional Development, the Ministry of Education, the Ministry of the Interior and the Ministry of Transport, Posts and Telecommunications, are partly involved in environmental noise measurements and management. The National Reference Centre for Noise and Vibration has been set up by the Ministry of Health. The role of the Centre is to keep professional contact with the Ministry of Health, the Public Health Authority and the regional public health authorities on the problems of environmental noise. The National Reference Centre for Noise and Vibration is involved also in provision of technical and methodological guidance to the regional public health authorities, which are responsible for the assessment of noise in the environment and preparation of proposals for measures to protect public health from noise and performance of the tasks associated with the harmonization of existing European legislation. The National Reference Centre for Noise and Vibration also assist with resolving complaints about noise.

Slovakia's case of noise management scheme is shown in Figure 4.4.

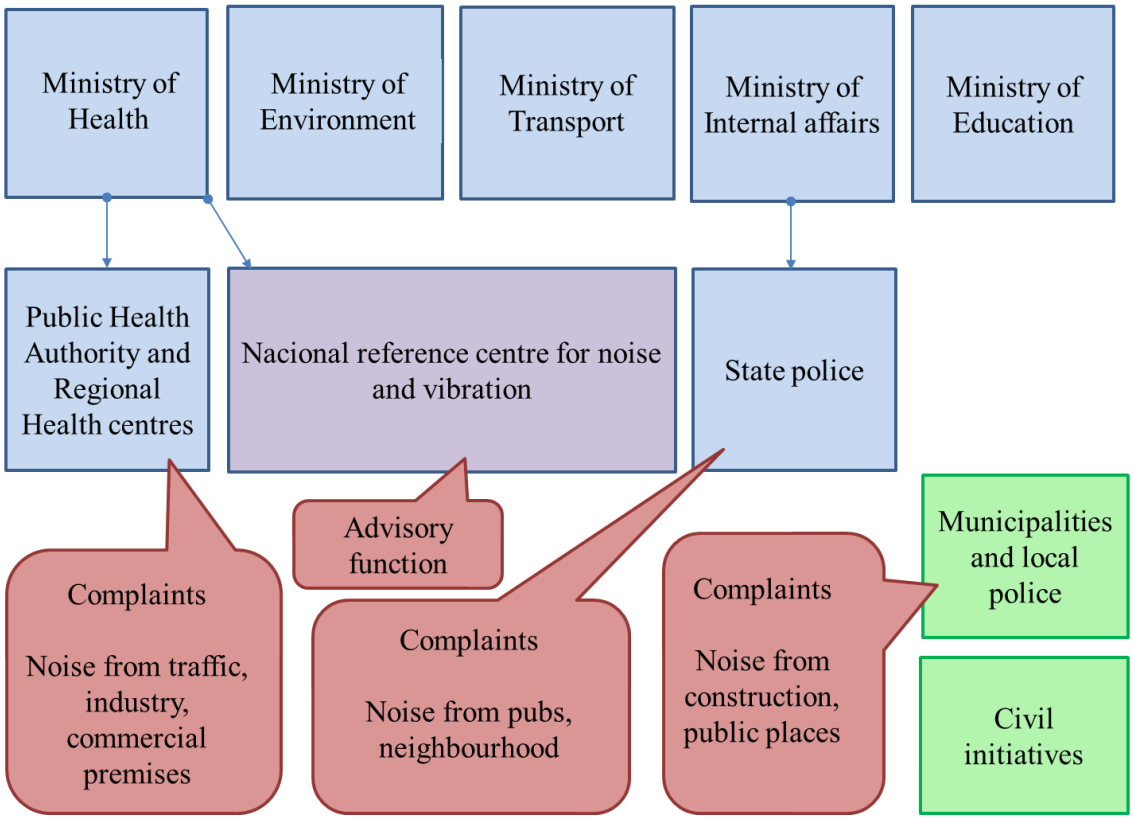

Figure 4.4. Noise management institutional scheme in Slovakia (created by the Author based on Jeram *et al.*, 2013)

4.2.2.2. Analysis of the candidate countries

Serbia

In Serbia, the Ministry of Environment and Spatial Planning, which is being reorganized under the Ministry of Natural Resources, Mining and Spatial Planning, performs noise assessment and oversees the noise-monitoring program. Noise assessment on the local level is performed by institutes of public health at the level of municipalities according to the programs adopted by the respective local government. A group for Protection from Noise and Vibrations has been established at the Ministry. The Environmental Inspectorate is directly accountable to the Ministry of Natural Resources, Mining and Spatial Planning and operates in all areas of environmental protection in Serbia and performs both monitoring and enforcement. The Secretariat for the Environment at the respective municipality performs assignments related to the protection and promotion of the environment, including noise through the realization of action plans and programs. The Secretariat for the Environment also ensures strategic noise mapping and the database from the noise monitoring information network (Ljubojev *et al.*, 2014).

Under the Law on Health Care, the responsibilities of the Secretariats for Health at individual municipalities are to provide social health at the municipality level and implementing programs for preserving and protecting people's health from the adverse effects of environmental pollution including noise. The Institute of Public Health at the level of each municipality is a member of the Network of Public Health Institutes. In the Institute's Centre for Hygiene and Human Ecology, multidisciplinary teams work on programs for monitoring environmental noise.

Municipalities have important responsibilities for environmental protection and urban planning, including protection from environmental noise through collaboration of the Secretariat of Environment, the Secretariat of Health, and the Network of Public Health Institutes. The role of the Community Police includes the protection from excessive noise pollution, and it also has an important role in directing maintenance of municipal and other important laws for the maintenance of public order and prevention of public disturbances (see Figure 4.5.).

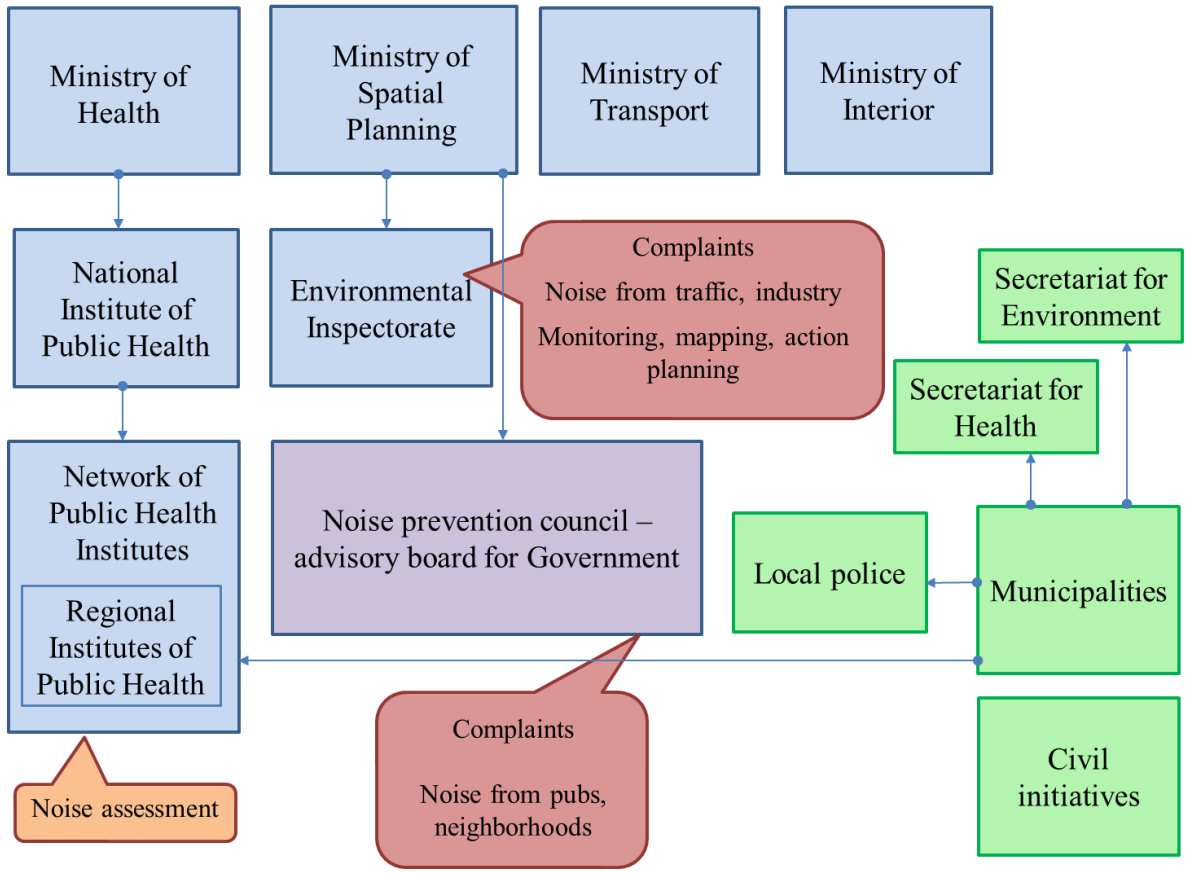

Figure 4.5. Noise management institutional scheme in Serbia (created by the Author based on Jeram *et al.*, 2013)

North Macedonia

In North Macedonia, the responsible authority for managing the environmental noise is the Ministry of Environment and Physical Planning. The Ministry of Health through the State Sanitary and Health Inspection and the Institute of Public Health has the responsibility of conducting risk assessment of noise-induced health effects. The management of environmental noise is regulated by the Law on Environmental Noise Protection, which is harmonized with Directive 2002/49/EC. This law identifies noise exposure indicators, responsible authorities, strategic noise maps, and action plans. The Ministry of Economy has a role in the control of noise emissions through surveillance of import and trade of equipment and vehicles for outdoor and indoor use. The Ministry of Environment and Physical Planning is responsible for collecting data on monitoring environmental noise from major roads, major railways and major airports in collaboration with authorized and accredited laboratories for noise-exposure assessment and the State Environmental and Nature Inspection. State Environmental and Nature Inspection under the Ministry of Environment and Physical Planning is dealing with society feedbacks.

4.2.2.3. Common framework of main noise management institutions

Analysis of the schemes allows identifying five main responsible institutions for noise management. These are ministries, agencies, municipalities, police, and Noise Prevention council (see Table 4.2.). Ministries are responsible for the development of noise management legislation and policy. Agencies' tasks include control of noise limits in large infrastructure objects and the dissemination of noise-related information and EIA, but municipalities are responsible for the regulation of community activities and noise control in objects of municipal-level significance. Violation control of community noise issues is usually a role for police. However, complementary recommendations on noise issues are given by the Noise Prevention council. This council acts like a multilevel advisory body and apart from Lithuania and Slovakia, it is also found in Serbia (Jeram *et al.*, 2013). The system is described in Table 4.2. below.

The noise level control from larger noise source in all countries is assigned to state health or Environmental inspectorates, but municipalities also have the right to control community noise.

Table 4.2. Main noise management institutions in the Eastern enlargement EU member countries (created by the Author based on Jeram *et al.*, 2013)

Institution	Function
Ministries	• Noise management legislation transposition, adoption and development • Design of noise policy • Noise mapping and action planning*
Agencies	• Control of traffic and industrial noise • Society feedback management • Collection and dissemination of information on noise issues • Environmental impact assessment • Evaluation of noise impacts
Police	Violation control of community noise issues
Municipalities (and municipal institutions)	• Regulation of community activities and noise control in objects of municipal-level significance • Society feedback management • Spatial and development planning • Noise mapping and action planning (where applicable)
Noise Prevention council	Complementary recommendations

**or delegated to subsidiary companies (as in Latvia case) or agencies*

4.3. Settlement of environmental noise problem situations, controls and dealing with society and its feedback

In order to see how noise problem situation are managed, noise controlled and society feedback is managed in other, Eastern enlargement countries, an international review (Jeram *et al.*, 2013) in Slovenia, Slovakia, Poland, and Lithuania. In addition, information on Serbia and North Macedonia that both are EU candidate countries are also included, because they also work on the transposition of EU legislation.

4.3.1. Slovenia

According to this research, in Slovenia, there are three main institutions: Ministry of Agriculture and Environment, Ministry of the Interior and the Institute of Public Health which are involved in addressing public feedback about environmental noise in Slovenia. As a division within the Ministry of Agriculture and the Environment, the National Inspectorate for Agriculture and the Environment is subdivided into seven regional inspectorates and the Chief Inspectorate. The Department for Protection of Environment and Nature of the Inspectorate is responsible for dealing with environmental noise problems. The main task of the Inspectorate is the supervision of the implementation of or compliance with the environmental policy. Inspections are carried out by independent, authorized inspectors who work in the interests of the public. Feedback sent by citizens to the Inspectorate is considered, the applicant, however, does not have a role in the inspection process. The important information for establishing contacts for regional units is available on the inspectorate website. The application should include all important information such as location, identification of the facility or activities that pertain to the matter in question, when available also the name of the investor, or other relevant information. Since the number of complaints from the public and thus the number of related inspections cannot be planned in advance, the inspectorate assesses the time required for such activities based on past experience. The number of received complaints from the public, initiatives and requests for various reports is increasing year by year, whereas their content varies in subject matter and level of complexity. The inspectorate has developed criteria for dealing with such cases. Non-routine inspections are generally carried out at the site without prior notice and are mostly limited to the contents of received complaints from the public. Over time, the number of investigations and measures is decreasing. However, the number of offenses is not showing any trend in changes.

There are also regular noise control activities. The platform and objectives for each action are defined, and guidelines for work in terms of the conduct of the procedures and for taking measures are prepared. Actions are carried out simultaneously over the entire territory of the state; they are time-limited and have a clearly defined subject matter. After the action is concluded, analysis and reports are produced. The advantages of such a mode of operation are the following: Systematic supervision of the area of work, feedback information received on the enforceability and level of compliance with regulations and integrated inspection.

The Slovenian government has adopted the Strategy of the Republic of Slovenia for the environmental health of children and adolescents for the period of 2012-2020. Based on this strategy, the ministries prepared an action plan. From all the recommendations listed in documents mentioned above, it is evident that understanding and tackling the environment-related health problems requires sustained cooperation between national, regional and local authorities, environmental, health and research communities, industry, agriculture, and stakeholders. Responsibility for making progress in this complex area should also include civil society. It is important to address these challenges by strengthening existing mechanisms and structures that can improve effective implementation, promote local actions, and ensure active participation. Therefore, the importance of involving of the society was one of the priorities at the National Institute of Public Health in Slovenia. Its main role is advising and raising awareness about possible hazards from noise on public well-being and health. To fulfil this role, the Institute has established a website with basic information on noise and health and an electronic contact address for citizens who need further advice. The

Institute systematically collects information on the type of public feedback received and the possible solution in order to prepare a "frequently asked questions" list for general advice to the public. In the last two years, the Institute received 30 requests for advice regarding noise from traffic, industry, construction works, public events and from the residential areas.

Several societies were established in Slovenia at the regional level to join efforts in solving local noise problems. One of the most active societies is the Society against enlargement of the airport and noise at the airport of Lesce. The Slovenian Acoustic Society is a non-profit scientific organization, the primary purpose of which is to help Slovenian engineers to compete successfully in the demanding foreign markets in ever stricter requirements to reduce noise and maximize quieter products.

4.3.2. Lithuania

In Lithuania, the Ministry of Health is the lead entity on the issue of noise, but responsibilities are shared with the Ministry of Transport and Communications, the Ministry of the Interior, the Ministry of Environment, and the Ministry of Agriculture and Municipalities. Researchers are also involved through the work of the Noise Prevention council. The council, with the Vice Minister of Health as its chairperson, acts as an advisory body to the government. The members of the Noise Prevention council are undersecretaries of noise management issues in responsible ministries, representatives from government and municipalities, and representatives of research and public institutions that work towards noise prevention. The annual reports of the Noise Prevention council on the state of noise prevention are presented to the government, published and available to the public, together with a set of conclusions and recommendations to be implemented. Although the Ministry of Transport and Communications is responsible for transport infrastructure noise management, primarily, the Regional Public Health Centres are dealing with public feedback due to road, railway, or air traffic noise. It also takes into account received feedback from society on noise from the roads and streets, which are under the responsibility of municipalities (personal communication: Ministry of Health). The municipalities are responsible for the control of construction or renovation work noise in residential buildings or districts, as also to perform control of noise prevention in public places through the implementation of rules. Regional public health centres under the Ministry of Health deal with feedback from the public related to noise from industrial activity, economic, commercial activity, and issues related to noise assessments while also performing environmental impact assessments for future economic activity. This feedback was related to noise sources such as railway noise and vibration, construction work, shop activity, neighbourhood noise, low-frequency noise from industry and agricultural machinery, as well as street reconstruction (widening). Residents were afraid that road works to widen streets will cause very high noise levels (50 meters from residential buildings), wastewater-treatment plants under construction, reconstruction of houses, and consequentially reduced sound insulation of apartments because of damage incurred during reconstruction work.

According to data, it can be concluded that there is limited control by police officers, related to the noise management-related legislation. Only a few cases were identified where penalties were given. They were related to noise from neighbours or the street. The noise limits for residential and public buildings are set in Lithuania's Hygiene Regulation HN 33:2011: Noise limit values in residential and public buildings and their environment.

There are some community initiatives in the largest cities in Lithuania against noise disturbance. Some of them are expressed in the form of an internet blog, trying to inform others. For example, some individuals created a blog, where they explain where and how people can provide feedback about noise and public disturbances related to noise, which procedure to follow, and what results to expect. One other type of initiative is to form a group of interested persons and try to solve disturbing noise problems together with the municipality in question and other relevant institutions.

4.3.3. Slovakia

In The regional public health authorities are generally responsible for objectively evaluating complaints from the public. They can professionally and responsibly identify and evaluate noise sources. The National Reference Centre for Noise and Vibration has also a role to prepare training materials for the Chief Hygienist, performing training for workers in the field of assessment noise and vibration and providing consultation for professionals, individuals and entities on noise and vibration.

Individuals, entrepreneurs or legal persons using or operating equipment giving rise to noise are required to ensure that the exposure of inhabitants and their environment to the noise is as low as possible and does not exceed permissible values. The evaluation of noise, infrasound and vibration should be carried out every year. In the design, construction or substantial reconstruction of the transport infrastructure, the associated noise in the external or internal environments should not exceed the value of the anticipated traffic load. In the design, construction or substantial renovation of buildings, protection of their indoor environment must be ensured against noise from outside.

Municipalities are entitled to assess exposure to environmental noise and vibration, although such evaluations can only be carried out by persons professionally authorized by the Ministry of Health. In case of complaints about noise generated by individuals or at public events at night the regional public health authorities cooperate with the local police to solve problems.

NGOs such as the Slovak Acoustical Society, the Slovak National Accreditation Service, the Technical Testing Institute in Pieštany and the Slovak Metrological Institute play their role in noise reduction and preventions. The Slovak Acoustical Society is a voluntary non-profit association of institutions, scientists and technical acousticians working within the framework of the Slovak Academy of Sciences. The Society encourages acoustic research and technical practice and organizes the international acoustic conferences that are well-known in the European acoustic community.

4.3.4. Poland

The limits for noise emitted by industrial and transportation sources, as well and reference methods for noise measurements, were set by the Minister of Environment in three regulations concerning the environmental noise levels, measurements of emissions and monitoring of noise. In general, the Inspection for Environmental Protection is responsible for dealing with public feedback about noise perceived outdoors, whereas the indoor noise is the issue of the State Sanitary Inspectorate. However, noise measurements are carried out not only by laboratories of the inspections above but also by other accredited testing laboratories. The tasks of the Inspection for Environmental Protection are performed in collaboration between the Chief Inspectorate for Environmental Protection and voivodes supported by 16 Voivodship Inspectors. The main tasks of the Inspection for Environmental Protection include controlling compliance with environmental protection regulations, examining the state of the environment, in particular, the measurement and assessment of noise emitted by industrial sources and transportation sources under the program of the National Environmental Monitoring. The Inspectorate for Environmental Protection also deals with public feedback about noise from industry, plant, road traffic, railway traffic, and air traffic. The Chief Inspector for Environment Protection submits the annual report on the activities of the Inspectorate for Environmental Protection to national authorities. The collected data on the acoustic state of the environment is available on the website of the Chief Inspectorate for Environmental Protection. Also, the status of the environment and its protection is presented on the Ekoportal website by the Environmental Information Centre. The primary activity of this centre is collection, development, and publication of information on the condition of the environment, including the acoustic state of the environment. Headed by the State Sanitary Inspectorate and reporting to the Minister of Health, the State Sanitary Inspection came into being to protect human health and life against adverse and annoying environmental factors. In general, it implements public health policy at the national level, through 16 Voivodship Sanitary-Epidemiological Stations and County Sanitary-Epidemiological Stations operating throughout Poland. The Department of

Environmental Hygiene is an organizational unit of the Chief Sanitary Inspectorate, which sets priorities and guidelines for the State Sanitary Inspectorate. Among the main tasks, the Department of Environmental Hygiene also supervises protection against noise. As far as noise protection is concerned, the local sanitary-epidemiological stations are involved in monitoring noise exposure both in occupational and public environments. Therefore, they are responsible for handling public feedback about indoor noise from sources in buildings like ventilation systems and lifts; reconstruction works in apartment buildings, noise from pubs, playgrounds, etc. Apart from both inspections, the feedback about environmental noise is also reported through local authorities, parliament deputies, as well as research institutes and social organizations, e.g., those involved in the protection of environment or consumer rights.

Several societies have been established in Poland to join efforts in solving local noise problems. The League of Noise Awareness is one of the most active societies. Some advice concerning the handling of feedbacks and interventions from the public concerning the environment, in particular about environmental noise, are available on the website of the Chief Inspectorate for Environmental Protection.

4.3.5. The candidate countries

Serbia

Inspections are performed as part of an annual plan or can be instigated through reports provided by the Institute of Public Health. The Law on Environmental Protection and specific laws on environmental protection define the responsibilities and rights of inspectors. The Environmental Inspectorate of the Ministry of Natural Resources, Mining and Spatial Planning is responsible for the surveillance and monitoring of industrial activities. The Law on Environmental Protection enables inspectors to react in most cases. The noise level monitoring is being done in major cities in Serbia. The public order and prevention of public disturbances, including noise, is provided by Community police.

The most frequent feedback from the public about noise in Serbia pertains to neighbourhood noise, the noise produced by individuals, animals, and home appliances, as well as noise from entertainment facilities like cafes and restaurants. Once the Community Police establish a problem, they contact the authorized and licensed public institution like the Institute of Public Health, who perform noise measurements and provide expertise on noise levels and their compliance with official limits.

In Serbia, noise monitoring in urban areas should be improved, as well as the spatial planning process improved (regarding the location of industrial areas and the land use zoning). In addition, there is a lack of projects for noise control and insufficient control of noise emitted by motor vehicles. (Ljubojev *et al.*, 2014)

North Macedonia

The responsibilities for dealing with noise-related feedback from the public are divided between the local authorities and the State Environmental and Nature Inspection under the Ministry of Environment and Physical Planning. Local problems with noise like local traffic noise, neighbourhood noise, noise from manufacturing activities, and construction activities are under the control and supervision of the environmental inspection located within the municipalities. The National Institute of Public Health has performed several surveys for indicators for noise exposure and health effects in urban centres in order to raise a question for noise pollution in urban areas, and it was concluded that railway and aircraft noise is not causing serious annoyance and sleep disturbance in the exposed population. These data were disseminated to all the relevant ministries in order to implement these findings in strategies for health, transport, development of urban areas, and urban plans.

The National Institute of Public Health have conducted many educational activities for vulnerable groups, including school children, to protect their health from noise exposure. Suitable activities for raising awareness about noise exposure and negative health effects are performed each year by the Institute on behalf of the World Noise Awareness Day (the Noise Awareness Day was also organized in Latvia in 2013, 2014 and 2015 with the Author's help). Several NGOs with the main aim of protecting the human

environment sometimes emphasize the question of high noise levels in urban settings. However, noise pollution is not the highest priority in their activities. The Macedonian Acoustical Association deals with exchange and upgrade of knowledge of experts in the field of acoustics and vibrations, to improve the quality of the living environment.

4.3.6. Analysis of public feedback investigations

This research showed that it was not straightforward to find information on public feedback procedures and statistical data in the several countries included in the review: Slovenia, Lithuania, Latvia, Slovakia, and Poland, as well as includes information on North Macedonia and Serbia. Though the results do not provide a complete picture, they do show important differences among national approaches and the need for further improvement in information policy. Different factors are involved in the implementation of the regulations concerning environmental noise, and even more, diversity follows in the registration of public opinions. Responsibilities are shared mainly among the ministries responsible for the environment and/or health, state police, and municipalities. Several other institutions or departments may have important roles like inspectorates, which supervise the implementation of, or compliance with, environmental policy. In general, the feedback is better managed in the cases of traffic and industrial noise. Nevertheless, there are very few guidelines for the public to provide feedback about noise from the neighbourhoods. as well as for municipalities to handle them. In Slovenia, for example, one can call the police in case of annoyance due to environmental noise, but there is no obligation for the police to provide feedback information to the person who made the complaint or to make the results of case investigation available to the public. The need to establish stronger collaboration with municipalities and to develop a unique system for public feedback registration has been identified. It is well known that transparency and good information policy are very important in the case of annoyance reduction. In Lithuania, as well, there is no existing unique public feedback management system with one institution governing it. It is therefore difficult to find information or even statistics related to different types of public feedback due to noise. The legislation should be more precise concerning the responsibilities of different institutions for dealing with public feedback on environmental noise issues. In North Macedonia, the responsibilities for dealing with noise feedback are distributed among different governmental bodies and institutions and data is collected from the monitoring of environmental noise, but not for noise feedback from the citizens delivered to municipalities. At this moment, there is no available integrated database for received public feedback on noise issues, and it is hard to collect data without introducing legal obligations for responsible bodies. The results from the surveys and media-delivered information show that citizens are most frequently providing feedback about noise from pubs, restaurants, and construction activities because many leisure activities are performed outdoors. The exact extent of the feedback and information about solutions are still not available. The accurate and precise procedure for solving environmental noise problem cases, data delivery, and data collection is necessary for building a database for public feedback on environmental noise. This database is also important for future urban planning, construction of residential areas, and development of noise mitigation measures. Serbia had problems related to inadequate legislation and limit values for noise, inadequate monitoring of noise in urban areas, lack of spatial planning, including noise zoning and improper location of industrial areas, lack of projects on protection against environmental noise, insufficient control of noise emitted by motor vehicles and improper traffic management. In addition, the noise that arises from infrastructure development is not considered during planning.

4.4. Brief summary of Chapter 4

Chapter 4 describes environmental noise management issues in European countries as investigated from legislative and institutional point of view, as well as provides information on dealing with feedback from the society. The comparative analysis of Baltic States' legislative acts shows that all three countries

have included the regulations related to noise mapping, action planning, application of noise indicators, assignation of responsible authorities, cooperation with neighbouring countries, and informing the public. However, the chosen methods and the noise management rules differ both in terms of content and the degree of detail. For instance, Lithuania's noise management legislation contains the most expanded strategic noise management descriptions, but Estonia's has elaborated guidelines for noise evaluation.

Analysis of public feedback management show the need for further improvement in information policy, for instance, there are very few guidelines for the public to provide feedback.

5. ENVIRONMENTAL NOISE POLICY PLANNING IN MUNICIPALITIES IN LATVIA

5.1. Legislation, policy and institutional aspects

The Latvian regulation on environmental noise management and assessment order in Latvia (Vides trokšņa novērtēšanas un pārvaldības kārtība, 2004) states the nature of the environmental noise management process that is used in municipalities of any size in Latvia. The regulation states that those persons who own or use the source of noise are required to limit noise emissions defined depending on the functions that are assigned for each territory. However, the obligation of the municipality is to execute spatial planning and assign different land use zones thus controlling environmental noise issues. The above mentioned determines municipalities' obligations to conduct spatial planning through the subdivision of different territory functioning zones and to control community noise levels created as a result of music and other public activity. Municipalities have the right to implement lower noise limitations in administered territories using binding regulations in order to preserve previously designated lower noise areas.

The monitoring of noise emissions from economic activity (including ventilation, freezing equipment, compressors, and elevators) and the noise produced by transport vehicles is done by Latvia's State Health Inspectorate, whereas control of music noise and other public noise sources is controlled by the respective municipal institution to which the municipality has assigned the responsibility. If the responsible institutions have established violations of environmental noise limits, the persons responsible for the source of the noise, or those who are performing the activity that has exceeded the noise limitations, has to pay all the costs that are related to the measurements of the environmental noise. In a territory in which the indicated noise strategic map or other noise measurement values are higher than the noise limitations mentioned in the Regulation, construction of buildings is permissible only in compliance with the territory planning type that is outlined in the territory planning of the local municipality. In that case, the developer is required to implement noise control according to the requirements of Latvia's construction standard LBN 016–15 "Construction acoustics."

The municipalities with more than 100 000 inhabitants have an additional duty to develop and update noise maps and action plans.

The legislation also supports the right for every municipality to plan and implement voluntary actions both in the fields of practical and strategic noise management, for example, noise mapping or detection of quiet (tranquil) areas in any size municipality, or set specific zones with lower environmental noise levels. This means that municipalities have to observe noise management obligations stipulated by national legislation, but they can also plan and realize other activities, i.e., initiatives, in order to solve specific environmental noise problems and ensure their activities are in accordance with the needs of the local community. These municipality initiatives determine the actual acoustical environment quality, which is especially important taking into account that municipalities are the closest governance level to the residents.

5.2. Analysis of development planning in Latvia's municipalities

5.2.1. Environmental noise aspects described in the spatial development planning documents

As the objects of study, four municipalities in Latvia – Rīga, Saulkrasti, Mārupe, and Ogre – were selected. These are municipalities of different sizes and they are required to implement different legal requirements as well as they have different noise sources present in their territories. A summary of the characteristics of these municipalities – number of inhabitants, size of the territory, population density, and noise sources are given in Table 5.1.

All of the research municipalities have fulfilled their spatial development planning obligations as stipulated by national legislation and have produced development documents according to the Spatial

development planning law - development programme, local government spatial plan and sustainable development strategy. These documents in municipalities with less than 100 000 inhabitants serve as the main and often the only strategic environmental noise management documents along with municipal binding regulations (that deal with community and neighbourhood noise, and public order).

Local government spatial plan for each of these municipalities contains information about zonings that are directly linked with the allowed maximum noise levels in the defined area. The only municipality that has assigned quiet areas is Rīga despite also other municipalities are allowed to do so (in coordination with the Ministry of Transport). The plans also include other information about noise management, for example, the requirements for noise barriers or housing design.

Table 5.1. Characteristics of the municipalities selected for the study (created by the Author, using Central Statistical Bureau data, 2019)

Parameter	Municipality			
	Rīga	Saulkrasti	Mārupe	Ogre
Inhabitants and territory				
Number of inhabitants	632 614	6 532 (in town – 3 012)	20 007	32 997 (in town - 23 232)
Size of territory (km^2)	304	4.7 (town – 4.8)	103	992 (town -13.6)
Road total length in the municipality	1 191 km, including 1 191 km of streets	203 km, including 76 km of streets	172 km, including 80 km of streets	1 103 km, including 157 km of streets*
Noise sources				
Roads of national significance and main traffic streets	Yes	Yes	Yes	Yes
Road of international significance	n/a	Yes (30 km)	n/a	n/a
Airport	Yes	n/a	Yes	n/a
Railway	Yes	Yes	Yes, planned	Yes
Seaport	Yes	Yes	n/a	n/a
Other noise sources about which inhabitant feedback has been received	Yes (production industry)	n/a	n/a	Yes (open-air concert hall)

** The road of national significance A6 is also a municipal street and is counted as the municipality's asset*

Municipality development plans and environmental programs mostly complement the activities defined in spatial and land use plans, though the approach to noise management and degree of detailed development differs in each municipality. The main information relating to environmental noise management that are reflected in the planning documentation are briefly summarized in Table 5.2.

Table 5.2. Environmental noise aspects described in the spatial and development plans (created by the Author)

Municipality	Substance of the documentation
Saulkrasti	• Defines short and general requirements for noise abatement barriers building • Determines the minimum distance from residential buildings to stadiums • Identifies the necessity for noise measurements and implements noise mitigation measures in the area of the port • Sets the need to have vegetation noise barriers for houses along railroads, as well as maintenance order for noise barriers. • It is forbidden to construct new residential houses in transport infrastructure protection zones
Mārupe	• Includes noise maps (2019 update) for main noise sources - airport, railway, and road noise • Defines indoor noise levels in acoustical discomfort areas • Foresees changes in zoning (to industrial or agriculture land) in some noise discomfort zones (for instance, near the main road), thus limiting construction of new residential houses in them • Determines particular parishes in which the construction on new residential houses is not advisable as this area for acoustic reasons is not suitable for residential purposes • Defines that newly-built or reconstructed buildings in the noise discomfort areas should be equipped with special sound insulation and such ventilation or air conditioning equipment that allows to be isolated from environmental noise permanently
Ogre	• Defines the requirements for the construction of noise barriers • Requires the appliance of noise mitigation measures in the technical infrastructure zones • Includes the strategic environmental assessment plan which contains an analysis of traffic flows and defines the need for road noise abatement measures • Includes the evaluation of open-air concerts and noise mitigation measures • Plans to map road noise and develop an action plan, as national road noise map excludes Ogre
Rīga	• Defines the need to plant greenery along the streets and railway lines • Sets the noise management policy - optimization of traffic flow, modernization of traffic infrastructure, development of business districts outside the city centre, detailed exploration of noise sensitive areas, noise mapping, and installation of noise screens • Includes the strategic environmental assessment plan which identifies noise management issues and possible measures in different parts of the city and near noise emission sources

5.2.2. Comparison of noise sources and noise management activities included in planning documents

Comparison of noise sources and activities included in municipalities' planning documentation and analysis of their mutual accordance is given in Table 5.3.

Table 5.3. Comparison of noise sources and noise management activities included in planning documents (created by the Author)

Parameter	Municipality				Total included actions
	Rīga	Saulkrasti	Mārupe	Ogre	
Roads of national significance and transit traffic streets	Actions included	Specific actions are omitted	Actions included	Actions included	3 of 4
Road of international significance	Not applicable (n/a)	Specific actions are omitted	n/a	n/a	0 of 1
Airport	Actions included	n/a	Actions included	n/a	2 of 2
Railway	Actions included	n/a	Actions included (2019)	Actions included	3 of 3
Port	Actions included	Actions included	n/a	n/a	2 of 2
Other noise sources	Actions included	n/a	n/a	Actions included	2 of 2
Total included actions	5 of 5	1 of 3	3 of 3	3 of 3	-

The comparison of the municipalities' documentation and best practices regarding noise management demonstrates that the activities planned by municipalities are on track with best practices identified for solving noise issues in Europe; however, there still is a room for improvements, because planned activities differ widely. Detailed information about the municipality activity's compliance with the best practice can be found in Table 5.4.

However, it should also be taken into account that not all municipalities need to implement all of the mentioned measures or some measures would not be technically possible; however, the degree of implementation of different type measures (especially, measures to avoid and reduce noise at source and other socio-economically oriented measures to prevent noise), allows to conclude on overall noise management topicality and approach used. The information summarized in Table 5.4. demonstrates that spatial and land use planning and the use of noise screening are the most commonly used noise management measures in Latvia's municipalities, and this is the only type of noise abatement measure used in one of the municipalities. It also can be seen that activities over time has improved.

Table 5.4. Comparison of the activities included in the documentation (created by the Author)

Parameter	Municipality			
	Rīga	Saulkrasti	Mārupe	Ogre
Measures to avoid and reduce noise at its source				
Low-noise surfaces	No	No	No	No
Traffic management	Yes	No	No	No
Traffic calming	Yes	No	No	No
Low-noise vehicles	Yes	No	No	No
Driver behaviour	Yes	No	No	No
Measures to reduce the propagation of noise				
Noise screens	Yes	Yes	Yes	Yes
Buildings or vegetation as noise barriers	Yes	Yes	Yes	No
Measures to reduce noise at the receiver				
Sound insulation	Yes	No	Yes	No
Building design	Yes	No	Yes	No
Socio-economically oriented measures				
Noise taxes and charges	Yes	No	No	Yes
Awareness raising, communication	No	No	No	No
Reducing the need for transport	Yes	No	No	No
Spatial and use planning and management	Yes	Yes	Yes	Yes
Other activities (municipal initiative)	Yes	Yes	Yes	Yes
Actions foreseen in total	11 of 13	4 of 13	6 of 13	4 of 13

5.2.3. Other primary complementary findings regarding environmental noise planning

Saulkrasti: complementary findings

The situation in Saulkrasti is analyzed in the case study described in subchapter 6.1.

Mārupe: complementary findings

In order to analyze changes in municipal planning documents, the Mārupe municipality spatial plan for 2002-2014 (Mārupes novada pašvaldība, 2003) and Mārupe Region Territory Planning for 2014-2026 and its 2019 update (Mārupes novada pašvaldība, 2014) are compared. An analysis of these plans has been made, because the international airport "Rīga" is expanding, and the trajectories of lift-off and landing aircraft affect the acoustic environment of Mārupe municipality, and a new noise source – Rail Baltica railroad – is planned. The current plan includes the environmental noise map, which is considered to be good practice in designing development and spatial plans since it allows to base the plans in the assessment of environmental pollution and its impact on the population. This practice was also applied during the development of the previous plan (in the year 2003).

In the new plan, some parts of the municipality are recognized not to be suitable for living purposes due to acoustic discomfort areas, and these buildings can be used temporarily. Therefore, there is an urgent need for measures to improve the quality of life of citizens living in the areas. Municipality plan changes in the zoning, transforming these areas from residential areas into business or airport functional areas. At the same time, the plan does not explain the strategy for the transformation of these territories. However, different other measures have been planned that are somewhat inconsistent with the above-mentioned. These measures include the expansion of the public services sector and the improvement of outdoor infrastructure in the areas of high noise levels. The development and spatial plan include noise maps (2019 update) for

airport, rail and road noise, and defines acoustical discomfort areas, sets indoor noise levels in discomfort areas and defines that new building there must have sound insulation and such ventilation or air conditioning equipment that allows being isolated from environmental noise permanently.

This case of municipal spatial planning shows that in cases, when the municipality has a topical issue of environmental noise, data on noise modelling are used in the planning of the territory and proposals for zoning changes that comply with good noise management practices at the planning stage are provided.

Rīga: complementary findings

The main environmental noise planning document is the environmental noise action plan based on environmental noise maps that has been developed and renewed in 2019. Environmental noise maps and noise actions plans in accordance with Directive 2002/49/EC have been developed for the Rīga agglomeration. The noise management plan contains information about existing noise levels, populations subjected to high noise levels, as well as recommendations for noise mitigation measures. The environmental noise maps show that in total 247 600 residents have been subjected to daytime noise levels that exceed 60 dBA and 149 507 or 23% of Rīga inhabitants that have been subjected to noise levels over 65 dBA daytime that exceeds the highest permitted noise level in the legislation (i.e. the one at industrial zones). 245 734 inhabitants of Rīga that have been subjected to noise levels over 55 dBA night-time that exceeds the highest permitted noise level in the legislation (i.e., the one at industrial zones). (ELLE, 2015; ELLE, 2017) The biggest impacts are caused by road transport infrastructure both day and night time. This is illustrated in tables 5.4. and 5.5.

Table 5.4. Number of residents subjected to different day-evening-night noise levels in Rīga agglomeration (created by the Author, using ELLE, 2017)

Noise source	Number of inhabitants subjected to noise levels (L_{den}), dBA					
	45-49	50-54	55-59	60-64	65-69	>70
Road traffic	48 865	90 969	155 229	195 132	104 999	41 147
Railway and tram traffic	38 388	28 690	8 639	5 445	309	26
Airplanes	748	287	191	166	10	0
Industry	12 996	5 716	2 094	239	153	0
Main roads	996	298	105	14	12	0
Main railroads	9 547	6 966	4 841	5 183	265	25
In total	111 540	104 236	171 099	206 179	105 748	41 198

Table 5.5. Number of residents subjected to different night noise levels in Rīga agglomeration (created by the Author, using ELLE, 2017)

Noise source	Number of inhabitants subjected to noise levels (L_{night}), dBA						
	40 - 44	45 - 49	50 - 55	55 - 59	60 - 64	65- 69	>70
Road traffic	76 012	123 106	183 083	160 936	61 630	8 747	2
Railway and tram traffic	37 937	31 640	16 599	7 286	5 004	296	26
Airplanes	2 369	435	230	170	0	0	0
Industry	42 764	11 948	6 396	2 559	156	153	0
Main roads	535	121	86	15	0	0	0
Main railroads	12 235	8 772	6 585	4 664	4 797	262	25
In total	171 852	176 022	29 896	173 071	71 587	9 458	53

In 2017, the Rīga prepared a new noise management plan for 2017 – 2022 (ELLE, 2017) based on noise mapping. As it can be seen by noise mapping and action plan development years, noise maps and action plans are prepared not respecting Directive 2002/49/EC terms (the noise map should be prepared every five years starting from 2007, and the action plan – within a year from noise mapping).

The Action Plan foresees a number of technical and infrastructure measures. These include restrictions on road traffic and speed, improving the street network and public transport (e.g., quieter tires), expansion of the bicycle network and stimulation of the use of electric vehicles, improvement of park and ride systems and public transport. Several administrative, regulatory, and environmental awareness measures are also planned (such as raising acoustic knowledge for municipal employees, developing interactive noise maps, etc.). Conclusions from the project "Promotion of New Urban Noise Management Approaches in Rīga" (Resilience, 2013) recommend that from residents' point of view more attentions in action planning should be paid to the issues of noise education and communication, traffic flow planning and impact monitoring. However, at the same time Rīga city investment plan that has been developed also in 2017 for the period of 2018 - 2021 do not include particular activities related to environmental noise management. This shows a lack of planning utilizing synergy and a systemic point of view. The EC has also noted that in Latvia, the budget is actually too low to implement noise abatement measures (EC, 2016). Therefore focused, impact-based approach for priority determination should be developed and applied.

Ogre: complementary findings

Ogre town environmental noise issues were analysed in the Authors' master thesis (Krūkle, 2008) and within a project ANTI-NOISE with the Author's participation. The data Author obtained through the resident survey (n = 1671) showed that 22% of the population feel noise discomfort and 25% feel more disturbed than not, and therefore a total of 47% are in favour of planning and implementation of noise prevention and control measures (see Figure 5.1).

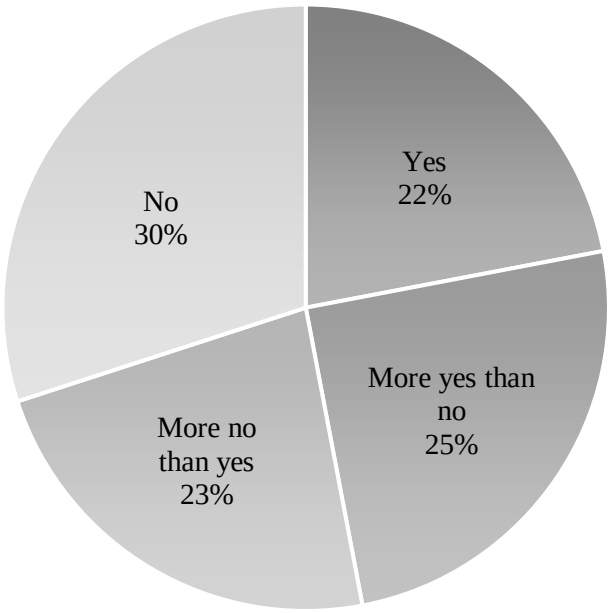

Figure 5.1. Answers to the question if the respondents feel the discomfort caused by the noise? (Created by Author)

The railway line crosses Ogre town with more than 30 000 train movements per year (over 1 million train passages, including over 884 freight train passages from/to non-EU countries). 15 062 inhabitants or 62% of Ogre town residents are subjected to elevated noise levels from the railway alone. The Latvian railway (according to delegation from the Ministry of Transport) has developed a railway noise map in 2017 and action plan in 2019. The action plan states that Ogre is the first priority noise discomfort zone, where the benefits to the society for the implementation of noise reduction measures are higher than the costs of these measures. The costs are evaluated at 608 000 EUR, but the action plan does not assign funding for the practical implementation of these measures, stating that the funding should come from public resources, including EU funds. As it was mentioned above, Directive 2002/49/EC does not penalize the non-implementation of action plans, therefore, it is possible that actions in the action plan are planned rather uncertainly, thus also increasing the risk that the action plans are not implemented that purposefully and systematically as it would be advisable in order to reduce impacts on society and public health.

5.3. Development planning in environmental noise aspects: Valmiera case study with sustainable mobility perspective

As mentioned above, transport is of the main environmental stressors regarding noise pollution, air pollution, and greenhouse gas emissions, etc. However, it is also a multi-dimensional concept and an integral and important part of the everyday life that ensures the delivery of goods and human travel from one place to another, enabling social, cultural, political and economic activities to take place (Rodrigue, 2017).

In order to see how environmental noise aspects are interactively taken into account in municipal development and territorial planning, especially in regard to transport (as the main noise source), the Valmiera case study was performed (Krūkle *et al.,* 2017, Krūkle *et al.,* 2018, Krūkle *et al.*, 2019). It highlights sustainable mobility - to have the ability of people to travel and supply goods in a way that balances environmental and socio-economic aspects and aims at reducing negative impacts on the environment, including noise pollution.

Research on Valmiera residents' behaviour showed a high dependence on private cars, low usage of public transport, and rather unsustainable mobility habits of the population (Krūkle, 2019). According to the national surveys, most Latvian households (49%) have one car at their disposal, and only 11% have two or more. 54% of respondents in Valmiera report having one car, but almost 29% of respondents report having more than one car (Krūkle & Gaugere, 2017).

The data from a household inhabitant survey (n = 373) show that 28% of residents face noise pollution constantly or often (see Figure 5.2), thus showing the potential need for tackling these issues.

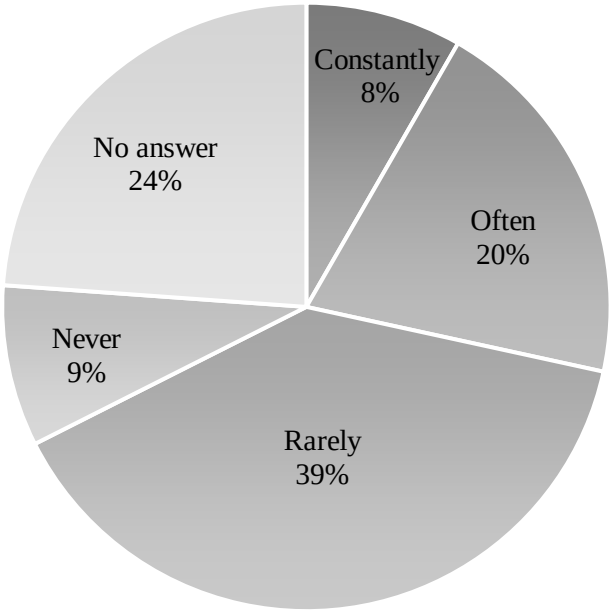

Figure 5.2. Answers to the question of how often residents face environmental noise problems near their homes (created by Author, using SUSTINNO data)

Valmiera has prepared a sustainable development plan for 2015 – 2030 and an environmental declaration. These documents clearly state that one main aim for the Valmiera city territorial development is to ensure the rational use of land, balanced economic development, and environmental quality as well as promote the optimal functioning of the transport systems. The strategy includes an evaluation of the transportation network as well as describes actions for the promotion of modality switches, in particular including the development of bike and pedestrian infrastructure, mixed land use planning, redirection of industrial transport, etc. These activities could reduce noise in an integrative manner if the number of motorized vehicles declines. Transport infrastructure and transit flow are one of the main elements that ensure a city's competitiveness, and therefore Valmiera city intends to construct new road infrastructure, in particular for the connection of industrial areas with major transit routes. The Valmiera city development plan for 2015 – 2030 clarifies and details particular sectoral and cross-sectoral actions that the city intends to implement to improve the transport system. In the analysis provided in the spatial plan, it is explained that further urban development will be based on the well-considered and sustainable development of the transport infrastructure and land use. It is also intended to develop different services throughout the city in order to reduce the need of transportation for residents. The city's development plan also includes the construction of transport infrastructure such as street reconstruction, cycle path construction and a new bridge over the river in the long-term. These activities would create conditions for vehicle flow management, shifting the industrial flow away from the populated parts of the city, reduce the need for cars and lessen the burden of traffic congestion. Implementation of these measures can reduce pollution,

including noise and air pollution and their impacts, while reaching the planned target of development of an economically and environmentally balanced sustainable mobility approach. Valmiera is also one of a few cities in Latvia that has adopted the city's environmental declaration. One of the tasks set in the declaration is to reduce emissions from transport and promote non-motorized transportation, especially bicycling, and to develop cycling infrastructure. The declaration was prepared in 2015 and up to now only 300 inhabitants, i.e., a bit more than 1% of Valmiera dwellers, have signed it. This shows the need for broader environmental communication that would raise environmental awareness.

The above illustrates that the municipality is willing and planning to move towards sustainable mobility. However, the analysis of the documents shows that the socio-ecological and cross-sectoral approach is poorly taken into account because the documents describe transport infrastructure only from the sector perspective. The only document concerning environmental pollution is environmental review included in the land use plan that provides little information on the environmental pollution caused by transport and estimates on environmental impacts of the establishment of the newly planned Vidzeme industrial park(an increase in transport flow). However, even then, no detailed information on the air or noise pollution from the increased transport flow was given, noting that this has to be specified during environmental impact assessment. Therefore, it can be concluded that planning documents currently do not explicitly evaluate and model transport-related environmental stressors, such as air pollution and environmental noise, which is the best practice from other countries and would show further intentions in terms of sustainability and environmental aspects.

In 2017-2018, the municipality (with the help of a consulting company) developed the municipal transportation strategy. The strategy evaluates the current Valmiera city transport infrastructure, identifies the main problems, and proposes a concept for further transport development. The strategy is a part of the thematic planning of Valmiera town and mostly focuses on its infrastructure.

Within the research, the authors (Kūkle *et al.,* 2019) participated in the process of the development of the strategy, provided information on the previous author's case studies in Valmiera town. The authors also perused the transportation strategy in great detail and proposed improvements to the strategy content through the public consultation process. The analysis of the strategy showed that it lacks a full and in-depth assessment of the stakeholder views. Without population surveys on the target group (pedestrians, cyclists, motorists, residents living near the motorway, etc.) views, their characteristics, desirable changes, most used routes, motivation to use one or another means of transportation, reasons for the high dependence on private motorised vehicles and low usage of public transport, it is impossible to develop a sustainable transport infrastructure development concept that would be purposeful and would bring the best benefits. Important information about environmental noise and other types of pollution and population survey results on the effects on the public were also missing. All these aspects are particularly important for the development of the transport concept, especially if the town aims at balanced and sustainable development. Only full information of these reasons can show the direction of the best and most appropriate solutions.

The strategy did not provide full assessment and proposals for the development of the integrative and comprehensive sustainable urban mobility concept in Valmiera city. It included some elements, such as information on priority modes of transport, which correspond well to the concept replacing the least sustainable transport mode with those more sustainable. However, as the strategy still foresees the expansion of motorization, it might prevent adequate implementation of the desirable sustainable mobility concept. The other two basic modal change concepts – the reduction of unsustainable patterns and efficiency improvement - have not been analysed at all. The interconnection of modalities was analysed to a very limited degree. All of the mentioned activities might impact noise and air pollution in the town as well.

The environmental impact assessment report only partially (and formally) contains information on environmental stressors and pollutants and lacks proper evaluation and modelling of noise and air pollution. When planning the development of urban transport systems, the modelling of transport emission dispersion and noise pollution is absolutely necessary, as that would help properly plan not only abatement measures,

such as traffic calming measures, street greening, noise prevention and reduction measures, but also take into account the complexity and interactivity of these impacts not only on environment per se, but also from the socio-economic aspect and economics (such as annoyance, lost life years due to these impacts on public health, medical costs, willingness to pay, abatement measures, etc.).

5.4. Brief summary of Chapter 5

Chapter 5 assesses development planning aspects in Latvia in environmental noise management aspects in five of Latvia's municipalities – Rīga, Ogre, Mārupe, Saulkrasti, and Valmiera. The assessment shows that the approach to noise management and the degree of detailed development differs in each municipally. Comparing the information reflected in the planning and regulatory documentation with the data on the main noise sources existing in the municipalities, it was concluded that sometimes noise from the largest noise sources are not evaluated in detail and are improperly reflected in the documents. This specifically refers to the Saulkrasti municipality, where the main noise sources are roads of national and international significance, and the planning documentation of which excludes any particular actions relating to the management of road noise emissions. Comparison of noise sources and activities included in municipalities' planning documentation and analysis shows that in the municipalities (except Rīga), there are many best practice activities missing. It also shows that noise evaluation and noise issue reflection in the planning documents improves with time (for instance, in Mārupe development documents). The Valmiera case study on urban transport systems, sustainable mobility and noise management shows that modelling of transport emission dispersion and noise pollution is not prepared despite the fact that the municipality develops transport mobility strategy and transport is the most important noise source. It also shows that no stakeholder behaviour and opinion analysis was done during the preparation of the strategy, however, the transportation and travel is one of the most important aspects for every household and many companies. These actions would help to plan abating measures and provide assessments of socio-economic aspects, as well as ensure town's sustainable and balanced development according to its environmental declaration and vision.

6. RESEARCH ON PRACTICAL ENVIRONMENTAL NOISE MANAGEMENT CASES IN LATVIA

6.1. Road noise management practical case study and environmental noise impact assessment

In order to analyse how road noise is managed and EIA is carried out, the integrative case study was carried out.

EIA is analysed as a preventative and integrative environmental impact evaluation tool. It aims to provide decision makers with appropriate information regarding a project's potential negative impact on environment quality and holistic health, as well as proposing methods to prevent or reduce possible harmful effects. One of the factors that are considered in an EIA is noise emissions. The necessity to evaluate noise-induced effects is determined by their impact on people's health, sleep regime, annoyance, psychological comfort, and social behaviour, as well as on wildlife.

The EIA as an environmental management tool in Latvia has been used since the 1980s when national legislation required environmental assessments for new technology and material applications, technical designs for construction works and environmental quality evaluations for construction sites. Current EIAs in Latvia are conducted in accordance with EU and national law and are applied to various construction projects, of which almost a quarter are related to infrastructure These infrastructure projects, and especially new motorways as they are major noise pollution cause, might cause significant changes in environmental noise levels, and therefore stress the importance of noise impact evaluation in the EIA process. The suitable assessment of noise impacts and necessary mitigation methods in the earliest project stages helps to ensure a acoustically acceptable living environment during the object's operation.

As mentioned above, this study aims to conduct an ex-post evaluation of EIA carried out for significant road projects relating to environmental noise issues. This includes the examination of the EIA's efficiency through actual noise level measurement data and analysis of its effectiveness through results of sociological surveys that would show public feedback on acoustic and non-acoustic factors. The ex-post evaluation of a project's EIA reflects the EIA's contribution to the provision of a sustainable and positive environment and allows assessment of whether the EIA has practically prevented the negative effects on the environment and society. In this aspect, the efficiency of a project's EIA can be described as the factual benefits resulting from the EIA, but effectiveness - as effects of EIA benefits. As efficiency and effectiveness are interrelated, they should be assessed together and be used to examine EIA.

Despite the fact that maximum noise levels were established in legislation only in the year 2001, EIA had been used prior to that for assessment of noise matters. Currently, the obligations of environmental noise management and EIA use for noise issues are fixed in national laws. National legislation determines the need for noise pollution limits and possible impact estimation not only in the EIA process but already at the stages of application for the planned action. In these reports, noise issues are mostly described as L_{day}, $L_{night,}$ and $L_{evening}$ noise levels. Every one of these three indicators have a significant role in the impact assessment process, and their importance is acknowledged both by experts and by the government (legislation and requirements in EIA program) (Lieplapa *et al.*, 2011). Meanwhile, factual examination of EIAs for 14 motorway projects shows that appropriate noise analysis that includes detailed numerical and descriptive comments on the existing and prospective situation and its alternatives has only been included in several EIA reports (Lieplapa *et al.*, 2011). Eight of these reports contain accurate information of day and night noise levels, but only 3 of them included evening noise (Lieplapa *et al.*, 2011).

The project under consideration is a span of the road VIA Baltica, which links Tallinn and Warsaw through the Baltic States and is part of one of nine priority European multi-modal transport corridors. The span is located in Latvia between the settlements of Lilaste and Skulte. It relieves other surrounding roads from vehicles and serves as a bypass around the seaside resort Saulkrasti. At the same time, the project barely can be considered as a true bypass, because it is partly incorporated into the infrastructure of

Saulkrasti town (Eirokonsultants, 2001). The new road infrastructure crosses Saulkrasti town area where cottages and private houses are located. In accordance to the local spatial plan 85 private houses as well as areas of allotments and summer cottages are located within 200 m of the road. It is possible that with future development of Saulkrasti town and an increase in traffic flow, debates about the bypass could be renewed.

The intensity of 24 hours of traffic flow in Saulkrasti in the year 2001(before road construction) was 8 750 vehicles (DEA Baltica, 2009). It is forecasted that by 2025 traffic flow could increase by 50% reaching 13 900 cars per 24 hours. The freight vehicle proportion in total traffic flow in the daytime is 20% and, in a night-time, it is 30% (Eirokonsultants, 2001).

The EIA report of the Saulkrasti by-pass contains information about the project's surroundings in terms of noise issues – the existing noise levels in daytime and night-time, territory zoning, forecasted noise levels, probable noise impacts and their significance, and a noise pollution mitigation plan. However, the report lacks information on monitoring activities, noise levels at the time of the object's construction and in the evenings $L_{evening}$, and noise level comparison to those that are set in national legislation.

In the EIA report, it is predicted that, during the object's operation, noise levels 430 m from the road will be less than 45 dBA during the night time and 55 dBA in the daytime (Eirokonsultants SIA, 2001). Forecasted noise levels and their impact zones can be seen in Table 6.1.

Table 6.1. Forecasted noise levels and their impact zone (Eirokonsultants SIA, 2001)

Period	Noise level	Impact zone (distance from the road)
Daytime	65 dBA	60 m
	59 dBA	185 m
	55 dBA	430 m
Night time	55 dBA	80 m
	49 dBA	235 m
	45 dBA	430 m

Taking into account the structure of the settlements near the road, the EIA report states that high noise impact on the inhabitants is expected to occur in 10 ha, moderate to high in 26 ha and moderate in 219 ha (from a total of 354 ha). In order to reduce the noise levels near the dwellings and ensure an acoustically acceptable living environment, the EIA report determines the necessity to use noise mitigation measures. It advises the replacement of windows for 11 private houses, the use of a 4 m high noise barrier wall, 2,5 m high compact fence and the planting of fir-trees (Eirokonsultants SIA, 2001).

In accordance with the modelling data of traffic flow and proportion of the freight vehicles within that flow, the EIA report contains forecasts that noise levels near the dwellings will be less than 55 dBA daytime and 45 dBA in the night time or that exceedances of this level will be corrected using reduction measures (Eirokonsultants SIA, 2001).

The data for forecasted and actual traffic (DEA Baltica, 2009) and measurements of traffic intensity (Zandberga *et al.*, 2009), showed that real intensity on a new road is close to, but a little less than that which is predicted. DEA Baltica data prognosis, based on actual traffic flow in the years 2007 and 2008, can be seen in Figure 6.1.

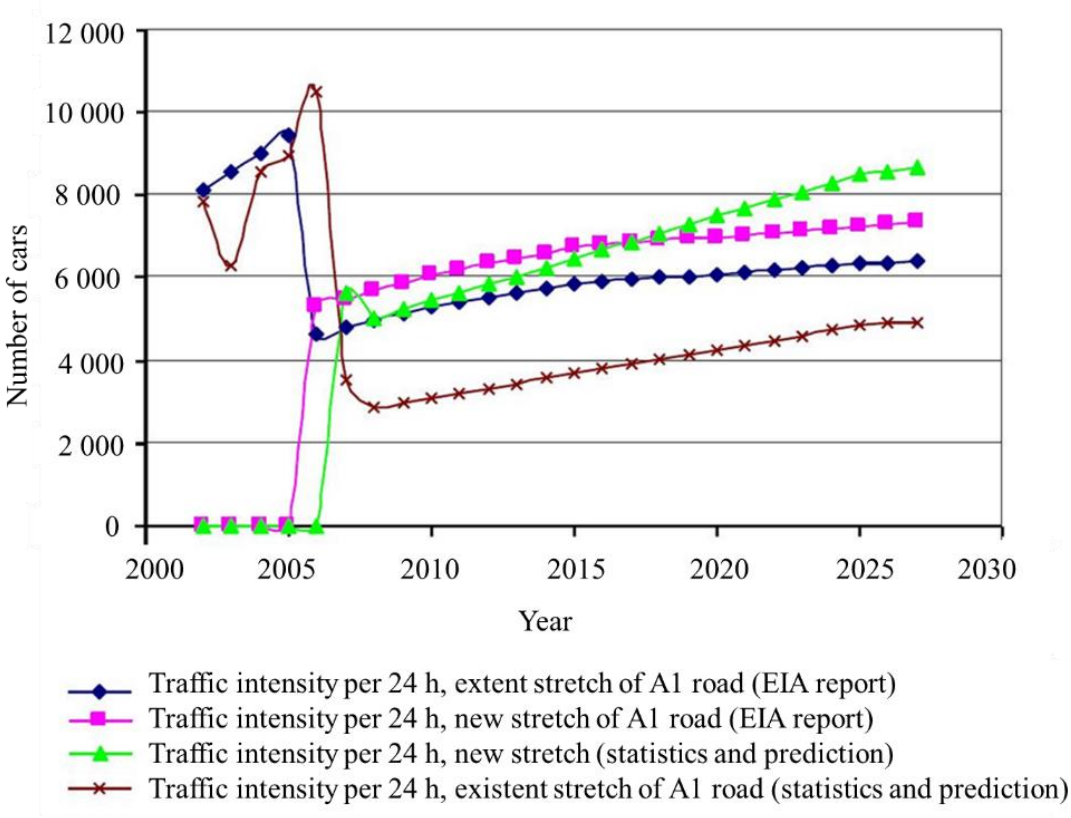

Figure 6.1. Actual traffic flow and prognosis (DEA Baltica, 2009)

In the meantime, the actual freight vehicle proportion in the daytime exceeds that which was predicted by 10% (Zandberga *et al.*, 2009). As these changes in traffic flow and proportion together can be considered as insignificant in relation to noise levels, forecasting of basic traffic data in the EIA can be considered as sufficiently accurate.

Noise level measurement data that are illustrated in Figure 6.2. indicates that noise level modelling in the EIA process has been conducted fairly accurately and that the installed noise barriers are insufficiently effective. This might be explained by an assumption that the modelling method was not applied accurately. Also, the EIA report lacks both a clear technical specification for noise walls or road surface characteristics which were taken into account when modelling, and information on how noise level calculations and decisions on mitigation measures were made.

Taking into account the mentioned factors, it can be concluded that, in order to improve the efficiency of the EIA process, noise level modelling should be conducted more accurately, and the report should contain more detailed technical specifications for those materials or objects which can influence noise levels as well as information on efficiency of noise mitigation measures. It also must be ensured that mitigation measures foreseen in the EIA are designed and implemented in a way to ensure accordance with national legislation in terms of noise levels. According to the interview with the responsible state institution regarding EIA, the quality of the EIA noise forecasts has improved since then.

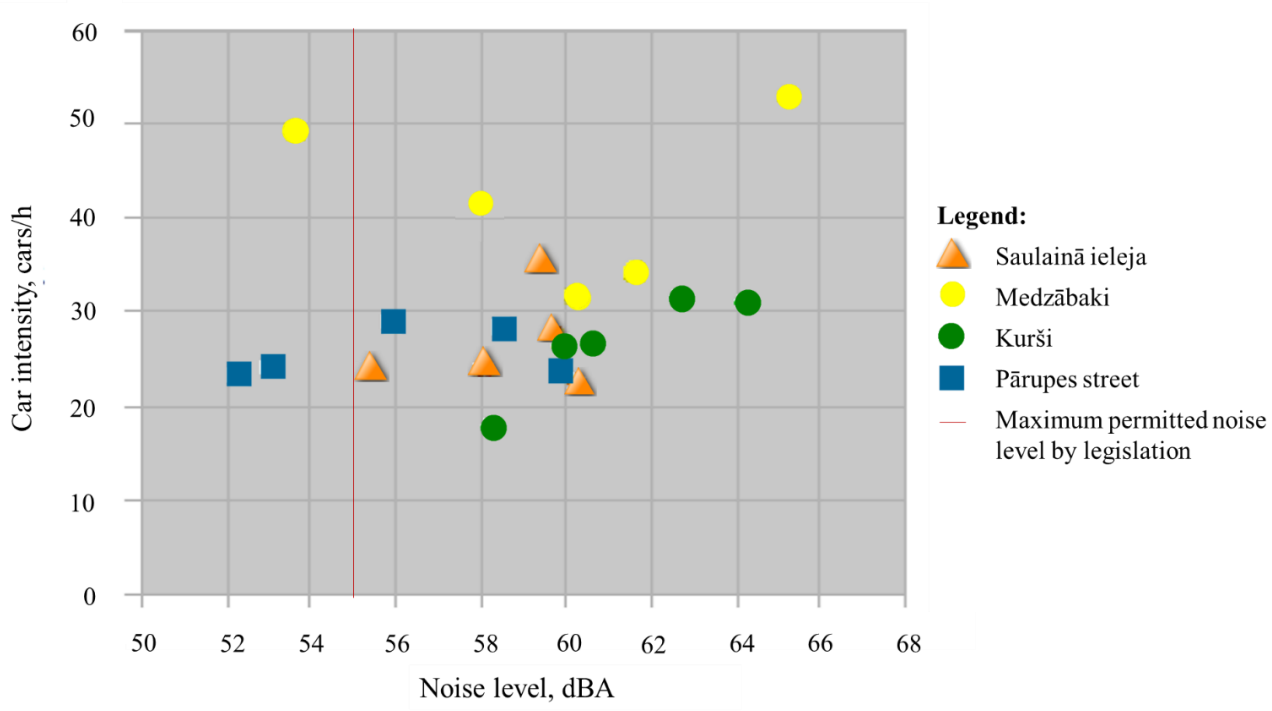

Figure 6.2. Measurement data (Zandberga *et al.*, 2009)

In the EIA report, it is forecasted that the noise impact on the inhabitants will be mostly moderate, moderate to high, or high. The noise impact will be reduced, and an acceptable living environment in relation to noise issues will be ensured with noise mitigation measures during the project's operation period. Six meters from the road, noise levels would only marginally exceed maximum permitted noise levels for the areas of private houses. The EIA expert's conclusion was that the values do not cause any threat to inhabitants, and "noise pollution is a non-critical factor in the total reduction of environmental quality" (Eirokonsultants SIA, 2001).

In the EIA public participation process, petitions from the inhabitants were received. They included comments about the project, concerns about possible noise impacts, and requests to take noise mitigation measures. The summary of received petitions from residents and owners of the summer cottages and allotments is given in Figure 6.3.

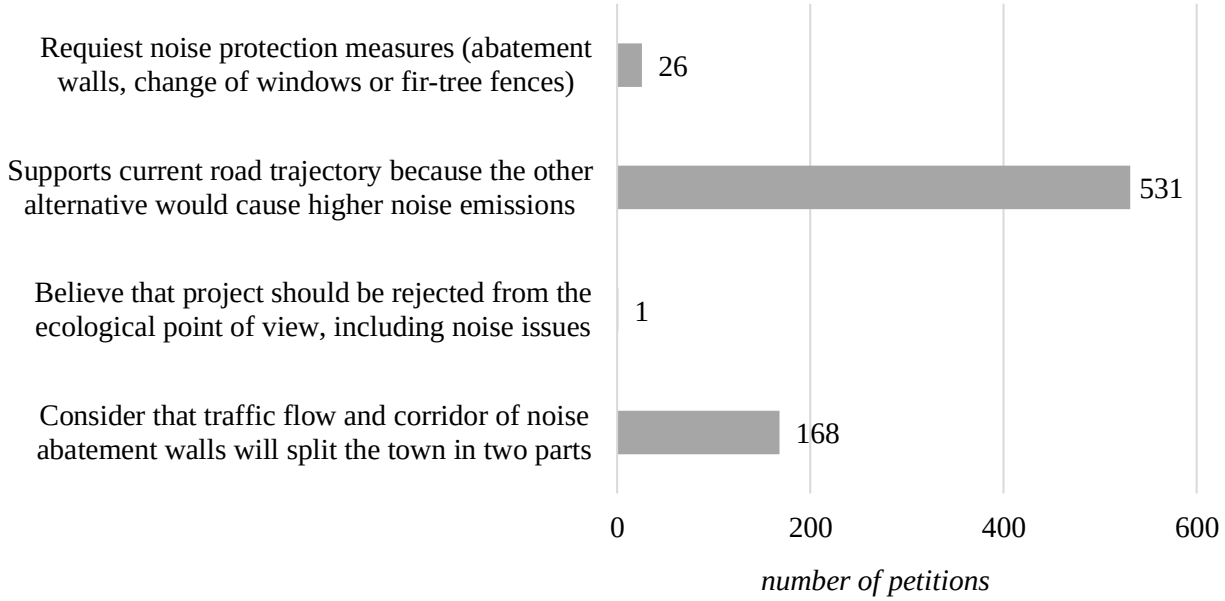

Figure 6.3. Summary of the received petitions (created by the Author, based Eirokonsultants SIA, 2001)

In order to assess changes in the acoustic environment after the construction of the motorway and noise protection walls, the author conducted the survey of residents' opinions. The results obtained from the interviews indicate that respondents perceived disruptive effects, especially outside their dwellings during the daytime and inside during the night time.

Surveys revealed that 42% of respondents feel subjected to elevated noise levels (outdoors or inside dwellings), unlike 58% of residents who feel not subjected to elevated noise levels. However, only 33% of respondents feel dissatisfied with the situation, but 67% are not disturbed by environmental noise levels and are satisfied with the situation. This well represents the subjective noise perception as it is shown in research of other authors (Guski, 1999).

Data show that those respondents dissatisfied with the acoustical situation mostly feel annoyed and are in psychological discomfort (see Figure 6.4.). These impacts are followed by unspecified impacts on their health and social behaviour, as well as sleep disturbance. This corresponds to the literature on environmental noise impacts. The most important noise sources for the respondents are road and railway noise, taking into account the close proximity of these noise sources (Figure 6.5.).

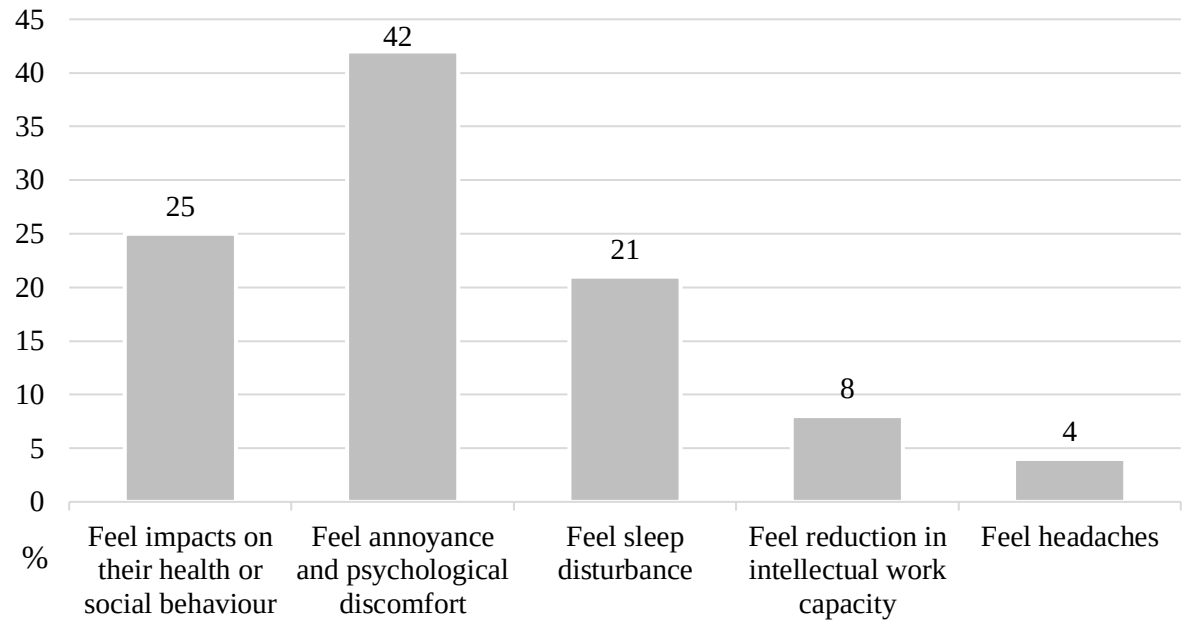

Figure 6.4. Sociological survey data: noise impacts (created by the Author)

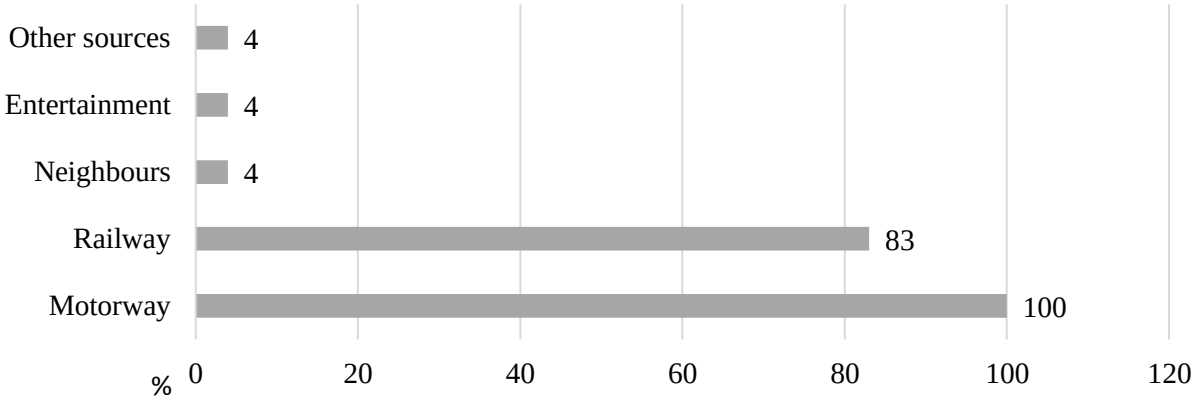

Figure 6.5. Sociological survey data: respondents' views on main noise sources in their neighbourhood (created by the Author)

Survey data on noise disturbance inside dwellings and outdoors in the daytime (corresponding to the hours used for of L_{den} calculation) and night-time (corresponding to the hours used for the L_{night} calculation) showed that higher disturbance during the night time is fixed indoors (i.e., 38% of residents) compared to outdoors (20% of residents). This could be explained by the natural day rhythm and need to rest during the night. This, possibly, might also be related to building insulation issues or noise non-acoustical factors and the idea that people hope to be more protected from the outside impacts in their homes and not having this protection might intensify the feeling of disturbance. The severity of the noise impacts in the evenings and night time is closely related to the season and the need for ventilation via open windows. Accordingly, higher disturbance outdoors daytime (i.e., 50% of residents) in comparison with indoors daytime (i.e., 29% of residents) shows the opposite trend, thus concluding that in the daytime people are more affected by noise

disturbance being outdoors which could be related to work rhythm and the fact of higher noise levels outdoors during the daytime.

The survey showed the differences in the attitudes towards noise issues in the answers of those people who have bought their properties near the road before the project's EIA, between EIA and construction works, and during the time of construction works or its operation. Those residents, who have obtained the properties after the construction of the project are mostly unconcerned about noise issues. This is because they had knowledge about the noise level before the settlement and assessed the possibility of noise pollution before the purchase. Meanwhile, those people, who have started living there in the time between the EIA and actual construction, are apprehensive of noise levels and impacts. This could be related to the lack of information or details about the project.

Attitude differences can also be seen in the responses of those residents, who live behind different noise barriers (special acoustical barrier, compact wood fence or fir-tree green fence). 35% of the respondents who live near the compact fence believe that the noise level at their dwelling is higher than in the properties behind noise walls. They consider that a sign of inequality in relation to living quality. These inhabitants evaluate noise levels inside and outside the buildings as high or very high and feel the noise causes annoyance and disturbance to their health. Meanwhile, those respondents who live behind the fir-tree green fence are moderately concerned about noise levels and consider that they are already used to the noise levels; however, they have doubt if the plants currently ensure proper reduction of the noise. At the same time, they hope that, by the time the traffic flow will increase more, the green fence will finally reach the necessary height and density to give practical benefit in noise reduction.

The results of interviews show that the noise mitigation measures proposed in the EIA and those actually constructed hardly ensure the needs for noise protection and acoustically acceptable living environments. Existing noise levels for a part of the residents cause acoustical discomfort, annoyance, and other impacts on holistic health. Thus, it can be concluded that EIA has been partially effective in reaching the main goal of EIA – to avoid or reduce negative impacts.

6.2. Railway noise management practical case study

Compared to other modes of transportation, the railway is considered the most environmentally friendly transportation mode in many aspects, such as CO_2 emissions, particulate air pollution, etc. In terms of noise pollution, the railway noise emissions are recognized to be less annoying than that from road or air traffic (Krohn *et al.*, 2009); however, in Latvia, railway noise is the second most important (by impacted residents) noise source (EC, 2019). Long term exposure to high levels of transportation noise can cause various socio-economic impacts, including increased noise annoyance and noise-related health impacts, as well as a decrease in property values due to noise pollution. Those impacts are most significant in residential areas and other noise sensitive areas, located in close proximity to transportation networks. Therefore, in order to reduce existing noise pollution levels, to promote the sustainability of the railway and to improve the environmental and acoustical quality of neighbourhoods, effective solutions for noise management should be found, and different environmental management tools should be introduced.

Theoretically, there is a set of environmental management instruments that can be used for railway noise management. The most important include planning, technical, administrative, economic, communication, and legislative instruments (Ernšteins *et al.*, 2014). Planning instruments deal with railway noise forecasting and estimation, noise action planning, as well as and planning of further development of railway systems. Technical instruments are related to the characteristics and maintenance of the railway infrastructure, equipment, and machinery used, as well as to the application of different technologies and tools, including noise modelling. Administrative instruments are understood as overall management tools of the sector, including EIA, eco-certification, and monitoring. Economic instruments deal with the funding of noise management actions, as well as taxes and fees applied in order to reduce noise emissions. Communication instruments are associated with the dissemination of information, engagement of society in

noise mitigation activities, and raising awareness on the topic. Legislative instruments include national and international regulations on noise issues.

The whole set of instruments have to be used not only at the stage of policy and action planning, but also when preparing and deciding on technical solutions to be used for environmental noise prevention or mitigation, and when preparing economical calculations for environmental noise management. For example, when deciding on construction of noise mitigation infrastructure, the assessment of legislative and land use planning requirements, environmental noise modelling data and costs have to be evaluated and taken into account, as well as communicated to the public.

For effective planning and implementation, the complementary use of all these tools is essential. However, the possibilities of their proper application are sometimes limited, and in practice, imperfections can be found due to various factors. The case of Latvia is one example: where railway noise management is still at a developing stage, and best practice adoption from other EU countries is limited due to different technical characteristics of the railway system and specifics of shipments.

In Latvia, like in other neighbouring countries, the main track width (the rail gauge) is 1 520 mm, which differs from the typical width of 1 435 mm used more widely in Europe. There are also differences in typical wheel diameters and geometry, brake systems, axle load, etc. The length of public railway lines in Latvia is 1 897 km, and the density is 29 km per 1000 km^2 (KPMG Baltics SIA, 2011). The railway in Latvia is the largest cargo transporter, handling more than 50% of total cargo traffic (KPMG Baltics SIA, 2011). During the last years, the reported rail cargo traffic is increasing. 97% of rail cargo is trans-national (transit) traffic, providing shipments from non-EU countries (Russia, Belarus, Kazakhstan) to other countries (82% of rail cargo transported further by the Latvian ports) (KPMG Baltics SIA, 2011). These shipments are mostly operated by non-EU operators, and therefore EU requirements on Technical Specifications for Interoperability are not being entirely fulfilled. Passenger transportation through the Rīga central railway station is provided daily from 5:30 to 23:00, but freight is transported 24 hours a day with the majority of cargo shipments made during the night period (KPMG Baltics SIA, 2011).

The aforementioned aspects significantly limit noise management possibilities and best practice adoption from other EU countries and determine the necessity to find specific solutions for Latvia.

Up-to-date noise mapping and a noise action plan for the major railway line from Rīga to Krustpils is required (according to Directive 2002/49/EC) as it has transport intensity of more than 30 000 train passages. The due date for noise mapping was July 2012, but the actual noise maps were finished in July 2013. Similarly, the development of the noise action plan was finished with a nine-month delay – in March 2014. However, the most recent noise mapping was done on time. The mapping results show for the Rīga – Krustpils railway line that there are 307 dwellings with approximately 2 500 inhabitants, located in areas where L_{day} values exceed 55 dBA, and 1 217 homes with approximately 13 658 inhabitants located in areas where L_{night} values exceed of 40 dBA. (ELLE, 2017)

Also, strategic noise mapping in the Rīga agglomeration has shown that a significant part of the population are subject to noise levels exceeding national limiting values, and the railway remains one of the major noise sources in the city. The most intensive railway line in the Rīga agglomeration, counting both freight and passenger traffic, is the Rīga – Moscow line that links Europe with Russia. Noise mapping shows that L_{den} noise levels in close proximity to the railway (40 – 200 m) vary from 50 to 75 dBA, but L_{night} – from 45 to 65 dBA. As the maximum allowed noise levels in Latvia's residential areas are 55 dBA daytime and 45 dBA night time, this causes noise nuisance and feedback from local residents. (ELLE, 2017) Similar situations were identified in other countries too, according to the information from the EC at the high-level noise conference in April 2017.

Integrative railway noise control employing a full set of management tools is still in its developing stage in Latvia. Since a big part of noise emissions arise from track-to-train wheel contact, railway infrastructure maintenance works are used to reduce noise at source. This includes, mostly within the scope of operational services, such measures as rail grinding, increasing the interval of track welds, track

restoration and replacement of damaged parts. However, the latest research on rail grinding on Latvia's railways has shown negative acoustical effects (Baranovskii, 2013). Laying and replacement of rubber coverings during the repair of railway level crossings also have been introduced as technical measures. Within EU supported projects, the Šķirotava station and its sorting hill have also been reconstructed, thus allowing a shift in the technical activities further from residential multi-story buildings and a reduction in noise levels. Noise screens are installed only in one particular case on a private railroad, but new barriers might be installed in acoustic discomfort areas depending on funding available. Problems related to funding were already analysed in Chapter 5 (Latvijas dzelzceļš, 2019).

Noise level forecasting or modelling is the main planning instrument along with the general railway development policy planning. Up to now, railway noise forecasting and coherent action planning are mainly used in cases stipulated by the EU and national legislation for agglomerations and major railway lines. Besides that, in 2013 the Latvian Railway performed noise level modelling for noise sensitive areas near railway lines, although no update has been performed since then. The use of railway noise modelling in Latvia, though, is a somewhat difficult task due to the applicable method and technical characteristics of the railway system. Latvia has so far used the European interim method RMR. However, due to technical differences of Latvian railway tracks (1520 mm gauge) and the rolling stock used, the RMR method does not provide correct data (for instance, RMR method does not take into account locomotive noise (Baranovskii & Krūkle, 2015)). Many of the developed and available market solutions cannot be applied on the Latvian railway thereof. It must also be taken into account that RMR method does not take into account locomotive. Research performed by the Rīga Technical University has shown that, by using the RMR modelling method on Latvia's railway system, the noise levels are significantly underestimated in all octave bands compared with the measured results (Baranovskis, 2013; Baranovskii, 2016). This indicates that the actual noise level exceedance may be greater than indicated in the strategic noise maps. Thus, if the RMR method is used in the circumstances similar to those of the Latvian railway, it may be impossible to ensure credible data on noise levels and therefore to decide on appropriate and cost-effective noise reduction measures.

It should also be mentioned that, despite the fact that the adaption procedures are included in the RMR description, they require quite sophisticated measurements. Consequently, the simpler approaches for RMR adoption should be developed (Baranovskis, 2013). Therefore in 2016, Latvian Railway, in cooperation with the Rīga Technical University, developed an approach for the adaption of RMR that could be used to obtain more reliable results.

According to the amendments to the Directive 2002/49/EC, after 31 December 2018, a common framework for noise assessment methods (hereinafter – CNOSSOS-EU) developed by the EC need to be used when preparing EU noise mapping. This framework provides a harmonized and coherent approach for noise level assessment from all the main sources of noise (road traffic, railway traffic, aircraft, and industry), and all member states will be obliged to use this method for further evaluations, noise mapping and action planning. In the meantime, Latvia's experts are of the opinion that the CNOSSOS-EU method will have the same limitations and issues as the RMR method regarding railway noise. CNOSSOS – EU was only tested in practise in three countries that use standard (1435 mm) gauge (Kephalopoulos *et al.*, 2016). More detailed research is still required to assess the variations across different countries to find the right correction approach to ensure CNOSSOS-EU applicability and correct results on 1520 mm rail gauge (Baranovkii, 2016; Murphy & King, 2014). This might show that there has not been proper communication of and lobbying for Latvia's interests during the development of the method and amendments to the Directive 2002/49/EC. Therefore, it is important to seek possible solutions to the above-mentioned issues in order to have coherent monitoring and forecasting of environmental noise. Currently, the RMR method is still set in Latvia's national legislation as the method to be used for the railway noise level assessment, but as of 10th July, 2019 the legislation sets the need to use the CNOSSOS-EU method for noise mapping. It is, though, believed, that the RMR method's approbation approach could give additional information also for

CNOSSOS-EU usage and approbation to the situation in Latvia.

Industry experts consider that Latvia's railway network needs renovation and upgrading. The shortage of resources for the maintenance and development of the existing rail system leads to the deterioration of the infrastructure and the rolling stock. This reduces the efficiency, safety, and environmental sustainability of the railway, including acoustic its quality. (KPMG Baltics SIA, 2011)

From an acoustical point of view, the main issue on Latvia's railroad system is related to freight traffic. Freight trains act as stochastic noise sources with a high, dynamic range. Such a high dynamic range of the freight train noise radiation makes it very annoying. The "annoyance" is not regulated by any standards, but it is found that a source with changing time radiation intensity causes more disturbance compared to a source with constant radiation - even at a higher level. This fact should be taken into account during train timetable planning, especially for the night period. (Baranovskis, 2013)

Current freight rolling stock uses cast-iron block brakes. The best practice of European rail operators for noise source reduction is retrofitting the brake system. However, this is hard to achieve on railways in Latvia because the main part of the rolling stock comes from non-EU countries. Freight diesel locomotives have high traction noise levels in low-frequency bands produced mainly by engines and exhausts, making traction noise the main noise source at low speeds. The problem of traction noise is especially important in shunting yard areas. Freight locomotive exhausts are fitted at a height of 4 – 5 m above the railhead, strongly limiting the possible noise attenuation from trackside noise barriers. To solve this problem, various passive and active source reduction techniques can be applied.

Diesel and electric passenger trains have lower levels of noise overall and a lower dynamic range of pass-by noise, being less annoying compared to freight trains. Diesel passenger trains have the lowest noise level, because of the disc brake system which is used instead of block brakes. In Figure 6.6, linear regression lines (least square method) which represent the pass-by noise level depending on speed for different types of rolling stock on Latvia's railway system are illustrated. The regression lines show pass-by noise level measurements at a horizontal distance of 7.5 m from the track centre line and at a height of 1.2 m above the railhead. The rail rolling surface was relatively smooth.

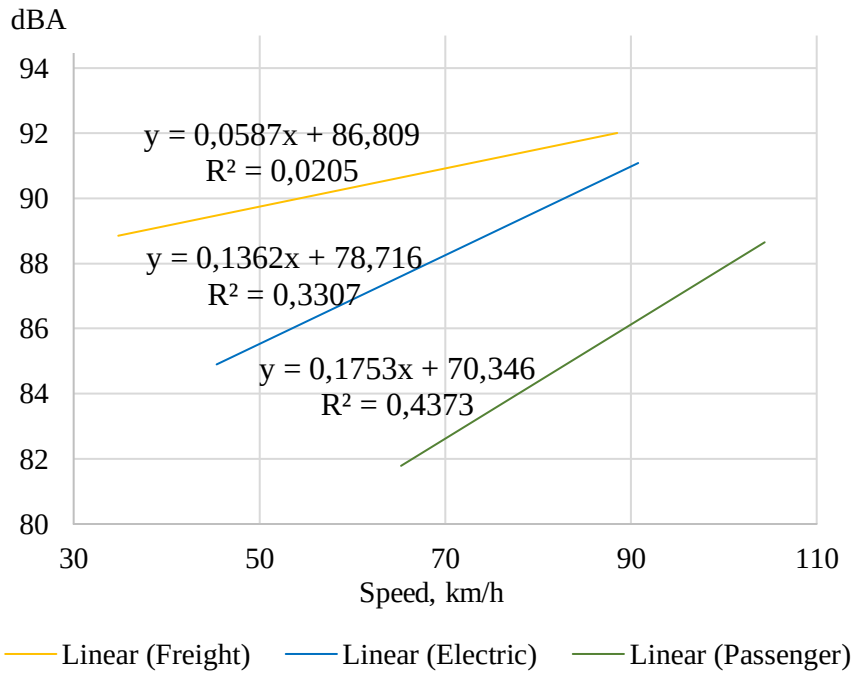

Figure 6.6. Pass by noise level (L_{Aeq}) speed dependence for all train types on Latvian railway on a relatively smooth rail rolling surface (Baranovskii, 2013)

Here it is important to mention, that the good practice of many European countries is the use of rail grinding for rolling stock noise reduction, yet, in Latvia, the acoustic effect of rail grinding has never been qualitatively evaluated. Figure 6.7.b) illustrates that a deep grinding stone pattern was left on the rail surface.

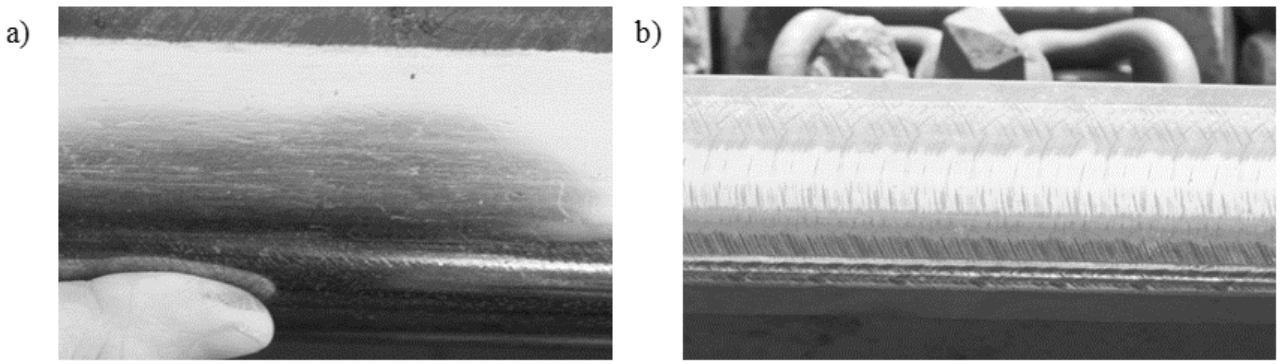

Figure 6.7. Pictures of rail rolling surface: a) track ground within 42 months; b) track ground within 6 months (Baranovskii, 2013)

It was discovered that the pass by noise levels, in all octave bands, of all train types at all speeds were increased due to poor quality rail grinding (Baranovskii, 2013). This indicates the current problems related to rail grinding works and the necessity to reconsider the process of quality control of grinding works (see Figure 6.8).

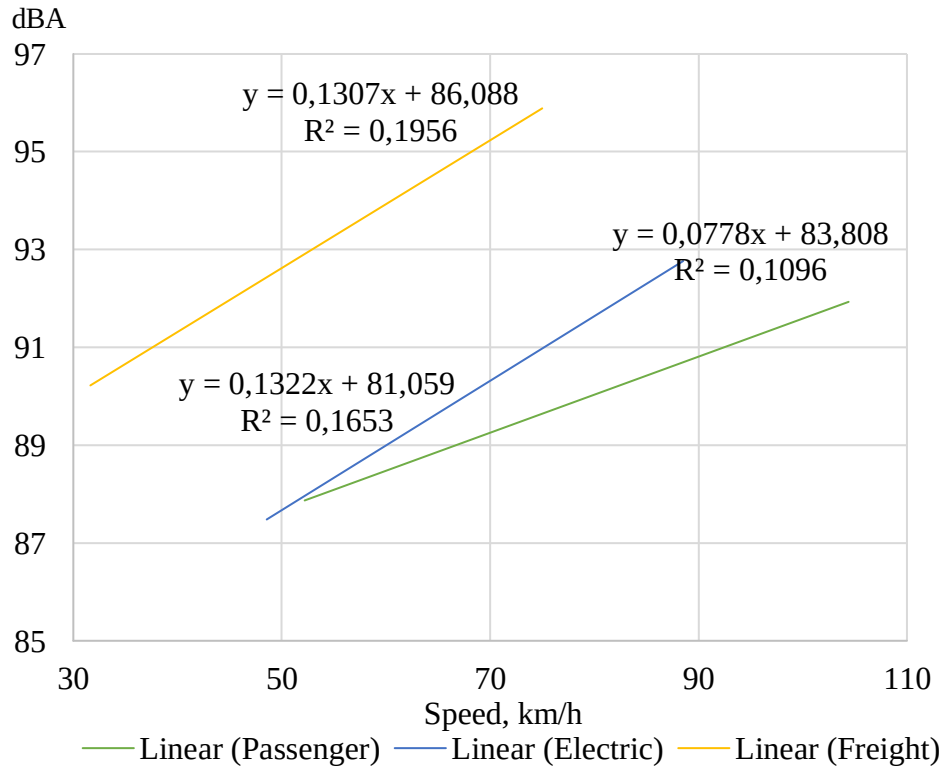

Figure 6.8. Pass by noise level (L_{Aeq}) speed dependence of all train types on Latvian railway on relatively rough rail rolling surface (Baranovskii, 2013)

Special consideration is needed for brake squeal, curve squeal, and rail joint impact noise. A particular problem is related to ground-borne noise and vibrations in buildings close to railway tracks. According to the interviews, the application of new and innovative solutions when it comes to tracks or trains is a difficult because of the safety considerations. Taking into consideration the above-mentioned technical character of the railway in Latvia, further proposals on how to control railway noise emissions should still be developed.

The evaluation of possible noise issues and their cumulative impacts on society and the environment as a part of the integrative impact assessment process is performed according to the requirements of the EU and national legislation and applied to major railway development projects. One of the assessments made is for a new railroad to connect Rīga International airport with Rīga the city itself. According to the EIA report and the decision of the responsible institution of EIA, environmental noise is considered to be the most important environmental stressor of the project (ELLE, 2011). This has prompted the use of complex technical instruments and an integrative urban plan that takes account the cumulative noise impacts from different sources which is a crucial aspect for well-being of society, environmental quality and proper further development of the project.

Considering railway development plans, including the Rail Baltica project, growing noise problems on Latvia's rail lines and the requirements of the legislation, Latvian Railway has developed the environmental quality system for better administration of environmental noise issues and provides educational opportunities to its environmental experts on noise control issues.

For future improvement in the use of administrative tools, the need to install regular noise monitoring of the "hot spots" should be considered, for example, in the areas where train brakes are tested.

For the moment, there is a shortage of productive networking with non–EU operators on railway noise issues, therefore further improvement in communication on the topic would be highly recommended. The European Community interoperability requirements for rail systems concerning the design, construction, placing in service, upgrading, renewal, operation, and maintenance, including noise limit values for trains do not apply to non-EU entities (and they so far have not requested to apply them).

According to the Latvian Railway Environmental Review (Latvijas dzelzceļš, 2018), during the period 2012 – 2017, 35 public complaints were received on railway noise. Several noise situations are also described in the media. Sarkandaugava residents, for instance, complain about elevated noise levels, especially with open windows in the summertime, and noise impacts on children. They have been approached by the State Health Inspectorate, which has made noise measurements and detected instances where permitted noise limit values have been exceeded (Anstrate, 2016). The residents have also joined together in a group against railway noise and called for a solution to be provided for the construction of noise screens or other noise-limiting structures (Skaties.lv, 2016; Delfi, 2016). The Ministry of Transport have explained that noise barriers are not always an effective tool for reducing railway noise. For instance, the noise barrier modelling in Rīga, Jāņavārti showed that noise barrier could better tackle noise at the first two floors. To reduce noise at higher floors, and to keep the $L_{evening}$ and L_{night} below limits, a 6.5 m – 7 m high barrier is required, that is not only economically expensive, but also could have issues with its placement in city due to protection zones around infrastructure networks and rail safety requirements (Brananovskii & Krūkle, 2015). Therefore, there must be complex national level solutions found for the operation of railways transport, but on-the-site installations should be carefully assessed, not to make even greater dissatisfaction, in case chosen methods do not provide the anticipated noise decrease.

Another topical issue from the point of view of the society is the Rail Baltica railway noise in Mārupe. The concerns are about noise from high speed rail lines and the impact combinations from different noise sources (airport, road, and railway). The EIA Report for Rail Baltica (Eiropas dzelzceļa līnijas, 2016) includes environmental noise modelling data, also background noise, and chapters on environmental noise reduction possibilities. The report mentions that the planned operation of the railway track will cause noise pollution that exceeds limit values and would require technical mitigation measures; however, evaluation on practical noise reduction will happen only during the construction design phase. It is concluded that

conventional noise screens might not give enough effect to result in environmental noise being below the permitted threshold level in houses that are located closer than 40 m from the tracks. Therefore, it is of utmost importance to plan a combination of different noise reduction measures and to have a sophisticated and thoughtful approach for designing noise measures in order to ensure environmental quality in accordance with national legislation. It would be advisable to show the possible solutions already in the EIA report in order to prevent a situation similar to Saulkrasti road noise case where noise level exceedance was detected (see sub-chapter 6.1.).

6.3. Industrial noise management practical case study

One type of environmental noise source that should be managed is industrial noise from stationary facilities. Among them - wind energy facilities. The operation of a wind turbine generates tonal, broad, low frequency, and impulsive sound (Rogers *et al.*, 2002). The level of noise generated by wind energy facilities depends on the parameters of the wind turbine, the distance to the receiver, air absorption, orographic conditions, meteorological conditions, as well as sound barriers.

The noise generated by wind energy facilities may cause behaviour disorders in the receptor; for example, discontentment, aversion, and annoyance, or it can advance disorders of speech, sleep or intellectual work performance (Rogers *et al.*, 2002). In practice, it is believed, that with appropriate wind park layouts, the negative influence of such noise can be reduced, although the perception of the noise and consequently the level of its impact is determined by various subjective factors. Whether the sound becomes undesirable depends on the type of sound, the sensitivity of hearing, and on other factors that may affect every person differently. In sensitive people, the agitation caused by noise might cause stress-induced illnesses. Still, part of society considers infrasound to be one of the main problems caused by wind parks, even though no evidence of its negative influence has yet not been confirmed. In addition, only limited information is available on the population's perception of wind parks. (WHO, 2018) Due to the above-mentioned subjective considerations and lack of evidence, it is impossible to clearly determine the effects of wind park noise generated impacts and the reactions associated with it.

Wind park noise is an significant cause of annoyance, and some socio-acoustic research was performed to assess the social response to it, and to understand what factors influence the annoyance the most. A study among homeowners living in the proximity of wind park in the Netherlands observed that self-reported noise annoyance was more considerable with higher wind turbine noise levels, and an exposure-response relationship was derived. Noise annoyance was also found to be an impacting factor in sleep disturbance and anxiety. Besides, respondents dwelling in territories with other environmental background noises were less affected than respondents in rather quiet territories, as it is usually in rural areas that wind parks are typically built. (Basner *et al.*, 2015)

The development of wind parks has become one of the most controversial environmental and public participation questions in Latvia. Shortcomings in legislation and in concepts of planning, as well as insufficient communication among involved parties about the development of wind parks and their diverse impacts, have increased the emergence of negative attitudes in parts of society as well as public protests. The recent Zemgale wind park case showed that society is still deeply interested in the environmental and health impacts that the noise park could cause, including about environmental noise impacts. The Environmental Impact Assessment Report (ELLE, 2018) on the wind park development in question states that, according to the results of calculations, the average noise level at all times of the day around the turbines can reach around 50 dBA. However, residential houses are a large distance farther from the turbines, so that wind turbine noise level in the residential areas is likely to be significantly lower than permitted in Latvia. However, inhabitants still protest – the Environmental State Bureau has received a letter signed by 197 inhabitants. This shows that wind park development is still important and is a society reaction issue that has been left unresolved since the year 2010, when several constitutional law-suits related to the impact of wind

park development on society´s health and rights to live in a congenial environment were adjudicated. Problematic situations of the development of wind parks have been widely reflected in the mass media. This illustrates the need for the studies on wind park noise and society attitudes.

The need to construct wind parks is determined by the necessity to develop the use of renewable energy, thus enabling the sustainable management of natural resources and ensuring the country´s energy independence from foreign countries. The potential of wind energy in Latvia is determined by location and meteorological conditions. Considering wind velocity and orographic aspects, the most suitable territories for development of wind parks in Latvia are on the southwestern coast, where some of the wind farms studied are located (Figure 6.9).

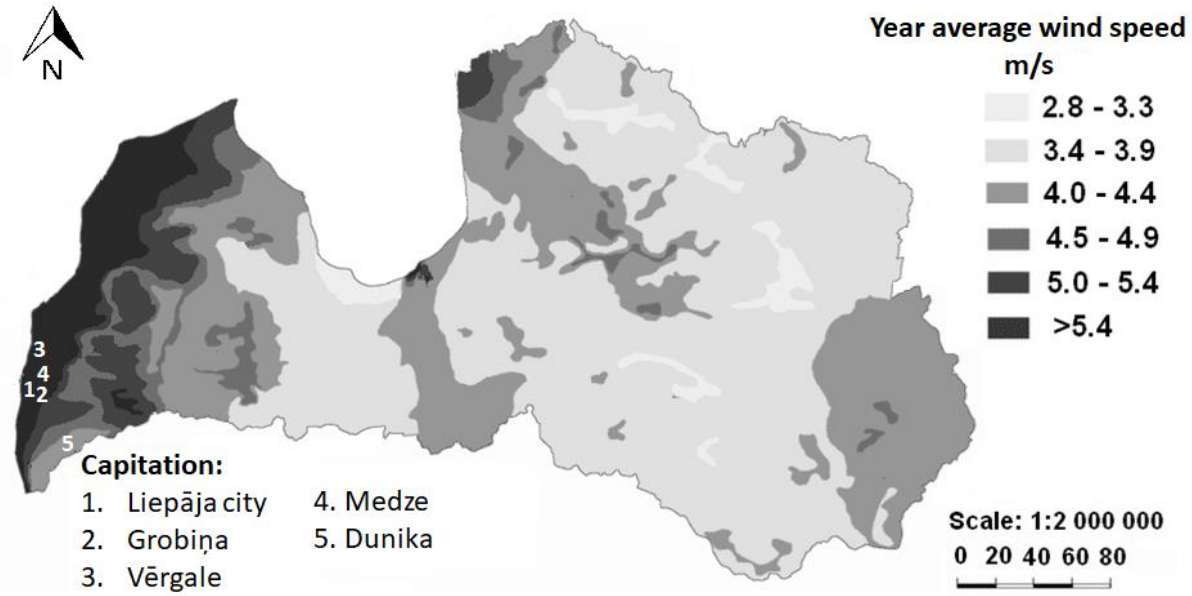

Figure 6.9. Location of wind turbine and wind farm areas in south-western Kurzeme under the scope of the research, and information on wind speed in these areas (Created by the author, using Wind energy website, 2011).

Although the use of wind turbines for generating electric energy in Latvia is still underdeveloped, the role of this renewable energy resource in Latvia´s energy balance is becoming more significant.

Within the framework of the case study, the operating wind parks in Grobiņa (33 wind turbines, 20 MW power) and Vērgale (3 wind turbines, 2.5 MW power) and those planned in Medze (4 wind turbines, 1 MW power) and Dunika (41 wind turbine, 117 MW power) were inspected.

All wind turbines are located in areas of detached houses and recreation areas, where the construction of wind turbines is permitted. The closest houses in Grobiņa, Vērgale and Medze, are located at a distance of 250-300 m from the wind turbines, but in Dunika – at a distance of 500 m. The wind park of Grobiņa is located in an open field where circa 30 residential houses are situated. In Vērgale, however, the wind turbines are located at the edge of a forest, and there are only 2 residential buildings nearby.

The initial environmental impact assessment information on the project shows that the respective environmental noise and construction rules are respected and the modelling of noise levels shows that permitted noise levels would not be exceeded; however, they are planned close to the maximum permissible level (L_{day}, 48 dBA). The noise model takes into account noise levels at a wind speed of 8 m/s at which the wind generator reaches maximum speed, hence also noise. The noise assessment takes into account the limit values regulated in regulatory enactments. In addition, it has been taken into account that in separate months

and even several months in a row, the average wind speed is higher than the average wind speed at a particular location. Accordingly, the potential significance of the noise impact is calculated taking into account the maximum possible speed of the wind power plant and the maximum possible noise level. (Judgment in case No.2010-48-03, 2011b).

The legislation does not stipulate the need to conduct monitoring of levels of environmental noise, nor does the operation permit. Residents have their doubts about the predicted levels of noise, considering that these actions are performed by the developers of the wind parks and, thus the residents are not convinced that these levels are accurate.

The data obtained from the interviews indicates that the majority of respondents living in close proximity to the wind parks perceived the sounds created by the wind turbines as not disturbing. At the same time, some residents point out the impacts on health caused by the noise, acoustic discomfort generated by the wind turbines, the limitations of outdoor recreation caused by vibrations, as well as expressing their concerns regarding wind turbine impacts on health. People who expressed negative attitudes or drew attention to health hazards were the owners of properties near the land where the wind turbine is located. Consequently, they obtain no direct profit from the development of the wind park. See data in Figure 6.10.

The negative attitude towards wind turbines expressed by a large part of the population inhabiting the territory of existing or planned wind parks is based on a potential decrease in their quality of life. This is shown by petitions against the construction of wind parks, addressed to the municipalities, signed by 55 inhabitants of Medze (population 1,558) and 182 of Dunika (population 749), that are based on their concerns about impacts of wind turbines on human health, including about the acoustic discomfort (Judgment in Case No.2010-54-03, 2011; Judgment in case No.2010-48-03, 2011). Although the predicted level of noise in these parishes is lower than the maximum permitted, the worries of residents of Dunika are increased by the fact, that the results of simulations predict levels of noise reaching 39 dB at the nearest dwelling that is merely 1 dB lower than the permissible level of environmental noise at night in this building zone (Judgment in case No.2010-48-03, 2011b).

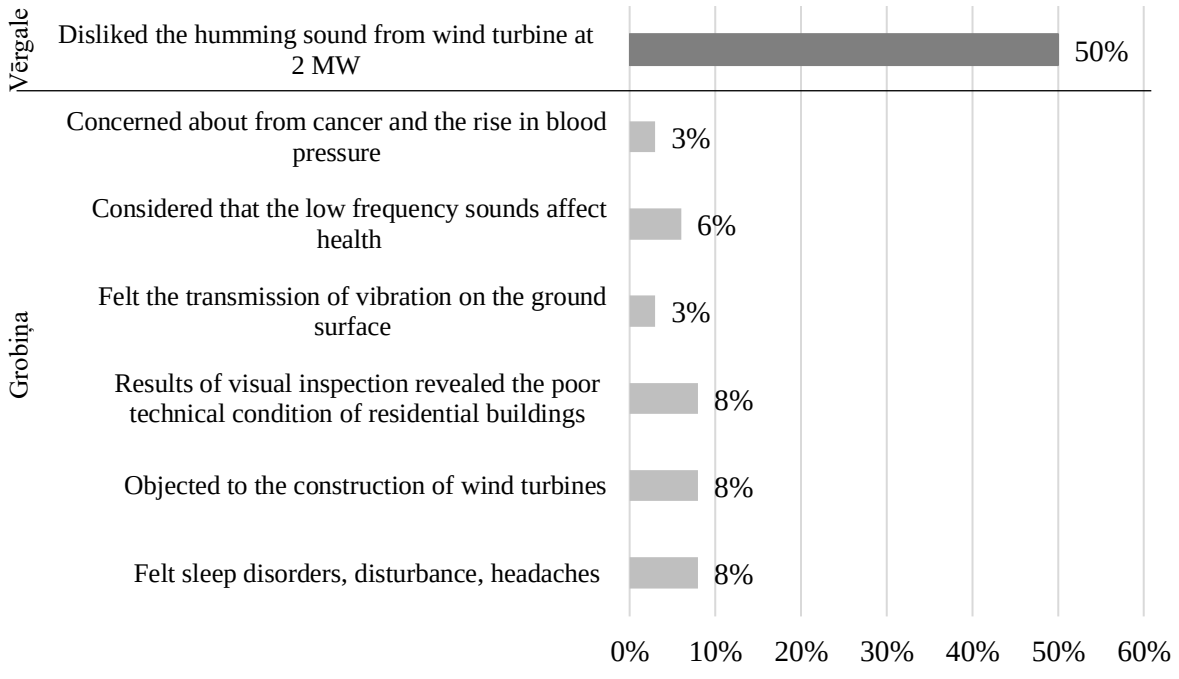

Figure 6.10. Responses on the noise from the operation of the wind park (created by the Author)

In addition to submitting the above-mentioned petitions, in the year 2010 with the support of non-governmental organizations, residents of Medze and Dunika have brought a petition to the Constitutional Court (Judgment in case No.2010-48-03, 2011 b; Judgment in Case No.2010-54-03, 2011) to litigate the territorial planning, that permits the construction of the wind turbines near the dwellings of the litigators and the incorporation of their properties in the territorial zoning of the wind park, thus infringing upon the property rights of these residents and their rights to live in a pleasant environment. 19 residents who reside in Dunika parish also submitted a claim at the European Court of Human Rights to oppose the construction of wind power stations close to their homes. The applicants based their claim on Articles 6 § 1 (fair trial) and 8 (respect for private life and for the home) of the Convention on Human Rights.

In both cases, the Constitutional Court and European Court of Human Rights ruled that in territorial planning, the plaintiffs´ ownership limitations have been foreseen, but that has been done with a legitimate purpose: to ensure the welfare of society. The Constitutional Court pointed out that defining the planned use of the territory as that of a wind park is not damaging to the health and life quality of the residents, because, regardless of the solution chosen in the territorial plan, the operation of the wind park will be permissible, only in cases where the environmental noise is under the levels stipulated by law. Though, the decision of the courts are not in favour of residents, the fact itself shows society concerns.

The inhabitants of Grobiņa and Vērgale consider that overall, the information they received from the municipalities, the developer and non-governmental organizations has been of limited quantity and quality, and as a consequence, they lack certainty that the wind turbines are harmless. All the respondents recognize that they would have wished and still desire to receive extensive and reliable information about the possible impacts of the wind park. For further information see Figure 6.11.

People, who own properties on neighbouring lands to those upon which the wind turbines are located, point out that their opinion before the construction of the wind park was not sought and a survey to determine public opinion should have been conducted. It also should have been ensured that the people inhabiting the vicinity of the wind turbines had information about the municipality´s plans.

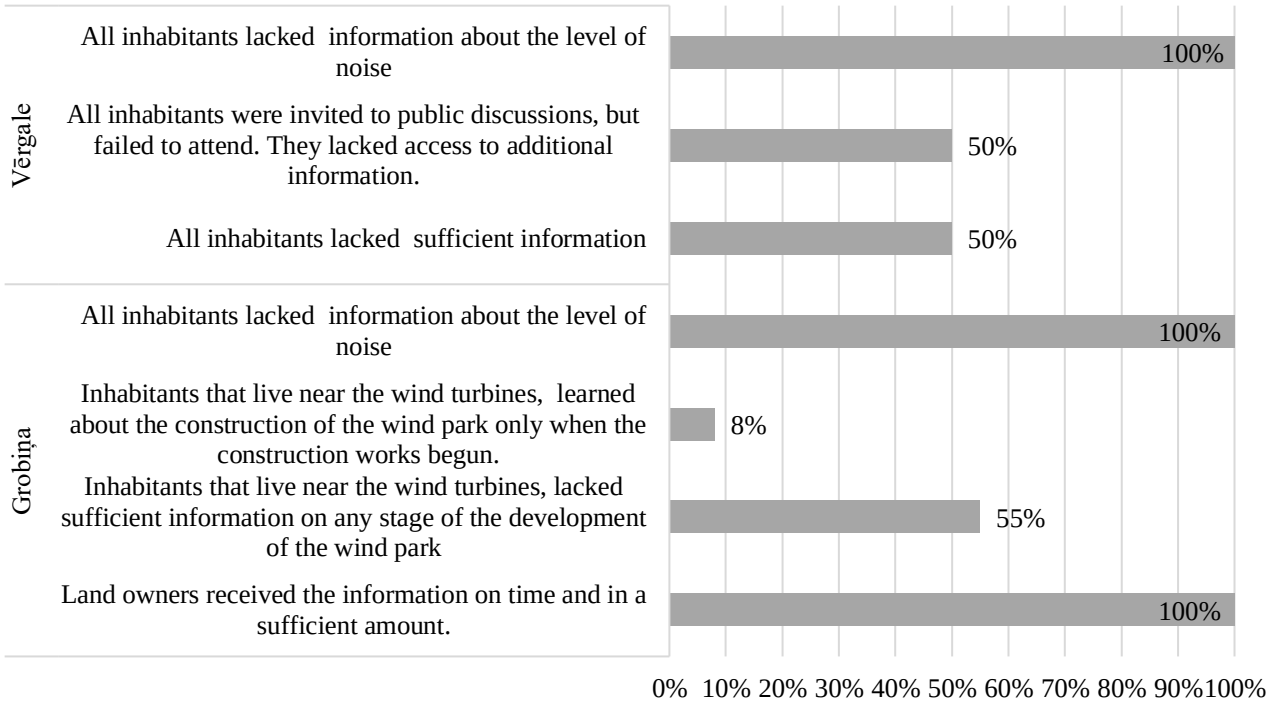

Figure 6.11. Answers of the respondents about the information availability (created by the Author)

The research shows that in the process of development of the territorial plan and detail planning only a small proportion of Grobiņa respondents and none of Vērgale respondents participated. Both Vērgale and Grobiņa residents were inactive in the processes of planning of the wind parks, due to the belief that public activities have no impact on the result. The residents of Grobiņa indicate that the low level of their participation is related to the lack of information about the process of public discussion (Table 6.2.).

Meanwhile, the inhabitants of Dunika drew attention to a formal process of public discussion of the spatial plan and the detailed planning, where the objections of the public were disregarded, and no reasonable arguments were given as to why public opinion had not been considered. The local population believes that it was insufficiently informed about the public discussion and that the municipality failed to respond to their questions and deal with their petitions (Judgment in case No.2010-48-03, 2011 b).

Table 6.2. Respondents' answers about the processes of public involvement
(created by the Author)

Criteria	Grobiņa	Vērgale
Percentage of residents that have participated in the process of the developement of territorial planning and detail planning	8% of all inhabitants	0% of all inhabitants that live in the neighbourhood of land where the wind turbines are constructed
	100% of owners of the lands where the wind turbines are constructed	
	3% of inhabitants that live near the wind turbines, which stand on land owned by others	
	25% of respondents that initially have been against the construction of the wind park	

The inhabitants of Dunika had indicated they believe procedural violations in the development of the territorial plan took place when the area of the wind park was defined after the public discussion and after the documents were sent out for adjustments to the controlling institutions. After adjudicating this case, the Constitutional Court (Judgment in case No.2010-48-03, 2011 b) has concluded that the municipality of Dunika has committed procedural violations, and as a result, the strategic evaluation procedure of impacts on the environment was left out.

6.4. Settlement of environmental noise problem situations and dealing with public feedback

The main institutions that are responsible for dealing with public feedback on environmental noise and its control in Latvia are the MoEPRD, the State Health Inspectorate, as well as municipalities. Noise level control in response to public feedback is undertaken by the State Health Inspectorate, municipalities, and their assigned institutions. The State Health Inspectorate, which is under the supervision of the Ministry of Health, is responsible for dealing with environmental noise problem cases arising from transportation and industrial activities, such as the operation of ventilation and air-conditioning systems and compressors, as well as from industrial plants in general. In 2016, the Inspectorate reviewed 95 complaints (in 2014 - 96, in 2015 - 77) on environmental noise in residences and residential areas. In the cases of environmental noise applications, 14 laboratory measurements were performed, out of which 8 exceedances of noise levels were detected. In addition to controlling the activities performed, the Inspectorate has been involved in solving noise issues by engaging in working groups organized by Rīga City council and Rīga International Airport, as well as to propose changes to the regulatory enactments regulating noise issues. Data on environmental noise complaints to the health inspectorate are no longer explicitly included in the State Health Inspectorate's annual reports. Therefore, no particular information on complaint numbers in 2017 and 2018

was found. The responsible institutions for dealing with public feedback about neighbourhood noise from pubs, concerts, or other sources are the municipalities and their assigned institution, the municipal police. When information on noise problem cases are received, a similar scheme of public feedback investigations as described above is applied. The municipal police usually have the right to issue administrative acts (abatement notices) and apply penalties for the offense also in cases when the maximum allowed noise levels are not exceeded.

The national legislation lacks a detailed description of practical noise management procedures, and this is exacerbated by a lack of guidance from the governing state institutions. Specifically, in relation to dealing with noise issues and the collaboration between public, municipalities, and state institutions, there is a strong need for clear management strategies to practically solve significant and acute noise issues. This includes regulations for cases where residents provide feedback about high noise levels. For municipal level noise handling guidance on a systemic approach might be needed.

The first practical noise management step which must be taken into account at the municipality-level is to define which of the respective municipal institutions is responsible for the control of noise related to music and other public noise sources. The usual practice of municipalities in Latvia is to assign this function to the municipal police. Meanwhile, municipalities sign contracts with certified noise measurement laboratories, which in accordance with national legislation are solely able to make legally defensible measurements. Only after this step can municipalities solve environmental noise problems in practice.

It is proposed that on receiving inhabitant feedback about high noise levels municipalities, or their assigned responsible institutions, should take the following steps:

1) Identify the noise source;
2) Determine whether the feedback is within the municipalities' competence;
3) Inform the noise measuring laboratory of the received feedback;
4) Undertake noise measurements (carried out by the noise measuring laboratory with the participation of a representative of the responsible institution) with prior contact with the person submitting the feedback;
5) Prepare a notice to be served if there is a violation in terms of permitted noise levels;
6) Take a decision on the appropriate fine or penalty and its amount (this action is taken by the administrative commission of the municipality).

To manage environmental noise problems which are not within their competency, municipalities must collaborate with the State Health Inspectorate, either by forwarding the feedback to the respective competent institution or by informing the person who submitted the feedback of the responsible institution and providing the contact information.

In cases when public feedback is received about noise created by economic activities, they must be considered by the inspecting officers within 30 days. The officers should initially identify the noise source and undertake calculations to determine the probable noise level generated by the noise source, assess the predicted noise, and undertake a site inspection.

In cases when the inspector having assessed all the available data considers that the permitted noise levels could be exceeded, they must require noise measurements to be carried out by a certified laboratory. If the results of the noise measurements show that the noise levels are exceeded, the developer receives a notification from the State Health Inspectorate detailing the noise reduction needed and the period during which this must be carried out (usually 1 – 2 months). To prove that the noise levels are reduced to that which is permissible, the developer must submit a report of further certified noise measurements. The health inspector must then evaluate the report, but it is not necessary to re-check the correctness of the data on-site.

Only in situations when the developer fails to reduce the exceeded noise levels, the State Health Inspectorate will require the administrative commission of the municipality to consider the case and decide on the application of a penalty.

A summary of the above is shown schematically in the practical noise management block scheme (Figure 6.12), which contains information about systematic activities of the municipalities and the State Health Inspectorate, as well as their mutual collaboration which was gathered by interviewing the municipality and State Health Inspectorate officials.

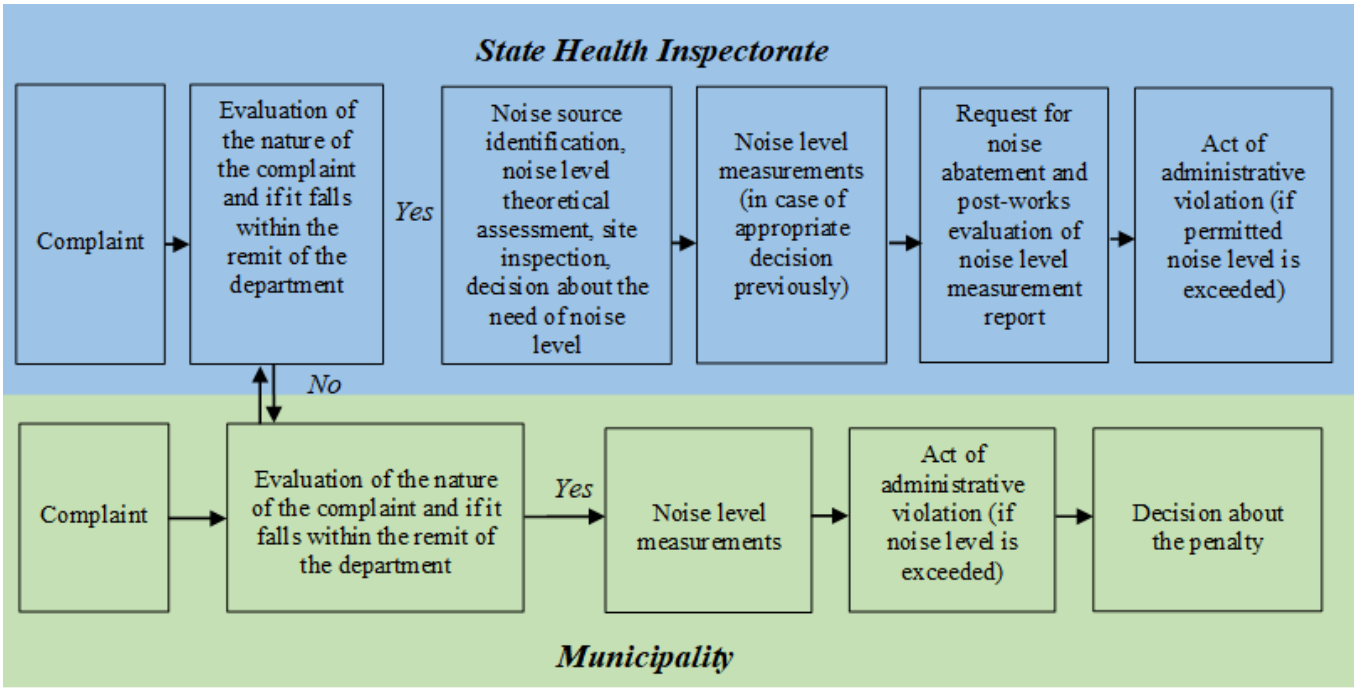

Figure 6.12. Noise practical management block scheme in Latvia (created by the Author)

It should also be mentioned that there are no clear descriptions of the public feedback management strategy available from municipalities or the State Health Inspectorate. Though information about noise created from economic activities is featured on the website of the State Health Inspectorate, the information featured is general and only related to the submission of public feedback. In addition, there is almost no information about public feedback investigation procedures. The municipal internet home pages feature no information on noise control at all and there is also no description about general complaint management.

Comparatively, in other EU countries, inhabitants get more information about noise and public feedback management. For instance, in the United Kingdom, inhabitants are informed through leaflets, websites, governmental and non-governmental institution booklets detailing multiple methods of public feedback relating to noise nuisance (and the relevant steps in submitting them) – contact details for those responsible for noise issues at the responsible institution or mediation services. In cases when the listed actions fail to resolve the situation, there is the possibility of making public feedback to the magistrates' court for noise nuisance proceedings or even an action under anti-social behaviour powers (Environmental Protection, n.d). Meanwhile, the municipality websites, for example, Birmingham, West Lancashire, Elbridge, and many other council homepages, contain detailed information about noise issues including contact details, details of public feedback investigation procedures, as well as helpful publications about noise management in the municipality. Inhabitants suffering from noise nuisance are advised to complete noise nuisance record sheets and fill in witness statements online. This helps the institution to receive detailed information on the case, as well as might reduce an plaintiff's annoyance.

There is no clear regulation on the institution that deals with raising awareness on environmental noise and public feedback about it. In general, the institution responsible for environmental issues, including raising awareness on the environment, is the MoEPRD. It is also responsible for environmental noise

legislation. In general, there is a lack of understanding and community initiatives relating to noise issues. However, in cases when new noise sources are planned or are already under construction, local communities develop an interest in these issues. Some of the examples are already mentioned in the PhD thesis. This includes local resident petitions against the construction of wind farms, construction of a span of the road "VIA Baltica" (more than 700 inhabitants living in close proximity to the pre-planned road expressed their views about the project and the associated noise issues), as explained previously in sub-chapter 6.1 of this thesis. Another example is a situation in Jelgava, where the Jelgava Journal (local news media) received a letter signed by 37 residents of residential houses living in the area of the Fortum cogeneration plant – Rūpniecības, Tērvetes and Vīgriežu streets. Residents complained about noise levels and asked that work on noise reduction from fans be continued, and not to deliver woodchips on weekends and holidays. The factory had installed small noise walls; however, inhabitants continued complaining. Inhabitants complain that environmental noise exceeds permitted levels during the daytime (57 dBA, based on a one-time, non-certified measurement), as well as there are emergency steam leakages about one to two times per month when the environmental noise levels exceed 70 dBA. According to diary data filled in by one inhabitant (based on non-certified measurements), there were emergency steam leakages from 03.30 am to 01.30 pm, exceeding 70 dBA. This characterizes well the peak noise issues. According to Latvia's legislation, there is no peak noise legislation for environmental noise; however, it assigns indicator L_{Amax}, that describes sound pressure maximal level in the room and is +20 dBA of permitted noise level night-time set in legislation (i.e., 50 dBA in the bedrooms, hospital and social facilities). However, the WHO (2011) recommends that sound levels should be kept below an average level of 30 dBA in the bedroom, or a maximum of 45 dBA for a single event. Higher sound levels have been related to reduced quality of sleep and awakenings. It appears that the majority of people will get used to common background noises at higher average sound levels, and their sleep will not be disturbed. However, the full restorative effects of sleep may be reduced even if people are not awakened. The company clarifies that emergency leakages cannot be foreseen and that the company tries to improve management measures as well as install technical measures to reduce noise at the source (improvements of installations) and on its pathway (noise barriers). Inhabitants also complain that the steam leakages are not mentioned in the A-category pollutant permit issued for the company. In 2017 residents of Jelgava city submitted a complaint to the State Environmental Service that it allowed an increase in the noise limits and there was no proper assessment of the noise generated by the heat producer's equipment before the permit was issued. The court is still in process (2019).

6.5. Brief summary of Chapter 6

Practical noise case studies on industrial (wind turbine), road and railway noise cases have been used to assess noise management situations from the acoustic (empirical data) and non-acoustic (sociological data) point of view.

The Saulkrasti case study on EIA, using noise level measurement data shows that noise level modelling in the EIA process has been conducted barely accurately and that installed noise barriers are insufficiently effective, i.e., the environmental noise levels are still over the maximum limits set in legislation. Surveys reveal that 33% of respondents feel dissatisfied with the acoustic situation. The survey showed differences in the attitudes towards noise issues could be found in the answers of those people who have bought their properties near the road before and after construction, as well as those who live behind different noise barriers.

Regarding railway noise, it was detected that the Latvian Railway uses different management tools; however, there are several shortcomings found in railway noise management. They include the applicable environmental noise management method (that underestimates noise levels and are not approbated to the 1520 rail gauge system), the noise level increase after rail grinding, lack of monitoring, society concerns on railway noise, including about Rail Baltica, etc.

The case study on the Grobiņa and Vērgale wind parks shows a high level of subjective environmental impacts that have arisen due to weaknesses in the spatial planning process, financial aspects, and other factors, despite the fact that noise modelling provides data that noise levels should not be exceeded. Society has brought the case to several courts but have lost the cases.

The chapter also includes information on how society feedback is managed at the state and municipal level. It shows that there is almost no information about public feedback investigation procedures. The municipal internet home pages feature no information on noise control at all as well as no description about general complaint management.

7. FINDINGS ON ENVIRONMENTAL NOISE MANAGEMENT DEVELOPMENT

Based on the findings of the review of noise management in Latvia and institutional models of other European countries, the main deficiencies in the existing noise management schemes have been identified, and proposals have been developed for further improvements concerning both, policies and the practical implementation thereof.

7.1. Conclusions and main findings from the noise management studies in Latvia

7.1.1. Main findings on noise policy in Latvia's municipalities

A municipality's commitment, including its comprehension and voluntary steps taken in regard to noise management and the improvement of noise situation, is demonstrated by the policy documents and regulatory acts adopted by the municipality, the measures and regulations proposed in these documents, their clarity, specificity and compliance with best practice. The analysis of noise management policy in municipalities in Latvia shows that, as a general rule, the municipalities implement the requirements set in national legislation regarding spatial developement planning, control of community noise, as well as noise mapping and action planning (when obligatory). At the same time, every municipality uses a different approach to noise management, and their regulative and planning documents differ greatly in terms of the extent and level of detail of the established regulation.

The research shows that planning documents often lack empirical data on the noise situation in the municipality, including data on noise levels. One of the reasons might be the fact that laws and regulations do not require to include or ground the proposal on topical and empirical noise-related information for instance, environmental noise maps or measurements, especially in areas with less than 100 000 inhabitants. In meantime, this information is crucial for spatial planning purposes, because legislation states that new residential and public building in the vicinity to airports, roads and railways can be planned only in case the pollution levels do not exceed the permitted ones.

The positive changes, are, thought, happening and the situation over time has improved. For instance, Mārupe municipality now uses noise mapping data in its latest planning documents, that allows grounding its land use zoning and requirements on factual data, identifying development limitations of particular areas, and propose development solutions. However, integrative information on the mutual interactions of different noise sources and air pollution is still missing. Also, development planning documents and thematic planning should be based on the sociological information on stakeholder views, opinions, habits, attitudes, etc., thus ensuring that society views are taken into account, thus helping to lessen protentional annoyance and noise discomfort.

The main findings of the comparative analysis on noise policy management aspects included in planning documents in four municipalities in Latvia are summarized in Table 5.7. It demonstrates that land use planning and the use of noise screening are the most commonly used noise management measures in Latvia's municipalities. It also shows that in municipalities with populations below 100 000 preventive, at-source and socio-economically oriented measures should be further developed, as those measures could provide benefits and improve the environmental noise situation at the local level.

Analysis of the documentation demonstrates that in some cases, municipalities with less than 100 000 inhabitants fulfil their noise management responsibilities only to a minimal extent. Despite the fact that all of them have prepared planning and regulative documents, they sometimes fail to plan activities in compliance with the actual situations, as they may occur and to properly take into account the emissions of all significant noise sources and their resulting influence on the inhabitants (as it was detected in Saulkrasti case). This may lead to growing dissatisfaction among the local residents with the local acoustic environment and the way it is governed and regulated. Planning documentation analysis also show that sometimes schools and kindergartens are located in noisy areas, however, it is also of utmost importance to

ensure good acoustic conditions for schools and kindergartens, as noise impacts learning quality. For instance, researchers found that aircraft noise exposure might impact reading performance, and policy makers must be responsible for noise abatement due to noise pollution's potential impact on children's development (Klatte *et al.*, 2013). It should be municipality's priority to regulate, prevent and abate noise impact on children.

Given the findings outlined above and regarding the need for municipalities to plan and implement such noise management activities, that would be based on the analysis of both the actual situation and best practice, the responsible state institutions, in turn, should provide guidance and develop methodological tools, i.e., workshops or guidelines on this.

7.1.2. Main findings on EIA and road noise management practices

The practical case study of road noise issues near Saulkrasti has produced the following findings:

- Comparison of the predicted and actual noise measurement data of noise levels proves that the actual noise levels during the object's operation time, both in places without and with noise barriers, exceed those predicted in the EIA report and also the legal maximum permitted levels. This probably might be explained by technical shortcomings in modelling, lack of detailed technical specification of road surface and noise barriers in the EIA report and technical expertise, as well as lack of testing and monitoring noise levels when object started to operate;
- Comparison of the data used in the EIA report and the results of the interviews with local residents show that the residents are subjected to higher noise levels than permitted in the legislation, and a part of them feel acoustical discomfort, annoyance and other impacts on their holistic health;
- In order to improve the efficiency of noise mitigation measures, the quality of noise modelling has to be upgraded; though, according to the interview with the State Environmental Service, the quality has already been improved (personal communication). Technical information about noise barrier and road surface characteristics should be provided already in the EIA report. There must be coherence between the EIA and technical design, and taking into account that EIA is valid for three years, it is also of utmost importance that particular solutions chosen within the technical design respects actual noise legislative regulation, new noise sources in the area and changes the background noise levels etc. In cases where significant noise impacts are foreseen (such as the construction of major roads and rail lines), the technical design should be acoustically verified. For instance, currently, the Rail Baltica EIA (Eiropas dzelzceļa līnijas, 2016) report concludes that in some places, noise levels, using conventional noise barriers, would not reduce environmental noise levels till the maximum permitted levels. Therefore, a combination of methods must be used. This means that, during the technical design stage, a valid solution must be found and verified before it is applied because the EIA report currently does not suggest an efficient solution;
- In order to improve an EIA's effectiveness, the efficiency and accuracy of noise mitigation measures should be increased, and people should be adequately informed about the project and choice of noise mitigation measures (for instance, clarifying why different technical solutions have been used). The dissemination of the information should take place prior to the start of the operation of the object in order to lessen the factors that influence subjective perception of noise and annoyance.

7.1.3. Main findings on general and railway noise management practices

The practice analysis of railway noise management from the acoustic and non-acoustic point of view shows that a broad set of noise management tools are used for railway noise management. However, significant improvement in the implementation of certain technical, planning, administrative and communication instruments is crucial for more effective railway noise prevention, reduction and control, as

well as to ensure compliance with the requirements of EU directives and acoustical quality.

In order to ensure further development and improve railway noise management in Latvia, the following actions should be taken:

- As since July 2019, the CNOSSOS-EU method's use for noise mapping is specified in Latvian legislation, the verification on Latvia's railway gauge system to significantly improve the quality of railway noise prediction is urgently needed because the CNOSSOS – EU method is not approbated on 1520 mm gauge. In addition, it must be taken into account, that further developed noise maps cannot be directly compared to those developed previously with different methods;
- The RMR method, which is specified in regulations and used for railway noise predictions due to the fact that it was developed for the noise forecast for 1435 mm gauge, shows significant differences between the measured and predicted levels on Latvia's railways (noise levels are underestimated), therefore RMR method's application should be further evaluated by the legislators, RMR adjustments ensured and the end data validity carefully checked;

  As currently Latvian legislation proposes different methods for noise assessment from different sources and another method for noise mapping, possibly, a method comparison algorithm has to be found, in order to make these data interchangeably usable. In addition, as legislation sets different methods, the application of CNOSSOS-EU method for all sources should be assessed by professionals and legislators, because it might simplify the noise assessment procedures;
- Further assessment of technical noise abatement measures should be carried out due to increased noise levels detected after rail grinding, and corrections in used practices should be ensured;
- Improved communication with non-EU operators on the topic, because the greatest amount of cargo traffic is provided by non-EU operators to which European regulations are not binding. There should be stringent requirements on train technical characteristics, that should be in accordance with the technical specification of interoperability. However, it also should be taken into account that noise management should not increase the overly large burden on entrepreneurship;
- Assessment of the needs for more regular noise monitoring.

7.1.4. Main findings on industrial noise management practices

The analysis of results for industrial noise issues from the inhabitants' point of view outlines several matters:

- Despite the fact that environmental noise management modelling shows that permissible environmental noise limits during the operation of the wind park should not be exceeded part of the local population considers wind parks to be important sources of environmental noise, which can adversely affect their health or quality of life. Residents of the affected areas experience acoustic discomfort, health, and social behaviour disorders, and they refer to other possible effects that sometimes may lack scientific proof. This demonstrates the public´s concerns about the possible effects of wind parks on their health. Also, WHO has provided guidelines for wind farm noise limit values (that were included in Table 2.3. of this Thesis) (WHO, 2018), that could be used for the development of environmental noise policy and local spatial planning, that allows municipalities to determine lower noise limits in their areas;
- Wind parks are designed to operate close to the maximum permissible levels of noise, thus increasing public concerns about their possible effects on health. Similarly, it should be noted that according to Latvia's regulation (on noise assessment and management procedure) the level of environmental noise is modelled as $L_{day,}$ $L_{evening}$ and L_{night}, considering all the periods during a year, thus indicating a general level of acoustic discomfort. The noise modelling practice shows that also maximum wind speed, technical characteristics of the turbines (such as automatic switch – off at a particular wind speed), legislative requirements on location and noise levels, are taken into account, and that noise

modelling is done taking into account also maximum noise levels at maximal wind speed. The only noise related explanatory document in Latvia is wind park noise assessment guidelines provide by Environmental State Bureau;

- Initially, wind parks were developed without conducting a thorough evaluation of the local situation and analysing public opinion, as well as without sufficient and good quality information about wind parks being provided to the local public. These factors, along with procedural violations in the process of spatial planning, have contributed to concerns of the local population about the insufficient evaluation of the potential effects of wind park development, which in its turn hinders the public's acceptance of the idea that the development of wind energy facilities is a harmless process undertaken as part of the municipality´s overall development process and, as a result, it leads to negative responses and protests from the residents;
- Discomfort, health disorders and changes in social behaviour caused by wind parks tend to have a more prominent effect on those people, whose dwellings are in a poor state and people who have no wind turbines located on their properties but on those of their neighbours. Negative attitudes were also expressed by those residents that gain no benefits from the construction of wind turbines or those who believe that the promises of the developers of wind parks have failed to come true. This shows the issue of the social acceptability of wind farms;
- The residents failed to initiate activities related to wind parks due to the belief that the municipality had no interest in their opinion and they lack any power over the municipality's development processes. Similar conclusion was found in literature (Maziul, 2002) that even when a large number of residents are annoyed by noise, not many of them submit feedback or complain, because they feel that nothing can be done about the noise. On the occasions when mediators are involved in wind park development processes, and similar activities take place in other territories, the residents take more active participation in the processes;
- The residents would like to receive reliable and scientific information about the wind parks, their impact on health and the actual noise level, that would be monitored regularly, before and after the construction of the wind parks.

Thus, the research carried out showed that the solutions to issues related to the management of environmental noise generated by the wind turbines in the municipalities should be developed in five main directions, using normative, institutional, communication and planning instruments. These are:

- *Analysis of the local situation and public opinion.*

  Before the development of a wind farm, it is necessary to conduct surveys in order to learn about public opinion, to obtain information about any unclear matters and issues of public interest, to identify the potential level of opposition, to prepare a full public awareness, inclusion and participation program, as well as to stimulate the creation of functioning feedback mechanisms. Such activities would help diminish the public´s concerns regarding any potential unfair threats to their environment and health.

  When assessing the changes in life quality caused by wind-turbine generated noise, not only the extent to which the statutory permissible outdoor noise levels are observed should be taken into account, but also the technical condition of the dwellings and the possibility of achieving an appropriate indoor noise level, the exceedance of which can lead to sleep disturbances and annoyance. In order to effectively address this issue, it is important that an obligation to model and measure indoor noise levels is stipulated by both the municipalities in their territorial planning documents and the environmental institutions in the licenses that they issue, and in case of any excess is noise limits, it would be the wind park developer´s duty to ensure that adequate noise mitigation measures are put in place that is required.

- *Sufficient and timely information.*
  At all stages of wind park development, the public should have access to information about the wind park´s technical parameters, their interpretation, as well as what specific impacts to expect. The given information should be verified, reliable, and as objective as possible, and at the same time, it should be comprehensible for any audience. The accessibility of the information should also be insured in the mass media and public spaces and via individual communication with those residents on whose land the equipment is to be constructed or those who live in close proximity.
- *Public engagement.*
  Municipalities should avoid formal involvement of the public in the development of a territorial planning process. They should be proactive in distributing information to the public. It would be advisable that the municipality should ensure the distribution of any notices and communications in public spaces, and the most appropriate spots for this purpose should be determined based on analysis of the daily movement patterns of the public as well as by evaluating the possibilities of the residents of the specific location where a particular project is being developed, getting acquainted with this information. During the process of public discussion, the municipality should ensure the participation of independent experts, in order to give a justified response to public questions and to decide about implementing any suggestions put forward by the public.
- *Monitoring of environmental noise.*
  Monitoring should be performed at all stages of the development of wind parks, and the gathered information should be offered to the community, thus ensuring a permanent sense that the environment noise climate is being protected for the public. In addition, the permissions granted by the environmental institutions should stipulate the obligation on the contractor to conduct monitoring of outdoor and where necessary also indoor noise levels after the start of the operation. Or it should be included in the State health inspectorate's annual control plan.
- *Territorial planning.*
  Municipalities should ensure that the process of territorial planning is being implemented not only in compliance with the applicable laws and regulations, but also have true involvement of the society. Procedural violations in the process of territorial planning act to increase suspicions and opposition towards the planned activities in the community.

This approach could be used for other projects, as well where issues with the populations´ subjective perception of noise can be reasonably anticipated because it stimulates a more favourable attitude among the public and helps prevent spurious public feedback on environmental noise.

7.1.5. Main findings on practical settlement of environmental noise problem situation, control and public feedback investigation

The study shows that the functions related to practical noise management in Latvia are assigned by legislation to two main responsible parties – municipalities and the State Health Inspectorate, however, neither the legislation nor any state-level official document specifies the precise implementation scheme for this arrangement.

The evaluation of actual noise management procedures shows that both responsible parties are dealing with noise control using comparable approaches. Several points for consideration can be identified:

- Responsible institutions do not always make noise measurements but base their preliminary assessment on theoretical approaches and on-site inspections without noise measurements. Though this approach is economically beneficial, it might fail to be reliable and objective all the time;
- Before the State Health Inspectorate requires the application of a penalty, the notification detailing the noise reduction requirements and the time period during which this must be carried out is sent to the noise emitter. By using this approach, the developers are given an opportunity to remediate the

problem and submit verified noise measurement data before any sanctions are applied. However, no further checks are currently foreseen, and it would be advisable to include those noise sources in annual control plan;

- The above approach is more appropriate when the noise level exceedances are frequent and not a one-off case or are repeated cases over an extended timeframe;
- There are no other noise level controls in place apart from public feedback management, as it is done other countries, where noise plan is prepared and planned controls also undertaken;
- There is little information available publicly on environmental noise feedback management processes at State Health inspectorate web-page. Also, municipalities lack information on where and how public can consult on noise issues and submit feedbacks, if necessary. As municipalities are the closest management level to their residents, information on pollution and noise SOS should be published on their webpages as well. This is important because unsuccessful complaining might even increase the annoyance (Botteldooren, 2003).

7.2. Institutional system

In the previous chapters, the key institutions involved in noise management both in Latvia and in other Eastern enlargement countries have been identified in order to develop a common noise management institutional model for them. The model consists of two main levels. The first level or the state level comprises of the responsible ministries and the subsequent agencies' sub-levels. The ministry level is made up of ministries dealing with noise issues such as the Ministry of Health, the Ministry of Environment, and the Ministry of Transport. Furthermore, in some countries, the ministries responsible for economics or internal affairs are also involved in the noise management scheme. The main agencies dealing with noise control and public feedback management from transport and industry sources, as well as data collection, are the national environmental and health inspectorates, agencies, or state-owned enterprises. However, the set and scope of functions and responsibilities delegated to these inspectorates differ from country to country. The second level is the municipal level, where the noise management responsibilities are undertaken by the local government (or inspectorates of the municipality, such as a construction board) and municipal police (mostly in case of community noise issues).

Based on the problem issues identified, the weakest elements and critical points of the existing noise management in Latvia, as well as taking into account institutional practice examples identified from other countries (that can provide approbated solutions not only for process improvements but also for institutional improvements), a new consulting body – a Noise Prevention council is proposed. As for now, noise prevention councils are established in Lithuania and Slovakia, as well as Serbia; however, it could also be introduced as a useful advisory body in Latvia as well as in other new EU countries.

The representation of local resident needs is provided by the residents themselves through joint non-formal groups of residents (for instance, as in Jelgava industrial noise case; sub-chapter 6.4.) or sometimes undertaken by NGOs (as in Kurzeme region wind park case sub-chapter 6.3. and 7.1.4).

Taking into account the research on the institutional system in other EU countries and the literature review on the United Kingdom, the municipal inspectorates dealing with environmental or health issues could also be established. They, along with other environmental or health issues could deal with urgent environmental noise cases, provide consultations, investigate and ensure the application of a common approach. Those activities could also be undertaken by environmental specialists of the municipality.

The common institutional model for the Eastern enlargement countries is presented in Figure 7.1.

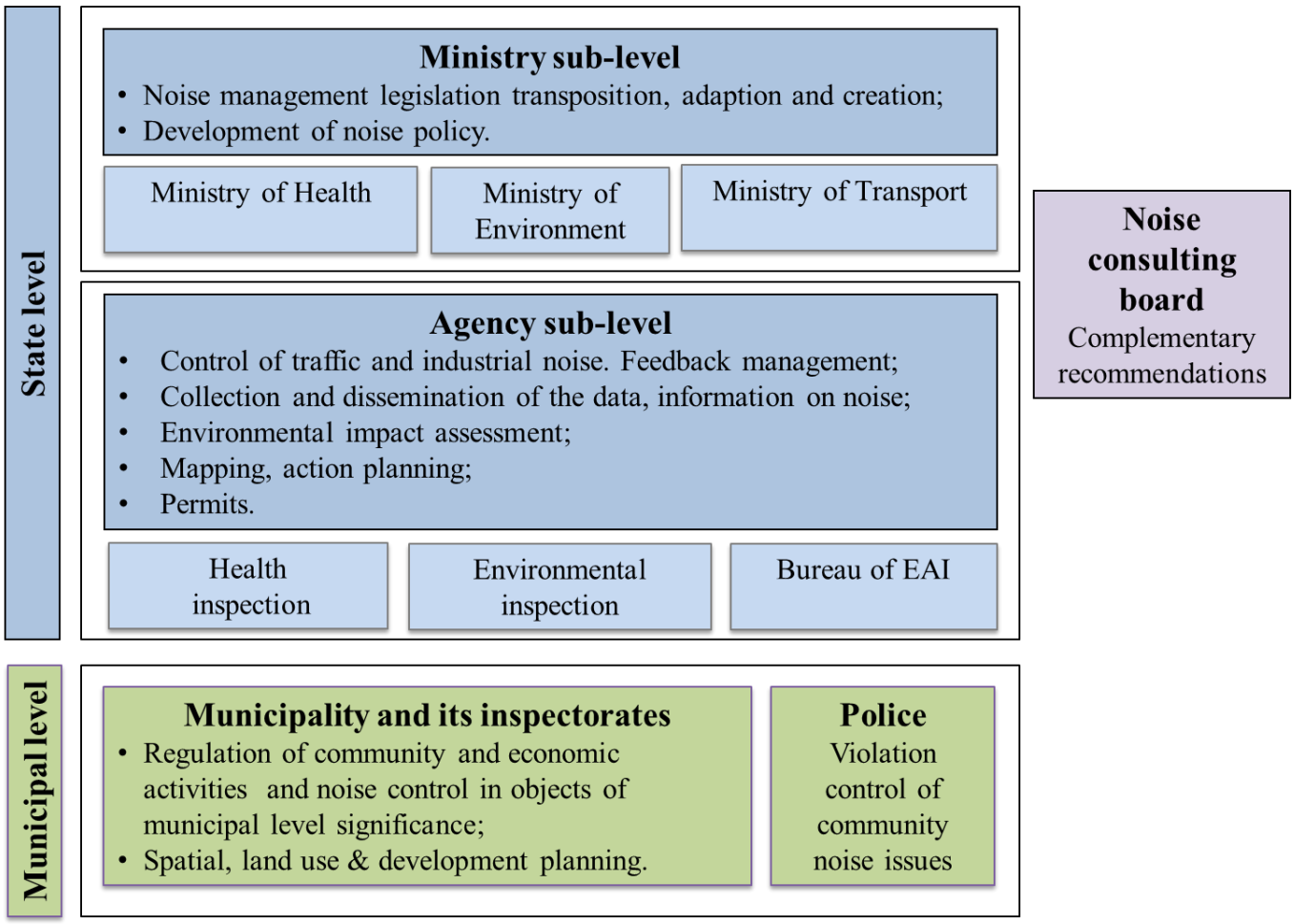

Figure 7.1. Common noise management institutional model for new EU member states (created by Author)

It must be mentioned that the model is generalized, it includes only main institutions, and every country might have deviations from it. For instance, in Latvia, the noise management institutional model would include also some functions designated to the Latvian Environment, Geology and Meteorology Centre, but Ministry of Transport has delegated noise mapping to the state companies (Latvian State Roads, Rīga International airport and Latvian Railway).

7.3. Environmental noise management deficiencies

According to above mentioned several main environmental noise management deficiencies in Latvia are observed. They deal with: awareness and knowledge, policy implementation, monitoring and control of the results, legislation and appliance of standards, high level of subjective noise perception, a low understanding of noise issues and management priority, low priority for preventive and remedy actions, and ineffective planning, implementation and monitoring of the existing noise management policies and actions. They are described in a more detailed manner in Table 7.1.

Table 7.1. Noise management situation analysis in Latvia (created by the Author)

Problem group	Problem identified	Reference to case
Awareness of impact, communication, and stakeholder involvement (high subjective noise perception; lack of community-based noise management)	Public is not fully involved, and its opinion on a potential source of noise is not fully taken into account during the planning, construction and operation of it	Saulkrasti, Kurzeme case
	Need for communication improvements between involved parties	Saulkrasti, Kurzeme case
	Development planning issues	Kurzeme case
	Lack of information, data about noise in general, lack of analysis and on noise impacts on residents (national wide)	Kurzeme, railway case, practice from other states
	No coordinative body	Institutional analysis
Political will and noise administration: low understanding and low policy priority, policy planning issues	Often only the mandatory tasks are fulfilled	Planning document studies
	Low application of priority noise management measures	Planning document studies
	Noise issues are usually treated as a low priority	All cases (generic)
	Need to improve integrative planning, taking into account main noise sources and their impacts - proper integration of noise aspects in sectoral policies and thematic planning, such as transport policy	Valmiera case
Policy implementation, noise reduction	Often only the mandatory tasks are fulfilled	All cases (generic)
	Low implementation of noise reduction measures (including implementation of action plans)	Planning document studies, railway case
	Low usage of priority noise management measures	Planning document studies
	No noise level checking after operational works	Railway case
	Lack of link between planning and financial programming documents	Rīga policy planning study
	Not proper EIA implementation check, planned measures do not ensure needed reduction	Saulkrasti case
Knowledge, data and information	Need to improve monitoring system and data collection	Railway case
	Need to improve data on the acoustic situation (modelling, monitoring data) and resident opinions, and to ensure their usage in spatial development planning	Valmiera, Saulkrasti Kurzeme case
	Not clear feedback provision processes, especially at the local level	Feedback process study
Policies, standards, and regulations	Need to update national legislation in order for it to be in accordance with EU legislation	Railway case
	Shortcomings with noise mapping and assessment methods' approbation to 1520 mm rail gauge, data quality	
	Noise levels do not correspond to hose proposed by WHO	
	RMR method is usable only with approbation to 1520mm gauge	
	Noise levels do not correspond to WHO suggested ones	Literature study and legislative analysis
	Lack of integrative guidelines and educational tools	Legislation study, best practice analysis
Monitoring and control	Need to conduct regular noise monitoring and control	Railway, Saulkrasti case
	Need for noise control when a new object starts to operate	Saulkrasti case
Funding	Lack of funding for action plan implementation	Rīga, Railway case
	Low funding for noise protection measure implementation near existing noise sources (for instance, railways)	Railway case

The identified problem groups in Table 7.1. are closely linked with the deficiencies identified in literature (Shwela *et al.*, 2008), however, it allows identifies or defines new (previously not described) issues such as "high impact of subjective noise perception factors" and "lack of community-based environmental noise management".

The Author concludes, that despite the fact that the environmental noise management elements are in place, environmental noise management in Latvia is yet to be improved so it is systematic, strategic, integrative and responsive.

7.4. Brief summary of Chapter 7

Chapter 7 provides analysis on legislative, policy planning and practical case study results and identifies the further improvement needs for Latvia. It also provides summary of institutional systems and common noise management institutional model for EU.

The research on planning documents indicate that documents often lack empirical data on the noise situation in the municipality, as well as analysis of stakeholder views, behaviour, attitudes to provide better noise solutions and take into account non-acoustic factors; however, positive changes over time can be observed. It also shows that most common noise management measures are land use planning and the noise barriers.

Kurzeme case showed issues with wind park's social acceptance, possibly, due to the consideration that wind parks are important sources of noise, the lack of information provision and public opinion analysis, as well as resident's belief that they lack any power over the municipality's development processes. Another important noise-annoyance impacting factor is condition of the buildings and personal benefit from the park.

As the railway noise modelling using RMR method shows noise levels underestimation compered to measured ones, the RMR application should be evaluated, adjustments ensured and data validity checked. There is also need for reassessment of applied operation practices as the railway measurement data shows noise level increase after rail grinding. As most rail cargo come from non-EU countries and these trains do not comply with the standards of interoperability, encouraging mechanisms for this should be developed.

The study of noise feedback handling and control allowed concluding that hat are no other noise level controls in place apart from public feedback management, as it is done other countries. There is also little information available publicly on environmental noise feedback management processes.

These practical case studies, allowed identifying main deficiencies dealing with awareness and knowledge, policy implementation, monitoring and control, legislation, high subjective noise perception, lack of community-based environmental noise management, a low understanding of noise issues and management priority, low priority for preventive and remedy actions, and ineffective planning, implementation and monitoring of the existing noise management policies and actions.

8. PROPOSALS FOR ENVIRONMENTAL NOISE MANAGEMENT MODEL DEVELOPMENT IN LATVIA

8.1. The concept of on environmental noise model and its development

In order to ensure the development of an effective environmental noise management system in Latvia, it is essential to promote the development and strengthening of the associated management processes. This can be achieved through changes and improvements in the existing management processes at all management levels in accordance with the conclusions about the most problematic environmental noise management issues and their possible causes. Taking into account the essential role of the municipal level processes in environmental management because they are closest to recipients of noise and their functions in regard to ensuring a favourable living environment for the local residents, it is necessary to support local level. However, environmental noise management at the national level also requires enhancement of the management processes in different environmental noise management process steps, for instance, by developing legislation and methodological materials or improving communication horizontally and vertically. Not only could this ensure clearer regulatory requirements for the application of the municipal development planning documents and solve of actual cases dealing with noise, but it could also promote understanding of the importance of the associated issues, to ensure more efficient use of resources as well as more efficient reduction or prevention of environmental noise. It generally would ensure better living environments in acoustic aspects, influence people's health, and could increase satisfaction with the quality of the environment.

The weaknesses of noise management are found both at state and municipal levels. This means that theoretically, the state has designed a noise management system that is focused on a top-down approach and the fulfilment of the legal requirements of the EU. However, there are some improvements needed to improve the noise management performance in different processes at the national level such as EIA (as clarified in Saulkrasti road noise case; sub-chapter 6.1 and 7.1.2.), noise policy planning and noise mapping and action planning (as shown in policy planning studies sub-chapter 5.3. and 7.1.1.), noise legislation (for instance, as shown in railway road noise case; sub-chapter 7.1.3), noise control and monitoring (as shown in practical settlement of environmental noise management description; sub-chapter 6.4. and 7.1.5.), etc. Also, on the practical level, noise management does not always solve the actual problems occurring at the municipal level, taking into account noise acoustic (empiric) and non-acoustic factors that impact noise annoyance. In addition, the low understanding of noise issues both from municipalities and local residents do not allow a change in the management approach from the top- down to the bottom- up. This leads to the conclusion that an important task for Latvia is to have procedural improvements of different processes, promote and strengthen municipalities, their capacity and knowledge on noise issues and to strengthen communication with the public.

As a result of the research carried out within the PhD Thesis, the proposed practice-based environmental noise management model is illustrated in Figure 8.1. The management model consists of three sub-model ensembles that comprises process models at the state and municipal levels. They are supplemented and interlinked with the coordination process for the vertical and horizontal integration of the activities and their cross-sectoral interaction. The process models consist of several integrative, interconnected and coherent processes according to the key functions assigned to each management level in the field of environmental noise. In total there are 11 processes of which several are included at both state and municipal levels – the development of legislation in the field of environmental noise, development of environmental noise policy, development of environmental noise mapping and action plans, environmental noise control and public feedback management, data and information collection, analysis and dissemination, EIA, development planning and preparation of spatial plan, as well as object construction (and operation).

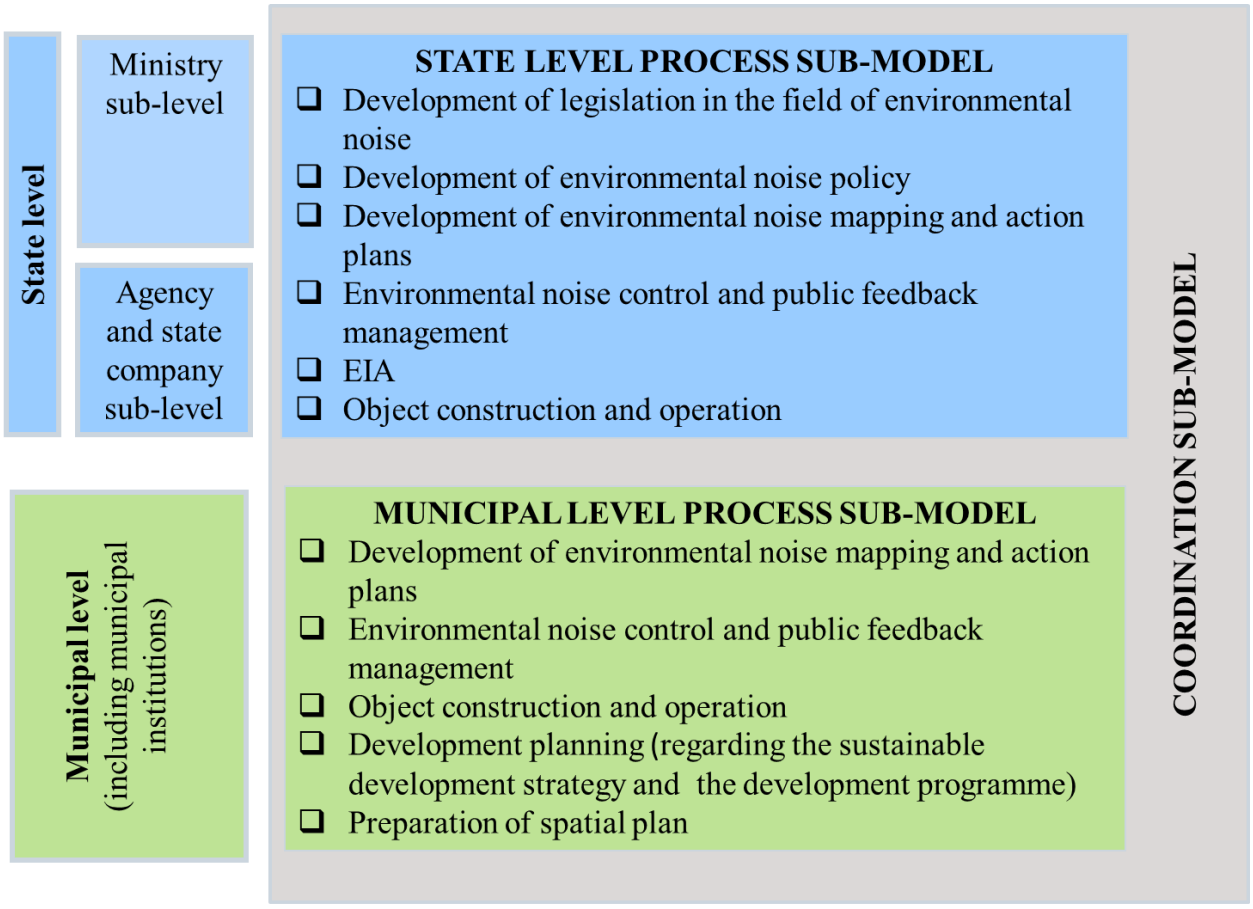

Figure. 8.1. Practice-based environmental noise management model (created by the Author)

The integrated process schemes that are included in the developed environmental noise management from a more detailed viewpoint, including the main processes steps are shown in Figure 8.2. They are interconnected, but they do not describe a linear process sequence due to interactions among several processes and the feedback from society. The step-like illustration is used for technical purposes in order to clearly illustrate interaction lines.

To give an example on interconnection – the legislation impacts environmental noise mapping and action plans by regulating the requirements that need to be taken into account by doing mapping; however, noise mapping and action plans may be a resource for updating legislation and providing tailor-made solutions. Similarly, noise legislation impacts other processes, and noise policy assessment, control, and monitoring data can be used for preparation or update of legislation.

Figure 8.2. shows both municipal and state level processes and their mutual interactions. Each process is coloured differently in order to improve understanding of the interconnections of the processes included in the model.

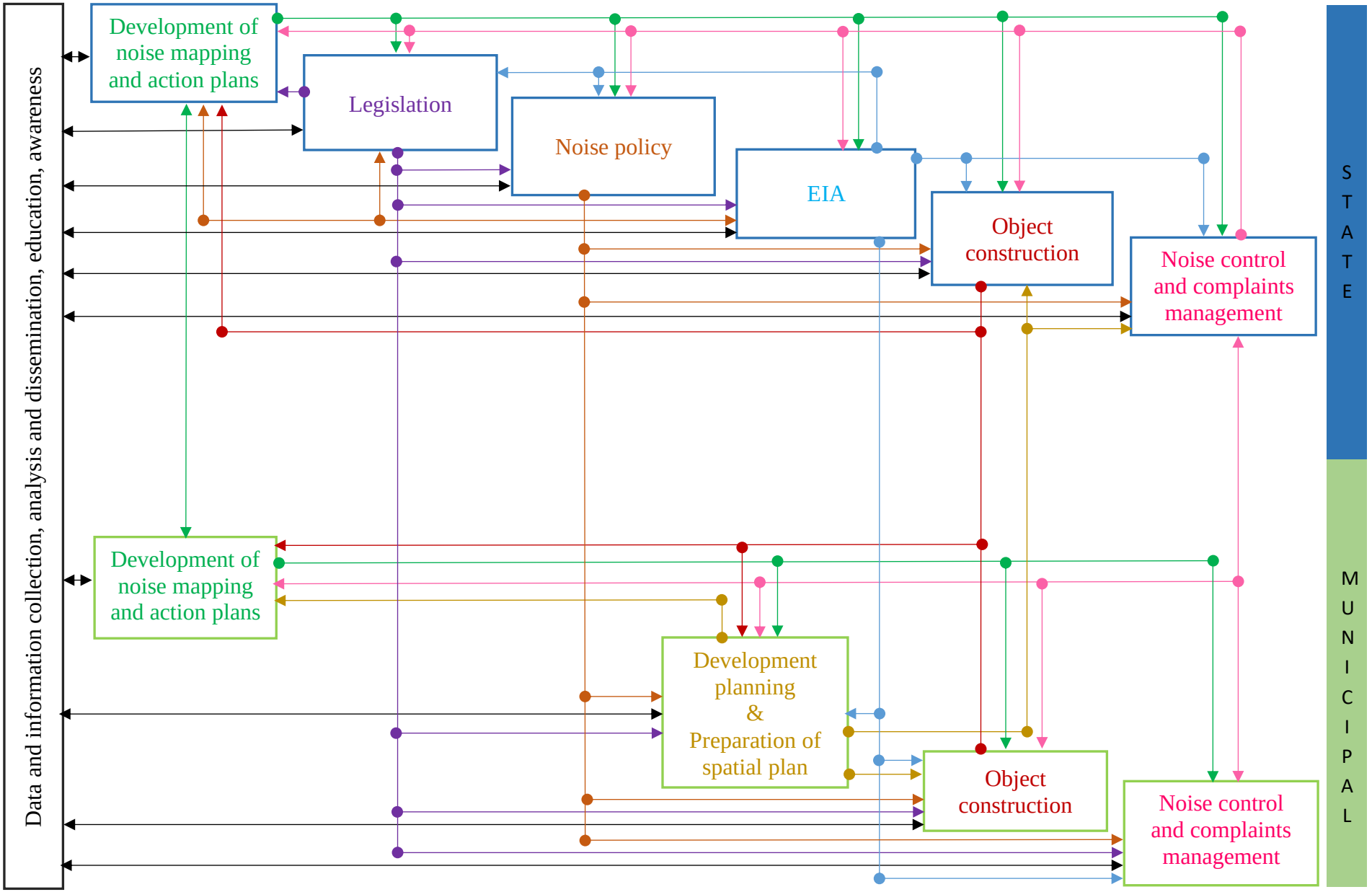

Figure 8.2. Integrative, non-linear illustration on the interconnections of the processes in the model (created by the Author)

8.2. Environmental noise management model proposal

The environmental noise model includes 11 process schemes. The process schemes describe the main processes steps, consequently, as they follow each other in procedural order in theory and in practice. The existing procedural steps are marked with black or red lines. Black lines are used for those existing process steps which are functioning well, but the red coloured lines are used for those existing process steps where some imperfections are found and improvements are needed (based on knowledge gathered during the studies performed within the scope of this dissertation). Issues of steps which are in red coloured boxes are addressed either through proposed improvements in the same process scheme, or it might require horizontal action, such as awareness raising that would allow improving the situation. Green coloured lines or letters are used to indicate suggestions for new procedural steps or other improvements that could help reduce management deficiencies identified in this thesis. The first step of each process scheme is marked with "*" symbol. In cases where there are several initiating steps (either to be done in parallel or only one, depending on the specifics of the case) all of them are marked with the symbol. Processes that are at the state and municipal level are described once (at state level process description).

8.2.1. State level process sub-model

The state-level process sub-model consists of six main environmental noise management processes that correspond to the main functions of both state-level sub-levels – the ministry and agency sublevel. The first three processes describe the ministry's functions, and the remainder are functions of the agency sub-level. Those processes (in non- linear order) are described below.

1. Development of legislation in the field of environmental noise.

The process model for the development of environmental noise related legislation is shown in Figure 8.3. and it describes the key management process steps. According to the studies carried out, the existing laws and regulations do not specifically promote or oblige the application of scientific and best practice-based approaches. This is justified by several examples, such as increasing maximum permissible noise levels or noise evaluation methods set in national legislation. In order to improve the quality of legislation, it would be necessary to provide officials with access to scientific databases, to raise institutional capacity and to highlight the need for education and consultancy services. The latest factor can be solved through the creation and involvement of a new consulting body – a noise protection consulting board that could provide expert advice in specific and ambiguous cases.

Perhaps, there are also deficiencies in the draft law and regulation conciliation stage with the social partners, because the opinions of professional NGOs are not always taken into account (as it has happened the review of noise legislation and described in sub-chapter 5.1. of this thesis). At this stage, especially in the cases mentioned above, the involvement and opinion of the Noise Prevention council would be necessary and useful.

National regulations must be in line with the EU-level regulations. For instance, the CNOSSOS-EU method must be applied in all EU member states since 1 January 2019, but the method is still missing in the national legislation of Latvia. There also should be a requirement set for non-EU train operators to comply with EU standards of interoperability or set national requirements for train technical characteristics, that should be in accordance with technical specification of interoperability and the local situation and rail system's technical characteristics.

The research also revealed the need to add a new procedural step after the enactment of the applicable legal acts, i.e., for the development of methodological tools (such as guidelines) for involved parties, because currently there is hardly any guidance or descriptions on noise management. This practice on issuing noise guidance is used in the United Kingdom (Murphy *et al.*, 2010) and in Estonia, for example. These materials should explain the regulation set in the legislative act and assist in the implementation of

regulatory requirements. The guidelines should be written as simplified explanations and descriptions of the application processes. The integrative guidelines for environmental noise management aspects should also include noise mapping and action planning, territorial and land use planning, explaining the process for detection of quiet areas, etc. They also should provide managemental, including technical, solution examples and alternatives, that could be applied based on the specifics of the particular situation – they also should include a tool on how to choose noise mitigation and prevention solutions, allowing a municipality to choose those which are appropriate and approbated (for instance, on when and how to consider the need for environmental noise barriers etc.), thus reducing much of the administrative and financial burden. They would contribute to a better understanding among the involved parties, the reduction of administrative burdens, and more effective policy implementation at the lower noise-management level.

2. Development of environmental noise policy

The environmental noise policy development process is done in accordance with the existing legislation regulating the preparation of policy planning documents, and it comprises of the development, evaluation, and revision thereof. The process is illustrated in Figure 8.4 and is characterized by the most important stages that require the integration of environmental noise issues. Due to the low understanding and priority of environmental noise issues, the shortcomings are found in the problem analysis section, which also defines whether environmental noise issues will be included in the planning document. Similarly, to the process of the development of laws and regulations, it would be necessary to raise knowledge and competence on the issue of those state officials who are responsible for developing the respective policy planning documents, as well as to raise the public's awareness on noise-related environmental issues. Whenever noise-related aspects are integrated into policy planning documents, information on the planned measures for noise abatement or prevention should be provided as well, including information on the proposed funding scheme/sources, their implementer, as well as indicators for the assessment of the progress in the context of this document (as identified in sub-chapter 5.3.1. in this thesis regarding the Rīga case, actions planned are not always linked to funding).

It is also necessary to involve the public fully and genuinely in the document's public review process (as it similarly was shown in the Kurzeme wind park case; sub-chapter 6.3. and 7.1.4.), and therefore it is proposed that planning documents should also be reviewed by the Noise Prevention council, that could give competent opinion on noise aspects. Besides, the planning document should be monitored and assessed regularly, at least at its mid-term and ending dates, and revised if the difference between the planned and actual activities is significant. If during the mid-term and final ex-post evaluation it is concluded that the planned measures were not implemented and the problem is not solved, or new issues have arisen during the implementation of the plan, information on those activities should be included in the update or next planning document. However, before that, the planning or implementation mistakes should be analysed in order to avoid them in the future. The process is illustrated in Figure 8.4.

3. Development of environmental noise mapping and action plans

The process of developing environmental noise mapping and action plans is generally done in accordance with the main stages defined in legislation, and it applies to public airports, roads and rail lines that meet the applicable set parameters stated in regulations and guidelines. The process is illustrated in Figure 8.5. However, there are shortcomings in the process, which are not only due to failure to comply with the set time-frame (in previous noise mapping and action planning rounds; the latest round was done without delay) as well as lack of data and ineffective adoption of methods, but mostly with the implementation of the developed strategies. This is because both the EU and the state at the national level do not enforce the implementation of the action plan (Murphy *et al.*, 2020), as well as due to the limited funding for noise abatement and protection projects. The latter, possibly, happens also due to deficiencies of the national development planning process, when noise issues are not reflected in the planning document

content to the full extent. For example, the distribution of the available EU funds is decided based on the National Development Plan, and, as a result, no funding from EU Cohesion policy funds for noise issues is available.

There are also no guidelines for noise mapping and action planning that could save the resources of the responsible institutions and ensure the use of similar, streamlined approaches, especially dealing with EU requirements that are not specified in Directive 2002/49/EC.

The action plans must be in line with other municipality documents (such as budgetary documents, spatial and development plans, etc.). It would also be advisable to take into account best practices from the United Kingdom. As the EU regulations do not set criteria for quiet areas in agglomerations, the responsible institutions for noise maps should publish technical guidance on main mapping approaches and criteria, for example, for detecting and deciding on the Quiet Areas in agglomeration or first priority areas for noise management.

According to best practices in Lithuania and taking into account the national situation, the Noise Prevention council should be involved in the preparation of strategic noise mapping and action plans, by giving its recommendations and annually assessing progress of the implementation of action plans, as well as presenting a report and recommendations to the Cabinet of Ministers.

The analysis of environmental noise mapping and action plans shows that not only environmental noise maps for one noise source should be developed (such as rail or road noise maps) as is done currently, but there should also be integrative noise maps that would evaluate noise levels and impacts from all the applicable noise sources. This also should be taken into account when developing an action plan.

The process is illustrated in Figure 8.5.

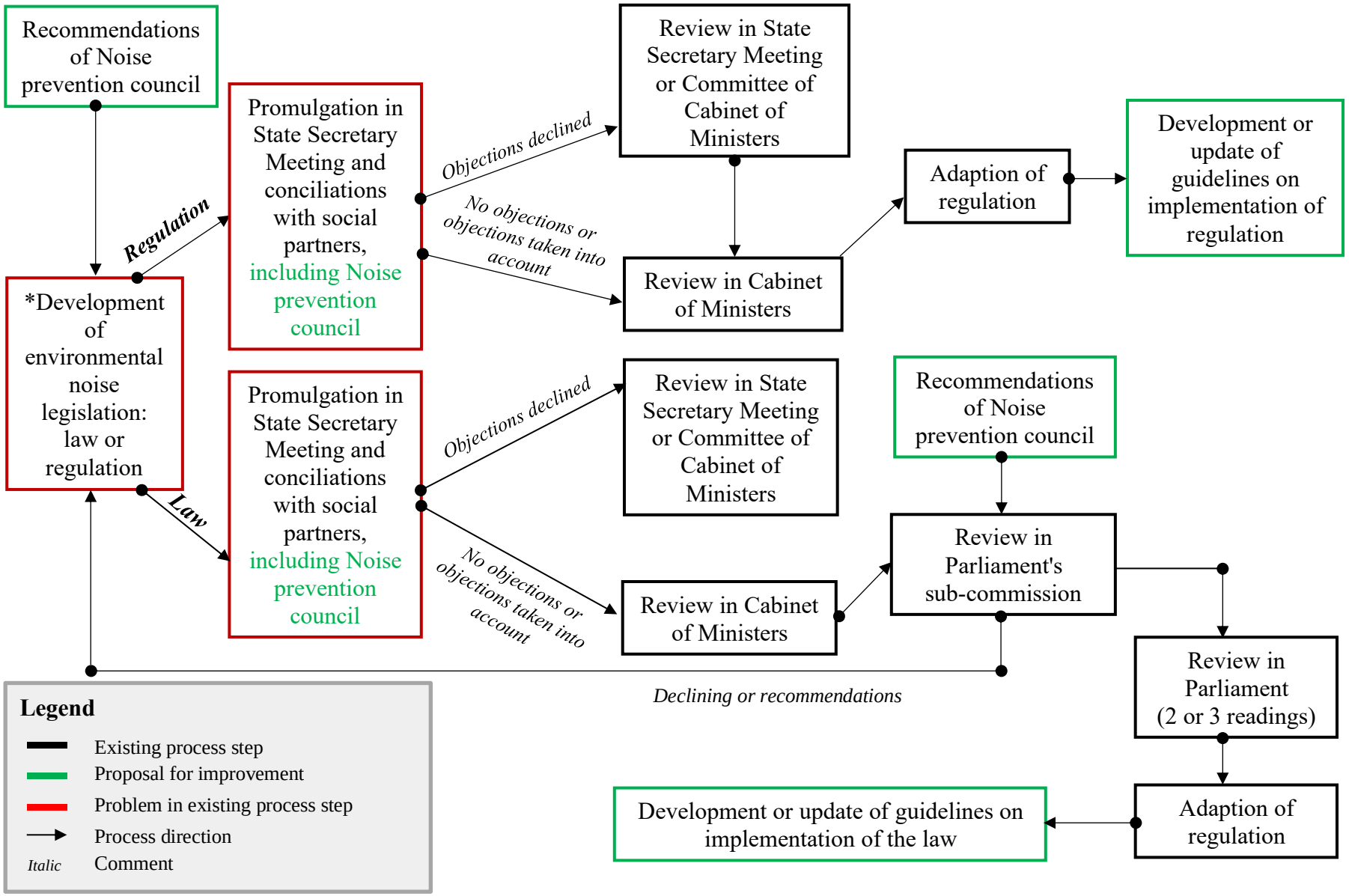

Figure 8.3. Main steps in the process of development of legislation in the field of environmental noise (created by the Author)

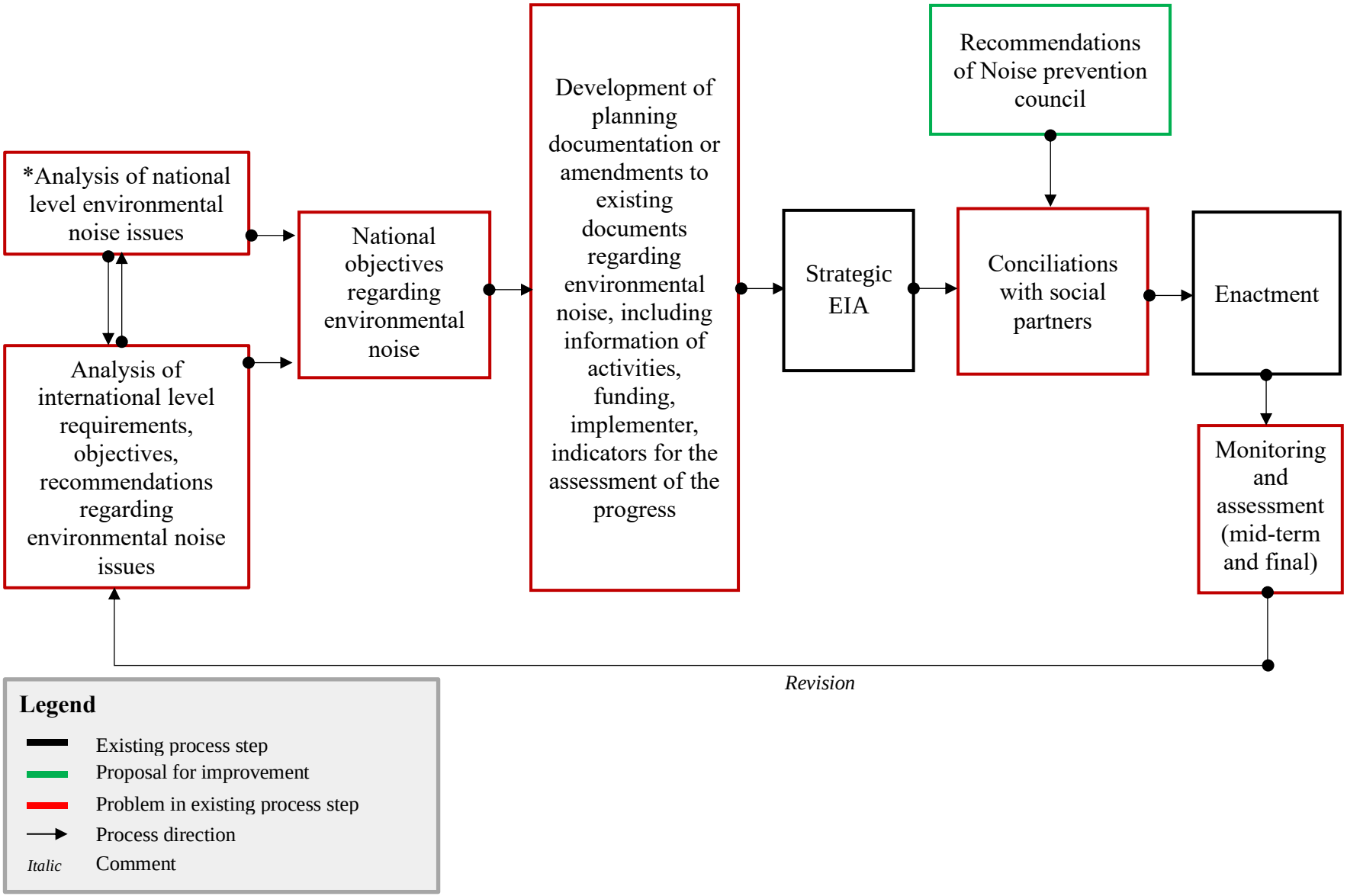

Figure 8.4. Main steps in the process of development of policy planning documentation in the field of environmental noise (created by the Author)

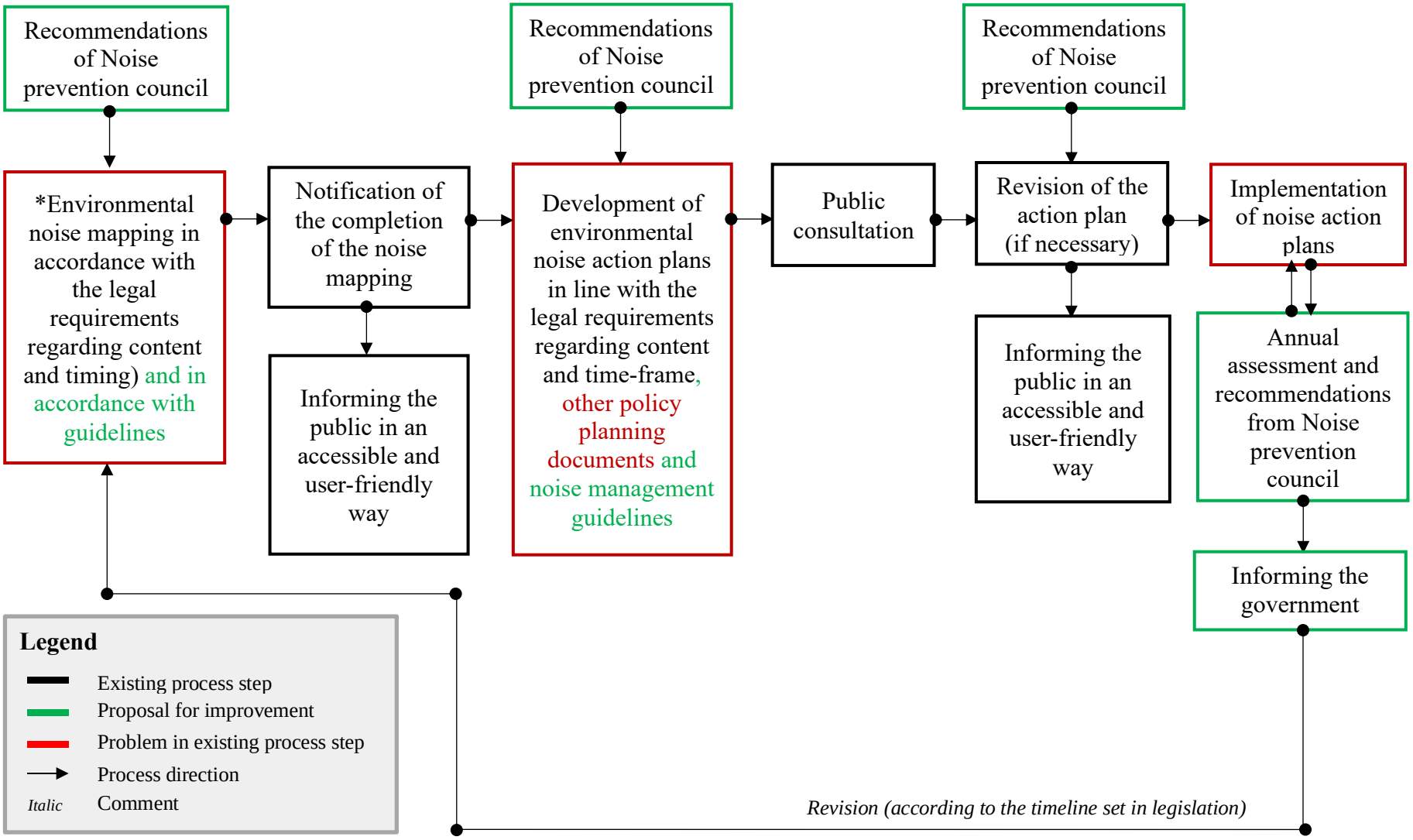

Figure 8.5. Main steps of the noise mapping and action planning process (created by the Author)

4. Environmental noise control and public feedback management

The existing process of environmental noise monitoring and public feedback management is described in sub-chapters 4.4. and 6.4. of this thesis. According to this assessment, it is concluded that the weakest process steps are related to the assessment of environmental noise levels before and after the request to the noise source manager to carry out environmental noise reduction measures is made. Theoretical environmental noise level excess probability evaluations should be carried out along with practical noise measurements with certified measuring equipment in all cases when public feedback on noise aspects is received. In order to reduce the administrative and financial burden, measurements initially should be done by the inspector. In cases where those measurements show potential exceedances of the permitted noise levels, a certified laboratory should be invited to perform noise measurements. In cases when the noise source manager is required to perform actions for noise abatement, it would be necessary to make measurements to check or prove compliance. Those measurements should be certified. Certified measurements, in cases when the environment noise limit value is exceeded and regarding new object commissioning and operation, should be financed by the noise source manager.

Control and public feedback investigations currently are done only in cases of receiving public feedback or information from the State Environmental Service. However, it would be advisable to develop annual inspection plans for the testing of the largest or new noise emitting objects, as well as to ensure permanent monitoring of environmental noise in noise-sensitive areas such as hospitals, social care centres, etc. The plan should also take into account the exceedances and violation cases in the previous year and foresee re-testing. According to Ireland's practice, normally, a licensed facility will be required to have a periodic noise assessment. The nature and scope of the assessment should be determined by site-specific conditions and operational history. Noise measurements should be appropriate to the facility, and representative sampling intervals should be selected and justified. For instance, the time intervals used may need to be adapted to site-specific conditions such as cycles of noise emissions at a plant.

Sometimes near objects with high, permanent noise levels, there should be a permanent monitoring required. Such monitoring equipment could be installed by the responsible institution or by the noise source operator upon the request of the State Health Inspectorate or State Environmental Service during the permit issuing process. Data from monitoring devices should be made available to responsible institutions at the state and municipal level (where appropriate). If it has been the case that there has been a history of complaints regarding noise, then the State Environmental Service should also require a licensee to undertake a more extensive assessment when applying for a permit.

In addition, according to the suggestions for the object construction and EIA process improvements, the State Health Inspectorate should carry out environmental noise assessment checks when the object subjected to the EIA procedure is commissioned. The check should be done during the object's commissioning (if it is possible to ensure real-life conditions equal to those of the object's operation) or during the warranty period.

In order to ensure implementation of the above-mentioned proposals, it would be required to increase the State Health Inspectorate capacity and improve equipment. The State Health Inspectorate should be a certified institution that can provide noise measurements itself.

There also should be internal guidance at the institution and noise measurement programme should be also prepared before follow-up checks and for object commission. It should include the information on the methods, points of measurements, etc.

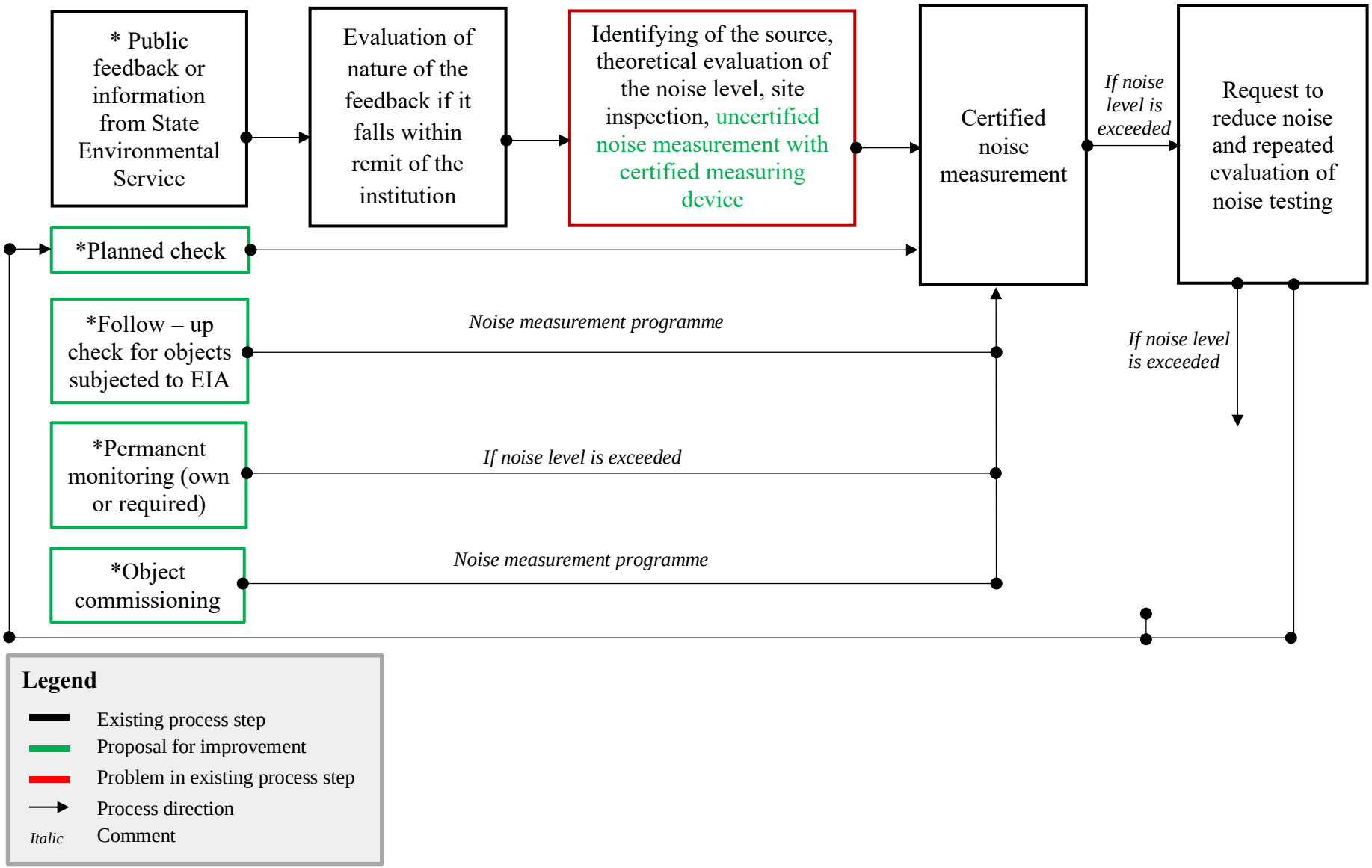

Figure 8.6. Main steps of the environmental noise control and public feedback management process (created by the Author)

5. EIA

During the EIA process, it is necessary to ensure that the process is done in accordance with the requirements of the applicable laws and regulations. For objects that can potentially cause noise pollution and are close to residential areas or noise-sensitive areas or objects located in quiet areas of the agglomerations (according to the requirements of Directive 2002/49/EC and noise action plans), the EIA program must include requirements for environmental noise assessment, including noise modelling (where necessary). These measures would enable gathering and illustration of liable information which should be understandable to the public on the planned activities and their possible noise levels. Such information could help to substantiate any analysis done by using reliable data and thus minimizing the subjective perception of noise and annoyance. The public consultation process of the EIA must be substantive, open, and reliable, and it must ensure public involvement and collection of feedback. After the EIA process, the construction of the object subjected to the EIA should be initiated within three years.

According to the results of a case study of the Saulkrasti bypass construction (sub-chapters 6.1. and 7.1.2.) that showed the associated significant noise annoyance due to subjective aspects of noise perception, it would be advisable to explain proposed differences between chosen noise mitigation methods and ensure timely information on the construction works during EIA process. The Saulkrasti case study also showed higher annoyance by those residents that were not informed of the construction plans. Currently, in 2019, the construction information system is used to inform the public on construction works, allowing residents to gather information on the actual status of an object set for construction and minimizing the subjective noise perception aspects.

The process scheme "*6. Object construction and operation*" (see further) provides suggestions for the object's construction, including that the State Health Inspectorate should carry out environmental noise assessment checks when the object subjected to the EIA procedure is being commissioned (if it is possible to ensure real-life conditions equal to those of the object's operational period) or during the warranty period. This will help control noise levels and evaluate the effectiveness and efficiency of the applied noise control measures, as well as ensure adjustment of the measures if the noise level is exceeded, thus ensuring that the aims of the EIA are fulfilled.

However, it must also be taken into account that sometimes the precautionary principle might be taken into account in an overly bureaucratic way and the modelling of environmental noise at the EIA stage is requested in cases when they might not be truly necessary. Therefore, EIA expert's knowledge on the issue is of high importance, as it could help to evaluate the situation better and reduce the administrative burden for the entrepreneur.

The EIA process regarding environmental noise issues is illustrated in Figure 8.7. The process does not include strategic EIA.

6. Object construction and operation

The process provides information on the key steps for the development of new objects. It includes the initial idea, EIA, submission of the application and receiving the construction permit, designing, receiving the approval of the design requirements (and its publishing in the construction system) and construction itself. The process proposes that technical design should be acoustically verified for noise emitting objects, if it is required by design requirements (during construction permit's design requirement fulfilling processes) and/or during EIA. These could be any noise emitting objects with potentially high noise levels and impacts, but, in particular, those whose noise levels according to the noise modelling are close to the maximum permitted ones, objects that need noise mitigation measures. The decision on the requirement for the acoustical verification should be taken by the Regional environmental board (included in the Technical regulations) or Construction board.

The technical design should be acoustically tested by the developer to ensure the compatibility with the national legislation, the EIA (when applicable), and preferably contain proposals for quieter technologies

and/or operation practice (if needed). This acoustical verification should be submitted to the construction board along with the technical design.

When the designing requirements are fulfilled and the construction is in progress, the construction work noise levels should be controlled according to the law and construction work organization program.

If it is technically possible to ensure the functioning of the object with such characteristics it would normally work during its operational phase commissioning (if it is possible to ensure real-life conditions equal to those of object's operation), noise levels for strategic objects with potentially high noise levels and impacts should be checked at the commissioning. If it is not possible, after the commissioning the State Health Inspectorate should take a decision on including the object in the planned check-ups according to the annual plan or require the developer to provide the certified noise testing results to the responsible institutions for evaluation. In order to do the, after the commissioning of the object, the local construction board should inform the State Health Inspectorate and State Environmental Bureau about the commissioning of an object that was subjected to EIA procedure. The process is illustrated in Figure 8.8.

The operation of the object must be ensured in accordance with national legislation and the permit of the respective Regional environmental board, ensuring that the noise levels do not exceed those permitted (permitted average L_{day}, L_{night}, $L_{evening}$ and maximum ones LAeq). In case noise levels are exceeded, urgent action must be taken to solve the issue. There must be quality mechanisms in place for nationally significant infrastructure operators on how they ensure that operational works do not increase noise levels.

For the existing objects, in case of infrastructure that has been built before the national legislation on environmental noise came into force (2002), environmental noise source operators must implement different technical, administrative and economic measures in order to reduce noise at source, on the pathway or at the receiver in order to comply with the law. However, as noise reduction measures may be expensive, noise source operators should take into account exposed population (in particularly vulnerable population), and DALYs (WHO, 2011) as well as public feedback when determining priorities. Latvian Railway, for instance, has used the DALYs and cost-efficient approach in their latest noise action plan (Latvijas dzelzceļš, 2019).

The existing noise source characteristics and noise levels have also been taken into account by the municipalities during spatial planning and when issuing construction permits for new residential houses near existing infrastructure. It is not advisable to issue construction permits for areas close to the strategic infrastructure at all. However, in case the permit is issued, it should include the requirements to ensure indoor noise levels are below the threshold and installation of such ventilation (and, possibly, cooling) systems that could reduce the need to open windows. Similar rules are planned to be imposed in Mārupe municipality. Such rules are especially important in areas impacted by national, strategically important transport infrastructure, where it is technically difficult to reduce noise levels (at the same time not hindering the economic development of the country (for instance in case of airport noise)). As it is mentioned above, it is also of utmost importance to ensure good acoustic conditions for schools and kindergartens, and it should be municipality's priority to regulate, prevent and abate noise impact on children, by stricter location and noise insulation requirements.

In addition, possibly, in areas of permanently high-noise levels, an environmental pollution encumbrance on a property could be introduced. This could be legal proof that the owners are informed and take full responsibility on living in the high pollution area. Meantime, this approach cannot relieve the noise source operator from its responsibility to use best mitigation solutions available and to further reduce noise levels. The idea of environmental noise pollution encumbrance should be further assessed in legal studies.

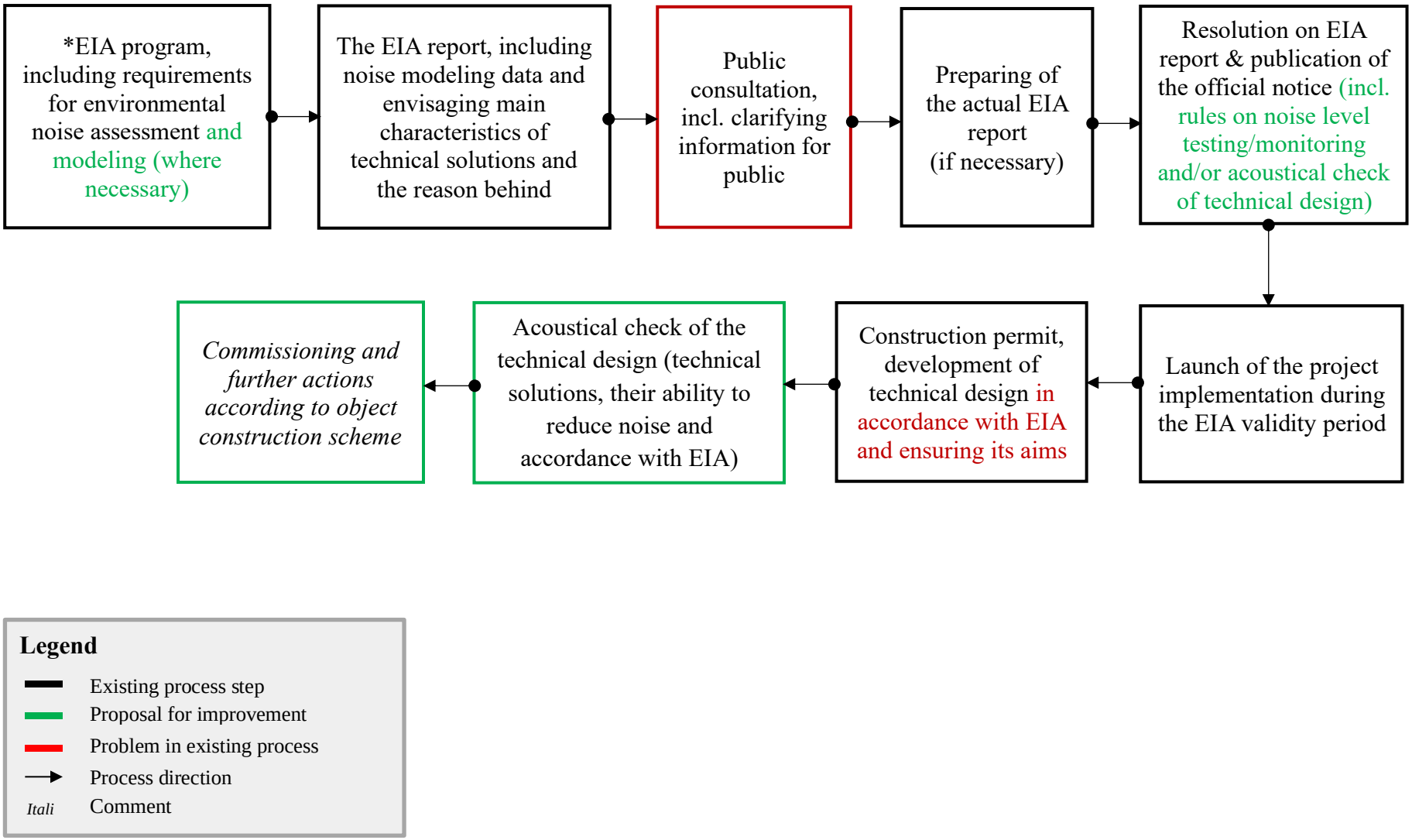

Figure 8.7. Main steps in the process of integrative EIA (created by the Author)

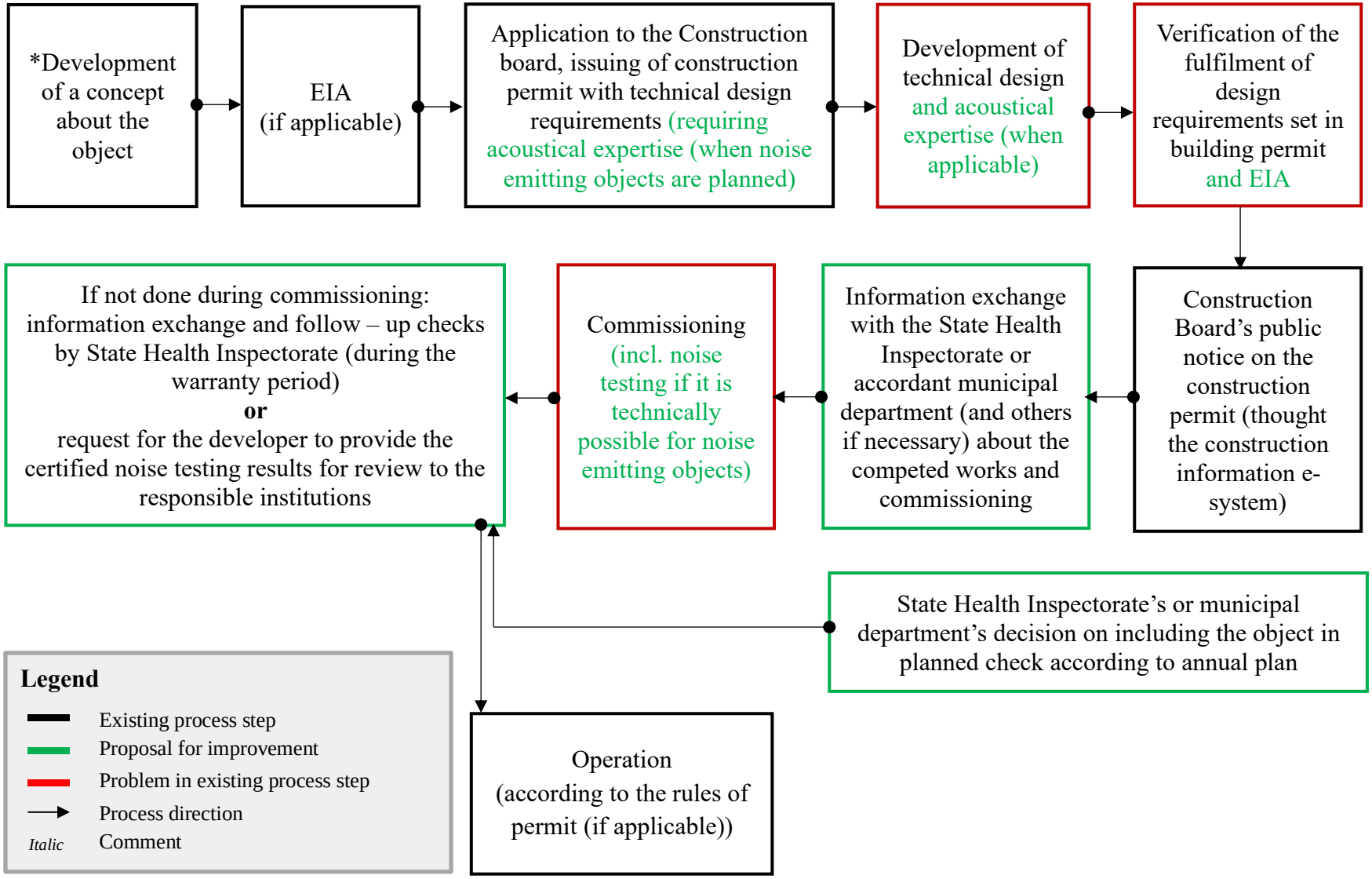

Figure 8.8. Main steps in the process of an object construction and operation (created by the Author)

8.2.2. Municipal level process sub-model

The municipal-level process model consists of four main environmental noise management processes. These are environmental noise mapping and action planning, development and territorial planning, object construction and environmental noise control and public feedback management.

1. Environmental noise mapping and action planning

Due to similarities with the state level, see the relevant process description and Figure 8.5.

2. Environmental noise monitoring and public feedback management

Due to similarities with the state level, see the respective process description and Figure 8.6.

3. Spatial development planning

3.1. Development planning (regarding the sustainable development strategy and the development programme)

The process of Development planning is illustrated in Figure 8.9. and it describes the most important stages that require the integration of environmental noise issues in such municipal documents as sustainable development strategy and the development programme. In order to ensure that environmental noise issues are taken into account in this process, the analysis of the local situation should be done taking into account the context and principles of the national legislative framework, local concerns, and public opinion. It would be advisable to carry out an analysis of the situation by developing environmental noise models (or use existing noise maps, if they are available), at least for the largest infrastructure and commercial objects. These documents should contain the municipal level objectives on noise mitigation or preventive protection of the population.

It would be advisable to provide local governments with a methodological material that could give suggestions and guidance for the assessment of environmental noise, impact analysis and local development planning in accordance to best practice (the United Kingdom, Estonia practice), as well as reduce administrative burden.

3.2. Development of the spatial plan

Despite the fact that a preparation of a spatial plan, a local plan and a detailed plan of a local government is a part of spatial development planning process, the Thesis specifically highlights the spatial plan preparation process and proposes specific detailed and specific requirements. As it was shown during the industrial environmental noise case study in Grobiņa and Vērgale counties, it is essential to avoid any procedural irregularities in the development planning process, to ensure substantive public involvement, the dissemination of information, as well as feedback. This would help reduce subjective noise effects and, possibly, reduce cause for negative public feedback on noise issues as well. It would also be advisable to take into account the existing noise levels in the area, location, and characteristics of the largest noise emitting objects, residential buildings, sensitive areas and quiet areas of the agglomerations when defining the planned use of the area and the location of objects and setting land-use conditions. After the development of the spatial planning document, it is crucial to monitor implementation of the requirements set in the document, and, if necessary, to review and update the document. It would be advisable to provide local governments with a methodological material that could give suggestions for spatial planning in environmental noise aspects.

The process is illustrated in Figure 8.10.

5. Object construction and operation

Due to similarities with the state level, see the relevant state-level process description and Figure 8.8

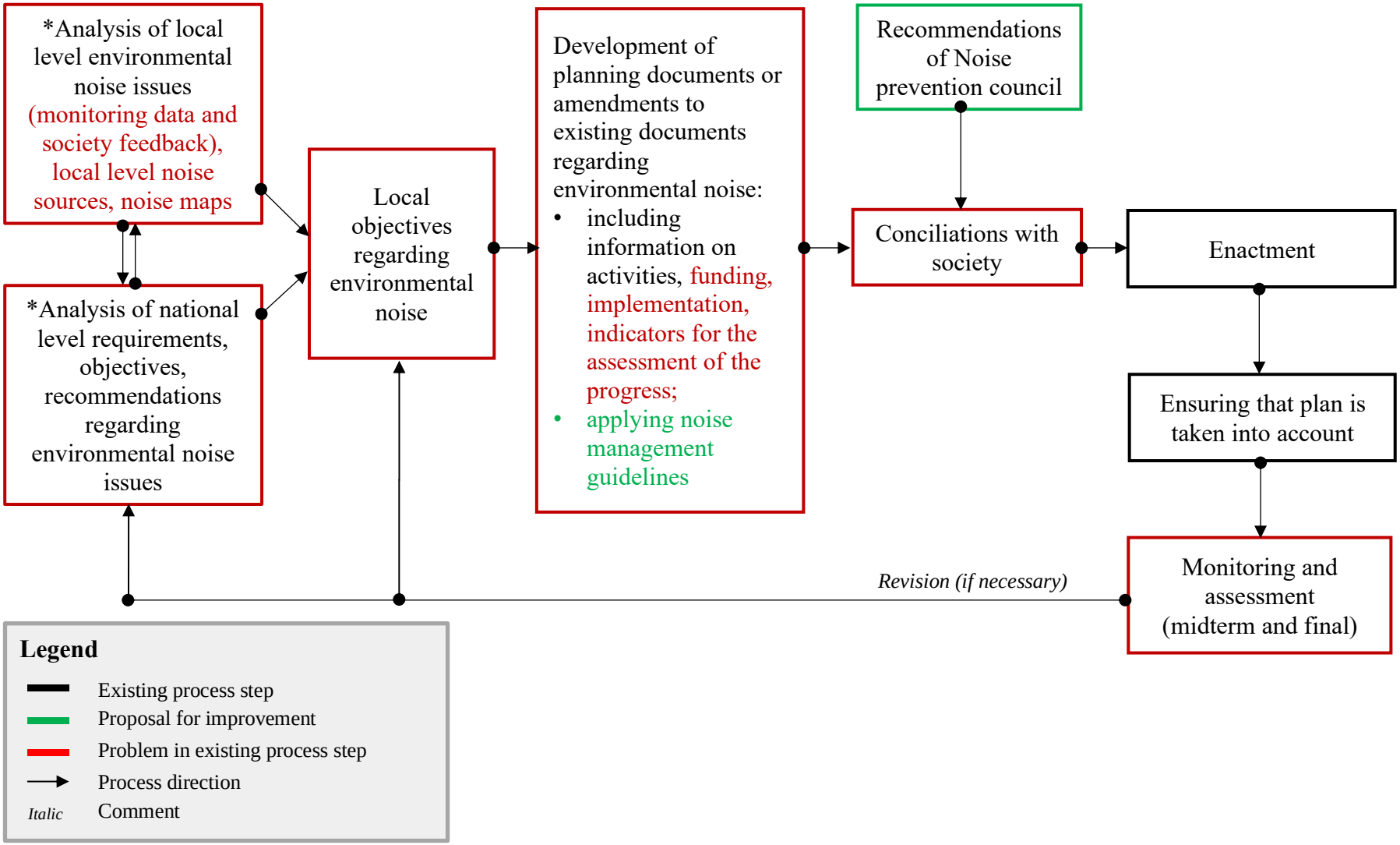

Figure 8.9. Main steps in the process of development planning (regarding the sustainable development strategy and the development programme) (created by the Author)

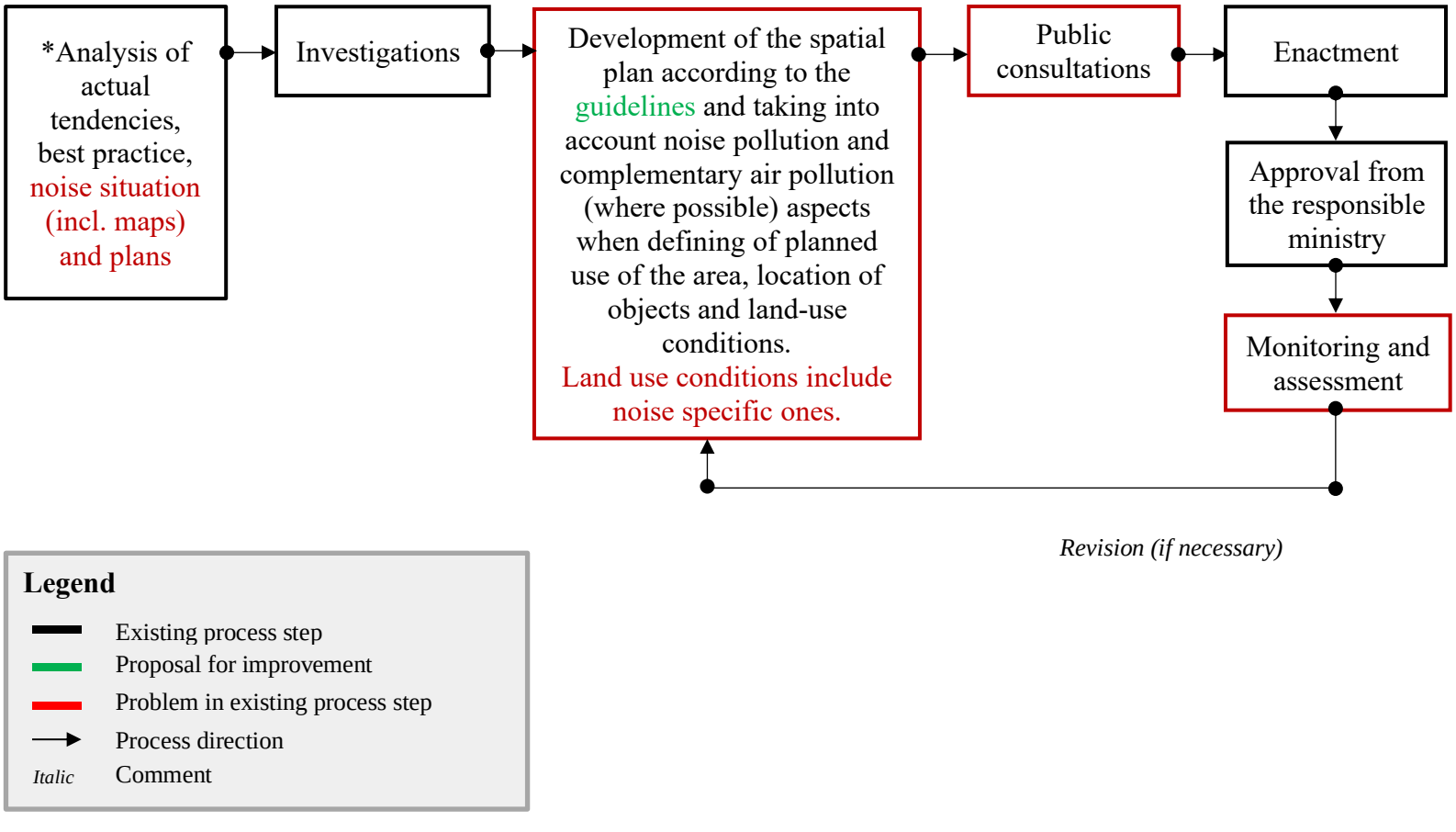

Figure 8.10. Main steps in the process of spatial plan preparation (created by the Author)

8.2.3. Coordination process sub-model

The noise management coordination process describes the vertical integration process between the state and municipal levels and between their sub-levels and establishes linkage between all the management processes in upper and bottom levels and sub-levels thus ensuring feedback. The crucial elements of the coordination process are the following:

1. Development of a Noise Prevention council

The Noise Prevention council has been identified as a best practice example from other EU countries. The Noise Prevention council serves as an intermediate body, and it comprises representatives of state-level institutions, municipal administrations or municipal associations, professional NGOs, scientific institutions, medical associations, etc. At least half of the members of the board must be experts, working in the area of noise prevention.

According to the best practice in Lithuania and taking into account the national situation, the Noise Prevention council should:

- be involved in the preparation of strategic noise mapping and action plans by giving its recommendations;
- annually assess the progress of the implementation of the action plans and national planning documents in relation to noise, and prepare a report and recommendations for the Cabinet of Ministers;
- assess the national and municipal noise management problems and give proposals for noise management improvements;
- prepare and submit to the national government annual reports on the number of people not protected against noise pollution and its effects;
- engage in the development and upgrading of national legislation and in development planning documents on noise aspects;
- act as an expert commission/government advising body in cases when significant noise problems must be resolved, especially for EIA or draft legislative acts.

2. Development of methodological tools and procedures

Methodological tools and clearly described procedures can help not only reduce administrative and financial burden but also ensure that the recommendations issued by the state-level responsible ministry are implemented in an accordant, coherent and efficient manner throughout the country and regardless of the size of the urban dwellings. For example, noise management guidelines as a methodological tool could ensure this vertical coordination and were already proposed as a necessary and advisable element for the improvement of several noise management process models at both state and municipal levels. Guidelines help to improve the understanding of the legislative act, as well as provide examples of how the noise can be managed and taken into account in different fields – in policy, land use planning, noise mapping, and action planning, deciding on technical solutions, reducing annoyance, etc. The guidance document, therefore, would be useful not only to municipalities, but also for other professionals whose primary tasks may not particularly deal with noise, but whose action could improve the acoustical quality of a place. The guidance documents also help to encourage more efficient use of administrative resources and provide a similarity in approach (where applicable).

It would be reasonable to learn from examples from the United Kingdom and provide guidelines or methodologies on what is considered to be a minimum standard of cooperation between the authorities when dealing with noise issues. These general guidelines would encourage consistency in terms of how local authorities plan, control, or deal with noise issues, while still enabling them to respond to local

circumstances and needs. The guidelines should set out the roles and responsibilities of each, giving examples of effective arrangements.

Also, a detailed description of management procedures may help to improve management efficiency not only horizontally, but also to regulate communication among the different levels and stakeholders.

In addition, it would be advisable to take the best practice from the United Kingdom and develop codes of practice for business activities for minimizing noise, such as for noise environmental noise control for construction activities, etc.

3. Inter-institutional information exchange and dissemination of information to the public, and awareness raising

Information on environmental noise and its aspects should be disseminated both to different management levels and the general public in effective ways on different environmental noise aspects. Information for the public should be easily understandable and accessible. Information, for example, can be distributed through institution web-pages and social networks, made available in public places, such as in train and bus stations, distributed together with regular payment bills for the use of utilities, etc. Information should be timely and reliable in order to avoid noise annoyance subjective aspects. Information for the institutions, however, must be more specific and include the most recent data and best approaches.

Awareness raising events should be organized at a different level.

4. Education and professional competence

Employees of municipalities and state institutions dealing with environmental noise, especially those who control noise issues, should be educated about acoustics in general, including noise measurements and assessment, noise impacts and the possibilities to reduce them. In addition, regular seminars, workshops or other educational activities should be organized by the MoEPRD, the State Health Inspectorate, the Noise Prevention council and professional NGOs informing both people working on noise issues and society in general, about legislative or methodological modifications, innovations, new scientific data, and approaches, etc. A good example is the Rīga noise action plan that foresees the raising of the competence of Rīga municipality specialists (ELLE, 2017).

5. Data and information quality and availability, analysis and dissemination

Collection, compilation, analysis, and dissemination of the data and information on environmental noise are necessary to ensure timely and representative information on the situation in the country. Availability of data is a precondition for making a more accurate assessment of noise and its effects to develop appropriate and adjusted legislation, planning documents, guidelines, etc. Not only data and information should be gathered according to the EU regulatory requirements for data collection and reporting, but also research on environmental noise and public health issues should be carried out. So far, studies on noise and its effects on society have rarely been made in Latvia.

The reports and studies on environmental noise aspects must be disseminated to the public in an effective and efficient way. Data and studies on environmental noise would be especially necessary for the institutions developing a regulatory framework and carrying out the EIA, as well for the municipalities. In the case of establishing a Noise Prevention council, it should review and collect the data and studies on the topic and give proposals for further research.

Data should be collected regularly and illustrate the situation on environmental noise background and on proposed changes that would occur during the process of the development. The data should be available to institutions dealing with environmental pollution, planning, permits, etc. at the state and municipal level.

The State Health Inspectorate should also become an institution with legal rights to provide certified measurements in order to gather independent and reliable data in a timely manner.

8.3. Brief summary of Chapter 8

Chapter 8 describes environmental noise management model for Latvia. It consists of 3 sub-models – state level model, municipal model and coordination model that interlink processes horizontally and vertically and ensure proper functioning of the model. The state and municipal level models together consist of 10 interrelated processes, and describe development of legislation in the field of environmental noise, development of environmental noise policy, development of environmental noise mapping and action plans, environmental noise control and public feedback management, data and information collection, analysis and dissemination, EIA, spatial planning, object construction. Several of them are included in state and municipal levels. Coordination process model consists of the proposal for development of coordination and advisory body (Noise Prevention council), development of methodological tools and procedures, provision of inter-institutional information exchange, awareness and competence raising, as well as availability of topical data and information.

9. APPROBATION OF THE ENVIRONMENTAL NOISE MANAGEMENT MODEL

The proposed environmental noise model is a practice-based theoretical model that is based on the best practice analysis of other countries, documentation studies, and results of case studies in Latvia. The management model (i.e., improvements in the existing processes) cannot be tested in practise, because this would require changes at different governmental levels and various institutions, as well as would require political will to implement it. However, the approbation of the model was done through the analysis of the best practices of other countries – proposing to adopt the practice that is already used elsewhere, thus proving the practical applicability of the model and effectiveness of proposed suggestions. The approval of the model was also gathered through expert consultation (interviews) with experts working in the field. The received comments were evaluated and taken into account (where appropriate). Corrections were made in several process schemes and disclosed in the previous chapter.

9.1. Main received comments

The Latvian Association of Local Governments expressed the view that there should be integrative guidelines on all environmental noise management aspects – i.e., noise mapping and action planning guidelines should be integrated with development planning guidelines in noise aspects, etc. The municipality association is willing to have more guidance tools, rather than more detailed specifics in legislative acts. The suggestion has been included in the process schemes, proposing either to have a sectoral or integrative guideline consisting of legislative act and policy planning implementation proposals and also on environmental noise mapping and action planning.

The municipal association suggests not to have Noise Prevention council as a sectoral consultative body, but to have noise aspects integrated on a broader scale, an integrative consultative body. However, the Author believes that there should be Noise Prevention council as a separate consultative body, because environmental noise is a specific type of environmental pollution, that causes a wide range of health effects and the environmental board in Latvia lack professionals who could evaluate environmental noise professionally regarding acoustic factors and health, thus giving expert advice on the issues, etc.

However, the municipalities themselves did not welcome the proposed idea of guidance documents too warmly. The author suspects it is due to the low priority placed on noise issues in the municipalities. Also, municipalities, possibly, want to act more independently. It might be so because a guidance, despite it is not a legally binding document, might be used by controlling bodies when evaluation municipal function fulfilment or during the approval of planning documents. However, the municipal association finds guidance to be the best practice approach, as there is a lack of guidance for municipalities developed in Latvia. The

The Latvian Association of Local Governments and the MoEPRD agree that there should be a possibility for further cooperation with the State Health Inspectorate units and municipalities, including in sharing equipment for noise management.

The State Health Inspectorate proposes the option to have the measurements after the object has started to operate to be carried out by the developer and to have the mandatory task to submit the testing results to the State Health Inspectorate for evaluation. This proposal has been included in the process scheme update.

In addition to the interviews mentioned above, in order to see how to implement the best practice approach, the information from of Lithuania's Ministry of Health was gathered on how the Noise Prevention council works. The information was taken into account when developing the environmental noise management model for Latvia and the respective schemes.

The State Environmental Bureau agrees with the proposal on noise level checking for the objects with possibly high noise levels, and in 2019 such requirement was included in the legal opinion of the EIA review

on Zemgale wind park. The institution also confirms that EIA quality has been significantly improved in comparison with Saulkrasti by-pass case. This information was also taken into account on main findings in Chapter 7 of the Thesis.

The interviewed experts, in general, agreed with the proposal environmental noise management model that is offered in this PhD thesis and described in the chapters above. Expert interviews allowed concluding that the processes and their improvement would be practically implemented and they could improve noise management in Latvia.

9.2. The implementation process of the environmental noise management model

In order to implement the environmental noise management model, the following steps have to be done:

- Legislation should be improved, for instance, regarding CNOSSOS-EU.
- Guidelines should be prepared, discussed with social partners (including municipalities, state institutions, noise source operators, and specialists – acousticians, land-use planners, architects, public health specialists, etc.) and accepted by the MoEPRD. The guidance document must be sent to the municipalities, state institutions, and professional organizations of professionals whose work deals with environmental noise in different aspects. The guidance documentation must be published in the web-page. The MoEPRD has stated that the ministry is considering the development of such guidelines. Consultation with relevant experts in Estonia on the development of the guidance might be considered.
- Noise Prevention council as a separate body or within the framework of Environmental Consultation Board should be established. There are several steps that have to be undertaken –decision on the Noise Prevention council's structure, members (acousticians, institutions, public health specialist, universities, non-governmental organizations, etc.), functions, tasks, work organization, etc. The proposal on the body should be directed by MoEPRD. The informative report on the Noise Prevention council has to be submitted to the Cabinet of Ministers. The amendments in the Law on pollution and its respective regulation of the Cabinet of Ministers should be made. Information on how the legislative acts (including their amendments) are adopted in the Cabinet of Ministers or Parliament is provided in Figure 8.3. The request to the members of the council to delegate the responsible person should be sent, and after the nominations, the Noise Prevention council is established with the decree of the Minister of MoEPRD. Regular meetings should be held and the tasks implemented, including annual assessments, informing the government, advising, scrutinizing of noise maps and action plans, involvement in researches and communication activities, etc. After its establishment, the Noise Prevention council should also be actively involved in educational training and advice, especially, when technical or specific knowledge is needed, such as for evaluating EC proposals for Directive 2002/49/EC amendments or before deciding on the scope of EIA.
- Improvements in the processes of environmental noise control and monitoring must be made - in addition to the investigation of public feedback, also planned checks, follow-up checks, and permanent monitoring should be carried out. To implement these activities, the State Health Inspectorate and municipalities (Latvian Association of Local Governments) should agree on mutual cooperation on the information exchange about the objects subjected to EIA (if the information is not available in the construction information system) or the State Health Inspectorate should come to an agreement with the Ministry of Economics on improvements in the construction information system, so that the information on the start of operation of the objects subjected to EIA is automatically sent to the State Health Inspectorate. Also, the procedure on how the on-site noise monitoring and control is performed should be amended, and new processes have to be included. All the involved parties have to be informed. In order to carry out the noise control and monitoring checks according to the proposed

improvements of the process, certified environmental noise measurement tools should be purchased, so that the inspectors can make uncertified noise measurements that would help to take decisions on future inspection activities. Funding for the purchase of the noise measurement devices must be allotted from the national budget or EU funds. This has to be taken into account when planning the annual budget when drafting financial parts of different project proposals or including it in new political initiative plans.

- Educational training and practice sharing platforms must be organized. The responsible authority for this initiative should the MoEPRD. These activities should be included in the annual communication plan, and information on them should be reflected in the review of Latvia's Environmental Policy Framework. There also could be a cooperation agreement with universities on specific education of government and municipal officials, so they could attend courses dealing with the work specifics and access scientific information for work needs.

9.3. Brief summary of Chapter 9

In order to implement the environmental noise management model, the following steps have to be done:

- guidelines should be prepared, discussed with social partners;
- Noise Prevention council must be established;
- improvements in the processes of environmental noise control and monitoring must be made
- educational training and practice sharing platforms must be organized. The responsible authority for this initiative should the MoEPRD. These activities should be included in the annual communication plan, and information on them should be reflected in the review of Latvia's Environmental Policy Framework. There also could be a cooperation agreement with universities on specific education of government and municipal officials, so they could attend courses dealing with the work specifics and access scientific information for work needs.

CONCLUSIONS

1. Environmental noise management is a prerequisite for ensuring a holistically healthy and acoustically favourable living environment through the reduction or prevention of noise as a form of environmental pollution. For this reason, it is necessary to develop comprehensive environmental noise management models describing different management levels that are based on the assessment of practical situations and best practice examples.
2. In this PhD Thesis the analysis of best practice examples of noise management in other countries in relation to the legislation, institutional systems, and public feedback management was carried out. The analysis allowed determination of the examples that could be adapted to other countries related to the development of methodological tools, setting of clear procedural orders, establishing a sectoral intermediate body (a noise consultation board) and regular noise control.
3. In order to see how environmental noise is managed, environmental noise management deficiencies in Latvia were identified though documentation research, case studies, participation and sociological studies. The findings concluded that environmental noise management issues are mainly due to the high impact of subjective noise perception on the public, a low understanding of environmental noise issues, low priority for preventive and remedy actions, and ineffective planning, implementation and monitoring of the existing noise management policies and actions. This shows that despite the fact that the environmental noise management elements are in place, environmental noise management in Latvia is yet to be improved so it is systematic, strategic, integrative and responsive.
4. Taking into account best practices identified and the findings on environmental noise management deficiencies in Latvia, the environmental noise management model was prepared, employing the business process model technique. The management model consists of an ensemble of three sub-models that comprise process models for the state and municipal levels, who are supplemented and interlinked with the coordination process for the vertical and horizontal integration of the activities and their cross-sectoral interaction.
5. The process models consist of several integrative, interconnected, and coherent processes according to the key functions assigned to each management level in the field of environmental noise. For the national noise model in total 11 processes have been established that are: the development of legislation in the field of environmental noise, development of environmental noise policy, development of environmental noise mapping and action plans, environmental noise control and public feedback management, data and information collection, analysis and dissemination, EIA, development planning and preparation of spatial plan, as well as object construction (and operation). Several of them are included in both management levels – state and municipal.
6. Proposed environmental noise management process improvements are related to the development of a new intermediate body – Noise Prevention council – development of methodological tools, extending noise control and monitoring, as well as adding new procedural steps in the processes of EIA, development planning, object construction, noise mapping and action planning, development of legislation and others. These activities should be done, taking into account also proper, reliable, coherent, and timely coordination, information distribution, and education on noise-related issues.
7. The approbation of the model was done through the analysis of the practices of other countries thus proving the effectiveness and practical applicability of the model, through consultation with state and management municipal level experts and practitioners, as well as with Lithuania's Ministry of Health. This approach was chosen because the proposed environmental noise model could not be practically tested as it would require changes at different levels and various institutions, as well as would require political will to implement it. The approbation also included the interviewed experts which agreed with the proposal environmental noise management model that is offered in this dissertation. Expert interviews allowed concluding that the proposed processes improvements can

be practically implemented and they can improve noise management in Latvia, thus improving the living environment for people and reducing holistic health and socio-economic effects.

8. The adaptation of the environmental noise management model would help to improve the environmental noise management situation in the country, reduce environmental noise exceedances and reduce acoustic and non-acoustic discomfort and annoyance for society, thus improving holistic health for residents, improve life quality. It might also improve the resident's opinion on state and municipal level management practices and strike a balance between economic development and environmental protection.
9. The research done shows that the suggested steps mentioned in the hypothesis - research of good practice of other countries, analysis of national problem situations and development and application of a strategic and integrative model - could improve environmental noise management in Latvia. The PhD Thesis, therefore, has reached the aim and proved the proposed hypothesis.

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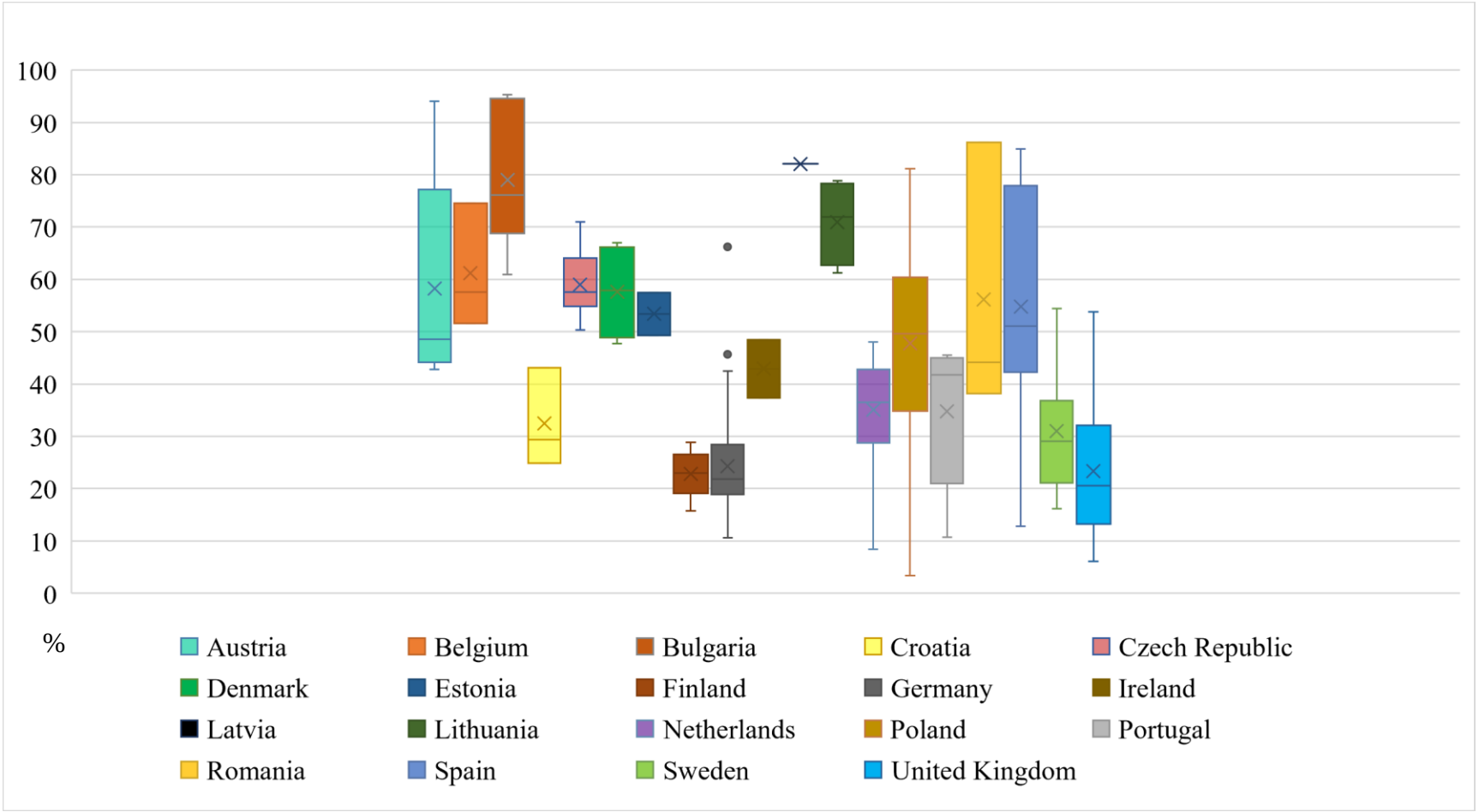
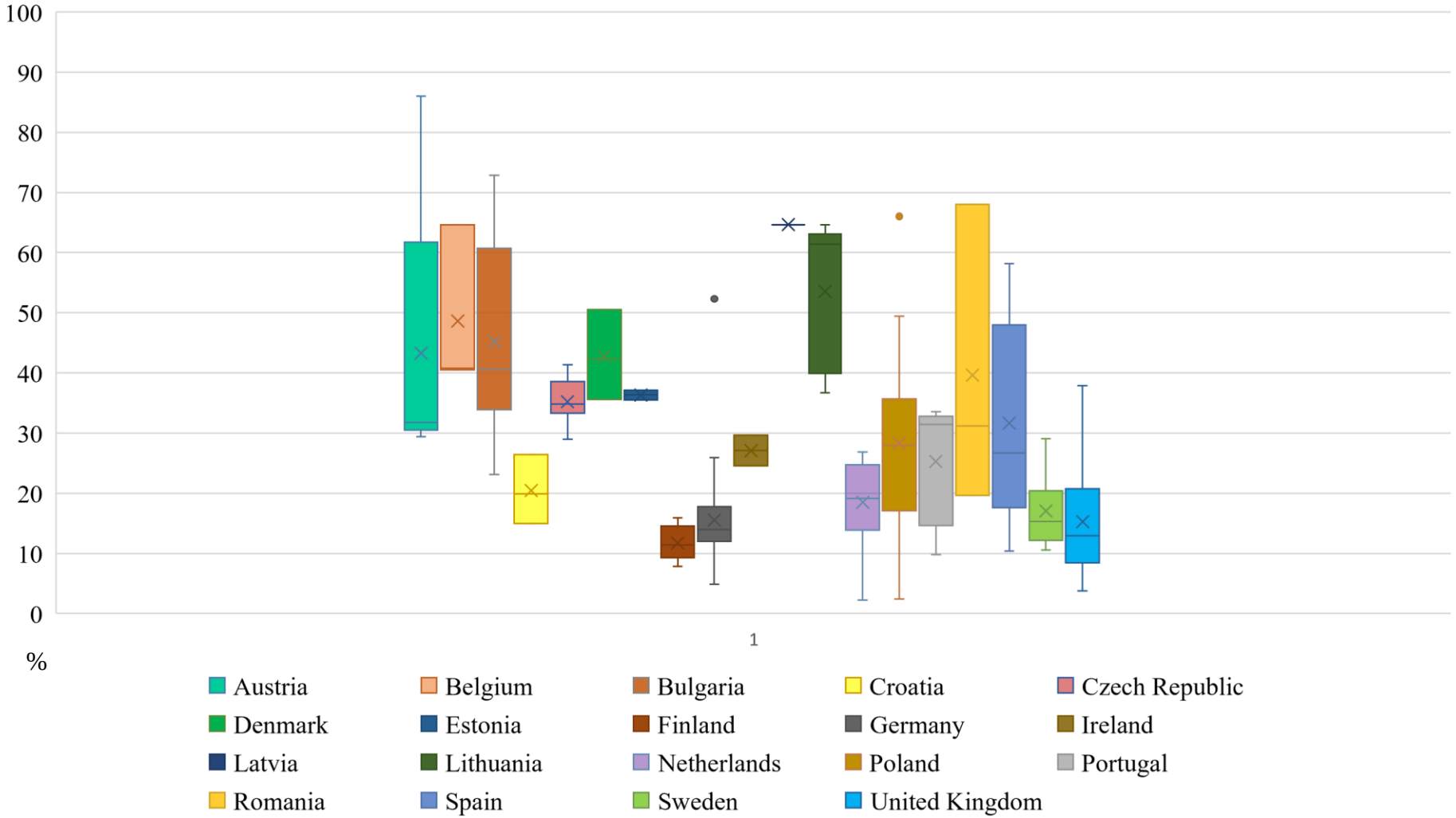
ANNEX I

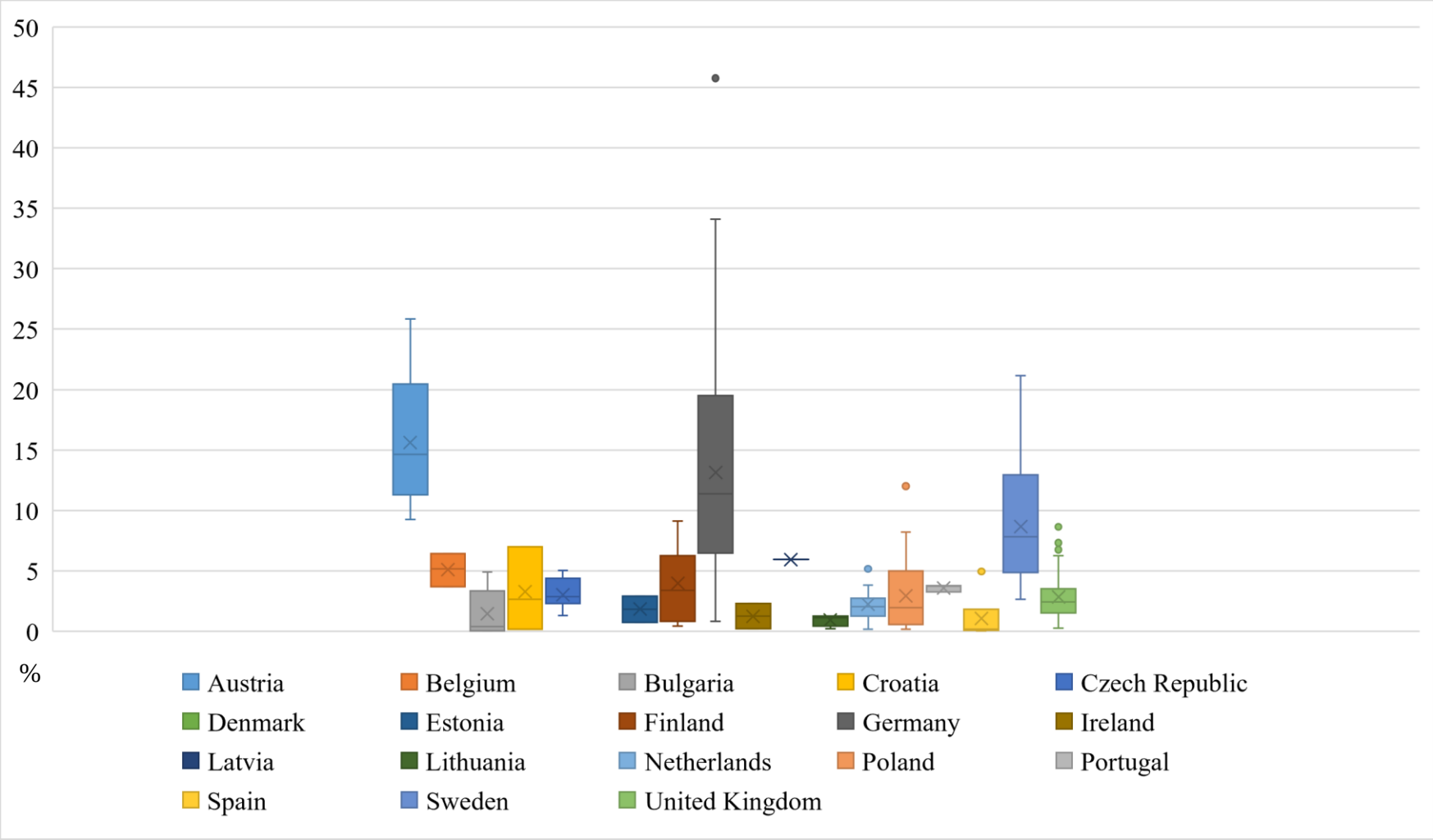
Box plots on population share impacted by L_{den} and L_{nights} values according to EU noise mapping data (2017)



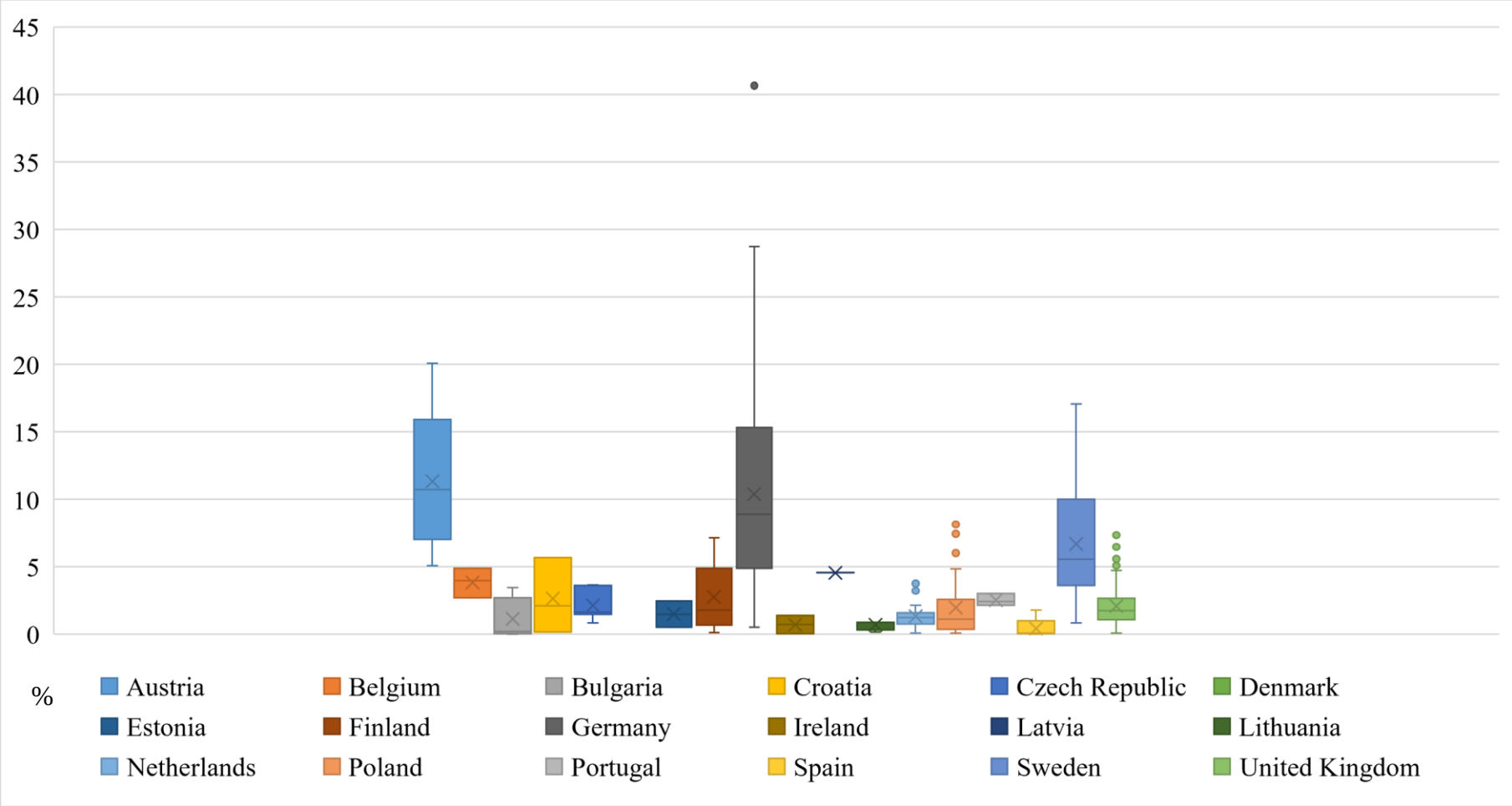
Road noise box plot - population share % in noise agglomeration impacted by L_{den} values over 55 dBA per country according to EU noise mapping data from 2017 (created by the Author, using European Commission, 2019)



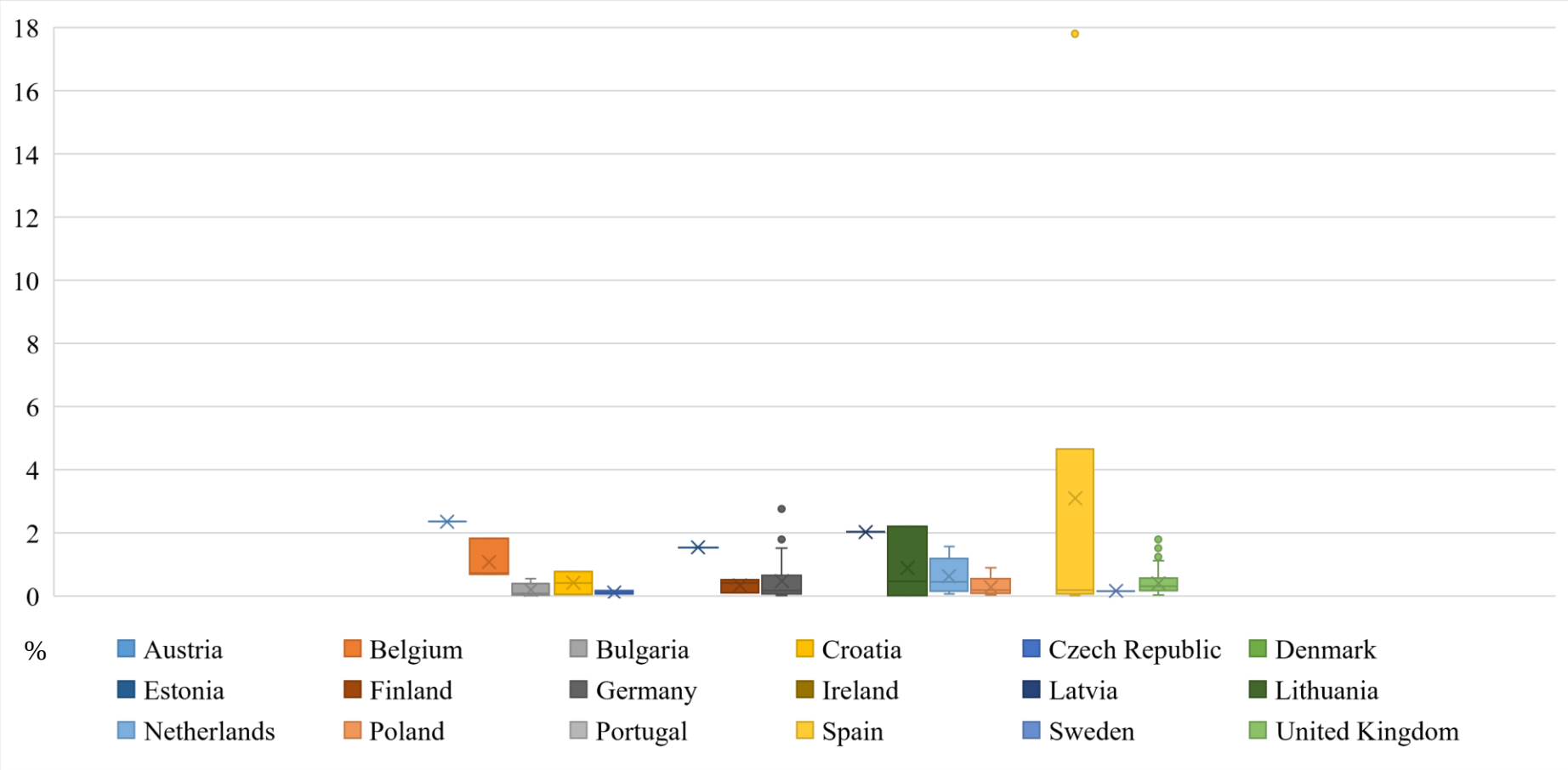
Road noise box plot - population share % in noise agglomeration impacted by L_{night} values over 50 dBA per country according to EU noise mapping data from 2017 (created by the Author, using European Commission, 2019)



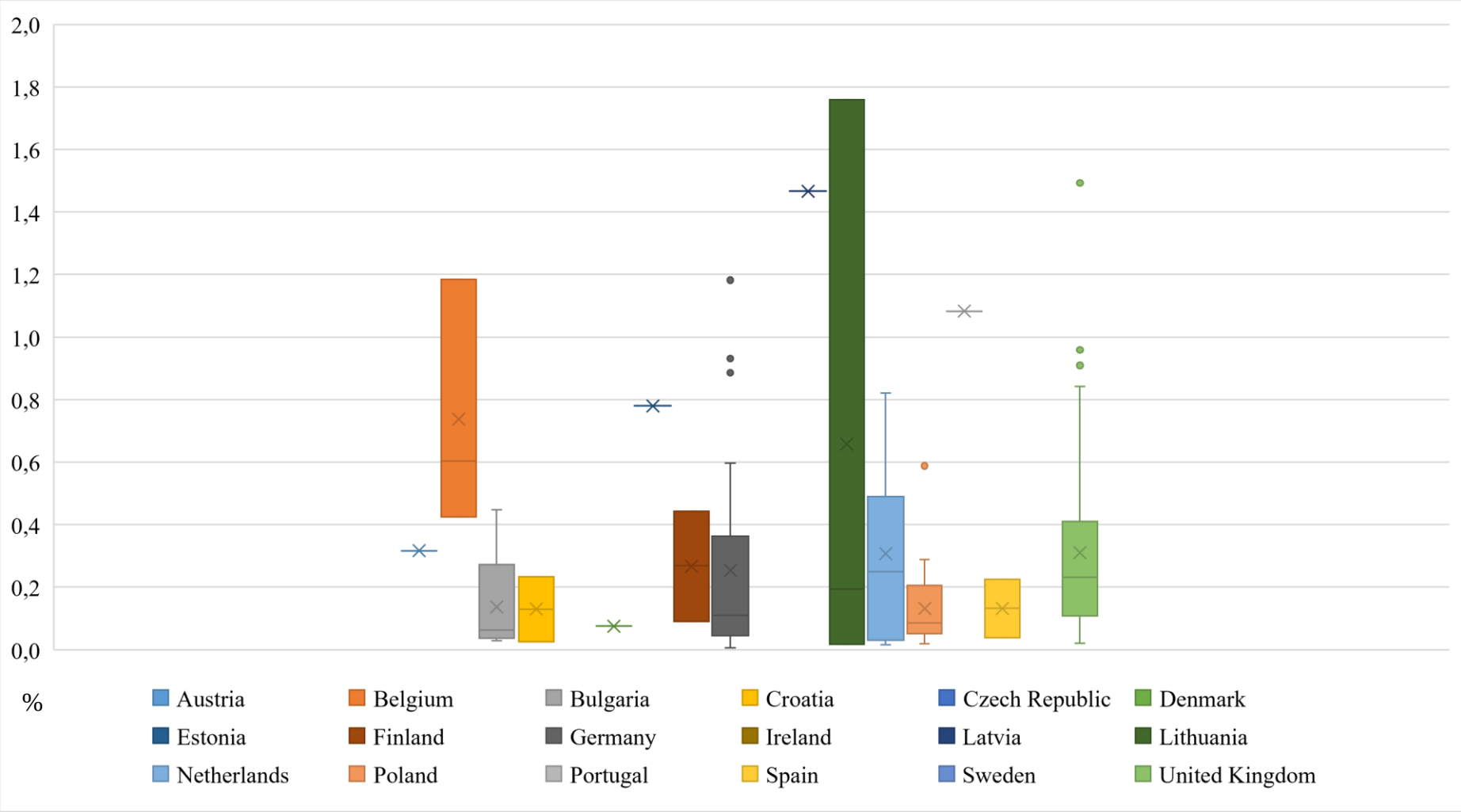
Rail noise box plot - population share % in noise agglomeration impacted by L_{den} values over 55 dBA per country according to EU noise mapping data from 2017 (created by the Author, using European Commission, 2019)



Rail noise box plot - population share % in noise agglomeration impacted by L_{night} values over 50 dBA per country according to EU noise mapping data from 2017 (created by the Author, using European Commission, 2019)



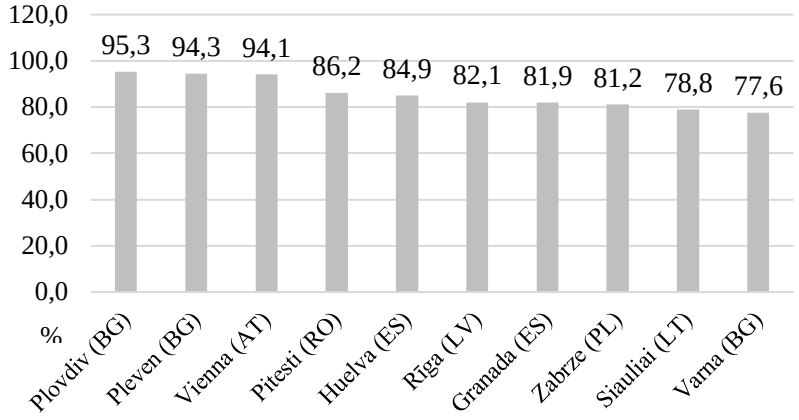
Industry noise box plot - population % share in noise agglomeration impacted by L_{den} values over 55 dBA per country according to EU noise mapping data from 2017 (created by the Author, using European Commission, 2019)



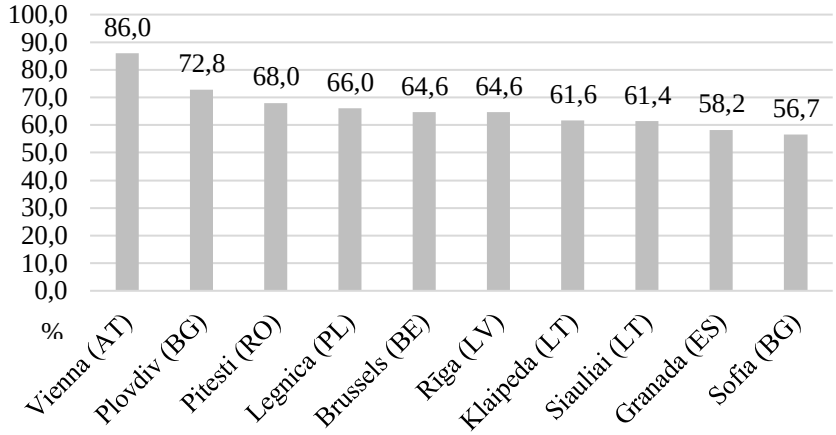
Industry noise box plot - population share % in noise agglomeration impacted by L_{night} values over 50 dBA per country according to EU noise mapping data from 2017 (created by the Author, using European Commission, 2019)

ANNEX II

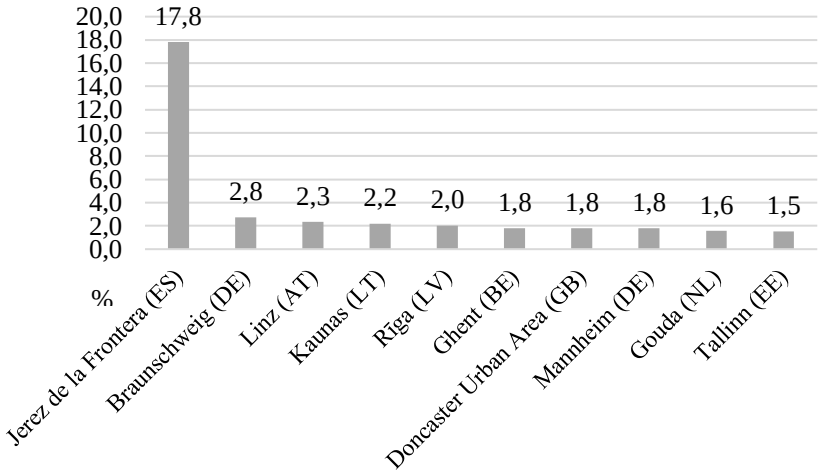
Ten the noisiest agglomerations (road and industrial noise) in European Union



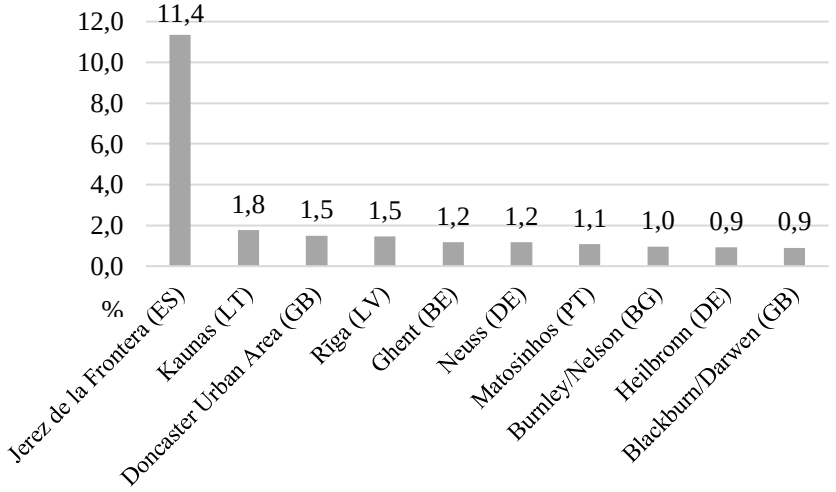
The proportion (%) of the populations exposed to L_{den} (>55 dB) road noise levels in EU environmental noise agglomerations



The proportion (%) of the populations exposed to L_{night} (>50 dB) road noise levels in EU environmental noise agglomerations



The proportion (%) of the populations exposed to L_{den} (>55 dB) industry noise levels in EU environmental noise agglomerations



The proportion (%) of the populations exposed to L_{night} (>50 dB) industry noise levels in EU environmental noise agglomerations

ANNEX III

Semi-structured interviews with Grobiņa and Vērgale residents (used in Latvian)

Interview questions

1. Question: Do you perceive the sounds created by the wind turbines as disturbing? Do you feel acoustic discomfort generated by the wind turbines?

   _____

2. Question: The modelling shows that noise levels in the area of wind park is below the maximally permitted threshold. Have you received the information about the level of noise created by the wind turbines?

   _____

3. Question: Have you felt the impacts on health caused by the noise? If yes, what kind of impacts?

   _____

4. Question: Do you experience limitations of outdoor recreation?

   _____

5. Question: What actions should be done in order to improve the acoustic quality and the satisfaction with living conditions?

   _____

6. Question: Did you participate in municipality planning process? What was the reason for participating or not participating?

   _____

7. Question: Do you think, you received the timely and sufficient information about the wind park and the process of its planning and construction? Where this information came from (municipality, contractor)?

   _____

8. Question: Did you receive information from the wind part constructor (enterpriser) and/or non-governmental organizations about construction of the wind park and the wind park environmental and health impacts before the construction?

   _____

9. Question: Do you obtain direct benefits from the development of wind park?

   _____

10. Question: Do own the land where the wind turbine is located?

    _____

11. Question: Do you own the land that neighbours the land on which the turbine is located?

    _____

Visual inspection

12. Condition of the building of the resident: poor or good or unknown. Description:

    _____

Information on the respondent

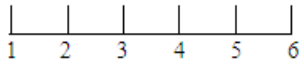
1. Name of the populated area you live: _____
2. Gender: □ Man □ Woman
3. Age: ___
4. Education: □ Primary education □ Secondary education □ Vocational education □ Higher education
5. Occupation: □ full time □ part – time □ unemployed □ student □ pensioner
6. Nationality: ___
7. Average monthly income (bruto): ___

Structured interviews with Saulkrasti residents (used in Latvian)

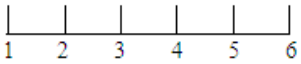
Interview questions

1. To what extent in your home area outdoors you are disturbed by environmental noise? Please assess in a scale from 1 to 6: (1 - to a very great extent, 2 - to a great extent, 3 - to moderate extent, 4 - to some extent, 5 - to a small extent, 6 - not at all). Please give separate answers for day and night time:

   a) Daytime and evening (07 - 22):

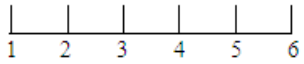
   

   b) Night time (23 - 06):

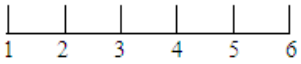
   

2. To what extent are you disturbed by environmental noise in your home (indoors)? Please assess in a scale from 1 to 6: (1 - to a very great extent, 2 - to a great extent, 3 - to moderate extent, 4 - to some extent, 5 - to a small extent, 6 - not at all). Please give separate answers for day and for night time:

   a) Daytime and evening (07 - 22):

   b) Night time (23 - 06):

3. Which environmental noise sources are the most troublesome for you? Please choose one or more answers:

□ Road transport
□ Railway
□ Airplanes
□ Public events and concerts
□ Community noise (please name) _____
□ Production
□ Construction
□ Other (please name) _____

4. Do you believe that you are exposed to increased environmental noise levels? Please choose one answer:

□ Yes, outdoors
□ Yes, indoors
□ Yes, outdoors and indoors
□ No

5. At what time do you feel environmental noise effects the most? Please choose one or more answers:

□ Night time (23 - 06)
□ Daytime (07 - 18)
□ In the evening (19 - 22)

6. Have you felt any signs of health or social behaviour during or after exposure to noise? Please choose one or more answers:

□ Headache
□ Sleep disorders
□ Psychological discomfort
□ Decrease in mental work performance
□ Annoyance
□ Speech and communication disorders
□ None
□ Other (please name) _____

If you have felt a sleep disorder, please indicate if:
□ You cannot fell asleep
□ You wake up throughout the night, but you are able to fell asleep easily
□ You wake up throughout the night, but it is hard to fell asleep again
□ Other

7. Did you participate in the environmental impact assessment process prior to the construction of the bypass? Please provide one response:
□ Yes
□ No. Please specify why: _____
□ I don't know what environmental impact assessment is

8. Have you or your household carried out activities to reduce the effects of environmental noise:
□ Yes. Please specify what _____
□ No. Please indicate why_____

9. Have you addressed complaints about environmental noise in the municipality, the State institution or the noise source manager? Please choose one answer:
□ Yes. Please specify why? _____
□ No. Please specify why? _____

10. Does your house have noise insulation?
□ Yes, the house has noise insulation since the building of the house
□ Yes, the house has noise insulation, but it is built later in addition to its own means
□ Yes, the house has noise insulation, but it is fully or partly covered by the noise source operator
□ No, the house has no noise insulation

11. In the light of the answers above, are you generally satisfied with the acoustic quality of your living environment? Please choose one answer:
□ Yes □ No

Information on the respondent

1. Gender: □ Man □ Woman
2. Age: ___
3. Education: □ Primary education □ Secondary education □ Vocational education □ Higher education
4. Name of the populated area you live: _____
5. Is this house your permanent place of residence: □ Yes □ No
6. Your house is in:
□ In the vicinity of the country's main road (an approximate distance from house: ___m)
□ Near the railway line (an approximate distance from house: ___m)
□ In the vicinity of an open-air installation, concert hall (an approximate distance from house: ___m)
□ Near another noise source (please define what source ___; an approximate distance from house: ___m)
7. You live in this house for: ___ years
8. Occupation: □ full time □ part – time □ unemployed □ student □ pensioner
9. Nationality: ___
10. Average monthly income (bruto): ___

ANNEX IV

Methodology of Valmiera study

Governance framework: process and instruments

Governance (policy) cycle – sustainable mobility

1. Problem/situation analysis
2. Policy definition,
3. Planning
4. Programming
5. Process monitoring

Governance instruments – sustainable mobility

1. Political and legislative
2. Planning instruments
3. Administrative and institutional instruments
4. Economic and financial instruments
5. Infrastructure and technical instruments
6. Communication instruments

Part 1 – sustainable mobility research

Document analysis

Sociological surveys:

Questionaires (n=373) on household behaviour in Valmiera

Express **questionaires** with town inhabitants (n=102)

Deep interviews (n=16) with all municipal level stakeholder sectors in Valmiera municipality

1. Non-governmnetal sector	***Mediators***
2. Mass media sector	
3. Education/training sector	
4. Science/proffesional sector	
5. ***State institutions*** *(local/regional level, national level)*	
6. ***Municipality governance sector***	
7. ***Business sector***	
8. ***Households*** (separate set of behavioural interviews; n=10)	

Observation study (cycling infrastructure and communication)

Additional verification on household environmental behavior including mobility: national questionaire (n=1004)

Part 2 – participation study

Step 1
SWOT analysis performed and conclusions from sustainable mobility research and development proposals sent to the municipality with an aim to support the municipality during the preparation stage of the transport strategy (including on noise aspects)

Step 2
Participation in the public hearing, including commenting on the document based on their professional knowledge and conclusions from the previous case studies, including on noise aspects

Step 3
Repeated comments sent to the municipality

Research methodology – complementary approaches and methods of Valmiera case study within Sustinno project (Krūkle *et.al*, 2019)

ANNEX V

Expert interview questions on the Noise prevention council work in Lithuania: expert questionnaire

This questionnaire is designed to gain more information and receive more detailed view to Noise Council work in Lithuania. The information reviewed will be used to base proposal for improvements of Latvian environmental noise management system.

Practical questions on the Noise Council work

Question	What is the legal status of the Noise Council?
Answer	The establishment of the Noise Prevention Council and its duties are defined by the Law on Noise Management. The membership and statute of the Noise Prevention Council is adopted by the decision of the Government. The Minister of Health adopts the personal membership of the Noise Prevention Council.

Question	What are the duties (tasks) of the Noise Council? What documents do they review/analyze?
Answer	According to its statute, the Noise Prevention Council: 1. Annually assess the implementation of the National Strategic Noise Mapping Programme and of the National Noise Prevention Programme and submits its findings to the Government (till 2016-11-01); 2. Draws up reports on the state of the protection of the public against noise pollution, and annually submits these reports to the Government; 3. Considers reports of competent national and municipal institutions on the implementation of noise management measures; 4. Evaluates drafts of the National Noise Prevention Programme (till 2016-11-01) and drafts of strategic noise maps; 5. Submits proposals on noise-related issues to the Government and national and municipal institutions that are responsible for the implementation of the national and municipal noise prevention policy; 6. Analyses and finds agreement regarding noise standards, limits and regulatory documents on the assessment of noise impact on public health; 7. Sets criteria for the selection of priority measures for the implementation of the National Noise Prevention Programme (till 2016-11-01).

Question	What are the topics they discuss over? What are the documents they review/analyze?
Answer	In principle Noise Prevention Council votes on the proposals of regulations on noise limit values, on the drafts of Annual reports on the state of noise management in Lithuania, evaluates process and results of strategic noise mapping, listens to the reports of representatives of competent authorities and makes decisions on particular issues. In addition to the topics mentioned in the answer No. 2, the Noise Prevention Council discussed the following topics: 1. Implementation of the requirements of building noise insulation; 2. Implementation of the noise control of domestic and leisure activities; 3. Noise issues related with the sale of alcohol products near residential buildings or in the stores or public catering establishments, located in the lower flats of multistore residential buildings;

	3. Cooperation between police officers and public health authorities in order to organize noise complaint investigation and carry out noise measurements; 4. Cooperation between authorities to draw strategic noise maps; 5. Projects of noise management related guidelines; 6. Implementation of the Environmental Noise Directive; 7. Issues related with the car alarm noise, noise from motor racing activities, etc.

Question	Are the decisions of the Noise Council binding? What if the decisions of Noise Council are not taken into account?
Answer	The Noise Prevention Council is a collegiate advisory body accountable to the Government of the Republic of Lithuania. In order to encourage implementation of decisions, notes of the meetings can be send to the Government and it can decide on the further actions. Annual reports on the state of noise management in Lithuania with the conclusions and proposals are sent to the government and it can make decisions and ask competent governmental institutions to take specific actions for solving certain issues. As Noise Prevention Council consists of decision makers from various institutions responsible for noise management, it can be assumed, that jointly agreed decisions are mandatory for the institutions where the member of Noise Prevention Council acts as a head.

Question	How often does the Noise Council have meetings? Are the meetings organized on regular base? Are there also extra meetings organized? Under what circumstances / when are those extra meeting organized?
Answer	According to the Statute of the Noise Prevention Council, 4 meetings a year have to be organized. But in practice meetings are organized according to the situation, sometimes one meeting in two years.

Question	How are the documents (noise maps, action plans etc.) analyzed? Is there a particular member assigned that checks the document thoroughly – provides deeper expertise? Do the Noise Council re-check the documentation in case they have provided comments or recommendations?
Answer	The documents for the discussions are disseminated prior to the meetings. During the meeting representative from the responsible authority makes presentation and answers questions. There are no dedicated members, that are responsible for the particular tasks. The representatives from the Ministry of Health (e.g. Executive Secretary of the Council) or from the institution under the Ministry of Health checks completeness of the strategic noise maps or action plans, checks if they meet legal requirements and makes comments during the meeting. If decisions of the Noise Prevention Council are related with the implementation of particular tasks, then after the implementation during the next meeting Noise Prevention Council hears and makes decisions about the implementation.

Question	How many members are in the Noise Council? What institutions do they represent?
Answer	The Noise Prevention Council consist of 25 members: • Vice Minister of Health (Chairman of the Council); • Director of the Health Promotion Department of the Ministry of Health (Deputy Chairman of the Council);

	• Representative of the Health Promotion Department of the Ministry of Health (Executive Secretary of the Council); • Vice Minister of Environment; • Vice Minister of Transport and Communications; • Vice Minister of the Interior; • Vice Minister of Agriculture; • Director of the Environmental Protection Agency; • Representative of the Environmental Centre for Administration and Technologies (ECAT–Lithuania); • Dean of the Faculty of Public Health, the Lithuanian University of Health Sciences; • Director of Kaunas University of Technology, Institute of Environmental Engineering; • President of the Lithuanian Acoustical Society; • Chairman of the Lithuanian Union of Architects; • Chairman of the Lithuanian Union of Hygienists and Epidemiologists; • Director General of the Lithuanian National Radio and Television; • Representative of the Lithuanian Association of Engineering Consulting Companies; • Representative of the Association of Local Authorities in Lithuania; • Representative of the Lithuanian Construction Engineers Union; • Representative of Alexandras Stulginskis University; • Coordinator for Lithuania, the World Health Organization; • National Coordinator, Healthy Cities, the World Health Organization; • Representative of the Ministry of Education and Science; • Director of the public enterprise Road and Transport Research Institute; • Representative of Vilnius Gediminas Technical University; • Director of the Institute of Public Health, Faculty of Medicine of Vilnius University.

Question	What is the structure of the Noise council? How the decisions are taken in the Noise Council?
Answer	The Noise Prevention Council consist of Chairman, Deputy Chairman, Executive Secretary and 22 other members. The Noise Prevention Council takes decisions by simple majority of the members present in the meeting. In the event of a tie vote, the decisive vote is that of the Chairman of the Council or, in his absence, the vote of his Deputy authorized to act as Chairman of the Council, or the vote of any other member appointed by the Chairman. The decision may be accompanied with individual opinions of the Council members.

Impact evaluation of the Noise Council work

Question	How has Noise Council influenced noise policy and its outcomes in Lithuania (for example, regarding noise action plans and mapping, legislation etc.)? Please mention good practice examples/success stories (if possible).
Answer	The Noise Prevention Council helps to encourage competent authorities to prepare strategic noise maps and action plans. The joint decision on noise limit values shares the responsibility in case of consequences or criticism of new noise limit values adopted.

Question	What could be considered as weak points regarding Noise Council? Have there been any dispute situations and situations where Noise Council should have acted differently (from today's perspective)? Please give an example.
Answer	Since the beginning of the work of Noise Prevention Council, the noise limit values were raised and became non-health based.

Question	Are there any comments received on Noise council work from public bodies, social partners, parliament, etc.? And what are the opinions about Noise Council?
Answer	Noise Prevention Council was recognized as a good administrative / political instrument by the EU FP6 funded project ProNET (Pollution Reduction Options NETwork. No other comments are known. In general Noise Prevention Council is advertised as a good example of interinstitutional collaboration.

Question	Are there any improvements / changes planned regarding the noise Council work (changes in duties, structure etc.)?
Answer	The membership and statute of Noise Prevention Council (governmental decision) is under revision. It is planned to update membership of Noise Prevention Council according to the attendance of meetings. It is proposed to include in to the council new representatives of National Public Health Surveillance Laboratory and State Service for Protected Areas under the Ministry of Environment. It is proposed instead of coordinator of WHO initiative "Healthy Cities" include into the Noise Prevention Council representative of Association of Public Health Bureaus of Municipalities. It is proposed to ament Statute of Noise Prevention council and incorporate requirements for the declaration of interests, requirements for the participation in the meetings and in the process of decision making in case of conflict of interest. The amendment includes improvements in the duties and tasks of Executive Secretary of the Council, includes terms for the organization of the meetings of Noise Prevention Council and the adoption of minutes. It is foreseen to include possibility of the written procedure of decision making.

Question	What suggestions/ recommendations you could give, if other counties would be willing to adopt the idea of Noise Council?
Answer	It might be considered an option to differentiate members of formation like Noise Prevention Council and establish internal group of true noise experts to provide advises and proposals on technical issues to support other members of political level. If the country is lacking of noise expert networks like Noise Abatement Society in UK or *Nederlandse Stichting Geluidshinder* in the Netherlands, then it might be considered to focus work of Noise Prevention Council on the promotion and raising awareness on noise pollution issues and possible solutions in public and on the political agenda (organize press conferences, debates, etc.). In order to ensure proper work of the formation like Noise Prevention Council and ensure implementation of its decisions, the host authority should assign dedicated personnel.

Other questions

Question	What changes (if any) are planned in existing noise management system in Lithuania?
Answer	In year 2012 The National Audit Office of Lithuania prepared report on environmental noise management in Lithuania. It was proposed to amend the Law on Noise Management and designate the Ministry, responsible for the forming of noise prevention policy at the state level, organizing, coordinating and controlling its implementation. Supreme audit institution proposed to amend the Law on Noise Management and define requirements for the noise action plans, prepare new governmental decision on the construction noise control. More detailed information on noise legislation changes is provided in further answers.

Question	What changes (if any) are planned in existing noise management legislation in Lithuania?
Answer	The Law on Noise Management was recently amended and according to changes that will enter into the force on 2016-11-01, majority of legal acts in the field of environmental noise management will have to be revised, particularly in the area of strategic noise mapping, action planning, reporting and new ones will have to be prepared (e.g. governmental decision on the noise strategic mapping and action planning). The provisions of the adoption of the National Strategic Noise Mapping Programme and of the National Noise Prevention Programme were repealed, inconsistencies of the transposition of the Environmental Noise Directive were solved. Major changes in the field of the strategic noise mapping are related with the assignment of the responsibilities of the strategic noise mapping of the major roads and railways within agglomerations. With the help of the amendment of the Law on Noise Management the absence of the requirements of noise action planning was solved. The Law on Noise Management will introduce deadlines for the preparation and adoption of strategic noise maps and action plans, define competent authorities, introduce provisions on the preservation of quiet areas within agglomerations. Bylaws will have to set more detailed requirements for the implementation of noise reduction measures, transpose Annex V of the Directive 2002/49/EC on the requirements for the contents of noise action plans, requirements for consultations with public, cooperation with neighbouring countries, etc. The Ministry of Health is assigned responsible for the forming of noise prevention policy at the state level, organizing, coordinating and controlling its implementation. The project of ministerial order on the adoption of low frequency noise limit values is planned for the submission to notify to the EC and other Member States. Ministerial order on the adoption of noise limit values is under revision too.

ANNEX VI

Brief summaries of the expert interviews
(except of one from Lithuanian Ministry of Health that is added in Annex V)

Institution	State Health Inspectorate
Main questions	How are the compliance with the legislation and rules of the operational permit, including, environmental noise levels, monitored? What is the procedure for handling environmental noise complaints? How many and what cases of environmental noise legislation violation there have been in last two years? What is your opinion on improved environmental noise management process scheme (that are presented to the interviewee by the author).
Date	28.08.2012.; 25.04.2017.
Summary of findings from interview (in English)	Environmental noise issues are dealt with by the Health Inspectorate when complaints are received. No pre-planned or regular inspections or independent monitoring of environmental noise levels are performed. When a complaint is received, it is assigned to the responsible inspector who, performs an on-the-site inspection and on the basis of his experience, assesses whether there is a potential for environmental noise limit violations. In cases where the inspector considers that there may be violations of the environmental noise limits, certified measurements (by a certified laboratory) are carried out. If a maximal permitted noise limit value is exceeded, the company are required to fix the situation and submit to the Inspectorate the measurement protocol from a certified laboratory in a particular period of time

Institution	State Environmental Bureau
Main questions	How would you evaluate the quality of environmental noise level forecasts and modelling in the EIA process? Has it improved over time? What is your opinion on improved environmental noise management process scheme (that are presented to the interviewee by the author)?
Date	08.04.2019.
Summary of findings from interview (in English)	The quality of EIA process, including, environmental noise modelling and forecasting has improved a lot in comparison to the first forecast in early 2000-ties. The legislative requirements are more explicate now, and the practice has developed over time. The bureau also hires experts for evaluation of the EIA reports in cases where the planned potential environmental impacts could be high. The idea on checking the real situation before the start of the operation of the object would be beneficial - it would help to ensure accordant operation of the object and this could also help for the evaluation of other objects. The State Environmental Bureau agrees with the proposal on noise level checking for the objects with possibly high noise levels, and in 2019 such requirement was included in the legal opinion of the EIA review on Zemgale wind park.

Institution	State Environmental Service
Main questions	How do you check the fulfillment of the permit requirements in regard to the environmental noise?
Date	27.02.2017.
Summary of findings from interview (in English)	Compliance with environmental noise legislation is checked by the Health Inspectorate. Environmental Service inspectors in case there is a suspicion of the violation of rules set in the permit regarding environmental noise levels, informs Health inspectorate.

Institution	Valmiera municipality
Main questions	Are environmental noise problems topical for Valmiera municipality? What actions municipality undertakes to reduce or prevent the environmental noise pollution? What are main issues regarding sustainable transport sector of the town and how is pollution management ensured? What actions are planned in this regard? What is your opinion on improved environmental noise management process scheme (that are presented to the interviewee by the author)?
Date	25.04.2017.
Summary of findings from interview (in English)	Environmental noise is not the most topical problem at Valmiera municipality; therefore, it is not for the high priority of the municipality. There could be additional documents and guidelines, however, we consider it that municipalities should not be overregulated and the administrative burden due to new documents cannot be raised. Main transport problematic is related to parking lots – this is what our residents want. The cycling infrastructure should be developed. Possibly, also helicopter landing place should be made. There is a good connection with Rīga (busses and trains). Internal bus lines are made according to the residential claims, which we are trying to take into account.

Institution	Ogre municipality
Main questions	Are environmental noise problems topical for Ogre municipality? What actions the municipality undertakes to reduce or prevents the environmental noise pollution? What is your opinion on improved environmental noise management process scheme (that are presented to the interviewee by the author)?
Date	12.12.2017.
Summary of findings from interview (in English)	Most environmental noise problems are related to transport sector and Ogre open-air concert hall; however, regarding the latest, municipality in recent years have changed the concert organization process in order to reduce complaints from inhabitants. This includes the time restriction for fire-works and also reduction of number of concerts organized in the hall. There is also a technical solution developed on how to reduce noise from the concert hall. Regarding road noise municipality has a problem with a span of the major road A4 Rīga – Daugavpils, as the span is an asset of the municipality, and therefore Ministry of Transport (in particular its subsidiary company Latvian State Roads) refuse to provide environmental noise maps and action plan for this span. Therefore, Ogre town currently do not have noise mapping and action plan. Municipality is considering to prepare it. There is also idea to put impose a road charge to get income to build noise abatement walls, prepare noise mapping and ensure road operation.

	Proposals for environmental noise management process could be implemented, but there should be national noise mapping for major roads done unitedly and not to overload municipal budgets with additions expenses.

Institution	Rīga municipality
Main questions	Are environmental noise problems topical for Rīga municipality? What actions the municipality undertakes to reduce or prevents the environmental noise pollution? What improvements in the sector are necessary? Guidelines for municipalities in environmental noise management sector, main PhD findings.
Date	12.10.2015.
Summary of findings from interview (in English)	Rīga municipality fulfills all its tasks, that are required by the law. Rīga has prepared environmental noise mapping and action planning. However, it must be admitted that implementation of the noise abatement activities is rather expensive. Therefore, it is crucial importance to plan measures. Rīga municipality actively participates also in legislative processes, providing comments on the technical and administrative issues and proposals from the municipal view. Rīga municipality considers that technical knowledge of officials should be considerably improved. Proposals for environmental noise management process could be practically implemented and useful.

Institution	Latvian Railway
Main questions	Noise management and its deficiencies regarding railway noise in Latvia. Opinion of main PhD findings, environmental noise model and possibility to practically implement proposals.
Date	10.09.2013., 03.03.2015.; 17.04.2017.
Summary of findings from interview (in English)	Latvian railway several times a year receives inhabitant complains on railway noise. Some complains are from newly residential buildings. In these cases, the principle of firstcomer should be observed – is it the railway or the residential building. If the building was constructed after the construction of railway, it should have respected the noise source. In meantime Railway considers that noise reduction measures for areas built before 2004 (when national noise legislation was accepted), can be as responsibility of Latvian Railway, but in territories built after 2004 anti-noise solutions are to be found in close cooperation with the relevant municipalities, agreeing on the technical and economic feasibility and possible solutions. There should be more cleared regulation on environmental noise mapping – according to the legislation – the environmental noise mapping should be done by the ministry of Transport; however, in the practice environmental noise mapping is done by Latvian Railway. At the first rounds of environmental noise mapping there were financial issues on how to ensure mapping, as well as on the responsible party of the mapping regarding railways within environmental noise agglomerations. The environmental noise policy is much influenced by the fact that most trains / cargos come from non-EU countries, therefore Technical Specifications for Interoperability are not applied. There are no environmental noise permanent monitoring stations; however, the company has established cooperation with Rīga Technical university on researches, including environmental noise.

Institution	Latvian Acoustic association, Rīga Technical university.
Main questions	Main deficiencies regarding railway noise management in Latvia. Opinion of main PhD findings, environmental noise model and possibility to practically implement proposals.
Date	10.08.2017.
Summary of findings from interview (in English)	The environmental noise policy is much influenced by the fact that most trains / cargos come from non-EU countries, therefore Technical Specifications for Interoperability are not applied. There are several operational / technical issues of railway tracks and applied methods (track molding, spaces between tracks), administratively – technical issues (the composition of train car chain), as well as appliance of the RMR method (that is set in Latvian national legislation) that is designed for 1400 mm railway and not for 1520 railway. This can also be regarding the use of CNOSSOS system, that is not adopted for 1520 mm railway. Believes that model could be practically implemented. There should be both technical improvements and political will regarding the implementation.

Institution	Head of Environmental protection department of the Ministry of Environmental protection and regional development
Main questions	Are environmental noise problems topical in Latvia? What are main problems? What are the main improvements in the sector necessary? Opinion of main PhD findings, environmental noise model and possibility to practically implement proposals.
Date	05.08.2018.
Summary of findings from interview (in English)	Environmental noise according to the legislation is environmental pollution; however, there is insufficient data on its harmful impact on people. The legislation and policy processes are much influenced by different (conflicting) interests from different stakeholders – companies prefer noise limit values to be higher due to limitation influence on their business (for instance, national transportation companies), however, inhabitants may complain on noise. Despite the fact that some complaints are reasonable, there are also unreasonable complaints, when complains are handed in only because of complaining purpose (for instance, one of recent cases was a complaint on Biķernieki motorsport track noise - when the company offered noise abatement wall, inhabitants did not want that either because it would screen not only noise but also the view to trace). The proposed changes in legislation and policy planning and implementation processes can be practically implemented and would be of help in improving the situation. The idea of Noise prevention council is particularly considerable and could be implemented, especially, if it is used successfully in other countries. MoEPRD agrees that there should be a possibility for further cooperation with the State Health Inspectorate units and municipalities, including in sharing equipment for noise management, for instance in planning region framework.

Institution	NGO Resilience that implements environmental and social projects, including on environmental noise
Main questions	Opinion of main PhD findings, environmental noise model and possibility to practically implement proposals.
Date	06.01.2018.
Summary of findings from interview (in English)	The NGO has implemented several projects in the sector of environmental management, including on noise. There has been a project on soundscape approach in Rīga, where we asked respondents to identified sound-paths and then we compared with noise maps. We recommended that from residents' point of view more attention in action planning should be paid to the issues of noise education and communication, traffic flow planning and impact monitoring. Environmental noise model also foresees these recommendations; therefore, we think it would be a good practice and could be improve acoustic situation in towns and cities.

Institution	The Latvian Association of Local Governments
Main questions	Opinion of main PhD findings, environmental noise model and possibility to practically implement proposals.
Date	17.04.2017.
Summary of findings from interview (in English)	The Latvian Association of Local Governments believe that there should not be specified guidelines, documents, councils, etc. on one particular environmental issue. There should be integrative guidelines, documents, council on whole environmental field rather than sector – specific. Noise aspects should be integrated in development planning documents, guidelines, etc. In meantime guidance is preferred over legislative acts, and as there is a lack of guidance for municipalities developed in Latvia in general and also noise aspects are rarely properly integrated. The Latvian Association of Local Governments and the MoEPRD agree that there should be a possibility for further cooperation with the State Health Inspectorate units and municipalities, including in sharing equipment for noise management. The State Health Inspectorate proposes the option to have the measurements after the object has started to operate to be carried out by the developer and to have the mandatory task to submit the testing results to the State Health Inspectorate for evaluation. This proposal has been included in the process scheme update. In addition to the interviews mentioned above, in order to see how to implement the best practice approach, the information from of Lithuania's Ministry of Health was gathered on how the Noise Prevention council works. The information was taken into account when developing the environmental noise management model for Latvia and the respective schemes. The interviewed experts, in general, agreed with the proposal environmental noise management model that is offered in this PhD thesis and described in the chapters above. Expert interviews allowed concluding that the processes and their improvement would be practically implemented and they could improve noise management in Latvia.

Institution	Public health specialist, lead researcher, at Rīga Stradiņš University, Safety, and Environmental Health Institute
Main questions	Opinion of main PhD findings, environmental noise model and possibility to practically implement proposals.
Date	12.06.2017.
Summary of findings from interview (in English)	Researches show that environmental noise is impacting people health, therefore it is of importance to find solutions to reduce and mainly – prevent noise. Therefore, noise management model would be of use for Latvia, especially, if we can use best practices from other countries. A lot is done in the UK, therefore, practice approbation on practice codes and guidelines would be very useful.

ANNEX VII

Information on the respondents – Grobiņa un Vērgale case study

Gender, age, number of respondents / Category	Males							Females						
	Age						Total number of respondents	Age						Total number of respondents
	15-24	25-34	35-44	45-54	55-64	65-77		15-24	25-34	35-44	45-54	55-64	65-77	
Number of respondents (n=24)	0	1	3	2	2	1	9	1	2	3	4	3	2	15
Level of education														
Primary	0	0	1	0	0	0	1	0	0	0	1	1	0	2
Secondary	0	1	1	1	0	0	3	0	0	1	2	0	0	3
Vocational	0	0	1	0	1	1	3	1	1	1	0	1	1	5
University	0	0	0	1	1	0	2	0	1	1	1	1	1	5
Monthly income per person														
>500 euro bruto	0	0	0	0	0	1	1	0	0	0	0	0	1	1
500-1000 euro bruto	0	1	1	0	1	0	3	0	0	1	1	1	1	4
>1000 euro bruto	0	0	2	2	1	0	5	1	2	2	3	2	0	10
Nationality														
Latvian	0	1	2	2	2	1	7	1	2	2	3	2	2	12
Russian	0	0	1	0	0	0	1	0	0	1	0	1	0	2
Other	0	0	0	0	1	0	1	0	0	0	1	0	0	1
Occupation														
Fulltime employed	0	1	2	1	1	0	5	1	2	3	3	1	0	10
Part-time employed	0	0	0	1	0	0	1	0	0	1	0	1	0	2
Unemployed	0	0	1	0	1	0	2	0	0	0	1	1	0	2
Student	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pensioner	0	0	0	0	0	1	1	0	0	0	0	0	1	1

ANNEX VIII

Information on the respondents - Saulkrasti case study

Gender, age, number of respondents / Category	Males							Females						
	Age						Total number of respondents	Age						Total number of respondents
	15-24	25-34	35-44	45-54	55-64	65-77		15-24	25-34	35-44	45-54	55-64	65-77	
Number of respondents (n=37)	0	2	4	6	4	1	17	1	2	7	5	3	2	20
Level of education														
Primary	0	0	0	1	0	1	2	1	0	0	2	0	0	3
Secondary	0	1	1	1	1	0	4	0	0	2	1	0	0	2
Vocational	0	0	1	3	2	0	6	0	1	2	1	2	1	7
University	0	1	2	1	1	0	5	0	1	3	2	1	1	8
Monthly income per person (euro, bruto)														
>500	0	0	0	1	1	1	4	1	0	1	1	0	1	4
500-1000	0	1	2	2	2	0	7	0	1	2	2	1	1	7
>1000	0	1	2	3	1	0	7	0	1	4	2	2	0	9
Nationality														
Latvian	0	1	1	3	3	1	9	0	2	3	3	2	1	11
Russian	0	1	3	2	1	0	7	0	0	3	2	0	1	6
Other	0	0	0	1	0	0	1	1	0	1	0	1	0	3
Occupation														
Fulltime employed	0	1	4	4	1	0	10	0	1	5	4	1	0	11
Part-time employed	0	0	0	1	1	0	2	0	0	1	0	1	0	2
Unemployed	0	0	0	1	1	0	2	0	0	1	1	0	0	2
Student	0	1	0	0	0	0	1	1	1	0	0	0	0	2
Pensioner	0	0	0	0	1	1	2	0	0	0	0	1	2	3

ANNEX IX

The main noise management legislative acts in the Baltic States (created by the Author)

Scope	Estonia	Latvia	Lithuania
General requirements for environmental noise management	Ambient air protection act	Law on pollution	Law on noise control
Noise levels	Normal levels of noise in residential and recreational, residential and public use in buildings and noise measurement methods	Process of environmental noise assessment and management	Hygienic standard HN 33:2011 on noise levels in residential and public buildings and their surroundings
		Regulation on noise in a residential and public buildings	
Requirements on noise emissions created by equipment used outdoors	Regulation on noise emissions created by equipment used outdoors, measurements of their noise levels, and procedures for conformity assessment	Regulation on noise emissions created by equipment used outdoors	*Requirements included in* the ambient air protection act
Noise from vehicles	Regulation on motor vehicle noise pollution emissions limit values	Regulation on vehicle safety	Regulation on engine noise limit values and their measurement procedures
		Regulation on vehicle technical inspection and control on the road	Regulation on vehicles and their parts certification procedures
			Regulation on the maintenance of tractors and farm machines
Pollution control	*Regulation included in* the ambient air protection act	Regulation on the application and issue of A, B, C category licenses	Regulation on the confirmation of the reports prepared by noise source managers, which hold a hygienic license
Others (but not limited to those which are mentioned in this table)	Public health act	Regulation on building acoustics	Regulation on information supply for the EC about noise management
	Regulation on building sound insulation requirements for protection against noise		Regulation on noise assessment and noise reduction control procedures

LATVIJAS UNIVERSITĀTE
Ģeogrāfijas un Zemes zinātņu fakultāte

Zanda Krūkle

VIDES TROKŠŅA PĀRVALDĪBA LATVIJĀ

Promocijas darba kopsavilkums

zinātniskā doktora grāda - zinātnes doktores (*Ph.D.*)
zemes zinātnēs, fiziskajā ģeogrāfijā, vides zinātnēs - iegūšanai

Rīga, 2020

Promocijas darbs izstrādāts Latvijas Universitātes Ģeogrāfijas un Zemes zinātņu fakultātē, Vides zinātnes nodaļā laika posmā no 2010. līdz 2020. gadam.

Darbs sastāv no ievada, 9 nodaļām, literatūras saraksta un 9 pielikumiem.

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Anotācija

Vides troksnis ir būtisks vides piesārņotājs, kas ietekmē daudzu eiropiešu ikdienu, kas rada dažādas veselības un starpdisciplināras ietekmes. Daudzos pētījumos ir atklāti pierādījumi, ka paaugstināts trokšņa līmenis rada negatīvu ietekmi uz cilvēka veselību gan fizioloģiski, gan psiholoģiski, traucējot, piemēram, miegam, atpūtai un komunikācijai. Pasaules Veselības organizācija (turpmāk – PVO) ir ieteikusi ierobežot nakts trokšņus uz L_{nakts} 40 dBA ārpus telpām, tomēr, ņemot vērā pieaugušu transporta plūsmas tendenci, uzņēmumu darbības un infrastruktūru paplašināšanu, šāda trokšņa līmeņa nodrošināšana nav viegls uzdevums.

Promocijas darbā tiek pētīti iespējamie risinājumi, kā novērst un samazināt vides troksni, analizējot vides trokšņa pārvaldības praksi Eiropā un Latvijā. Šīs doktora disertācijas mērķis ir izpētīt vides trokšņa pārvaldības problēmjautājumus un izstrādāt stratēģisku, praksē bāzētu vides trokšņa pārvaldības modeli Latvijai, kas pirms šī pētījuma nav ticis darīts. Lai sasniegtu mērķi, ir noteikti vairāki pētījumu uzdevumi, tostarp vides trokšņa likumdošanas, institucionālās sistēmas un sabiedrības atgriezeniskās saites pārvaldības un tās prakses analīze Eiropā un Latvijā, kā arī pārvaldības galveno trūkumu identifikācija un izpēte. Šim nolūkam ir izmantota empīrisko un statistisko datu analīze, dokumentācijas analīze, socioloģiskie pētījumi (intervijas un anketēšana), gadījumu izpētes metodes, kas ietver gan akustisko, gan neakustisko aspektu analīzi.

Rezultāti parāda, ka vides trokšņa pārvaldības nepilnības Latvijā galvenokārt saistītas ar augstu subjektīvo trokšņa uztveri, nepietiekamu sabiedrības izpratni par vides troksni, zemu prioritāšu noteikšanu un neefektīvu esošās trokšņa pārvaldības politikas ieviešanu un uzraudzību. Ņemot vērā izpētīto, ir izstrādāts integrēts, daudzlīmeņu un praksē bāzēts vides trokšņa pārvaldības modelis. Modelis ietver procesa apakšmodeļus valsts un pašvaldību līmenī un koordinācijas apakšmodeli, kā arī ņem vērā identificēto labo praksi un ierosina uzlabojumus pašreizējos pārvaldības procesos. Modeļa priekšlikumi ir aprobēti ar nozares speciālistiem un valsts un pašvaldību līmeņa ekspertiem.

Promocijas darbs sniedz zinātnisku un praktisku pienesumu vides trokšņa pārvaldības jomā. Iegūtie rezultāti papildina un atjaunina zināšanas par teorētisko un praktisko vides trokšņa pārvaldību, kā arī sniedz priekšlikumus, kas var veicināt efektīvu, koordinētu, integratīvu un jēgpilnu pārvaldības attīstību. Ievērojot to, ka izstrādātais modelis un rekomendācijas ir praksē bāzētas un aprobētas pie ekspertiem, pētījuma rezultātus var ieviest praksē. Pētījums var kalpot par piemēru situācijas analīzei un pārvaldības uzlabojumu rekomendācijām arī citās Eiropas valstīs, kas vēlas attīstīt vides trokšņa pārvaldību ātrākā tempā.

Atslēgvārdi: vides troksnis, Latvija, pārvaldība, praksē bāzēts modelis

Satura rādītājs

Ievads

Pētniecības aktualitāte

Termins "vides troksnis" tiek lietots, lai apzīmētu trokšņa emisiju, kas radusies āra vidē. Vides troksnis, kura galvenie avoti ir transports, ražošana, kā arī dažādas sabiedrības aktivitātes, šobrīd kļūst par vienu no galvenajiem vides piesārņojuma veidiem. Transporta troksnis saskaņā ar Eiropas vides aģentūras (turpmāk – EVA) datiem (2019) tiek ierindots kā otrs būtiskākais vides piesārņotājs, kuram ir nozīmīga ietekme uz sabiedrības veselību. Pie tam, trokšņa ietekmei Eiropā ir tendence pieaugt, salīdzinot ar citiem vides piesārņotājiem (piemēram, sekundārajiem dūmiem, dioksīniem un benzolam) (Kephalopoulos *et al.,* 2016).

Vides trokšņa ietekmes efekti cieši korelē ar dzīves kvalitāti attiecībā uz iedzīvotāju fizisko un psiholoģisko veselību, teritorijas sociālajiem un ekonomiskajiem aspektiem, kā arī kopējo labklājību. Troksnis var izraisīt saslimšanu, diskomfortu, aizkaitinājumu, kā arī apgrūtināt komunikāciju. Tomēr visbūtiskāk troksnis ietekmē miega režīmu. Tāpēc PVO rekomendē, ka āra vides trokšņa mērķa vērtība nedrīkstētu pārsniegt 40 dB vidēji gada laikā (WHO, 2009). Eiropas Komisijas aprēķini liecina, ka 34 miljoni cilvēku var tikt pakļauti ilgtermiņa ceļu satiksmes troksnim, kas nakts laikā pārsniedz 50 dB (Eiropas Komisija, 2016). Savukārt Eiropas Savienības (turpmāk – ES) tiesiskais regulējums pieprasa vides trokšņa samazināšanas darbību plānošanu teritorijās, kur vides troksnis pārsniedz 50 dB nakts laikā un 55 dB dienas laikā (Directive 2002/49/EC, 2002). Strauja urbanizācija, industrializācija un pieaugošs transporta lietojums ir galvenie faktori, kas rada trokšņa radītās ietekmes negatīvo efektu palielināšanos īpaši attīstības valstīs (Schwela *et al.,* 2011).

Sākotnēji vides troksnis tika galvenokārt uzskatīts par pilsētvides problēmu. Ir novērtēts, ka aptuveni 40% iedzīvotāju, kuri dzīvo lielākajās ES27 pilsētās, var tikt pakļauti ilgtermiņa ceļu satiksmes troksnim, kas pārsniedz 55 dB āra vidē. Tomēr uzņēmējdarbības un infrastruktūras attīstība (piemēram, ceļu infrastruktūra un ražošana) ir kritisks faktors, kādēļ trokšņa līmenis palielinās arī ārpus pilsētām. ES līmeņa vides trokšņa kartēšanas dati (EVA, 2015) parāda, ka trokšņa līmenim L_{den} virs 50 dB ir pakļauti vairāk kā 84 miljonu iedzīvotāju aglomerācijās (teritorijas daļa, kurā ir vairāk nekā 100 000 iedzīvotāju un tāds iedzīvotāju blīvums, ka ES dalībvalsts to uzskata par urbanizētu teritoriju), bet ārpus tām – 38 miljoni iedzīvotāju. Jāatzīmē, ka nelielas piepilsētas bieži ir dzīvesvieta cilvēkiem, kuri ikdienā strādā lielās pilsētās un vēlas pavadīt laiku ārpus tās trokšņainās vides. Eiropā nav veikti daudz pētījumi par vides trokšņa pārvaldību mazpilsētās un ciemos, kaut arī šie ir dominējošie apdzīvoto vietu veidi Latvijā un vairākās citās ES valstīs.

Ievērojot augstāk minētos faktorus, ir nepieciešams rast visaptverošu un starpnozaru integrējošu vides trokšņa pārvaldības pieeju, lai mazinātu trokšņa ietekmi visefektīvākajā veidā. Tas būtu jāveic, ņemot vērā citur izmantotās labās prakses pieredzi un datus par sociālo, ekonomisko un vides dimensiju un to integrācijas aspektiem, kā arī plānošanas un attīstības perspektīvas. Efektīvai trokšņa pārvaldībai būtu jāaptver gan akustiskie, gan neakustiskie faktori, jo trokšņa akustiskās īpašības var izskaidrot tikai ar aptuveni vienu trešdaļu trokšņa radītā kairinājuma (Suau-Sanchez *et al.,* 2011; Guski, 1999).

Atbilstoša un pilnvērtīga vides trokšņa pārvaldība, kas nodrošina nekaitīgu un veselīgu akustisko vidi, novēršot un samazinot trokšņa negatīvos efektus, ir nozīmīga veselīgas un pilnvērtīgas dzīves vides radīšanai. Lai tā būtu efektīva, trokšņa politikas veidošanai jābūt plašai un jānotiek dažādos pārvaldības līmeņos – starptautiskā, valsts un vietējā līmenī (Murphy & King, 2010). Saskaņotas trokšņa pārvaldības politikas attīstība dažādos līmeņos un starpnozaru un starpdisciplīnu pieejas piemērošana ļaus labāk koordinēt trokšņa novēršanas un mazināšanas pasākumus un līdz ar to izveidot labākas trokšņa pārvaldības pieejas katrā valstī (Murphy & King, 2010).

Tikmēr pētījumi par vides trokšņa pārvaldību dažādos pārvaldības līmeņos ir parādījuši nepilnības vides trokšņa pārvaldībā gan valsts, gan pašvaldību līmenī. Papildu pētījumi par trokšņa pārvaldības stāvokli, kuri veikti tā sauktajās "Austrumu paplašināšanās valstīs" (ES dalībvalstīs (Čehijā, Igaunijā, Ungārijā, Latvijā, Lietuvā, Polijā, Slovākijā, Slovēnijā, Bulgārijā, Rumānijā, kā arī Kiprā un Maltā), kas 2004. – 2007.gadā pievienojās ES piektās un sestās paplašināšanās laikā; turpmāk – Austrumu paplašināšanās valstis) ir atklājuši, ka, salīdzinot ar tām ES valstīm, kur vides trokšņa pārvaldības politika ir attīstījusies pakāpeniski un

sistemātiski vairāku dekāžu laikā, Austrumu paplašināšanās valstīs vides trokšņa pārvaldības attīstībā ir novērojamas nepilnības, īpaši saistībā ar trokšņa novērtēšanu un tās kvalitāti.

Autores iepriekšējie pētījumi par šo tēmu (piemēram, maģistra darbs un zinātniskās publikācijas) ir parādījuši, ka trūkst atbilstošas, efektīvas un iedarbīgas trokšņa pārvaldības gan pašvaldību, gan valsts līmenī. Uz to norāda arī Eiropas līmeņa vides trokšņa kartēšanas dati (EEA, 2019), saskaņā ar kuriem Rīga ir viena no trokšņainākajām aglomerācijām Eiropā, tostarp attiecībā uz iedzīvotāju īpatsvaru, kas pakļauti augstam trokšņa līmenim dienā (vairāk kā 70 dBA). Latvijā ir bijusi arī negatīva sabiedrības reakcija un sūdzības par vides trokšņa jautājumiem, kā arī sabiedrība vairākas lietas ir virzījusi izskatīšanai tiesu instancēs.

Latvijā līdz šim nav veikti visaptveroši un integratīvi pētījumi par trokšņa (kā vides piesārņojuma veida) pārvaldību ne pašvaldību, ne valsts līmenī, tostarp par politikas plānošanu un faktisko problēmu analīzi, transporta un industriālo trokšņa avotu attīstību, ievērojot akustiskos un neakustiskos aspektus.

Ņemot vērā minēto, doktora disertācijas ietvaros tiek plānots izstrādāt praksē balstītu Latvijas vides trokšņu pārvaldības modeli, kas varētu būt praktiski pielietojams vides trokšņa politikas veidošanā, ieviešanā un pārskatīšanā. Tā kā Latvijai ir nepieciešams ātrā tempā attīstīt vides trokšņa pārvaldību, vides trokšņa pārvaldības modeļa pamatā jābūt analīzei gan par vides trokšņa pārvaldības praksi gan Latvijā, gan citās ES dalībvalstīs, īpaši ņemot vērā labo praksi un to valstu pieredzi, kurām ir līdzīga pārvaldības attīstības pakāpe (piemēram, kaimiņvalstīm un citām Austrumu paplašināšanās valstīm).. Šī prakses analīze var parādīt efektīvus veidus, kā īsā laika posmā attīstīt trokšņa pārvaldību. Tikmēr teorētiskajā daļā ir analizēta arī vispārējā trokšņa pārvaldības prakse Lielbritānijā un Nīderlandē – valstīs, kuras pirmās Eiropā jau piecas desmitgades ir attīstījušas trokšņa pārvaldību un sasniegušas labus rezultātus.

Mērķis un uzdevumi

Šīs doktora disertācijas mērķis ir izpētīt vides trokšņa pārvaldības problēmjautājumus un izstrādāt stratēģisku, praksē bāzētu vides trokšņa pārvaldības modeli Latvijai.

Šīs doktora disertācijas uzdevumi ir:

1. Pierādīt vides trokšņa pārvaldības uzlabošanas nepieciešamību dažādos pārvaldības līmeņos, pamatojoties uz teorētiskiem pētījumiem par vides troksni kā vides piesārņojumu.
2. Analizēt izveidoto likumdošanas, institucionālo un sabiedrības atgriezeniskās saites pārvaldības ietvaru vides trokšņa jomā Eiropā un Latvijā.
3. Izpētīt un analizēt vides trokšņa pārvaldības problēmsituācijas Latvijā, lai novērtētu vides trokšņa pārvaldību no empīriskā un neakustiskā viedokļa pamatā izmantojot daudzlīmeņu pārvaldības pieeju.
4. Izstrādāt praksē balstītu vides trokšņa pārvaldības modeli Latvijai, balstoties uz veiktajiem pētījumiem, iekļaujot priekšlikumus vides trokšņa pārvaldības procesu uzlabošanai Latvijā.

Hipotēze

Vides trokšņa pārvaldību Latvijā var attīstīt:

- Izpētot un izmantojot ES valstīs izmantoto paraugpraksi vides trokšņa pārvaldībā;
- Novērtējot un risinot nacionālā un vietējā līmeņa vides trokšņa pārvaldības nepilnības;
- Izstrādājot praksē balstītu, integratīvu trokšņa pārvaldības modeli, kas sastāv no diviem galvenajiem komponentiem – kompleksa procesa apakšmodeļa, kas raksturo horizontālo trokšņu pārvaldību gan valsts, gan pašvaldību līmenī, un vertikālās integrācijas koordinācijas apakšmodeļa.

Tēžu ietvars un struktūra

Šī doktora disertācija sastāv no četrām galvenajām daļām, kas ietver teorētisko aspektu analīzi, pētījumu metodoloģijas un metožu aprakstu, pētījumu rezultātus un to apspriešanu, kā arī priekšlikumus vides trokšņa

pārvaldības modelim un tā aprobāciju. Tēzes satur 174 lapas, ieskaitot 41 ilustrāciju, 22 tabulas, 9 pielikumus un atsauču sarakstu ar 144 literatūras avotiem.

Promocijas pētījuma ietvaros vides troksnis tiek analizēts kā vides piesārņojuma pārvaldības jautājums. Šajā doktora disertācijā vides trokšņa jēdziens tiek saprasts un pētīts Eiropas Parlamenta un Padomes 2002.gada 25.jūnija Direktīvu 2002/49/EK par vides trokšņa novērtēšanu un pārvaldību (turpmāk – Direktīva 2002/49/EK) kontekstā, jo tā nosaka obligātās prasības ES dalībvalstīm attiecībā uz trokšņa pārvaldību un galvenokārt pievēršas pastāvīgajam troksnim, kas rada nepārtrauktu nelabvēlīgu ietekmi uz veselību. Doktora disertācija detalizēti neaplūko sadzīves un izklaides trokšņus, kā arī troksni no militārās darbības un trauksmes signāliem. Tās tvērumā nav iekļauti iekštelpu trokšņa un ēkas akustisko aspektu pētījumi, kā arī infraskaņas, ultraskaņas un vibrācijas jautājumi. Doktora disertācijā vides trokšņa jautājumi netiek apskatīti no privāto uzņēmumu biznesa viedokļa, kā arī netiek pētīta ietekme uz dzīvniekiem un konkrēti tehniskie risinājumi.

Metodoloģija un metodes

Lai sasniegtu promocijas darba mērķi un izpildītu uzdevumus, Autore izmanto dokumentācijas analīzes metodi, gadījumu pētījumus un socioloģiskos aptaujas, veic empīrisko, socioloģisko un statistikas datu analīzi, kā arī izmanto procesu modelēšanas tehniku, lai izstrādātu vides trokšņa pārvaldības modeli.

Pētījuma ietvaros Autore analizē tiesību aktus par vides trokšņa pārvaldību un institucionālo sistēmu, trokšņa politikas plānošanas praksi, praktiskos trokšņa pārvaldības gadījumus, kā arī sabiedrības atgriezeniskās saites. Šajos Autores pētījumos iekļauta Latvijas un Baltijas valstu tiesību aktu analīze un Austrumu paplašināšanās valstu institucionālo sistēmu salīdzinājums, lai novērtētu to atbilstību ES direktīvām, konstatētu nepilnības un identificētu citu valstu labās prakses piemērus, kā arī aprakstītu vienotu trokšņa pārvaldības institucionālā shēmu ES Austrumu paplašināšanās valstīm. Autore veic esošo politikas plānošanas dokumentu analīzi pašvaldību līmenī četrās Latvijas pašvaldībās, kā arī gadījuma pētījumu Valmieras pašvaldībā transporta plānošanas kontekstā, lai noteiktu Latvijas pašvaldību funkciju un uzdevumu apjomu trokšņa pārvaldības jomā un identificētu trokšņa jautājumu integrāciju rīcībpolitikas plānošanā un tās trūkumus. Pētījumi ietver arī konkrētu trokšņa pārvaldības jautājumu praktisku izpēti Latvijā, pētot ceļa, dzelzceļa un industriālo trokšņa jautājumus, jo šie avoti saskaņā ar vides trokšņa kartējumu ir lielākie trokšņa avoti Latvijā (EK, 2019). Šie pētījumi tika veikti Grobiņā, kur sabiedrība protestēja pret vēja parku būvniecību, un Saulkrastos, kur netālu no privātmāju rajoniem tika izbūvēts jauns trokšņa avots – apvedceļš ar lielu plānoto automašīnu plūsmu un kravas automašīnu īpatsvaru. Savukārt dzelzceļa trokšņa jautājumu izpēti Autore veic sadarbībā ar uzņēmumu "Latvijas dzelzceļš". Iegūtie rezultāti ļauj Autorei identificēt labo praksi un galvenos trūkumus esošajā trokšņu pārvaldības ietvarā Latvijā, kas kalpo kā pamats tālākiem ieteikumiem pašreizējās trokšņu pārvaldības politikas un prakses uzlabošanai, kā arī trokšņa pārvaldības modeļa izstrādei, ko varētu izmantot ne tikai Latvijā, bet varētu pielāgot arī citām valstīm ar līdzīgiem trokšņa pārvaldības jautājumiem.

Autores ieguldījums

Ievērojot to, ka doktora disertācija sniedz priekšlikumus vides trokšņa pārvaldības uzlabošanai:

- Autore veic komplicētu ar vides troksni saistītu problēmu situāciju integrētu analīzi Latvijā, pamatojoties uz inženiertehniskajiem un citiem empīriskiem un statistikas datiem, politikas plānošanas dokumentiem, tiesību aktiem, vienlaikus sniedzot informāciju par sabiedrības attieksmi (par to, kā sabiedrība uztver ar troksni saistītus jautājumus, situācijas un risinājumus). Tādējādi Autore sniedz kompleksu un integratīvu akustisko un neakustisko datu un informācijas analīzi, kas ļauj izdarīt secinājumus un piedāvāt risinājumus vides trokšņa pārvaldības attīstībai, t.sk., iespējams, arī mazināt trokšņa radīto kairinājumu un sabiedrības sūdzības. Šāda kompleksa izpēte Latvijā tiek veikta pirmo reizi;
- Autore analizē Latvijas pašvaldību plānošanas dokumentus no vides trokšņa pārvaldības jautājuma integrācijas aspekta;
- Autore apraksta vides trokšņa pārvaldību no likumdošanas, institucionālā un sabiedrības atgriezeniskās saites nodrošināšanas viedokļa Latvijā un ES Austrumu paplašināšanās valstīs, t.sk. veicot salīdzinošo

analīzi, apzina citu Eiropas valstu trokšņa pārvaldības praksi, kas Latvijā netiek izmantota, bet varētu būt adaptējama, kā arī izstrādā vienotu institucionālās sistēmas modeli;

- Autore veic faktiskās situācijas kompleksu un integratīvu analīzi un pārvaldības trūkumu izpēti Latvijā, jo pašlaik Latvijā ir veikti tikai atsevišķi gadījumu pētījumi, taču tie neveic sistemētisku analīzi, t.sk., ievērojot gan akustiskos, gan neakustiskos faktorus;
- Autore izstrādā sistēmisku, daudzlīmeņu praksē balstītu pārvaldības modeli, tostarp sniedz priekšlikumus pārvaldības procesu uzlabošanai;
- rezultāti papildina un atjaunina teorētiskās un pārvaldības prakses zināšanas.

Inovācijas aspekti un praktiskais pielietojums

Šīs doktora disertācijas novatoriskos aspektus demonstrē šādi elementi:

- pirmo reizi ir izstrādāts un detalizēti raksturots komplekss, praksē balstīts trokšņa pārvaldības modelis Latvijai, ņemot vērā valstu trokšņa pārvaldības prakses piemērus un sabiedrības attieksmes datus. Izstrādāto modeli potenciāli var pielāgot arī citās valstīs, jo tas sastāv no galvenajiem vides pārvaldības procesiem katrā pārvaldības līmenī. Vienlaikus tas varētu sniegt arī ierosmi potenciāliem uzlabojumiem citās valstīs;
- pirmo reizi aprakstīts vides trokšņa pārvaldības institucionālais modelis ES Austrumu paplašināšanās valstīm;
- šis ir pirmais pētījums, kas kompleksi veikts par dažādu avotu vides trokšņu pārvaldības jautājumiem Latvijā, apvienojot gan datus par akustiskajiem un neakustiskajiem faktoriem;
- pētījumā sniegti ierosinājumi, kā paātrināt vides trokšņa pārvaldības attīstību ES Austrumu paplašināšanās valstīs, pamatojoties uz praksi, ko citas valstis jau ir izmantojušas vides trokšņa jomā, lai izpildītu ES prasības, kas attiecas uz visām dalībvalstīm.

Rezultātu aprobācija

Promocijas pētījuma rezultāti ir aprobēti, sagatavojot 15 publikācijas un piedaloties 19 starptautiskās un vietējās konferencēs. Promocijas pētījuma rezultāti ir publicēti indeksētajos žurnālos "*NoiseHealth*" un "*European integration studies*", kā arī vairākos konferenču rakstu krājumos. Zinātniskajās datu bāzēs ir pieejamas sešas publikācijas un trīs anotācijas.

Autorei piešķirts apbalvojums par labāko stenda referātu 10.· starptautiskajā kongresā par troksni kā sabiedrības veselības problēmu ("10th International Congress on Noise as a Public Health Problem").

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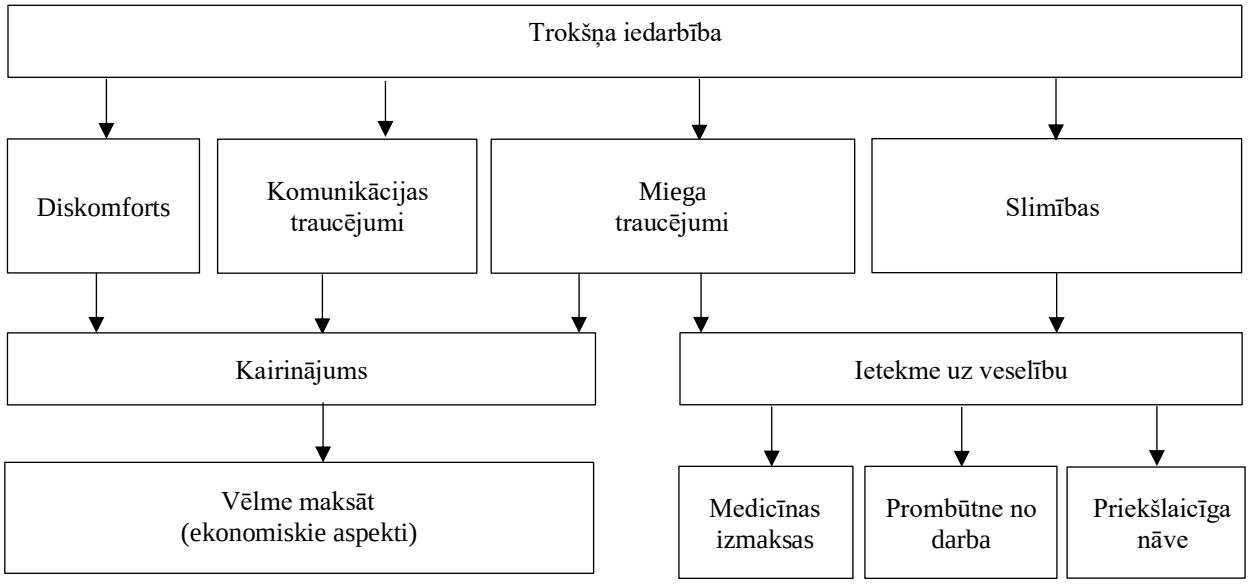
1. Vides trokšņa pārvaldība

Vides troksnis ir būtisks vides piesārņotājs, kas ietekmē daudzu eiropiešu ikdienu. Tas rada dažādas starpdisciplināras un starpsektoriālas ietekmes. Daudzos pētījumos ir pierādīts, ka troksnis rada kairinājumu, sirds un asinsvadu slimības, kā arī paaugstina citus veselības riska faktorus (WHO regional office for Europe, 2011; Ndrepepa and Twardella, 2011; Babish, 2014, Bendokiene *et al.*, 2011; Argalášová-Sobotová *et al.*, 2013; Zijlema *et al.,* 2016). Tomēr Svarīgākā trokšņa izraisītā ietekme ir miega traucējumi. Tie ietver nemierīgu naktsmieru, atkārtotu pamošanos, ilgāku aizmigšanas periodu, bezmiegu u.tml. Saskaņā ar PVO (World Health Organisation, 2009) datiem troksnis atstāj nelabvēlīgu ietekmi uz iedzīvotāju veselību jau gadījumos, kad tas pārsniedz L_{nakts} 40 dB. 13% respondentu ir ziņojuši par lielu un 33,5% mērenu trokšņa kairinājumu dienas laikā virs trokšņa līmeņa $L_{diena,}$ 60 dB, savukārt nakts laikā kairinājums tiek ziņots sākot ar trokšņa līmeni L_{nakts} virs 46 dB (Ritkovska *et al.,* 2009). Turklāt trokšņa piesārņojums kopā ar citiem vides piesārņotājiem, piemēram, gaisa piesārņojumu, var radīt kompleksas ietekmes, kas vēl sīkāk ir jāvērtē epidemioloģiskajos pētījumos (Schwela *et al.,* 2011).

Troksnis rada arī sociāli ekonomisko ietekmi, ko var raksturot ar vēlmi maksāt par labāku vides kvalitāti, lai izvairītos no trokšņa kairinājuma, lielākiem izdevumiem par medicīnas pakalpojumiem un zālēm, kā arī ekonomiskiem zaudējumiem, ko rada prombūtne no darba, potenciāli zaudētie mūža gadi, u.tml. Minētās ietekmes un to savstarpējas mijiedarbības ilustrētas 1.attēlā. Saskaņā ar Eiropas Komisijas (2017) datiem par vides trokšņa iedarbību 14,1 miljonu pieaugušo katru gadu ir pakļauti vides trokšņa kairinājumam, bet 5,9 miljoniem pieaugušo ir būtiski miega traucējumi. Ir netieši aprēķināts, ka ikgadēji 69 000 eiropiešu varētu būt hospitalizēti un 15 900 priekšlaicīgas mirstības gadījumi varētu būt saistīti ar vides trokšņa ietekmēm (Eiropas Komisija, 2017).

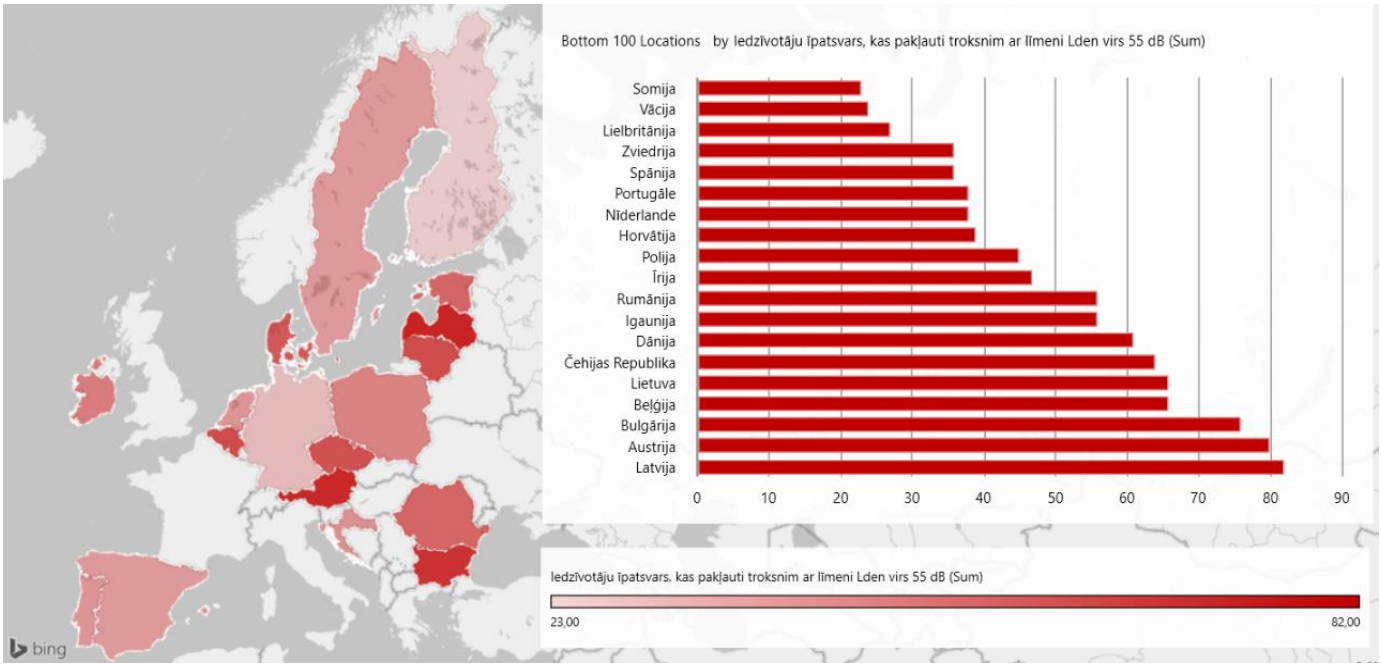


1.attēls.Trokšņa ietekme un tā sekas (Gerike *et al.*, 2012)

Vides trokšņa aktualitāte

ES līmeņa trokšņa kartēšanas dati parāda, ka ceļu satiksmes troksnis gan aglomerācijās, gan ārpus tām ir visizplatītākais trokšņa avots ES (aptuveni 100 miljoni cilvēku tiek pakļauti satiksmes trokšņa ietekmei ar trokšņa līmeni L_{den} virs 55 dB). Dzelzceļš ir otrs būtiskākais vides trokšņa veids (tiek ietekmēti aptuveni 8 miljoni cilvēku), kam seko lidmašīnu radītais troksnis (ietekmei pakļauti gandrīz 4 miljoni cilvēku) un rūpnieciskais troksnis (tiek ietekmēts aptuveni 1 miljons cilvēku). Saskaņā ar Eiropas vides trokšņa kartēšanas rezultātiem, visaugstākās vides trokšņa vērtības 2012.gada trokšņa kartēšanas laikā tika konstatētas piecās

valstīs – Latvijā, Lietuvā, Bulgārijā, Spānijā, Islandē un Kiprā –, kur L_{den} un L_{nakts} trokšņa līmeņiem, kas pārsniedz 55 dBA, ir pakļauti vairāk nekā 29,5% no kopējā valsts iedzīvotāju skaita (European Environmental Agency, 2018). Tā kā ne visas valstis ir iesniegušas jaunākos 2017.gada kartēšanas datus, pilnīgu salīdzinājumu veikt nevar, tomēr aktuālie dati liecina, ka Latvijas, Austrijas, Bulgārijas un Lietuvas aglomerācijās ir vislielākā troksnim pakļauto iedzīvotāju daļa (skatīt 2.attēlu).



2.attēls. Trokšņa kartēšanas dati - to aglomerācijas iedzīvotāju procentuālais daudzums, kuri pakļauti L_{den} ceļu trokšņa līmenim virs 55 dBA (Autore, izmantojot European Environmental Agency, 2019)

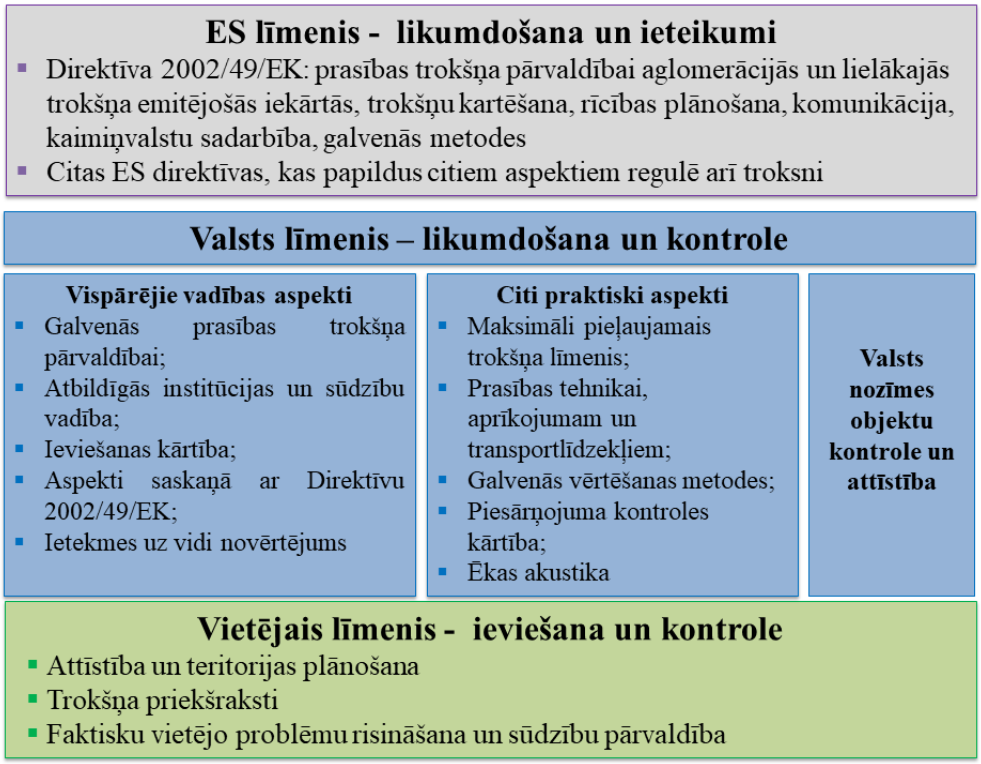
Latvijā saskaņā ar 2017.gadā vides trokšņa kartēšanas datiem (European Environmental Agency, 2019) galvenie trokšņa avoti prioritārā secībā (ņemot vērā trokšņa līmeni un ietekmēto iedzīvotāju apmēru) ir autoceļi, dzelzceļš un rūpniecība. Savukārt gaisa satiksmes troksnim ir vismazākā ietekme. Kā ilustrēts 2.attēlā Rīga ir viena no desmit skaļākajām aglomerācijām Eiropā attiecībā uz to iedzīvotāju īpatsvaru, ko skar satiksmes un industriālais troksnis, kas pārsniedz 55 dBA L_{den} (European Environmental agency, 2019).

Tomēr trokšņa līmenis ir tikai viens no vides trokšņa ietekmes aspektiem. Saskaņā ar PVO datiem plaši izplatīta trokšņa ietekme uz veselību ir kairinājums (World Health Organisation, 2011), attiecībā uz ko akustiskie faktori izskaidro tikai 10–25% no cilvēka reakcijas (Guski, 1999; Job, 1999; Suau-Sanchez et al., 2011). Sūdzību saņemšana no iedzīvotājiem ir nozīmīgs signāls par nepieciešamību rīkoties un nodrošināt atbilstošu vides trokšņa pārvaldību. Gandrīz viena trešdaļa Eiropas iedzīvotāju ziņo par problēmām, kas saistītas ar troksni (World Health Organisation, 2009). Sūdzību saņemšana no iedzīvotājiem ir nozīmīgs signāls par nepieciešamību rīkoties un nodrošināt atbilstošu vides trokšņa pārvaldību. Latvijā no **sabiedrības ir saņemtas negatīvas atsauksmes saistībā ar troksni**, t.sk., dzelzceļa troksni, un iedzīvotāji izskatīšanai tiesā ir virzījuši vairākas lietas, piemēram, lietas par mototrašu radīto troksni, Grobiņas un Dunikas vēja parku un Jelgavas uzņēmuma "Fortum" darbību.

Vides trokšņa pārvaldība

Vides trokšņa pārvaldība kā stratēģisks un komplementārs pasākumu kopums, kas ietver politikas izstrādi, īstenošanu un monitoringu, pamatojoties uz apzināto problēmu analīzi, palīdz novērst un mazināt vides trokšņa piesārņojumu un tā ietekmi uz cilvēku veselību un sociālekonomisko attīstību. Vides trokšņa

pārvaldība tiek īstenota dažādos pārvaldības līmeņos – globālā, valsts un vietējā līmenī –, jo katram līmenim ir savas funkcijas, t.sk. ievērojot lejupejas un augšupejas pārvaldības pieejas. Katra līmeņa galvenās funkcijas ir sniegtas 3.attēlā, un šis funkciju dalījums tiek izmantots tālāk promocijas darbā.



3.attēls. Vides trokšņa pārvaldības līmenis un tā galvenās funkcijas (Autore)

Vienlaikus, zinātniskās literatūras analīze atklāj trūkumus vides trokšņa pārvaldības stratēģiskajā īstenošanā visos līmeņos. Šīs nepilnības ietver nepietiekamu politisko gribu un zemu trokšņa pārvaldības prioritāti, vāju sabiedrības informētību un ieinteresēto personu līdzdalību, nepietiekamu infrastruktūru, nepilnības rīcībpolitikās, piemērojamajos normatīvajos aktos un standartos, kā arī datu trūkumu, kas raksturo veselības un ekonomiskās ietekmes (Schwela *et al.*, 2008). Apkopojums par literatūrā identificētajiem pārvaldības trūkumiem sniegts 1.tabulā. Šie trokšņa pārvaldības problēmjautājumi tiek tālāk izmantoti šajā promocijas darbā, izpētot Latvijas situāciju un sniedzot priekšlikumus vides trokšņa pārvaldības uzlabošanai.

1.tabula. Vides trokšņa pārvaldības problēmjautājumi (Autore, izmantojot datus no (Jeram *et al.*, 2013; Schwela *et al.*, 2008; Schwela *et al.*, 2008; Basner *et al.*, 2015; Licitra *et al.*, 2014; Moudon, 2009))

Grupa	Vides trokšņa pārvaldības problēmjautājumi
Zināšanas, dati un informācija	Trūkst vai ir nepilnīgas zināšanas par trokšņa līmeņiem
	Pastāv vāja veselības ietekmju uzraudzība
	Daudzās valstīs ir maz datu par trokšņa veselības un ekonomisko ietekmi
Politika, standarti un noteikumi	Noteikumi un standarti dažkārt neatspoguļo labāko tehnisko praksi
	Politikas, standartu un noteikumu nepilnības; nepieciešamība uzlabot tiesību aktus
Trokšņa samazināšana	Reti pieejamas lētas un efektīvas alternatīvās tehnoloģijas trokšņa mazināšanai
	Trūkst atbilstošas infrastruktūras
	Joprojām maz tiek darīts, lai uzlabotu esošo infrastruktūru

Tabulas turpinājums

Grupa	Vides trokšņa pārvaldības problēmjautājumi
Uzraudzība un kontrole	Trokšņa monitorings ierobežots tā telpiskajā pārklājumā, nav konsekvents vai vispār nepastāv
	Trūkst kvalitātes kontroles plānu;
	Slikta datu kvalitāte
	Uzraudzība un kontrole galvenokārt tiek veikta jauniem, lieliem projektiem
Informētība, saziņa, ieinteresēto personu iesaistīšana	Zema ieinteresēto personu līdzdalība
	Iedzīvotājiem un politikas veidotājiem trūkst zināšanu par vides trokšņa un pārvaldības jautājumiem
	Risināmi jautājumi attiecībā uz riska uztveri, riska paziņošana, informācijas izplatīšana un izpratnes veidošana
Finansējums	Finansējuma pieejamība, trūkstot labai pārvaldībai un vides trokšņa apsaimniekošanai, piešķirot zemu prioritāti
Politiskā griba	Pietiekamas politiskās gribas un vadības apņemšanās trūkums
	Ekonomiskie apsvērumi bieži tiek vērtēti pretstatā un prioritārāk vides un veselības aizsardzībai
Trokšņa administrēšana	Vispārēja nepieciešamība pēc labākas pārvaldības

2. Metodes

Doktora disertācijā izmantotas literatūras, dokumentu un statistikas datu analīzes metodes, lai ilustrētu vides trokšņa kā vides piesārņojuma jautājumu nozīmību Latvijā un Eiropā, pārvaldības nepieciešamību un citus saistītos jautājumus, kas attiecīgi parāda jautājumu problēmātiku un pamato pētījuma nepieciešamību.

Promocijas darba ietvaros ir veikta **institucionālās sistēmas, tiesību aktu analīzes un sabiedrības atgriezeniskās saites pārvaldības pētījumi** Austrumu paplašināšanās valstīs, lai izpētītu vides trokšņa pārvaldība tajās , ievērojot to, ka šīm valstīm vides trokšņa pārvaldība bija jāattīsta ātrā tempā (salīdzinoši ar citām Eiropas valstīm, kur vides trokšņa pārvaldība ir attīstījusies pakāpeniski vairāk kā piecdesmit gadu periodā). Šie veiktie pētījumi parāda valstu pieejas, ko var salīdzināt un adaptēt arī Latvijas vides trokšņa pārvaldības ietvarā. Savukārt tiesību aktu analīze tiek veikta, izmantojot dokumentācijas analīzes metodes, analizējot normatīvo aktu un dokumentu saturu attiecībā uz trokšņa līmeni un pārvaldības ietvaru Baltijas valstīs. Institucionālās sistēmas analīze ietver to institūciju noteikšanu, kas ir atbildīgas par trokšņa pārvaldību sešās Austrumu paplašināšanās valstīs un divās kandidātvalstīs, kam arī jāizpilda ES tiesību aktu prasības. Tāpat ir pētīta arī sabiedrības atgriezeniskās saites pārvaldība, analizējot sabiedrības sūdzības un institūciju rīcību šajos gadījumos. Institucionālo sistēmu un atgriezeniskās saites pārvaldības pētniecība galvenokārt veikta, darbojoties starptautiskā darba grupā ar kompetentiem ekspertiem no katras pētījumā iekļautās valsts.

Lai analizētu vides trokšņa pārvaldību vietējā līmenī, ir veikta Latvijas pašvaldību plānošanas dokumentu analīze un praktiskie trokšņa **gadījumu pētījumi** plānošanas un pārvaldības prakses un problemātikas identificēšanai, . Trīs pētījumi tiek veikti kā kompleksi empīriski un socioloģiski pētījumi, kuros analizēti reāllaika un reālās vides piemēri, izmantojot gadījumu pētījuma metodiku. To dizains tika izstrādāts tā, lai tie atspoguļotu informāciju par visizplatītākajiem trokšņa avotu veidiem Latvijā (atbilstoši trokšņa kartēšanas datiem), kā arī informāciju par valsts un pašvaldību līmeņa vides trokšņa pārvaldību no dažādām perspektīvām. Gadījuma pētījumi attiecīgi ietver ceļu satiksmes, dzelzceļa un rūpnieciskā trokšņa pārvaldības izpēti no dažādām perspektīvām – ietekmes uz vidi novērtējuma, objektu būvniecības un ekspluatācijas, vēja parku un horizontālās vispārējās trokšņa pārvaldības perspektīvām. Šie pētījumi ļauj apkopot informāciju par trokšņa pārvaldību un tās procesiem, identificēt nepilnības, kā arī analizēt aktuālos jautājumus Latvijā. Visi minētie

pētījumi sniedz horizontālu informāciju par valsts un pašvaldību sektoru, trokšņa avotu pārvaldītāju un iedzīvotāju viedokli. Visos gadījumu pētījumos ir izmantoti empīriskie dati par akustisko situāciju, ko papildina pētījumi par sabiedrības atgriezenisko saiti un neakustiskajiem faktoriem, kas iegūti caur socioloģiskajiem pētījumiem, jo sabiedrības reakcijai uz troksni ir gan objektīvi, gan subjektīvi elementi (Suau-Sanchez *et al*., 2011; Job, 1999, Guski, 1999). 4.attēlā parādīta gadījumu izpētes dizaina shēma, tostarp informācija par katra pētījuma fokusu.

4.attēls. Latvijas pašvaldību praktiskās vides trokšņa pārvaldības gadījumu pētījuma izpētes integratīvā metodika (Autore)

Ceļu un rūpnieciskā trokšņa gadījumu pētījumi attiecīgi ietver strukturētas **intervijas** ar iedzīvotājiem, kuru mājokļi atrodas 200 m attālumā no automaģistrāles vietās, kur veikti trokšņa mazināšanas pasākumi (n=24), un iedzīvotājiem, kuri dzīvo 500 m attālumā no vēja turbīnām (n=37).

Trokšņa politikas plānošanas analīze Latvijas pašvaldībās (Saulkrastos, Ogrē, Mārupē, Rīgā un Valmierā) tika veikta, izvērtējot pašvaldību obligātās un brīvprātīgās darbības vides trokšņa jomā, kas aprakstītas pašvaldības dokumentos (piemēram, teritorijas attīstības plānošanas dokumentos , trokšņa rīcības plānā u.c.). Autore pētīja, kā tajos paredzētās darbības atbilst trokšņa pārvaldības labākajai praksei un vai tās ir vērstas uz galvenajiem trokšņa avotiem pašvaldībā. Papildus attiecībā uz šīm pašvaldībām ir izcelti arī atsevišķi, specifiski vides trokšņa pārvaldības trūkumi, kas tika identificēti dokumentācijas studijās un ekspertu intervijās. Savukārt Valmieras politikas plānošanas pētījumā tika veikts ilgstpējīga transporta gadījuma pētījums, ietverot autores, izpētīto plānošanas praksi un procesu analīzi, priekšlikumu sagatavošanu pašvaldībai par trokšņa pārvaldību transporta sektorā, kā arī dalību transporta stratēģijas izstrādes publiskajā apspriešanā.

Iegūtie dati un informācija izmantota, lai izstrādātu integratīvu, sistēmisku un daudzlīmeņu **vides trokšņa pārvaldības modeli**, kas izriet no trokšņa pārvaldības prakses Latvijā un ietver priekšlikumus procesu uzlabojumiem, pamatojoties uz pētījumos konstatētajām nepilnībām un labās prakses piemēriem. Modelis sagatavots, izmantojot biznesa procesu modelēšanas tehniku, kas attēlo pārvaldības procesus un apvieno tos vienotā integratīvā modelī, kas balstīts uz institucionālo un funkcionālo atbilstību un attiecīgo pārvaldības līmeņu iedalījumu. Lai pierādītu, ka izvēlētais modelis un priekšlikumi ir pielāgoti, lietderīgi, funkcionāli, efektīvi un sniegs esošās situācijas uzlabojumus, tika veikta modeļa aprobācija caur daļēji strukturētām 13 ekspertu intervijām ar pašvaldību un valsts institūciju (t.sk. Lietuvas Veselības ministrijas) ekspertiem, zinātniekiem un akustikas jomas speciālistiem.

3. Rezultāti un diskusija

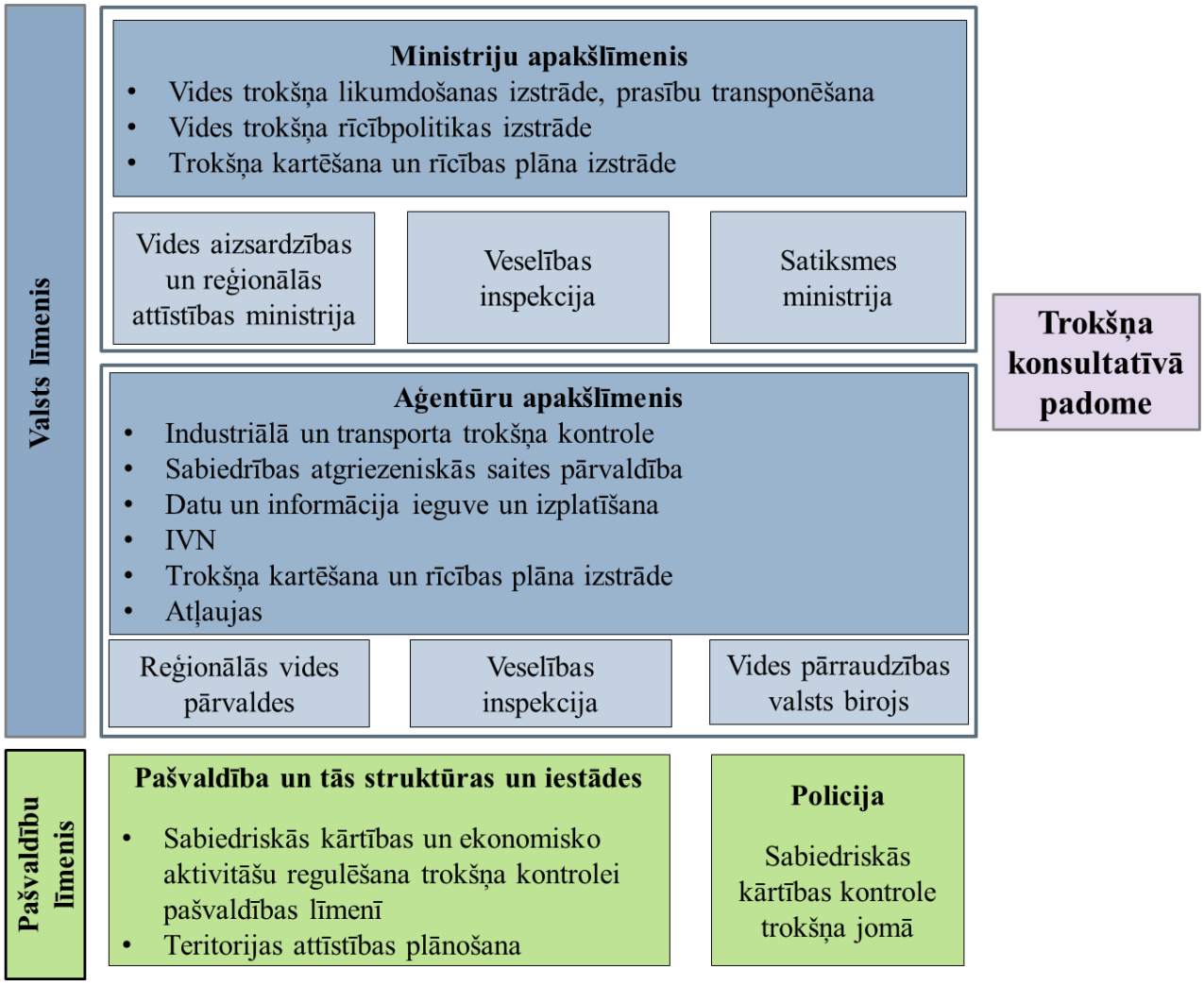
Baltijas valstu **tiesiskā regulējuma** salīdzinošā analīze liecina, ka visas trīs valstis normatīvajā ietvarā ir iekļāvušas ES prasības, kas saistītas ar trokšņa kartēšanu, rīcības plānošanu, trokšņa rādītāju piemērošanu, atbildīgo iestāžu piesaisti, sadarbību ar kaimiņvalstīm, kā arī sabiedrības informēšanu. Tomēr izvēlētās metodes un trokšņa pārvaldības noteikumi atšķiras gan satura ziņā, gan detalizācijas pakāpē. Piemēram, Lietuvas tiesību aktos par trokšņa pārvaldību ir iekļauti plašākie stratēģiskie trokšņa pārvaldības apraksti, bet Igaunijā ir izstrādātas trokšņa vadlīnijas normatīvo aktu piemērošanai. Baltijas valstīm ir noteikti dažādi maksimāli pieļaujamie vides trokšņa līmeņi un metodes, kas tos nosaka katrā valstī (skatīt 2.tabulu). Latvijā un Lietuvā vides trokšņa robežlielumi ir atkarīgi no teritorijas izmantošanas veidu, bet Igaunijā – no trokšņa avota.

2.tabula. Āra vides trokšņa robežvērtības Baltijas valstīs, $L_{Aeq,T}$ (Autore)

Valsts	$L_{A,max}$*	L_{nakts}	L_{diena}	L_{vakars}
Latvija	+20	40-55	50-65	45-60
Lietuva	+5 līdz +10	35-55	45-85	40-80
Igaunija	-	40-60 (satiksmes troksnis)	50-70 (satiksmes troksnis)	-
	-	35-55 (rūpniecības troksnis	55-65 (rūpniecības troksnis)	-

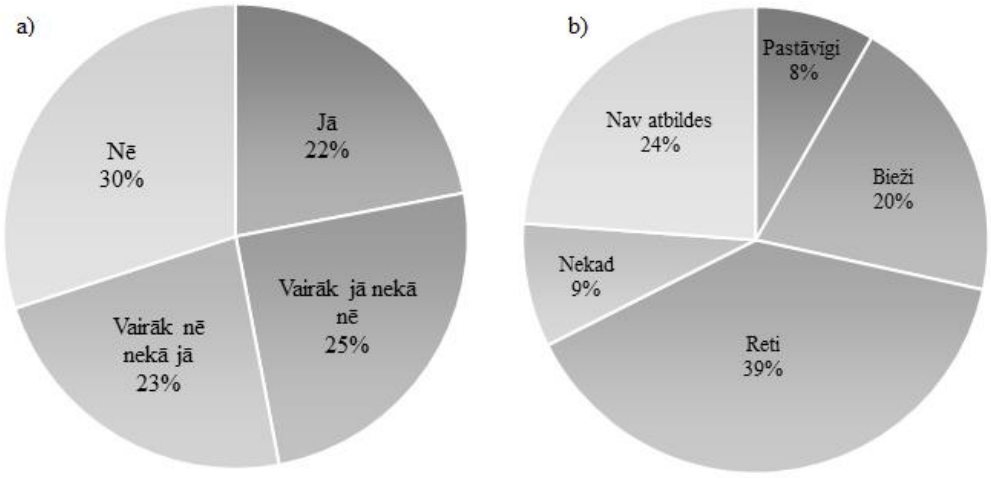
* *no iekštelpu trokšņa līmeņa*

Austrumu paplašināšanās valstu **institucionālā** analīze ļauj identificēt sistēmiskas līdzības. Galvenās atbildīgās institūcijas vides trokšņa pārvaldības jomā ir ministrijas (visbiežāk Veselības vai Vides ministrijas sadarbībā ar Satiksmes un Iekšlietu ministrijām), aģentūras (visbiežāk Veselības inspekcijas vai Vides inspekcijas), pašvaldības un policija. Ministrijas ir atbildīgas par trokšņa pārvaldības tiesiskā regulējuma un rīcībpolitikas izstrādi. Aģentūru uzdevumos ietilpst trokšņa kontrole infrastruktūras objektos, ietekmes uz vidi novērtējuma (turpmāk – IVN) procesa veikšanu atļauju izsniegšana, bet pašvaldības ir atbildīgas par sabiedriskās kārtības, sadzīves un izklaides trokšņa regulēšanu, kā arī par teritorijas un attīstības plānošanu. Trokšņa kartēšanu veic ministrijas vai aģentūras saskaņā ar deleģējumu. Sadzīves un izklaides troksņa (mūzikas, būvniecības u.tml.) jautājumu pārkāpumu kontrole parasti ir policijas (valsts vai pašvaldības) uzdevums. Dažās valstīs (piemēram, Lietuvā un Slovākijā) trokšņa jautājumu risināšanai papildu ieteikumus sniedz Trokšņa uzraudzības padome, kas darbojas kā nozares padomdevēja (Jeram *et al.*, 2013), un ko varētu uzskatīt par labo praksi. Minētais ļauj Autorei sagatavot institucionālo modeli, kas ir parādīts 5.attēlā. Vienlaikus ir jānorāda, ka modelis ir vispārināts un tajā ir iekļautas tikai galvenās iestādes, un atsevišķām valstīm var būt atkāpes no tā.



5.attēls. Kopējais trokšņa pārvaldības institucionālais modelis jaunām ES dalībvalstīm (Autore)

Lai analizētu, kā vides trokšņa politikas plānošana tiek veikta lokālā līmenī, ir veikta vides trokšņa politikas plānošanas un pārvaldības aspektu izvērtēšana piecās Latvijas pašvaldībās (Rīgā, Ogrē, Mārupē, Saulkrastos un Valmierā). Analizē secināts, ka trokšņa pārvaldības aktualitāte un pārvaldība katrā novadā ir atšķirīga. 6.attēls ilustrē iedzīvotāju viedokli par trokšņa problemātiku Ogres un Valmieras pilsētās.



6.attēls. Atbildes uz jautājumu, vai respondenti izjūt trokšņa radīto kairinājumu a) Ogrē (n = 1671) b) Valmierā (n = 373) (Autore)

Neskatoties uz to, ka dati par trokšņa diskomfortu un kairinājumu Valmieras un Ogres pilsētās iegūti un apkopoti, izmantojot dažādas anketas, tika konstatēts, ka daudziem iedzīvotājiem pat neliela izmēra pilsētās ir aktuāli trokšņa jautājumi.

Analizējot pašvaldību dokumentos iekļauto informāciju attiecībā uz vides trokšņa pārvaldību un salīdzinot plānotās darbības un regulējumu ar datiem par galvenajiem trokšņa avotiem šo pašvaldību teritorijās (skatīt 3.tabulu), secināts, ka visi pašvaldību dokumenti ietver vides trokšņa pārvaldības aspektus, tomēr ir atšķirīga gan detalizācijas pakāpe, gan plānotās vai regulētās darbības attiecībā uz vides trokšņa radīšanu, kā arī dažkārt troksnis no tā galvenajiem rašanās avotiem pašvaldībā netiek detalizēti izvērtēts un atspoguļots dokumentos. Tas īpaši attiecas uz Saulkrastu pašvaldību, kur galvenie trokšņa avoti ir valsts un starptautiski nozīmīgi ceļi, bet kuras plānošanas dokumentācijā nav iekļauti nekādi konkrēti pasākumi, kas saistīti ar ceļu satiksmes trokšņa emisiju pārvaldību.

3.tabula. Plānošanas dokumentos iekļauto trokšņa avotu un trokšņa pārvaldības darbību salīdzinājums (Autore)

Parametrs	Pašvaldība				Kopā iekļautās darbības
	Rīga	Saulkrasti	Mārupe	Ogre	
Vietējās nozīmes ceļi un ielas	+	-	+	+	3 no 4
Starptautiskie ceļi	n/a	-	n/a	n/a	0 no 1
Lidosta	+	n/a	+	n/a	2 no 2
Dzelzceļš	+	n/a	+ kopš 2019.gada	+	2 no 2
Osta	+	+	n/a	n/a	2 no 2
Citi trokšņa avoti	+	n/a	n/a	+	2 no 2
Kopā iekļautās darbības	5 no 5	1 no 3	2 no 2	3 no 3	-

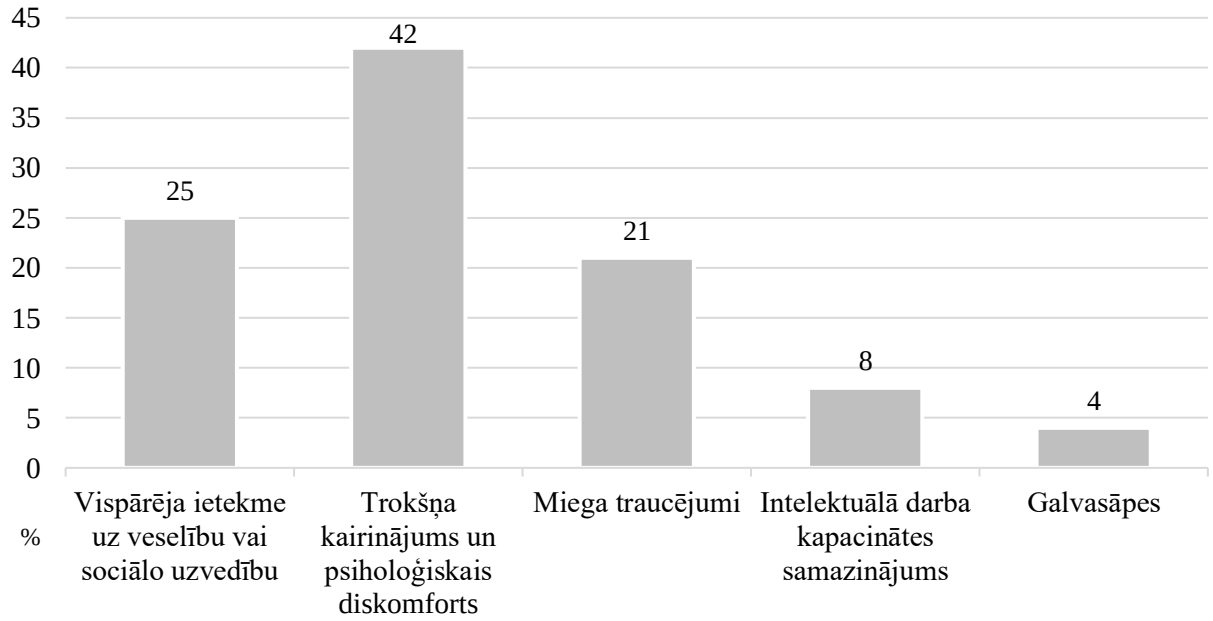
Apzīmējumi: "+" specifiskas darbības iekļautas, "-" specifiskas darbības nav iekļautas, "n/a" nav attiecināms

Pašvaldību plānošanas dokumentācijā un analīzē iekļauto trokšņa avotu un aktivitāšu salīdzinājums liecina, ka pašvaldībās (izņemot Rīgu) netiek plānoti daudzi potenciāli izmantojami labas trokšņa pārvaldības

prakses pasākumi (piemēram, sociālekonomiskie pasākumi, trokšņa mazināšana avotā u.tml.). Visbiežāk izmantotie pasākumi ir teritorijas zonējuma plānošana un trokšņa barjeru izbūve. Plānošanas dokumentu pētījumi liecina, ka tajos bieži vien nav empīrisku datu par trokšņa situāciju pašvaldībā, kā arī netiek analizēti ieinteresēto personu viedokļi, rīcība un attieksme, lai varētu nodrošināt labākus trokšņa risinājumus un tiktu ņemti vērā arī neakustiskie faktori. Piemēram, Valmieras gadījuma pētījums par ilgtspējīgu mobilitāti un trokšņa pārvaldību liecina, ka, neskatoties uz to, ka pašvaldība 2019.gadā izstrādāja transporta mobilitātes stratēģiju un to, ka transports ir būtiskākais trokšņa avots pilsētā, Valmierā nav veikta transporta emisiju izkliedes un trokšņa piesārņojuma modelēšana. Transporta stratēģijas sagatavošanas laikā nav veikta arī iedzīvotāju uzvedības un viedokļu analīze, kas sniegtu būtisku neakustisko informāciju un ļautu uzlabot ne tikai trokšņa, bet arī gaisa piesārņojuma un viedo satiksmes pārvaldību, t.sk. plānot preventīvos un samazināšanas pasākumus un sociāli ekonomisko attīstību. Vienlaikus pētījumi liecina, ka citos gadījumos (piemēram, Mārupē) ar laiku plānošanas dokumentos ir uzlabojusies vides trokšņa novērtēšanas kvalitāte un trokšņa jautājumu atspoguļojums, t.sk. dokumentos iekļaujot trokšņa kartēšanas datus un nosakot akustiskā diskomforta zonas.

Praktiskie trokšņa gadījumu pētījumi veikti attiecībā uz industriālajiem (vēja parki), ceļu satiksmes un dzelzceļa trokšņa avotiem Latvijā, un tie novērtē trokšņa pārvaldību no akustiskā (empīriskā) un neakustiskā (socioloģiskā) viedokļa.

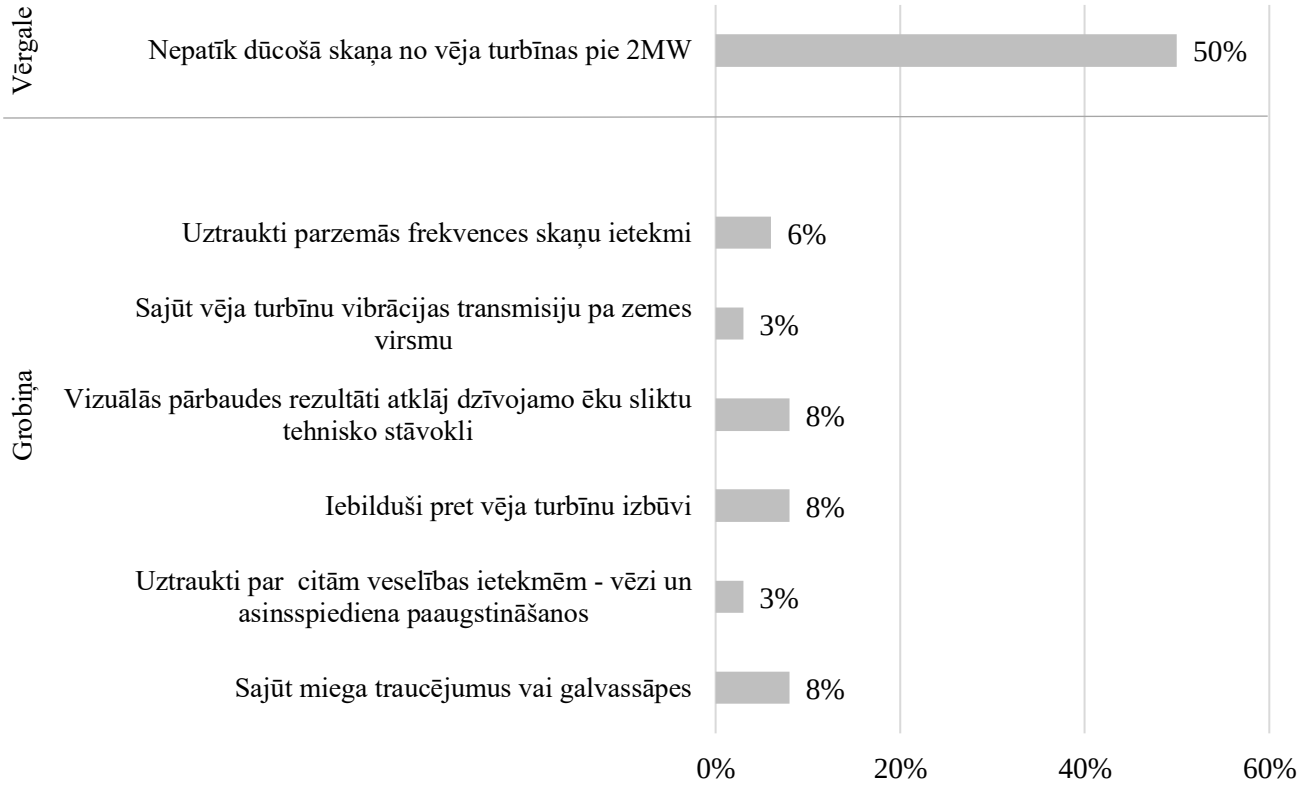
Saulkrastu gadījuma pētījumā par ceļu satiksmes troksni un *ex-post* IVN iekļauta empīrisko datu analīze par faktisko trokšņa līmeni (Zanberga *et al.*, 2011) pēc jauna ceļa posma izbūves salīdzinājumā ar IVN procesā izmantotajiem modelēšanas datiem, kā arī vērtēta atbilstība valsts tiesību aktiem. Vides trokšņa mērījumu datu analīze liecina, ka modelēšana ir veikta neprecīzi un uzstādītās trokšņa barjeras nav pietiekami efektīvas, t.i. vides trokšņa līmenis gan pirms, gan pēc trokšņa barjerām joprojām pārsniedz tiesību aktos noteiktās maksimālās L_{diena} robežvērtības attiecīgajai apbūves teritorijas izmantošanas funkcijai, tāpēc ir nepieciešami uzlabojumi IVN un būvniecības procesos. Savukārt Autores veiktās intervijas pētījuma teritorijā atklāj, ka 33% respondentu jūtas neapmierināti ar akustisko situāciju. Dati liecina, ka šie respondenti arī jūtas aizkaitināti, jūt psiholoģisko diskomfortu, sajūt miega traucējumus vai citus negatīvus efektus (skatīt 7.attēlu).



7.attēls. Socioloģiskās aptaujas dati: trokšņa ietekme (Autore)

Pētījums parāda, ka atšķirības attieksmē pret trokšņa jautājumiem ir identificējamas to aptaujāto iedzīvotāju atbildēs, kuri ir iegādājušies nekustamos īpašumus autoceļa tuvumā pirms un pēc tā būvniecības (t.i., ir vai nav zinājuši par trokšņa avotu), kā arī to cilvēku atbildēs, kuri dzīvo aiz dažāda veida trokšņa barjerām (kompozītmateriāla siena, koka dēļu blīvžogs vai dzīvžogs). Iedzīvotāji nav saņēmuši skaidrojumus, kā un kāpēc izvēlēts konkrētais barjeras veids.

Gadījumu pētījums par **Grobiņas un Vērgales vēja parkiem (industriālā trokšņa gadījums)** ietvēra vides trokšņa modelēšanas datu analīzi, kas ilustrē, ka pie maksimāla vēja ātruma, pie kā darbosies vēja turbīnas, maksimālais vides trokšņa līmenis būs zem normatīvajos aktos noteiktā līmeņa un nepārsniegs $L_{dienā}$ 48 dBA. Tomēr vēja parka izbūve ir radījusi opozīciju sabiedrībā, un tā ir iesniegusi lietu izskatīšanai vairākās tiesu instancēs. Intervijās ar iedzīvotājiem tika konstatēta subjektīvā (ne-akustiskā) trokšņa faktoru prevalēšana, kas, iespējams, varētu būt saistīta ar teritorijas plānošanas procesa nepilnībām (iedzīvotāji nebija pilnībā informēti par teritorijas zonējuma izmaiņām, kas ļāva būvēt vēja parku), personīgajiem ieguvumiem no vēja parka (tiek vai netiek gūts finansiāls labums no parka, īpaši salīdzinājumā ar kaimiņiem), sliktu ēku tehnisko stāvokli u.c. faktoriem. Tādējādi gadījuma pētījums ilustrē problēmas ar vēja parka sociālo akceptējamību (skatīt 8.attēlu).

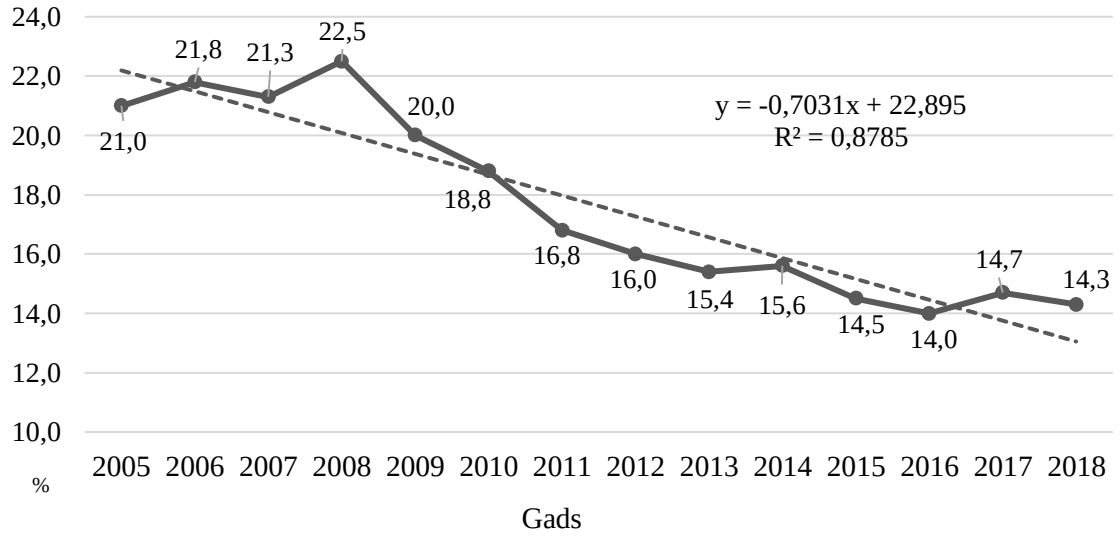


8.attēls. Atbildes par vēja parka darbības radīto troksni (Autore)

Attiecībā uz **dzelzceļa troksni** tika pētīts, kā uzņēmums "Latvijas Dzelzceļš" izmanto dažādus trokšņa pārvaldības instrumentus, kas ļāva konstatēt vairākas nacionāla līmeņa nepilnības. Piemēram, Latvijā tiek piemērota Nīderlandē izstrādātā dzelzceļa trokšņa aprēķina metode "RMR", kā arī ES līmenī trokšņa kartēšanai izmantojamā CNOSSOS-EU metode, kas nav veidotas un pielāgotas 1520 mm sliežu ceļa sistēmai. Tāpēc dzelzceļa trokšņa modelēšana, izmantojot metodi "RMR", uzrāda zemāku trokšņa līmeni salīdzinājumā ar izmērītajiem datiem. Savukārt CNOSSOS-EU metode vēl ir jānovērtē, jāveic korekcijas un jāpārbauda rezultāti, kā arī jāvērtē abu metožu savietojamība. Tāpat jāpārvērtē pielietotā būvniecības un ekspluatācijas

prakse un darbu kvalitāte, jo mērījumu dati liecina, ka trokšņa līmenis ir palielināts pēc sliežu slīpēšanas, kā arī sliežu salaiduma vietās, kur ir spraugas. Tā kā lielākā daļa dzelzceļa kravu nāk no valstīm, kas nav ES dalībvalstis, ritošais sastāvs neatbilst ES savstarpējas izmantojamības standartiem. Saskaņā ar uzņēmuma "Latvijas dzelzceļš" vides pārskatu (Latvijas dzelzceļš, 2018) no 2012. līdz 2017.gadam ir saņemtas 35 sūdzības par troksni. Plašsaziņas līdzekļu analīze parāda sabiedrības bažas par dzelzceļa troksni, tostarp par plānoto Rail Baltica līniju. Reaģējot uz sūdzībām, arī Veselības inspekcija ir veikusi trokšņa mērījumus un secinājusi, ka atsevišķos gadījumos ir pārsniegts pieļaujamais trokšņa līmenis, savukārt iedzīvotāji aicina veikt trokšņa barjeru izbūvi. Tomēr, lai mazinātu dzelzceļa troksni un sūdzības, jārod kompleksi valsts līmeņa risinājumi, savukārt darbības *in-situ* ir rūpīgi jāvērtē, lai neradītu lielāku neapmierinātību gadījumā, ja izvēlētās metodes nenodrošina vēlamo samazinājumu, jo pētījumi parāda gan "RMR" metodes nepilnības, gan to, ka risinājumi trokšņa novēršanai augstākajos daudzdzīvokļu māju stāvos var būt nepietiekami efektīvi un izmaksu ietilpīgi (Baranovskii & Krūkle, 2015).

Sabiedrības atgriezeniskās saites un trokšņa kontroles pētījums parāda ciešu sakarību (R^2 = 0,8785) par mājsaimniecību ziņotajām trokšņa problēmām laika periodā no 2005. – 2018.gadam (skatīt 9.attēlu), kas ļauj secināt, ka Latvijā samazinās trokšņa ietekmēto mājsaimniecību īpatsvars. Vienlaikus pētījumi parāda, ka Latvijā netiek veiktas regulāras trokšņa kontroles, izņemot sabiedrības atgriezeniskās saites pārvaldību Latvijā. Citās valstīs (piemēram, Slovēnijā) tiek sagatavoti gada plāni un veiktas regulāras pārbaudes saskaņā ar tiem. Tāpat Latvijā nav publiski pieejama informācija par atgriezeniskās saites izskatīšanas procedūrām ne valsts, ne pašvaldību līmenī. Veselības inspekcija saņemto sūdzību sākotnējo novērtējumu veic, balstoties uz teorētisku pieeju, un pārbaudēs uz vietas bieži neveic mērījumus, jo nav pieejamas trokšņa mērierīces, savukārt sertificētu mērījumu pasūtīšana ne vienmēr ir nepieciešama. Lai gan šāda pieeja ir ekonomiski izdevīga, tā ne vienmēr var būt pietiekami objektīva.



9.attēls. Latvijas mājsaimniecību īpatsvars, kas ziņo par trokšņa problēmām (Autore, izmantojot Centrālās statistikas pārvaldes (2019) datus)

Tiesiskā regulējuma, institucionālās sistēmas un atgriezeniskās saites analīze un praktiskie gadījumu pētījumi ļāva **novērtēt galvenos vides trokšņa pārvaldības trūkumus Latvijā**, kas saistīti ar zemu izpratni, neefektīvu politikas īstenošanu, uzraudzību un kontroli, likumdošanu, augstu subjektīvo trokšņa uztveri, kā arī trokšņa jautājumu zemo prioritāti. Galvenie trūkumi ir aprakstīti 4.tabulā un izmantoti vides trokšņa pārvaldības modeļa izstrādē. Tie ir grupēti atbilstoši 1.tabulā atspoguļotajiem vides trokšņa pārvaldības

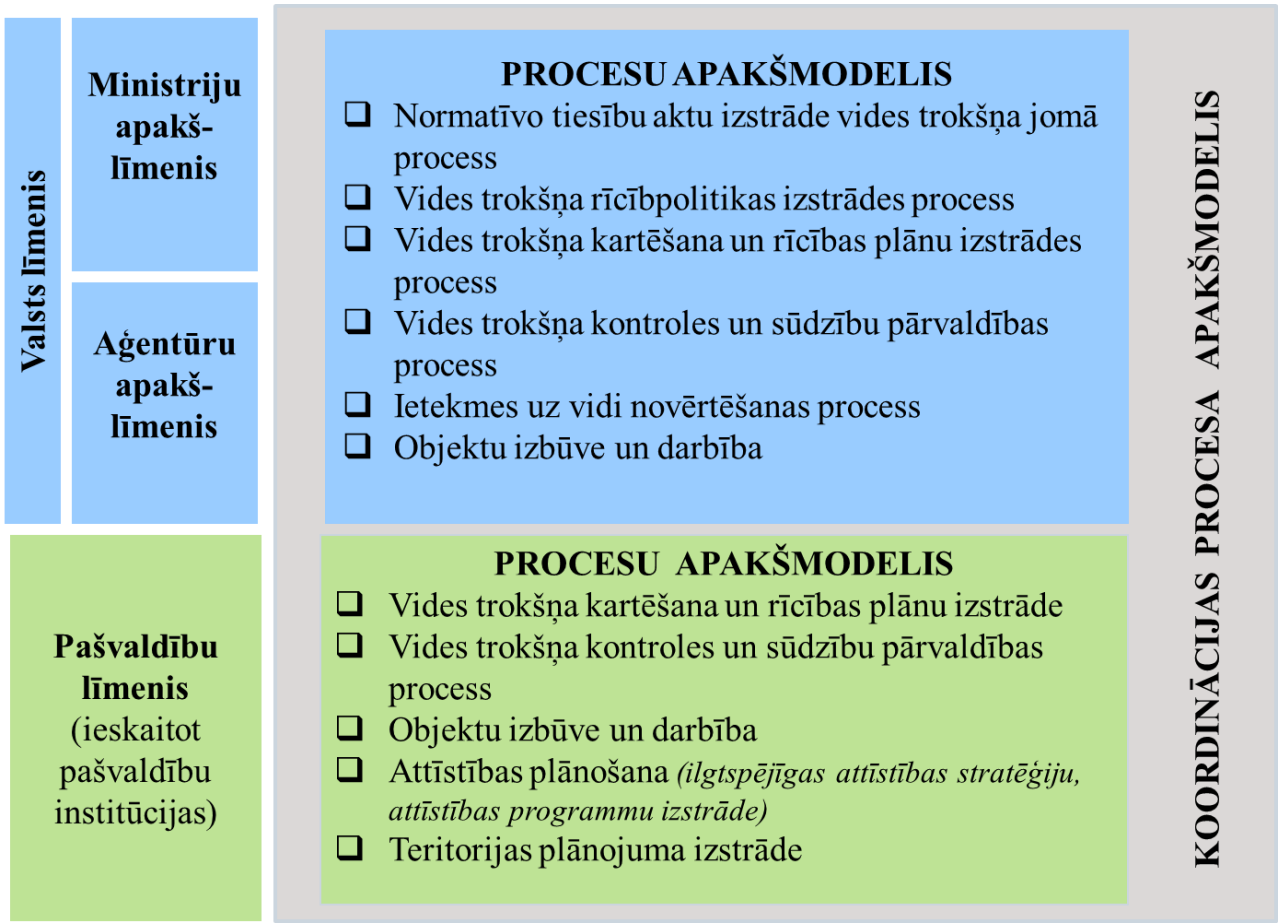
problēmjautājumiem. Katrs problēmjautājums, kas iekļauts tabulā ir identificēts promocijas darba pētījumos, tāpēc tabulā iekļauta informācija uz konkrētu autores pētījuma daļu.

4.tabula. Trokšņu pārvaldības situācijas analīze Latvijā (Autore)

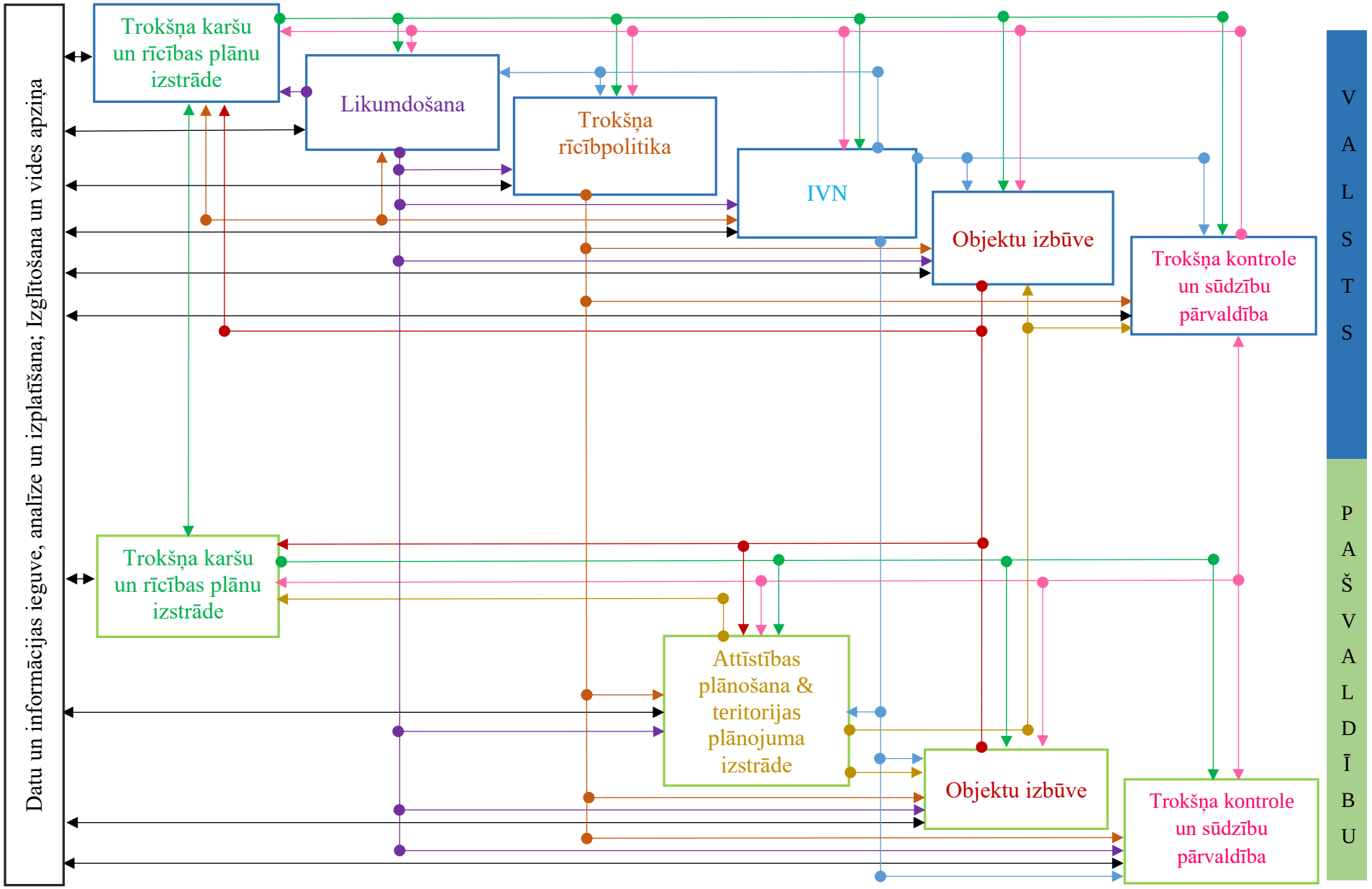
Galvenie identificētie problēmjautājumi	Atsauce uz pētījumu
Informētība par ietekmi, saziņa un ieinteresēto personu iesaistīšana	
Sabiedrība ir daļēji iesaistīta un tās viedoklis netiek pilnībā ņemts vērā. Vajadzība pēc labākas saziņas	Saulkrasti, Kurzeme
Teritorijas plānošanas jautājumi un sabiedrības iesaiste	Kurzeme
Maz informācijas par trokšņa ietekmi uz iedzīvotājiem	Kurzeme, dzelzceļš, Valmiera
Politiskā griba un trokšņa pārvaldība	
Prioritāro pārvaldības pasākumu zema piemērošana	Politikas plānošana
Trokšņa jautājumi parasti ir ar zemu prioritāti. Lielākoties tiek veikti tikai obligāti uzdevumi	Visi gadījumi (vispārīgi)
Nepieciešamība labāk integrēt trokšņa aspektus nozaru politikās, tematiskajā plānošanā	Politikas plānošana, Valmiera
Nav nacionāli koordinējoša orgāna	Institucionālās sistēmas
Politikas īstenošana, trokšņa samazināšana	
Trokšņa samazināšanas pasākumu neieviešana (tostarp rīcības plānu neīstenošana)	Plānošanas dokumenti (Rīga), dzelzceļš
Vājā saikne starp plānošanu un finanšu plānošanu	Rīga
Neatbilstoši veikts IVN, plānotie un piemērotie pasākumi nenodrošina vajadzīgo samazinājumu	Saulkrasti
Ekspluatācijas laikā netiek veikta trokšņa līmeņa pārbaude	Dzelzceļš, Saulkrasti
Politika, standarti un noteikumi	
Problēmas ar kartēšanas un novērtēšanas metodēm 1520 mm sliedēm; RMR metode ir izmantojama tikai ar īpašu aprobāciju; datu kvalitāte	Dzelzceļš
Neatbilstība savstarpējas izmantojamības standartiem	
Pamatnostādņu un izglītības instrumentu trūkums	Tiesību aktu izpēte, labākā prakse
Trokšņa līmenis neatbilst PVO ieteikumiem	Literatūra, tiesību aktu izpēte
Zināšanas, dati un informācija	
Nepieciešams uzlabot datus par akustisko situāciju un iedzīvotāju viedokli	Valmiera, Saulkrasti, Kurzeme
Neskaidrs atsauksmju sniegšanas process	Atgriezeniskā saite
Uzraudzība un kontrole	
Neregulāras trokšņa kontroles un monitorings	Dzelzceļš, atgriezeniskā saite, labākā prakse
Nepieciešamība pārbaudīt troksni jaunos objektos	Saulkrasti
Finansējums	
Nepietiekams finansējums	Dzelzceļš, Rīgas politikas pētījums

4. Vides trokšņa pārvaldības modelis

Promocijas darba veikto pētījumu rezultātā izstrādāts praksē balstīts vides trokšņa pārvaldības modelis, kas ilustrēts 10.attēlā. Tas sastāv no trim apakšmodeļu kopām, kas ietver valsts un pašvaldību līmeņa procesu apakšmodeļus, kas papildināti un savstarpēji saistīti ar vertikālās un horizontālās integrācijas koordinācijas procesu apakšmodeli. Procesu apakšmodeļi sastāv no vairākiem praksē bāzētiem, integratīviem, savstarpēji saistītiem un saskaņotiem procesiem atbilstoši galvenajām attiecīgā pārvaldības līmeņa funkcijām. Kopumā valsts un pašvaldību līmeņa apakšmodeļos ir iekļauti 11 procesi (no kuriem daži procesi ir iekļauti abos līmeņos): tiesību aktu izstrāde, vides trokšņa politikas izstrāde, trokšņa kartēšanas un rīcības plānu izstrāde, kontrole un sabiedrības atgriezeniskās saites pārvaldība, datu un informācijas vākšana, analīze un izplatīšana, IVN, attīstības plānošana un teritorijas plānojuma izstrāde, kā arī objektu būvniecība. Savukārt koordinācijas apakšmodelis apraksta vertikālās integrācijas procesus starp valsts un pašvaldību līmeņiem un starp to apakšlīmeņiem un izveido saikni atgriezenisko saiti starp visiem vadības procesiem. Būtiski koordinācijas procesa elementi ir trokšņu novēršanas padomes izveide, metodisko līdzekļu un procedūru izstrāde, informācijas apmaiņa un izplatīšana, izpratnes veidošana, izglītības un profesionālās kompetences celšana, kā arī datu kvalitāte un pieejamība. Procesu savstarpējā integratīvā sasaiste parādīta 11.attēlā.



10.attēls. Vispārējais vides trokšņa pārvaldības modelis (Autore)



11.attēls. Vides trokšņa pārvaldības modeļa integratīvā procesu shēma (Autore)

Visās procesa shēmās secīgi aprakstīti galvenie procesi, kas cits citam seko procesuālā kārtībā gan teorijā, gan praksē. Gadījumos, kur Autore ir konstatējusi nepilnības procesā, ir sniegti ieteikumi jaunām procesuālajām darbībām vai citiem uzlabojumiem, kas varētu palīdzēt risināt promocijas pētījumā identificētos vides trokšņa pārvaldības trūkumus.

Lai uzlabotu trokšņa pārvaldības procesus valsts un vietējā līmenī, tiek sniegti šādi ieteikumi:

- **Trokšņa pārvaldības vadlīniju izstrāde**. Autore ierosina nodrošināt pašvaldības ar metodoloģiskiem materiāliem, kas palīdzētu uzlabot tiesību aktu izpratni, kā arī sniegtu piemērus, kā troksni var pārvaldīt un ņemt vērā dažādās jomās – rīcībpolitikas un plānošanas dokumentu izstrādē, trokšņa kartēšanā un rīcības plānu izstrādē, lemjot par tehniskiem risinājumiem, samazinot kairinājumu un aizkaitinājumu u.tml. Vadlīniju dokuments būtu noderīgs ne tikai pašvaldībām un valsts institūcijām, bet arī citiem profesionāļiem, kuru darbība varētu uzlabot vietas akustisko kvalitāti. Vadlīniju dokumenti arī palīdz veicināt efektīvāku administratīvo resursu izmantošanu un nodrošina līdzīgu pieeju (attiecīgā gadījumā).
- **Trokšņa novēršanas padome**. Trokšņu novēršanas padome šajā promocijas darbā ir identificēts kā paraugprakses piemērs no citām ES valstīm. Trokšņu novēršanas padome kalpo kā konsultatīvs orgāns, un tajā ietilptu valsts līmeņa iestāžu, pašvaldību pārvalžu vai pašvaldību apvienību, profesionālo NVO, zinātnisko institūciju, mediķu apvienību u.c. pārstāvji. Trokšņa novēršanas padomes būtu jāiesaista stratēģiskās trokšņa kartēšanas un rīcības plānu sagatavošanā, ikgadēju novērtējumu izstrādē par valsts un pašvaldību trokšņa pārvaldības problēmām, priekšlikumu sagatavošanā par trokšņa pārvaldības uzlabojumiem, kā arī darbojoties kā ekspertu komisija/valdības padomdevēja struktūra gadījumos, kad jāatrisina būtiskas trokšņa problēmas vai jāizstrādā normatīvie akti vai rīcībpolitikas dokumenti.
- **Vides trokšņa kontrole un monitorings**. Vides trokšņa kontrole šobrīd tiek veikta tikai gadījumos, kad tiek saņemta sabiedrības atgriezeniskās saite. Tomēr būtu ieteicams izstrādāt ikgadējās pārbaudes plānus lielāko, problemātisko vai jaunu troksni radušo objektu testēšanai, kā arī nodrošināt pastāvīgu vides trokšņa monitoringu trokšņa jutīgajās teritorijās, piemēram, slimnīcās, sociālās aprūpes centros u.c. Dažkārt teritorijās ar augstu, pastāvīgu trokšņa līmeni būtu jāveic regulāra uzraudzība. Nepieciešama tehniskās aparatūras iegāde nesertificētiem mērījumiem (sākotnējām izpētēm), kā arī informatīvu proceduāru aprakstu sagatavošana par trokšņa gadījumu ziņošanu un izskatīšanas kārtību.
- **Būvprojekta ekspertīze**. Būvobjektu, kas ir nozīmīgi trokšņa avoti, projektēšanas laikā būtu jāveic būvprojekta akustiskā ekspertīze, lai nodrošinātu risinājumu atbilstību valsts tiesību aktiem, IVN (ja attiecināms) un, vēlams, ietvertu priekšlikumus par klusākām tehnoloģijām un/vai ekspluatācijas praksi. Šī akustiskā pārbaude kopā ar tehnisko projektu būtu jāiesniedz būvvaldei, lai saņemtu atzinumu par būvprojektēšanas nosacījumu izpildi.
- **Trokšņa preventīva kontrole**. Ja ir tehniski iespējams testēt trokšņa avota darbību atbilstoši plānotajai ekspluatācijas praksei, **trokšņa līmenis stratēģiskiem objektiem ar potenciāli augstu trokšņa līmeni un ietekmi** būtu jāpārbauda objekta nodošanas ekspluatācijas laikā. Ja tas nav iespējams, pēc objekta nodošanas ekspluatācijā Veselības inspekcijai būtu jāpieņem lēmums par objekta iekļaušanu plānoto pārbaužu plānā vai jāpieprasa, lai attīstītājs iesniedz sertificētus trokšņa testēšanas rezultātus izvērtēšanai. Tas attiecas arī uz tiem troksni radošiem objektiem, kam piemērota IVN procedūra.
- **Datu apmaiņa, izglītošana un prakses apmaiņas platformas**. Šādas aktivitātes būtu jāiekļauj ikgadējā komunikācijas plānā, un informācija par tām būtu jāatspoguļo pārskatos Latvijas vides politikas ietvaros. Ieteicams izveidot sadarbību starp augstskolām un valsts un pašvaldību iestādēm par tālākizglītības kursiem un aktuālai piekļuvei zinātniskajai informācijai darba vajadzībām.

Ierosinājumi paredz arī jaunu procesuālo darbību pievienošanu dažādos procesos (t.sk. IVN procesos, attīstības plānošanas, objektu būvniecības, trokšņa kartēšanas un rīcības plānošanas, tiesību aktu izstrādes procesos).

Priekšlikumi ir **aprobēti** ekspertu intervijās ar valsts un pašvaldību līmeņa ekspertiem un citiem speciālistiem. Visi eksperti kopumā atbalstīja izstrādāto pārvaldības modeli, un Latvijas Vides aizsardzības un reģionālās attīstības ministrija piekrita, ka šāds pārvaldības modelis būs praktiski pielietojams un nodrošinātu pārvaldības uzlabojumus.

Secinājumi

1. Vides trokšņa pārvaldība ir priekšnoteikums, lai nodrošinātu holistiski veselīgu un akustiski labvēlīgu dzīves vidi, samazinot vai novēršot troksni kā vides piesārņojumu. Tādēļ ir jāizstrādā visaptveroši vides trokšņa pārvaldības modeļi, kas ietver dažādus pārvaldības līmeņus un kā pamatā ir faktisko situāciju novērtējums un paraugprakses piemēru analīze.
2. Šajā promocijas pētījumā ir analizēti labās prakses piemēri attiecībā uz trokšņa pārvaldību citās valstīs saistībā ar to izstrādātajiem tiesību aktiem, institucionālajām sistēmām, kā arī sabiedrības atgriezeniskās saites pārvaldību. Šī analīze ļāva identificēt adaptējamus labās prakses piemērus, kas ietver metodoloģisko līdzekļu izstrādi, skaidru proceduāru kārtību noteikšanu, nozares konsultatīvā orgāna (trokšņa konsultāciju pārvaldes) izveidošanu un vides trokšņa kontroles nodrošināšanu.
3. Lai noteiktu, kā tiek pārvaldīts vides troksnis, ir veikta vides trokšņa pārvaldības izpēte Latvijā, ietverot dokumentācijas analīzi, gadījumu izpētes, līdzdalības pētījumus, intervijas un anketēšanu, un identificētas pārvaldības nepilnības. Ir secināts, ka vides trokšņa pārvaldības problēmjautājumi galvenokārt ir saistīti ar lielu subjektīvo faktoru ietekmi vides trokšņa jautājumu uztverē, zemu izpratnes līmeni un vides trokšņa jautājumu zemu prioritāti, un pašreizējā trokšņa pārvaldības politikas un attīstības projektu plānošanu, efektīvu ieviešanu un uzraudzību.
4. Ņemot vērā labās prakses piemērus, kā arī informāciju par vides trokšņa pārvaldības trūkumiem, balstoties uz esošajiem vides trokšņa pārvaldības procesiem, tika sagatavots vides trokšņa pārvaldības modelis, izmantojot biznesa procesu modelēšanas tehniku. Pārvaldības modelis sastāv no trim apakšmodeļu kopām, kas ietver procesa modeļus valsts un pašvaldību līmenī, un ir papildināti un savstarpēji saistīti ar pasākumu vertikālās un horizontālās integrācijas koordinācijas procesu modeli.
5. Procesu modeļi sastāv no vairākiem integratīviem, savstarpēji saistītiem un saskaņotiem procesiem atbilstoši galvenajām vides trokšņa jomas funkcijām katram pārvaldības līmenim. Valsts trokšņa pārvaldības modelis kopumā sastāv no 11 procesiem, kas ietver: tiesību aktu izstrādi vides trokšņa jomā, vides trokšņa politikas izstrādi, vides trokšņa kartēšanas un rīcības plānu izstrādi, vides trokšņa kontroli un sabiedrības atgriezeniskās saites pārvaldību, datu un informācijas vākšanu, analīzi un izplatīšanu, IVN, attīstītības plānošanu un teritorijas plānojuma izstrādi, kā arī objekta būvniecību. Vairāki no tiem iekļauti abos vadības līmeņos. Savukārt koordinācijas apakšmodelis apraksta vertikālās integrācijas procesus starp līmeņiem un apakšlīmeņiem, un tā galvenie elementi ir Trokšņu novēršanas padomes izveide, metodisko līdzekļu un procedūru izstrāde, informācijas apmaiņa un izplatīšana, izpratnes veidošana, izglītības un profesionālā kompetences celšana, kā arī datu kvalitāte un pieejamība.
6. Piedāvātie vides trokšņa pārvaldības procesa uzlabojumi ir saistīti ar jauna konsultatīvā orgāna – Trokšņu novēršanas padomes – izveidi, metodisko līdzekļu izstrādi, trokšņa kontroles un monitoringa paplašināšanu, jaunu trokšņa emitējošu objektu būvprojektu kontroli un praktisko testēšanu pie objekta nodošanas ekspluatācijā, kontroli. Tāpat tie ietver jaunu procesuālo darbību pievienošanu IVN procesos, attīstības plānošanu un teritorijas attīstības plāna izstrādi, objektu būvniecību, trokšņa kartēšanu un rīcības plānošanu, tiesību aktu izstrādi un citus. Šīs darbības būtu jāveic, ņemot vērā arī pareizu, uzticamu, saskaņotu un savlaicīgu koordināciju, informācijas izplatīšanu un izglītošanu par trokšņa jautājumiem.
7. Modeļa aprobācija tika veikta, analizējot citu valstu labāko praksi, tādējādi pierādot modeļa efektivitāti un praktisko piemērojamību, kā arī konsultējoties ar valsts un pašvaldību līmeņa ekspertiem un praktiķiem, tāpat ar Lietuvas Veselības ministriju. Šāda pieeja tika izvēlēta, ņemot vērā apstākli, ka piedāvāto vides trokšņa modeli nebija iespējams praktiski testēt, jo tā ieviešanas testēšanai nepieciešamas izmaiņas

dažādos pārvaldības līmeņos un dažādās iestādēs, kā arī ir politiskā griba to ieviest. Aptaujātie eksperti piekrīt disertācijā piedāvātajam vides trokšņa pārvaldības modelim, un ekspertu intervijas ļāva secināt, ka procesus un to uzlabojumus var gan praktiski īstenot, gan tie var uzlabot trokšņu pārvaldību Latvijā, tādējādi uzlabojot dzīves vidi sabiedrībai.

8. Promocijas darba pētījums parāda, ka hipotēzē minētie piedāvātie soļi – citu valstu labās prakses izpēte, nacionālo problēmsituāciju analīze un stratēģiska un integratīva modeļa izstrāde un pielietošana – spētu uzlabot vides trokšņa pārvaldību Latvijā. Promocijas pētījumā attiecīgi sasniegts izvirzītais pētniecības mērķis, izpildot definētos uzdevumus, kā arī pierādīta hipotēze.

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