

Factors moderating people's subjective reactions to road noise

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Introduction

Even when the road administrations have used all the technically feasible and economically possible measures to reduce the noise, there might still be a need for a further reduction of the annoyance perceived by people exposed to road noise to achieve acceptable conditions. Former analyses of the results from noise surveys reveal that only about 1/3 of the variance in the annoyance response is caused by the noise level itself. The other 2/3 are determined by other factors, among these are those often referred to as “non-acoustic factors” [1]. According to the World Health Organization (WHO), road traffic noise is one of the most important environmental risks to health and a major contributor to 1.6 million healthy life-years are lost annually in Europe due to road traffic noise [2]. About half of these can be related to the subjective element “annoyance”.

The surveys display a wide range for the annoyance response. Differences in noise levels of up to L_{den} 20-25 dB to evoke a certain percentage of annoyance are not uncommon [4]. This means that the annoyance response can be altered within wide limits without doing any changes to the actual noise level. So, when all practical noise reduction measures have been applied, the noise impact can still be reduced by making changes in the non-acoustic factors known to moderate the annoyance response.

The FAMOS project is about analysing and testing if non-acoustic moderators for noise annoyance can be a promising tool for obtaining an additional supplement to other noise and annoyance mitigation measures to reduce the annoyance without reducing the noise level further. Non-acoustic moderators in FAMOS covers a large range of “activities” from performing a very good public participation process integrating the neighbours of a road in the decision process, over having access to silent side, to using greenery to improve the visual environment.

FAMOS has been initiated by the Conference of European Road Directors (CEDR) and funded by the CEDR members of Belgium – Wallonia, Denmark, Ireland, Netherlands, Norway, Sweden and United Kingdom. FAMOS is the acronym for “Factors MODerating people's Subjective reactions to road noise”. The project consortium consists of the partners FORCE Technology (Project leader), LÄRMKONTOR and SINTEF.

The Annoyance equivalent noise level shift

Reports from previous surveys of annoyance caused by road traffic noise have been systematically analysed in order to describe the different annoyance moderators [4].

Scientific methods have been used to find, extract, and analyse data and turn the results into models formulated for practical use. It has been quantified how different factors modify people's subjective reactions to road traffic noise.

The “Annoyance Equivalent noise level Shift”, L_{eas} , is the (hypothetical) shift in noise level that will give the same change in annoyance as the presence or absence of a moderator. This is a practical way to express the effect of a moderator. It should not be confused with any actual changes in noise levels. At the same noise level, persons who are not affected by one moderator (blue curve in Figure 1, e.g. “traffic visible”) could be more annoyed than people that are affected by a moderator (orange curve in Figure 1, e.g. “traffic not visible”). The difference of percentage of Highly Annoyed may e.g. be 30 % points. The same annoyance reduction may be observed by lowering the noise level L_{den} by 13 dB (see the black arrows in Figure 1). The “Annoyance equivalent noise level shift”, L_{eas} in this case is about 13 dB. In this example the moderator will change the annoyance response in the same way as a reduction of about 13 dB in the noise level.

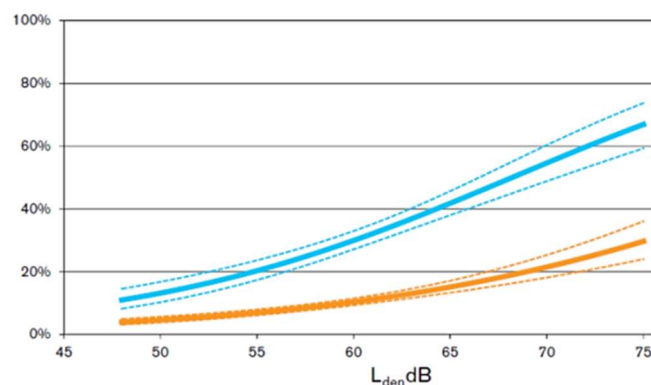


Figure 1: The blue curve shows an example for the percentage of people being highly annoyed in a situation without moderators. The orange curve shows the percentage of highly annoyed in a situation where a moderator has been implemented.

Moderator search and qualification

As a main fundamental of the FAMOS project, the identification of possible moderators was carried out through an international literature study of previous noise annoyance

surveys [4]. It revealed that several factors can change the perceived annoyance by people exposed to road traffic noise [4]. Reducing the noise is an obvious factor, but many other factors have an influence on the annoyance. Moderators are factors that can change the relation between the noise exposure and the perceived annoyance response.

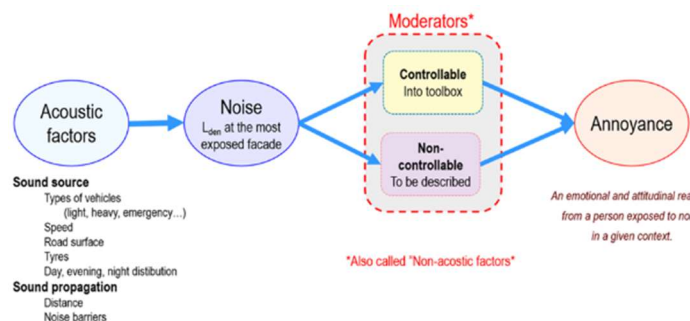


Figure 2: Connection from acoustic factors leading to noise and moderators influencing the perceived annoyance [4].

The non-acoustic factors that will modify the annoyance response can be categorised in different ways:

- The road itself and its immediate surroundings such as type of road, traffic volume, speed limit, road pavement, barriers, visual appearance, etc. These are factors that to a large extent can be controlled or influenced by the road owner – the road administration.
- Factors pertaining to the neighbourhood such as type and location/orientation of residences, prevalence of community conveniences like shops, schools, parks, playgrounds, etc. neighbourhood traffic conditions and so on. These factors can only to a small extent be influenced by the road owner. Options for control are better at completely new developments than for projects in existing communities.
- Relationship between the local residents and the road owner. Do the residents feel a personal ownership to the road and benefit from its existence? Have the residents had a chance to be involved in the planning and construction process?
- Do the residents/neighbours trust the decision makers and road administration? These factors deal with public relations and can to a large extent be controlled and managed by the road owner.
- Factors completely out of control by the road owner. However, it is important to recognize that such factors exist and to know how they affect the annoyance response. These are typically personal and demographic factors like age, gender, income, noise sensitivity, etc.

The results from surveys on annoyance from road traffic noise indicate that the annoyance response is affected by a set of non-acoustic factors in this project defined as moderators. The influence of these moderators, *i.e.*, the magnitude of the effect varies, and the feasibility and practicality of manipulating these factors depend on local circumstances. The objective of the FAMOS project was to focus on moderators that have a large potential for annoyance reduction, and that are easily implemented by road administrations.

Data collection, hypothesis testing and modelling

Three different methods for data collection on perceived noise annoyance were investigated in FAMOS within a limited experimental setup to investigate the suitability of methods for measuring the effect of moderators in future road projects, for hypothesis testing of the order of magnitude for already identified moderators and for gap filling for knowledge missing for important moderators retrieved [4]. The methods used were:

- Soundscape measurements (sound walks)
- Mini survey using questionnaires
- Listening tests performed in the laboratory

Supplementing the findings of the first work packages additional modelling ways concentrated on the most relevant moderators already retrieved. Based on input from the two large Danish questionnaire surveys on perceived noise annoyance [5], [6], the models developed could demonstrate the effect of various moderators [4]. The models provide strong evidence for the effect of the moderators that are found significant in this study [4].

The data from the Danish studies had a very high quality and covered a broad range of questions, many of which were identified in the literature as relevant. This confirms the findings in the literature study to a large extent. The contribution of the modelling was also to further investigate the potential of including more moderators and more interactions between moderators in a multiple regression model and further qualify the list of “questions of importance” to be used in future studies.

Summary on moderators of noise annoyance

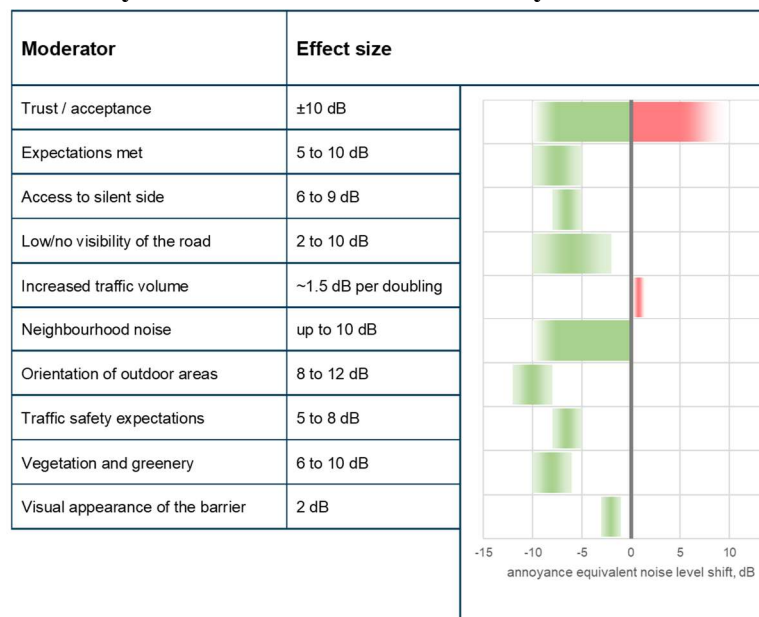


Figure 3: Overview on effect sizes of moderators [4].

Evidence was found that a wide range of moderators affects the noise annoyance [4]. The “direction” of the effect size depends on the situation itself: when implementing a “favourable moderator” like improving greenery the effect

size works towards “lower annoyance”. Whenever a moderator is removed (like greenery) or changed towards a less favourable situation (like increase in neighbourhood noise), the same effect might occur towards “higher annoyance”.

The selected moderators and their order of magnitude can be seen in Figure 3. Except “trust/acceptance”, only the “positive effect” is plotted. This depicts the possible gain that is achievable by road administrations for each moderator, based on a situation “without positive influence of a moderator”. For “trust/acceptance”, the possible effect size of ± 10 dB shows that this moderator might in most cases have an “average” from which a change is possible in both directions. So even without further influence or consideration, the annoyance might increase.

Regarding uncertainties, the literature analysis shows a high variance in the annoyance equivalent noise level shifts for some moderators between different surveys.

Results of listening tests, mini surveys and sound walks also show a high uncertainty, mostly due to a low number of respondents.

For some moderators, dependencies and interactions can be found. The effect size suggests that the effects are not simple to combine for different moderators, as they would result in a total change higher than actual noise levels (e.g., ± 10 dB for trust, up to 10 dB for expectations, 10 dB for vegetation and greenery and so on).

The knowledge found on these moderators has been used as the foundation for developing the FAMOS guidebook (Guidebook how to reduce noise annoyance [3]) that road administrations can use in planning of new roads, enlargements of existing roads, road maintenance as well as in noise abatement projects. The Guidebook also contains examples for different situations on possible effects of those moderators and gives indications on how to implement measures to address those moderators.

Literature

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