A PROPOSAL FOR A HARMONIZED QUESTIONNAIRE AND AN OVERVIEW OF ITS DEVELOPMENT

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1. Introduction

One of the goals for the COST TU 0901 action is to prepare a uniform questionnaire, for the purpose of making ‘standardized’ surveys among habitants in residential buildings, where they are asked to rate the sound insulation and the noise from technical equipment in their homes. The main goal is to compare in a uniform way their average response to the measured physical performance of the building.

The reason for this initiative was a collection of previous studies in the member states that provided some insights, but were difficult to compare since both questions and type of answers differ. The relationship between subjective responses and physical performances may help building authorities decide on minimum, regular and comfort requirements in terms of ISO-standardized single number values. The questionnaire is quite specific on building performance, it addresses sound insulation of floors, partitions walls, external walls as well as noise levels from building service equipment. It is not intended for general noise prevalence studies among the population, nor for traffic noise disturbance surveys. The rationals for different wordings and scales is discussed below and the audience is invited to propose improvements, e.g. during the poster sessions.

2. Some considerations during development

It became clear to us that developing a questionnaire is a complicated task, even more so when it should be applicable to several countries with different languages and building traditions.
On the individual level, the subjective response to noise in one's own home may be influenced by a variety of factors that are beyond the scope of this questionnaire to document. Further information may be found in [21, 6, 7]. Our main focus is to determine the average response of 30-50 habitants in each type of building. Hence individual factors influencing the given answers are hopefully averaged to some extent. The RIGO study in the Netherlands supports this choice [11].

A more detailed background to the questionnaire is described in section 4.

3. The draft questionnaire

The draft questionnaire (Figure 1) is currently tested in 3 buildings in Sweden and possibly also tried in Spain and Austria. The development process will continue during next year, when some experiences with this questionnaire have been analyzed. Future versions will then be proposed and discussed in the WG2 forum on the COST server. The long term goal is to deliver a useful questionnaire during 2012.

4. A background discussion

This section (4) has been prepared mainly by M.Sc. Francisco Javier Andrés Gallego during a three months short term scientific mission stay in Gothenburg.

4.1 Wording questions

The questions should use the right words to get the most appropriate answers to describe responses and the effects of noise from habitants. The language barrier and translations play an important role in exporting and importing data from other surveys and should be taken into account in the selection of the terminology of the questions and the responses scales in the questionnaire.

H. Howarth & M.J. Griffin explains in the paper [18] they have been using combinations of words in the questions of their survey in order to cover a wide range and to be able to establish comparisons. For instance, annoyance or disturbance used in the same sentence let us compare with surveys conducted in other languages because the meaning of them are different in those other languages. So introducing several words let us cover a wide range of surveys and questions. In other words if we want to compare studies between countries we should include several words in the questions.

There are basically three ways to evaluate the subjective response to noise exposures in dwellings, i.e. how people subjectively assess noise: hearing, annoyance and assessment of sound insulation of the home [2, 10]. These terms are described by three questions:

- Do you hear the next source of noise when you are inside your home?
- How much does noise annoy, bother or disturb you?
- How do you assess the sound insulation of your home?

The first question is called as a "filter question" where the answer is "yes or no" and usually it is placed before the annoyance question. The second question on annoyance assesses the degree of discomfort being subjectively perceived, in which the scale of response and its terms play an important role. Lastly, the third question has a technical component which stresses the insulation and acoustic quality of dwellings.
### Instructions:

Choose an answer on the 0-to-10 scale for how much noise bothers, disturbs or annoys you when you are in your house.

<table>
<thead>
<tr>
<th>If you hear the noise but you are not at all disturbed by it, choose 0.</th>
<th>If you are extremely bothered, disturbed or annoyed by it, choose 10.</th>
<th>If you are somewhere in between, choose a number from 1 to 9.</th>
<th>If you do not hear anything at all, the source does not exist or if you cannot answer, choose “Don’t know.”</th>
</tr>
</thead>
</table>

#### Thinking about the last 12 months in your house, how much are you bothered, disturbed or annoyed by:

<table>
<thead>
<tr>
<th>Noise in general e.g. from neighbours, technical installations etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neighbours; daily living, e.g. people talking, audio, TV through the walls</td>
</tr>
<tr>
<td>Neighbours; daily living, e.g. people talking, audio, TV through the floors / ceilings</td>
</tr>
<tr>
<td>Neighbours; Music with bass and drums</td>
</tr>
<tr>
<td>Neighbours; footstep noise, i.e. you hear when they walk on the floor</td>
</tr>
<tr>
<td>Neighbours; rattling or tinkling noise from your own furniture when neighbours move on the floor above you</td>
</tr>
<tr>
<td>Staircases, access balconies etc; people talking, doors being closed</td>
</tr>
<tr>
<td>Staircases, access balconies etc; footsteps or other impact sounds</td>
</tr>
<tr>
<td>Water installations; plumbing, using or flushing WC, shower</td>
</tr>
<tr>
<td>Climate installations; heaters, air condition, air terminal devices</td>
</tr>
<tr>
<td>Service installations; elevators, laundry machinery, ventilation machinery</td>
</tr>
<tr>
<td>Premises; garages, shops, offices, pubs, restaurants, laundry rooms or other, heard indoors with windows closed</td>
</tr>
<tr>
<td>Traffic (cars, buses, trucks, trains or aircraft); heard indoors with windows closed</td>
</tr>
</tbody>
</table>

#### Before moving to the apartment, how important was the sound insulation to you, with respect to:

<table>
<thead>
<tr>
<th>Not at all important</th>
<th>Extremely important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise in general e.g. from neighbours, technical installations etc.</td>
<td></td>
</tr>
</tbody>
</table>

#### How sensitive are you to:

<table>
<thead>
<tr>
<th>Not at all sensitive</th>
<th>Extremely sensitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise in general e.g. from neighbours, technical installations etc.</td>
<td></td>
</tr>
</tbody>
</table>

### Comments:

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Figure 1 - The draft questionnaire (version 2010-09-09)
Then, which is the best wording on how to assess subjective responses to noise in residential buildings? The authors of some major studies prefer annoyance as the primary indicator of noise, have made great efforts in research and development of questions and their influence on the results [4,7]. But the customer satisfaction or assessment of the acoustic conditions begin to have some importance especially in the surveys conducted indoors in new buildings [1].

However, one of the main reasons the ISO/TS 15666 use annoyance as an indicator of noise answers is the ease of comparison with other reports and studies which allows to calibrate surveys.

Terminology used in the question should take into account other factors such as the period of time in the question (results may differ if we ask for a period of 12 months compared to shorter or longer periods). Other factors that may influence the results are the place where the respondent is asked about noise, (in his house, inside home, balcony, garden...), and finally what type of noise sources one asks for. There may also be influences from the use of verbal time (present or past) and the use of “you”, asking the respondent directly or mentioning a more generalized problem [4].

After long discussion, the model question proposed in this questionnaire follows the pattern of questions described in the ISO/TS 15666 [4]:

"Thinking about the last (12 months or so), when you are here at home, how much does noise from (noise source) bother, disturb or annoy you?"

4.2 Rating scale

During the early stage of collecting information when several studies were briefly evaluated, it was found that most of these studies recommended the use of a verbal scale against a numerical scale, or a combination of both to ensure the accuracy of results [4, 7, 16, 17]. Their authors explained verbal scales are easy to understand and to interpret because respondents are familiar with terms, and this contribute to make a more comprehensive scale.

However, there are serious drawbacks with verbal scales. The value of each answer category is influenced by the choice of the most appropriate wording and the standard deviation introduced by this choice [5, 17, 20]. Any word chosen has a different meaning to each respondent, as illustrated by Figure 2.
With a questionnaire designed for several languages, translation of questions and answers is a sensitive and tedious task to perform to get the same meaning of the results. These substantial disadvantages made us choose the numerical scale rather than a verbal scale. The numerical scale does not need any translation because respondents in the member states are familiar with the 10-scale. The steps between the numbers are equidistant, which is important. A possible disadvantage with the numerical scale is that it may appear “technical” to some respondents.

An example may illustrate the effect of a verbal scale where not all words have the same proximity on a numerical scale, as seen by some respondents. For instance, the five answer categories "not at all, slightly, moderately, very, extremely" may appear a reasonable solution for a verbal scale. However, if there is a large gap between two levels, e.g. "3" and "4" [17, 20], the distance between 3 and 4 is different than the between 1 and 2, getting a scale with not equidistant terms. Several authors have tried to find the
best translations and the best equidistant terms introducing mathematical factors [5, 17], but there are still difficulties and need for further research. See figure 3.

<table>
<thead>
<tr>
<th>Verbal label</th>
<th>M</th>
<th>sd</th>
<th>M</th>
<th>sd</th>
<th>M</th>
<th>sd</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>M</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a little</td>
<td>2.5</td>
<td>1.3</td>
<td>2.5</td>
<td>1.4</td>
<td>10</td>
<td>17</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.1</td>
<td>2.7</td>
</tr>
<tr>
<td>average</td>
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<td>1.0</td>
<td>4.8</td>
<td>0.9</td>
<td></td>
<td></td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>1.0</td>
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<td>completely</td>
<td>9.8</td>
<td>0.6</td>
<td>9.7</td>
<td>0.8</td>
<td>81</td>
<td>161</td>
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<td></td>
<td></td>
<td>40</td>
<td>8.5</td>
<td>1.6</td>
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<td>considerably</td>
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<td>1.2</td>
<td>7.6</td>
<td>1.1</td>
<td>57</td>
<td>129</td>
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<td></td>
<td></td>
<td>6.3</td>
<td>1.7</td>
<td></td>
</tr>
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<td>9.6</td>
<td>0.6</td>
<td>9.6</td>
<td>0.8</td>
<td>76</td>
<td>145</td>
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<td></td>
<td></td>
<td>8.3</td>
<td>1.4</td>
<td></td>
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<td>fairly</td>
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<td>1.3</td>
<td>5.4</td>
<td>1.4</td>
<td>46</td>
<td>113</td>
<td>6.4</td>
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<td></td>
<td></td>
<td></td>
<td>6.4</td>
<td>1.8</td>
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<td>fully</td>
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<td>1.2</td>
<td>9.3</td>
<td>1.3</td>
<td>78</td>
<td>161</td>
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<td></td>
<td></td>
<td>7.1</td>
<td>1.8</td>
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<td>hardly</td>
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<td>1.4</td>
<td>1.7</td>
<td>1.2</td>
<td>9</td>
<td>17</td>
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<td></td>
<td></td>
<td>7.1</td>
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</tr>
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<td>highly</td>
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<td>8.8</td>
<td>0.9</td>
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<td>130</td>
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<td>2.1</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td>mainly</td>
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<td>1.1</td>
<td>6.1</td>
<td>1.4</td>
<td>58</td>
<td>129</td>
<td>7.4</td>
<td>1.6</td>
<td></td>
<td></td>
<td>7.3</td>
<td>2.3</td>
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<td>4.8</td>
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<td>4.9</td>
<td>0.8</td>
<td></td>
<td></td>
<td>25</td>
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<td></td>
<td></td>
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<td>6.5</td>
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<td>1.3</td>
<td>5.1</td>
<td>1.1</td>
<td>43</td>
<td>112</td>
<td>37</td>
<td></td>
<td></td>
<td></td>
<td>9.1</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>not</td>
<td>0.4</td>
<td>0.5</td>
<td>0.5</td>
<td>0.9</td>
<td>2</td>
<td>3</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.4</td>
<td>1.0</td>
</tr>
<tr>
<td>not at all</td>
<td>0.1</td>
<td>0.4</td>
<td>0.2</td>
<td>1.0</td>
<td>1</td>
<td>0</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>9.1</td>
<td>1.5</td>
</tr>
<tr>
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<td>1.4</td>
<td>3.8</td>
<td>1.4</td>
<td>21</td>
<td>49</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td>7.0</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>quite</td>
<td>6.1</td>
<td>1.5</td>
<td>5.9</td>
<td>1.5</td>
<td>38</td>
<td>81</td>
<td>6.5</td>
<td>2.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>quite a bit</td>
<td>6.4</td>
<td>1.7</td>
<td>6.5</td>
<td>1.6</td>
<td>45</td>
<td>97</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.5</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>rather</td>
<td>5.9</td>
<td>1.7</td>
<td>5.8</td>
<td>1.6</td>
<td>46</td>
<td>113</td>
<td>5.7</td>
<td>2.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>slightly</td>
<td>2.5</td>
<td>1.4</td>
<td>2.3</td>
<td>1.5</td>
<td>12</td>
<td>27</td>
<td>6.9</td>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>somewhat</td>
<td>4.3</td>
<td>1.7</td>
<td>4.5</td>
<td>1.7</td>
<td>27</td>
<td>49</td>
<td>5.3</td>
<td>2.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>very</td>
<td>8.0</td>
<td>0.9</td>
<td>7.9</td>
<td>0.9</td>
<td>63</td>
<td>129</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td>9.2</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>very much</td>
<td>8.7</td>
<td>0.7</td>
<td>8.6</td>
<td>1.0</td>
<td>71</td>
<td>145</td>
<td>8.7</td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Project VGS, ROHRMANN 1998

Figure 3 - Relation between verbal scale labels and estimated mean and standard deviation in the corresponding numerical rating of these labels. Rohrmann [17]

The questionnaire in figure 1 uses a 11 point numerical scale (10 steps from 0 to 10) with an explanation in the header, see Figure 4.

Instructions:
Choose an answer on the 0-to-10 scale for how much noise bothers, disturbs or annoys you when you are here at home.

- if you hear the noise but you are not disturbed by it, choose 0
- if you are extremely bothered, disturbed or annoyed by it, choose 10
- if you are somewhere in between, choose a number from 1 to 9
- if you do not hear anything at all, the source does not exist or it is not possible to answer, choose "?"

Figure 4 - Instructions for completing the scale of the questionnaire.

The familiarity with the 10-scale in different countries (ten point scale better than 5 point or 7 point) made some authors recommend it for international studies [4, 7, 16]. Its ease to turn answers into percentages, among other factors, made us choose this scale for the draft questionnaire.
The design of the scale uses two words for the extremes, “not at all and extremely” which are easy to translate into other languages so as to have a clear understanding. Also two “funny faces” where placed above each word to remind the respondents of the meaning and direction of the annoyance scale, see Figure 5.

4.3 Use of filter questions

The use of filter questions can be a good choice [16], whenever they do not increase the questionnaire time. Howarth & Griffin [18] recommend them in some cases (based on their experience) but also to avoid them if possible, because filter questions can be viewed by respondents as long questions introducing errors in their answers.

In this draft questionnaire we do not use any filter question. The institute should take care to inhibit questions on noise sources that do not exist in the surveyed building. However, the question should not be omitted, its presence shows the respondents it is taken into account in other places but is not relevant in the case it is “grey”. In this way we avoid repeating filter question asking about the existence or the respondent hearing a specific noise source.

4.4 Blocks of questions

The questionnaire contains a minimum amount of questions. It is based on several types of surveys [10, 12, 16, 18, 22, 23] and addresses the most important sources of noise inside dwellings. It also addresses rattle noise produced by vibrations in the floor, e.g. when neighbours walk on it.

The questionnaire consists of several blocks:

1. Introduction: Explanation of the purpose and objectives of the questionnaire
2. General question: a question about noise in general.
3. Questions about annoyance generated by different noise sources.
4. Question about expectations.
5. Question about sensitivity.
6. Personal data

Building data should be collected by the survey institute prior to making the survey. The institute should document building details, drawings, and other information that may be useful to characterize the sound performance of the constructions.
4.5 Order of the questions in the questionnaire

The order of questions in the questionnaire follows the criteria of the ISO/TS 15666 [4] and some other studies [7]. It introduces a general question, before the annoyance questions, without specifying the source type or the situation of the respondent in their home. The questions about other factors that influence the reported annoyance, e.g. the sensitivity and expectations are included after the annoyance questions in order not to influence them. This is because personal preferences could influence the response to the annoyance questions.

4.6 Noise sources evaluated

Respondents are not asked to determine which sources of noise they hear in their homes. The institute could determine those noise sources through by other means (building data, measurements etcetera). The most annoying sources in each type of dwelling will be included in the questionnaire so as to save time not asking twice (first if they hear the source and then about the annoyance level).

Each subjective response and each noise source will be correlated with the different parameters of airborne and impact sound insulation or sound pressure level. Other studies [11, 24] show an increased discomfort by certain sources of noise on habitants and give a list of the most heard noise sources and most annoying. In these lists it is found that most countries have the same noise sources and almost the same most annoying sources (loud conversations, music, walking heavily on floors...). There is no need to ask for them several times.

4.7 Sampling respondents

The sampling of the survey respondents should preferably be as heterogeneous as possible in each block of buildings, trying to cover different types of buildings and different types of personal factors as a age and gender.

4.8 Measurements

To correlate the noise dose with sound insulation values it is important to take measurements “in situ” (including in the survey documentation the methodology followed, number of measurements and the instrumentation used) or to be able to estimate those values through construction details, building data and traffic noise plans (calculated by computer programs, through laboratory measurement values, etc).

4.9 Analysis of results

Analysis of the results will be carried out using, as a recommended method, linear regression. There are other methods, including a classification of the sample surveyed in clusters (age, quality of construction...), but the simplicity and the ease and interpretation of data without complex mathematical operations allow a faster exchange of information and data, without having to convert scales or analyse complex results. If the survey institute want to make a classification with clustering or introduce other changes everything would be explained in detail and the reasons why has been made, enclosing it in the survey documentation.
The results of the expectations and sensitivity blocks could be used, if necessary, to adjust the slope of the results obtained in the annoyance block.

5. Acknowledgements

This work has been facilitated by several persons. We have enjoyed an open discussion climate where documents, opinions and advice were shared. Surveys and other related documents were submitted by COST Action members, other acousticians and experts through mails and through the COST server. Survey researchers from the Sahlgrenska Academy and the Chalmers University in Gothenburg gave valuable advice. All support given is hereby gratefully acknowledged.

6. References

[19]. A. Izewska, “Requirements for impact sound insulation between dwellings from the point of view of acoustical comfort of inhabitants”, Poland 2005.