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Developing a Uniform Questionnaire for Socio-Acoustic Surveys in Residential Buildings

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CHAPTER 6 Developing a Uniform Questionnaire for Socio-Acoustic Surveys in Residential Buildings

6.1. Introduction

The purpose of this chapter is to document the development of a uniform template for a socio-acoustic questionnaire and some supporting documents. This work has been made by the working group 2 (WG 2) under the COST action TU 0901, from 2010 to 2013.

Noise from sources of different kinds in multi-storey residential buildings is often problematic to their occupants. The noise may be caused by the neighbours (music, conversation, walking, jumping, running and even pet noise) as well as service equipment or environmental activities (traffic, industrial noise). The European Construction Product Regulation states in its 5th essential requirement that new and renovated dwellings shall provide sufficient protection against noise (i.e. sound insulation) to allow privacy and reasonable activities without disturbing neighbours. Indeed, exposure to noise can have negative effects on a person's ability to communicate, relax and sleep, and it can generate health troubles, psychological disorders as well as conflicts. It is not necessarily the noisy event itself that is most problematic for health but rather, the lack of silent periods needed to recover.

The results from the World Health Organization's WHO "Lares" Survey about European housing (Large Analysis and Review of Housing and Health) carried out in 2002-2003 show that neighbour noise is a health problem and the reduction of indoor noise exposure was included in the proposed objectives for a policy with the following recommendation:

> *"Little attention was paid to neighbour noise till now and therefore pathological effects are considerably under-estimated. The health effect of neighbour noise induced annoyance is approximately in the same range as the health effect of traffic noise induced annoyance. The results point out, that it is necessary to improve the sound insulation in residential buildings. The cardio-respiratory system also reacts to neighbour noise with increased relative risks."* (http://www.euro.who.int/en/health-topics/environment-and-health/Housing-and-health/

activities/the-large-analysis-and-review-of-european-housing-and-health-status-lares-project)

Therefore, there is a need to improve the awareness in the construction sector of the negative effects of insufficient sound insulation on dwelling occupants. Sustainable building and urban development as well as certification schemes should take into account the acoustic and sound insulation requirements.

The main task of the COST TU0901 Action was to propose harmonized criteria for sound insulation and a classification scheme for residential buildings in Europe. To choose suitable criteria, it was essential to establish statistical relationships between the average reaction of occupants of a building to noise and the physical single number quantities that can either be predicted during the design stage or measured in the erected building. The physical single number quantities could be the weighted airborne and impact sound insulation as described by the international standard EN ISO 717. Other single number quantities could be considered as well.

However, assessing the reaction of occupants to noise in their homes is a complex task to accomplish. Such reactions are often influenced by factors other than the sound exposure. The other factors can include the occupants expectations, satisfaction, sensitivity and attitude to noise. Hence, such factors may be expected to influence individual answers given in a questionnaire. There are some studies where researchers have tried to take such effects into account (e.g. the "Genlyd" project made at the DELTA institute in Denmark 2004-2007). Furthermore, reactions to noise can be affected by a presence of several simultaneous sources of noise, e.g. exposure to noise from several types of traffic may increase the overall annoyance compared to exposure from one source at a time.

The underlying intention of the questionnaire presented by WG 2 is to determine the average annoyance of the occupants in a building and to relate an average value to the physical property of the building, e.g. the average annoyance from traffic noise (heard indoors) with the sound insulation of the façade. The questionnaire is not intended to reveal causes of subjective responses by individuals to noise in buildings. Furthermore, the questionnaire was written so as to minimise the possibility of unreliable interpretations of terminology or label or scale errors, bearing in mind it should be used in many countries. For this purpose, it was decided at an early stage that the questionnaire template,

a cover letter and some instructions to the survey should be written in a kind of simplified "Euro-English" in order to facilitate the translations into a variety of European languages as translated by the WG 2 members, including even a UK English version.

The summary of the questionnaire presented in this chapter is based on a student project report made by F J Andrés Gallego from the University of Valladolid (Spain) during his COST short term scientific mission (STSM) in 2010 at Simmons akustik & utveckling in Gothenburg, Sweden. However, the first draft of the questionnaire which was presented in 2010 has since been revised several times to reflect the lessons learned from surveys which were conducted in the participating countries. For this reason, the STSM-report by Gallego has been slightly modified by C Simmons and members of WG 2. The reasons for the changes have been described and a list of the surveys made since 2010 has been included.

It should be kept in mind that the COST TU0901 questionnaire template has been developed within a collective process that was more in line with standardization work than purely scientific work. Therefore, the questionnaire template is based on several scientific publications as well as practical experiences. Many compromises have been made in the process and the final result is based on the contributions of several people whose work is gratefully acknowledged.

This report provides descriptions and comments made during the stages of development of the socio-acoustic survey questionnaire. The questionnaire has been designed to obtain averaged responses by the occupants of buildings for the purpose of correlating those responses to various types of single number quantity related to airborne sound insulation, impact sound insulation, service equipment sound and traffic sound. Measurements would be used to determine the physical parameters, or in some cases predicted values from theoretical calculations.

The various means of perceiving noise, alternative response terminologies and ratings scales, the effects of wording questions, the use of filter questions, the order of questions and the segments of the questionnaire have all been considered. In some supplementary parts of the template, the means of obtaining building data and acoustic building measurements are described for the purpose of correlating these to the subjective ratings given by the occupants.

While a range of international standards defining measurements of noise, vibrations and other environmental measures are readily available, there

are presently no standards or common methods for measuring people's ratings of the protection against noise although many types of questionnaires have been used in Europe. The lack of standards and common methods makes it almost impossible to compare results from different studies and different countries.

Therefore the socio-acoustic survey questionnaire template presented may be a first step to establish a standardised way of assessing occupants' rating of their dwellings with respect to noise sources, e.g. neighbouring apartments, building service equipment, and traffic noise. The design of interior walls and floors as well as facades may differ between the European countries, but the methods to describe the physical performances of the building elements and the method of surveying the occupants to determine their impression of the sound and impact insulation the elements provide should be harmonized.

6.2. Scope

The main purposes of a harmonized questionnaire and its application to socio-acoustic surveys are:

1. To make survey results among occupants from different studies more comparable within or between countries.
2. To deduce the best correlation between the subjective ratings by occupants of the sound levels and sound insulation of their dwellings and to compare these ratings to the various physical single number quantities that describe the acoustic performance of the building.

6.3. Field of application

The questionnaire is intended for socio-acoustic surveys where objective data on the acoustic performance of buildings and service equipment are collected and correlated to the subjective rating by the occupants in order to establish target values for physical single number quantities that reflect the quality goal of a builder, e.g. «not more than 10% should be annoyed by noise more than occasionally».

The institute undertaking the survey shall either collect measured sound data, use generic data of constructions developed by WG 1, or estimate data based on the building constructions and service equipment prior to the enquiry. This step is essential since all questions in the template that are not relevant for a particular site shall be blocked and painted with a

grey shadow. This is to still show the occupants that such questions are considered in general cases but the institute performing that specific survey is aware that they are irrelevant in the specific building. For instance, questions about traffic noise or noise from air conditioning shall be blocked if such sources are not present at the site. The numbering and order of questions shall not be changed if individual questions are blocked out.

The principal quantity used to rate the performances is «the annoyance of noise». It has been considered to ask the occupants for their opinions on «how satisfied are you with the sound insulation». However, such approaches were discarded during the development process. One reason the approach was discarded was that the question was difficult to translate into some languages. Another reason was the recommendations of the ISO technical specification ISO/TS 15666 which has influenced the design of the questionnaire to a large extent.

6.3.1. Limitations

The questionnaire is not intended for broad prevalence surveys to characterize the general degree of annoyance from noise in the population of a city or a country. This questionnaire is also not intended for social surveys where no building data is available. It is also not suited to predict annoyance by individuals. Rather, the survey is only applicable for determining the average rating given by a large population of occupants of dwellings in multi-storey houses or attached row houses. Questions about traffic noise or noise from service equipment may be relevant to occupants of single-family housing, but in such cases, questions about noise from neighbours should be blocked.

This questionnaire should not be amended by more questions, e.g. related to other environmental factors or customer satisfactions. Doing so will change the meaning of the questions, potentially giving different results and introducing errors. To keep the questionnaire within one A4-page proved an important property to obtain a high response rate. This is because questionnaires that span over many pages may tire the respondents and therefore, may reduce the response rate as well as the quality of the answers submitted.

The questionnaire is not intended for research on annoyance from traffic noise outdoors. There are other questionnaires designed for this purpose. The questions on façade insulation are only included to assess whether the occupant judge the performance of the building elements (wall, window, air inlet etcetera) appropriate with respect to the sound insulation of the dwelling.

This questionnaire is not intended for assessing neighbours behaviour. The only purpose of the questionnaire is to evaluate the acoustics conditions of the dwellings in a broad sense.

This questionnaire doesn´t make a difference between day and night annoyances but it asks for working times. Therefore, provided the number of responses is large enough to allow for subsets of responses, the response of the could be sorted into different categories.

There are many other factors that are not taken into account, e.g. type of ownership, personal situations, etcetera. Any specific factor may be researched if several studies are performed in parallel, while all other factors are randomized.

6.3.2. Recommendations for translations

The questionnaire should be translated with the intention of keeping the meaning and the wording in the new language the same as the original in the Euro-English template. It is recommended to reference the standard, ISO/TS 15666 as it includes translations in many languages of the main questions of the questionnaire. Particular attention should be paid to the words which replace "bothered, disturbed or annoyed by".

It is not recommended to include any other words in the scale except the extremes, as has been done in the questionnaire template. Introducing an intermediate word in the numerical scale does not facilitate occupant answers, but rather confuses the occupants [5,17]. Furthermore, these intermediate terms are more difficult to translate than the extremes. This is discussed further in the following sections.

The numbering and order of questions shall not be changed and the layout shall be maintained. Only changes necessary for the translated texts to fit on one page should be made [7, 18, 25].

6.4. Terms used during the development

In order to facilitate translations and interpretation, this section provides definitions to describe the intended meaning of the wording in the questionnaire template. These definitions are not applicable outside of this context and not all of them are used in the questionnaire.

Socio-acoustic survey

Surveys designed to measure an average rating by occupants of noise in buildings to establish statistical relationships to physical parameters, e.g. the measured sound insulation as defined in EN ISO 140. The noise may

come from interior sources (neighbours, equipment) or traffic noise heard indoors (through windows).

The main characteristic of socio-acoustic surveys when compared with social surveys is that they provide information about the actual building performances and sound levels that pertain to the group of dwellings as have been rated by their occupants.

Social survey

General surveys of living conditions or broader environmental studies where responses are not usually linked to objective measures of noise exposure [16].

Noise

Unwanted sound from specific sources in the building or its outside, as described by measured or calculated single number quantities. [4]

Tolerance

In this context tolerance is defined as the act or capacity of enduring to noise. In other words it is the "sensitivity to annoyance from noises" or the risk of annoyance when hearing sounds.

Tolerable noise

Noise that seems not to bother occupants too much. For example, broadband and stable sounds at low levels from remote traffic, heating and ventilation, without any tones or impulses [20].

Intolerable noise

Noise that seems to bother or annoy occupants, possibly because the levels are too high or the character of the sound is unpleasant, e.g. from the usage of a WC, flushing water through the sewage water pipes, tonal and impulsive noise from an elevator as well as a laundry machine [20].

Noise-induced annoyance: a person's individual adverse reaction

The reaction may be referred to in various ways, including for example, dissatisfaction, bother, annoyance, and disturbance due to noise.

Global annoyance

The accumulated specific annoyance integrated over a range of contexts and over a range of locations at home (e.g. at the balcony, in the kitchen, in the bedroom) [4].

Specific annoyance

Accumulated specific annoyance: The annoyance for a specified stimulus in a specified context for specified persons integrated over time and experiences.

The accumulated specific annoyance is the immediate annoyance and the connected experiences integrated over time, i.e:

- Conversations inside a home affected by traffic noise
- Working next to a noisy printer
- Neighbour usually rehearses drums every evening [7]

Immediate annoyance: The annoyance for a specified stimulus in a specified context for specified persons when the noise actually is present during or immediately before the evaluation of that particular noise. Immediate annoyance may be relevant for the following examples:

- Aircraft passing while you are talking in a phone
- Passing a pneumatic drill on the pavement
- Irrelevant speech while you are working in an office

Noise Annoyance

An emotional and attitudinal reaction from a person exposed to noise in a given context [7].

Noise sensitivity

The degree of susceptibility to noise. According to several authors [21, 26] there are two different concepts of noise sensitivity:

- *Sensitivity to loud noises*: susceptibility to very loud sounds in the distance such as traffic or construction noise.
- *Sensitivity to situations of distraction*: susceptibility to lower, but disturbing, sounds from the direct vicinity such as rustling paper in the cinema or people talking in the background while watching TV (daily disturbances or sensitivity to noise).

Annoyance question

Question or questions with or without filter questions utilized for eliciting people's annoyance to sounds including the response that the sounds are not noticeable [16].

Filter questions

Could be used to determine the respondents who are affected by hearing noise and to measuring their reaction. However, filter questions have been avoided in the questionnaire template because they lengthen the time to complete the survey [16].

Behaviour

The actions or reactions of any person while making or receiving noise.

Modifying factors

Factors that influence the relationship between exposure and effect [16].

Such factors can be

-*external* - such as the presence of additional environmental problems, smells, air pollutions, visual impact in general, visibility of source from home, size of the source, vibrations, location of the dwelling, home ownership, sound scape, etcetera.

-*internal* - such as the degree of sensitivity to noise, expectation, attitude to source, perceived health risks, etcetera.

Exposure-effect relationships

Describe the proportion of people who report or experience an effect at different values or intervals of the chosen noise exposure measure. Exposure-effect relationships may also be described statistically by means of the estimated relationship between an exposure and an effect based on a stochastic model.

Expectations

What is considered the most likely to happen. In this context the hope of having a home with good airborne and impact insulation and the hope of living in a good area, good apartment as the interviewed expected. According to the Genlyd project, there are three types of expectations: Expectation

about acoustic quality, about the noise duration and about the increase in the noise level.

Satisfaction

Confident acceptance of something as satisfactory, dependable, true, etcetera. It has been determined that questions regarding satisfaction were not as direct as questions regarding annoyance. Therefore, they could be used to infer the quality of the rating, in particular for noise from equipment or traffic. Questions about satisfaction were considered for use about the sound insulation but were discarded after some considerations within the WG 2.

Attitude to source

The attitude to the sound source may be seen as a number of reasons that may moderate the rating people give to the noise. Several reasons could be grouped under one common factor called attitude. Personal attitudinal factors like attitude to the specific sound source in the specific neighbourhood (Do I want it here?), feeling that the noise annoyance is preventable, did we have influence on the planning process, etcetera [7].

6.5. Question wording

Selecting the wording of the questions used for a questionnaire is a delicate task. There are many factors that influence how the respondents (the occupants) understand the questions, in particular when the questions are to be translated into many languages. The type of, relative weights of, and the optional answers presented are also important to consider. In every word, the way of asking, the type of question and its context introduces a bias error to the answer. This is why it is strongly recommended not to change the questions of the sample questionnaire or the rating scale and to preserve the meaning of the template as much as possible in the translations.

In this work, different ways of wording questions and types of questions were analyzed and it was concluded that are three categories of wordings for question and answers.

- **Hear / notice questions** - An objective question used for detecting noise through partition walls and used as a filter question before the annoyance or assessment question. Rating Scale: Yes/No, or asking to select the sources you can notice or hear through a wall or a floor, etcetera [16, 22].
- **Annoyance questions** - ISO/TS 15666 was published, many questionnaires have followed the guidance of the standard to be able to make relations

with other surveys. Many of the traffic noise and vibration surveys have followed the guidance of the standard. Quantifying annoyance is indispensable for two tasks: to identify individual levels of noise impacts and to operationalize the noise problem for populations (e.g., "% highly annoyed" in the vicinity of an airport) [17]. It is a subjective question. Rating Scale: Neutral to negative (unipolar) [4, 7, 16].

- **Assessment or satisfaction questions** - A subjective question but more objective than annoyance question to assess, evaluate, or to rate the insulation or the acoustics qualities of an apartments or dwelling. Rating Scale: Positive to negative and neutral to positive [1, 12]. This type of questions is further commented in section 10.

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

Some surveys [18] have used combinations of words to cover a wide range of meanings and to be able to establish comparisons. For example, annoyance or disturbance used in the same question allows for comparison of data against surveys conducted in other languages since the meanings of words may be different in those other languages. Therefore, introducing several words makes it possible to cover a wide range of surveys and questions.

What is the best wording or how to assess subjective responses to noise in residential building? The authors are convinced annoyance is the primary indicator to noise *for the purpose of this questionnaire*, making a great effort in research and development of questions and their influence on the results [4,7]. The satisfaction or neutral assessment of the acoustic conditions has some advantages, c.f. section 10 of this report. The assessments begin to be more common especially in the surveys conducted indoors and in new buildings [1]. However, one of the main reasons why the authors opted for the use of annoyance as an indicator is the ease of comparison with other reports and studies which allows for the calibration of the template questionnaire. Another reason is the ease of making translations.

The remaining terminology used in the question took into account other factors such as the period of time in the question (It is not the same to ask for a period of 12 months than a shorter or longer period), the place the occupant is asked about, (in his house, , balcony, garden...), and finally

what type of noise sources are involved. Finally, the importance of the verbal time (present) and the use of "you", asking directly to the interviewed [4] has also been taken into account.

The model question proposed in this study follows the pattern of questions developed by the standard, ISO/TS 15666 [4] where the influence of those factors is studied. As a result, the following question wording was included in this questionnaire*:

The right period of time:	"Thinking about the last 12 months when
Person or family reaction asked for:	you are, your family are
Place:	here at home, in your neighbourhood, outdoors
Answer to choose for a degree of response:	how much
General noise:	does noise,
Specific noise source:	from (name of the source)
Wording for assessing the degree of annoyance:	annoy, disturb, bother
Person evaluation the question:	you"

See reference [4]

* Question used in the questionnaire: "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?"

6.6. Type of questions

There are four types of questions: the direct rating question, the indirect and comparison questions, and the indirect question via statement. The direct question has been almost universally accepted as the primary measure of relationship between noise and respondent´s subjective reactions. Answers to such direct questions are more explicit and more readily interpreted than indirect questions or comparison questions [4]. Indirect and comparison questions have not supplemented the direct question as the primary indicators of noise impact because they can only be used to infer indirectly how people feel about noise.

Direct questions are the most commonly used in noise surveys questionnaires. Although the use of direct questions can lead to good results since they explain clearly what you are asking for, so there is not too much wide range of interpretations, the direct questions introduce an error due to inducing people to chose an answer. This questionnaire follows the ISO/TS 15666 recommendation and makes use of the direct question.

6.7. Rating Scales

Two main scales have been considered in the course of developing the questionnaire template: verbal/categorical and numerical scales. During the preliminary stage of collecting information where several studies were 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]. The protocol used to choose the words used for the answer scale attempts to ensure that the commonly understood meaning of the word is consistent with its position on the scale [4, 16]. The verbal scale is needed for the clearest, most transparent communication. The simple task of choosing a word is most likely to be easily performed by respondents of any degree of sophistication and in any culture. Other advantages are the easy understanding and the familiarity with the words, assuming most people prefer verbal scales and it also facilitates to capture normative judgments [17].

The disadvantages of using the verbal scale are determined by using the most appropriate terms and the standard deviation introduced by it [5, 17] as shown in Table 6.1. Not all the words used have the same meaning and there is not necessarily the same distance between the categories the words are compared with a numerical scale as shown in Figure 6.1. Also, multi-lingual translations of words with ambiguous meanings are difficult and since this questionnaire is intended to be used in many languages, it was considered an advantage to use as few words as possible.

There are some cultural factors that might confound the data, and most important, cross national and international comparability makes it difficult due to the meaning of the words in different countries. Not all words have the same proximity on the scale, in particular in the middle part of the scale. So, to take an example, if we consider using the five terms [17] “not-at-all”, “slightly”, “moderately”, “very” and “extremely”, they may appear a reasonable solution for a verbal scale. However, evaluating this trial scale, shows that there is a rather large gap between level “3” and “4”, so the distance between 3 and 4 may be different than the separations between 1 and 2, resulting in a scale with terms that are not equidistant. Several authors have tried to determine the best translations in different languages for a verbal scale and the best equidistant terms by introducing mathematical factors, but there are still difficulties and further research is needed. This problem is explained in the document “On the Meaning of Noise Annoyance Modifiers: A Fuzzy Set Theoretical Approach” [5] where a five point verbal scale is deducted as the most accurate in several languages thanks to the mathematical model applied, as shown in Table 6.2.

Table 6.1. Scaling Verbal Qualifiers: selected results for "Intensity". B. Rohrmann.

Scaling task	Categorial (0...10 scale)				Magnitude <#>		Prefered Label (% respondents) for annoyance scale level					Familiatity	
Context	Noise		All		All							Noise	
	M	sd	M	sd	M	sd	1	2	3	4	5	M	sd
Verbal label													
a little	2.5	1.3	2.5	1.4	10	17		13				7.1	2.7
average	4.7	1.0	4.8	0.9					28			8.8	1.0
completely	9.8	0.6	9.7	0.8	81	161					40	8.5	1.6
considerably	7.5	1.2	7.6	1.1	57	129				21		6.3	1.7
extremely	9.6	0.6	9.6	0.8	76	145					47	8.3	1.4
faily	5.1	1.3	5.4	1.4	46	113						6.4	1.8
fully	9.2	1.2	9.3	1.3	78	161							
hardly	1.6	1.4	1.7	1.2	9	17		18				7.1	1.8
highly	8.6	0.7	8.6	0.9	68	130						7.4	2.1
mainly	6.4	1.1	6.1	1.4	58	129				18		7.4	1.6
medium	4.8	0.8	4.9	0.8					25			7.3	2.3
moderately	4.9	1.3	5.1	1.1	43	112			37			6.5	2.0
not	0.4	0.5	0.5	0.9	2	3	17					9.4	1.0
not at all	0.1	0.4	0.2	1.0	1	0	70					9.1	1.5
partly	3.5	1.4	3.8	1.4	21	49		14				7.0	1.8
quite	6.1	1.5	5.9	1.5	38	81						6.5	2.4
quite a bit	6.4	1.7	6.5	1.6	45	97							
rather	5.9	1.7	5.8	1.6	46	113						5.7	2.3
slightly	2.5	1.4	2.3	1.5	12	17		27				6.9	1.8
somewhat	4.3	1.7	4.5	1.7	27	49						5.3	2.7
very	8.0	0.9	7.9	0.9	63	129				16		9.2	0.8
very much	8.7	0.7	8.6	1.0	71	145						8.7	1.5

The results indicate:

- for some of the tested VSPLs people differ considerably in their allocation of pertinent intensity levels - see items with high standard deviation sd;
- no significant differences between ratings of context-bound (noise) and context-free presented VSPLs;
- rank order of main VPSLs very similar in CAT, MAG-N and MAG-L scaling results;
- when selecting VSPLs for to-be-labelled 5-point scales, most respondents prefer extreme labels at the end (levels "1" and "5");
- most VSPLs are rated as familiar and easy to understand.

Source: Project VQS, ROHRMANN 1998

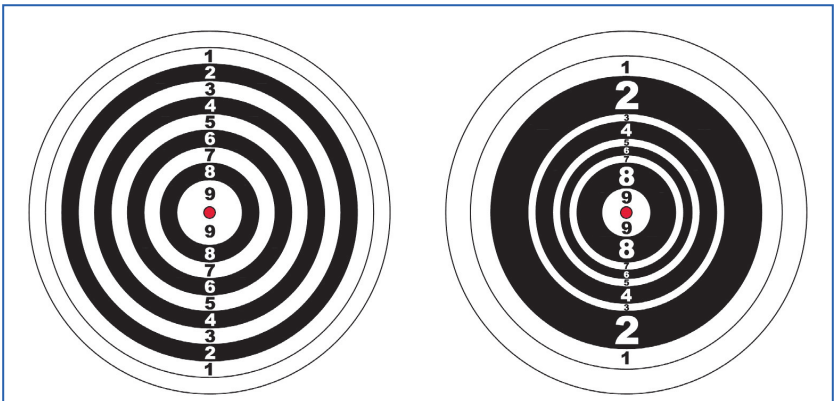

Figure 6.1. *Illustration of the meaning of a numerical scale and a verbal scale from the point of view of how occupants. Wording can make some words appear more important and with more weight than the others, distorting the real meaning of each number or word. Also reducing or increasing the gaps between words may play a role.*

Table 6.2. *Best match with the 5 fuzzy ideal labels in each of the languages considered. Source D. Botteldooren.*

	label 1	label 2	label 3	label 4	label 5
German	nicht	**etwas,** teilweise	**mittelmäßig**	beträchtlich, besonders, stark	völlig
Enlish	insignificantly	**slightly,** partially	**moderately**	very, **strongly**	**extremely**
French	pas	**légèrement**	**moyennement**	**beaucoup**	énormément
Japanese	Hotondo..nai	Amari, .nai, Taishite ..nai, Sorehodo ..nai	Yaya, **Tashou,** Hikakuteki, Warini	**Daibu**	**Hijooni**
Spanish	insignificantemente	un poco, algo, un tanto	**medianamente**	**muy,** altamente	**extremadamente**
Turkish	degil	hafifce, birazcik, bir miktar, **biraz,** az cok	**orta derecede**	epeyce, cok fazla	**feci sekilde**
Norwegian	minimalt	noe	**middels**	**mye**	alvorlig
Hungarian	**egyáltalán nem,** nem, alig	mérsékelten	**közepesen**	**nagyonna**	**rettenetesen**
Dutch	niet	iets, lichtelijk, **een beetje,** enigzins, matig	matig, **tamelijk,** behoorlijk	**erg,** sterk	**extreem**

The disadvantages of the verbal scale are why a numerical scale was used for the questionnaire template. The questionnaire template uses an 11-point (0-10) numerical scale (even if a 1-to-10 scale would be more readily understood and treated statistically. Shorter 7-point scales are sometimes used [4, 7]). As shown in Table 6.3, an explanation of the meaning of the scale appears in the header of the questionnaire to allow for the determination of the proper use of extremes and their meaning in the analysis of the results. The familiarity with this scale in different countries (most occupants are familiar with base-10 numeric systems) and recommendations for international surveys [4, 7, 16, 18] studies, among others factors (easy to convert in % and to analyse it), led to the use of this scale as shown in Figure 6.2.

Table 6.3. *Instructions for completing the scale of the questionnaire.*

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 "?"***

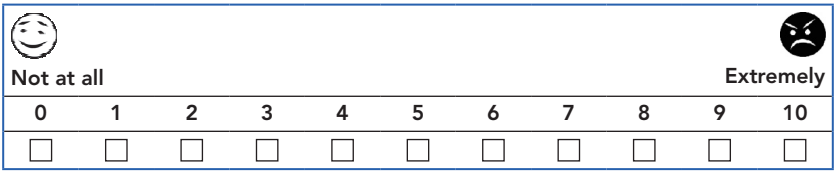

Figure 6.2. *Instructions for completing the scale of the questionnaire.*

The scale uses both verbal descriptions (texts) and graphical emoticons in the extremes in order to remind the occupants of the meaning of the scale and to make respondents see the simple use of it. In the expectations and sensitivity segments, the wording in the extremes is reinforced by adding "important" and "sensitivity" so as to show the question scale asses their personal reactions to noise.

6.8. Sources list

Section 6.8 is omitted in this printed version but is fully available in the corresponding e-book.

6.9. Segments of the questionnaire

Section 6.9 is omitted in this printed version but is fully available in the corresponding e-book.

6.10. Sampling

The primary aim of the sampling procedure in socio-acoustics surveys designed for establishing relationships between measured data and occupants' ratings is to capture a representative sample of occupants. In many cases, all occupants within a block of buildings can be invited, which is advantageous from a statistical point of view.

Sample selections (by means of a stratified sampling) may be used, if they select the same per cent of people according to age, gender, length of residence and the building age and characteristics for getting and heterogeneous sample which will give a wide range of the acoustic quality of the buildings in each European countries. A more common application is probably within one block of buildings. Results from such limited studies are not representative for the whole population, but may return important information to builders and others. If many such studies are performed, a broader perspective and relevance for national guidelines etcetera may be derived.

This questionnaire could use two criteria for the sampling procedure:

Sample Selection:

- Respondent sample selection method (probability, judgmental, etcetera)
- Respondent exclusion criteria (age, gender, length of residence, etcetera)

Sample Size and quality

- Response rate
- Reasons for non-response

Further discussions on the effect of sampling must be analyzed by a statistician in each application, unless all occupants within a specific area are invited. However, the results are then only representative for this area. If the sampling is sparse, other effects may occur.

6.10.1. Measurements

As already mentioned in the previous section, in order to correlate the occupants' ratings of annoyance with sound insulation values it is

important to make measurements "in situ" (and include in the survey 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, etcetera).

There are three main methods available for obtaining the sound insulation values of constructions solutions of dwellings and correlate them with the subjective responses:

1. Measurements "in situ", adequately planned, may describe the properties of the construction solutions and the existing sources of noise. At least 5% of all partitions or rooms should be measured to get at reliable estimate of the building performance, and at least 3 partitions should be included
2. Applying generic data, e.g. from the catalogue established by COST TU0901 WG
3. Estimate the measurements via:

- Acoustic Software: to calculate airborne and impact sound insulations using standardised software (according to Standards)
- Laboratory measurements and tests insulations values of constructions solutions

6.10.2. Analysis of the results

Statistical analyses of responses from the questionnaire can test the reliability of the responses and examine relationships between subjective responses and objective values of sound insulation.

This questionnaire has been applied in surveys and the analysis of the results has been performed mainly using linear regressions. Examples of studies are listed in section 11. Other correlation methods maybe considered as well, e.g. multivariance analyses. There are many other statistical methods which can be used, depending on each type of survey and the way of treating results [1, 2, 12, 18, and 21].

This questionnaire may be used with more advanced statistical methods, since it collects information on age, gender, length of residence, and quality of construction, year of the building etcetera. Simplicity and interpretation of data without complex mathematical operations allows for a faster exchange of information and results, without having to convert scales or analyse complex results. If the survey institute would like to make

a classification with clustering or to introduce other changes, then everything should be explained in detail with the survey results as well as the reasons why this has been made.

The results of the blocks of expectations and sensitivity could be used to adjust the slope of the results obtained in the annoyance block, explaining where, why and how these results modify the slope of the curve obtained.

6.11. Updates to the questionnaire after preliminary studies and experiences

Since the first draft of the questionnaire based on the ISO/TS 156664, the UK delegation expressed concerns that the use of terms "annoyed, bothered and disturbed" as the basis of the subjective experience of noise in the home, would cause problems. Some other delegates shared this concern.

In the UK, consumers are accustomed to receiving 'customer feedback' questionnaires every time they buy a new product or use a service. Such questionnaires are invariably of the 'customer satisfaction' format, asking "how satisfied are you with.....". The use of a direct question which asks "how annoyed are you with...." was considered to be likely to provokes a negatively biased response, or even invoke a complaint where none existed.

The first attempts in the UK to 'test' the questionnaire involved asking house-builders, housing associations and building managers if the questionnaire could be circulated to new occupants of homes for which test data was available, both rented and privately owned. Without exception, all such requests were refused.

The UK then proposed two alternative versions of the questionnaire, one which was 'neutral' e.g. asking "how much noise can you hear from....." and a second which was based on 'satisfaction' e.g. "how satisfied are with the level of sound insulation of.....". The latter approach roughly followed the format of previous surveys used in the UK. When the same group of house-builders, housing associations etcetera were consulted, about 30% thought that the 'satisfaction' version would be OK.

However, after much discussion about the alternative approach, it was considered too problematic to have two different questionnaires when the objective of WG2 was to create a single 'harmonised' questionnaire. There were also concerns that some countries might not understand the

concept of 'sound insulation'. A decision was therefore made at the Warsaw COST meeting in 2013 to revert to the ISO format questionnaire, i.e. the original draft which was based on annoyance.

The recent version of the questionnaire has been carefully re-worded, however, avoiding the use of the term 'neighbour noise' so as to make it more objective.

One issue which does remain in the UK and will continue to be a barrier to obtaining a response to questions about noise disturbance is the fact that any problem with a property, including a 'noisy neighbour' or 'neighbour noise' problem, has to be declared when the property is sold. Failure to report problems like this can result in serious litigation so people are obviously reluctant to make formal complaints.

To help with this, the introduction to the questionnaire now explains very clearly that the research is solely concerned with the acoustic performance of the building, not the behaviour of neighbours and that the research results are completely confidential. When these facts and goals have been explained, we think it will be easier to convince the UK building industry and building occupants to use the harmonised questionnaire.

It is also noted that the questionnaire has already been translated into several European languages and cultures to enable comparisons across different countries and cultures. These can be found at http://www.costtu0901.eu

6.12. Applications of the questionnaire in field surveys

The questionnaire has been applied in several studies, as has been reported in international conference proceedings. Some examples:

1. The "SBUF" socio-acoustic survey in modern multi-family residential houses with floors and walls made of massive concrete or light framed structures of wood or steel, ref [31]. The number of occupants responding to the survey was in all cases more than 30, in most cases more than 50.
2. The "AkuLite" socio-acoustic survey in modern multi-family residential houses with floors and walls made of wood, ref [32]. The results were used to propose a new single number quantity to the ISO TC 43/SC 2/WG 18 for inclusion in the proposal for a new standard (ISO/NP 16717-2).
3. The "AcuWood"-project by Fraunhofer Institute, presented at Internoise 2013 ref [33, 34]

4. The "ÄKK"-project by Finnish Institute of Occupational Health, ref [35]
5. Small scale tests with the questionnaire have been undertaken in Italy (Pontarollo et al), in the UK (Critchley), Serbia (Sumarac) and Spain (Herráez et al) but these studies have not yet been published.

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