The assessment and monetizing of noise affectedness due to air and road traffic

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Abstract

This contribution is an introduction and overview of a new approach – the noise affectedness risk approach (NARA) – in the scope of noise assessment. The former approach among the noise effect research, in this paper still considered as partial approach, aimed to explain the reactions due to sound impacts and thus deriving prognosis. The main problem of the former approach is that the explained variance or the explained randomness, measuring the proportion to which a model accounts for the variation is relatively modest. The emerging uncertainties, specifically in the application of the noise mitigation, are intensifying.

This document bases on an internal outline from Oliva & Co. in Zurich dated on December 11th 2007 of which partly has been presented on invitation by the former head of Noise Protection Dr. Urs Jörg at the Federal Office of Environment (FOEN), of the Department of Environment, Transport, Energy, and Communication (DETEC) on the 21st of January 2008. The here presented paper highlights at the outset the findings of the noise affectedness due to road traffic and subsequently due to air traffic. By doing so, the advantage shall therefore be taken at the same time not only to give access of the here newly developed approach to a broader audience, but present and discuss this approach at the forthcoming meeting.

Keywords

Noise Affectedness Risk Approach, NARA – Quality of Life – Well-being – Noise mitigation – Sound Impact – Road Traffic – Air Traffic – Methodology – Zurich International Airport

1. Problem

Sociology as a part of the noise effect research investigations of sound impacts and well-being did contribute much to our understanding of quality of life[1]. As empirical results accumulate on how quality of life is stressed, our recent research points to two innovations within a new noise assessment approach shaping our course of inquiry. First the methodical reasons and second the theoretical neglect are supporting to uncover the gap – the risk of noise affectedness – bearing still in mind that some risks are immediate in their effect while others take some considerable time to become manifest.

With its conventional approach the noise effect research did up to now rely on a concept trying to explain the stressors being of interest along a process of an environmental impact, the situate condition of the exposed persons, and its personal features[2]. This concept – the 'process of impacts' – has been understood as a form of annoyance due to noise impact. The aim was thereby to conclude from the 'process of impacts', which furthermore can be understood as reactions of an impact on social, psychological, and/or somatic impairments. This action taken frequently dealt with the empirical description and the explanation of the question: Which impairments of the somatic, psychological, and/or social well-being appear when, why, and by whom?

In order to answer this question, the way which had to be chosen was clearly structured and has been compulsory for investigations of this paradigm. It had to be investigated in how far the acoustical impact has been the cause for the impairments, or whether the established strength of the impairment has to be assessed as unwanted, or unacceptable[3]. Out of reason of easiness the paradigm obliged discussion was lead in relation to the core target measurement of the 'highly annoyance'.

The paradigm's main problem consisted in the approach of the causal explanation, which in its legitimated way and out of empirical considerations of the noise effect research has been

[1] Graeven, D.B. (1974): The Effects of Airplaine Noise on Health: An Examination of Three Hypotheses. Journal of Health and Social Behavior, Vol. 15, No. 4, pp. 336-343.

[2] Lazarus, R.S. et al. (1985): Stress and adaptational outcomes. The problem of confounded measures. American Psychologist, 40, 770-779.

[3] Oliva, C. (1998): Belastungen der Bevölkerung durch Flug- und Strassenlärm. Berlin: Duncker & Humblot.

valued as the appropriate method[4], although only a few and significant causal relationships being in fact directly attributed to the acoustical impact were documented[5]. A number of indicators were introduced on the other hand postulating the sound impact as the single cause for the above listed impairments, but these causation remained so far unproven[6,7,8,9,10,11].

The absence of these postulated effects leads immediately to a dilemma of reason in view of the fact that being unable to give a clear answer to the following three questions:

(1) Does in fact the postulated causal noise effect not exist?

(2) If in spite of the fact the causal noise effect does exist, then why has with the so far applied approaches no suitable representation been possible?

(3) Does nevertheless the causal noise effect exist, but it can however not be seized under the considered requirements or can it be recorded indirectly?

The dilemma of reason points out an unsatisfactory situation giving space for speculations and allowing uncertainty. The deficiency of the empirical proof of the causal noise effect – marking this uncertainty – leads to unwanted consequences: (1) Very important is the fact that in the case of the verification of regulations and measures of noise mitigation can only fairly be proven empirically. (2) On an undersized basis of empirical results further considerations were made which are far reaching out from any permissible statistical range. (3) Even clear statements of supposed noise effects, unnecessary worries, and fears, could not have been

[4] Mosteller, F. and J.W. Tukey (1977): Data Analysis and regression. A second course in statistics. Reading, Addison-Wesley.

[5] Berglund, B. and T. Lindvall (1995): Community noise. Stockholm: Jannes Snabbtryck.

[6] Kaltenbach, M. et al. (2008): Gesundheitliche Auswirkungen von Fluglärm. Health Consequences of Aircraft Noise. Deutsches Ärzteblatt, 105(31-32):548-56

[7] Rosenlund M. et al. (2001): Increased prevalence of hypertension in a population exposed to aircraft noise. Occup. Environ. Med. 58:769-773.

[8] Jarup L. et al. (2003): Hypertension and exposure to noise near airports - The Hyena project. Epidemiology 14 (5): S78.

[9] Stansfeld, S.A. et al.(2005): Aircraft and road traffic noise and children's cognition and health. Lancet 365: 1942-49

[10] Schreckenberg, D. und M. Meis (2006): Belästigung durch Fluglärm im Umfeld des Frankfurter Flughafens. Im Auftrag der IFOK GmbH im Rahmen des Regionalen Dialogforum Flughafen Frankfurt. Bensheim.

[11] Wirth, K. (2004): Lärmstudie 2000. Aachen, Shaker Verlag.

confirmed. (4) The less the postulated noise effects can be reasoned to the sound impact, the less efficient are the mere physical measures of noise reduction, and the more the noise mitigation will be dominated by psychological particulars.

Not holding on, but searching a manner of getting out of this dilemma of reason we are now introducing a pragmatic way bringing together the following three components or mechanisms.

- The dilemma of reason can be solved, if it is recognized that the up to now applied causal model explaining the effects of noise has been systematically incomplete, thus being aware of a harmonized model and by means of this case a number of additional possibilities are existing which were not investigated in so far.
- The closure of this systematic gap of approach within the noise effect research is in a manner possible that the so far proven findings and the consequently derived regulations are not being questioned.
- For this purpose the actual available statistical possibilities of the multivariate causal analysis ought to be applied for the simulation and the presentation of findings in a more pragmatic way.

2. Noise Affectedness Risk Approach (NARA)

The risk of noise affectedness – the new approach – has not a specific noise effect as an explanation target, but the central aim is the risk assessment of being affected by sound impacts. This explanation target shall be here defined as the noise affectedness. Formally spoken is the noise affectedness the logical product of the relative frequency of one or more noise affectedness intensities and its probability.

This noise affectedness risk approach (NARA) shows the possibility as the up to now as inconsiderable identified correlations can be determined as relevant and highly significant effects (such as health variables). It will be shown that the noise effect research for methodical reasons and out of theoretical neglects systematically has not been able to recognize certain relationships. For the application of this approach nine rules, or the recommended steps, are identified in order to structure the now presented procedure.

The noise assessment can be carried out for single residential areas (clips) up to whole regions. A region will be dismantled in acoustically homogeneous clusters representing the unit of analysis for the noise assessment. The authors are discussing the assessment of noise affectedness risk with an example of a residential clip being located in the vicinity of the Zurich International Airport.

The noise assessment first determines the sound impact and thus derives the probability of the noise affectedness and its relative frequency of the intensities. With it covering the 'vertical' aspect of the noise affectedness risk. For the aim of the noise assessment, the determination of the noise affectedness is at this point still inaccurately and will be adjusted by a grading factor covering the 'horizontal' aspect of the noise affectedness that is the variability of the affectedness on the same sound impact level. The requirements are met herewith to determine the external risk of the noise affectedness.

The following step concerns the monetizing of the noise affectedness referring to the determination for the extent of the loss of quality of life, independently for the impairment and the annoyance due to the sound impact. The next step in the here recommended procedure is the balancing of the quality of life loss. The last step engages in the transformation to money, which is not already written yet, because this is not a sole task of the noise effect research. In any case the monetizing ought to express the societal acknowledged loss of the quality of life.

3. Rules for the assessment and monetizing of the noise affectedness risk – the results

The application of the here discussed and outlined NAR-approach, the assessment and monetizing of noise affectedness risk due to air and road traffic, shall be accomplished by means of the following rules. The presenting of these rules is illustrated for one possible residential clip. These rules can be certainly thought in the same manner for a whole region as well.

3.1 Rule 1: The determination of the sound impact

3.1.1 Example of the sound impact determination due to air traffic

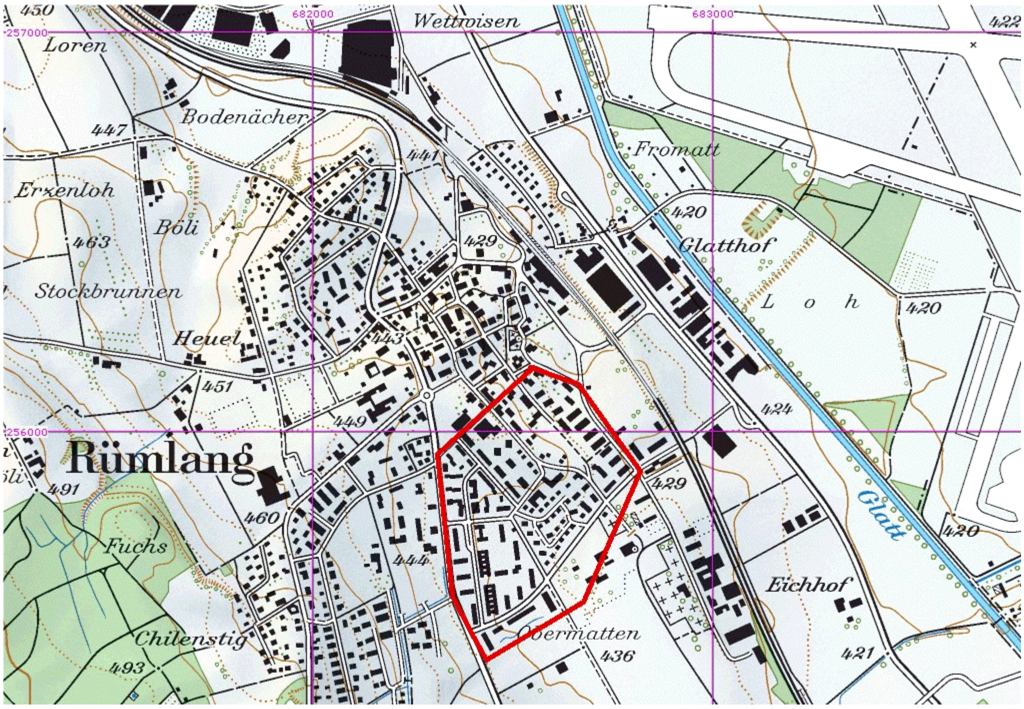
For the determination of the sound impact in the here chosen residential clip the defined sound assessment level of the 'Lärmschutz-Verordnung'[12] (LSV) shall be applied. The area has to be chosen in that manner thus the variation of the LAeq does not exceed 3 dBA.

As an example of the sound impact determination for the here chosen residential clip the following assumption are made.

It is hypothesized that the here chosen residential clip will be exposed to a sound impact due to air traffic of ~65 LAeq during16 hours per day. Furthermore it is hypothesized that the variation of measuring points within this residential clip is smaller than 3 dBA. The residential clip shown in Figure 1 shall be further applied for the demonstration of the following rules.

[12] SR 814.41

Figure 1 Residential Clip of Rümlang ('Linden') as an example of the noise assessment



3.1.2 Example of the sound impact determination due to road traffic

Analogues assumptions are made for the sound impact determination due to road traffic, but they are not identical ones. In contrast to the exposition due to air traffic in the here chosen residential clip, the exposition of persons due road traffic sound impacts varies on three levels. On the A-level a high exposition, on the B-level a medium exposition, and on the C-level a low exposition due to road traffic will be experienced. Persons being situated in the A-level within this residential clip are exposed to 57 LAeq during 16 hours per day, persons being located in the B-level within this residential clip are exposed to 52 LAeq during 16 hours per day, and finally persons living in the C-level within this residential clip are exposed to 47 LAeq during 16 hours per day.

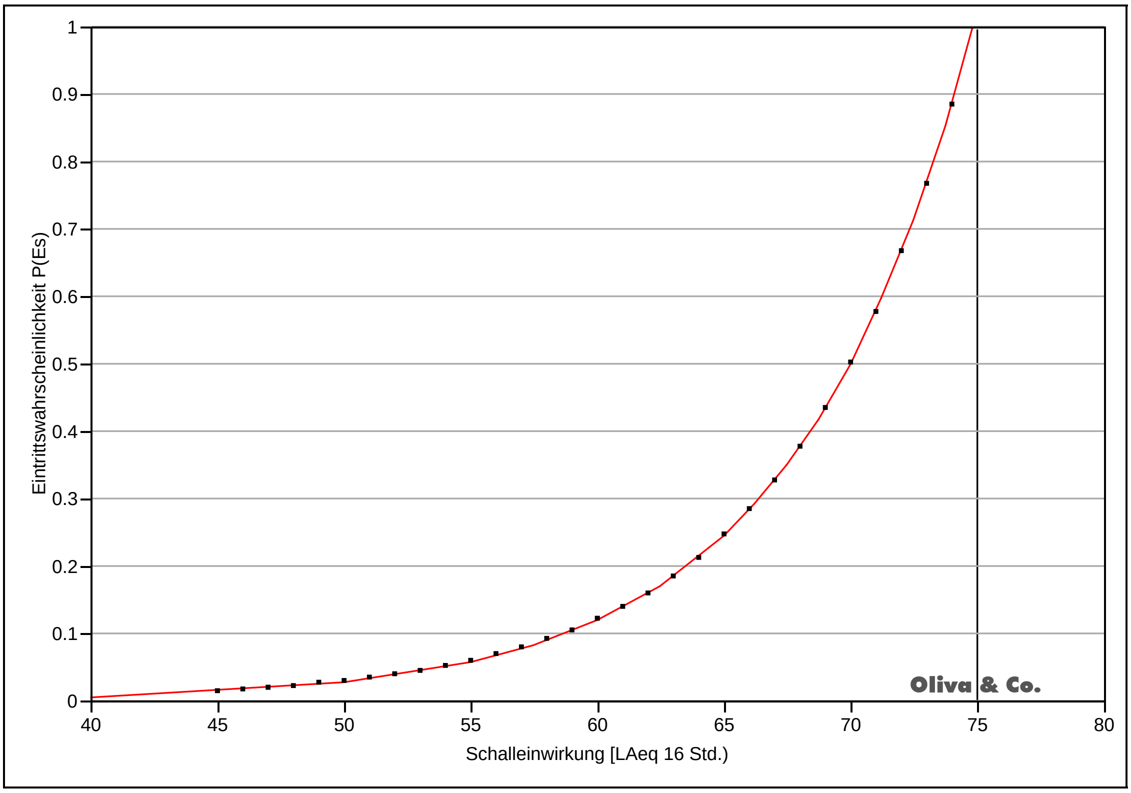
3.2 Rule 2: The determination of the probability

The probability is defined as the measure of how likely it is that some event will occur. This can be a number expressing the ratio of favourable cases to the whole number of cases possible. The standard example of the probability is usually given somewhat in this manner that an unbiased coin will fall with the head up is 0.5. If we talk about the determination of the probability for sound impact due to the air traffic and road traffic, then we also talk about the likelihood. Thus the likelihood is the probability of this specified outcome. In the here discussed case the probability $P(E_S)$ shall be as next determined separately for the sound impact due to the air traffic and road traffic.

3.2.1 Example for the probability $P(E_S)$ of the air traffic sound impact

For the determination of the probability $P(E_S)$ of a high-level sound impact within the here chosen residential clip, the relevant doses-response-curve shall be applied. Figure 2 summarizes the likelihood as function of the sound impact levels due to air traffic from 40 LAeq to 75 LAeq. If it would be the case that the sound impact of air traffic (doses) would be 75 LAeq, then the probability as shown in Figure 2 is nearly 1, respectively the specified outcome of the noise affectedness (responses) is approximately 100%.

Figure 2 Probability $P(E_s)$ as function of the sound impact due to air traffic



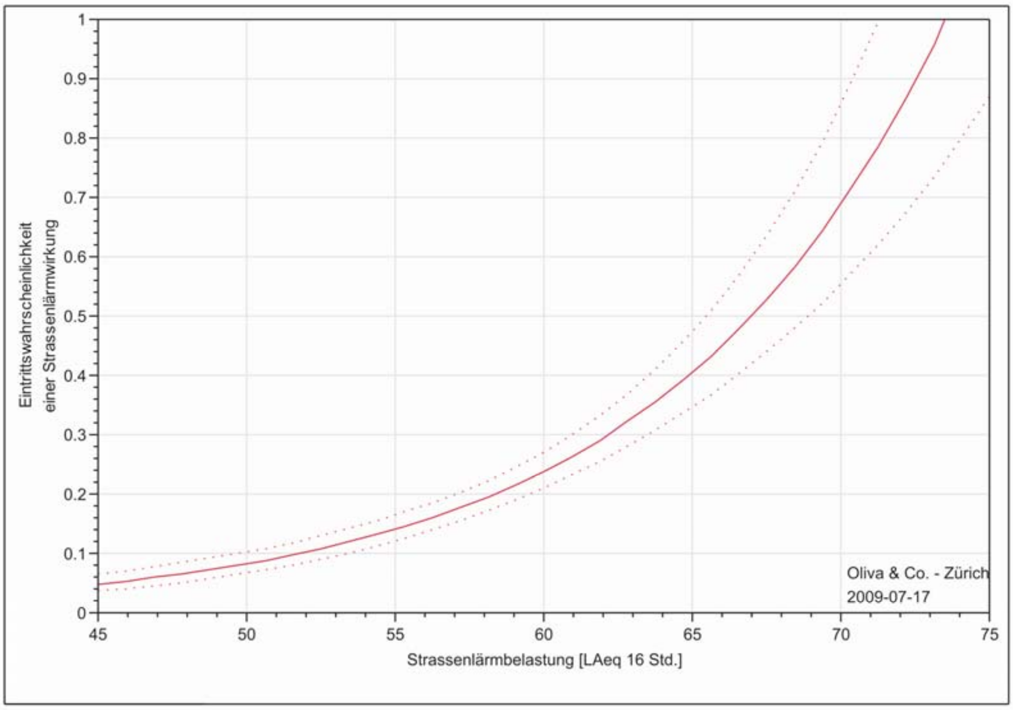
As a next step an example of the probability $P(E_S)$ for the particular residential clip is given.

Within the here chosen residential clip the probability $P(E_S)$ counts more or less 0.25. This number, or the likelihood of approximately 25% of noise affected persons, or respondents, corresponds to the sound impact level of 65 LAeq due to air traffic for the in Figure 2 established doses-response-curve.

3.2.2 Example for the probability $P(E_S)$ of the road traffic sound impact

For the determination of the probability $P(E_S)$ of the sound impact due to road traffic within the here selected residential clip, the significant doses-response-curve shall be applied again. Figure 3 shows the likelihood as function of the sound impact levels from 45 LAeq to 75 LAeq due to road traffic. If it would be the case that the sound impact due to road traffic (doses) valued 60 LAeq, then the probability is circa 0.25, respectively the specified outcome is approximately 25% for the noise affectedness (responses).

Figure 3 Probability $P(E_s)$ as function of the sound impact due to road traffic



The next stage of the analysis is to demonstrate an example of the probability $P(E_S)$ for all three exposition levels, high, medium, and low due to the road traffic sound impact within the selected residential clip. On the A-level a high, on the B-level a medium, and on the C-level a low exposition of the sound impact due to road traffic is experienced.

The probability $P(E_S)$ of the A-level counts to a value of 0.17 for a sound impact level of 57 LAeq during 16 hours per day. The probability $P(E_S)$ of the B-level counts to a value of 0.10 for a sound impact level of 52 LAeq during 16 hours per day. The probability $P(E_S)$ of the C-level counts to a value of 0.06 for the sound impact level of 47 LAeq during 16 hours per day.

3.3 Rule 3: The determination of the grade factor k_1

As a next point it has to made clear in what extend the probability $P(E_S)$ for the here assessed residential clip must be graded up by a factor k_1. This upgrading comes about for the assessment of the 'horizontal' variation of the probability $P(E_S)$ which is possible for the same sound impact level.

3.3.1 Example for the grade factor k_1 due to the air traffic sound impact

For the here chosen example the best corresponding prototype is scrutinized, which must be underlined with survey data, as long as the 'horizontal' regularity has still to be defined.

The average position of a residential clip being assessed can be described as follows:

- Cross distance to baseline of arrival and departure route (=1'260 m)
- Cross distance to the actual departure path (=1'340 m)
- Frequency of flight movements (~230 per day)
- Portion of 'heavy' aircraft category of flight movements figure (for example 20%)

The example for the grade factor k_1 within the chosen residential clip presents itself as follows.

$$P(E_S) = 0.25$$

$$k_1 = 0.08$$

$$P(E_S) + k_1 = 0.25 + 0.08 = \underline{0.33}$$

3.3.2 Example for the grade factor k_1 due to the road traffic sound impact

For the here chosen example the best corresponding prototype is again inspected, being aware of that is should be underlined with survey data, as long as the 'horizontal' regularity has still to be defined.

The outcomes of the example for the grade factors k_1 within the chosen residential clip and for all three impact levels high, medium, and low presents them as follows.

A-level (high exposition) 57 LAeq:

A: $P(E_S) = 0.17$

$k_1 = 0.41$

$P(E_S) + k_1 = 0.17 + 0.41 = \underline{0.58}$

B-level (medium exposition) 52 LAeq:

B: $P(E_S) = 0.10$

$k_1 = 0.34$

$P(E_S) + k_1 = 0.10 + 0.34 = \underline{0.44}$

C-level (low exposition) 47 LAeq:

C: $P(E_S) = 0.06$

$k_1 = 0.02$

$P(E_S) + k_1 = 0.06 + 0.02 = \underline{0.08}$

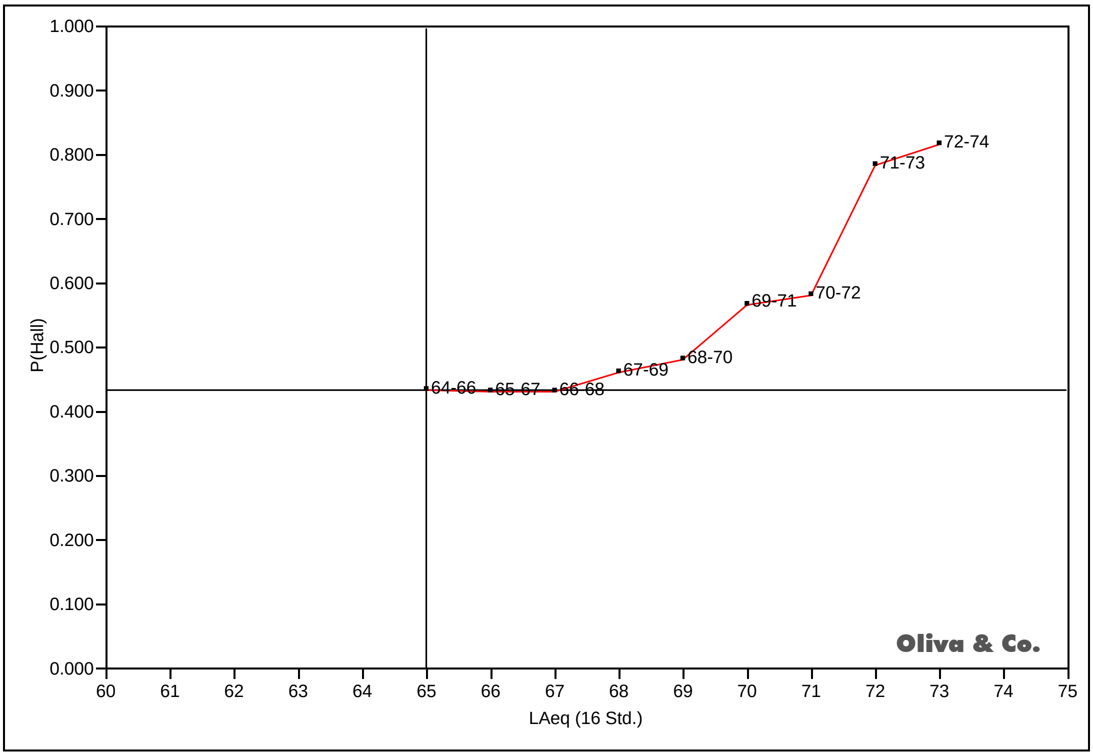
3.4 Rule 4: The determination of the probability $P(H_{all})$

For the determination of the relative frequency of harmful or annoying impacts the linear combination must be resolved by the means of a principal component analysis. With it a summarized description of the effects of impacts is achieved. Afterwards the relative frequency $P(H_{all})$ is calculated for the specific sound impact level.

3.4.1 Example for the probability $P(H_{all})$ due to the air traffic sound impact

An example of the relative frequency as a value for $P(H_{all})$ for a specific sound impact level due to air traffic is illustrated in Figure 4 the $P(H_{all})$.

Figure 4 Determination of $P(H_{all})$ under condition of LAeq = 65



$P(H_{all})$ / 65 LAeq = <u>0.43</u>

3.4.2 Example for the probability $P(H_{all})$ due to the road traffic sound impact

A same example of the relative frequency as a value for $P(H_{all})$ for the three specific sound impact level, high, medium, and low due to road traffic is given as next.

A-level: 57 LAeq, ranging from 56 to 58 LAeq

$P(H_{all})$ = <u>0.14</u>

B-Level: 52 LAeq, ranging from 51 to 53 LAeq

$P(H_{all})$ = <u>0.08</u>

C-Level: 47 LAeq, ranging from 46 to 48 LAeq

$P(H_{all})$ = <u>0.03</u>

3.5 Rule 5: The determination of the grade factor k_2

It has to be made clear in what extend the probability $P(H_{all})$ for the investigated residential clip has to be upgraded with the factor k_2. This upgrading takes place in respect of the 'horizontal' variation of the probability.

3.5.1 Example for the grade factor k_2 due to the air traffic sound impact

As a next point an example for a upgrading factor k_2 within the chosen residential clip is presented, bearing still in mind that the systematic ‚horizontal' regularity still has to be defined, and therefore the best corresponding prototype for which survey data are existing has to be investigated in.

$P(H_{all})$ / 65 LAeq = 0.43

$k_2 = -0.04$

$P(H_{all})$ / 65 LAeq + k_2 = 0.43 – 0.04 = <u>0.39</u>

3.5.2 Example for the grade factor k_2 due to the road traffic sound impact

The results of the grade factors k_2 for the example within the here selected residential clip for all three impact levels, high, medium, and low are illustrated next.

A-Level: 57 LAeq, ranging from 56 to 58 LAeq

$P(H_{all}) = 0.14$

$k_2 = 0.23$

$P(H_{all}) + k_2 = 0.14 + 0.23 =$ <u>0.37</u>

B-Level: 52 LAeq, ranging from 51 to 53 LAeq

$P(H_{all}) = 0.08$

$k_2 = 0.13$

$P(H_{all}) + k_2 = 0.08 + 0.13 = \underline{0.21}$

C-Level: 47 LAeq, ranging from 46 to 48 LAeq

$P(H_{all}) = 0.03$

$k_2 = 0.11$

$P(H_{all}) + k_2 = 0.03 + 0.11 = \underline{0.14}$

3.6 Rule 6: The determination of the noise affectedness P(B)

Generally the noise affectedness P(B) is defined as the logical product from $P(E_S) + k_1$ and $P(H_{all}) + k_2$.

3.6.1 Example of the noise affectedness P(B) due to air traffic sound impact

Example for the noise affectedness P(B) with and without grading factors k_1 and k_2:

$P(B) = P(E_S) + k_1 * P(H_{all}) + k_2 = 0.33 * 0.39 = \underline{0.13}$

Without grading factors:

$P(B) = P(E_S) * P(H_{all}) = 0.25 * 0.43 = \underline{0.11}$

3.6.2 Example of the noise affectedness P(B) due to road traffic sound impact

Example for the noise affectedness P(B) due to road traffic sound impact with and without grading factors k_1 and k_2:

A-Level:

$P(B) = P(E_S) + k_1 * P(H_{all}) + k_2 = 0.58 * 0.37 = \underline{0.21}$

B-Level:

$P(B) = P(E_S) + k_1 * P(H_{all}) + k_2 = 0.45 * 0.21 = \underline{0.10}$

C-Level:

$P(B) = P(E_S) + k_1 * P(H_{all}) + k_2 = 0.08 * 0.14 = \underline{0.01}$

Without grading factors:

A-Level:

$P(B) = P(E_S) * P(H_{all}) = 0.17 * 0.14 = \underline{0.02}$

B-Level:

$P(B) = P(E_S) * P(H_{all}) = 0.10 * 0.08 = \underline{0.00}$

C-Level:

$P(B) = P(E_S) * P(H_{all}) = 0.06 * 0.03 = \underline{0.00}$

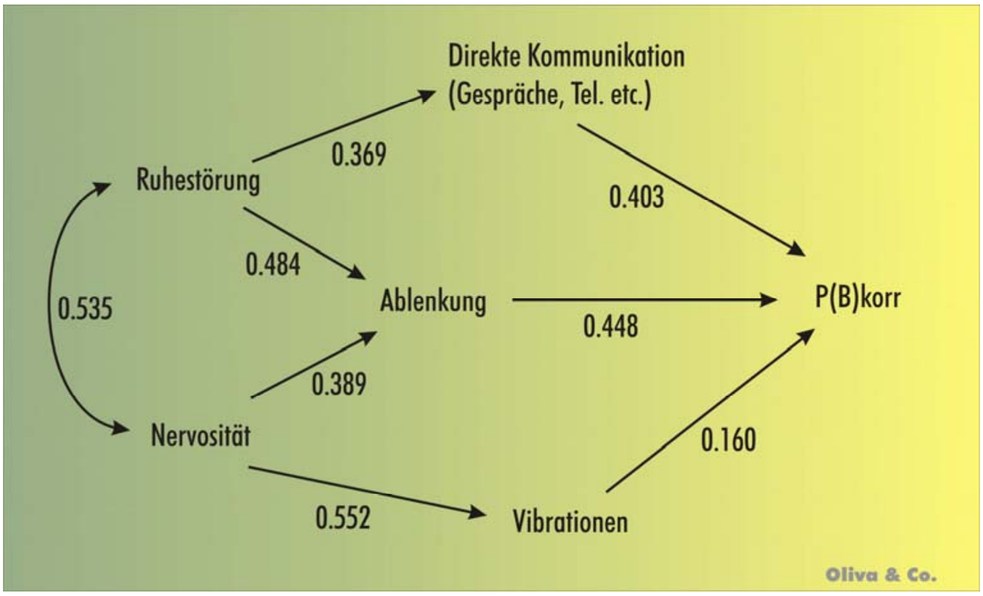
3.7 Rule 7: Interpretation of the noise affectedness

In order to understand the feature of annoyance of the social situation, the here presented noise affectedness is by means of specific variables. These variables are input variables for a causal analysis, thus serving first to describe the quality and second the extent of the annoyance. These findings are supporting the manner of recognizing the patterns which were – in a given frame – responsible for the shaping of the noise affectedness.

3.7.1 Example for the interpretation of the noise affectedness due to air traffic sound impact

The causal analysis has to be conducted in the manner that not only the ‘vertical’, but also the ‘horizontal’ aspect is attained. This kind of analysis is by the means of the here introduced prototype possible, and thus serving as a representative for the reference sample. An interpretation of the noise affectedness is also possible for the sound impact due to road traffic, but in this first step of investigation the path analysis has been carried out only for the sound impact due to air traffic. As next an example of the path analysis is shown in Figure 5 building the starting point for the interpretation of the noise affectedness respectively.

Figure 5 Formation pattern of noise affectedness in frame of the prototype R: partial regression coefficients ($p<.05$; $N = 36$)



In Figure 5 all major paths being significant on the 5% level are presented for the variables H_1 to H_9 in relation to the dependent variable of the noise affectedness P(B)korr. These partial correlation coefficients are showing the pattern of the knotted effects of the sound impact in the frame of the here evaluated residential clip for the chosen prototype. The path analysis serves for the interpretation of the *value* of the noise affectedness by showing how it – the value of noise affectedness – accumulates.

The residential clip being discussed here, the sound impact causes disturbance ('Ruhestörung') and nervousness ('Nervosität'). These components however do not directly affect the noise affectedness because they are effective on specific paths: (1) the disturbance ('Ruhestörung') is effective on the noise affectedness through the disturbance of the direct communication ('Direkte Kommunikation, Gespräche, Tel. etc.'). (2) The disturbance ('Ruhestörung') is effective on the noise affectedness through the distraction from work ('Ablenkung'). (3) The nervousness ('Nervosität') is effective on the noise affectedness through the distraction from work (‘Ablenkung’). (4) The nervousness (‘Nervosität’) is effective on the noise affectedness through the perception of vibrations (‘Vibrationen’).

3.8 Rule 8: The interpretation of the loss of quality of life

The noise affectedness indicates the scope of the likelihood a person must expect – against her will – a quality of life loss resulting from the sound impact due air traffic or road traffic. The quality of life loss can be referred to the harm or the annoyance of the sound impact. In order to identify a loss of quality of life which is connected with the recognized pattern by the recommended step, the seven rules, the indicators of the quality of life loss ought to be introduced in the model of the path analysis, thus showing the effect being at least able to absorb the direct effects. It is hypothesized that the extent of the direct effects reduction is proportional to the loss of the quality of life and thus can be observed, respectively experienced from it.

3.8.1 Example for the loss of the quality of life due to air traffic sound impact

Again the following example, shown in Table 1, for the interpretation of the loss of quality of life has been carried out for the sound impact due to air traffic, but can be realized in the same manner for the sound impact due to road traffic.

Table 1 Partial regression coefficients on the noise affectedness P(B), prototype R (N=36)

	Model 1	Model 2	Model Parameter Model 2	
Variable			F-Value	Prob>F
Drug consumption	0.542	0.068	0.844	0.3653
Distraction	--	0.444	20.805	<.0001
Direct communication	--	0.469	25.997	<.0001
Vibrations	--	0.132	3.825	0.0596
R^2	0.295	0.892		
F-Value	14.126	63.74		
Prob>F	0.0006	<.0001		

Source: Oliva & Co. - Zürich

The variable drug consumption (‘Konsum von Arzneimitteln’) is a valid indicator for the record of the loss of quality of life, and this indicator will be arranged for the measurement of the harm. This variable has been collected and measured independently from the noise question, thus no causal attribution exists.

The variable drug consumption (‘Konsum von Arzneimitteln’) – as shown in Table 1 – demonstrates a correlation with the noise affectedness in Model 1 with $\beta = 0.542$. After the introduction of the control variables distraction from work (‘Ablenkung’), direct communication (‘Direkte Kommunikation, Gespräche, Tel. etc.’), and vibrations (‘Vibrationen’), concerning the determinants of the noise affectedness P(B), the direct relationship between drug consumption (‘Konsum von Arzneimitteln’) and noise affectedness P(B) disintegrates, which means that all the three control variables can be understood for the explanation of drug consumption (‘Konsum von Arzneimitteln’).

With it, an indicator is further determined which can, for the here questioned residential clip (survey area), be monetized, and therefore is serving for the processing of the proportions for the loss of quality of life. The still remaining and open question puts now forward the stipulation whether further indicators can be identified.

3.9 Rule 9: The consideration of the loss of quality of life

3.9.1 Setting of one point against the other

The actual loss of quality of life determination asks for a number of points which must be set one against the other. At present, they have not all been mentioned yet. The setting of one point against the other should however – as firstly shown by the here introduced rules – be accomplished by an in depth empirical investigation. This balancing process asks for further aspects being included.

- Is it a normal and an unavoidable impact of an industry having a public interest?
- Must the sound impact as a consequence of a basic public service in favour of the airport provider be accepted?
- Is it a case of an expropriation of the legal neighbourhood counter claim?
- Is the loss of quality of life proportional to the compensation of expropriation?

- How can the excessiveness of the effects be assessed, like the seriousness ('Schwere'), speciality ('Spezialität'), and the unpredictability of the effects ('Unvorhersehbarkeit der Einwirkungen')?

The seriousness of effects has been demonstrated with the rule eight, thus showing the loss of quality of life that is in view of the harm and the effects of annoyance. The speciality has been demonstrated by the rule seven. Consequently a reference to the unpredictability and the basic public service has to be made.

3.9.2 Analyzing the balancing process

As next an example for the analysis of the balancing process of the quality of life loss is given. The examination of the balancing process of the quality of life loss is again carried out in respect of the prototype R and the sound impact of ~65 LAeq. The effects of adaptation for a prototype R residential clip are summarized in Table 2.

Table 2 Partial regression of adaptation on the noise affectedness P(B), prototype R (N=36, p<.05)

	Model 1	Model 2	Model Parameter Model 2	
Variable			F-Value	Prob>F
Drug consumption	0.542	0.512	19.9769	<.0001
Turn-up device	--	0.467	16.6353	0.0003
Ohropax	--	0.239	4.3490	0.0451
R^2	0.295	0.594		
F-Value	14.126	15.637		
Prob>F	0.0006	<.0001		

Source: Oliva & Co. - Zürich

Among the variables of adaptation it is the turn-up device variable ('Geräte lauter stellen') which shows the significant effect on the noise affectedness. This result is simultaneous and therefore parallel effective to the drug consumption variable ('Konsum von Arzneimitteln'), hence without absorption of shares of effects of this variable. Consequently adaptation does not lead to reductions (or alleviations).

In Table 3 the effects of aims on noise affectedness is shown.

Table 3 Partial regression of aims on the noise affectedness P(B), prototype R (N=36, p<.05)

	Model 1	Model 2	Model Parameter Model 2	
Variable			F-Value	Prob>F
Drug consumption	0.542	0.578	17.6277	0.0002
Recreation	--	-0.302	4.8268	0.0351
R^2	0.295	0.384		
F-Value	14.126	10.7215		
Prob>F	0.0006	0.0003		

Source: Oliva & Co. - Zürich

Among the target variables it is recreation as the variable (‘Zuhause als Ort zur Erholung’) of showing the strongest effect on the noise affectedness. This effect proves to be a weak suppressor of the drug consumption variable (‘Konsum von Arzneimitteln’) and its effect on the noise affectedness. If recreation (‘Zuhause als Ort zur Erholung’) is partially removed, then the effect strength is rising. Moreover, recreation is (‘Zuhause als Ort zur Erholung’) negatively effective on the noise affectedness and being significantly for persons which are unable to accomplish their aims because of being noise affected.

In Table 4 the effect of the daily pattern preservation is shown.

Among the variables describing the daily pattern preservation only parallel effects were discovered, however none of them being in position of absorbing the direct path. As a result, none of the effects referring the daily pattern preservation (‘Alltagsorganisation’) are directly connected (knotted) with the effect drug consumption (‘Konsum von Arzneimitteln’) and noise affectedness. This subject complex should under certain circumstances further be investigated.

The Table 4 shows the effects on the pattern preservation (rules (regulations), agreements, and expectations):

Table 4 Partial regression of pattern preservation on the noise affectedness P(B), prototype R (N=36, p<.05)

	Model 1	Model 2	Model Parameter Model 2	
Variable			F-Value	Prob>F
Drug consumption	0.542	0.412	9.5877	0.0041
Unacceptability indoor	--	0.348	5.1768	0.0297
R^2	0.295	0.499		
F-Value	14.126	10.6257		
Prob>F	0.0006	<.0001		

Source: Oliva & Co. - Zürich

Among the pattern preservation variables, the expectation that the indoor noise is not acceptable represents an important absorbing effect on the noise affectedness. Thus persons showing a correlation between drug consumption (‘Konsum von Arzneimitteln’) and noise affectedness are also supporting the ‘judicial’ expectation that noise is unacceptable.

4. Discussion

The empirical findings of the noise effect research, as the former approach shows, are often and only under the scope of the highly annoyance due to the sound impact further applied. Thus not keeping in mind that the highly annoyance is an indicator only serving as an operator of the probability because it concerns the highest possible effects of all probable effects. Thus, the former approach lacks of the determination of the risk of being annoyed or harmed which is inherently related to the sound impacts due to air and road traffic. The here introduced and presented new approach assessing the risk of noise affectedness is defined as the risk from the product of the damage/affectedness and the probability of the damage/affectedness due to sound impacts of air and road traffic. The application of this noise affectedness risk approach, NARA; is an investigation in the product formed out of a *syndrome* of empirical recorded harms, respectively noise affectedness.

The NARA, noise affectedness risk approach for the assessment of noise affectedness due sound impacts of road and air traffic and its effects on quality of life can be further developed as a comprehensive suite of software tools – a manual – that will allow a thorough computation for the risk of the noise affectedness and its costs on the basis of only a few input data. Subsequently the impacts due to air traffic and road traffic noise will be evaluated in form of mitigation costs, external costs, and benefits. The results in the form of monetizing relationships enable to conduct an introduction as a part of a global-level investigation, including monetized benefits, and societal costs. The here presented research design has firstly been carried out for the assessment of the sound impact due to air traffic, but can be thought in the same manner for the assessment of transportation noise impacts. Some examples concerning the noise affectedness due to road traffic were hereby illustrated too.