On-site Odour Analysis and Assessment – Method and Case Studies

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SUMMARY
The Austrian ministry of the environment together with the German Association of Ecological Research Institutes e.V. (AGÖF) recently presented a guideline for indoor odour measurement and evaluation with regard to their reasonability (indoors odours - olfactory sensory analysis and evaluation; Gerüche in Innenräumen – Sensorische Bestimmung und Bewertung). The aim is to measure on-site the perceived indoor air quality (odour intensity, hedonic scale and acceptance) by a trained panel. Essential element for measuring the odour intensity is the on-site sensory calibration of the expert person with n-butanol dilutions. The method performance according to the guideline is presented by two exemplary case studies: In the first case 48 rooms were tested with 8 persons (a trained panel of 5 persons and an untrained panel of 3 persons) and in the second case 87 rooms were tested with a trained panel of 5 persons. The resulting data were statistically evaluated and uncertainty was determined of the olfactory sensory odour evaluation.
Interestingly, this study demonstrates that evaluations performed by a trained panel of 3 persons according to the guideline for indoors odours show under 18% of uncertainty comparable to uncertainty of chemical analysis of indoor air.

IMPLICATIONS
With increasing frequency complaints of non-acceptable odour are reasons for Indoor-Air analysis. Chemical analyses often give no hints about the problem and cannot contribute to the evaluation and the solution. Therefore, it is important to have a method for indoor odour measurement and evaluation with regard to their reasonability. In this study, we show exemplary an elegant and useful method according to the recently presented guideline for indoor odour analysis and assessment.

KEYWORDS
Panel, odour guideline, indoor odour measurement, standards, odour intensity

INTRODUCTION
The perceived indoor air quality gains nationally and internationally more and more relevance because of the lack of sufficient air change due to energy saving constructions and airtight buildings. Therefore, prolonged indoor stay is increasingly reasonable for occupants' health problems. Sources of odour can be located inside or outside of buildings. In many cases, chemical analyses are not sensitive enough and often give no hints about the problem and cannot contribute to the evaluation and the solution. Therefore, it is important to have a method for indoor odour measurement and evaluation with regard to their reasonability.

These days sensory evaluations are much more appreciated (ECA 1999). Remarkably, the human sensory system can detect intense odour substances in concentrations that are below the chemical detection limit or which cannot even be detected in routine chemical analyses. Moreover, using the human olfactory "*instrument of measure*" additional parameter like intensity, quality and hedonic can be incorporated into assessment. The perception of odours

is individually and sometimes dependent on situations. Therefore, the informational value of sensory evaluations can be reduced. So far, no generally accepted guideline or method for sensory evaluation in German-speaking countries did exist. To achieve a comparable assessment of indoor odour evaluation the Austrian ministry of the environment together with the German Association of Ecological Research Institutes e.V. (AGÖF) recently presented a guideline for indoor odour measurement and evaluation with regard to their reasonability (indoors odours - olfactory sensory analysis and evaluation; *Gerüche in Innenräumen – Sensorische Bestimmung und Bewertung; 2010*).

METHODS

The aim is to measure on-site the perceived indoor air quality (odour intensity, hedonic scale and acceptance) by a trained panel. Essential element for measuring the odour intensity is the on-site sensory calibration of the expert with n-butanol dilutions. 1 ml of each calibration standard is diluted into 4 ml H_2O_2 in tubes with screw caps and 10 mm diameter. The method is described in ÖNORM S 5701. The AGÖF guideline also describes the different aims as well as training and preparation of the panel. The calibration of the panel is performed via calibration standards at an olfactory neutral location. The calibration standards are composed as follows:

0: „neutral“ (0 g n-Butanol /l H_2O),
1: very weak odour (1,0 g/l),
2: weak odour (5,0 g/l),
3: medium-strength odour (25g/l)
4: strong odour (90 g/l, saturated solution)

For the adjustment of the olfactory sense to the odour intensities quick smelling after opening the tube was performed. For the calibration, the tube has to be kept in a distance of 1 cm to the nose for 5 sec which is the essential time point for the adjustment.

The following odour parameters were then evaluated:

- Odour intensity: intensity of odour perception released by olfactory stimuli. Evaluated in a categorie scale between 0 (neutral) and 5 (very strong).
- Hedonic: effect of olfactory stimuli described with the characteristics "very comfortable" und "very uncomfortable". Evaluated in a categorie scale between + 4 (very comfortable) and - 4 (very uncomfortable).
- Acceptance: Scale of satisfaction with indoor odour in consideration of the room use. Evaluated in a categorie scale between + 10 (clearly acceptable) and – 10 (clearly not acceptable).
- Odour quality: Description of odour with intuitive keywords (not considered in evaluation)

RESULTS

The method performance according to the guideline is presented by two exemplary case studies:

Project 1 (Thumulla 2010)

Occupants of a 2000 m² office in the new building of a car dealer in Bavaria were complaining about intensive indoor odour and health problems. The question if the indoor odour is beyond normal new building odour affected should be answered within a lawsuit.

Therefore 48 rooms were tested by a trained panel of 5 persons. Additionally, the rooms were evaluated by an untrained panel consisting of 3 representatives of all involved parties.

In the following diagrams the overview of all sensory evaluated rooms is depicted. (Blue curve: trained panel, green curve: untrained panel, red curve: both together)

Diagram 1. Results of the odour intensity evaluation, x-axis room numbers, y-axis: odour intensity scale

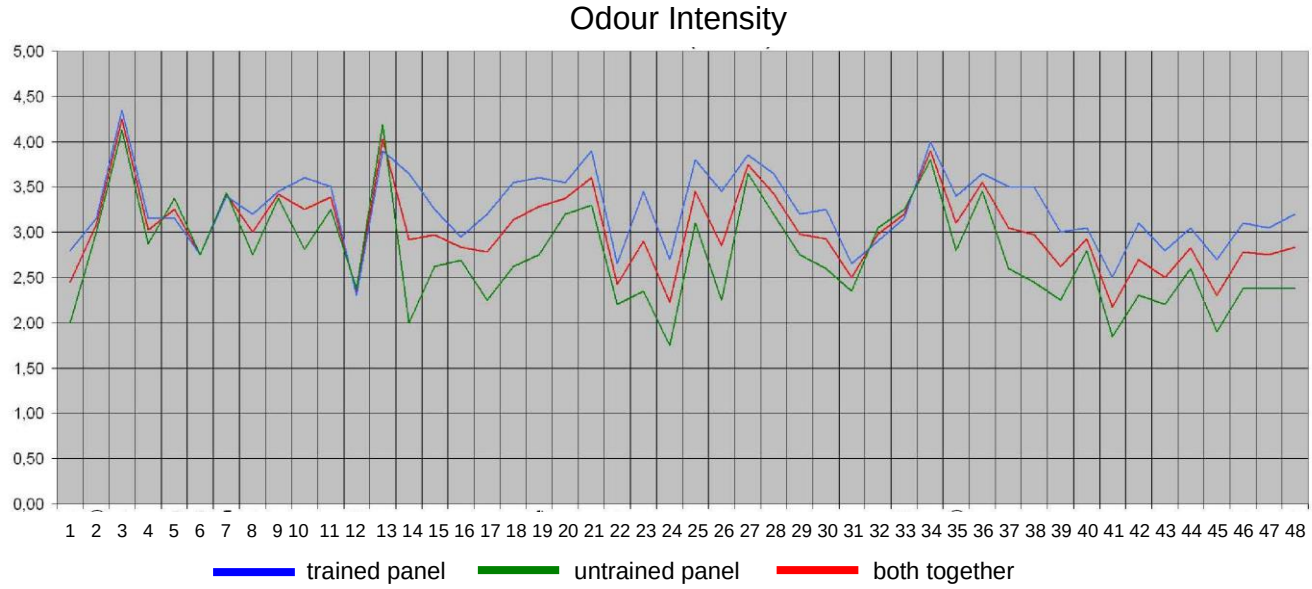


Diagram 2. Results of the hedonic evaluation, x-axis room numbers, y-axis: hedonic scale

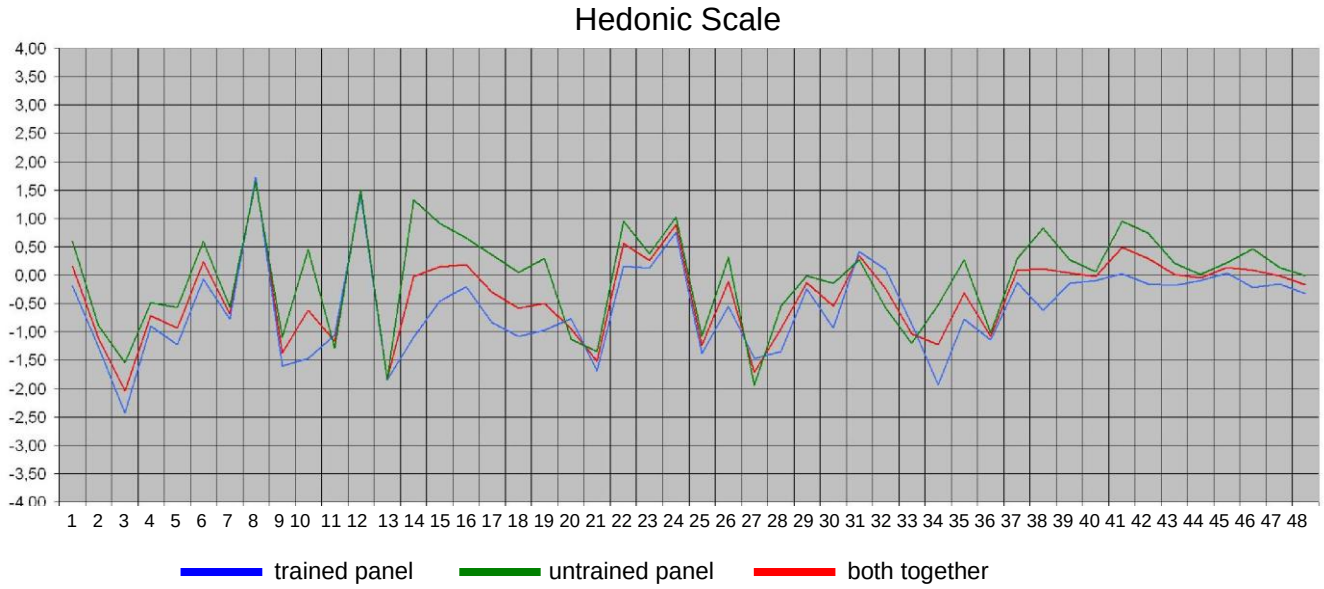
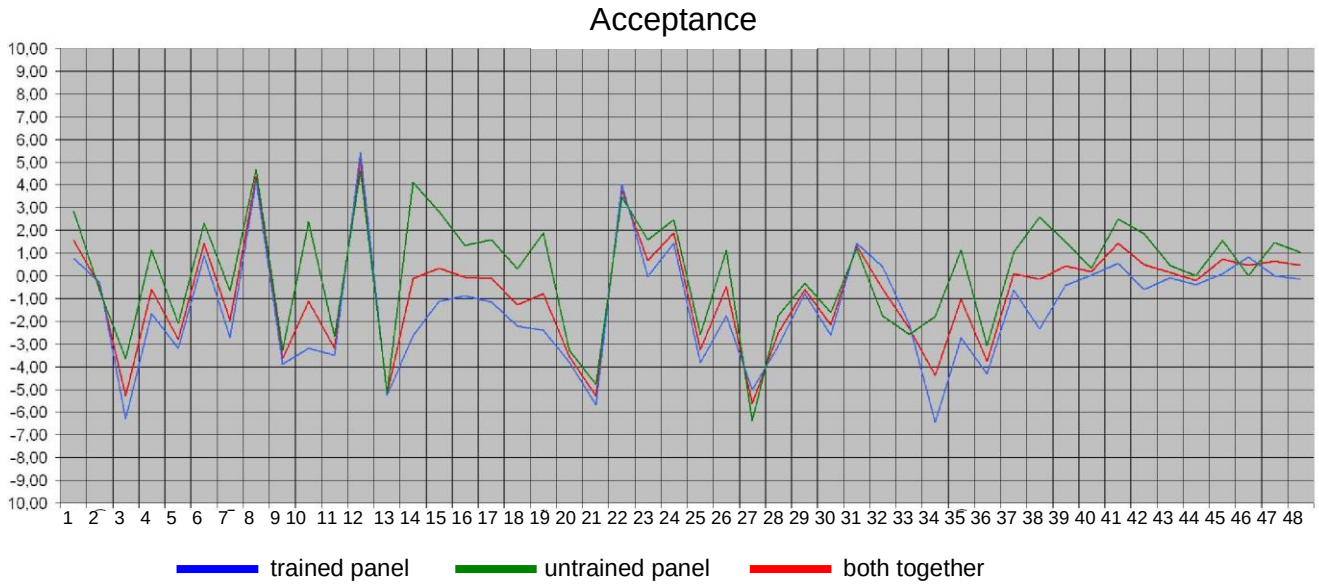


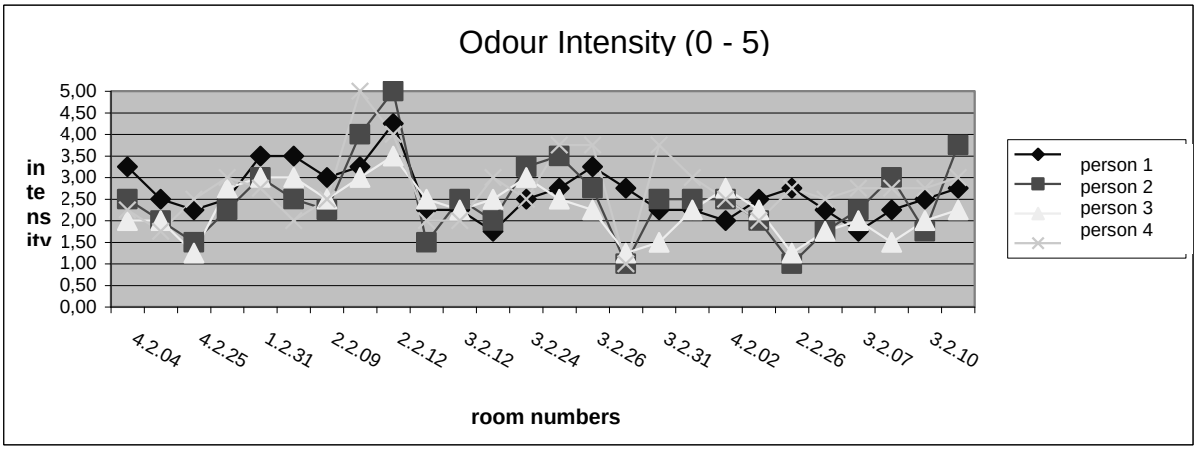
Diagram 3. Results of the acceptance evaluation, x-axis room numbers, y-axis: acceptance scale



Project 2: (Santen 2010)

The buiding is located in the „Speicherstadt“(which means storehouse-town of the old importers) of Hamburg. For decades, it was used as a carpet and partly as grocery storage. In 2006, it was converted into an office building after 10 years of vacancy. Subsequent to the renovation, there was a strong indoor odour perceivable mainly in the part of the building where coffee, tea and animal guts were formerly stored. To analyse this odour disturbance 87 rooms were tested with a trained panel of 4 persons („Testperson“ 1-4). The following diagram shows the intensity evaluation in 26 rooms of the single persons of the panel and gives an impression about the scatter of the results.

Diagram 4. Results of the sensory evaluation of every single person, x-axis room numbers, y-axis: intensity scale



Statistical evaluation of the results and error analysis

The resulting data from both projects were statistically evaluated and uncertainty was determined of the olfactory sensory odour evaluation. In the following table the pooled standard deviation of trained panel, standard uncertainty and extended measure uncertainty (refered to measured value interval) in dependency of the panel quantity from project 1 and 2 for the parameter intensity, hedonic and acceptance is presented.

Table 2: Pooled standard deviation of trained panel, standard uncertainty and extended measure uncertainty in dependency of the panel quantity from project 1 and 2

Project 1						
	Odour Intensity		Hedonic scale		Acceptance	
Scale	0 to 5		-4 to +4		-1 to +1	
Measured value interval	0 to5		0 to8		0 to 2	
	absolute	relative*	absolute	relative*	absolute	relative*
Pooled standard deviation panel	0,72	14,4%	1,14	14,3%	0,30	15,1%
	standard uncertainty	extended measure uncertainty *	standard uncertainty	standard uncertainty	standard uncertainty	extended measure uncertainty *
1 Panel	0,72	28,8%	1,14	28,5%	0,30	30,1%
2 Panel	0,51	20,4%	0,81	20,2%	0,21	21,3%
3 Panel	0,42	16,6%	0,66	16,5%	0,17	17,4%
5 Panel	0,32	12,9%	0,51	12,8%	0,13	13,5%
10 Panel	0,23	9,1%	0,36	9,0%	0,10	9,5%
30 Panel	0,13	5,3%	0,21	5,2%	0,05	5,5%
50 Panel	0,10	4,1%	0,16	4,0%	0,04	4,3%
100 Panel	0,07	2,9%	0,11	2,9%	0,03	3,0%
* refered to measured value interval						

Project 2						
	Odour Intensity		Hedonic Scale		Acceptance	
Scale	0 to 5		-4 to +4		-1 to +1	
Measured value interval	5		8		2	
	absolute	relative *	absolute	relative*	absolute	relative *
Pooled standard deviation Panel	0,61	12,2%	1,13	14,2%	0,34	16,9%
	standard uncertainty	extended measure uncertainty *	standard uncertainty	standard uncertainty	standard uncertainty	extended measure uncertainty *
1 Panel	0,61	24,4%	1,13	28,3%	0,34	33,9%
2 Panel	0,43	17,3%	0,80	20,0%	0,24	24,0%
3 Panel	0,35	14,1%	0,65	16,4%	0,20	19,6%
5 Panel	0,27	10,9%	0,51	12,7%	0,15	15,2%
10 Panel	0,19	7,7%	0,36	9,0%	0,11	10,7%
30 Panel	0,11	4,5%	0,21	5,2%	0,06	6,2%
50 Panel	0,09	3,5%	0,16	4,0%	0,05	4,8%
100 Panel	0,06	2,4%	0,11	2,8%	0,03	3,4%
* refered to measured value interval						

DISCUSSION

In contrast to the current consideration of sensory evaluation as unreliable, this study shows for the trained panel astonishing accordance. Interestingly, this study demonstrates that evaluations performed by a trained panel of three persons according to the guideline for indoor odours show under 18% of uncertainty.

CONCLUSIONS

This study shows for the first time a substantiated statistical error analysis of a sensory indoor odour evaluation for a trained panel. The failure analysis of the case studies demonstrates that the perceived indoor air quality (odour intensity, hedonic scale and acceptance) of on-site evaluations by a trained panel according to the guideline for indoor odours is comparable to the certainty of chemical analyses concerning the statistical error.

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