Investigation of indoor air quality and emission of indoor used materials in Hungary

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ABSTRACT
In the course of laboratory investigation we examined the adaptability of naive panels on indoor air quality measurements. We made the investigation on a measuring team of 45 participants. We examined the measurement precision and standard deviation of the measuring team with the help of Olf-Box. Our results show that despite the economic efficiency the number of persons in a measuring team cannot be reduced to less than 30 subjects. We built a measuring system to examine the emission of indoor used materials. The examined materials were: fitted carpet, plywood, laminated panels, PVC floor covering. The paper details the measuring system used and the results of the measurement.

INDEX TERMS
Contamination; IAQ assessment; Material emission; Measurement technique; Perceived air quality

INTRODUCTION

Indoor air quality has an impact on human comfort and work performance for intellectual work. This makes it important to measure indoor air quality, which may be evaluated using two methods:

- subjective evaluation with the involvement of test persons;
- measurement of the given pollutant using instruments.

No measuring instrument has been developed so far that is capable of measuring the joint impact of airborne pollutants. To evaluate air quality it is necessary to understand the joint impact of pollutants; therefore, the subjective measurement method with subjects is used internationally. Such a measurement may be carried out in two ways: using olf-testers or naive panels. The olf-tester method requires a measuring team of a few subjects (six to eight persons), their training however is very costly.

The advantage of naive panels is that no training needs to be conducted but more subjects are required. The majority of research projects focus on how many persons should be used for measurements. Internationally, the number of subjects in a measuring team is typically 32. In our measurements we investigated how changes in the number of subjects in the measuring team influence measurement precision. In addition, we dealt with the emission of various indoor used materials in the course of the laboratory measurements as no results have been yet produced in this field in Hungary.

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METHODS

Measurements were conducted in the Air Quality Laboratory of the Building Services Department of the Budapest University of Technology and Economics with the participation of 45 university students aged between 22 and 25. First, the olfactory sense of the measuring team was tested with the olf-box, then the pollutant emission of various indoor used materials, perceptible to humans, was examined.

The Relative Error of the Measuring Team

When developing the olf-decipol system, Professor Fanger and his team linked the value of the decipol scale to the given concentration of a typical gas, evaporated acetone. It is therefore possible to produce any air quality using air quality standards.

For the measurement, an olf-box was created that contains air quality standards the equivalent of 1, 5, 10, 20 decipol (decipolmeter) and the unknown pollution source (Figure 1).

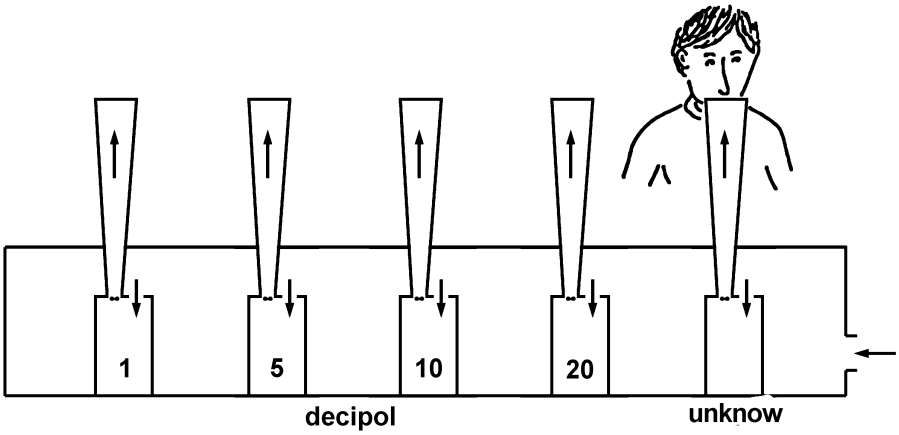

Figure 1 Draft of laboratory measurement to evaluate the error of the measuring team.

Components of the air quality standard are the sampling funnel, fan, mixing space, acetone source. Vented air mixes in the mixing space with acetone vapour from the acetone source. Subjects evaluate the acetone–air gas mix perceived through the sampling funnel. To develop the air quality standard we used materials such as glass and stainless steel which have minimal smell emission. Different air qualities may be produced by adjusting the number and diameter of bores on the aluminium plate closing off the acetone source.

In the measurement, subjects estimated eight different unknown values using the standards. Based on the results we examined how the relative error varies depending on the number of test persons in the measuring team. The following were investigated:

- evaluation of the total group of 45 subjects;
- evaluation of the selected group of 25, 30, 32, 35, 40 subjects.

The selection subjects may be done in three ways:

- through random sampling;
- in the order of best measurement results;
- in the orders of worst measurement results.

Values measured for different air qualities (for 45 persons) are shown in Figure 2. Table 1 contains the processing and evaluation of measurement results of these selected teams. Based on the box-plot method, measurement results of randomly selected subjects are contained in Figure 3.

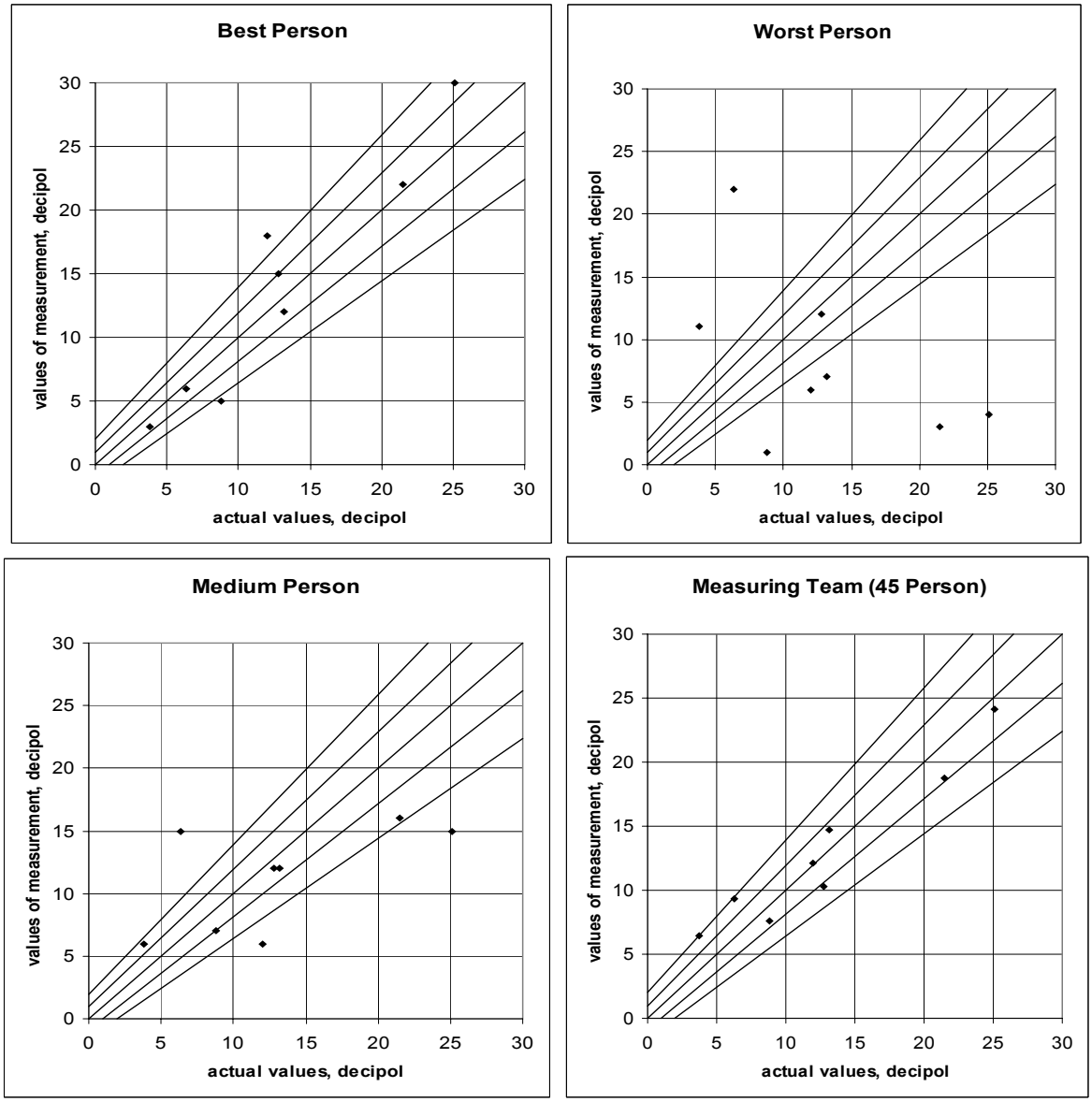

Figure 2 Measurement results of the measuring team.

Table 1 Evaluation of relative errors

Number of subjects	Relative error of the measuring team; %					
	25	30	32	35	40	45
Best subjects	3.54	4.90	3.34	3.70	7.65	10.19
Worst subjects	12.31	13.59	13.48	15.33	11.66	10.19
Randomly selected subjects	17.90	13.27	9.01	6.79	10.49	10.19

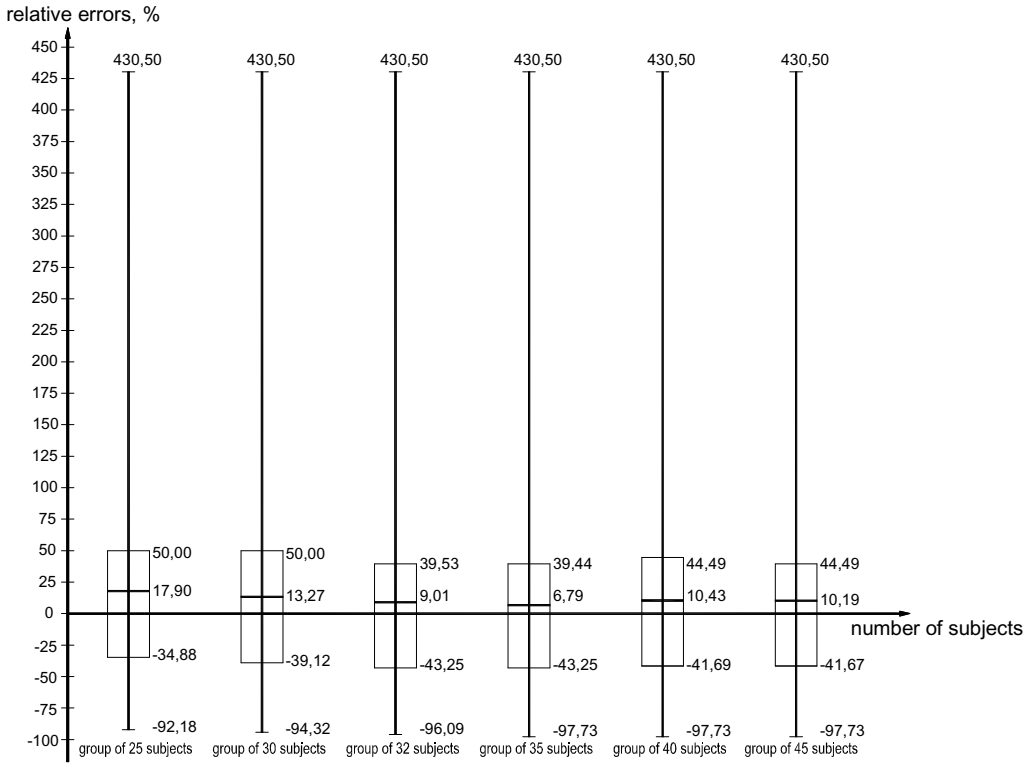

Figure 3 Evaluation of results of randomly selected subjects.

Examination of Indoor Used Materials

The pollutant emission of indoor used materials in Hungary was measured with the help of 45 subjects. The organization of the measuring device is shown in Figure 4. The emission was evaluated on an un-graded and Hedonic scale. Subjects evaluated air coming from the funnel marking the values +1 (clearly acceptable) and –1 (clearly unacceptable). Based on the marked values the percentage of dissatisfied (PD) may be calculated and from that the intensity of the pollution source. Measurement results are contained in Table 2. Values measured using the Hedonic scale for different indoor used materials are shown in Figure 5.

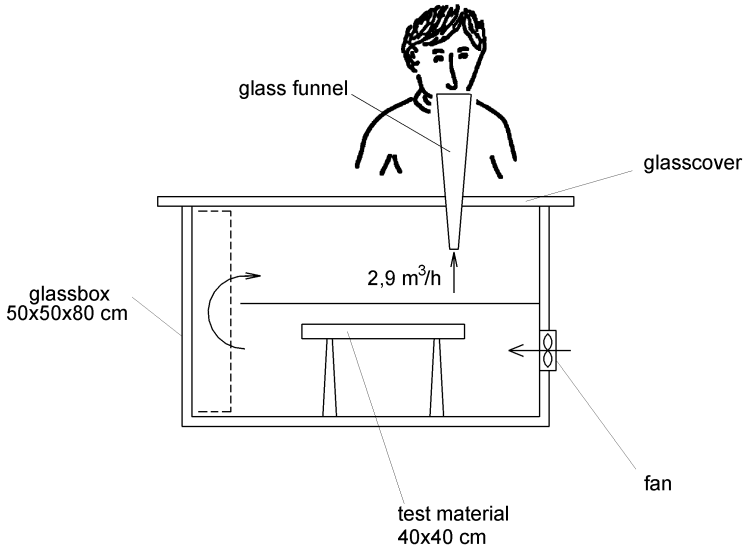

Figure 4 Measuring pollutant emission.

Table 2 Intensity of indoor used materials as pollution source

Number	Name	Votes Mean	Votes SD	Conf. 95% Mean	+Conf.	Mean –Conf.	PD %	G olf/m^2
1	Plywood	0.09	0.35	0.10	0.19	–0.02	29.77	0.46
2	Laminated panels	0.39	0.48	0.14	0.59	0.25	9.24	0.07
3	Fitted carpet 5mm	0.16	0.41	0.12	0.28	0.04	23.70	0.32
4	PVC floor	–0.12	0.38	0.11	–0.01	–0.23	48.34	1.11
5	Fitted carpet 3mm	0.04	0.53	0.15	0.19	–0.12	34.34	0.59
6	Furniture panels	0.04	0.44	0.13	0.17	–0.09	34.34	0.59

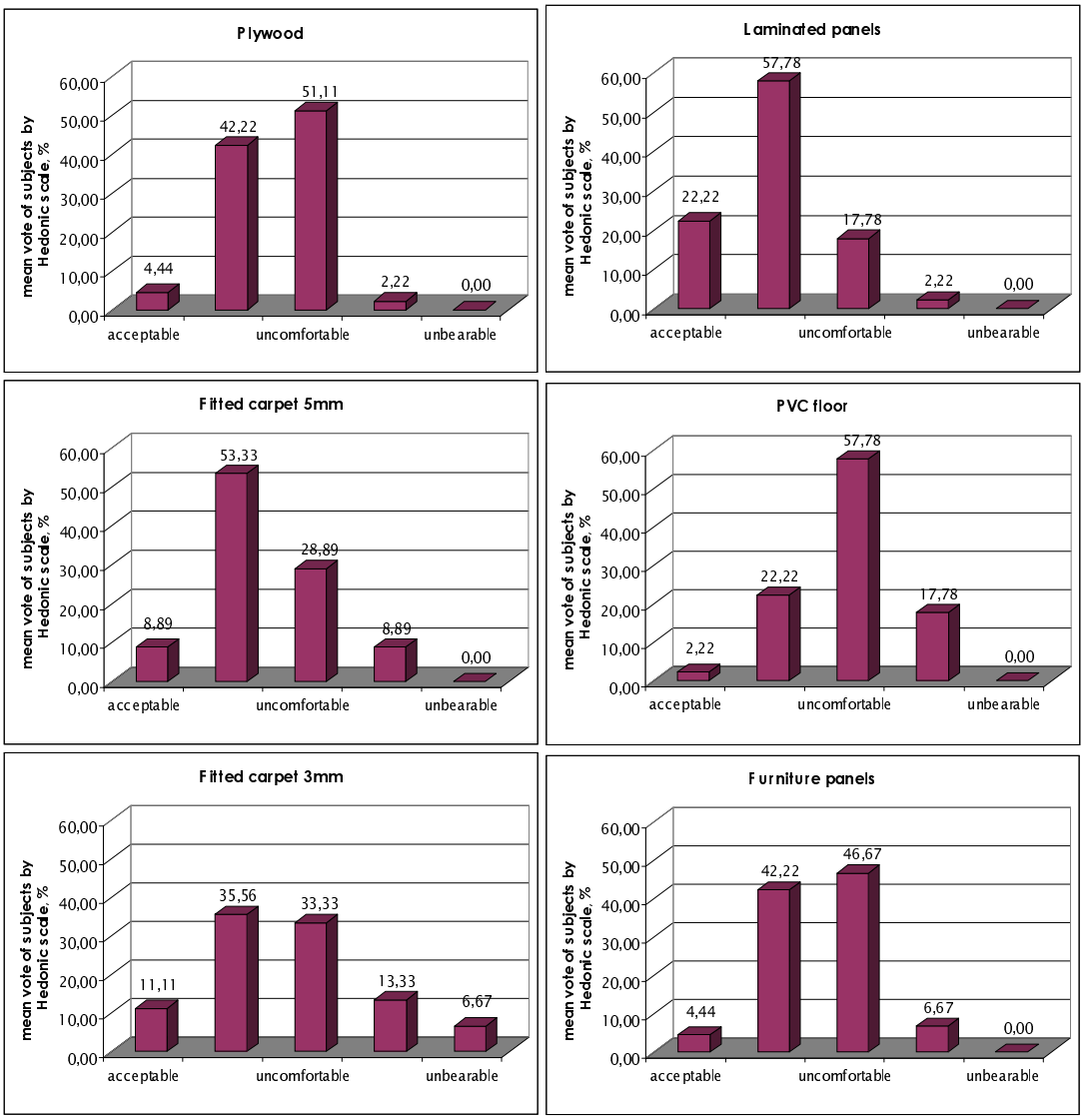

Figure 5 Measurement results of the Hedonic scales.

CONCLUSIONS, REMARKS

A laboratory measuring stand has been constructed and a measuring method has been developed to determine pollutant emission. In the last three years (2000–2003) several investigations were carried out using experimental groups consisting of different number of subjects (32–55). The measuring stand has been continuously improved on the basis of collected results. This made it possible in Hungary to measure pollutant emission with naive panels. This method is in agreement with international practice.

Based on the measurement results changes in the relative measurement error may be evaluated depending on the number of subjects in the measuring team. Economic efficiency requires that the team should include a smaller number of subjects. For the measurement precision, however, it is necessary to have a higher number of test persons. Table 1 shows the impact of the number of people in the measuring team.

Our results show that despite economic efficiency the number of persons in a measuring team cannot be reduced to less than 30 subjects. There was scarcely a shade of difference between results of measurements (mean, box-plots) of a team consisting of 30 subjects and results of a team consisting of 45 subjects. This is true for the best, for the worst and for randomly selected subjects (Table 1).

We have developed a laboratory measurement method to study the various indoor used materials in Hungary. With the help of the constructed measuring stand we determined the emission of plywood, laminated panels, fitted carpet, furniture panel and PVC floor. The measurement results provide basic data for dimensioning. The evaluation of emission figures has shown that such values are close to values published about similar materials in international specialist literature.

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