Reliability of IAQ subjective vote, collected during unorganized experimental measurements

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Reliability of IAQ subjective vote, collected during unorganized experimental measurements: *This publication presents an analysis of results of experimental study of microclimate parameters, conducted by physical measurements and subjective reporting of vote of a closed air environment. The subjective assessment has been carried out through complex specialized questionnaires. The participants in the experiment were not prepared in advance and where not familiar with the aims. The study has been conducted in a small lecture hall, during a one-hour lecture organized. The publication summarized the main objectives of the presented work, the used methods and an experimental setting. The obtained data have been analyzed especially in terms of the human behavior as a factor influencing the accuracy of responses in this particular study. The results indicate a reduced level of air quality in the room based on the measured concentration levels of carbon dioxide. Also it has been reported a very low level of "responsiveness" of participants (found only 17% correctly completed questionnaires) in both organized and spontaneous uncontrolled experimental studies. The explanation for these results is a complex task that requires additional interdisciplinary analysis. At present, the resulting data are processed and concrete results relating to meetings and vote subjective measurements of the physical parameters of the internal environment will be presented later.*

Key words: *Indoor Air Quality (IAQ), Thermal Comfort (TC), Occupant Behavior, Subjective Assessment, Experimental Studies.*

INTRODUCTION

Some of the best applied methods, for indoor air quality and thermal comfort assessment in occupied indoor spaces, are the objective physical measurements and subjective questionnaire based occupant response [1, 2, 5, 7]. The physical measurements are relatively easy to perform, if the well-known standards are followed. Also, if suitable measurement devices are used, the results achieved are mostly reliable. But, the subjective vote from occupants could be quite hard to be taken and analyzed. This is especially true if the experimental study is spontaneous and if the participants are untrained and not familiar with the aim of the study. Recent publications in Bulgaria also confirm that fact, and it is suggested that additional analyses and assessment in this area are required [6, 7]. That is why the presented study will focus on the reliability of the results from a paper based questionnaire study, performed spontaneously, without any training of the assessment panel.

Further motivation for the presented study is the well-known fact, that nowadays people spend most of their lifetime indoors. But, there are various indoor factors, having significant impact over occupant's health, comfort, performance and productivity [4]. Numerous studies in this area have been performed in the recent decades and lots of norms and standards, describing the preferred microclimatic conditions, are established [1, 2, 3]. But still, all these recommendations are not met in many, many buildings in Bulgaria and around the world as well. Poor indoor air quality and general discomfort from the indoor environment in the residence buildings and in the non-residence, commercial, buildings could be found also as common situation in Bulgaria [6, 7]. That is why, one of the tasks in this case study is to analyze the indoor environment parameters in small lecture room, part of well-known university in Sofia, Bulgaria.

AIM OF THE PRESENTED STUDY

The aim of the presented study is to assess the reliability of the results from unorganized and spontaneous subjective assessment of the indoor environment parameters in small lecture room.

Some of the outlined tasks, based on the stated objective include: to perform

subjective assessment of the indoor environment, organized by untrained and unprepared assessment panel; to perform parallel physical measurements of the main indoor environment parameters, and to analyze the reliability of the results from the subjective assessment.

The presented paper reveals part of the results obtained during the performance of all of the above stated tasks.

METHODS OF THE PRESENTED STUDY

Basically, the main methods applied in the presented study include physical measurements of the indoor environment parameters (air temperature, relative humidity, carbon dioxide (CO2) concentration) and paper based questionnaires for the subjective occupant assessment. The entire experimental study was performed during one hour informative lecture, which concerned in general the topics of indoor air quality and thermal comfort. The lecture was delivered in small lecture room, part of one of the biggest universities in Sofia, Bulgaria. For the purpose of the study, this lecture was widely advertised among the students and the academic staff, for several weeks prior to the exact date and time. The invited participants were not told anything about their participation in the experimental study, neither the planned experimental procedure.

At the beginning of the specially organized lecture, a set of questionnaires were spread among all participants. They were asked to fulfill them and to leave them on the place, where they were sitting. Part of the delivered lecture also concerned the subjective assessment of indoor environment parameters, and so instantaneously the participants were explained how to give their votes. The questionnaires covered wide range of questions and assessments over visual-analog scales, concerning the human perception of the enclosed environment. The questions covered in the different parts of the paper based questionnaire, were organized in the following way:

1. Perceived Air Quality 1 – Participants' first impression;
2. Current State – Participants' general condition prior to the experimental period;
3. Perceived Air Quality 2 – Participants' assessment after period of adaptation;
4. Thermal Comfort – Participants' assessment at the work place;
5. Sick Building Syndrome (SBS) symptoms – Assessment at the work place;
6. Clothing – Participants' assessment of the clothing insulation;
7. General Comfort – Participants' assessment at the work place;
8. Personal Data – Collected by the participants.

Each questionnaire consisted in total of 8 printed pages. None of the participants was familiar with them, prior to the experiment. Also, there was not assigned any time, for which the questions should be answered (as it is in the organized experiments with trained assessment panel).

Parallel with the subjective vote study, a continuous physical measurement of the indoor environment parameters (air temperature, relative humidity, CO_2 concentration) at three points in the room was performed by the experts, involved in the project. It was performed by modern wireless loggers. The methodology for assessment used, follows the requirement of CEN CR1752 document [3].

EXPERIMENTAL SET UP

Schematic representation of the experimental set up is shown on Figure 1. Small lecture room, with capacity of 34 sitting places (work places), in one of the biggest universities in Sofia, Bulgaria, was selected for the purpose of the study. That number of sitting places was considered as the maximum possible number of participants in the presented experimental study. The room is situated on the 3th floor in a 12 story concrete building, build in 1978. The orientation is "South" and the sitting places were organized in big elliptical circle.

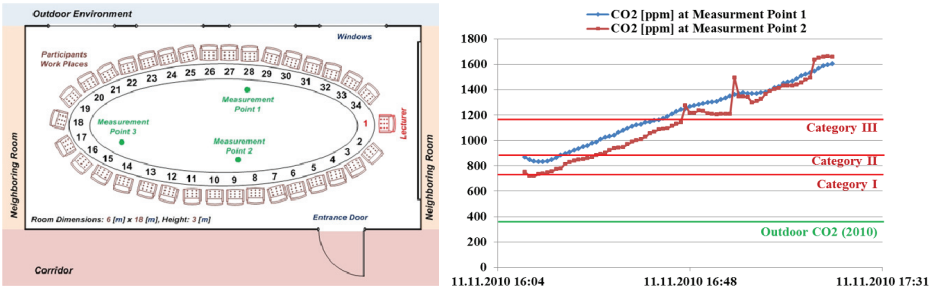

Fig.1. Scheme of the lecture room layout and CO_2 concentration measurements during the experimental period

Room dimensions are 6 meters by 18 meters, and the height is 3 meters. This corresponds approximately to 324 m^3 of air, without considering the furniture. The entire south facade is covered by double glassed windows with aluminum frames, and PVC blinds. The experiment was performed during the winter period (11.11.2010), and so none of the windows were open during the entire lecture. There was no ventilation system as well. Figure 1 also shows the distribution of the work places (the sitting places for the participants), and moreover illustrates the measurement points, in which the indoor environment parameters were monitored.

RESULTS AND DISCUSSION

The CO_2 concentration at measurement points 1 and 2, for the entire experimental period is again presented on Figure 1. The measurement interval was 1 hour and 10 minutes, and data was recorded for each minute, which means 70 records in total. The minimum value measured was 776.37 ppm, recorded at the beginning of the lecture, and the maximum value was 1634.22 ppm at the end. The CO2 concentration could be considered as very important indicator for the indoor air quality [1, 2, 3]. The results clearly show that, for significantly short time, approximately half of the lecture duration, the CO2 concentration level inside the lecture room increases so much that it exceeds the categories prescribed in the standards [1, 2, 3]. That corresponds to very low air quality inside the room and high level of percentage dissatisfied by the perceived air quality.

These results become even more remarkable, because of the fact, that only half of the room was occupied during the performed experiment. Nevertheless that this lecture was significantly advertised, only 14 participants took part of it voluntarily. Since 34 work places were organized, that means that 59% of them were empty and the response rate was 41%. These results are presented on Figure 2. Also, from the 14 people involved in the lecture, only 11 of them returned questionnaires and 3 persons did not. So, based on the initially organized 34 work places, that means that the participant's response rate, estimated with the collected questionnaires, drops to 32%.

After further analyses in terms of the collected votes by the participants, it was found out that, that from the 11 people who have returned questionnaires, only 6 of them were completely fulfilled. Five of the collected questionnaires were incomplete or not fulfilled at all. These results are also presented on Figure 2. Once again, based on the initially organized 34 work places, the participant's response rate, estimated with the completely fulfilled and collected questionnaires, drops to 17%. This percentage is considered as very low.

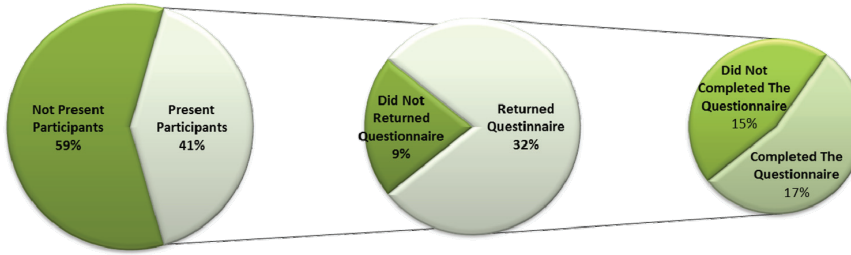

Fig.2. Percentage distribution of the present participants, who have completed the questionnaires, based on the 34 prepared work places

Figure 3 shows the distribution of the completely fulfilled groups of questions, based on the 11 returned questionnaires. The most completely answered groups of questions are the “Perceived Air Quality” and the “Current State” groups. One possible explanation may be that, these groups contain much less questions compared to the others. The voting over the simple visual analog scales seems to be much more appreciated by the participants, compared to giving complex answers with several possibilities. As the figure indicates, the rest of the groups are much less completely fulfilled. The group which has the fewer fulfillments is the “General Comfort” group. Another reason for these results could be found in the time distribution of the subjective vote assessment. Clearly, the groups of questions which have been given at the beginning of the experiment are much more fulfilled, then the one given at the end. The tiredness and concentration loss of the untrained participants may be a reason for avoiding the answers of the more complex questions.

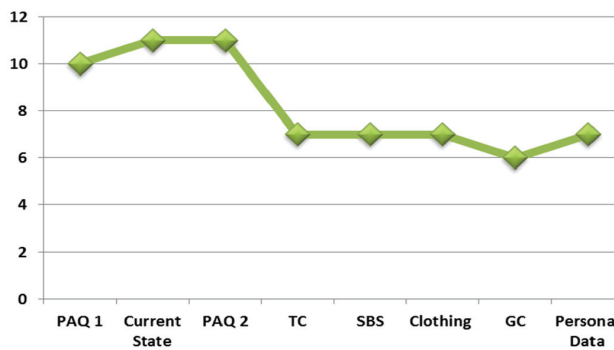

Fig.3. Distribution of the completely fulfilled groups of questions, based on the 11 returned questionnaires

CONCLUSION

● The physical measurements clearly show low indoor air quality parameters in the room, during the lecture period. The CO2 concentration was significantly high (above 1200 ppm), nevertheless that the room was only half occupied.

● The data collected for the subjective indoor air quality assessment based on the questionnaires might not be reliable. The main reason is the very low participant response

rate (17% for the presented study).

● The spontaneous and unorganized experimental studies are complex tasks and require more interdisciplinary analyses. Trained and motivated assessment panel is beneficial for such kind of study, which is usually recommended by the experienced researchers in that area.

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This paper has been reviewed.