

Survey Evaluation of the Indoor Environment Quality in a Large Romanian Hospital

Cristiana CROITORU*¹, Andreea VARTIRES¹, Florin BODE^{1,2}
Angel DOGEANU¹

*Corresponding author

¹ CAMBI, Technical University of Civil Engineering in Bucharest, Building Services Department, 66 Avenue Pache Protopopescu, 020396, Bucharest, Romania, cristiana.croitoru@cambi.ro, vartires2@gmail.com

²Technical University Of Cluj-Napoca, Mechanical Engineering Department
103-105 Muncii, D03, Cluj-Napoca, Romania
florin.bode@termo.utcluj.ro

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Abstract: *The medical units represent a challenge for the building services engineers who are often put in difficulty to ensure the indoor optimal conditions. The destination variety of the indoor environment in such buildings and the different internal thermal loads lead to discomfort zones, for all involved users. The requirements imposed by standards lead often to dissatisfaction for the users: while some of the medical staff asks for low temperatures, others feel discomfort and often the patients have thermoregulatory problems due to this non-homogeneity of thermal conditions found.*

Several sets of survey studies were made in a large emergency hospital located in Romania of 1070 beds. Medical and non-medical team participated in this study regarding the indoor quality from different work-zones of this hospital. The zones studied were: internal medicine, cardiology, gastroenterology, hematology, neurology, neurological recovery, the emergency unit, and also functional and auxiliary areas: dietetics, administrative, statistics, etc.

All the queried persons had to response to a 15 minutes questionnaire, where local and global comfort questions were asked, in addition to specific characteristics like gender, age etc.

The results have shown high differences from one zone to another and more of that, high differences between the categories of personnel. Uncomfortable thermal sensations, lack of fresh air and important level of polluted air, noise or lack of space are just some of the problems met in hospital environment.

Key Words: *field survey, indoor environment quality, healthcare facility, indoor perceived comfort.*

1. INTRODUCTION

Maintaining good Indoor Environmental Quality (IEQ) in hospital buildings to ensure health and safety for both the patient and medical team is of the highest importance. The medical units represent a challenge for the building services engineers who are often put in difficulty to ensure the indoor optimal conditions. The destination diversity of the indoor environment in such buildings and the different internal thermal loads lead to discomfort zones, for all involved users. The requirements imposed by standards lead often to dissatisfaction for the users: while some of the medical staff requires cool temperatures, others feel discomfort and often the patients have thermoregulatory problems due to this non-homogeneity of thermal conditions. Furthermore, it could be observed from a standards review that minimum and maximum values of temperature recommend for the Standards are different.

A significant consideration is that different types of ventilation systems have different designs, dimensions, applicability and resultant airflow dynamics. According to [1], in some cases the ventilation system can decrease the percentage of infection. Some types of ventilation systems improve infection control, because they provide airflow dynamics that “divide” the OR (operating rooms) in different zones, ensuring different protection levels. Previous studies [2-4] reported satisfactory results using ventilation systems which resulting in three zones in the OR.

Romanian standards are permissive, giving the possibility of a heterogeneous conception approach. There are two standards taken into consideration: The C253-0-94 norm from 1994 [5] for designing clean rooms (including post operator therapy rooms and rooms for immune depressed patients) and the Design Norm NP-015-97 from 1997 [6] for Hospital Buildings and the corresponding equipment. The difference between the standards makes it difficult to choose and to know that requirement is better to recommend in operating rooms or other healthcare environments and to ensure safety for the patient and the surgical team.

To find the relevance of the standards used in the conception of the hospital buildings concerning thermal comfort, several sets of survey studies were made in a large emergency hospital in Romania. This hospital is a typical building for healthcare category in our country so the results’ conclusions can be extended to a national level.

This is the first time that such a field study is performed in our country, for an overall evaluation of medical institutions’ buildings. Medical and administration personnel from operating rooms, hospital wards and other administrative zones participated in these studies. The hospital is a 12 floors building with 4 aisles, having 1070 beds (Fig. 1.a). The building has been built in 1978, being partially renovated (changed windows and interior refurbishment) – Fig. 1.b. The Emergency Unit area is entirely new and is the only zone with central air conditioning system. In the remaining areas, including operating rooms, common split units are installed (without a special air filtration or purification).



Fig. 1 – Photographs of the studied hospital: a) North and East aisle; b) Interior of a renovated hospital ward.

2. METHODS

Data about overall perceived environmental quality were considered through questionnaires distributed to the occupants. We have distributed 2 types of questionnaires: for operating rooms and other areas like wards and medical and non-medical offices. A specific questionnaire was elaborated with regards to EN ISO 10551/2002 [7] and incorporated with

additional questions for surgeons in the operating rooms survey concerning the infections status in the hospital. The study was conducted in winter 2012-2013. We developed a questionnaire with 25 questions (Fig. 2); the questionnaire was filled in by 122 hospital occupants such as physicians, nurses and non-medical staff. Of the total of the 122 questionnaire, 50 questionnaires were completed by non-medical personnel of auxiliary fields (operator data, medical register, reviewer, statistician and economist).

The study was carried out in several departments such as surgery, internal medicine, cardiology, gastroenterology, hematology, neurology, neurological recovery, ER (emergency room unit), functional explorations and ancillary areas: dietetics, administrative, statistical, etc. The questionnaires have 4 categories of questions:

Type 1 regarding **personal data** (age, sex, working period etc.);

Type 2 regarding **thermal aspects and HVAC systems** (opinion about thermal discomfort, air movement or draft sensation, preference for different thermal conditions, fresh air need);

Type 3 regarding **overall evaluation of the environment**: light, noise, odors, air quality, air pollution, work productivity assessment etc.

Type 4, for surgeons only, related to the **nosocomial infection rate of operations**, by answering questions regarding the difficulty level of operations, cleanliness etc.

We define here the referring zones for which we exploited the results: Operating Rooms (OR) and Other Zones like hospital wards or administrative areas (OZ).

Survey – Indoor Environmental Quality OPERATING ROOMS

Department / Medical Unit:
Date:
Hour:

Please fill in the appropriate answers:

1. How long have you been working in this building?
 - Less than 1 year;
 - 1-2 years;
 - 3-5 years;
 - More than 5 years;
2. How long have you been working in this department/operating room?
 - Less than 6 months;
 - 6-12 months;
 - 1 an - 3 years;
 - More than 3 years;
3. In a normal week how many hours do you spend in the operating room?
 - Less than 10 hours;
 - 10-20 hours;
 - 20-30 hours;
 - More than 30 hours;
4. What age do you have?
 - Less than 30 years;
 - 30-40 years;
 - 40-50 years;
 - More than 50 years;
5. Specify your gender:
 - Female;
 - Male;

Fig. 2 – Form of questionnaire for OR - example of the first page

We present in the next tables (Table 1, 2) the repartition of completed questionnaires for each department:

Table 1: Number of questionnaires completed in each department and the corresponding number of beds

Department/ Operating Rooms	No. beds	No. questionnaires
Neurosurgery I	30	5
Neurosurgery II	30	7
Ophthalmology	40	5
ORL	10	5
General Surgery II	45	7
General Surgery IV	45	6
Thoracic Surgery	15	3
Cardiac Surgery	20	4
Total	42 questionnaires	

Table 2: Number of questionnaires completed in each department and the corresponding number of beds

Department/ Other Zones	No. beds	No. questionnaires
Cardiology	50	5
Gastroenterology	25	4
Neurology	10	6
Hematology	25	7
Dietetics	-	4
Statistics	-	6
Administrative	-	11
Medical II, III	65	2
Neonatology	35	5
Functional Explorations	N/A	4
Emergency Unit	N/A	5
Neurology	70	7
Medical IV	25	6
Internal Medicine	25	8
Total	80 questionnaires	

3. RESULTS

Of a total of 122 respondents participating in the field survey, 35 respondents (29%) were males while the rest of 87 (71%) were females, if we consider both the operations zone and other spaces zone. It is important to mention that in the operation rooms the distribution by gender is almost uniform, 48% males and 52% females. In the surgery units, the majority of personnel are between the ranges of 30-40 years (33%) or 40-50 years (50%), in contrast to the other zones, where the age distribution is more uniform, meaning we also have both young and aged respondents. In order to investigate the subjective factor of workplace adaptation, we have found that more than 75% of 122 participating persons are working in the current place for more than 5 years (Fig. 3.a). The program of the people working in other spaces (OZ) than surgery departments is more than 30 hours per week. In the operating rooms (OR), people are working in function of their specialization: surgeons spend approximately 10 hours in the operating rooms carrying out a particularly intense work and the remaining medical staff spends between 10-20 hours (26%), or 20-30 hours (21%) or over 30 hours (17%), Fig. 3.b. The numbers can be analyzed in the next figure.

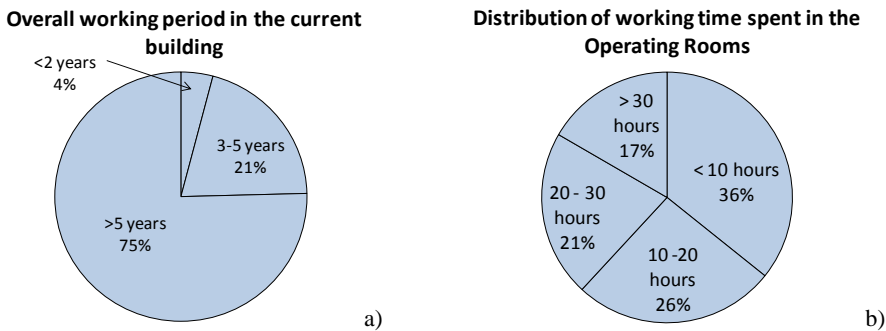


Fig. 3 – Respondents’ working adaptation: a) Overall working period in the current building (OR+OZ); b) Distribution of working time spent in the OR

The questions in this survey are mostly addressed to evaluate the indoor environmental quality and the implications on the medical activity.

Regarding the air quality, it is perceived as low, for both interrogated zones.

For example, 56% of the respondents from the OZ stated that there is fresh air introduced in the building, 5% don't know and the rest of 39% believe that there is no fresh air supply.

A different situation is in the OR where only 36% of the personnel consider that the fresh air is introduced in the occupied zone, 38% not and 26% don't know.

In our investigation, the administrative manager reported that the operating rooms use only split type air conditioning systems, so the fresh air is practically absent.

Given these results, the answers regarding the presence of water droplets on the air-conditioning units (due to the absence of fresh air) are plausible: in the OR 31% of the personnel observed the water droplets, in comparison to 4% only in OZ.

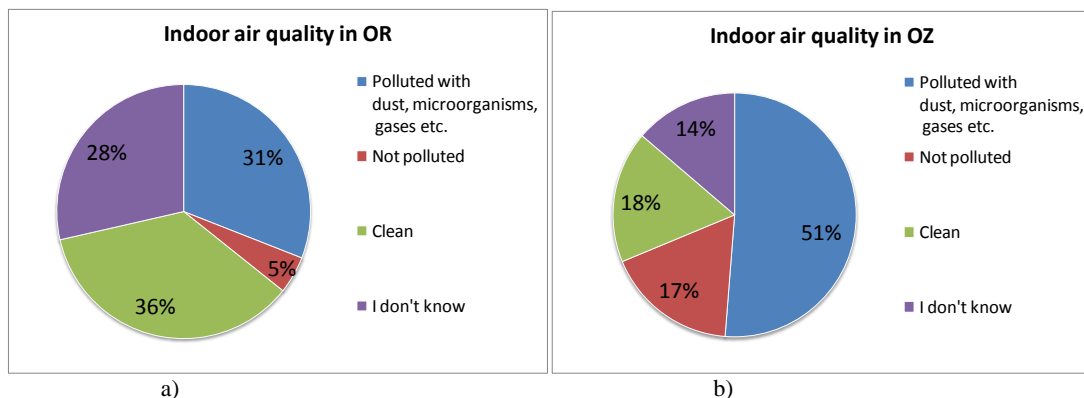


Fig. 4 – Respondents' perception of indoor air quality: a) IAQ in OR; b) IAQ in OZ

The situation is reversed when considering the air quality in terms of pollution: while in OR 31% of people believe that the air is polluted, in OZ, the more than a half of the occupants have this perception (Fig. 4 a, b).

These numbers can be explained by the fact that people know that the levels of indoor pollution load must be limited between standard ranges for the operating rooms.

Both in operating theaters and in other areas indoor air is considered to be polluted with various chemicals, dust, germs, microorganisms (in proportion of 30-50%), this may have been due to poor intake of fresh air.

Even if the interrogated personnel considers that only 14% of OR are not renovated in comparison with 34% of OZ, an interesting indicator of IAQ is the disturbing odor perceived in proportion of 21% in the OR and only 8% in OZ.

In fact, this kind of complaint was found in different survey studies of other hospitals performed by our team.

The source of these odors is: mold smell, food, tobacco etc. while functioning the air-conditioning system.

The global perception is indicating a 13% discontent regarding the indoor odors. Other type of discomfort is the lighting level, more than 25% of OR personnel complaining about a low lighting level.

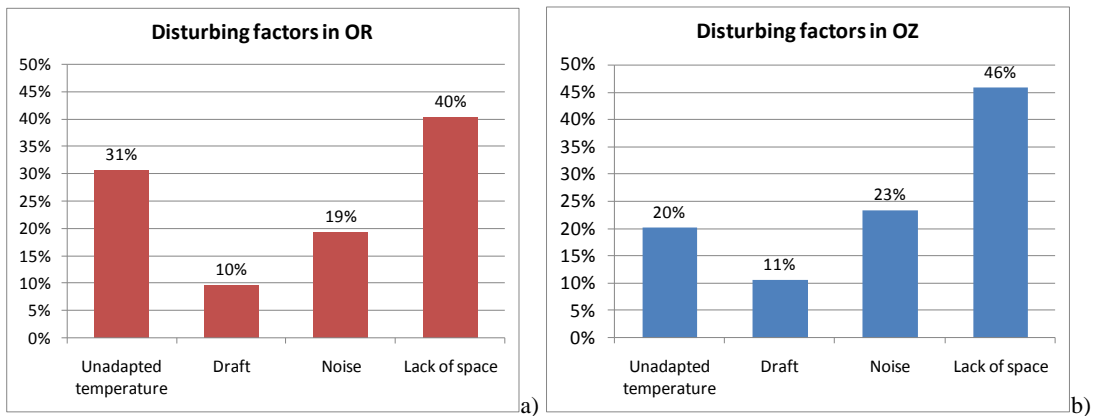


Fig. 5 – Negative aspects for the smooth running of activities: a) in OR; b) in OZ

We evaluated the overall discomfort factors for all kind of indoor types. When asked what impediment they find in doing their work, the respondents affirmed both for operating theaters and other areas of the hospital that lack of space is the main negative aspect for the smooth running of activities (Fig. 5).

On the second position we have found as disturbing factor the temperature too high in surgery units (31%) or excessive noise to other areas (23%).

In the graph below (Fig. 6) it is shown the percentage of people dissatisfied by environmental quality, taking into account aspects such as the lighting in working area, draft sensation perceived by occupants, noise, odors, air pollution with different categories of substances, the degree of thermal discomfort of occupants.

Following all this, it can be seen that temperature too high (both in case of summer and winter) is the most disturbing factor (the proportion of 79%), followed by air pollution by various substances (44%) and the degree of lighting (25%).

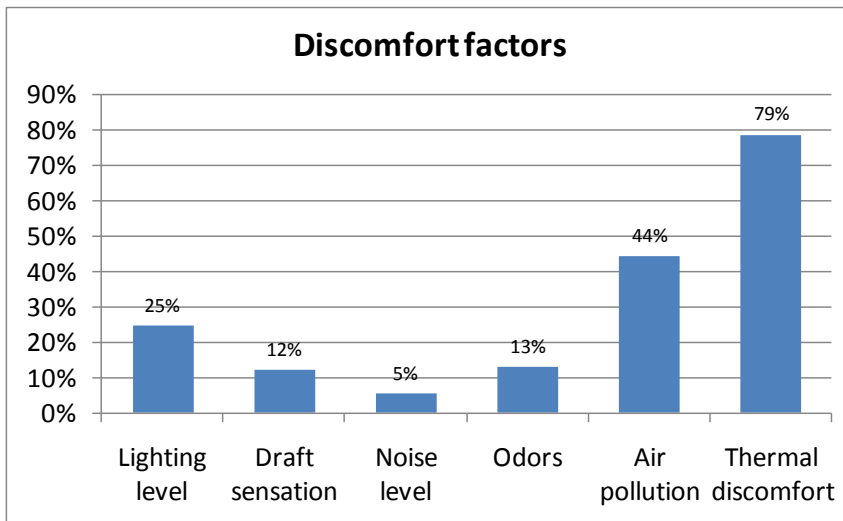


Fig. 6 – Overall IEQ discomfort factors

Considering the factors regarding IEQ in the healthcare facility, the overall response indicates high level of thermal discomfort (either too warm or too cold indoor conditions), situation that occurs for both zones for winter and summer as well (Fig. 7).

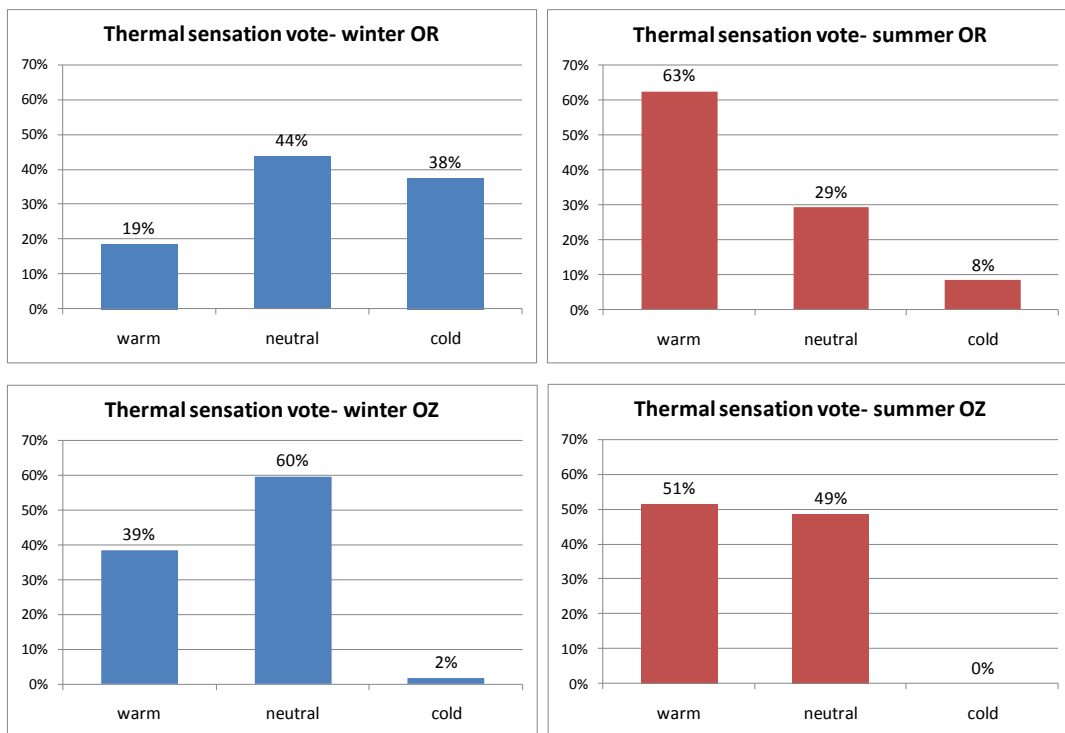


Fig. 7 – Thermal sensation vote for OR and OZ in winter and summer

These data indicate that medical personnel might prefer lower temperatures or more intense air movement, especially in the operating rooms during the summer.

Surgeons complain during all seasons by warm conditions inside operating rooms, where important heat loads are released, along with an intensive activity that can take place for several hours.

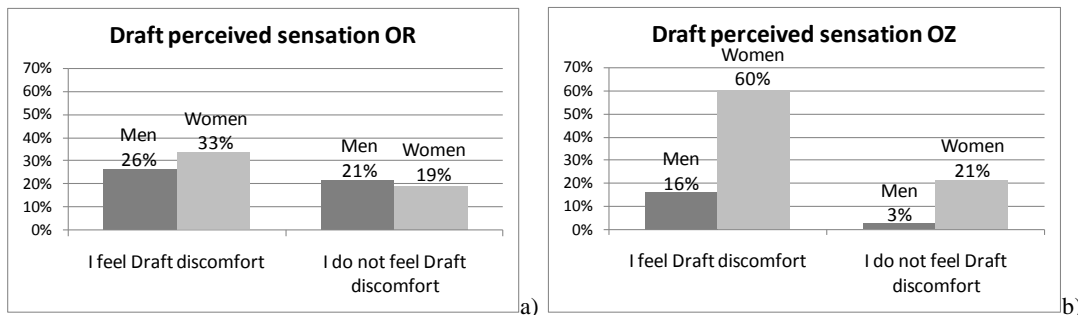


Fig. 8 – Draft sensation perceived by gender categories: a) in OR; b) in OZ

In correlation with draft perception caused by the ventilation or air conditioning systems, subjects were interviewed to express in which part of the body this sensation is felt more pronounced.

The neck is the most sensitive part of the body, no matter what department was taken into consideration.

More than 50% of the personnel expressed this kind of local discomfort. For the surgery units, another sensitive part is the lumbar region (33%), while employees in other areas considered shoulders and arms (23%) to be more sensitive to draft, after the neck zone.

The overall conditions at workplace are perceived as “good” at the majority of interrogated personnel, but we have found an important percentage, more than 25% of subjects, who complain about “poor” working conditions.

4. CONCLUDING REMARKS

Most people participating in the field survey perceive in general, especially in winter conditions, a sensation of thermal neutrality, in operating areas or other spaces. The situation is totally changed in summer period, a significant proportion of personnel in operating rooms, medical and non-medical staff, expressed discomfort thermal (hot) in working area. This may explain the need of centralized cooling systems, in studied building being installed only local units for air conditioning (split systems).

Associated with cooling insufficient / inadequate conditions, the respondents also reported the presence of stale air sensation, which is due to an inadequate fresh air flow, below the health standards imposed for different working areas in hospitals.

Regarding working conditions in hospitals we can observe that more than 20% of the personnel are complaining about poor working conditions.

The study reveals that the current standards are either not respected, or, in best cases, they do not suit the occupants' requirements, who complain about thermal, light, noise etc. discomfort. The standards should be changed to respect to occupants comfort, in order to provide working optimal conditions.

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