

Indoor Air Quality and Associated Health Effects. Current Perspectives

Calitatea aerului interior și efectele asupra sănătății. Perspective actuale

Cristian Păcurar¹, Adriana Tokar¹, Marius Adam¹

¹ Politehnica University of Timisoara, Romania

Traian Lalescu 2, Timisoara 300223, Romania

E-mail: cristian.pacurar@upt.ro, adriana.tokar@upt.ro, marius.adam@upt.ro

Abstract: *The relation between air quality and human health is one of the most well-documented contemporary public health topics and this is determined by the interaction between air pollutants and the body's physiological systems.*

Key words: indoor air quality, ambiental comfort, thermal comfort, productivity, performance, environmental quality

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1. Introduction

Indoor comfort is a determining factor for our physical and mental health, considering that we spend approximately 90% of our time in indoor spaces. The quality of the air we breathe indoors has a direct and immediate impact on our well-being [1]. Health effects are usually divided into two categories: short-term and long-term. Short-term effects often occur after a single or prolonged exposure to stale air (for example, a whole day in an unventilated office). Symptoms are like those of a cold, irritation of the nose, throat and eyes, sneezing, coughing or feeling of suffocation. Or for example, dryness, itching or irritation may occur on the skin, especially if the humidity is below 30%. Also, at the neurological level, dizziness, headaches, chronic fatigue and difficulty concentrating may occur. All these symptoms define the "Sick Building Syndrome", and the health condition improves rapidly as soon as the person leaves the building. Long-term effects are given by constant exposure to indoor pollutants can be much more severe, because toxic substances accumulated in the body. Examples are chronic respiratory diseases (e.g. worsening of asthma, development of bronchitis or other obstructive pulmonary diseases). As cardiovascular problems occur when fine particles (PM2.5) can pass from the lungs directly into the bloodstream, increasing the risk of hypertension or

heart disease [2]. Severe allergic reactions can also occur, such as constant exposure to mold spores or dust mites, and then permanent allergies can be triggered. Another major risk is prolonged exposure to gases such as radon or volatile chemical compounds (benzene, formaldehyde). The goal is to have the cleanest air possible in the rooms to have optimal efficiency of the activities of the individuals in those.

From a technical and functional point of view, improving the indoor space is based on optimizing the interior environment, not only in terms of aesthetics, but also the performance of buildings in relation to human biology. This paper will show how each of the points mentioned above can be improved.

2. Content of the paper

The optimization of the interior environment can be done through air quality optimization (e.g. ventilation and purification), sustainable design and materials, the quality of lighting, acoustics, as well as the functionality of the space.

Optimizing air quality is the most important part where you can improve the quality of life in the indoor space and below are some points where you can intervene. You can intervene by controlling humidity, maintaining relative humidity between 40-60%, so that mold growth will decrease and limit the survival of airborne viruses. Another method of intervention is through active purification, using purifiers with HEPA H13 filters and layers of activated carbon (for absorbing gases and odors). Another way to optimize air quality is through heat recovery (HRV/ERV), replacing natural ventilation with mechanical systems that filter outside air and recover thermal energy, simultaneously eliminating volatile organic compounds [3].

Improving the interior space can also be done at the design level and the materials used for construction, because the integration of natural elements has the role of reducing cortisol. It can be done through vegetative integration by painting the walls green or adding indoor plants (e.g. Sansevieria Trifasciata, Spathiphyllum, Chlorophytum Comosum, Dracaena) which, although they have a limited purification effect on a large scale, significantly improve the mental state. Also can be used materials with low emissions, and by selecting finishes (furniture, paints, adhesives,) with Low VOC or Formaldehyde Free certifications, "indoor pollution" will be prevented [2].

The quality of lighting is another factor, because light adjusts the biological rhythm, so having biodynamic lighting, you can increase the quality of the interior space, and this is achieved by installing LED systems that change their color temperature throughout the day: cold light in the morning to inhibit melatonin and warm light in the evening. Another way is to maximize natural light, using reflective surfaces and glazed areas reduce dependence on artificial sources [4].

Acoustic comfort plays an important role, as background noise is a major factor of physiological stress. This can be achieved through sound-absorbing treatments, i.e. by using acoustic panels, carpets or porous materials to reduce the reverberation time. Acoustic comfort can also be achieved through noise insulation; to attenuate structural sounds specific membranes are added under the floor.

The functionality of the space consists of adapting the space to the dimensions and movements of the human body. This is achieved by using smart thermostats to create micro-climates adapted to the activities in each room. Functionality can also be achieved by adding adjustable furniture to the spaces, namely sit-stand desks and chairs with active lumbar support to prevent musculoskeletal disorders [4].

A summary of what was written above can be found in Table 1.

Table 1

Summary on the optimization of the interior environment

Environmental Parameter	What to optimize?	How to optimize?
Thermal	Humidity and Temperature	Maintain 20-22°C and 40-60% humidity. Use plants to naturally regulate humidity.
Visual	Natural vs. Artificial Light	Place the desk perpendicular to the window. Use warm light (2700K) for relaxation and neutral (4000K) for work.
Acoustic	Sound Absorption	Add soft materials (carpet, thick curtains) to eliminate echo and reduce background noise.
Olfactory/Air.	Air Quality (CO ₂)	Ventilate (5-10 min) three times a day or install a purifier with a particle sensor.

If we look at all the factors we have discussed (thermal, lighting, visual, acoustic and air quality), the one that has the main role for environmental comfort is, without a doubt, thermal comfort, immediately followed by air quality. As an interaction of these factors, we can say that Thermal comfort is the central factor, because it is very important how the human body reacts instantly to temperature variations. Even if there is light or silence in the room, if the individual is too cold or too hot, then he cannot concentrate on the activity he is carrying out. Reason why he does not give maximum efficiency. Moreover, to maintain an ideal balance it is necessary that the temperature of the walls and windows be close to the air temperature to avoid the discomfort of the cold sensation. On the other hand, even if there is an ideal temperature in a room and the CO₂ level is high, then we have stale air, which most of the time leads to a decrease in the ability to concentrate by up to 40%. This decrease in concentration is often accompanied by drowsiness, headaches, and malaise. However, if the humidity is not within normal parameters and is at a critical level, then we can be in a situation where the air is too humid, and mold appears or when it is too dry and the mucous membranes become irritated [1]. All of this is related to the quality of the air in a room. To optimize a room, we must ensure that fresh air can be breathed in, that heat is not lost from the room. Then that there is adequate light depending on the time of day, and only then that the room has adequate acoustics and that background noise does not increase. As a result of what is presented above, we can say that thermal comfort is the "basic pillar" because it directly affects

others, a better visibility of the hierarchy of importance on well-being can be seen in Figure 1.

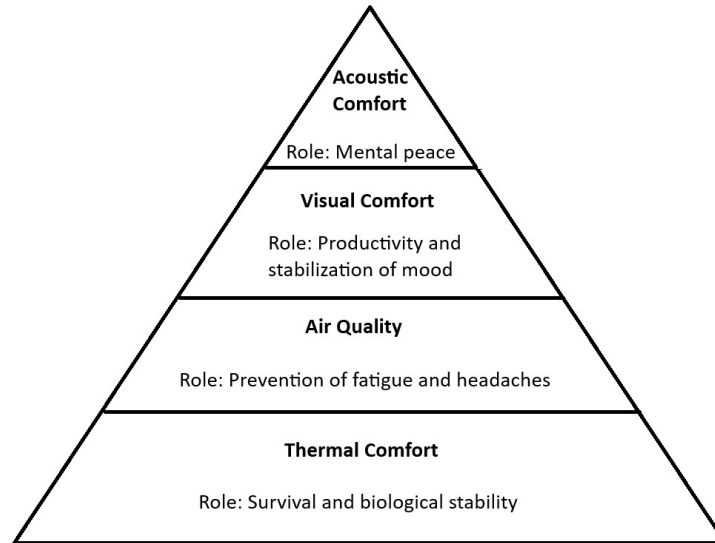


Fig. 1. The hierarchy of importance of factors that optimize the indoor environment

To optimize a room, the first step is to invest in temperature control (insulation, thermostat, efficient radiators) and ventilation, as these ensure an optimal impact on well-being.

3. Conclusions

Indoor air quality is not just an environmental factor, but a critical determinant of health, which is why it needs to be at a high level so that people can have advanced productivity. The thermal comfort is the main pillar who influence the productivity of people and influences the other factors.

References

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- [2] I. Sârbu, C. Păcurar, „Sisteme de încălzire și răcire a clădirilor”, Editura Politehnica, Timișoara, 2015.
- [3] EEA (2022a), NMVOC: non-methane volatile organic compounds; NOX: nitrogen oxides; PM2.5: particles with a diameter smaller than 2,5 microns; PM10: particles with a diameter smaller than 10 microns; SO2: sulphur dioxide.
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