

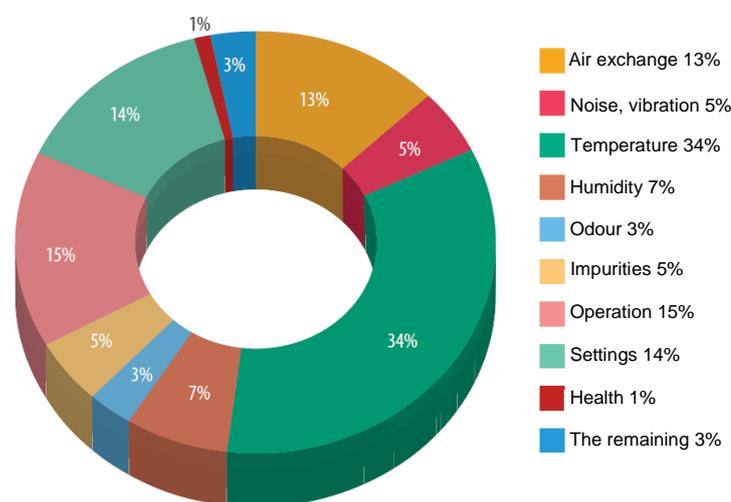
The impact of ventilation and air conditioning on productivity

Companies prioritizing the commitment and well-being of employees achieve better financial results than their competitors. One of the key parameters to affect employee satisfaction is air quality as well as thermal and humidity comfort.

The importance of work environment

A report published by Velux states that 81.4 million people work in offices across Europe, including 5.2 million people in Poland. Comfort in the workplace is an extremely important factor influencing many aspects, such as the productivity, health condition and motivation of the workforce. According to the same report, as much as 90% of the costs of running a business are personnel costs (salaries), which are constantly increasing. Any indisposition of an employee has an impact on the functioning of the enterprise, reduces the company's effectiveness, diminishes the quality of services it provides and increases the costs borne by the company.

The operating costs of a typical company renting office space and employing employees are distributed according to the following scheme: 1% energy costs, 9% rental costs and 90% personnel costs: salaries and other benefits. Improving indoor comfort directly translates into savings in the area of the abovementioned 90% of the costs, while affecting many very important factors.



Percentage of HVAC faults (C&W study 2018/2019)

The difference in the productivity of work in companies that care about employees' health is estimated at 3:1, in favour of companies that care for comfort in the workplace. This translates directly into 37% lower absenteeism, 21% higher productivity and 10% higher customer satisfaction than in the case of companies that don't pay attention to employees' health. As many as 76% of employees combine malaise at work with working conditions. Companies with satisfied and engaged employees experience up to 25-65% lower personnel turnover.

Ventilation and air conditioning systems

HVAC systems have a substantial impact on the parameters that determine the internal comfort: air quality, temperature and humidity.

Analysis of 2018/2019 data from 15 office buildings (C&W data from the E-PM IT is EASY helpdesk system) showed 888 faults related to HVAC installations, which represents 40.1% of all reports in the total number of 2,213 reported faults and failures. On this basis, we have determined the most common comments regarding the operation of the ventilation and air conditioning system as follows:

- ◆ Too weak or too intensive air exchange
- ◆ Noise and vibration associated with HVAC
- ◆ Inadequate air temperature
- ◆ Inadequate air humidity
- ◆ Unpleasant smell, inadequate air quality, dirt, impurities
- ◆ Inappropriate operation of devices or automation equipment
- ◆ Problem with control and parameter settings
- ◆ Illnesses and infections associated with the operation of HVAC installations

Air quality

American studies have shown a correlation between the amount of fresh air delivered to a room and the productivity of personnel, as well as employee absenteeism due to respiratory diseases. Productivity was understood as the ratio of results of work done to expenditure incurred. In order to assess this, account is taken of, among other factors, employee absences, medical costs, results obtained by working groups, speed and accuracy of tasks performed and fatigue.

According to the D.K. Milton research from 2000, in a building where 24 l/s fresh air was provided to users, the number of illness cases was 35% lower compared to the number of illness cases in a building where 12 l/s was provided to users. Assuming a 100% decrease in productivity for absent employee and 25% decrease due to malaise, the value of work not completed for these reasons was estimated at USD 34 billion annually. Additionally, the cost of treating diseases was USD 36 million.

In 2017, research on CO₂ in the air and mental performance was published, conducted by scientists from Harvard, the University of Syracuse and SUNY Upstate Medical School. The results revealed a close relationship between air quality and mental performance. People who worked in an environment without harmful substances in the air and with forced ventilation had a mental performance double that of people breathing average office air.

People working in an environment without harmful substances in the air (but without forced ventilation) achieved 60% better productivity.

Temperature

Research also indicates that inappropriate working temperatures can affect mental abilities.

In the case of offices being too cold, women are the most vulnerable group. Such conclusions were drawn on the basis of research conducted on a group of 543 students, each of whom received a logical task to solve and a puzzle of scattered letters. The tasks were to be carried out in a cold and warm room. The temperature range was from 16°C to 32°C. In order for the atmosphere to be similar to the conditions of paid work, the participants were paid in cash for each good answer.

The results of solving logical tasks were similar in the whole group of participants, however, women had better results in mathematical and lexical tasks in rooms with higher temperature.

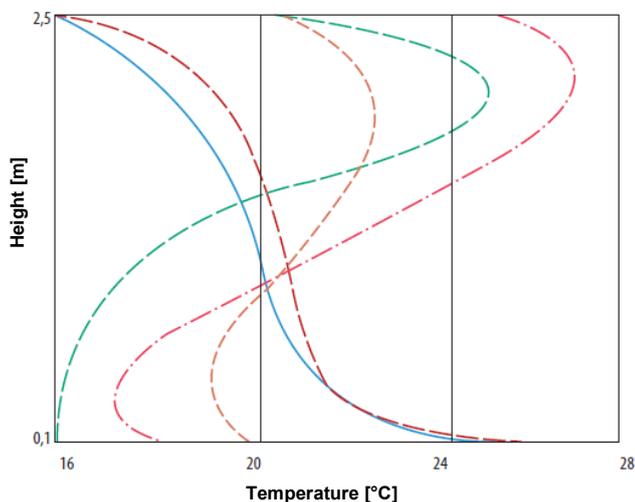
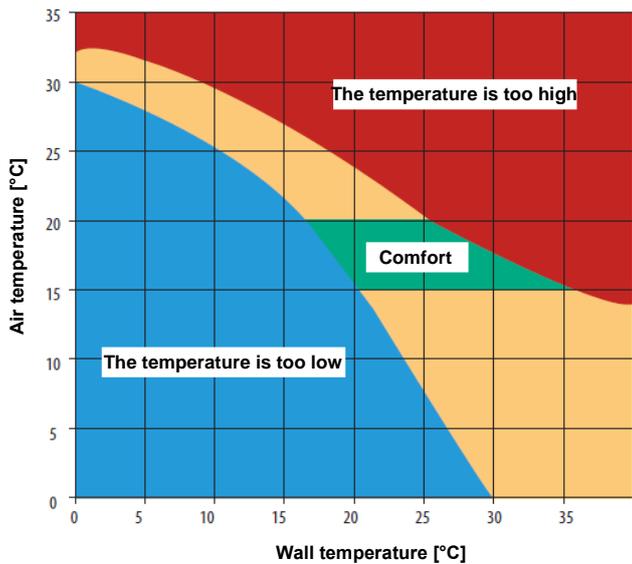
Each one degree change in temperature changed results by 2%. Men exhibited the opposite tendency. They performed better at lower temperatures.

Cornell's Human Factors and Ergonomics Laboratory conducted research in 2001 to check the number of typos and errors in texts written by people depending on the ambient temperature. Decreasing the air conditioning power and setting 5 degrees higher temperature (25°C instead of 20°C) meant that the number of typos dropped by 44% and the efficiency improved by 150%. In addition, air conditioning working with less power gave savings of \$2 per hour for each employee.

In turn, research published in the Energy Research and Social Science proved that the feeling of thermal comfort is also affected by the colour of light. Observation showed that people sitting in a room lit by yellow light felt greater thermal comfort than those who stayed in blue light, even when the temperature was falling.

Researchers at the University of Maastricht in the Netherlands confirmed that women prefer a higher temperature in the workplace.

TECHNOLOGY



- Ideal profile (*for convection heating)
- - Convection heaters at the external walls
- - Convection heaters at the interior walls
- · Air heating
- Floor heating

Women most often were opting for 25°C, while men considered the optimum temperature to be 22°C. 16 young women doing light office work were analysed during the study. The results confirmed that cooling set as high as specified in the air conditioning guidelines was not needed.

The rate of metabolism decreases with age, which suggests that older workers may also feel too cold and react badly to such conditions. Research results showed that the comfortable temperature range for women was 23.2 to 26.1°C. It is worth noting here that air conditioning in work places is most often set to 22°C.

Research conducted by Software Advice in the US showed that 42% of people working in offices describe the room temperature as too hot, for 56% it is too cold. The problem of optimal temperature selection in the workplace also applies to Poland.

In particular, it is very visible in open space zones.

Humidity

Air that is too moist or too dry has a negative effect on human health and the state of the building.

When the humidity is too high, colonies of mould fungi reproduce. In addition, people staying in such an interior will feel cool despite the correct temperature.

Low humidity conditions cause the conjunctiva and mucous membranes of the mouth and nose to dry, as well as dry skin, which increases susceptibility to allergies and inflammation. In such conditions breathing is more difficult. Dust particles float in the air more easily, affecting the air quality negatively.

In facilities equipped with installations in which devices enabling the change of the relative humidity value are adopted the following criteria are assumed:

- ♦ Winter calculative period 40-60% (for all types of physical activity)
- ♦ Summer calculative period 40-55% (for low physical activity) and 40-60% (for medium and high physical activity)

For the remaining cases, the permissible values are specified as follows: minimum 30% (winter), maximum 70% (summer).

Noise

When designing HVAC systems, special attention should be paid to the acoustics of the installation, because noise is another very important factor affecting the sense of comfort. Noise affects productivity because it distracts, reduces concentration and negatively affects health. It also causes stress, irritability and headaches.

In 2012, the Harvard Business Review confirmed that the average loss of performance caused by irritating sounds reaches up to 70 minutes during an eight-hour working day.

As many as 60% of people working in open-plan offices pay attention to the noise level. Such conditions make it difficult to focus on the work and reduce the performance of personnel.

Comfort in the workplace

A satisfied employee is 16% more efficient, 32% more involved in their tasks and 130% less exposed to burnout. That is why as many as 74% of corporations operating on the European market have implemented a strategy of care for the well-being of employees in the workplace.

In Poland, the main reason for improper working conditions in public buildings are microbial air pollution (fungi, moulds, bacteria), as well as organic and inorganic chemical agents. This is due to improper air exchange in buildings, lack of assessment of the effectiveness of ventilation and air conditioning systems equipped with air filters, improper operation and maintenance of these systems, which is an additional source of pollution emissions, radiation phenomena, air ionization, electrostatic phenomena, noise and vibrations.

Incorrect design, incorrect workmanship, poor service or the desire to minimize investment and operating costs can lead to the fact that the fresh air stream is too small and does not provide hygienic minimum conditions.

It should be remembered that airborne pollutants come not only from people inside but also from equipment that emits volatile compounds. This can lead to contamination from poorly cleaned and disinfected HVAC installations.

In Sweden, an obligation was introduced to periodically check the condition of installations and air quality, and in just the first year the collected results led to the disqualification of 43% of ventilation systems in office buildings. The main reasons for disqualification were: improper ventilation air stream, lack of operating instructions and deposition of pollution on devices and ventilation ducts.

Maciej Gwiazdziński

Paweł Klimczak

Cushman & Wakefield Polska Trading