Natalia KRAWCZYK, Luiza DĘBSKA, Łukasz ORMAN

Faculty of Environmental, Geomatic and Energy Engineering
Kielce University of Technology, Poland
Corresponding author: ldebska@tu.kielce.pl

Doi: 10.53412/jntes-2022-4-5

THERMAL COMFORT ANALYSIS IN THE SMART SUSTAINABLE BUILDING

Abstract: *Modern times are a challenge for many building designers. Creating the internal environment, in particular in sustainable construction, puts the feeling of thermal comfort in the most important place. Therefore, 3 lecture halls in a smart building called Energis belonging to the Kielce University of Technology were examined. In addition to research related to thermal sensations and preferences, PMV (Predicted Mean Vote) and PPD (Predicted Percentage of Dissatisfied) indices were also calculated on a group of students aged 21 to 25.*

Keywords*: Thermal Comfort, Smart Sustainable building*

Introduction

The society spends most of its life in a closed space, this applies to employees' offices, shops and houses. This is also significantly influenced by the trend of sustainable construction, equipped with a BMS system, various types of technological solutions using renewable energy sources.

Many authors are working on research related to thermal comfort. One such example is Becker and Paciuk [1], who examined 205 apartments in the summer and 189 in the winter, turning out that there is a difference between the PMV and the respondents' answers. Another example [2] focuses on 25 buildings with air conditioning. Again, as in research [1], PMV also did not coincide with people's assessment of their real heat sensations. Similarly to the works [3-5].

The aim of this study is to compare the results of the surveys with the actual results for an intelligent building.

Methodology

The building that was tested is called Energis and belongs to Kielce University of Technology, Poland. Three rooms were tested for temperatures from 22.9-24.6°C, air humidity from 33.01 to 49.4 and for the content of carbon dioxide ranging from 678-2607 ppm. Two methods were used for this purpose. The first one consisted of thermal impressions and humidity surveys, which were supplemented by students and the Testo 400 meter, which collected microclimate data through probes. A total of 37 people were examined, 13 women and 24 men.

Results

Thermal impressions, according to the respondents' assessment, for all tested rooms showed that about 85% of people described their feelings as "pleasantly cool", "comfortable" and "pleasantly warm". On the other hand, about 15% rated their feelings at the moment as "too warm" and "too hot".

Another value that appeared in the survey concerned the acceptability of temperature. About 59% of people found it acceptable, and about 38% found it comfortable. Only about 3% of the respondents declared that the temperature during the examination was no longer acceptable. Turning to room temperature preferences, about 62% would not decide to change it at all, as opposed to about 30% who would like it to be cooler or about 5% much cooler. Only about 3% would like the room to be warmer. The answers of the respondents have their overlap with the answers they marked. Because when assessing thermal sensations, the respondents mainly marked "pleasantly cool/warm" and "comfortable", but also values for "too warm/hot", which proves when asked about preferences that this environment could be cooler. The Thermal Sensation Vote (TSV) was compared to the PMV (Predicted Mean Vote) based on the ISO 7730 [6] standard, as was the PPD (Predicted Percentage of Dissatisfied). The TSV indicators for three rooms showed that in one of them people felt comfortable, in another the comfort range included in the ISO 7730 [6] standard of 0d -0.5 to +0.5 was slightly exceeded, and in the last tested room the TSV definitely exceeded the comfort range with a value above +0.75. More interestingly, the values for PMV were low in the room where the TSV was high. In a room where TSV was low, PMV was high. This proves that there is a significant difference between the real feelings of people and the norm, which assumes that where the environment is good according to the respondents, the PMV according to them is always much higher.

Conclusion

Summing up, according to the respondents, the examined classrooms met their thermal expectations. On the other hand, the Fanger model, which is the basis of the ISO 7730 standard, and the real thermal sensations of people at the moment have no overlap. So the conclusion is that it would be necessary to modify Fanger's model in such a way as to bring it as close as possible to the actual feelings of people.

References

[1] Becker R., Paciuk M., 2009, *Thermal comfort in residential buildings – Failure to predict by Standard model*. Building and Environment 44, pp. 948-960, http://dx.doi.org/10.1016/j.buildenv.2008.06.011.

[2] Broday E.E., Moret J.A., de Paula Xavier A.A., de Oliveira R., 2019, *The approximation between thermal sensation votes (TSV) and predicted mean vote (PMV): A comparative analysis*. International Journal of Industrial Ergonomics 69, pp. 1-8, https://doi.org/10.1016/j.ergon.2018.09.007.

[3] Mors S.T., Hensen J.L.M., Loomans M.G.L.C., Boerstra A.C., 2011, *Adaptive thermal comfort in primary school classrooms: Creating and validating PMV-based comfort charts*. Building and Environment 46, pp. 2454-2461, https://doi.org/10.1016/j.buildenv.2011.05.025.

[4] Manu S., Shukla Y., Rawal R., Thomas L.E., de Dear R., 2016, *Field studies of thermal comfort across multiple climate zones for the subcontinent: India Model for Adaptive Comfort (IMAC)*. Building and Environment 98, pp. 55-70, https://doi.org/10.1016/j.buildenv.2015.12.019.

[5] Vilcekova S., Meciarova L., Burdova E.K., Katunska J., Kosicanova D., Doroudiani S., 2017, *Indoor environmental quality of classrooms and occupants' comfort in a special education school in Slovak Republic*, Building and Environment 120, pp. 29-40, http://dx.doi.org/10.1016/j.buildenv.2017.05.001.

[6] ISO International Organisation for Standardization, Ergonomics of the thermal environment – Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria International Standard ISO 7730 2005.