

A study on thermal comfort of thermal controllable chair and its cooperation with ambient air-conditioning

Shintaro HANAZONO

Abstract

Individuals have different requirements for thermal environments, and these requirements vary from person to person. The reason why personal air-conditioning has been attracting attention is that it is reasonable to adjust the thermal condition to resolve these individual differences. In recent years, it has also attracted renewed attention from the viewpoint of resilient cooling.

In this paper, thermal controllable chair with a personal air-conditioning function is proposed and put into practical use.

First of all, based on a review of previous studies, the required performance was set at -1°C for cooling and $+1^{\circ}\text{C}$ for heating by evaluation using a thermal manikin. In the practical application, both performance as an office chair and functionality for personal air-conditioning were required. For example, the seat surface was made of urethane to improve sitting comfort. By inserting a breathable material inside the seat, the thermal resistance of the seat surface was lowered to ensure both comfort and a cooling effect.

Secondary, it was applied the thermal controllable chair to an actual office and analyzed its operational status. As a result, an all-or-none law was confirmed based on the usage tendency. Even at the same indoor air temperature, the tendency to use differed depending on the season, suggesting the influence of thermal hysteresis. There were individual differences in the tendency to use, and they were roughly classified into three groups.

Based on these data, a mathematical model was used to generalize the usage trends. A hierarchical Bayesian model was used for the mathematical model, which can include individual differences as explanatory variables. As a result, the influence of thermal environment conditions and individual differences on the use of the cool/heat chairs could be understood by the mathematical model.

Finally, an energy simulation was performed using this mathematical model. The results showed that, when the standard room temperature is set at 26°C in summer, the room temperature can be kept at the same level of thermal comfort even if the room temperature is set at 27°C with the thermal controllable chairs. The energy consumption of the thermal controllable chairs was negligible. Therefore, when two batteries were provided for each person, it was shown that self-sufficiency was possible if the capacity of the photovoltaic system per person was 20W.