

Aivars Rubenis
Latvia University of Life Sciences and Technologies

Aigars Laizāns
Latvia University of Life Sciences and Technologies

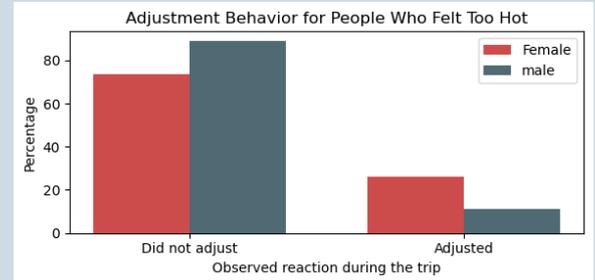
Leslie Adrian
Lesla Latvia, SIA

Contact information:
Phone: +371 29 462 363
aivars.rubenis@lbtu.lv

Overall, the results of this research have demonstrated that there is a headroom for lowering the average temperature in the public transportation of short-haul trips.

While most participants selected winter garments appropriate for -5°C conditions, self-reported thermal comfort was strongly influenced by individuals' willingness to modify their clothing levels in response to dynamic environmental changes.

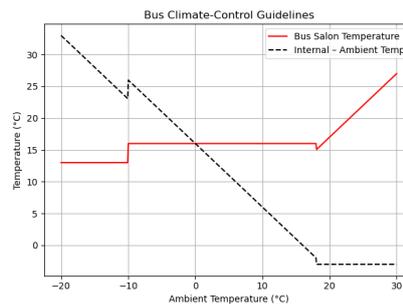
These results imply that vehicle-cabin set-points could be lowered to conserve energy, but precisely defining optimal temperature parameters will require dedicated future research.



Introduction

One of the primary challenges in integrating electric buses into public transport systems is their cost. This financial burden is exacerbated in colder climates due to the significant energy required to heat the passenger compartment.

The heating energy costs have not been an issue so far, because of the excess heat generated by ICE motors, hence no one had seriously looked at this issue before the age of electric vehicles. Typical temperature range in busses has been determined by German for climate control of buses: in summer in urban areas the cabin temperature should be 3°C less than ambient temperature; in winter it should be held at $18^{\circ}\text{C} \pm 2^{\circ}\text{C}$ or $18 \pm 5^{\circ}\text{C}$ if the ambient temperature is less than -10°C



Methodology

To test if this is adequate, a study for the in-person questionnaire was conducted in two phases:

- Passenger survey - A questionnaire to understand public perception of heating, willingness to adapt to energy-saving measures, and expectations for thermal comfort.
- Observational study - Monitoring passenger behaviour related to clothing adjustments in response to indoor temperatures.
- The observations were based on From ISO 9920/ANSI 55 clothing insulation value tables.

Results

Participants generally wore clothing ensembles appropriate for -5°C , typically including insulated jackets or parkas, sweaters or thermal underlayers, heavy trousers, insulating boots, hats, and gloves.

This combination generally aligns with an overall insulation of roughly 1.3 to 1.5 clo:

- Heavy coat/parka: approximately 0.7–0.9 clo
- Sweater or thermal layer: around 0.2–0.3 clo
- Long pants or thick trousers: 0.2 clo
- Insulated boots, hat, and gloves: combined 0.2–0.3 clo

Clothing Adjustment and Impact on Thermal Comfort

- Among those who reported feeling "too hot," the majority did not remove or loosen any layers. Many continued wearing hats and full winter attire even while indoors or in warmer intervals of the trip, contributing to mild overheating or discomfort.
- Respondents who reported feeling most comfortable tended to adjust their layers more frequently, removing their hats or opening their jackets when they noticed a shift in temperature.
- Overall, most participants were appropriately dressed for the outdoor conditions but could have improved comfort by actively removing or adding layers throughout the journey.

