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# Effect of individual and collective heat cost allocation on indoor environment in Danish apartments

Rune Korsholm Andersen\*, Søren Andersen and Bjarne W. Olesen

ICIEE, Department of Civil Engineering, Technical University of Denmark, Nils Koppels Allé 402-2, 2800 Kgs. Lyngby, Denmark

\*Corresponding email: [rva@byg.dtu.dk](mailto:rva@byg.dtu.dk)

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## INTRODUCTION

Occupants' behavior has a large influence on indoor environment and energy consumption in buildings (Andersen 2012). As a consequence, changes in occupants' behavior patterns are instrumental to improvements in indoor environmental quality while reducing or maintaining energy consumption. One way of changing occupants' behavior is to provide feedback to occupants. Heating bills are a simple form of feedback influenced by indoor temperature, air quality and humidity.

The aim of the paper was to survey how two types of heating bill schemes (individual and collective) affected the indoor environment in Danish apartment buildings.

## METHODS

Measurements of temperature, relative humidity and CO<sub>2</sub> concentration were conducted in 56 apartments in two buildings in Copenhagen, Denmark (Building 1 and 2). Measurements were taken in a central hall way at a five minute interval from December 2012 to April 2013, using internet connected sensors (IC-meter).

39 apartments in building 1 did not have individual energy meters and paid for heating costs based on floor area (collective payment). 17 apartments in building 2 had individual heat cost allocators and distributed heating costs based on these (Individual payment). The occupants in both buildings paid their heating bill on a monthly basis. The amount was fixed each month and adjusted yearly, based on the buildings' (building 1) and apartments' (building 2) consumption.

Residents from 10 apartments (four and six living in building 1 and 2, respectively) were interviewed about their heating and ventilation practices and their views on how this affected their heating consumption. All interviews were conducted in the residents' home.

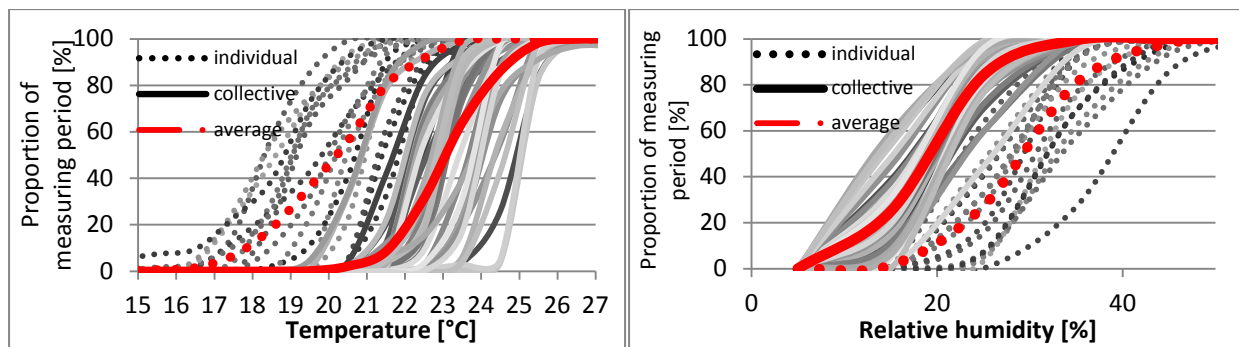
## RESULTS

The primary focus of the interviewed informants in building 1 was a comfortable and safe indoor environment, while the four informants living in building 2 focused on saving money on the heating bill. Although none of the informants in building 2 were able to remember how much

they paid for heating, they all stated that they often accepted uncomfortable conditions to save money.

The measured temperatures were generally lower in building 2 than in building 1. Only three apartments (out of 39) in building 1 had temperatures below 21 °C for more than 10 % of the time. In contrast, 13 apartments (out of 17) in building 2 had temperatures lower than 21 °C for more than 80 % of the time. The relative humidity also differed between the two buildings.

All informants stated that they were able to heat their apartment to thermally comfortable conditions, suggesting that the observed differences in temperature and relative humidity were a consequence of the residents' focus on comfort (building 1) or energy savings (building 2).



**Figure 1** Time distribution of temperatures (Left) and relative humidity (right) from the 56 apartments. The figure shows the amount of time the temperature/relative humidity was below a certain level.

When the occupants were motivated, in this case by a profit, they were willing to accept low indoor air temperatures and low indoor air quality. This was accepted even though the occupants' assessed conditions as uncomfortable.

## CONCLUSION

If the buildings heat consumption was paid as collective payment, occupants focused on comfort, health and safety. Individual payment made the occupants aware of the heating consumption, resulting in occupants accepting conditions outside their comfort zones.

## REFERENCES

Andersen, R., 2012. The influence of occupants' behaviour on energy consumption investigated in 290 identical dwellings and in 35 apartments. In *Healthy Buildings2012*. Brisbane.

IC-Meter version 2.1 (2012) <http://www.ic-meter.com/what-is-ic-meter/>