

# Occupant-centric control in non-residential buildings

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## SUMMARY

Current HVAC control systems assume occupant-related information, i.e., preferences, occupancy and behaviour. Furthermore, occupants often have limited control over the indoor environment in non-residential buildings. As a result, occupants are often dissatisfied with the indoor environmental quality (IEQ). This study works towards defining a novel occupant-centric control (OCC) framework which integrates occupants' feedback regarding their satisfaction with the IEQ. This study collected both occupant satisfaction assessments via surveys and IEQ measurement data in various case studies. The collected data is used to (1) determine the statistical relationships between occupant satisfaction and IEQ and (2) develop personalized models to predict occupants' satisfaction with IEQ. Afterwards, the developed personalized models will be integrated in an occupant-centric controller. A suitable consensus strategy, seeking the most optimal conditions in case of conflicting occupant preferences, is determined to make the OCC system applicable in multi-occupancy spaces, such as, classrooms and open-plan offices.

## KEYWORDS

Occupant-centric control, Occupant satisfaction, Indoor Environmental Quality, All-air HVAC systems

## 1 INTRODUCTION

Occupants in non-residential buildings usually have limited possibilities to adapt the indoor environmental conditions to their preferences. Furthermore, current control systems often consist of conservative and fixed schedules and setpoints, based on simplified assumptions regarding the occupants that hardly correspond with the actual situation (O'Brien et al., 2020). The lack of occupant-related knowledge in current control systems and limited control possibilities for occupants leads to low occupant satisfaction levels with the IEQ in current non-residential buildings (Cheung et al., 2021).

A possible solution to increase occupant satisfaction levels is to move towards an occupant-centric control loop for HVAC systems which adapts setpoints and schedules to the preferred IEQ conditions of the occupants. The work package in this project aims to increase insights in the relationships between IEQ conditions and occupants' satisfaction and to define an occupant-centric controller (OCC) which integrates occupants' feedback on their satisfaction with IEQ.

## 2 DATA COLLECTION AND STATISTICAL ANALYSIS

Data collection campaigns have been set-up consisting of both IEQ monitoring (e.g., temperature, relative humidity, CO<sub>2</sub>, sound level,...) and regular satisfaction assessments (i.e., 5 star rating scale) via surveys (Carton et al., 2021, 2022). Up till now, approximately 6800 satisfaction assessments have been collected in different classrooms located in primary schools, a secondary school and a university. The mixed-effects regression analysis of a sub-dataset (n=834) containing measurements of 3 classrooms of a secondary school, showed that the indoor temperature is the main influencing IEQ parameter of occupant satisfaction. Furthermore, some non-IEQ related parameters, such as location of the participant in the classroom and moment of satisfaction assessment (at beginning or end of course), showed a statistically significant relationship with the satisfaction scores given by the participants.

Further steps consist of (1) data collection and statistical analysis in open-plan offices, and (2) using the collected data to construct personalized models that predict occupants' satisfaction with IEQ.

### 3 INITIAL SCHEME OF THE OCCUPANT-CENTRIC CONTROLLER

The aim of this study is to define an OCC that (1) integrates occupants' feedback regarding IEQ satisfaction, (2) is applicable in multi-occupancy spaces and (3) controls an all-air HVAC system. Figure 1 shows the initial scheme of the proposed OCC in which all three control requirements are included.

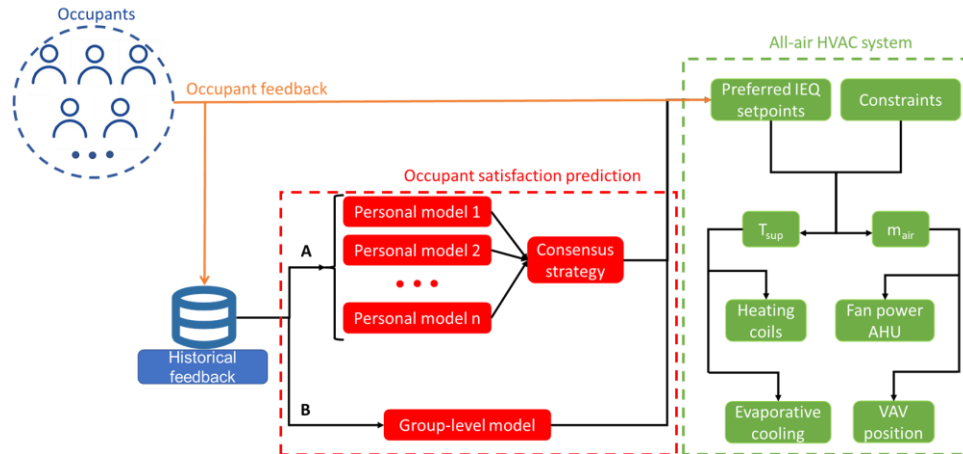


Figure 1: Proposed occupant-centric controller

The OCC controls the supply air temperature ( $T_{sup}$ ) and air flow rate ( $m_{air}$ ) for an all-air HVAC-system by determining the preferred IEQ conditions of a group of occupants sharing the same space. The preferred IEQ conditions are defined using feedback from the occupants on the received IEQ. Occupant feedback can be integrated immediately into the control (e.g., complaints result in direct change of the setpoints) or can be stored with historical feedback data. The database with historical data will be used as a source to construct predictive models on group-level (e.g. class group or colleagues sharing the same classroom or office) or personal level. Personalized models will be combined with a consensus strategy, balancing conflicting occupant preferences, to determine the most suitable IEQ condition for a group of occupants.

### 4 ACKNOWLEDGEMENTS

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