OSKU – An Application for Collecting User Feedback on Living Conditions in Buildings

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Motivation

- The importance of reducing overall energy consumption and CO2 emissions

- Significant amount of energy is used on the cooling and heating of buildings
  - In Finland, about 25% of total produced energy is used on heating

- Newer "smart buildings" have various means of optimizing energy usage...
  - ... but large majority of building stock consists of older, less energy efficient buildings

Motivation ➡ Goals

- Not to simply to reduce energy consumption, but to also consider (building) occupant comfort
  - Comfort is subjective – one person's hot is another person's cold.
  - How to collect user's feelings on comfort? How to compare feelings with sensor measurements?

- To develop user-friendly application for collecting user's feelings
  - Living and working conditions, as well as user feedback has been extensively studied...
  - ... but the studies seldom focus on user interface aspects,
  - and most applications in literature are limited to simple occupant voting applications

- Real-life (consumer) applications do not seem to exist or are very rare – why?

Use Case – A Daycare Center

- A small single-floor building (approximately the size of a suburban house)
- 12 rooms, 1 hallway, and 2 outdoor locations with installed sensors (and about 10 rooms, hallways, etc. without sensors – not selectable in the application)
- All 16 locations had temperature and relative humidity sensors
- Five out of 13 indoor locations also had CO_2 and VOC sensors
- Testing period: 4 months (winter-spring)

Use Case – An Elementary School

- A large building complex consisting of two separate buildings connected by a hallway

- 11 rooms (classrooms, teachers' room, kitchen and an indoor gymnastics hall), 1 hallway and 1 outdoor location with installed sensors

- All 11 "rooms" (including the gymnastics hall) and an extra 5 classrooms without sensors are selectable in the application. I.e., all rooms in active use within the building complex.

- 2 classrooms with CO_2, temperature, and relative humidity sensors, other locations without CO_2 sensors

- Testing period: 2 months (winter)

Use Cases – Similarities

- Both locations are in active use only from fall to spring (closed or in limited use only in summer)

- Both locations had "regular hours"
  - No usage during nighttime
  - More or less exact daily schedules – knowledge of room usage (occupancy)

- ...although because of COVID-19, both had exceptions in hours during our (desired) testing periods

- Both locations had some reports of "poor" air quality, but neither one had any excessive issues in the past

Use Cases – Test Setup

- "Black box" building (automation) systems
  - Sensor measurements

- User feedback application (called OSKU)
  - HTML5/JavaScript web application
  - Running in kiosk mode in a wall-mounted 10" Android tablet

- Cloud = a simple REST end-point implemented with Spring boot app and MariaDB database
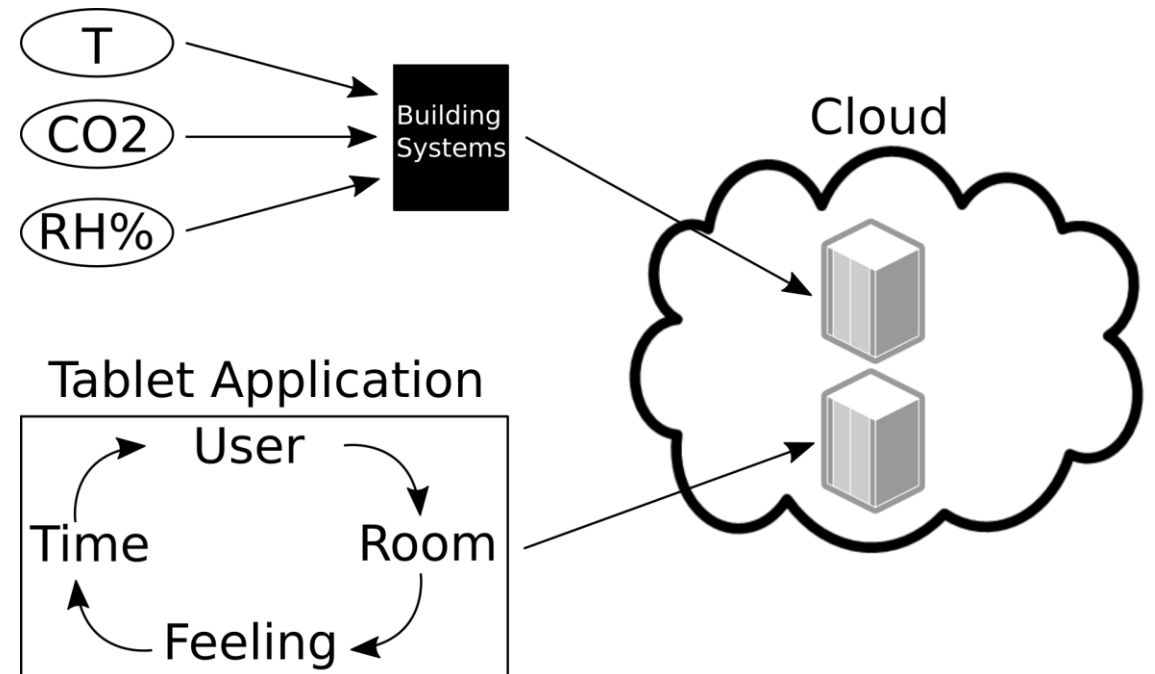
OSKU – User Selection
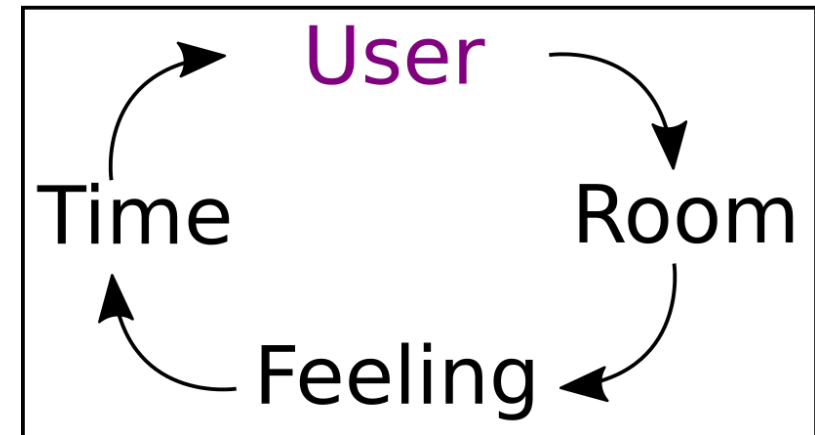
OSKU – Room Selection
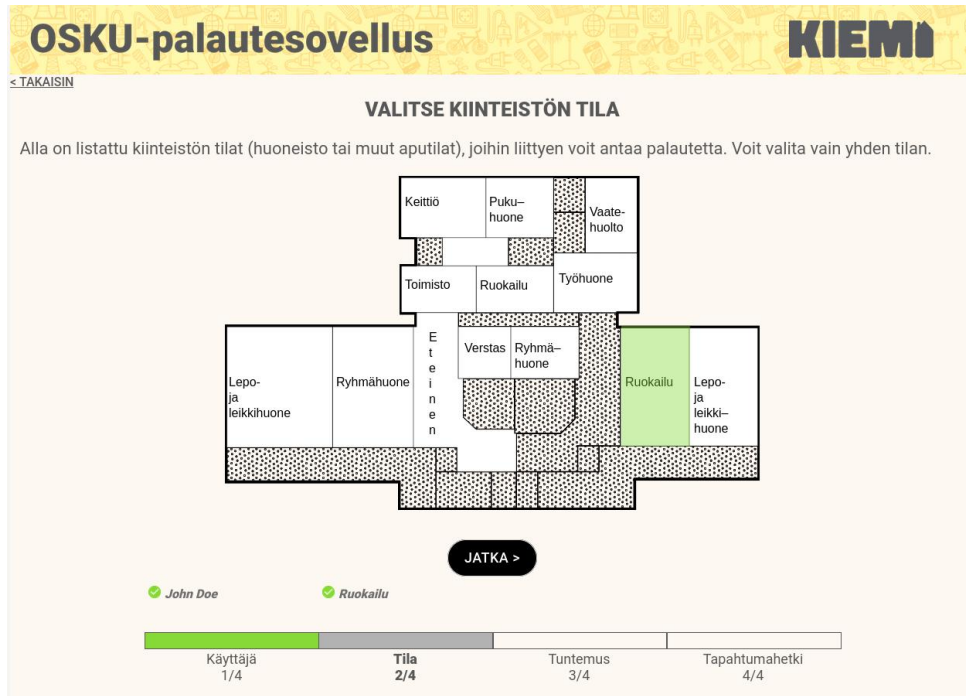
Daycare Center

Elementary School

Tablet Application
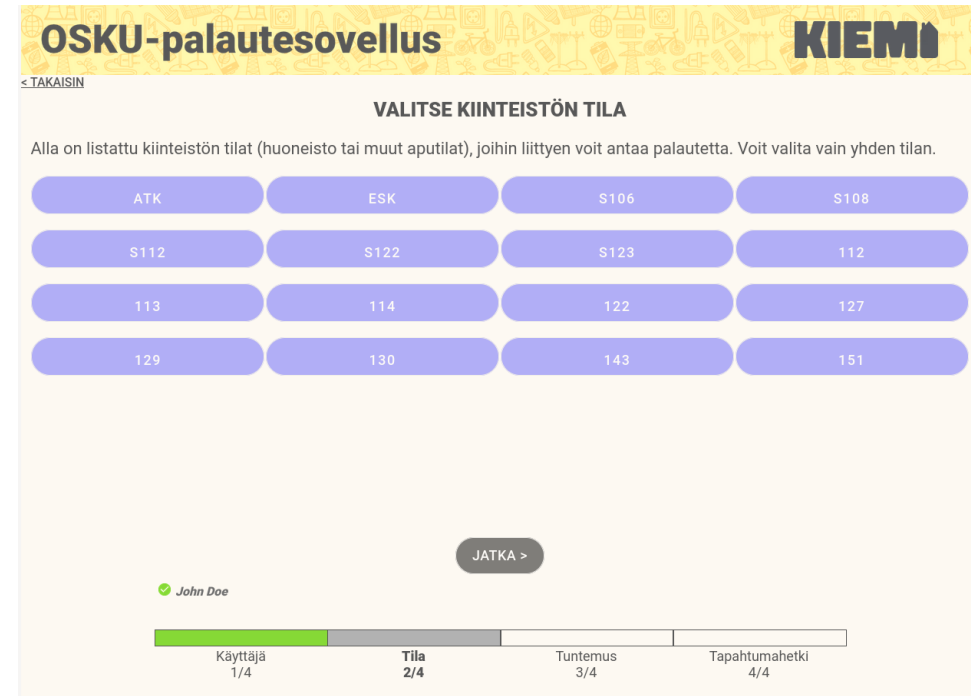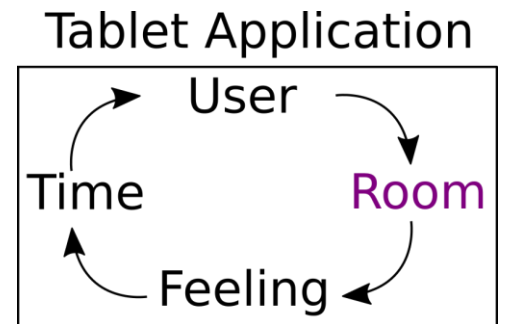
OSKU – Feeling Selection

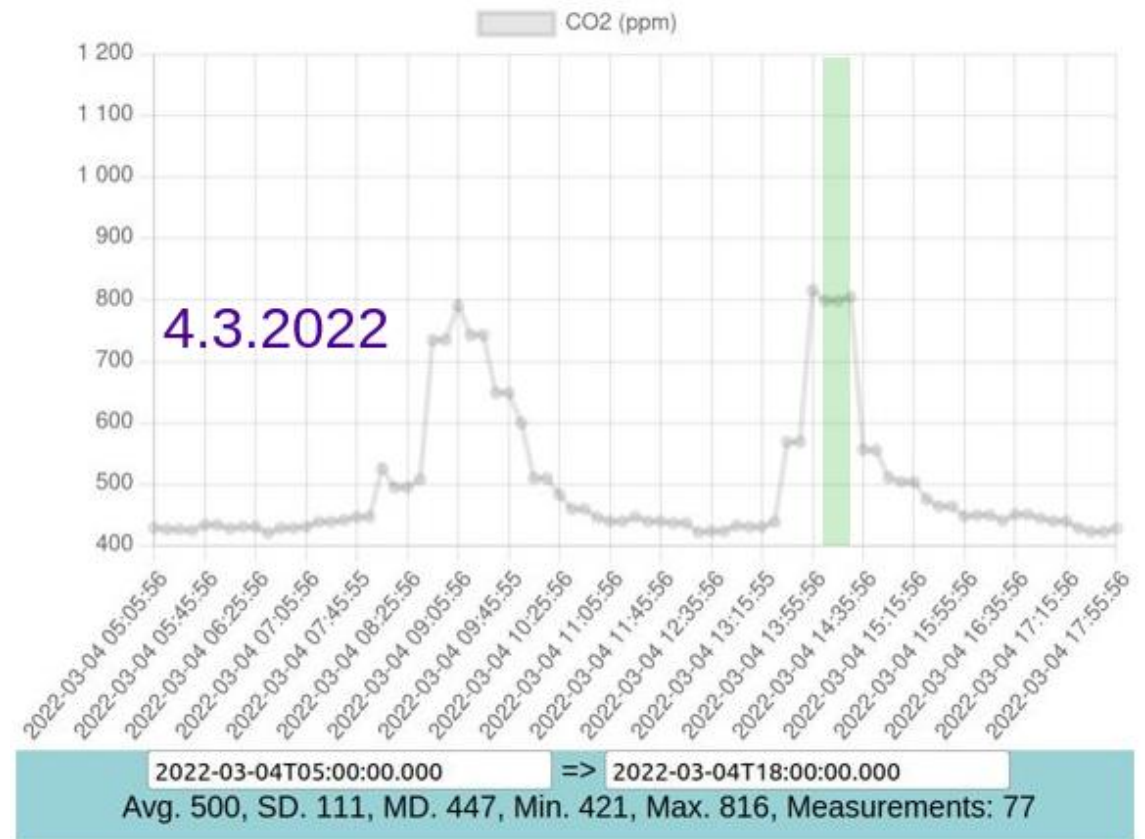# OSKU – Time Selection
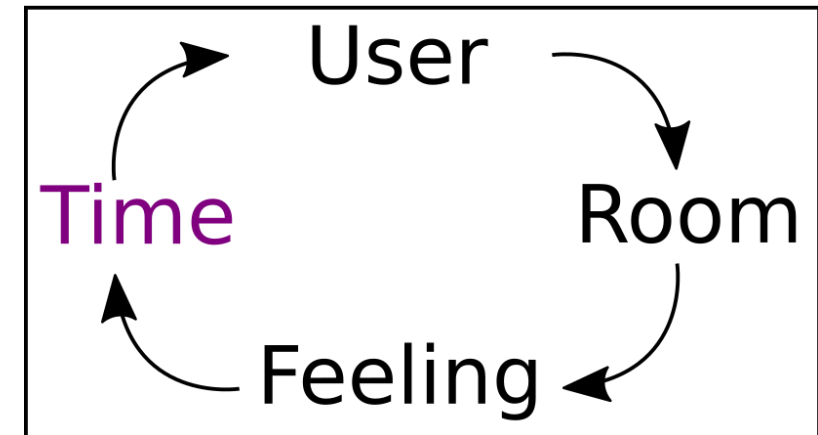
Conclusions - Data

- User feedback ("feelings") can generally be traced from the sensor data

- The feedback can also help to locate hard-to-detect issues in building automation
  - Ventilation issues
  - Sensor issues

- The feedback can also detect unsolvable or "undetectable" problems

Conclusions – User Survey

- Based on a user survey the application's look'n feel did not have any issues

- The user interface was found to be clean and easy-to-use

- The (feeling and time) choises offered by the application were felt by the users to be adequate

- In the daycare center users were fine with some rooms (the ones without sensors) not available for selection, but in the elementary school the teachers felt this was a counterintuitive (thus, all rooms in use were changed selectable)

- In the dry winter air the touch screen was sometimes a challenge, and we had to provide a touchscreen pen

Conclusions – User Behavior

- Regardless of overly positive feedback on the application, the users' interest seemed to wane over time
  - Based on sensor data, no measureable change was observed...
  - ... though the conditions in either location were not *that* bad

- In the daycare center use case, the application was removed for some time (the testing was done in two parts), and restoring the application seemed to restore users' interest in giving feedback
  - ...yet, based on sensor data, the conditions had been quite similar during the first period, the absence, and during the second period

- Thus, perhaps the application works better when utilized shorter periods at a time rather than over longer, continuous time
  - Ways to motivate users?

Thank you!
Questions?