IEQ Management System for Building Energy

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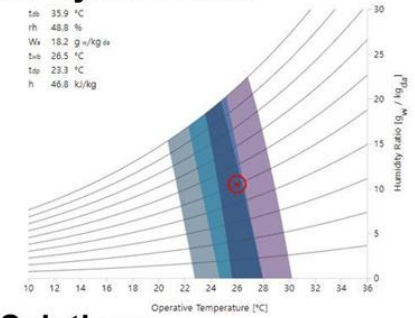
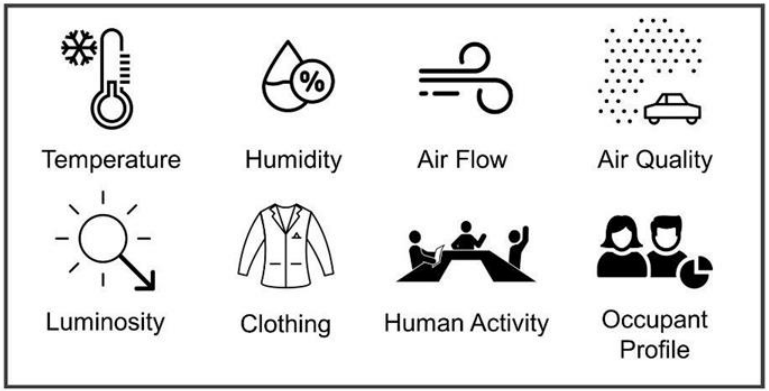
Target Space: Small Office (2~4 People)

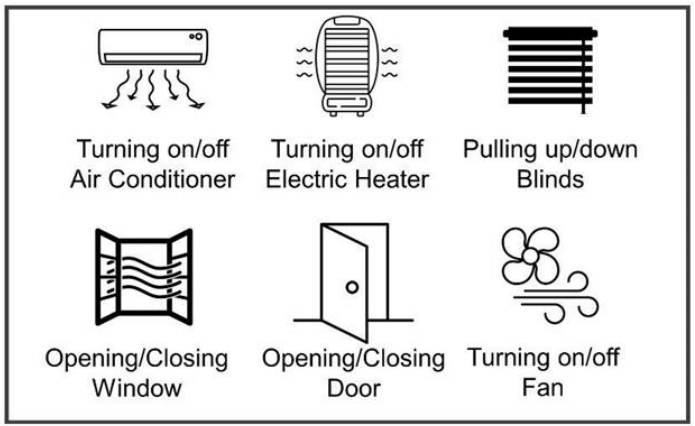
Example of Psychrometric

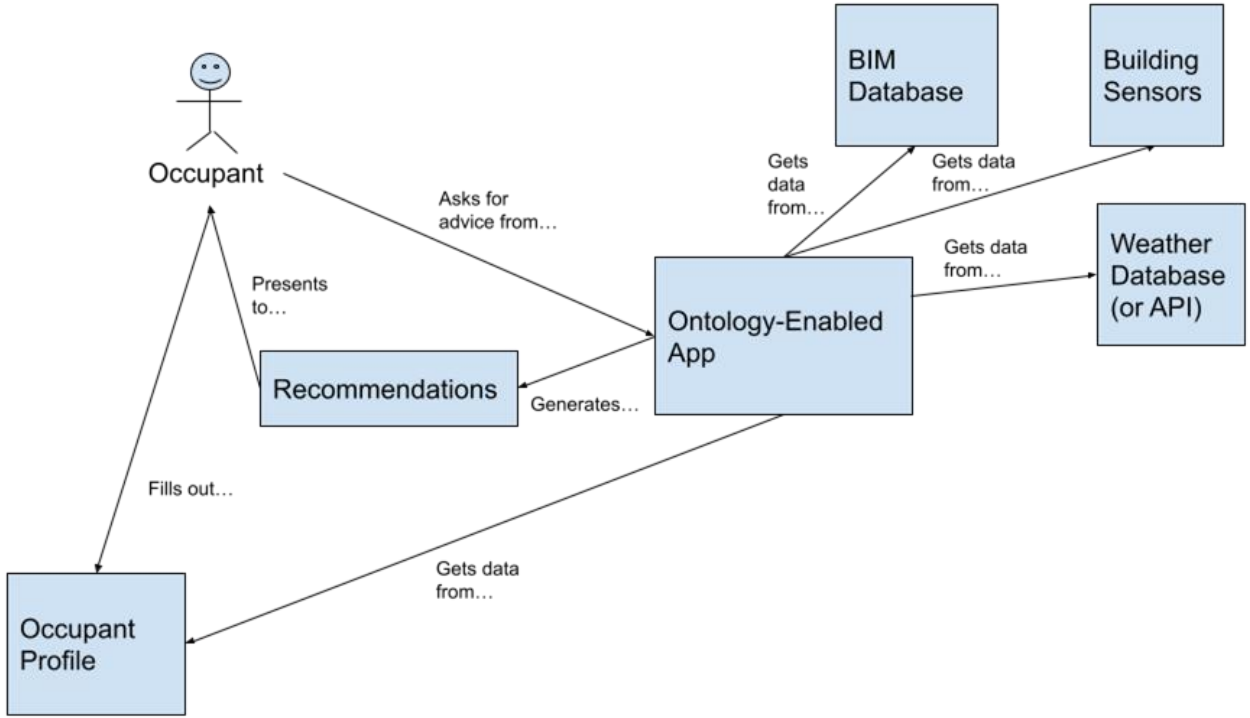


IEQ factors



Potential Solutions





System Diagrams

Concrete Question 1

Question: Which solution is relevant to improve indoor environmental quality and make an occupant feel comfortable?

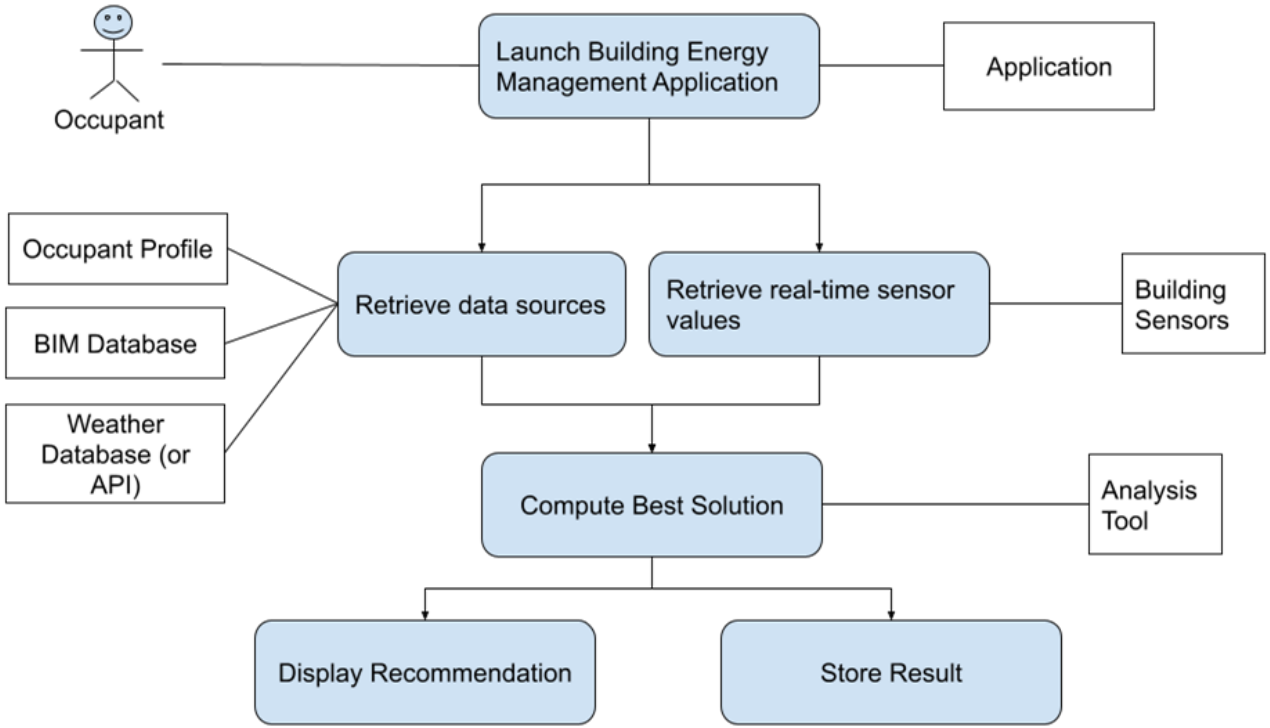
Parameters:

- Outdoor air temperature: 86℉
- Humidity: 83%
- Daylight: 110,000
- Outdoor air quality index: 273, “bad”
- Corridor temperature: 74℉

Answer: Pull down blinds to block the sunlight, turn on a fan, and open the door.

Process:

1. In the knowledge graph, load BIM database, weather data, sensor data, *etc.*
2. Calculate an occupant’s thermal comfort zone using loaded data
3. Query to find a solution how to change IEQ parameters using potential solutions
4. Suggest the best solution to improve IEQ and to minimize energy use
5. Show results on how the solution enhances the environment and reduces energy consumption



Activity Diagram for Concrete Question 1

Concrete Question 2

What IEQ parameters, such as temperature, humidity, airflow, etc., make the multiple occupants feel comfortable in an office room?

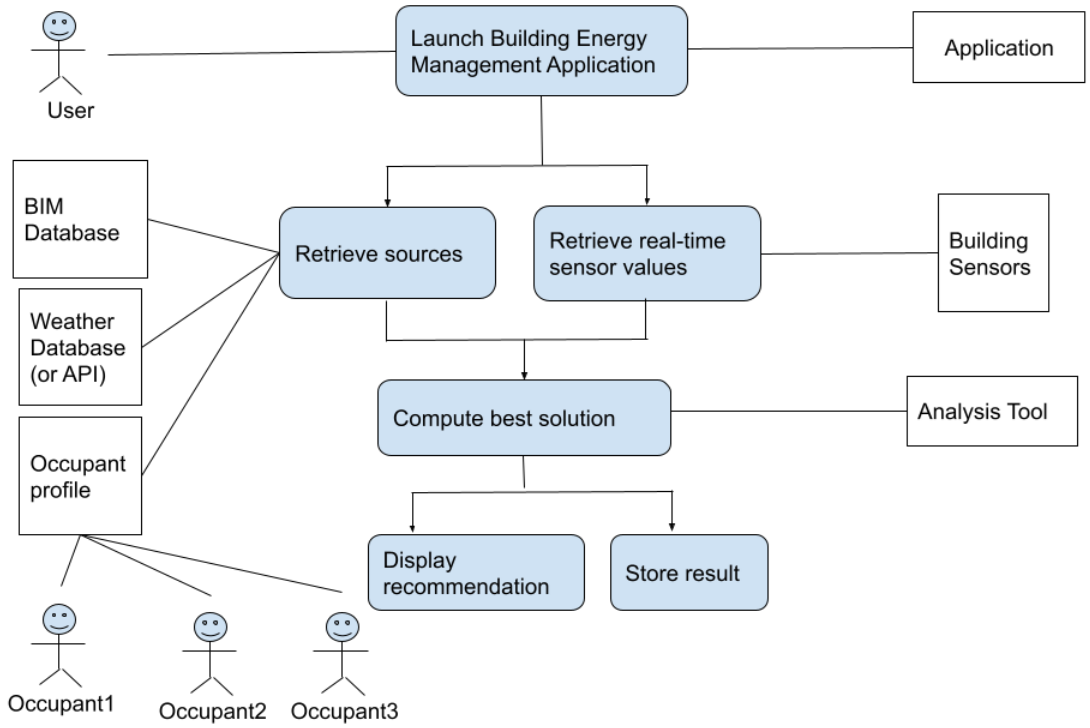
Parameters:

- Occupant 1: 22-year-old male,
- Occupant 2: 53-year-old female
- Occupant 3: 42-year-old male.
- Outdoor air temperature is 18°F
- Corridor temperature is 75°F.

Answer: Keep the thermostat setting at 75°F and turn on an electric heater

Process:

1. In the knowledge graph, load BIM database, weather data, pre-registered demographic employees' data, real-time sensor values including temperature, humidity, airflow, air quality, etc.
2. Calculate occupants' thermal comfort zone based on the loaded data
3. Query to find a solution how to change IEQ parameters using potential solutions, such as pulling up/down blinds, opening/closing door, window, turning on/off the air conditioner, fan, electric heater, etc.
4. Suggest the best solution to improve IEQ and minimize energy use.
5. Show results on how the occupants have different thermal comfort zones and what is the optimal temperature & humidity for them.



Activity Diagram for Concrete Question 2

Resources

Databases:

- ASHRAE Global Thermal Comfort Database (https://github.com/CenterForTheBuiltEnvironment/ashrae-db-II)
- ASHRAE Global Occupant Behavior Database (https://ashraeobdatabase.com/#)
- ROBOD, room-level occupancy and building operation dataset (University of Singapore, https://figshare.com/articles/dataset/ROBOD_Room-level_Occupancy_and_Building_Operation_Dataset/19234530/7)
- flEECe, an Energy Use and Occupant Behavior Dataset for Net Zero Energy Affordable Senior Residential Buildings (https://osf.io/2ax9d/)

Ontologies:

- obXML (https://behavior.lbl.gov/?q=obXML)
- Occupancy Profile ontology (https://bimerr.iot.linkeddata.es/def/occupancy-profile/#Driver)
- Brick Ontology (https://brickschema.org/ontology)
- Smart Appliances Reference Ontology (SAREF, https://ontology.tno.nl/saref/)
- ifcOWL Ontology (https://standards.buildingsmart.org/IFC/DEV/IFC4/ADD2_TC1/OWL/index.html)
- Semantic Sensor Network (SSN, https://www.w3.org/TR/vocab-ssn/)
- Calidad-Aire (Air Quality Ontology, http://vocab.linkeddata.es/datosabiertos/def/medio-ambiente/calidad-aire/index-en.html)