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Indoor Facilities Management Analysis

Antra Tripathi

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- Data Wrangling
- Analysis Report
- Power Bi Dashboard

Data Overview

Original Data: Json Format

- Indoor air quality data [iaq.json] : (102629, 5)
- Outdoor air quality [oaq.json] : (2892, 4)
- Sensor locations [floors.json] : (2, 3)

Processed Data: Pandas Dataframe and .CSV output

Loaded dated into pandas dataframe and normalized it where required

Data wrangling steps:

- Datetime conversion
- Creating separate date and time feature
- Checking/ treating missing values
- Checking for inconsistency in the data
- Stats check: with respect to required operational values
- Data rollup: hourly and daily basis

```
ers > antra > Downloads > fandp > Interview_Assignment_FandP > raw_data > {} iaq.js
[{"documentTime": "2023-01-23T00:03:37.000Z", "temp": 23.5, "humid
"temp": 23.6, "humidity": 23, "co2": 778.0, "sensor_id": "ENKZYW
"sensor_id": "ENKZYW001882"}, {"documentTime": "2023-01-23T00:01
"2023-01-23T00:04:29.000Z", "temp": 22.8, "humidity": 23, "co2":
"humidity": 23, "co2": 796.0, "sensor_id": "ENKZYW001837"}, {"do
"ENKZYW001819"}, {"documentTime": "2023-01-23T00:00:16.000Z", "t
"2023-01-23T00:00:19.000Z", "temp": 24.2, "humidity": 23, "co2":
"humidity": 24, "co2": 766.0, "sensor_id": "ENKZYW001884"}, {"do
"ENKZYW001884"}, {"documentTime": "2023-01-23T00:00:19.000Z", "t
```

1

df_indoor.head(5)

documentTime

temp

humidity

co2

sensor_id

1

floor_sensor.head(5)

sensor_id

location.y

location.x

id

0

ENKZYW001792

487.47

355.19

H-3F

1

ENKZYW001804

313.77

203.47

H-3F

2

ENKZYW001819

153.54

387.91

H-3F

3

ENKZYW001837

134.67

609.73

H-3F

4

ENKZYW001848

156.61

891.23

H-3F

Data Findings

- ✓ **Missing values:** 1078 missing values for wind speed in outdoor data, replaces by zero
- ✓ **Data Consistence:**
 - No inconsistencies found between IAQ and floor dataframes
 - Data for all the sensor is not coming at exact 5 minutes,

```
↳ Data for sensor ID ENKZYW001792 is not coming every 5 minutes
Data for sensor ID ENKZYW001804 is not coming every 5 minutes
Data for sensor ID ENKZYW001819 is not coming every 5 minutes
Data for
Data for ↳ Average time difference for sensor ID ENKZYW001792: 0 days 00:05:05.231419558
Data for Average time difference for sensor ID ENKZYW001804: 0 days 00:05:33.916206515
Average time difference for sensor ID ENKZYW001819: 0 days 00:05:05.163386323
Average time difference for sensor ID ENKZYW001837: 0 days 00:05:06.599949296
Average time difference for sensor ID ENKZYW001848: 0 days 00:05:05.027868852
Average time difference for sensor ID ENKZYW001856: 0 days 00:08:05.830688893
```

- Average time difference for outdoor data is 13 minutes
- ✓ **Operational Requirement check:**
 - There are 2170 data point where temperature falls below the required operational standard, minimum being at 13 degree
 - There are 1267 data point where CO2 level exceeded the optimal levels with max at 1378 ppm

Data Wrangling



Calculating Humidity Ratio:

The humidity ratio or specific humidity is the weight of water vapour per unit weight of dry air. Humidity also affects the performance of buildings, causing condensation, mould growth, mildew, staining, slip hazards, damage to equipment and the corrosion and decay of the building fabric as well as poor performance of insulation.



Data Rollup: Hourly and Daily

Since the data is collected at interval of approx. 5mins, its recommended to aggregate data (*mean*) on hourly or daily basis to generate graphs and analysis patters. It also reduces noise in high volume the data.



Data Merge.

Used merge and join function of python to combine all the data where required for performing analysis and generating graphs

Analysis Report:

1. **Indoor Air Quality (IAQ) Analysis:** As the given indoor data includes indoor temperature, humidity, and CO2 levels, we can analyze the IAQ of the building. We can analyze mean and standard deviation of each sensor on both the floor. We can also identify any area that have high CO2 levels, which may indicate poor ventilation. We can suggest improving the ventilation system in those rooms to enhance the IAQ.

The temperature readings from different sensors can be compared to identify areas with a high or low temperature, and hence help to optimize heating and cooling systems

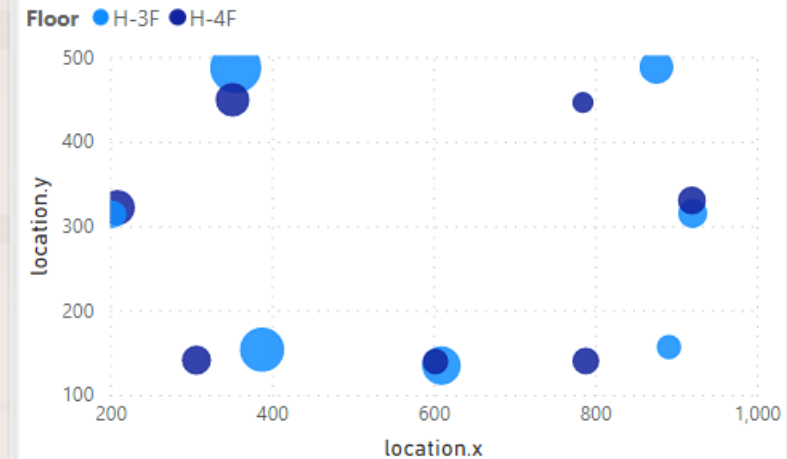
Indoor: Summary Statistic

565.38 ppm Avg. CO2	1378.00 ppm Max CO2	411.00 ppm Min CO2
31.27% Avg. Humidity	62.00% Max. Humidity	20.00% Min Humidity
23.52°C Avg Temperature	27.20°C Max Temperature	13.00°C Min Temperature

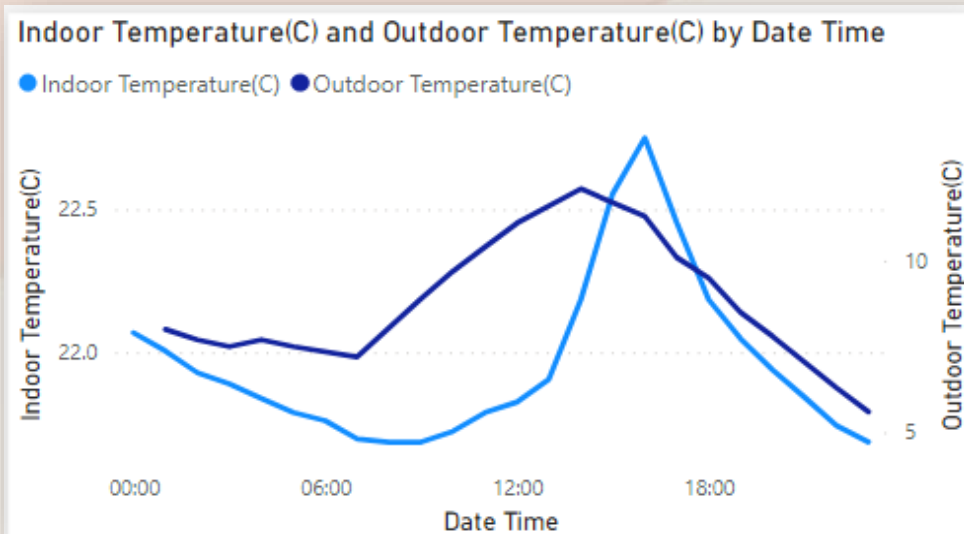
Last 30 mins status window

Floor	Sensor Id	Temperature (C)	Humidity (%)	CO2 levels (ppm)
H-3F	ENKZYW001792	22.23 ✓	30.00 ✓	431.43 ✓
H-3F	ENKZYW001804	21.68 ✓	33.00 ✓	434.00 ✓
H-3F	ENKZYW001819	21.85 ✓	33.00 ✓	436.83 ✓
H-3F	ENKZYW001837	22.00 ✓	32.00 ✓	434.17 ✓
H-3F	ENKZYW001848	21.70 ✓	32.00 ✓	431.25 ✓
H-3F	ENKZYW001856	21.70 ✓	32.00 ✓	434.00 ✓
H-3F	ENKZYW001882	20.50 ⚠	35.00 ✓	428.75 ✓
H-4F	ENKZYW001883	20.07 ⚠	35.00 ✓	433.50 ✓
H-4F	ENKZYW001884	19.85 ⚠	36.00 ✓	435.17 ✓
H-4F	ENKZYW001888	21.10 ✓	34.00 ✓	434.33 ✓
H-4F	ENKZYW001900	22.40 ✓	31.00 ✓	432.83 ✓

Sensor Location on Floor sized by CO2 variation in last 1hr

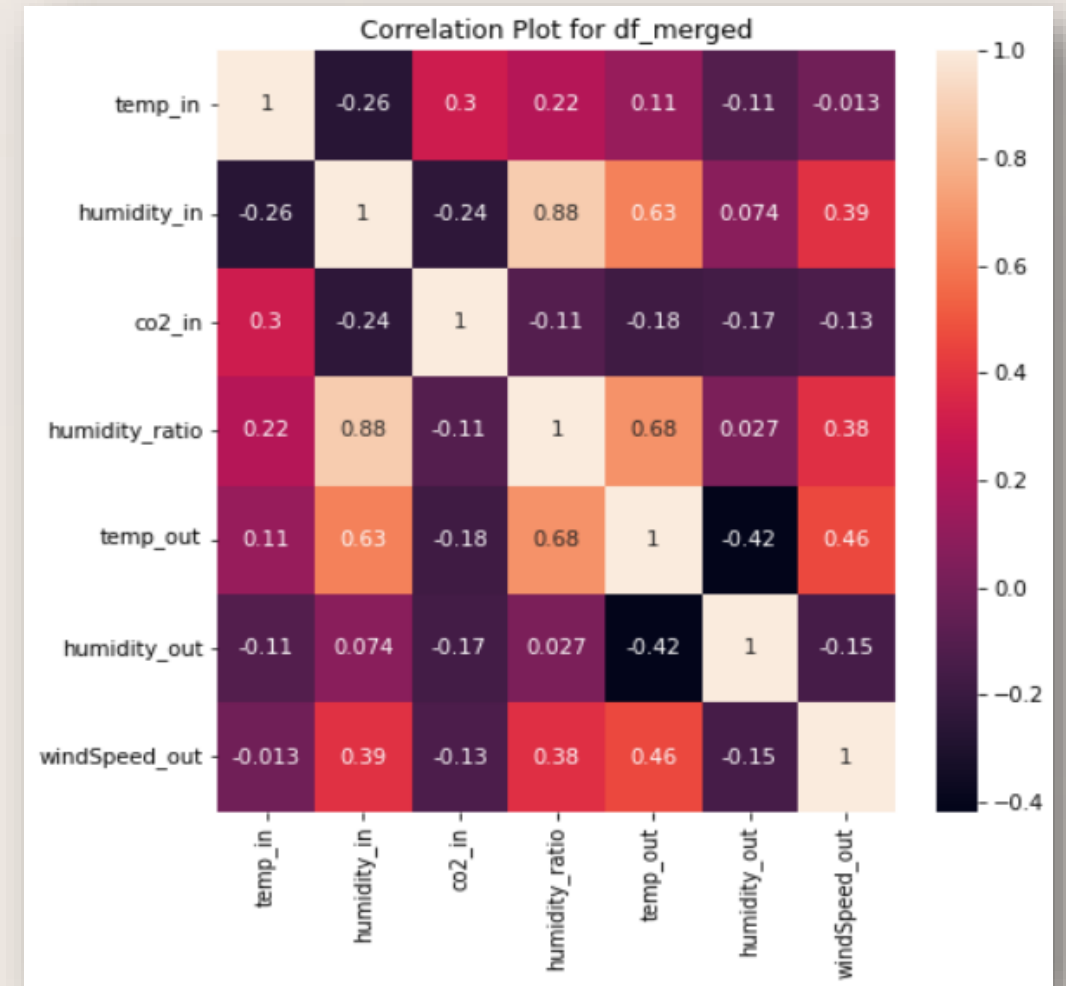


2. Outdoor Air Quality (OAQ) Analysis: We can also analyze the OAQ data and see how it affects the IAQ of the building. We can compare outdoor data with the indoor data to identify any correlations. We can also analyze the wind speed data and see how it affects the IAQ of the building, as wind speed affects the ventilation of the building.

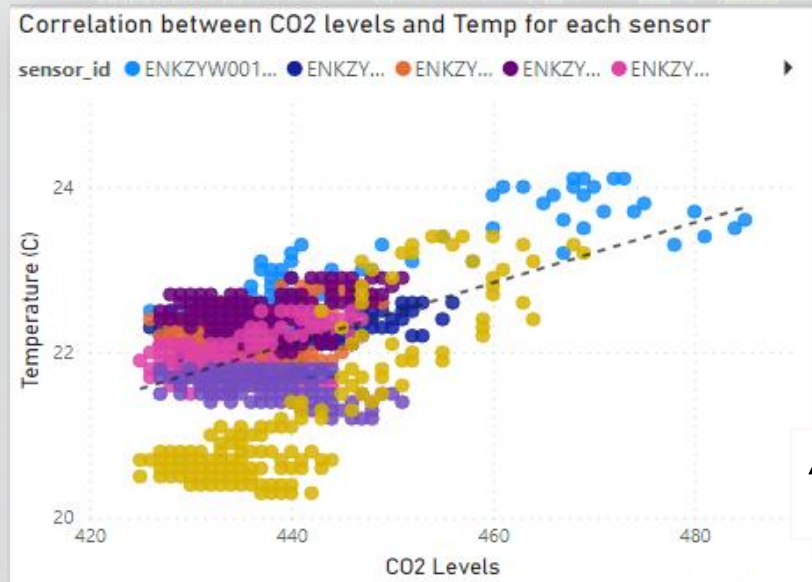


Outdoor: Summary Statistic

0.81	8.10	0.00
Avg. Windspeed	Max Windspeed	Min Windspeed
82.62%	93.00%	50.00%
Avg. Humidity	Max Humidity	Min Humidity
5.76°C	13.80°C	-2.70°C
Avg Temperature	Max Temperature	Min Temperature



3.) **Occupancy analysis:** The indoor temperature and CO2 measurements can be used to estimate occupancy levels in different areas of the building. By analyzing the patterns of temperature and CO2 fluctuations, we can identify which areas are frequently occupied and which ones are not. This information can be used to optimize HVAC systems and ventilation rates.

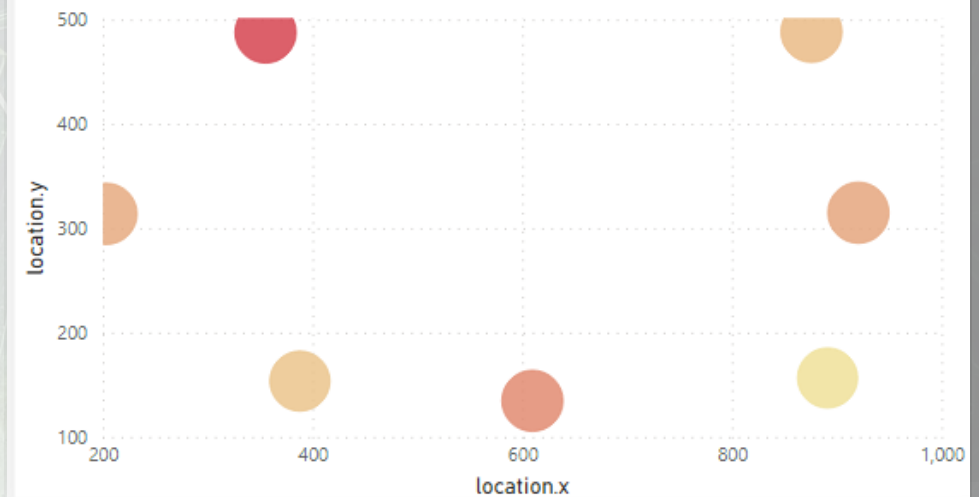


A positive correlation between temperature and CO2 levels, indicate indoor poor ventilation.

High levels of CO2 can lead to discomfort and health problems

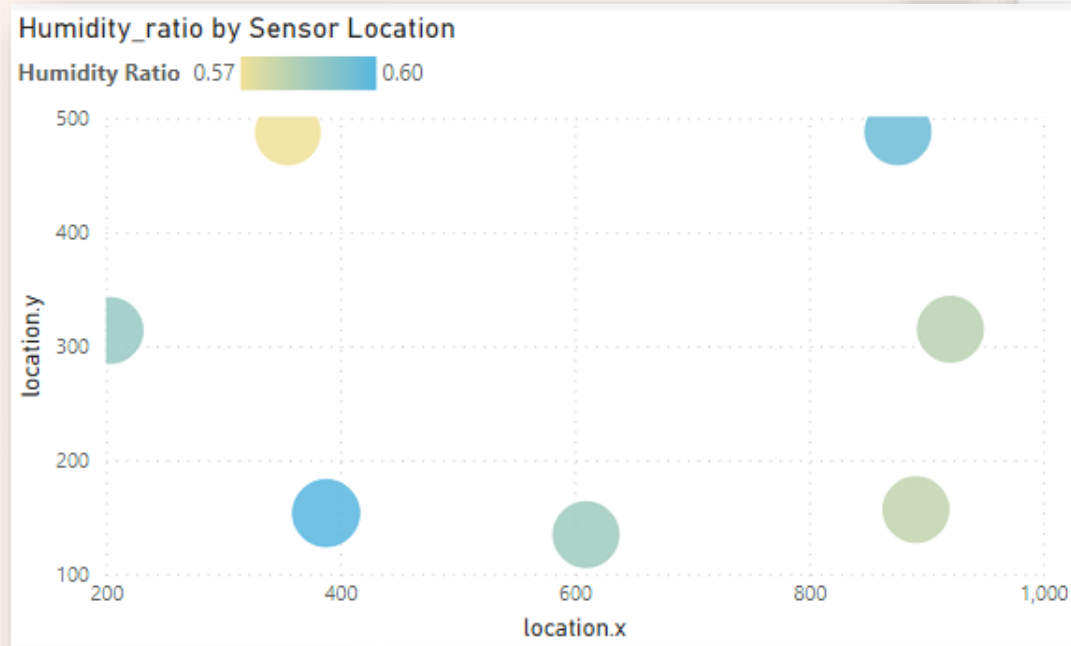
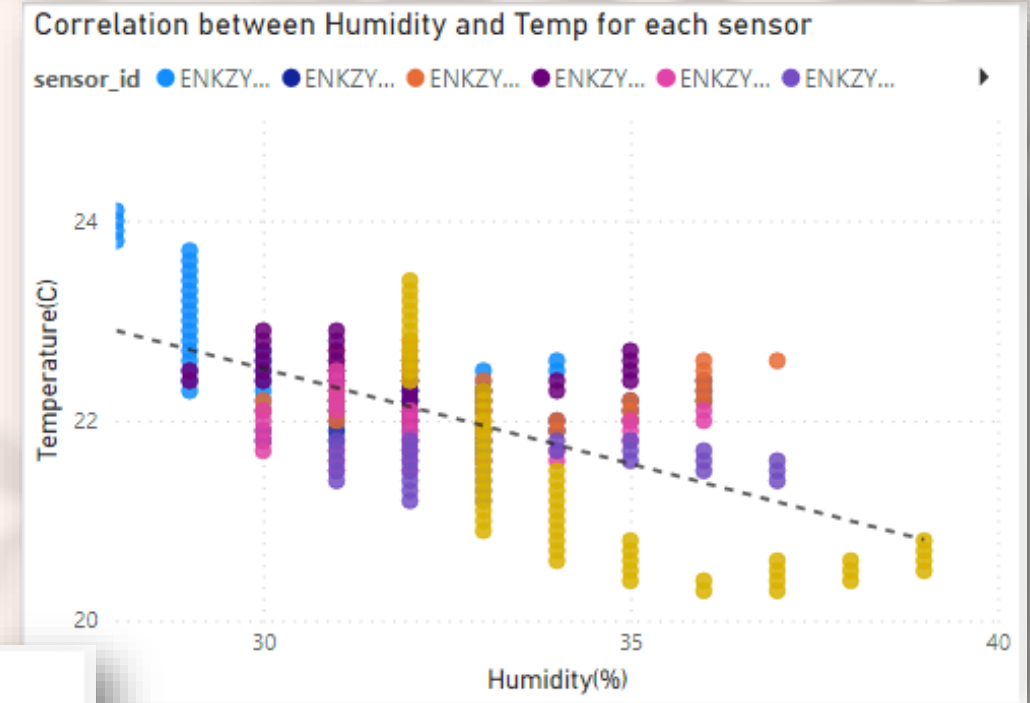
CO2 Levels by Sensor Location

Average CO2 Levels 432.39 435.91

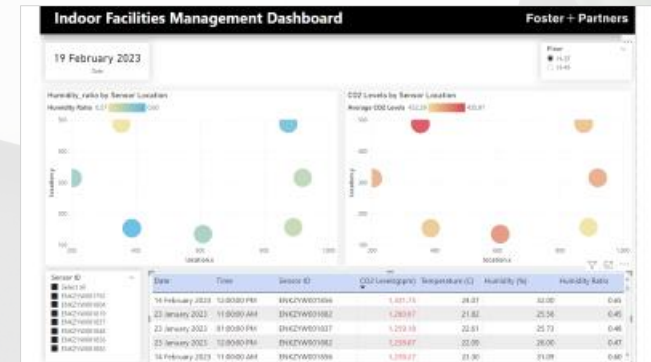
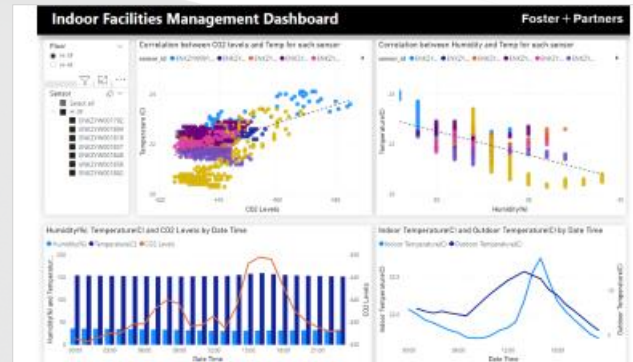


4. HVAC Analysis : The indoor temperature and humidity measurements can be used to optimize the HVAC system of the building. By analyzing the data from temperature and humidity sensors in the building, we can gain insights into how the HVAC system is performing and identify areas for improvement. For this we will look for correlations between temperature and humidity data for each sensor

Humidity ratio is the ratio of the mass of water vapor to the mass of dry air in a given air-vapor mixture. It is an important parameter in indoor environmental quality (IEQ) analysis as it affects thermal comfort, indoor air quality, and building energy performance.



Power Bi Dashboard



2

Total No.of Floors

14

Total No.of Sensors

Date Hierarchy

- ☐ Select all
- ☒ 2023
 - ☒ Qtr 1
 - ☒ January
 - ☒ February
 - ☒ March
 - ☐ Qtr 2
 - ☐ Qtr 3
 - ☐ Qtr 4

Floor

- ☒ Select all
- ☒ H-3F
- ☒ H-4F

Current Outdoor Stats

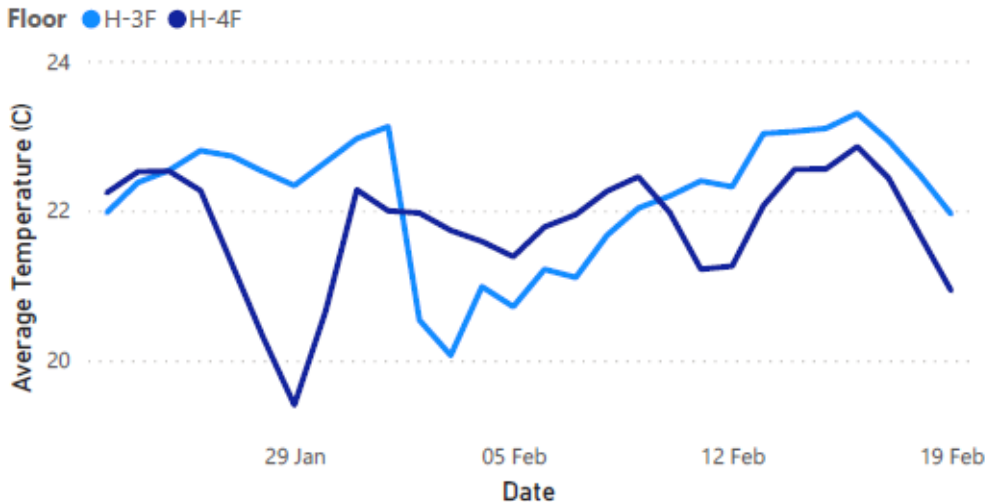
19-02-2023 18:00:....

9.50
Temperature (C)
77.40
Humidity (%)
0.80
Windspeed

Last 30 mins status window

Floor	Sensor Id	Temperature (C)	Humidity (%)	CO2 levels (ppm)
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H-3F	ENKZYW001804	21.68	33.00	434.00
H-3F	ENKZYW001819	21.85	33.00	436.83
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H-3F	ENKZYW001848	21.70	32.00	431.25
H-3F	ENKZYW001856	21.70	32.00	434.00
H-3F	ENKZYW001882	20.50	35.00	428.75
H-4F	ENKZYW001883	20.07	35.00	433.50
H-4F	ENKZYW001884	19.85	36.00	435.17
H-4F	ENKZYW001888	21.10	34.00	434.33
H-4F	ENKZYW001900	22.10	31.00	432.83

Average Temperature (C) by Date and Floor



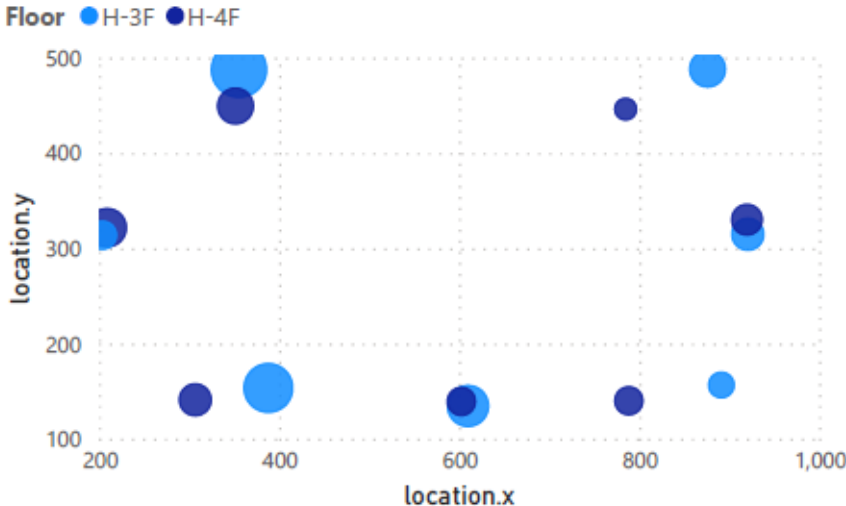
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82.62% Avg. Humidity	93.00% Max Humidity	50.00% Min Humidity
5.76°C Avg Temperature	13.80°C Max Temperature	-2.70°C Min Temperature

Sensor Location on Floor sized by CO2 variation in last 1hr



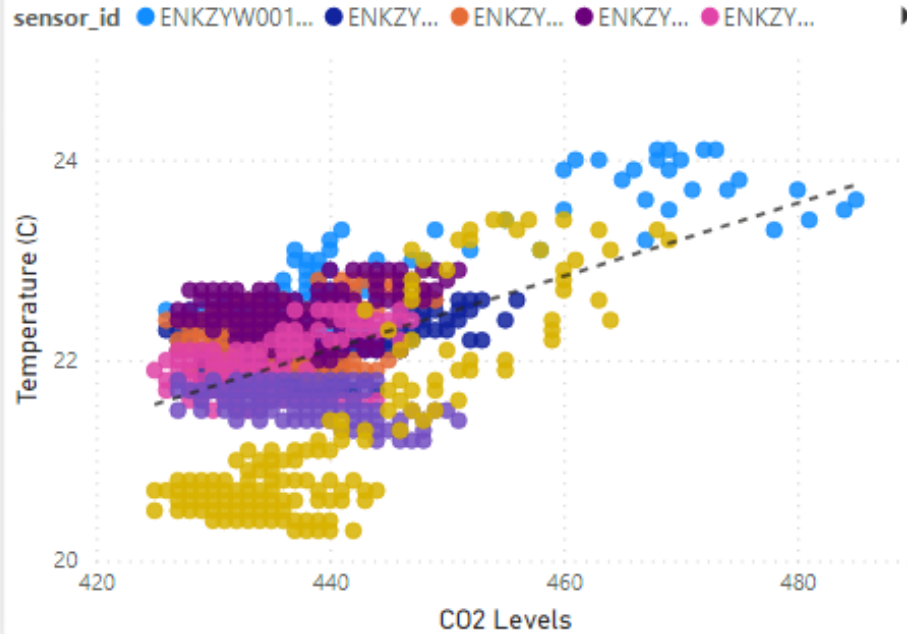
Indoor Facilities Management Dashboard

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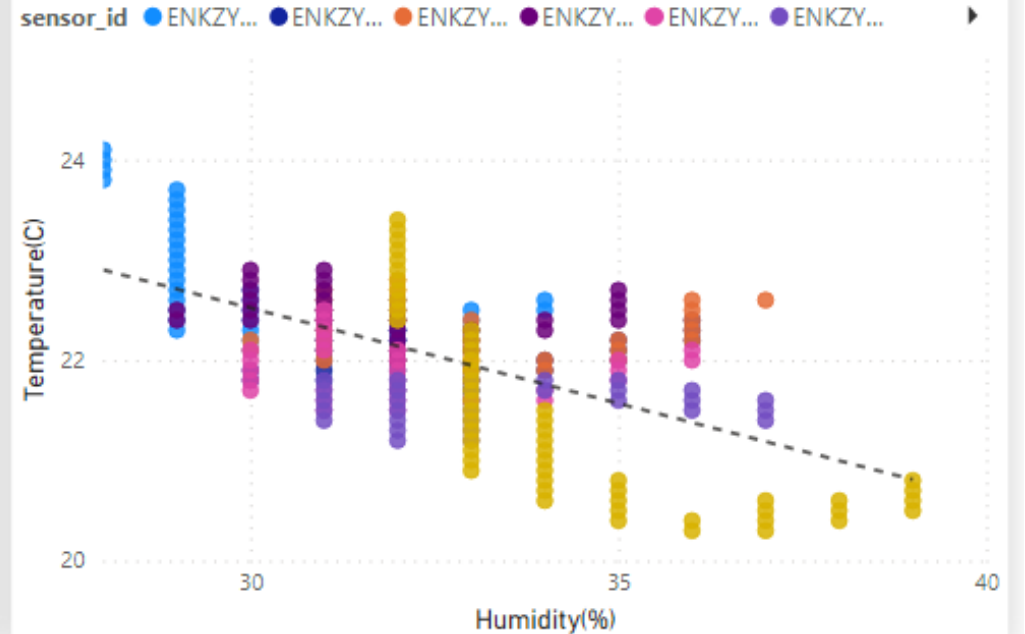
Floor
● H-3F
○ H-4F

Sensor
■ Select all
■ H-3F
■ ENKZYW001792
■ ENKZYW001804
■ ENKZYW001819
■ ENKZYW001837
■ ENKZYW001848
■ ENKZYW001856
■ ENKZYW001882

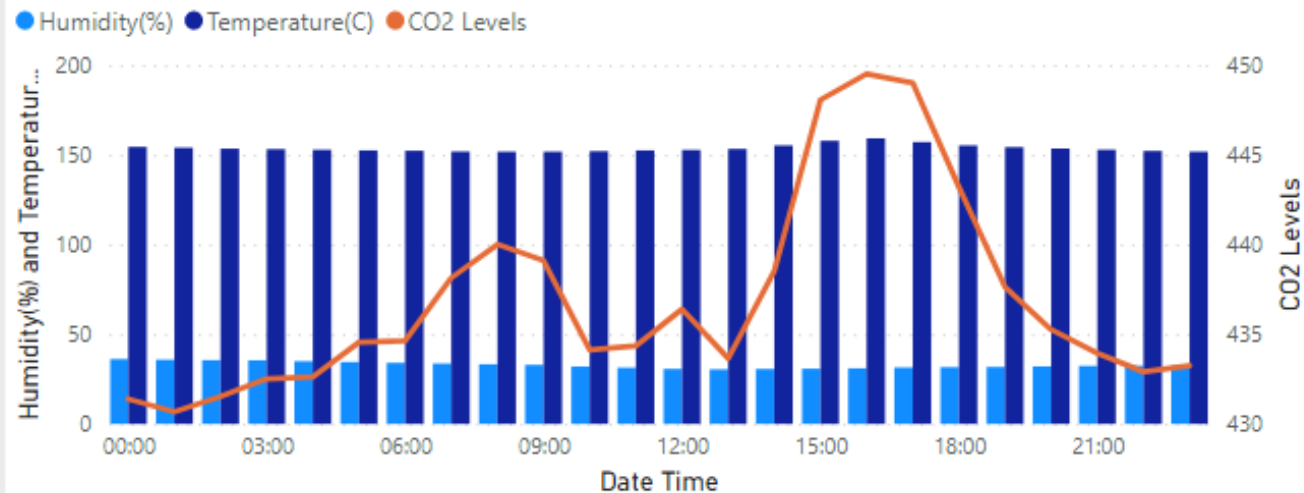
Correlation between CO2 levels and Temp for each sensor



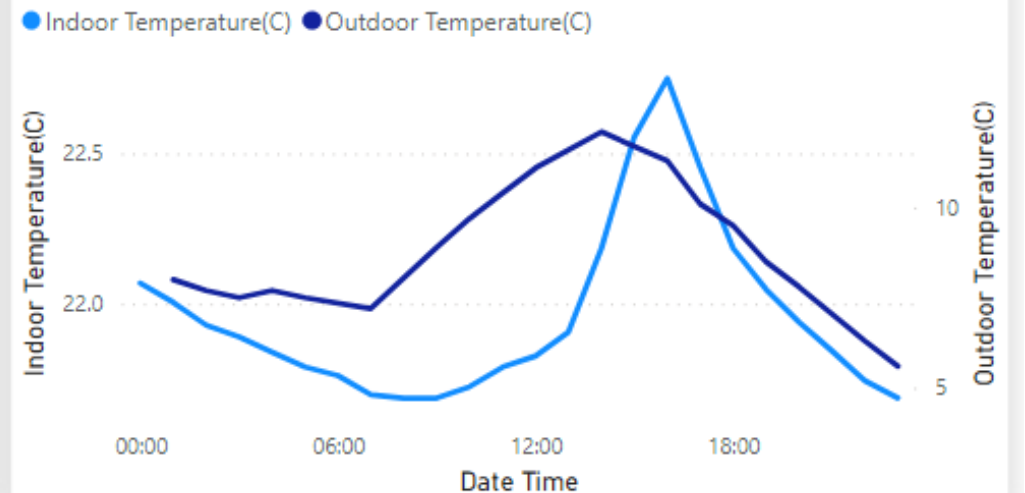
Correlation between Humidity and Temp for each sensor



Humidity(%), Temperature(C) and CO2 Levels by Date Time



Indoor Temperature(C) and Outdoor Temperature(C) by Date Time



19 February 2023

Date

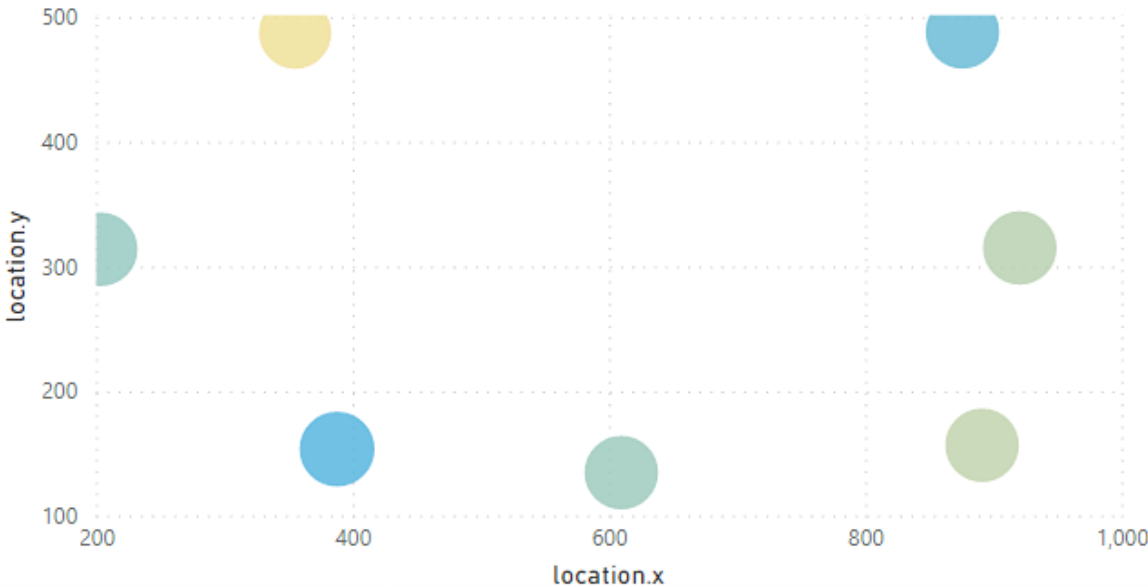
Floor

☒ H-3F

☐ H-4F

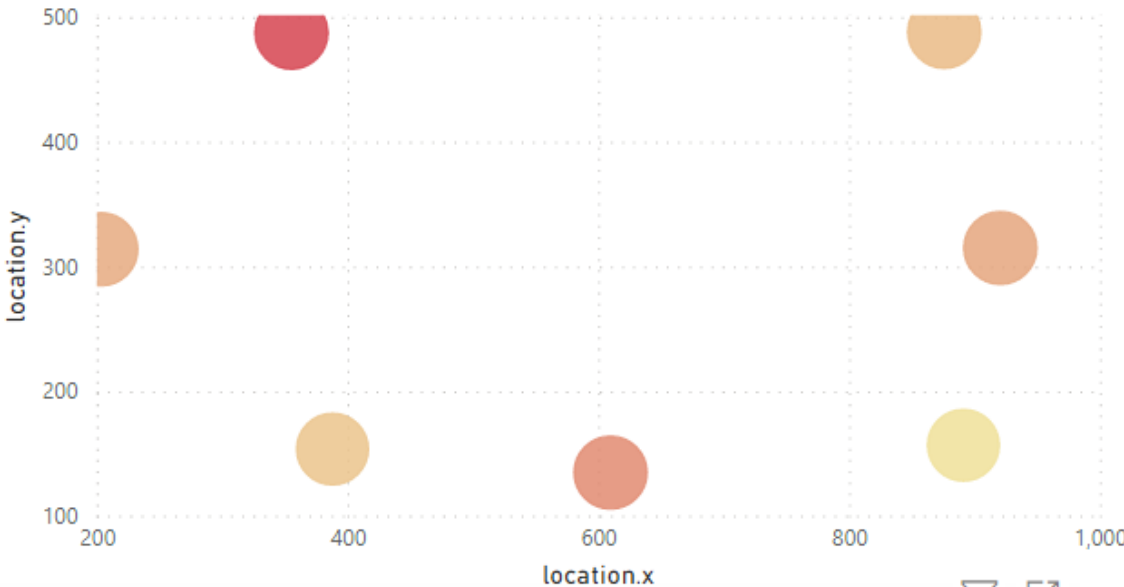
Humidity_ratio by Sensor Location

Humidity Ratio 0.57 0.60



CO2 Levels by Sensor Location

Average CO2 Levels 432.39 435.91



Sensor ID

☒ Select all

☒ ENKZYW001792

☒ ENKZYW001804

☒ ENKZYW001819

☒ ENKZYW001837

☒ ENKZYW001848

☒ ENKZYW001856

☒ ENKZYW001882

Date	Time	Sensor ID	CO2 Levels(ppm)	Temperature (C)	Humidity (%)	Humidity Ratio
14 February 2023	12:00:00 PM	ENKZYW001856	1,331.75	24.07	32.00	0.65
23 January 2023	11:00:00 AM	ENKZYW001882	1,280.67	21.82	25.56	0.45
23 January 2023	01:00:00 PM	ENKZYW001837	1,259.18	22.61	25.73	0.48
23 January 2023	12:00:00 PM	ENKZYW001882	1,238.67	22.09	26.00	0.47
14 February 2023	11:00:00 AM	ENKZYW001856	1,238.27	23.30	31.09	0.60

The background of the slide features a close-up of green, elongated leaves on the left and right sides, which are slightly out of focus. A central vertical panel in a soft pink color contains the text.

**THANK
YOU**