Introduction

In today's modern age, the integration of technology and data analytics has revolutionized various industries, including facilities management. This report delves into the analysis of a dataset centered around an office building's facilities management, leveraging the wealth of information provided by Internet of Things (IoT) sensors. Through the examination of trends and insights derived from the dataset, this report aims to offer valuable insights and recommendations for enhancing the operational efficiency of the building.

The dataset provided for this exercise offers a comprehensive view of sensor measurements captured from the interior rooms of a multi-floor office building. This includes crucial parameters such as indoor temperature, humidity, and CO2 levels, all of which significantly influence the occupants' comfort and overall indoor air quality. The data, sampled from two floors stacked upon each other, is enriched with information from multiple sensors, each identified by a unique 'sensor_id'.

To provide context to the analysis, accompanying JSON files outline the spatial distribution of sensors within the floor plans, aiding in understanding the data's spatial dynamics. Additionally, limited outdoor data, encompassing temperature, humidity, and windspeed, further enriches the dataset, providing insights into the external factors influencing indoor conditions.

1. Motive

This report aims to answer the following questions:

1. How is the Data Quality: Does data has any duplicate values, missing values and errors?

2. Does data have any patterns and trends?

3. How does the internet of Things data vary across different sensors, and floors?

5. Is there any possible factors that affect the internet of Things data, such as outdoor weather?

6. What are the number incidents when the operational goals have not met?

7. Is there any possible anomalous behaviours?

2 How is the data quality?

The dataset includes "Floor Plans" data, outdoor data, encompassing temperature, humidity, and windspeed.

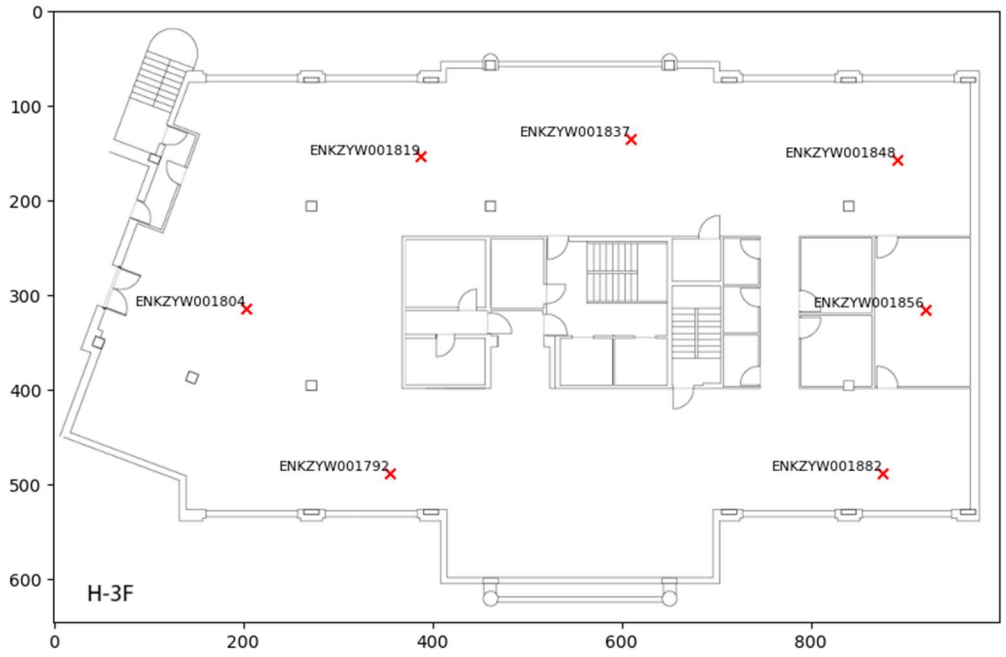
2.1 Floor Plans Data

2.1.1 Data Information

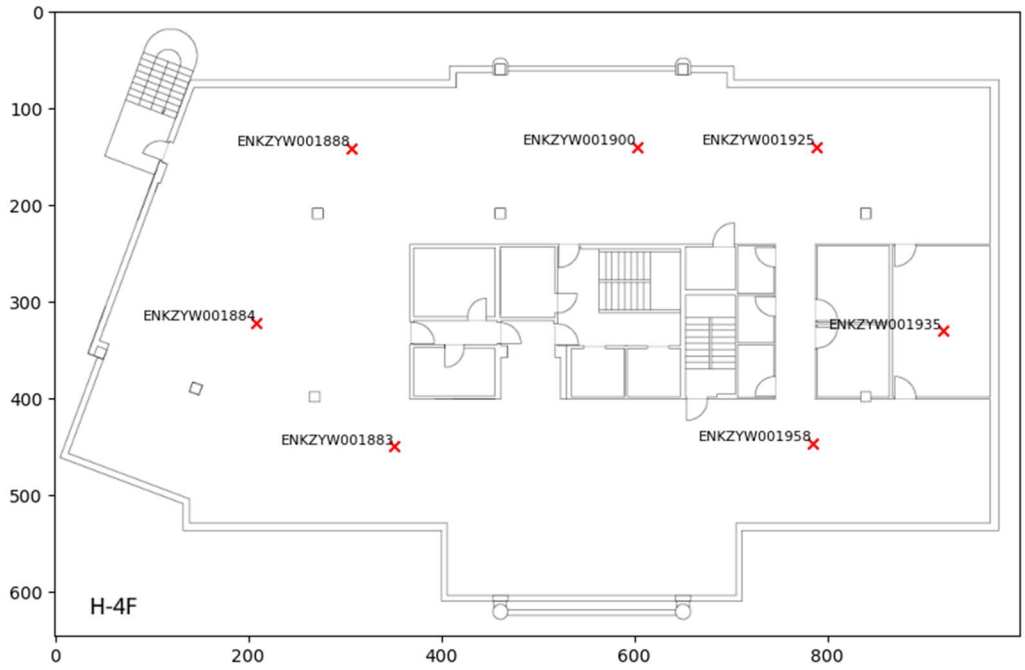
There are two rows and three columns, which contain floor id, Image information and Floor coordinates. There is no problem with the data.

2.1.2 Data Visualization

The sesnors in 3rd Floor are displayed below in the image:



The sensors in 4th floor are displayed below in the image.



2.2 Outdoor Data

2.2.1 Data Information

The data is provided on an hourly interval for the period 23 JAN 2023 to 19 FEB 2023 for the location of the building. It has four columns: 'documentTime', 'temperature', 'humidity' and 'windSpeed'. It has a lot of duplicate values. The details are as follows:

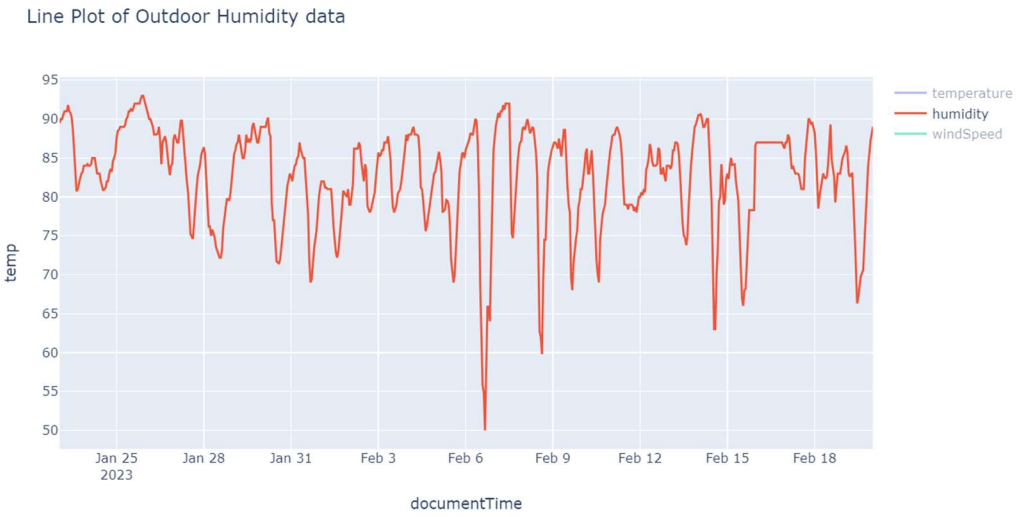
Total Data Points	Duplicate Points	Duplicate Timestamp after removing duplicate data
2892	2204	59

After removing duplicates, some instances have been found where there is a gap in the data. F or example, between “2023-01-25 23:00:00” to “2023-01-26 01:00:00+00:00”, there is no dat a point found. For more details, please refer to Appendix A.

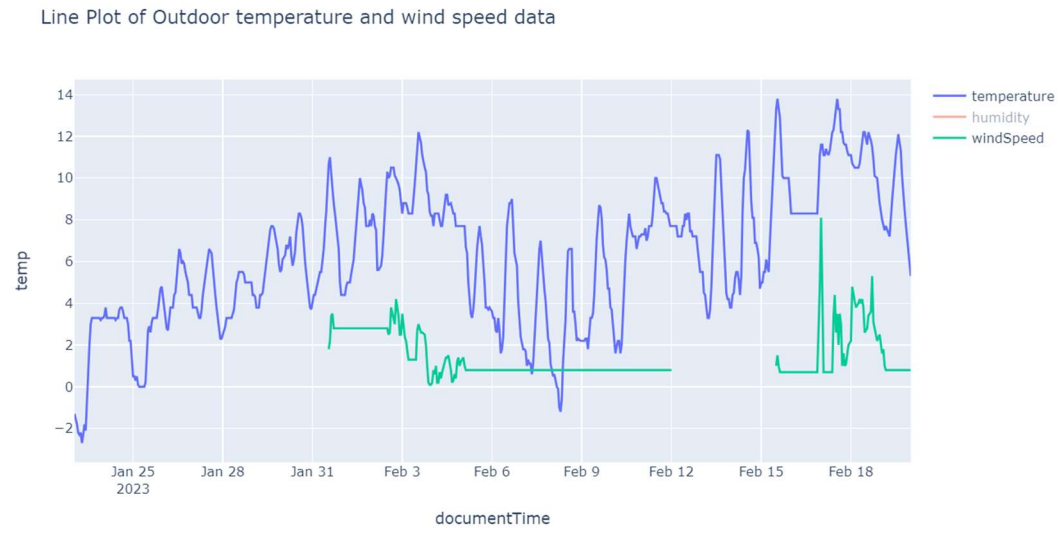
There are no null values in the outdoor data, except for the "windspeed" column, which conta ins almost 63% null values.

2.2.2 Data Visualization

Line Plots of outdoor data are displayed below.



Humidity: The overall trend is flat. There have been a couple of dips e.g. Feb 6.



Temperature: It kept increasing from the start till Feb 3. It started going downward and again started going upwards from 9-10 Feb.

WindSpeed: Most of the data is missing and long flat lines. The data seems to be unreliable to use.

2.3 Indoor Data

2.3.1 Data Information

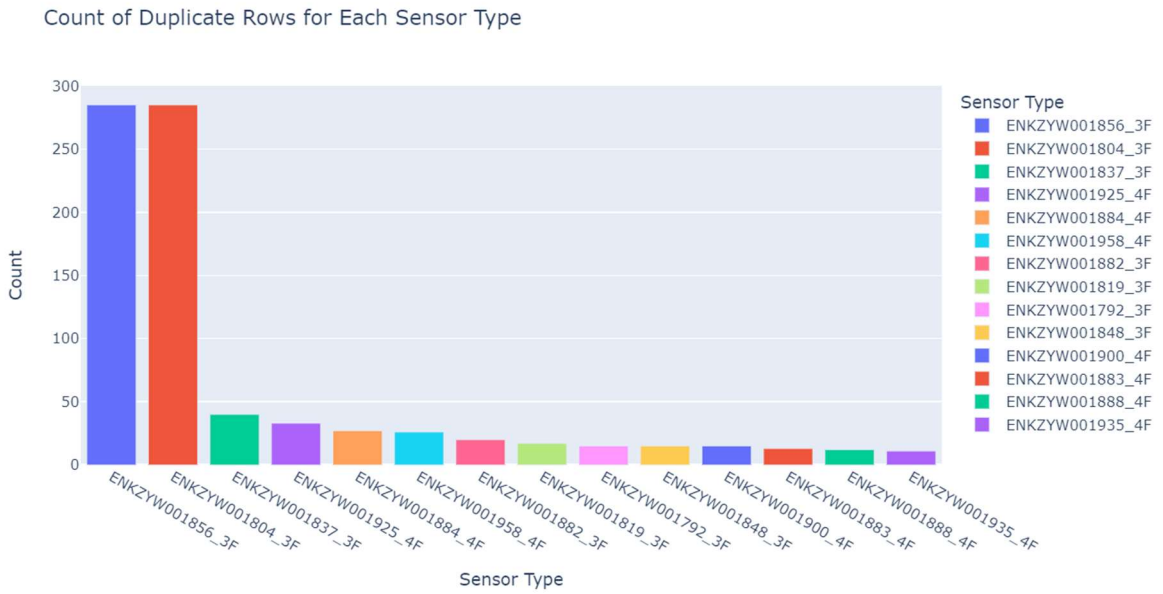
The data is provided on a 5-minute interval for the period 23 JAN 2023 to 19 FEB 2023. It has four columns: 'documentTime', 'temp', 'co2' and 'sensor_id'. Moreover, some new columns are created for data exploration which can be displayed in the plots. The information about the features is as follow:

temp_c: Temperature at ceiling Hight. temp_c = temp (given temperature)
temp_d: Temperature at desk Hight. temp_d = temp_c - 1.5
Floor: Floor of the given sensor e.g. '3F'.
sensor_id_floor_lon: Combination of 'sensor_id' and 'Floor' in long format e.g.'ENKZYW001900_4F'.
sensor_id_floor_sho: Combination of 'sensor_id' and 'Floor' in short format e.g. '1900_4F'.

It has some duplicate value as well. The details are as follows:

Total Data Points	Duplicate Points
102629	814

The distribution of the duplicate rows as per sensors is displayed in the below plot:



After removing duplicates, some instances have been found where there is a gap in the data for each sensor. The most significant ones are displayed below:

1. ENKZYW001804_3F:
Gap start: 2023-02-04 05:01:10+00:00 | Gap end: 2023-02-07 12:26:52+00:00 | Gap length: 3 days 07:25:42

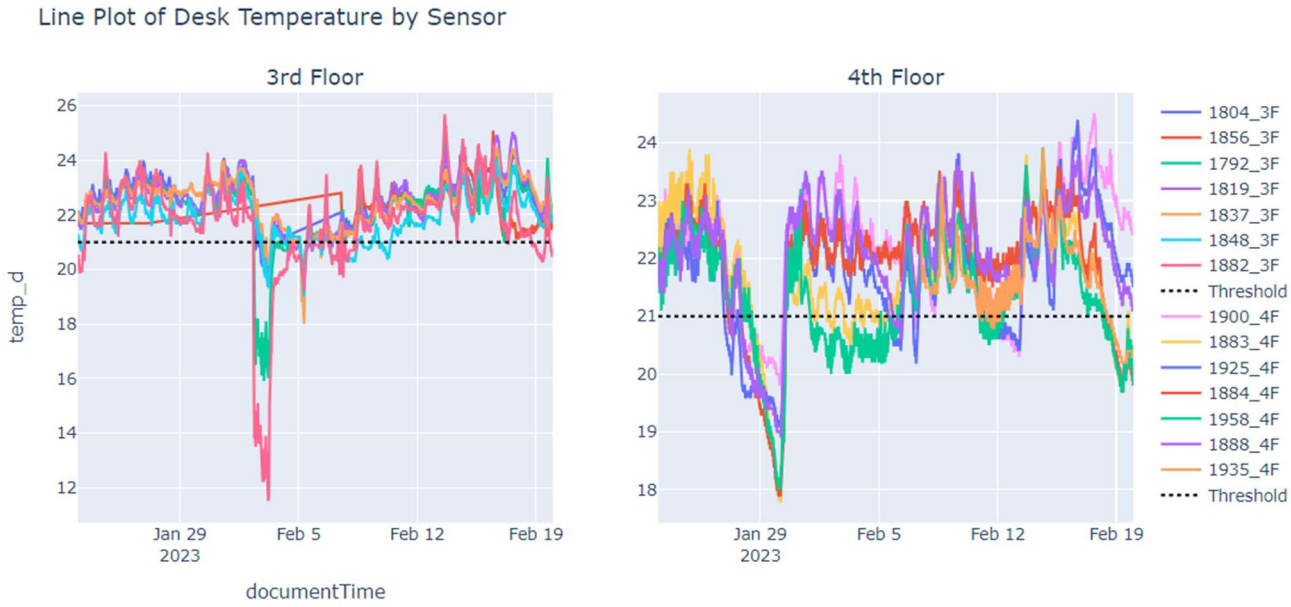
2. ENKZYW001856_3F
Gap start: 2023-01-27 03:31:27+00:00 | Gap end: 2023-02-07 12:22:27+00:00 | Gap length: 11 days 08:51:00.

For more details refer appendix B. Indoor data has no null values.

3. Is there a trend in the data?

3.1 Temperature

As mentioned above, desk temperature has been used for the analysis. Line plots for both the floors are displayed below.



Please find below the observations:

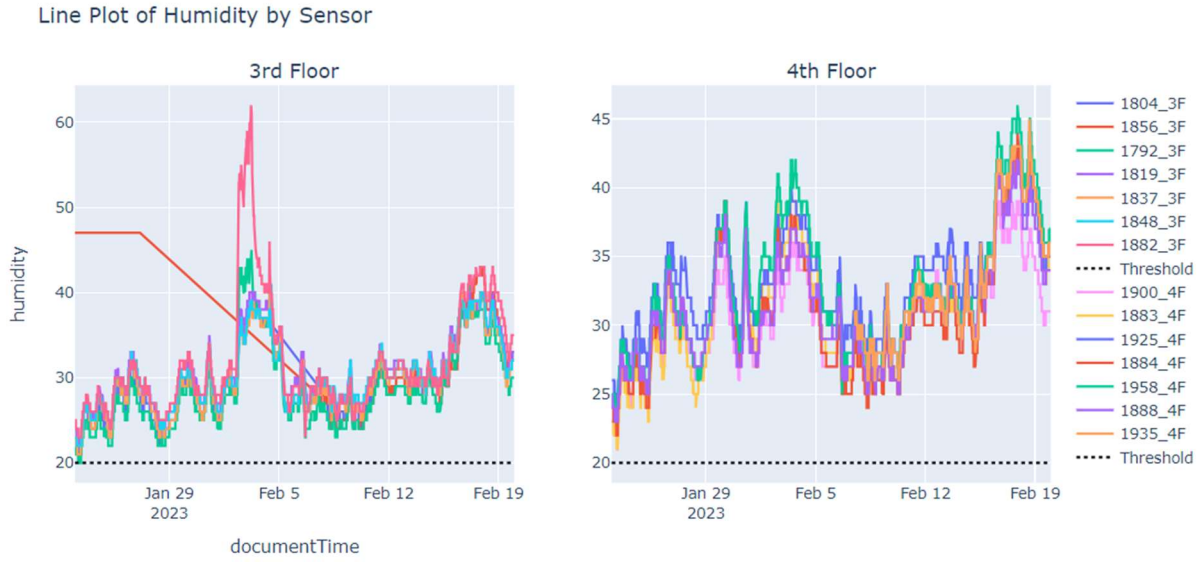
Third-floor sensors: The values appear to be relatively stable ("flat") until February 2nd, after which they start to increase steadily from February 5th onward.

Fourth-floor sensors: There are higher fluctuations observed, particularly with sensors labeled '1958_4F' and '1935_4F'. This suggests that the data from these sensors is more variable compared to those on the third floor.

Missing data: There are gaps in the plot indicating missing data for certain sensors, such as '1856_3F' and '1804_3F'. This could be due to various reasons such as sensor malfunction, data transmission issues, or maintenance.

3.2 Humidity

Line plots for both the floors are displayed below. There is no instance of a value crossing the given threshold.



Third-floor sensors: The overall trend seems to be flat. However, in the first half (before Feb 5) and From Feb 10 - Feb 19, there is an increasing trend.

Fourth-floor sensors: There is an increasing trend till 5th February and then it changed to decreasing trend. From Feb12, it again picked up to go upwards.

For both floors, the values look highly correlated to each other.

3.2 Co2

Line plots for both the floors are displayed below.

The overall trend seems to be quite fluctuating like sine wave unlike indoor and humidity plots. It is indicating some daily/weekly pattern. The sensors look highly correlated to each other.

4. Is there any patterns in the data?

Here, we'll be looking patterns that occur regularly on a daily or weekly basis.

Based on the limited data of 24-25 days, daily and weekly patterns has been explored. In this section, for plotting the data, 'sensor_id_floor_lon' has been used which is the combination of 'sensor_id' and 'Floor' in longer format e.g. ' ENKZYW001804_3F'.

4.1 Temperature

4.1.1 Daily patterns

Daily patterns plot for both the floors are displayed below which suggest pattern in the data of both floors. The values start increasing in the morning and starts to go downhill in the evening.

4.1.2 Weekly pattern

For weekly pattern, the data is quite limited. Based on the plot displayed below, there are a few observations:

1. 3rd Floor: Not a clear weekly pattern.

2. 4th Floor: Some sort of pattern is displayed where the sensors are showing downward trend on weekends.

4.2 Humidity

4.2.1 Daily patterns

Daily pattern plots for both the floors are displayed below which suggest pattern in the data of both floors. The values start increasing in the morning and starts to go downhill in the evening. On comparing with 3rd floor, 4th Floor, it looks a bit stronger.

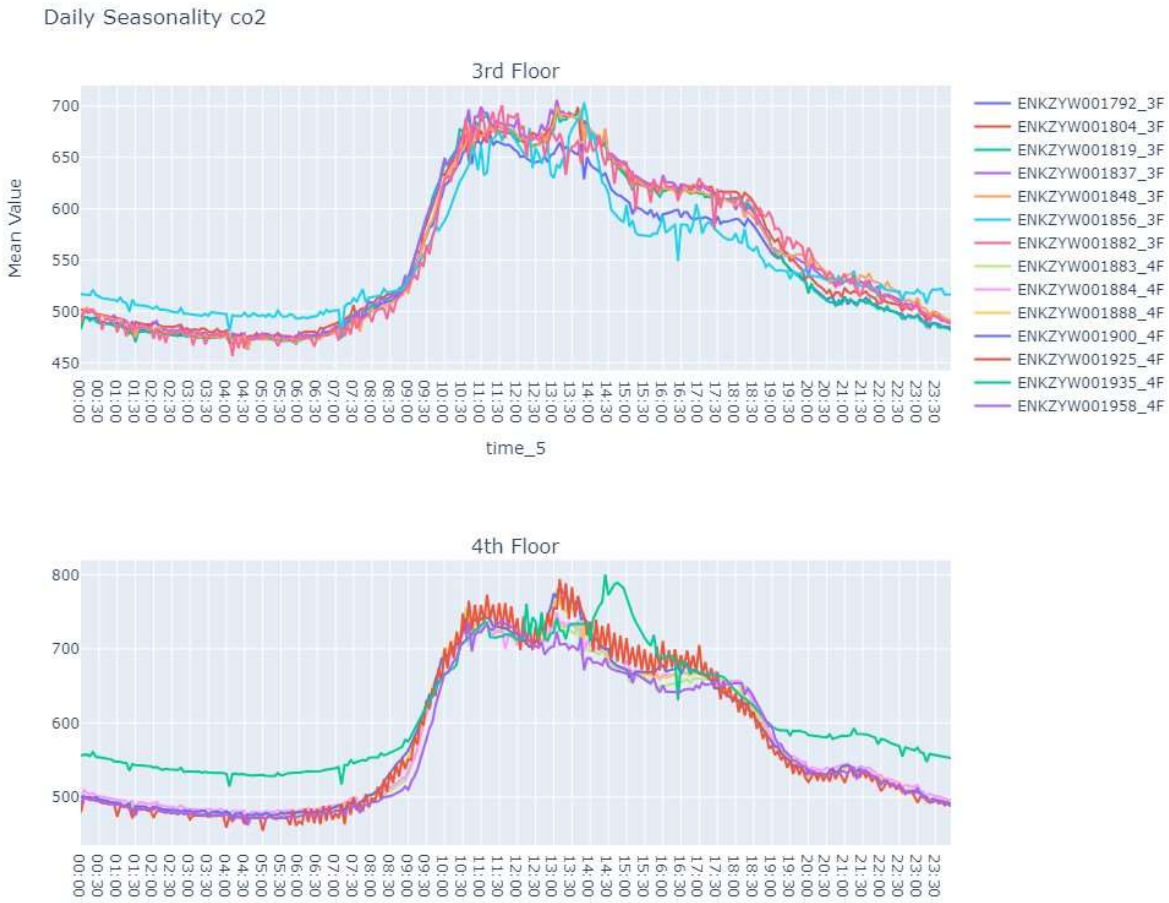
4.2.2 Weekly pattern

On both the floors, not a clear weekly pattern is found.

4.3 Co2

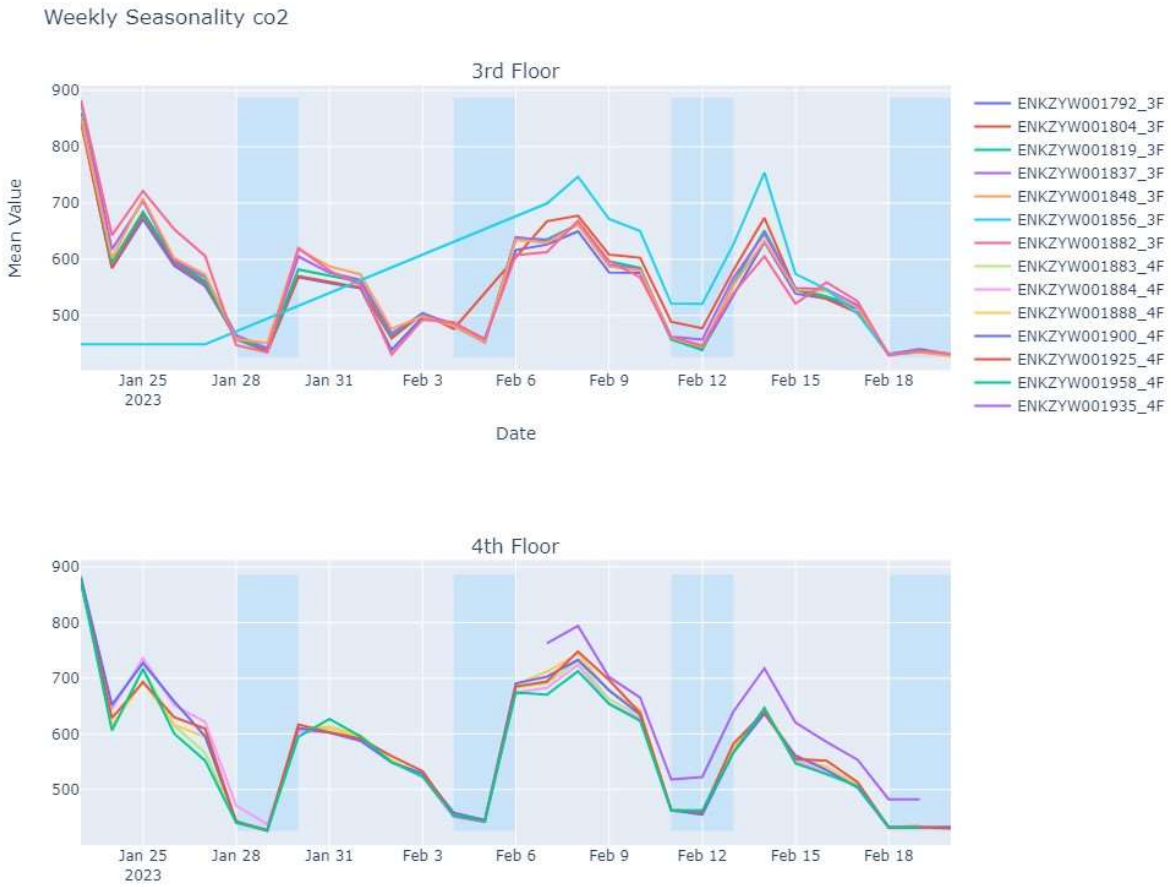
4.3.1 Daily pattern

Daily pattern plots for both the floors are displayed below. For Co2, the pattern looks much stronger as compared to temperature and humidity.



4.3.2 Weekly pattern

Like Daily pattern, the pattern looks stronger as compared to temperature and humidity based on the plot displayed below. It is showing a downward trend on weekends.



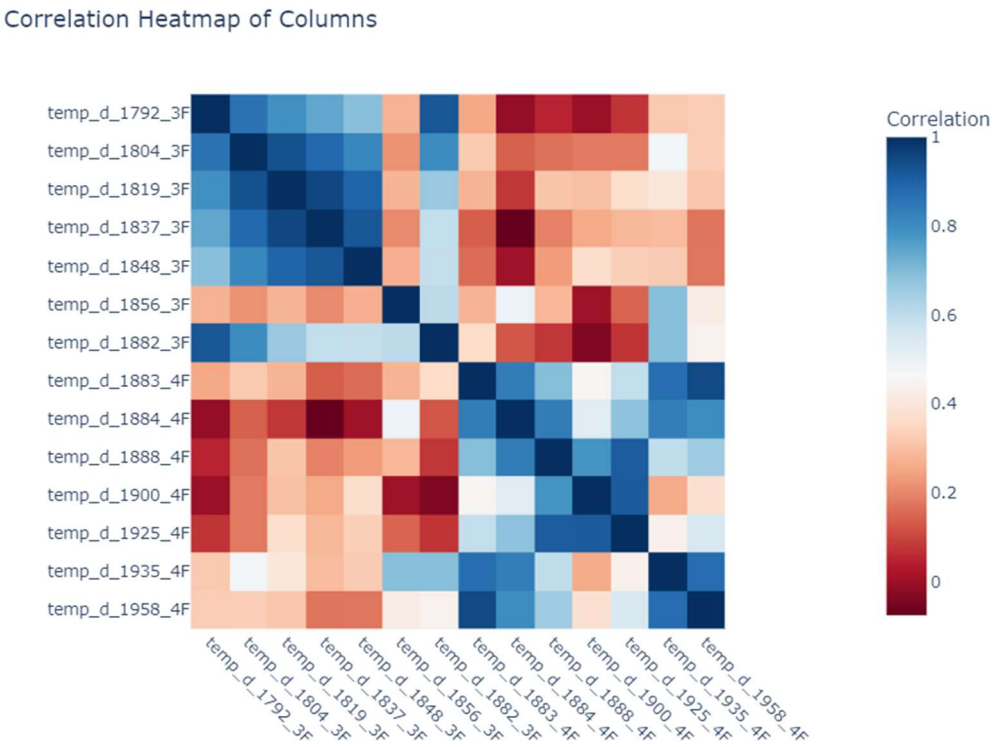
5. Are the values related to each other?

5.1 Temperature

5.1.1 Indoor Temperature values relation with each other

A heat map of correlation is displayed below which gives an idea of correlation of all temperature values of both the floors with each other. ‘Dark Blue’ color indicates strong relationship and’Dark Red’ indicated weak relationship.

Note: For example, in ‘temp_d_1792_3F’: temp_d is for desk temperature, 1792 is for sesnor’s last 4 digits and 3F is for third floor.



Based on the correlation results,

1. Are there any sensors on the 3rd floor that are correlated to sensors on the 4th floor as far as 'desk temperature' is concerned?

In most of the cases, the sensors of the 3rd floor are not strongly correlated to the sensors of the 4th floor except in two cases which are '1856_3F' and '1882_3F'. They are correlated to '1935_4F'. Interestingly, looking at the sensor location, the positions of these sensors are at a similar point (area) on their respective floors.

2. What are the pairs of sensors which are strongly correlated to each other? Are these pairs mounted next (near) to each other?

On the 3rd floor, each sensor is highly correlated to each other except '1856_3F'. It is correlated to '1882_3F' which is mounted near to it. Interestingly, the other sensor i.e. 1848_3F', which seems to be in a similar distance with '1856_3F', is not as highly correlated as '1882_3F'.

On the 4th floor as well, each sensor is highly correlated to each other except 'temp_d_1900_4F'. It is highly correlated to the sensors which are at the right and left of the sensor i.e. temp_d_1925_4F and temp_d_1888_4F.

The correlation can help us to understand the behaviour of one sensor concerning others.

5.1.2 Indoor Temperature relation with Outdoor weather

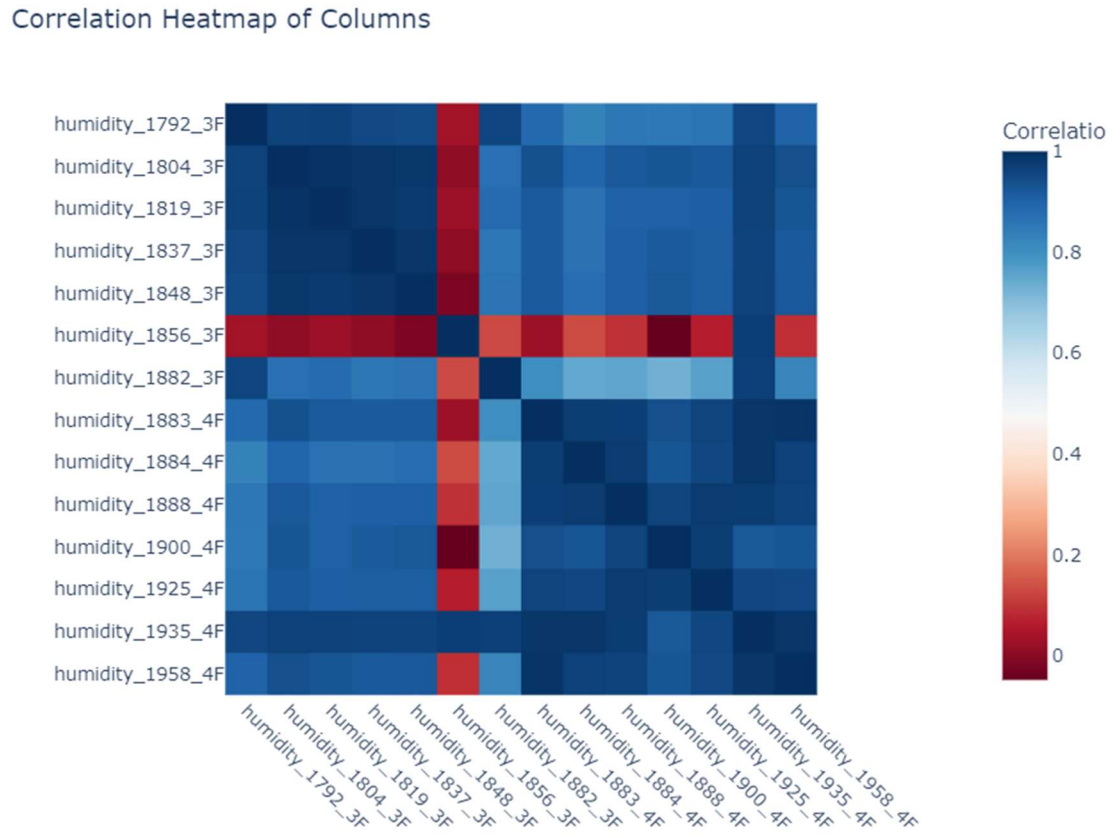
The Outdoor weather is weekly related to the temperature of indoor for both floors.

5.2 Humidity

5.2.1 Indoor Humidity values relation with each other

A heat map of correlation is displayed below which gives an idea of correlation of all humidity values of both the floors with each other.

Note: For example, in ‘humidity_d_1792_3F’: humidity is for humidity, 1792 is for sensor’s last 4 digits and 3F is for third floor.



Based on the correlation results, we can clearly see that all the sensors are strongly correlated to each other as far as 'humidity' is concerned except 1856_3F. One can thought, it could be possible due to its location but on the 4th floor, 1935_4F is also highly correlated with almost all the sensors.

5.2.2 Indoor Humidity values in relation with Outdoor weather

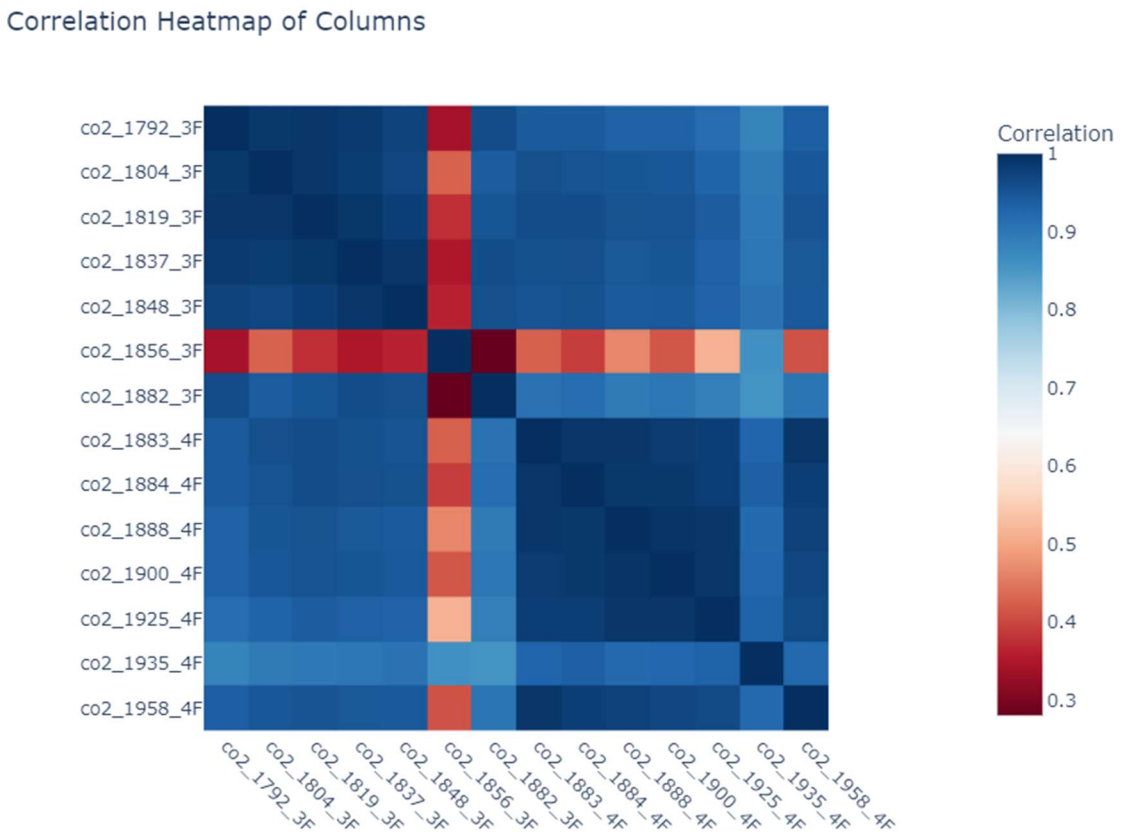
The outdoor temperature seems to be strongly correlated to all the sensors except 1856_3F as far as indoor 'humidity' values are concerned. On the other hand, outdoor humidity is not at all correlated.

5.3 Co2

5.2.1 Indoor Co2 values relation with each other

A heat map of correlation is displayed below which gives an idea of correlation of all Co2 values of both the floors with each other.

Note: For example, in ‘Co2_d_1792_3F’: Co2 is for Co2, 1792 is for sensor’s last 4 digits and 3F is for third floor.



As expected, based on the correlation results, we can clearly see that all the sensors are strongly correlated to each other as far as 'Co2' is concerned except 1856_3F.

5.2.2 Indoor Co2 values in relation with Outdoor weather

Based on the analysis, the Outdoor weather is found to be weekly related to the co2 of indoor for both floors.

6. Incidents when the operational goals have not met

The given operation goal details are as follows:

Building operation goals for indoor air quality - winter months		
Type	Operation goal during work hours	Comment
Temperature	At or above 21°C	Sensors installed at ceiling height. Temperature at desk height is estimated to be 1.5°C lower than the recorded data.
Humidity	At or above 20 %	
CO2	At or below 1000 ppm	

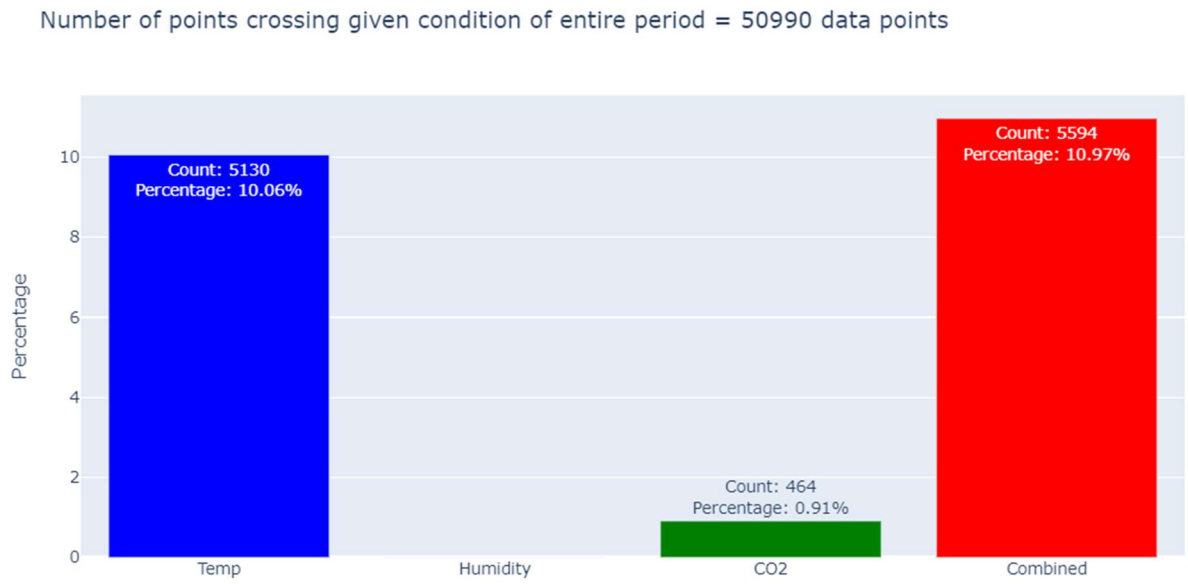
For temperature, the height is not specified. In the analysis, the assumption of temperature at desk height has been taken. A new column ‘temp_d’ has created which temperature at desk Hight calculated by this formula: temp_d = temp_c - 1.5, where temp_c is temperature at ceiling height.

6.1 Operational goal analysis 3rd Floor

6.1.1 Operational goal analysis 3rd Floor in all hours

A bar chart has been displayed below which provides details on the number of incidents where the data points are not in operational goals.

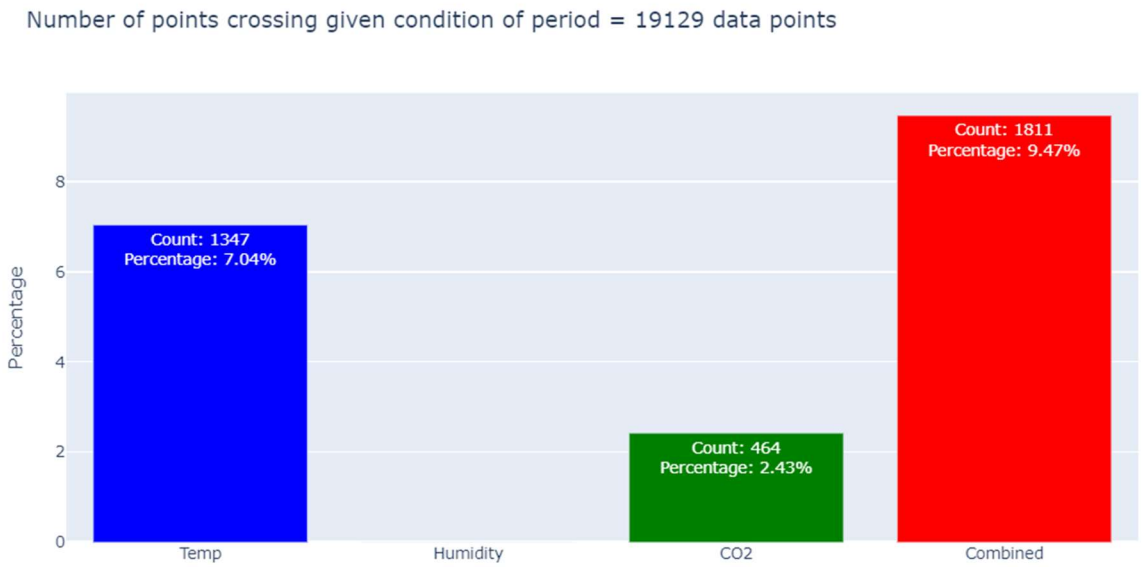
Temperature reading from the sensors contributing the most as far crossing the limit is concerned in 'Overall' time. It is followed by co2. There is no case of Humidity as far as crossing the limit is concerned.



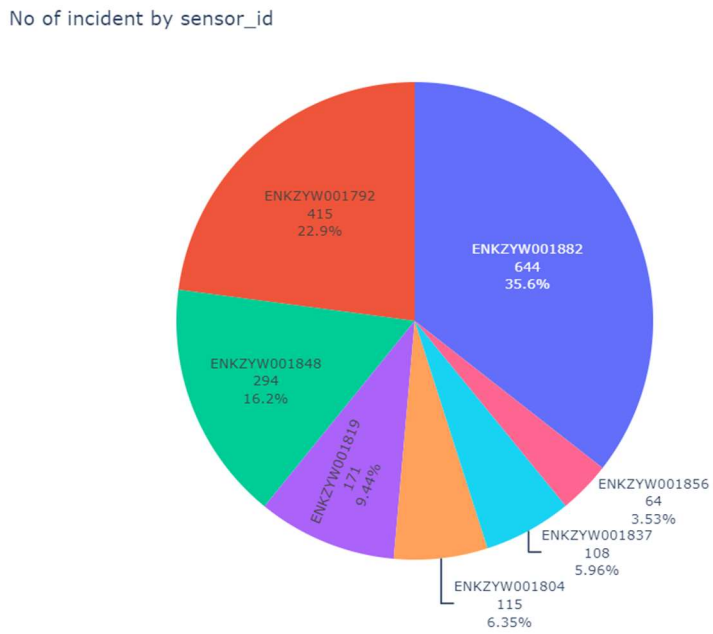
6.1.2 Operational goal analysis 3rd Floor in working hours

No working hours has been specified so an assumption of 9 AM to 5 PM has been taken. Based on the assumption, a bar plot is created which is displayed below.

Again, Temperature reading from the sensors contributing the most as far crossing the limit is concerned in 'Working hours'. It is followed by co2. Interestingly, all the points of co2 are from assumed 'Working hours' i.e. 9-5.



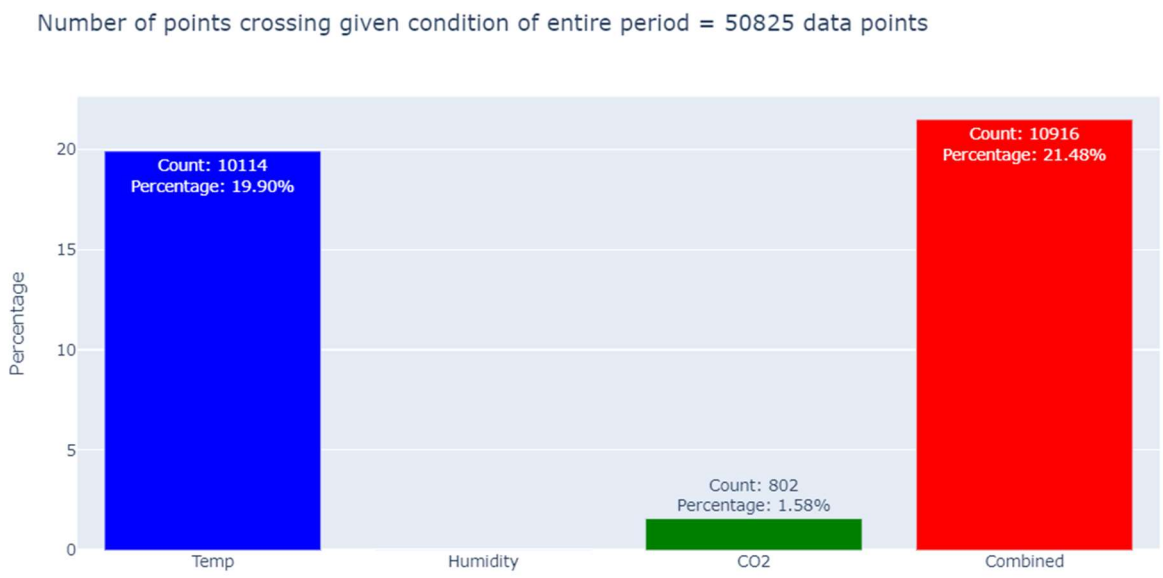
A Pie chart has also been displayed below which provide details on sensors that are contributing the most. As far as sensors are concerned, 'ENKZYW001882' with 35.6% is contributing the most followed by 'ENKZYW001792' with 22.9%.



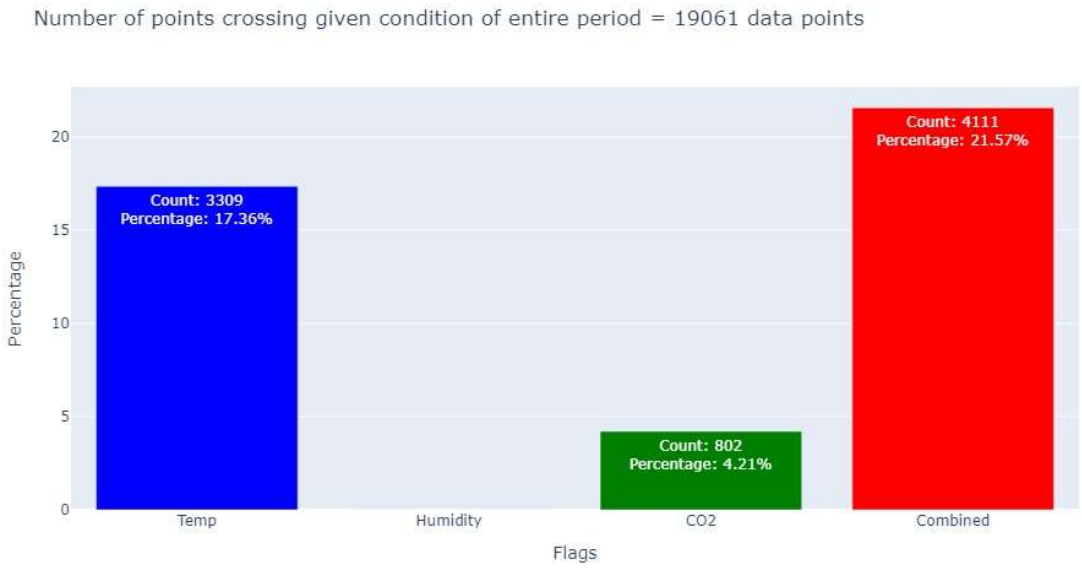
6.1.3 Operational goal analysis 4th Floor in all hours

A bar chart has been displayed below which provides details on the number of incidents where the data points are not in operational goals.

Temperature reading from the sensors contributing the most as far crossing the limit is concerned in 'Overall' time. It is almost double as compared to floor 3. It is followed by co2. There is no case of Humidity as far as crossing the limit is concerned.



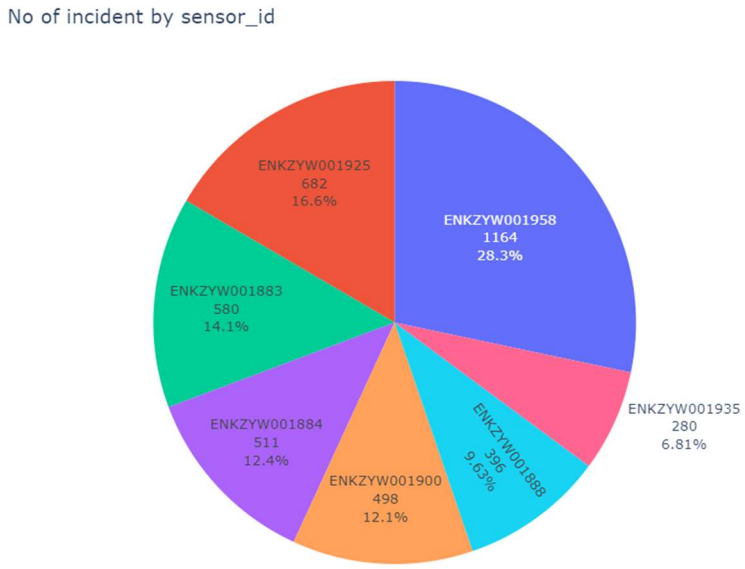
6.1.4 Operational goal analysis 4th Floor in working hours



No working hours has been specified so an assumption of 9 AM to 5 PM has been taken. Based on the assumption, a bar plot is created which is displayed below.

Again, Temperature reading from the sensors contributing the most as far crossing the limit is concerned in 'Working hours'. It is followed by co2. Interestingly, all the points of co2 are from assumed 'Working hours' i.e. 9-5.

A Pie chart has also been displayed below which provide details on sensors that are contributing the most. As far as sensors are concerned, 'ENKZYW001958' with 28.3% is contributing the most followed by 'ENKZYW001925' with 16.6%.



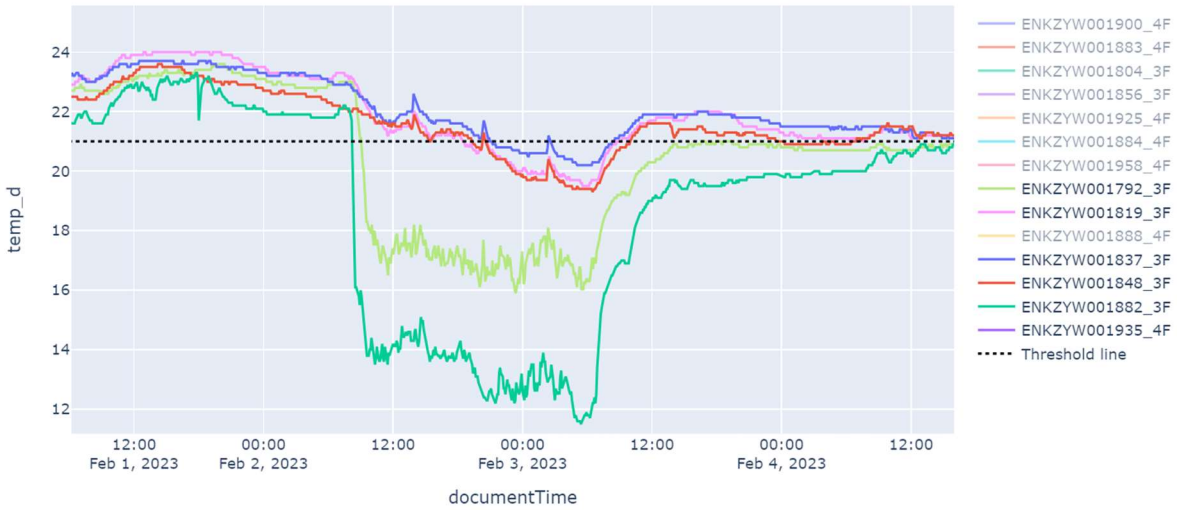
7. Anomalies/ Possible incidents

7.1 3rd floor

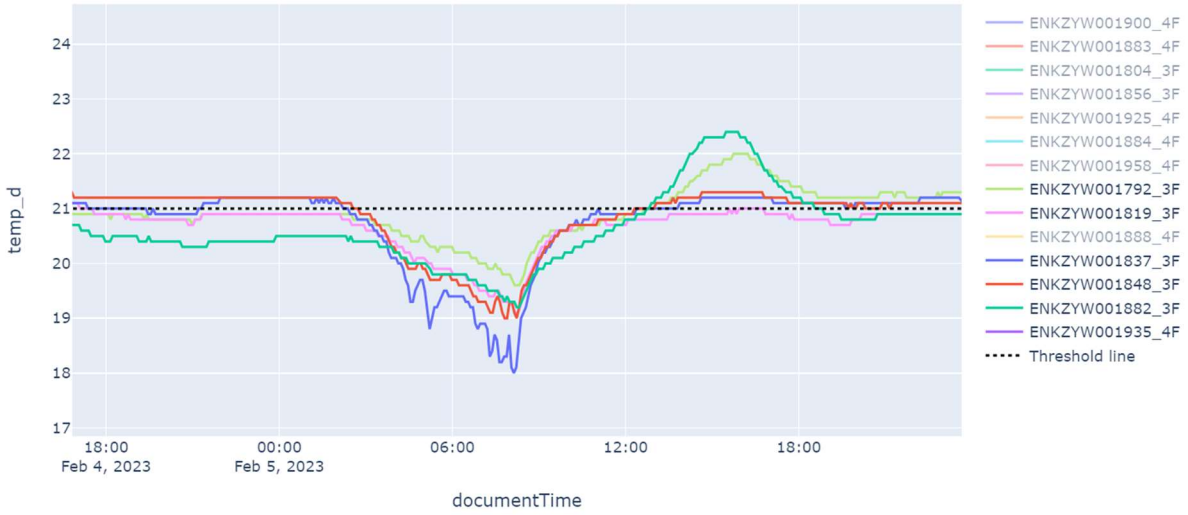
7.1.1 Temperature

There are some cases where the values seem to be anomalous. For 3rd floor, these are as follows:

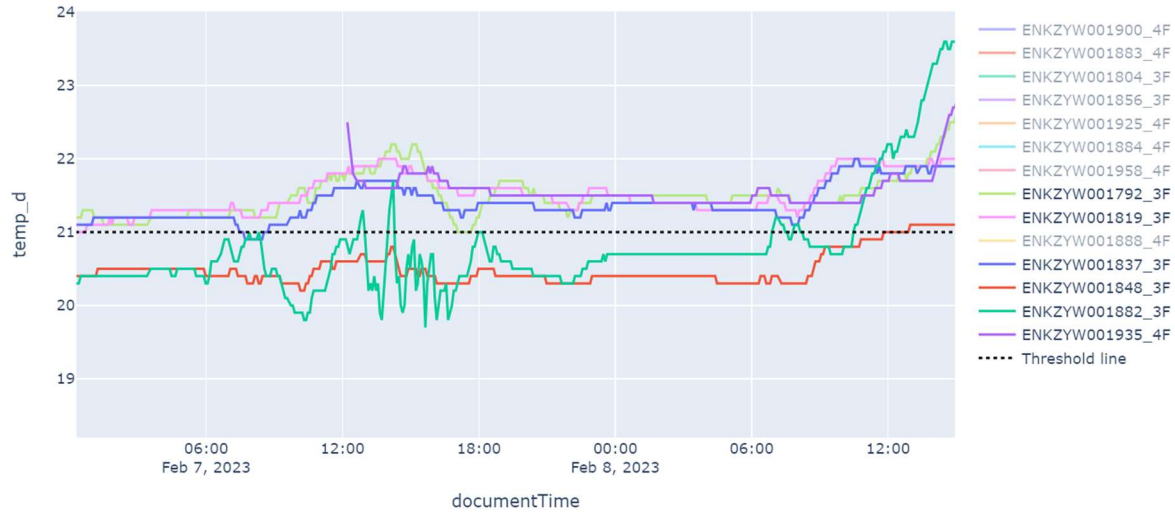
1. Feb 2- Feb 3: All the sensors showed a downward trend especially 'ENKZYW001882_3F' which reached around 11°C-13°C and 'ENKZYW001792_3F' which reached around 16-18. All other sensors, whose data is available, also crossed the temperature threshold from the Feb 2 evening to the next day's morning around 10 AM.



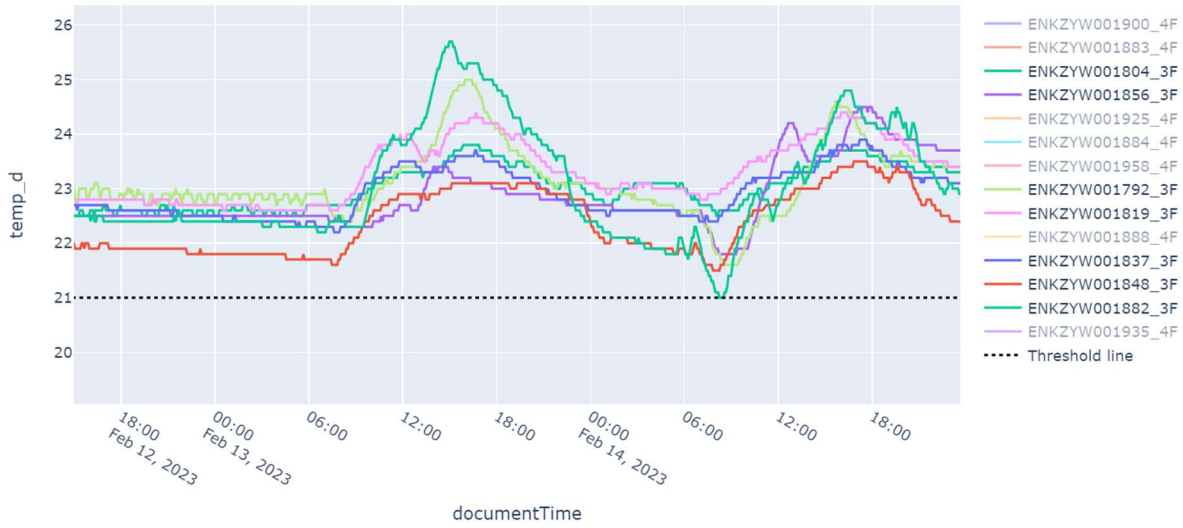
2. Feb 5 (2 AM - 1 PM): All the sensors showed a downward trend and crossed the temperature threshold.



3. Feb 7 - 8: Both 'ENKZYW001882_3F' and 'ENKZYW001848_3F' were out of the threshold most of the time. 'ENKZYW001882_3F' also showed high fluctuation around 11-5 on Feb 7. Interestingly both the sesnors are placed on the other side of the floor.



4. Feb 13 -14: All the sensors showed an upward trend, and some sensors reached their max value e.g. 'ENKZYW001882_3F' touch around 26.



5. Feb 16 -19: 'ENKZYW001856_3F' fell sharply from 25°C to 21°C and remained around 21°C till the end. Other sensors showed an upward trend, and some sensors reached their max value e.g. 'ENKZYW001882_3F' touching around 26.

7.1.2 Humidity

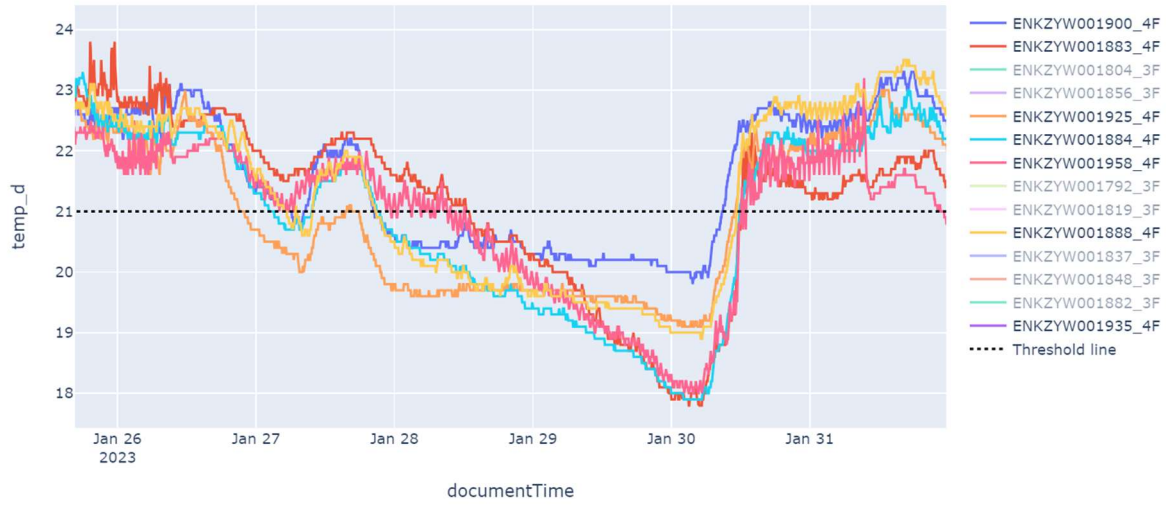
Feb2 - Feb4: All the values are going in upward direction with some sensors going high e.g. 1882_3F and '1792_3F'. Interestingly, around the same period temperature sensors in 3rd floor also showed anomalous trend. All the sensors showed a downward trend.

7.2 4th floor

7.2.1 Temperature

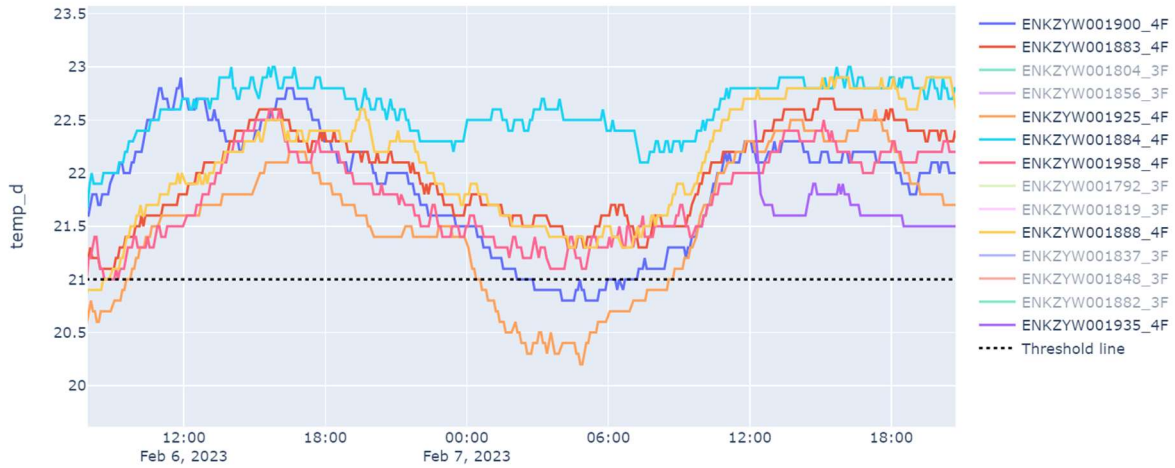
The cases are as follows:

1. Jan 29 - Jan 30: All the sensors showed a downward trend and crossed the temperature threshold.



2. Feb 1 - Feb 4: 'ENKZYW001958_4F' was below the threshold in this period and showed high fluctuation.

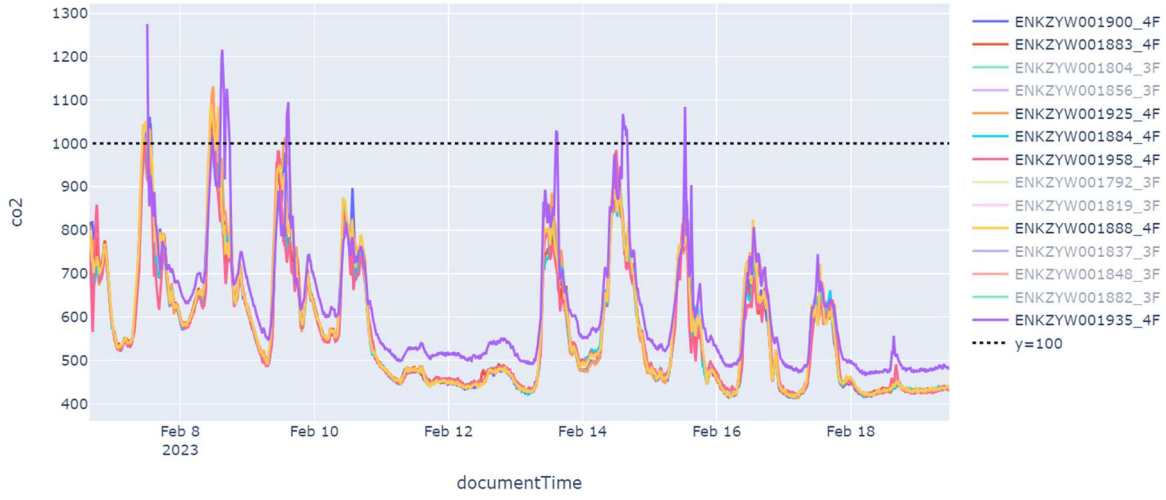
3. Feb 7: Earning morning, Feb 7 all the sensors went downward, with 'ENKZYW001900_4F' and 'ENKZYW001925_4F' crossing the threshold. Only 'ENKZYW001884_4F' went upwards which is unusual as it highly correlated with sensors '1888_4F', '1883_4F', '1935_4F', and '1958_4F'.



4. Feb 18 - Feb 19: All the sensors showed a downward trend and some sensors liek'ENKZYW001958_4F'," ENKZYW001883_4F', etc. crossed the threshold.

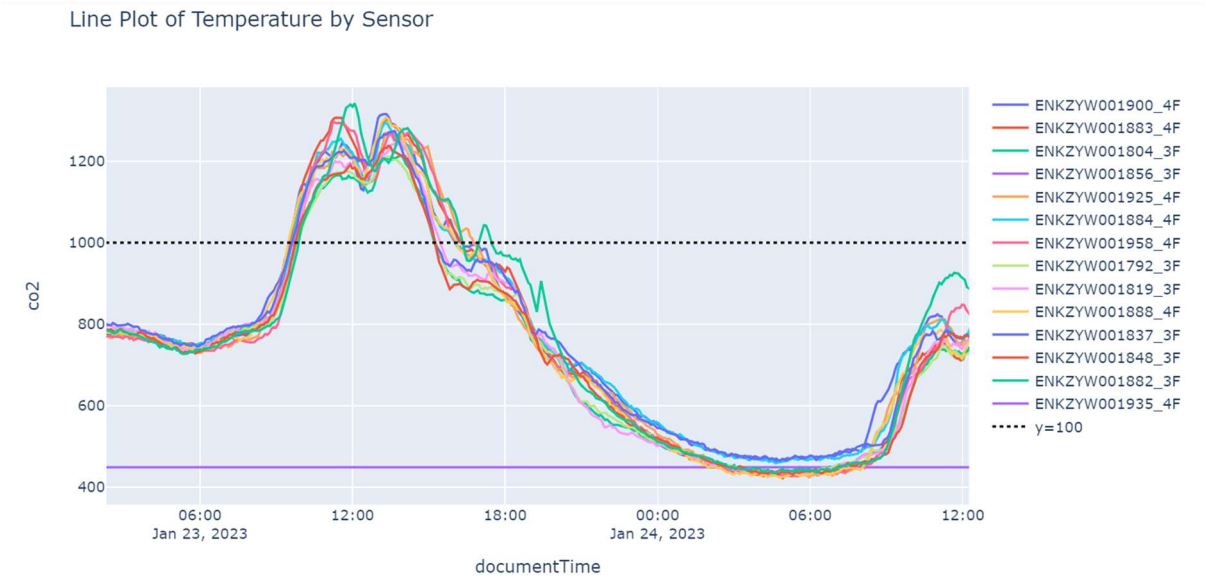
7.2.2 Co2

There are a couple of incidents where values are going above the threshold. For example, around Feb 7 and Feb 8, 1935_4, F1900_4F and 1888_4F are crossing the threshold.



7.3 Combined

One observation has been found, when Co2 values in all sensors, including both floors, are crossing the threshold. The values are going up in the morning of the 29th around 8-9 AM and crossing the threshold to reach quite a high value of 1200-1300. It started going downward around 2-3 PM.



8 Conclusion

In conclusion, this report has successfully addressed the key objectives outlined at its onset. Through meticulous examination and analysis, it has shed light on various aspects concerning the data quality, patterns, and trends within the realm of Internet of Things (IoT) data. The investigation delved into the presence of duplicate values, missing entries, and errors, while also identifying discernible patterns and trends across different sensors and floors. Additionally, the report explored external factors, such as outdoor weather, that could potentially influence IoT data. Furthermore, it highlighted instances where operational goals were not met and scrutinized possible anomalous behaviors within the dataset. By addressing these questions comprehensively, this report provides valuable insights essential for informed decision-making and effective management of IoT systems.

9 Recommendations

Based on the findings presented in this report, several recommendations can be proposed to enhance the management and utilization of Internet of Things (IoT) data:

1. Implement Data Quality Assurance Measures: Develop and implement robust data quality assurance processes to mitigate issues such as duplicate values, missing entries, and errors. Regular data cleansing and validation procedures should be established to ensure the integrity and reliability of the dataset.
2. Investigate all the mentioned anomalous regions and determine the factors responsible for them.
3. There have been instances where environmental readings have exceeded operational goals, posing potential risks, such as elevated CO2 levels surpassing safe thresholds for 5-6 hours on 29th January, which can impact people's health. To prevent such occurrences from recurring, it is imperative to install air purifiers to maintain optimal air quality and ensure the safety and well-being of individuals within the premises.
4. Enhance Sensor Monitoring and Maintenance: Based on the analysis, there could be some sensors that are not providing correct readings. For example, 'ENKZYW001882' on the 3rd floor was displaying extremely abnormal temperature and humidity values in certain instances. It is possible that the readings were inaccurate. Invest in continuous monitoring and maintenance of IoT sensors to ensure accurate and consistent data collection. Regular

calibration and upkeep of sensors can minimize discrepancies and improve the overall quality of the dataset.

5. Integrate External Data Sources: Incorporate more relevant external data sources, such as Higher occupancy and activity levels, into the analysis to better understand and account for potential factors that may influence IoT data variability.

Appendix

Appendix A

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Gaps found
Gap start: 2023-01-25 23:00:00+00:00 | Gap end: 2023-01-26 01:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-01-27 03:00:00+00:00 | Gap end: 2023-01-27 05:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-01-27 08:00:00+00:00 | Gap end: 2023-01-27 10:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-01-27 13:00:00+00:00 | Gap end: 2023-01-27 15:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-01-28 07:00:00+00:00 | Gap end: 2023-01-28 09:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-01-30 19:00:00+00:00 | Gap end: 2023-01-30 21:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-01-31 11:00:00+00:00 | Gap end: 2023-01-31 13:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-01-31 19:00:00+00:00 | Gap end: 2023-01-31 21:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-01 07:00:00+00:00 | Gap end: 2023-02-01 09:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-01 11:00:00+00:00 | Gap end: 2023-02-01 13:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-01 19:00:00+00:00 | Gap end: 2023-02-01 21:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-02 05:00:00+00:00 | Gap end: 2023-02-02 07:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-02 15:00:00+00:00 | Gap end: 2023-02-02 17:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-02 19:00:00+00:00 | Gap end: 2023-02-02 21:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-03 05:00:00+00:00 | Gap end: 2023-02-03 07:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-03 08:00:00+00:00 | Gap end: 2023-02-03 10:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-03 13:00:00+00:00 | Gap end: 2023-02-03 15:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-03 16:00:00+00:00 | Gap end: 2023-02-03 18:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-04 13:00:00+00:00 | Gap end: 2023-02-04 15:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-05 05:00:00+00:00 | Gap end: 2023-02-05 07:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-05 16:00:00+00:00 | Gap end: 2023-02-05 18:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-06 12:00:00+00:00 | Gap end: 2023-02-06 14:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-06 23:00:00+00:00 | Gap end: 2023-02-07 01:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-08 21:00:00+00:00 | Gap end: 2023-02-08 23:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-08 23:00:00+00:00 | Gap end: 2023-02-09 01:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-10 20:00:00+00:00 | Gap end: 2023-02-10 22:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-14 11:00:00+00:00 | Gap end: 2023-02-14 13:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-15 15:00:00+00:00 | Gap end: 2023-02-15 17:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-16 10:00:00+00:00 | Gap end: 2023-02-16 12:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-16 21:00:00+00:00 | Gap end: 2023-02-16 23:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-17 22:00:00+00:00 | Gap end: 2023-02-18 00:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-18 01:00:00+00:00 | Gap end: 2023-02-18 03:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-18 04:00:00+00:00 | Gap end: 2023-02-18 06:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-18 11:00:00+00:00 | Gap end: 2023-02-18 13:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-18 14:00:00+00:00 | Gap end: 2023-02-18 16:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-18 19:00:00+00:00 | Gap end: 2023-02-18 21:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-18 21:00:00+00:00 | Gap end: 2023-02-18 23:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-18 23:00:00+00:00 | Gap end: 2023-02-19 01:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-19 05:00:00+00:00 | Gap end: 2023-02-19 07:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-19 07:00:00+00:00 | Gap end: 2023-02-19 09:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-19 12:00:00+00:00 | Gap end: 2023-02-19 14:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-19 14:00:00+00:00 | Gap end: 2023-02-19 16:00:00+00:00 | Gap length: 0 days 02:00:00
Gap start: 2023-02-19 20:00:00+00:00 | Gap end: 2023-02-19 22:00:00+00:00 | Gap length: 0 days 02:00:00
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Appendix B

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ENKZYW001804_3F
Gaps found
Gap start: 2023-02-04 01:51:10+00:00 | Gap end: 2023-02-04 02:11:10+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-04 02:31:10+00:00 | Gap end: 2023-02-04 02:51:10+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-04 03:01:10+00:00 | Gap end: 2023-02-04 03:36:10+00:00 | Gap length: 0 days 00:35:00
Gap start: 2023-02-04 03:51:10+00:00 | Gap end: 2023-02-04 04:21:10+00:00 | Gap length: 0 days 00:30:00
Gap start: 2023-02-04 04:21:10+00:00 | Gap end: 2023-02-04 04:56:10+00:00 | Gap length: 0 days 00:35:00
Gap start: 2023-02-04 05:01:10+00:00 | Gap end: 2023-02-07 12:26:52+00:00 | Gap length: 3 days 07:25:42
Gap start: 2023-02-16 16:37:10+00:00 | Gap end: 2023-02-16 16:57:12+00:00 | Gap length: 0 days 00:20:02
Gap start: 2023-02-19 23:30:36+00:00 | Gap end: 2023-02-19 23:45:37+00:00 | Gap length: 0 days 00:15:01


ENKZYW001856_3F
Gaps found
Gap start: 2023-01-27 03:31:27+00:00 | Gap end: 2023-02-07 12:22:27+00:00 | Gap length: 11 days 08:51:00
Gap start: 2023-02-16 16:37:20+00:00 | Gap end: 2023-02-16 16:57:20+00:00 | Gap length: 0 days 00:20:00


ENKZYW001837_3F
Gaps found
Gap start: 2023-02-04 00:59:36+00:00 | Gap end: 2023-02-04 03:27:38+00:00 | Gap length: 0 days 02:28:02
Gap start: 2023-02-16 16:37:02+00:00 | Gap end: 2023-02-16 16:57:02+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-18 10:22:03+00:00 | Gap end: 2023-02-18 11:17:04+00:00 | Gap length: 0 days 00:55:01


ENKZYW001792_3F
Gaps found
Gap start: 2023-01-26 20:37:54+00:00 | Gap end: 2023-01-26 20:52:55+00:00 | Gap length: 0 days 00:15:01
Gap start: 2023-02-04 01:32:29+00:00 | Gap end: 2023-02-04 01:49:14+00:00 | Gap length: 0 days 00:16:45
Gap start: 2023-02-16 16:39:32+00:00 | Gap end: 2023-02-16 16:59:32+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-18 10:24:34+00:00 | Gap end: 2023-02-18 11:19:34+00:00 | Gap length: 0 days 00:55:00


ENKZYW001819_3F
Gaps found
Gap start: 2023-02-02 09:04:01+00:00 | Gap end: 2023-02-02 09:24:01+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-04 00:49:08+00:00 | Gap end: 2023-02-04 01:05:49+00:00 | Gap length: 0 days 00:16:41
Gap start: 2023-02-16 16:35:58+00:00 | Gap end: 2023-02-16 16:55:58+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-18 10:20:59+00:00 | Gap end: 2023-02-18 11:15:59+00:00 | Gap length: 0 days 00:55:00



ENKZYW001848_3F
Gaps found
Gap start: 2023-02-01 21:38:45+00:00 | Gap end: 2023-02-01 21:58:45+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-16 16:33:57+00:00 | Gap end: 2023-02-16 16:53:57+00:00 | Gap length: 0 days 00:20:00


ENKZYW001882_3F
Gaps found
Gap start: 2023-02-03 23:35:04+00:00 | Gap end: 2023-02-04 00:15:07+00:00 | Gap length: 0 days 00:40:03
Gap start: 2023-02-04 02:40:07+00:00 | Gap end: 2023-02-04 03:03:34+00:00 | Gap length: 0 days 00:23:27
Gap start: 2023-02-16 16:33:57+00:00 | Gap end: 2023-02-16 16:53:57+00:00 | Gap length: 0 days 00:20:00
```

ENKZYW001925_4F
Gaps found
Gap start: 2023-02-03 23:11:55+00:00 | Gap end: 2023-02-04 00:56:55+00:00 | Gap length: 0 days 01:45:00
Gap start: 2023-02-04 03:01:55+00:00 | Gap end: 2023-02-04 03:18:55+00:00 | Gap length: 0 days 00:17:00
Gap start: 2023-02-16 16:38:17+00:00 | Gap end: 2023-02-16 16:58:17+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-18 10:23:19+00:00 | Gap end: 2023-02-18 11:18:19+00:00 | Gap length: 0 days 00:55:00

ENKZYW001884_4F
Gaps found
Gap start: 2023-02-01 21:37:37+00:00 | Gap end: 2023-02-01 21:57:37+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-04 01:17:55+00:00 | Gap end: 2023-02-04 02:35:50+00:00 | Gap length: 0 days 01:17:55
Gap start: 2023-02-16 16:36:15+00:00 | Gap end: 2023-02-16 16:56:15+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-18 10:21:16+00:00 | Gap end: 2023-02-18 11:16:17+00:00 | Gap length: 0 days 00:55:01

ENKZYW001958_4F
Gaps found
Gap start: 2023-02-04 01:33:36+00:00 | Gap end: 2023-02-04 02:38:04+00:00 | Gap length: 0 days 01:04:28
Gap start: 2023-02-16 16:37:20+00:00 | Gap end: 2023-02-16 16:57:20+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-18 10:22:20+00:00 | Gap end: 2023-02-18 11:17:20+00:00 | Gap length: 0 days 00:55:00

ENKZYW001900_4F
Gaps found
Gap start: 2023-02-04 03:30:17+00:00 | Gap end: 2023-02-04 03:47:39+00:00 | Gap length: 0 days 00:17:22
Gap start: 2023-02-16 16:37:38+00:00 | Gap end: 2023-02-16 16:57:38+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-18 10:22:38+00:00 | Gap end: 2023-02-18 11:17:38+00:00 | Gap length: 0 days 00:55:00

ENKZYW001883_4F
Gaps found
Gap start: 2023-02-04 01:45:38+00:00 | Gap end: 2023-02-04 02:02:22+00:00 | Gap length: 0 days 00:16:44
Gap start: 2023-02-16 16:37:29+00:00 | Gap end: 2023-02-16 16:57:29+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-18 10:21:37+00:00 | Gap end: 2023-02-18 11:16:37+00:00 | Gap length: 0 days 00:55:00

ENKZYW001935_4F
Gaps found
Gap start: 2023-02-07 12:37:39+00:00 | Gap end: 2023-02-07 12:56:32+00:00 | Gap length: 0 days 00:18:53
Gap start: 2023-02-16 16:35:50+00:00 | Gap end: 2023-02-16 16:55:50+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-18 10:20:52+00:00 | Gap end: 2023-02-18 11:15:52+00:00 | Gap length: 0 days 00:55:00

ENKZYW001888_4F
Gaps found
Gap start: 2023-02-04 02:24:11+00:00 | Gap end: 2023-02-04 02:39:59+00:00 | Gap length: 0 days 00:15:48
Gap start: 2023-02-16 16:35:05+00:00 | Gap end: 2023-02-16 16:55:05+00:00 | Gap length: 0 days 00:20:00
Gap start: 2023-02-18 10:25:06+00:00 | Gap end: 2023-02-18 11:15:06+00:00 | Gap length: 0 days 00:50:00