Temperature, Relative Humidity, and Carbon Dioxide Data Science Analysis for a Highrise Office Building

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ABSTRACT

The goal of occupational health and safety (OHS) is to safeguard the health and safety of employees by preventing workplace diseases and accidents. An OHS used parameters, some of which could be captured via sensors, and it became a significant concern in social sustainability. These variables include things like temperature, noise level, and air quality. This research aims to perform data science analysis on the temperature, relative humidity, and carbon dioxide levels. Tried to read and comprehend the sensor data and learn the trends based on actual and typical data. This research used a quantitative approach to collect preliminary information via sensor observations and descriptive measures. Secondary data were used as a source of information during the literature review to support this research. Three office environment data were successfully captured and analyzed. Room temperature decreased during office hours and office days, but on average, it was still acceptable for a day or a month of data. Relative humidity was found in 64.24% for both sample and population data. Also, for carbon dioxide, it was found an average of 580.29 ± 132.53 ppm.

Keywords: *Carbon dioxide, Data Science, Humidity, Sensor, Temperature.*

ABSTRAK

Tujuan Kesehatan dan Keselamatan Kerja (K3) adalah untuk menjaga kesehatan dan keselamatan karyawan dengan mencegah penyakit dan kecelakaan di tempat kerja. K3 menggunakan parameter, beberapa di antaranya dapat ditangkap dengan sensor, dan menjadi perhatian yang signifikan dalam keberlanjutan sosial. Beberapa variabel ini seperti suhu, tingkat kebisingan, dan kualitas udara. Penelitian ini bertujuan untuk melakukan analisis data ilmiah terhadap suhu, kelembaban relatif, dan kadar karbon dioksida. Mencoba membaca dan memahami data sensor dan mempelajari tren berdasarkan data aktual dan tipikal data. Penelitian ini menggunakan pendekatan kuantitatif untuk mengumpulkan informasi awal melalui pengamatan sensor dan pengukuran deskriptif. Data sekunder digunakan sebagai sumber informasi selama tinjauan literatur untuk mendukung penelitian. Tiga data lingkungan kantor berhasil ditangkap dan dianalisis. Suhu ruangan menurun pada jam kerja dan hari kerja, namun rata-rata masih dapat diterima untuk data sehari atau sebulan. Kelembaban relatif ditemukan sebesar 64,24% baik untuk data sampel maupun populasi. Juga, untuk karbon dioksida, ditemukan rata-rata 580,29 ± 132,53 ppm.

Kata kunci: *Data Ilmiah, Karbondioksida, Kelembaban, Sensor, Temperature*

1. INTRODUCTIONS

OHS is a set of practices that aims to protect workers' health and safety by preventing occupational diseases and accidents [1]. There were parameters used in an OHS where some of them can be captured by using sensors, and an OHS has become an essential issue in the scope of social sustainability [2]. These parameters are air quality [3], temperature [4], noise [5], and others. Air quality [6] is one of the vital parameters, some information related to outdoor air quality in Indonesia, especially in Jakarta, can be found on the Internet website [7] or through mobile phone applications [8], [9].

Regulation on this to protect employee health and safety [10] also has been made and needs to be implemented. Related parameters have been defined, including how to measure them. How to configure the sensors and capture the data appropriately was the problem due to lack of experience. Reading and analyzing a massive amount of data requires experience in how to do data preprocessing [11].

This research aims to do a data science analysis of the temperature, relative humidity, and carbon dioxide. Tried to read and understand the data captured from the sensors and learn the trends based on actual and average data. How to do the research methodology is explained in the following section.

2. RESEARCH METHODOLOGY

This research used a quantitative method, with primary data gathered from a sensor observation and descriptive measurements, similar to the previous research [12]—secondary data was used as a reference during the literature study to support these research activities. The data population collected was a month of data gathered from the sensor device, and sample data used was a day (24 hours data). Then these population and sample data were analyzed to find conclusions.

Research preparations with fellow researchers happened one month before the research began. Figure 1 shows research activities:

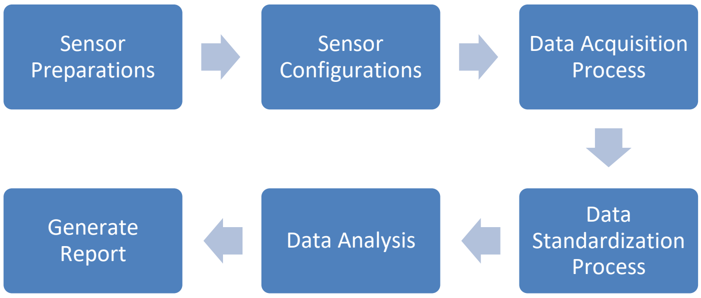


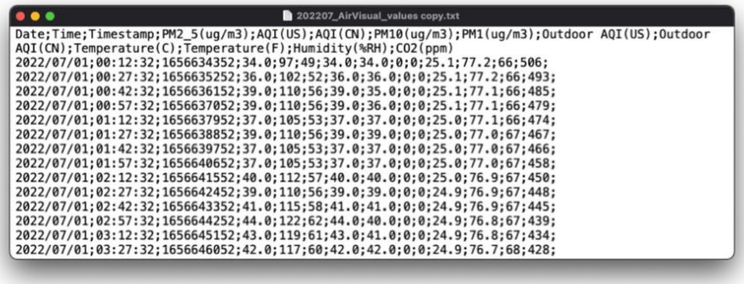
Figure 1. Research Activities

The sensor used for this research was IQAir AirVisual Pro [8]. The sensor was placed indoors for more than 10 meters above ground, and it was above the 5th floor of the building. Specifically, it was on the standard office desk in the working environment cubicle in South Jakarta - Indonesia. The sensor was plugged into the electrical power 24 hours a day and seven days a week to make this sensor up and running during the research processes.

The sensor was configured; a supporting mobile app was installed in a personal mobile handheld for monitoring sensor activities. This sensor was then connected to a small network router to relocate captured data from the sensor to a computer for analysis and sensor activity monitoring previously mentioned. The sensor device was also configured to capture data every 15 minutes.

Data acquisition processes were in July 2022 for a month, starting from date 1 in the very early morning to date 31 close to midnight. Data was stored in the sensor device as a text file (.txt) in comma-separated value format. This file was relocated to a personal computer via a wireless network [13] for further analysis.

The sensor captured various data, and only three were used in this research, they were temperature (^{O}C), relative humidity (%RH), and carbon dioxide (CO_2). There were 3,272 rows of data captured in July 2022 from date 1 to date 31. The following Figure 2 shows how the text data look like:



202207_AirVisual_values copy.txt

```
Date;Time;Timestamp;PM2_5(ug/m3);AQI(US);AQI(CN);PM10(ug/m3);PM1(ug/m3);Outdoor AQI(US);Outdoor
AQI(CN);Temperature(C);Temperature(F);Humidity(%RH);CO2(ppm)
2022/07/01;00:12:32;1656634352;34.0;97;49;34.0;34.0;0;0;25.1;77.2;66;506;
2022/07/01;00:27:32;1656635252;36.0;102;52;36.0;36.0;0;0;25.1;77.2;66;493;
2022/07/01;00:42:32;1656636152;39.0;110;56;39.0;35.0;0;0;25.1;77.1;66;485;
2022/07/01;00:57:32;1656637052;39.0;110;56;39.0;36.0;0;0;25.1;77.1;66;479;
2022/07/01;01:12:32;1656637952;37.0;105;53;37.0;37.0;0;0;25.0;77.1;66;474;
2022/07/01;01:27:32;1656638852;39.0;110;56;39.0;39.0;0;0;25.0;77.0;67;467;
2022/07/01;01:42:32;1656639752;37.0;105;53;37.0;37.0;0;0;25.0;77.0;67;466;
2022/07/01;01:57:32;1656640652;37.0;105;53;37.0;37.0;0;0;25.0;77.0;67;458;
2022/07/01;02:12:32;1656641552;40.0;112;57;40.0;40.0;0;0;25.0;76.9;67;450;
2022/07/01;02:27:32;1656642452;39.0;110;56;39.0;39.0;0;0;24.9;76.9;67;448;
2022/07/01;02:42:32;1656643352;41.0;115;58;41.0;41.0;0;0;24.9;76.9;67;445;
2022/07/01;02:57:32;1656644252;44.0;122;62;44.0;40.0;0;0;24.9;76.8;67;439;
2022/07/01;03:12:32;1656645152;43.0;119;61;43.0;41.0;0;0;24.9;76.8;67;434;
2022/07/01;03:27:32;1656646052;42.0;117;60;42.0;42.0;0;0;24.9;76.7;68;428;
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Figure 2. Raw Data Screenshot from Sensor

These rows of data were then standardized after the import process to the spreadsheet for analysis purposes. Some data imported in the column must be converted into numerical for calculations. Some parts of data were also required to convert from dot (.) to comma (,) as decimal since the spreadsheet configuration used local reference. The data analysis process was then explained in the following section, and the report was also generated once this research manuscript had been completed.

3. RESULTS AND ANALYSIS

After a month of the data acquisition, the data was in a spreadsheet. Day-to-day regular sequences were then identified. The room's central air conditioner was activated in the morning during office hours and deactivated after office hours. The air conditioner was also not operated during weekends, except for office activities. Since the activities inside the room were regular, then day 1 with 117 rows of data as a sample taken from the rest of the 31 days of population data.

The first data analyzed from the captured data was temperature. The temperature in Celsius is then put in a line chart to see the flow. Figure 3 shows that the temperature went down in the morning during office hours since the air conditioner was activated. The temperature also increased after office hours once the air conditioner was deactivated.

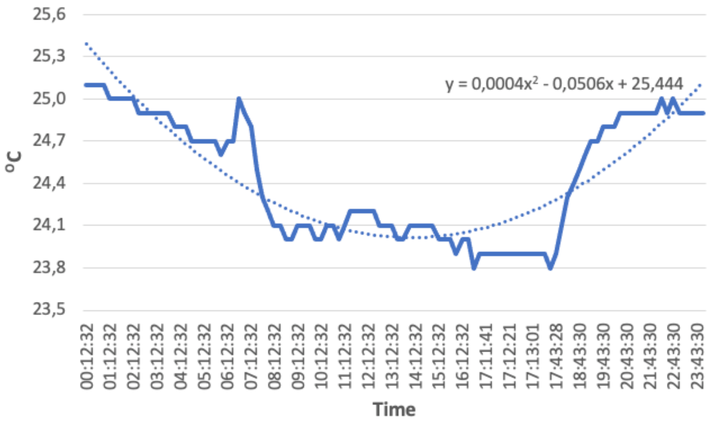

Figure 3. 1-Month Temperature Sample Data

Figure 3 shows a polynomial [14] trend generated in the chart to find the curve trend. This curve was then represented in the following equation 1:

$$y = 0.0004x^2 - 0.0506x + 25.444 \quad (1)$$

Next was the relative humidity. Humidity increased in the early morning and decreased significantly during office hours. Around 5 pm, the humidity slowly increased again, as shown on the following Figure 4:

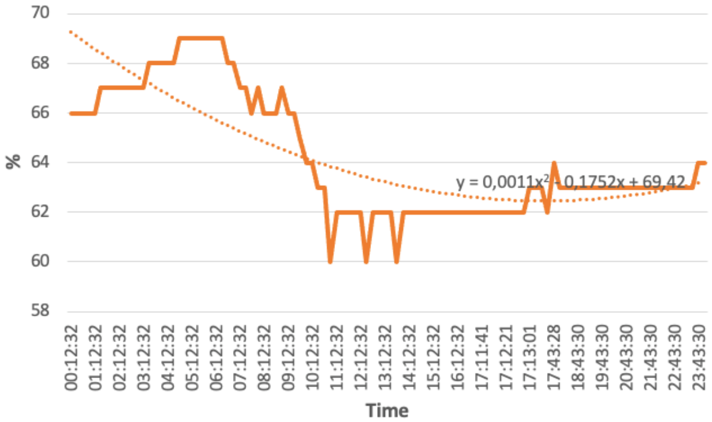

Figure 4. 1-Month Relative Humidity Sample Data

Similar to before, a polynomial trend was generated to find the curve trend based on Figure 4. This curve was different compared with the last and represented in the following equation 2:

$$y = 0.0011x^2 - 0.1752x + 69.42 \quad (2)$$

Then these temperature and relative humidity lines were put in the same chart to see the trend in a day. Figure 5 shows that both temperature and relative humidity decreased during office hours and that humidity required some time to decrease and increase compared with temperature.

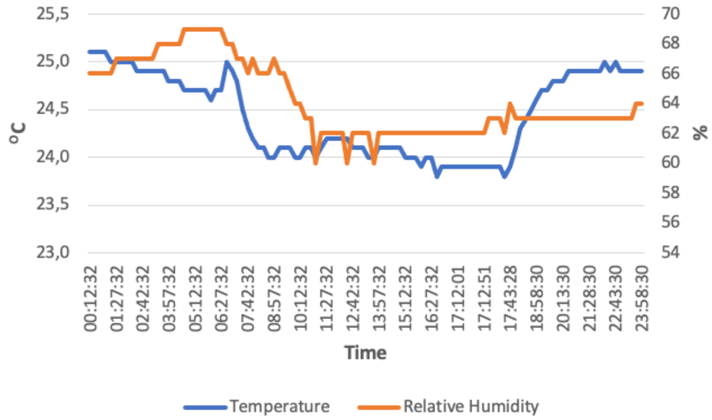

Figure 5. 1-Month Temperature and Relative Humidity Sample Data Comparisons

Carbon dioxide was the last for analysis. Carbon dioxide value was at its lowest at 6 am and started to increase the office hour and decreased again after the office hours around 5 pm. This carbon dioxide range value was still acceptable to humans [15], and its trends are shown in the following Figure 6:

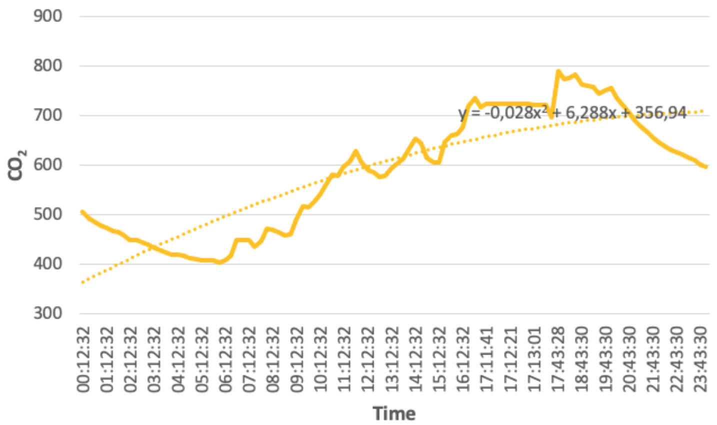

Figure 6. 1-Month Carbon Dioxide Sample Data

These parameters (temperature, relative humidity, and carbon dioxide) were then compared between the sample and the entire month's population data to learn their similarity and differences. The data has been compiled and shown on the following Table 1:

Table 1. Average Sample Data vs. Population Data

	Temperature (°C)	Relative humidity (%RH)	Carbon Dioxide (CO_2 ppm)
Sample Data Day-1	24.44 ± 0.43	64.24 ± 2.51	587.05 ± 120.48
Population Data Day-1 to Day 31	25.37 ± 1.07	64.24 ± 3.23	580.29 ± 132.53

Table 1 shows that the temperature for the 1st of June had the whole day of temperature was 24.44 °C with a standard deviation for the sample of about 0.43; this was not much. The relative humidity was 64.24%, with a standard deviation of 2.51%. Carbon dioxide on the 1st of June was 587.05 ± 120.48 ppm, which was still in acceptable condition.

In the broader month of June, 24/7 and every 15 minutes of data acquisition, the room temperature average was 25.37 ± 1.07 ºC, higher than 0.93 ºC compared with only a day of data. Surprisingly, for relative humidity average was the same for both, 64.24%; this was still in the ideal range with the standard deviation of 3.23%—carbon dioxide for a month of data was found to be lower at 6.76 ppm, which was great.

4. CONCLUSIONS AND RECOMMENDATIONS

Three office environment data were successfully captured and analyzed. Room temperature decreased during office hours and office days because of the centralized air conditioner, but on average, it was still acceptable for a day or a month of data. Relative humidity was found in 64.24% for both sample and population data. Also, carbon dioxide was found in an average of 580.29 ppm with a 132.53 standard deviation. These measurement approaches were suitable for supporting the OHS. Future work can be done by using minor time frequency with endless streamlined data to be shown on the dashboard for evaluations and assessments.

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