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Relationship of $PM_{2.5}$ Value between Rain-No Rain & Indoor-Outdoor on Occupational Health and Safety Information System Development (Study Case in East Bekasi, West Java - Indonesia)

Tika Endah Lestari [1*], Wandy Wandy[2]
[1]Industrial Engineering, Sampoerna University, South Jakarta 12780, Indonesia
[2]Doctoral Program of Information System, Diponegoro University, Semarang 50275, Indonesia
[1]tika.lestari@sampoernauniversity.ac.id, [2]wandy@students.undip.ac.id

Abstrak

Kualitas udara merupakan hal penting untuk diukur baik di situasi dalam maupun luar ruangan, dan kualitas udara ini berhubungan dengan manusia. Kesehatan dan Keselamatan Kerja adalah operasi efisien dari suatu tugas yang secara signifikan mempengaruhi tingkat keselamatan dan kenyamanan di lingkungan kerja. Adalah keadaan kesehatan yang bertujuan agar lingkungan kerja memperoleh kesehatan jasmani, rohani, dan sosial yang setinggi-tingginya untuk mencegah dan mengobati penyakit atau gangguan kesehatan. Penelitian ini bertujuan untuk menganalisis apakah data $PM_{2.5}$ yang ditangkap oleh sensor dalam beberapa situasi, ketika direkam ke basis data, valid untuk ditampilkan dalam grafik dan tipe data yang sesuai ketika data ditampilkan di dasbor. Keadaan hujan dapat menurunkan nilai $PM_{2.5}$ baik dalam maupun luar ruangan dan pada kasus ini penggunaan $PM_{2.5}$ di Bekasi Timur pada kondisi dalam ruangan memiliki nilai yang lebih rendah dibandingkan luar ruangan. Sistem pakar atau sistem pendukung keputusan dapat diimplementasikan untuk pengembangan dasbor di masa mendatang guna menampilkan dasbor cerdas untuk situasi Hujan-Tak Hujan dan Dalam-Luar Ruangan ini. Data dari sensor dapat ditampilkan sebagai tipe data Integer tanpa desimal, tetapi selama analisis, data memerlukan nilai desimal untuk rata-rata, standar deviasi, dan tren $PM_{2.5}$. Sebuah bagan pengukur akan sesuai untuk data waktu-nyata, dan bagan batang/garis akan baik untuk data historis.

Kata kunci: Dalam-Luar Ruangan, Dasbor, Hubungan, Hujan-Tak Hujan, $PM_{2.5}$.

Abstract

Air quality is vital to be measured for indoor and outdoor situations, and this air quality relates directly to humans. Occupational Health and Safety is the efficient operation of a task that significantly influences the level of safety and comfort of a working environment. It is a health condition that aims to make the working environment obtain the highest physical, spiritual, and social health to prevent and treat diseases or health problems. This research aimed to analyze whether the PM2.5 data grabbed by the sensor in several situations, when recorded to the database, are valid to be displayed in an appropriate chart and data type when the data is shown on the dashboard. The Rain situation can reduce the PM2.5 value both Indoor and Outdoor, and in East Bekasi, Indoor PM2.5 has a lower value than Outdoor. An expert system or decision support system can be implemented for future dashboard development to show an intelligent dashboard for these Rain-No Rain and Indoor-Outdoor situations. The data from the sensor may show as an Integer data type without the decimal, but during the analysis, the data required decimal values for average, standard deviation, and PM2.5 trends. A gauge chart will be appropriate for real-time data, and a bar/line chart will be good for historical data.

Keywords: *Dashboard, Indoor-Outdoor, PM2.5, Rain-No Rain, Relationship.*

1. INTRODUCTION

Air quality is vital to be measured for indoor and outdoor situations, and this air quality relates directly to humans. Particulate matter 2.5 ($PM_{2.5}$) is typically 2.5 micrometers or smaller fine inhalable particles (*AQI Basics | AirNow.Gov*, n.d.); this pollutant is 1 of 5 significant pollutants for the US Air Quality Index (Empowering the World to Breathe Cleaner Air | IQAir, n.d.). In Indonesia, seven parameters are used for the quality index (Wandy et al., 2022), and both use $PM_{2.5}$. This pollutant value is also related to wind speed (Ścibor et al., 2020), causes long-term health effects, and must be regulated and monitored (Miller & Xu, 2018).

Occupational Health and Safety is the efficient operation of a task that significantly influences the level of safety and comfort of a working environment. It is a health condition that aims to make the working environment obtain the highest physical, spiritual, and social health to prevent and treat diseases or health problems. This task is also supported by equipment that is fit for use and does not endanger workers (Sister et al., 2021). An information system will later be generated with a dashboard page, where this dashboard will have parameters to be shown in real-time or historical value for analysis purposes.

This research aimed to analyze whether the $PM_{2.5}$ data grabbed by the sensor in the rain-no rain situation and indoor-outdoor location. When recorded to the database, they are valid and can be displayed in an appropriate chart and data type when the data is shown on the dashboard.

A dashboard page is essential in an information system; it can show relevant and representative data in charts or other formats. Some aspects of a dashboard page development, such as screen size, layouts, and colors, may be considered (Wandy et al., 2022). This dashboard will only have one page with detailed information inside the Occupational Health and Safety Information System, where the development processes may follow to match the decision-making (Valks et al., 2021). The dashboard page must be helpful for the users and shows information only based on login authentication.

2. RESEARCH METHODOLOGY

In this quantitative study, primary data was used and kept track of for two months. Descriptive information and non-probability sampling were also utilized in this study. Data from the exact location was also used for the research data acquisition.

1.1. Research Preparations

Research preparations started a month before December 2021, when it started to rain in Jakarta and its surroundings, including East Bekasi. Some preparations were made for this research, starting from location, a sensor used, a human resource, and technology used for data acquisition. The location chosen was Setu District, East Bekasi, West Java - Indonesia because this place had potential due to many factories, warehouses, and other types of businesses.

A sensor used in this research was Xiaomi Mijia Smartmi Air Detector, which was stable and used in previous research. One additional person was involved in helping with the data acquisition, starting by activating the sensor, reading the $PM_{2.5}$ value, and then filling it in an electronic form. A Microsoft Form was chosen to support this research due to the software subscription by the institution.

1.2. Data Acquisitions

The research period was two months, from December 2021 to January 2022, in East Bekasi, West Java – Indonesia. Data was captured using a $PM_{2.5}$ sensor through observation and then stored manually using Microsoft Form using a mobile phone Internet browser. This information was later exported in a Spreadsheet. Figure 1. shows how the data acquisition flowchart represents the process of collection of the data.

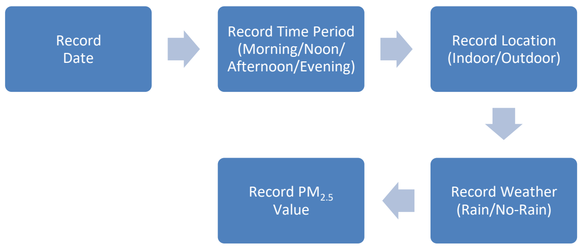

Figure 1. Data Acquisition Process

The date was recorded automatically from the Microsoft Form, and the date was date/month/year in dd/mm/yyyy format. The time was recorded where morning time was covered from 04:01-10:00, noon covered from 10:01-14:00, afternoon covered from 14:01-18:30, and evening 18:31-04:00. The period was in drop-down menu format for easier input.

The location was also recorded with only two options, and they were Indoor and Outdoor. Location in Microsoft Form was also in the drop-down menu. Similar to the location, the Rain-No Rain situation was recorded in drop-down format. $PM_{2.5}$ value was recorded using a sensor with the same condition as former research (Wandy et al., 2021). The sensor must be activated 1 meter above ground and wait 30 seconds before recording.

After two months, the result was extracted from Microsoft Form and downloaded in CSV format. There were 492 records recorded, and sample 16 records for two days are shown in the following Table 1:

Table 1. Recorded Sample 2 Days Indoor-Outdoor Data

Date	Period	Location	Weather	$PM_{2.5}$
12/1/21	Morning	Indoor	No-Rain	79
12/1/21	Morning	Outdoor	No-Rain	41
12/1/21	Noon	Indoor	No-Rain	16
12/1/21	Noon	Outdoor	No-Rain	12
12/1/21	Afternoon	Indoor	No-Rain	37
12/1/21	Afternoon	Outdoor	No-Rain	5
12/1/21	Evening	Indoor	No-Rain	88
12/2/21	Evening	Outdoor	No-Rain	68
12/2/21	Morning	Indoor	No-Rain	19
12/2/21	Morning	Outdoor	No-Rain	13
12/2/21	Noon	Indoor	No-Rain	45
12/2/21	Noon	Outdoor	No-Rain	10
12/2/21	Afternoon	Indoor	No-Rain	69
12/2/21	Afternoon	Outdoor	No-Rain	62
12/2/21	Evening	Indoor	No-Rain	37
12/2/21	Evening	Outdoor	No-Rain	44

As shown in Table 1, five values were recorded during the observation. The Date, Period, Location, and Weather are clear to understand, and for $PM_{2.5}$ value was recorded in µgram/m^3. There were four records missed from these totals of 492 records. These records were missed because the data was manually inputted into the Microsoft Form.

Table 2. Data Quantity

		Day	# of data	Total
Ideal	Dec 2021	31	124	248
	Jan 2022	31	124	248
Total				**496 (100%)**
Actual	Dec 2021	31	124	248
	Jan 2022	31	120	244
Total				**492 (99.19%)**

Table 2 shows that 492 data were successfully recorded out of the ideal 496 opportunities to record the data on December 2021 and January 2022. The 99.19% data quantity from the observation was valid to be used for this research analysis.

3. RESULT AND DISCUSSION

Weather conditions were the first to be analyzed to understand these two months of weather with options of Rain and No-Rain situations. Table 3 shows the result with the percentage value:

Table 3. Weather Conditions

		December 2021	January 2022
Rain	Value	40	46
	Percentage	16.13%	18.85%
No-Rain	Value	208	198
	Percentage	83.87%	81.15%

During these two months of observation, No-Rain conditions were in the majority. In December 2021, 83.87% were in the No-Rain situation, and 81.15% were also No-Rain in January 2022. In December 2021 and January 2022, rainy conditions were less than 19%, and there was a 2.72% rain increase from December 2021 to January 2022. This inclining situation gave a more exact comparison value between Rain-No Rain in these two months. Even though December 2021 to January 2022 was not the top of the rainy season in Indonesia (Prasetyaningtyas, 2021), the peak of the rainy season was January and February 2022.

Briefly, the entire $PM_{2.5}$ value was shown on following Figure 2, where all data was found very scattered since day 1; this was because the data capturing processes were taken from various periods (morning, noon, afternoon, evening):

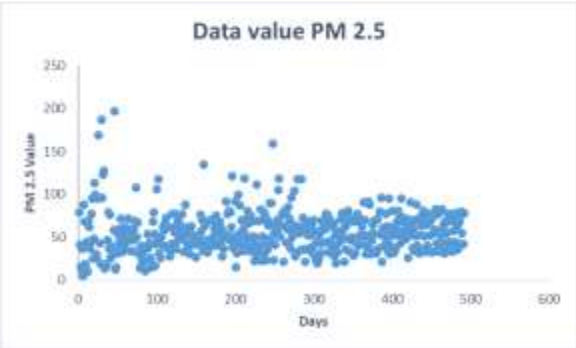

Figure 2. $PM_{2.5}$ Data

Rain and No-Rain conditions were then compared with Indoor and Outdoor locations to find the correlation between these two aspects. Data from the data set were grouped based on December 2021 and January 2022, then grouped again into Rain and No-Rain. After that grouped into Indoor and Outdoor locations. $PM_{2.5}$ average value was then found with the Formula 1 below:

$$\bar{x} = \frac{\sum x}{N} \qquad \text{...............} (1)$$

With the same group as the average, the standard deviation was calculated to support the average value to analyze the variation of the value. In this case, the standard deviation for the population was used. Formula 2 below shows how the standard deviation was calculated:

$$\sigma = \sqrt{\frac{\sum (xi - \bar{x})^2}{N}} \qquad \text{...............} (2)$$

The average and standard deviation were found based on these two formulas. Then the result was put on the table with primary columns as December 2022 and January 2022, also rows as Indoor and Outdoor, grouped by Rain and No-Rain. The relationship between location and weather conditions is shown in the following Table 4.

Table 4. $PM_{2.5}$ Average Value Overview

		Dec 2021	Jan 2022
Rain	Indoor	36.75 ± 12.50	36.57 ± 13.56
	Outdoor	47.05 ± 22.96	59.57 ± 11.79
No-Rain	Indoor	47.73 ± 22.59	44.69 ± 12.83
	Outdoor	64.68 ± 33.23	72.30 ± 14.15

Table 4 shows the average and population standard deviation for $PM_{2.5.}$ Indoor and Outdoor standard deviation values are enormous both in December 2021 and January 2022; this was because the period for data acquisition is vast from morning to evening. Also, the value for outdoor locations shown in red was higher than indoors in Rain and No-Rain situations.

This result was similar to other research where outdoor $PM_{2.5}$ value was higher than indoor (Ouyang et al., 2020) but has a different perspective from another report (IQAir, 2021) and research (Tofful et al., 2020) that showed vice versa, where indoor higher than outdoor.

Here the average and population standard deviation for $PM_{2.5}$ are displayed. For Indoor and Outdoor, standard deviation values are enormous both in December 2021 and January 2022; this was because the value for outdoor locations shown in red was higher than indoors in Rain and No-Rain situations.

Also displayed in Table 4 is that the Rain related to $PM_{2.5}$ value was also lower compared to the No-Rain situation; this means that the Rain can reduce the number of $PM_{2.5}$ in the air. Even though the Rain condition was higher in January 2022 by 2.72%, the outdoor $PM_{2.5}$ value was also increased by 12.52%; this has a different condition from the Indoor, where the increment of the Rain makes the $PM_{2.5}$ value decrease, even though it was not that significant (0.18%).

Similar to Table 4, Table 5 shows the $PM_{2.5}$ value with more details in the period for comparison purposes. Here the period divided into four that have been previously mentioned, they were: morning, noon, afternoon, and evening.

Table 5. $PM_{2.5}$ Average Value Distributions

	Indoor		Outdoor	
	Rain	No-Rain	Rain	No-Rain
Dec. 21				
Mor	33	40.8 ± 18.3	31	55 ± 30
Noon	41	44.9 ± 12.4	75	60.7 ± 31.5
After	37.7 ± 12.7	54.7 ± 34.8	41.9 ± 20.1	71 ± 38.6
Eve	35.5 ± 12.0	54.2 ± 20.1	52 ± 22.6	76.8 ± 28.9
Jan. 22				
Mor	36 ± 9.4	36.4 ± 7.7	65 ± 6.5	62.2 ± 8.6
Noon	35.7 ± 10.1	51.7 ± 11.7	66.3 ± 10.3	77.2 ± 13.5
After	43.1 ± 17.8	47.1 ± 9.2	57.1 ± 16.5	72.2 ± 7.9
Even	31.2 ± 7.4	43.9 ± 16.2	57.7 ± 5.4	79.3 ± 17.8

As shown in Table 5, the $PM_{2.5}$ Rain value is lower than No-rain, except for December 2021, which has Noon, and Morning in January 2022, which has higher values; this is an uncommon situation. The morning period was the best value in December 2021, where both Rain and No-Rain were the lowest value for both Indoor and Outdoor.

However, in January 2022, the results were different: Evening-Rain-Indoor was the lowest, Morning-No-Rain-Indoor was the lowest, Afternoon-Rain-Outdoor was, and Morning-No-Rain-Outdoor was also the lowest. In January 2022, the lowest $PM_{2.5}$ value was found to be more distributed.

Then the Rain-No Rain Data was analyzed with a linear approach based on the $PM_{2.5}$ data movement on a day-to-day basis. Also, analysis has been made in a similar approach for the Indoor-Outdoor. This data is then shown in Figure 3 below:

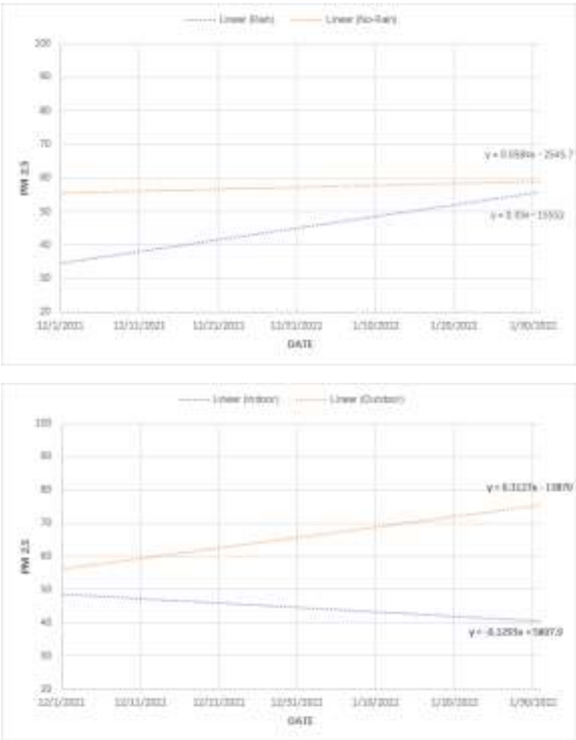

Figure 3. Rain - No-Rain and Indoor – Outdoor Linear Data

Figure 3 shows that No-Rain has a more stable increment for $PM_{2.5}$ value than the Rain, which had a significant increment within two months. For the Indoor-Outdoor situation, the $PM_{2.5}$ value increased significantly for the Outdoor, but for Indoor was decreased quite significantly for the $PM_{2.5}$. This situation was unusual for the linear outdoors because the Rain was more in January 2022 compared with December 2021.

As seen from the data shown in this result, the data type for $PM_{2.5}$ would be suitable for the float data type (Wandy et al., 2021). The data from the sensor may show as an Integer data type without the decimal, but during the analysis, the data required decimal values for average, standard deviation, and $PM_{2.5}$ trends. So based on this data, a gauge-type chart will be appropriate to be shown on the dashboard for showing real-time data. Historical data for more details can also be shown on the dashboard with a bar chart or line chart.

4. CONCLUSIONS

The dashboard page requires data to be shown on a graph. Data type $PM_{2.5}$ value had dynamic results and can be related to the geographical issue. The Rain situation can reduce the $PM_{2.5}$ value both Indoor and Outdoor. The data type for $PM_{2.5}$ would be suitable for the float data type. The data from the sensor may show as an Integer data type without the decimal, but during the analysis, the data required decimal values for average, standard deviation, and $PM_{2.5}$ trends. In East Bekasi, Indoor $PM_{2.5}$ has a lower value than Outdoor, but this may differ from other regions. Here can be found that in Indonesia, an expert system or decision support system can be implemented for future dashboard development to show an intelligent dashboard for this Rain-No Rain and Indoor-Outdoor situations. A gauge chart will be appropriate for real-time data, and a bar/line chart will be good for historical data.

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