Assessment on Air Quality Index (AQI) UTHM Campus Pagoh

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Abstract: An air pollutant is any substance that affects the natural nature of the atmosphere whether chemical, physical, or biological. Major pollutant of public health concern includes particulate matter, carbon monoxide, ozone, nitrogen dioxide, and sulphur dioxide. Monitoring the major pollutants of particulate matter (PM) 2.5 and 10, carbon dioxide (CO_2) and carbon monoxide (CO) using E- Sampler and Ambient Air Quality which can analyse and interpreted by determine the air quality index that polluted by several gases at UTHM Campus Pagoh area. Universiti Tun Hussein Onn Malaysia (UTHM) has provided two tool that can monitoring the gases. E-sampler brand Met One Instrument is a tool that can measure the air pollution index in airborne particulate matter (PM) which contain particulate matter gases 2.5 and 10. While the indoor air quality tool brand Kanomax IAQ Monitor version 2.21 can detect carbon dioxide (CO_2) and carbon monoxide (CO). All the data was obtained at Universiti Tun Hussein Onn Malaysia in student residential college block A16, main entrance gate, and cafe residential college. The objective of this research is to measure the air pollution gases using E-Sampler and Indoor Air Quality tool and analyse air quality index and gas concentration at selected area. The data air quality index is collected for 24 hours for the E- Sampler and 12 hours for the Ambient Air Quality Index. There are a few high-value concentrations, and the highest location to collect concentration gases is at Cafe Residential College UTHM. The concentration is high because the surrounding produces car emission and cooking fumes. Air pollution is the most serious issue for living things, with disastrous consequences for human health. Most of studies on identifying the air quality index and predictive analysis on the air quality index is insufficient to solve health-related issues, but it does aid in understanding the level of air pollution in the air. It is critical to understand which air particles can cause problems so that preventive measures or essential actions can be taken before venturing out.

Keywords: Air Quality Index, Air Pollution, Particulate Matter (PM) 10, Particulate Matter (PM) 2.5, Carbon Dioxide (CO_2), Carbon Monoxide (CO)

1.   Introduction

An air pollutant is any substance that affects the natural aspects of the atmosphere, whether chemical, physical, or biological. Air pollution can occur indoors or outdoors. Automobiles, industrial activity, domestic combustion appliances, and forest fires are all common sources of air pollution. Particulate matter (PM), carbon monoxide (C0), carbon dioxide (CO_2), ozone (O_3), nitrogen dioxide (NO_2), and sulphur dioxide (SO_2) are pollutants of great public health concern. Indoor and outdoor air pollution are major factors contributing to deaths and morbidity and are known to cause respiratory and other disorders. World Health Organization has state 99% of the world's population takes a breath air with high levels of pollutants that exceed WHO guidelines [1].

Toxic chemicals or other compounds that are present in the air at amounts that damage human health are always referred to as air pollution [2]. Air pollution occur when fumes or smoke, dust particles, gases or odors are released into the atmosphere that are detrimental to plants, animals and human. The health of humans and other living beings on the planet is at risk due to air pollution. The air quality index is used for reporting the daily air quality whether it clean or polluted in air. The air quality index has been classified by different types of gases. The air quality index has already defined the parameter and the range of air quality. Based on the air quality, it may acquire extensive information on the many types of gases dissolved in the air. The air quality index can be classified into several categories. There are four levels of severity, which are good, moderate, poor, and severe. The air quality index will always express an individual pollutant's concentration on a common scale where it has health implications and occurs at a value shared by all contaminants [4].

Major public health pollutants are always present in a variety of gases, including nitrogen dioxide (NO_2), carbon dioxide (CO_2), particulate matter (PM) 2.5 and 10, ozone (O_3), carbon monoxide (CO), and sulphur dioxide (SO_2) (WHO, 2022). Most of gases in air pollution, nitrogen oxide (NO_x) and carbon dioxide (CO_2) is the types of gases produced in high of pollution. High temperatures that seem to be present in areas with heavy traffic can cause the interaction of nitrogen and oxygen. This nitrogen oxide (NO_x) was emitted as air pollution that can be harm to people and surrounding such as headaches, breathing problem and eye irritation. According to United States Environmental Protection Agency (EPA) nitrogen oxide (NO_x) is one of the highly reactive gases and the main sources of nitrogen oxide is the burning fuel in the atmosphere. Nitrogen oxide (NO_x) is created as result of emissions from automobiles, trucks, buses, power plant and the off road vehicle [3].

Air pollution comes from various gases as nitrogen dioxide (NO_2), carbon dioxide (CO_2), particulate matter (PM) 2.5 and 10, ozone (O_3), carbon monoxide (C0) and sulphur dioxide (SO_2). Some of the gases can effect to human health. Carbon dioxide (CO_2) are coming in various types of combustion in transportation, power plant, industrial and domestic environment. Since it is derived from methane, carbon monoxide is a form of gas that is naturally present in the air. Over time though, it changes into carbon dioxide (CO_2). These gases have greenhouse effect and can be consequence of global warming. Besides, carbon dioxide can toxicity to human in respitory system, muscular in tremor, increased heart rate and blood pressure and skin can be sweating. Carbon dioxide (CO_2) is the most common pollution and the worst climatic pollutant due to its role as a greenhouse gas [8]. A study said naturally occurring element of the atmosphere, carbon dioxide is required for plant life and released by the respiratory system of living things [9].

From the previous study, the numerous building, vehicle fumes and development projects have raised a number of environmental concerns, most especially air pollution. Since the Higher Education Branch in Bandar Universiti Pagoh was built, the development in Pagoh town nearest to Universiti Tun Hussein Onn Malaysia area is the clearest picture of how construction and development in this area has improved infrastructure development and health problems related to air pollution resulting from such activities. The probability the contaminant of air pollution can be raise due to construction sites and the emission of transportation. Therefore, the community in UTHM Campus Pagoh area needs to have a better chance of being healthy, so air quality needs to be monitored and managed.

According to the three location study conducted there have three issues. In residential college block A16, there was under construction at the back of the block. Due to construction, there are many

trucks and vehicles that emit hazardous fumes and dust from the tar. The second location is at cafe residential college. The bus parking lot especially when buses pick up students from 08.00 a.m. to 06.00 p.m produces the most automobile emissions inside the cafe area and students residential. As a result, the departing buss emissions continue. The third problem is at main entrance gate of UTHM. The locations were determined by the factors of vehicle access and exit routes that emit contaminated gas. This study aims to identify air quality index of E-Sampler and Ambient Air Quality at Universiti Tun Hussein Onn Malaysia.

2. Materials and Methods

This project uses the existing E-Sampler Brand Met One Instrument tool from Air Pollution Laboratory Faculty of Engineering Technology and Indoor Air Quality tool brand Kanomax IAQ Monitor version 2.21 at Faculty Engineering Technology Laboratory of Building Service, University Tun Hussein Onn Malaysia (UTHM) as the field instrument. From table 1, there are three locations was selected at behind block A16 residential college, main entrance gate UTHM and cafe residential college UTHM.

Table 1: GPS Coordinator at Universiti Tun Hussein Onn Malaysia

GPS Coordinator	Entrance Gate	Cafe Residential College	Block A16
Latitude	2.146835928068628	2.146164376560172	2.1440582198066425
Longitude	102.73041906309632	102.72750479062039	102.72659207891066

The E-Sampler tool was collect and measure the data of air pollution index which contain gases of particulate matter 2.5 and 10, mean while the Ambient Air Quality detect carbon dioxide and carbon monoxide gases. Data air quality index category were determined using the US EPA index value standard. For E-Sampler and Indoor Air Quality tool, the data was collect and obtain based on the concentration value of gases. Through this two tool, the data range are combine and be plot using the index value of air quality system. Based on result, E-Sampler were collect 24 hours and Ambient Air Quality was state 12 hours. Data was conduct in 17 May of 2023 and analyses using 1 hour during the peak hour. The study was conducted at UTHM Campus Pagoh area and the air quality index were monitor the data that focuses on the air pollution gases that caused by transportation fumes. An extensive infrastructure of industries, offices, homes, and other buildings has been built all around the UTHM area and accurate information was provided to the public to take precautionary measures to protect health.

From table 2 shows the different nations place a higher priority on safety than others. The United States reports air quality using a 500-point scale. Any score between 0 and 50 is regarded as good. A substantial level of health concern is indicated by a score between 51 and 100. For area that receives like the elderly or those with lung or cardiac difficulties, an AQI reading between 101 and 150 is regarded as unhealthy. Scores of 151 to 200 are classified unhealthy for sensitive group, and 201 to 300 are very unhealthy. Finally, hazardous air quality is defined as being between 301 and 500 [6] [10].

Table 2: Air quality index values, PM2.5 and PM10 concentration, colour codes, air pollutant level of health concern.
Source: US EPA (Rohit Bansal, 2016)

AQI Value Of Index	Levels of Health Concern	PM2.5 Conc. (µg/m3)	PM10 Conc. (µg/m3)	Daily AQI Colour	Air Pollution Level
0 – 50	Good	0-12.0	0-54	Green	Level 1
51 – 100	Moderate	12.1-35.4	55-154	Yellow	Level 2
101 - 150	Unhealthy	35.5-55.4	155-254	Orange	Level 3
151 - 200	Unhealthy for sensitive group	55.5-150.4	255-354	Red	Level 4

| 201 – 300 | Very unhealthy | 150.5-250.4 | 355-424 | Purple | Level 5 |
| 301 – 500 | Hazardous | 250.5-500.4 | 425-604 | Maroon | Level 6 |

To monitoring E- Sampler data from table 3 and table 4, there are several assessments need to follow. One of the basic and necessary requirements for using E-Sampler is using US EPA Standard because the data was collect 24 hours. This method is using mean value to monitoring the reading for PM2.5 and PM10 and compared with the world health organization guideline. The annual mean for PM2.5 (fine particulate matter) is 10 µg/m^3 and 24-h mean is 25 µg/m^3 while that of PM10 (coarse particulate matter) is 20 µg/m^3 and 24-h mean is 50 µg/m^3. These mean value were used to calculate the air quality index. The indices for each pollutant (average of the total sum from each sampling location) were derived using the mathematical formula as seen below [7].

Table 3: Mean Value Particulate Matter (PM2.5)
Sources: Sienna Bishop (2021)

Annual Mean	Fine Particulate Matter	24 Hours
Particulate Matter (PM2.5)	10 µg/m3	25 µg/m3

Table 4: Mean Value Particulate Matter (PM10)
Sources: Sienna Bishop (2021)

Annual Mean	Coarse Particulate Matter	24 Hours
Particulate Matter (PM 10)	20 µg/m3	50 µg/m3

To obtain the graph of the air quality index for PM 10 and PM 2.5, equations 1 and 2 were used. Equation 1 is used to calculate concentration. The air quality index pollutant is calculated using Equation 2.

Equation 1 of Concentration:
Concentration Value (µg/m³) x 1000 = mg/m³

Equation 2 of Air Quality Index Pollutant:
$$\text{AQI}_{Pollutant} = \frac{Pollutant\ Concentration}{WHO\ Standard} \times 100$$

From the table 5, the National Ambient Air Quality Standard has state six different range carbon dioxide and carbon monoxide category colour. Any score between the range will indicates the index value data [5].

Table 5: The National Ambient Air Quality Standard
Sources: (NAAQS, 2016)

CATEGORY	C0 (PPM)	CO_2 (PPM)
Good	0.0 – 4.4	700
Moderate	4.5 – 9.4	800
Unhealthy for sensitive group	9.5 – 12.4	1100
Unhealthy	12.5 – 15.4	1500
Very unhealthy	15.5 – 30.4	2000
Hazardous	30.5 - 10004	3000- 50000

3. Data and Analysis

Particulate matter is one of the air pollution which poses riskier of health problem. It can be

summarized that by knowing the level of the particulate matter concentration and their trends gives out the information about the air quality index for each station it contributes to the air quality level. This study was gather and present the data for the assessment of PM 2.5 and PM 10, CO_2, and C0 concentration using standard of air quality index.

3.1   Concentration Result PM 10 at Three Location UTHM

There were higher concentration results PM 10 for 24 hours at three locations. The data was collected at the main gate UTHM, student residential college block A16, and cafe residential college UTHM.
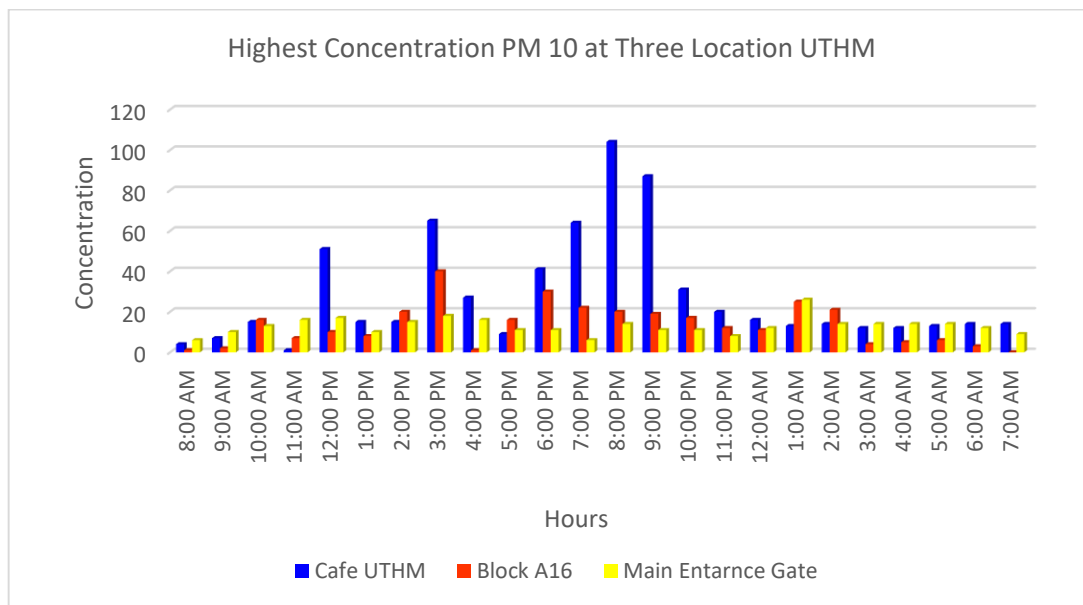

Figure 1: Higher Concentration Particulate Matter 10 at Three Location

Figure 1 is use to highlight the highest concentration PM 10 at three locations. The concentration was collected at main gate UTHM, student residential college block A16, and cafe residential college UTHM. Similarly, for PM10 the calculated values for the concentration AQI in all three locations were used to derive the graph shown in Figure 1 below, which was created using Equation 1 above. The cafe residential college UTHM has the largest value concentration among the three locations. It was followed by the UTHM main gate and the student residential college block A16.

Cafe residential college UTHM (above with 100 concentration value) showed highest level particulate matter and unhealthy of levels health concern. Unhealthy air quality can penetrate deep into the lungs and occasionally into the bloodstream, and long-term exposure can result in increased respiratory issues, asthma, and early death as a result of heart and lung disease. When this pollutant has an AQI above 100 this will effect to sensitive group. Sensitive group members may have negative health effects. It is less certain that the general population will be impacted. For PM 2.5 and PM 10 the populations most at risk are those with heart or lung illness, elderly persons, kids, and those from poor socioeconomic backgrounds [4].

3.2   Concentration Result PM 2.5 at Three Location UTHM

There were higher concentration results PM 2.5 for 24 hours at three locations. The data was collected at the main gate UTHM, student residential college block A16, and cafe residential college UTHM
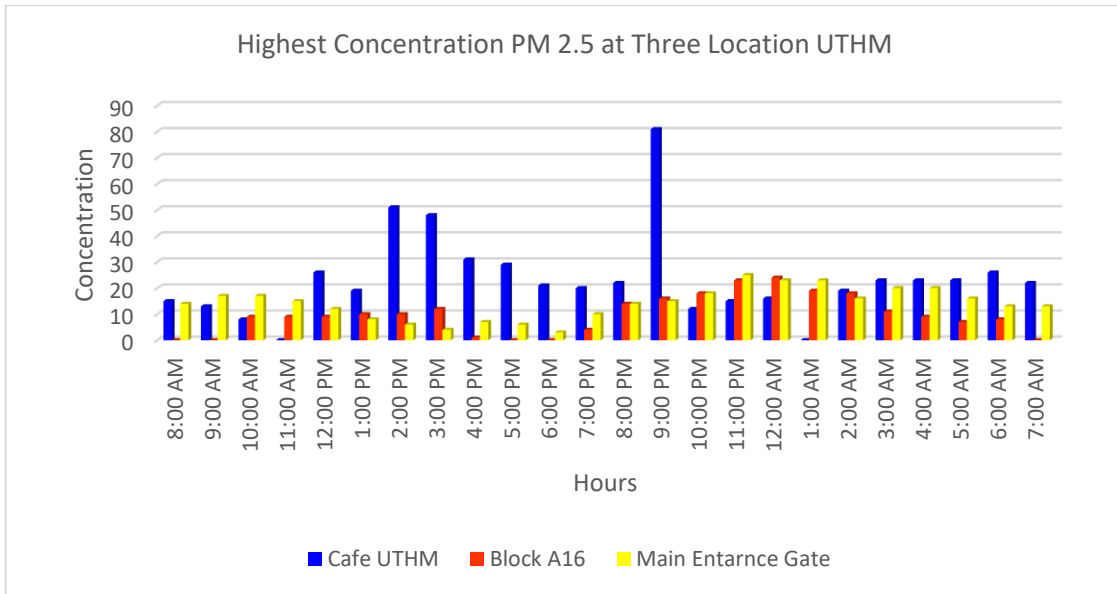
Figure 2: Higher Concentration Particulate Matter 2.5 at Three Location

Figure 2 is use to highlight the highest concentration PM 2.5 at three locations. The concentration was collected at main gate UTHM, student residential college block A16, and cafe residential college UTHM. Similarly, for PM 2.5 the calculated values for the concentration AQI in all three locations were used to derive the graph shown in Figure 2 below, which was created using Equation 1 above. The cafe residential college UTHM has the largest value concentration among the three locations. It was followed by the UTHM main gate and the student residential college block A16.

Cafe residential college UTHM (above with 80 concentration value) showed highest level particulate matter and it was moderate of levels health concern. Moderate air quality can penetrate deep into the lungs and occasionally into the bloodstream, and long-term exposure can result in increased respiratory issues, asthma, and early death as a result of heart and lung disease. The air quality is in good condition. But for some people, especially those who have very high sensitivity to air pollution, there might be a risk. For PM 2.5 and PM 10 the populations most at risk are those with heart or lung illness, elderly persons, kids, and those from poor socioeconomic backgrounds [4].

3.3   Ambient Air Quality

The ambient air quality data are follow the National Ambient Air Quality Standard (NAAQS) for carbon monoxide and carbon dioxide gases.
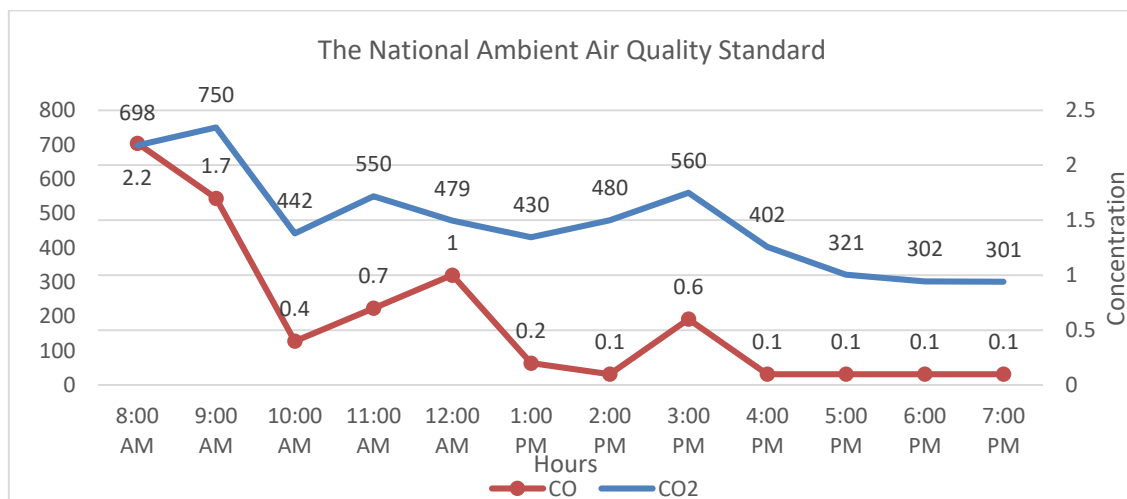

Figure 3: Data CO_2 and CO at Cafe Residential College UTHM

Based on figure 3, the raw data CO_2 and CO gases has been tested at Cafe Residential College UTHM. The data was collected for 12 hours a day, between 8 a.m. to 7 a.m. on April 6, 2023. Figure 3 show all concentrations during the entire period of 12 hours can be classified into good air quality index category. Due to vehicle fumes, the highest level concentration is 770 ppm for carbon dioxide and 2.2 ppm for carbon monoxide.

The concentration is due to human activities that produced emission cooking area and vehicle fumes. Besides, the concentration high at morning to afternoon due to buses pick up students and other vehicle causing vehicular emissions. Cooking on gas or electric stoves produces small particles called particulate matter which can be 65 times higher than background levels. Steaming, boiling, or using a microwave produce fewer particles, and gas stoves can generate combustion products like carbon monoxide. Most of air pollution comes from different types of sources. This air pollution or harmful gases effecting national parks that have been created outside park boundaries. Most of gases comes from mobile sources, stationary sources, area sources and natural sources [11].

3.4 Result Average Particulate Matter 10 at Three Location

There were a result of average PM 10 at 12 hours at three locations. The data was collected at the main gate UTHM, student residential college block A16, and cafe residential college UTHM.
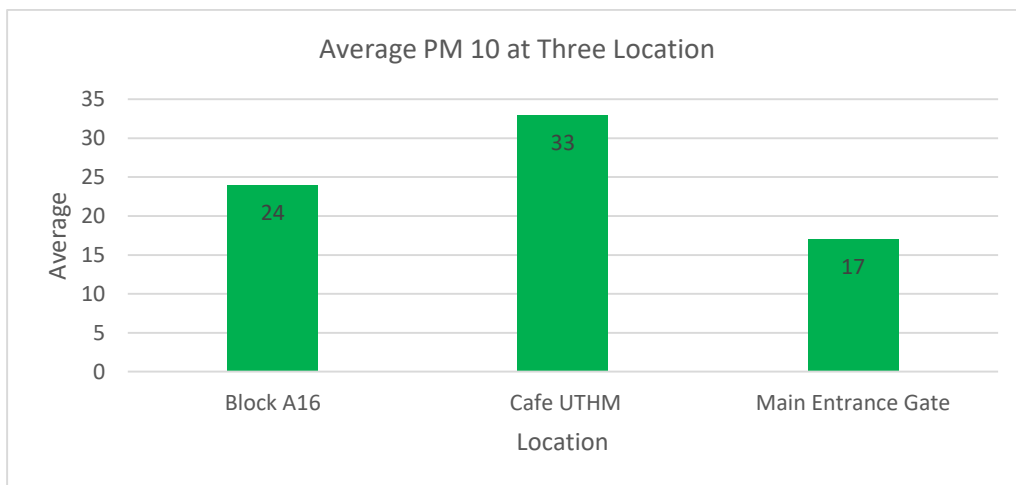

Figure 4: Average PM 10 At Three Location

Figure 4 shows the average particulate matter 10 at three locations. The average was collected at the main gate UTHM, student residential college block A16, and cafe residential college UTHM. Figure 4 show all the averages during the entire period of 24 hours can be classified into good air quality index category which the air pollution is in level 1 using US EPA Standard. The consequences have no effect on human health due to green category index rating.

3.5 Result Average Particulate Matter 2.5 at Three Location

There were a result of average PM 2.5 at 12 hours at three locations. The data was collected at the main gate UTHM, student residential college block A16, and cafe residential college UTHM.
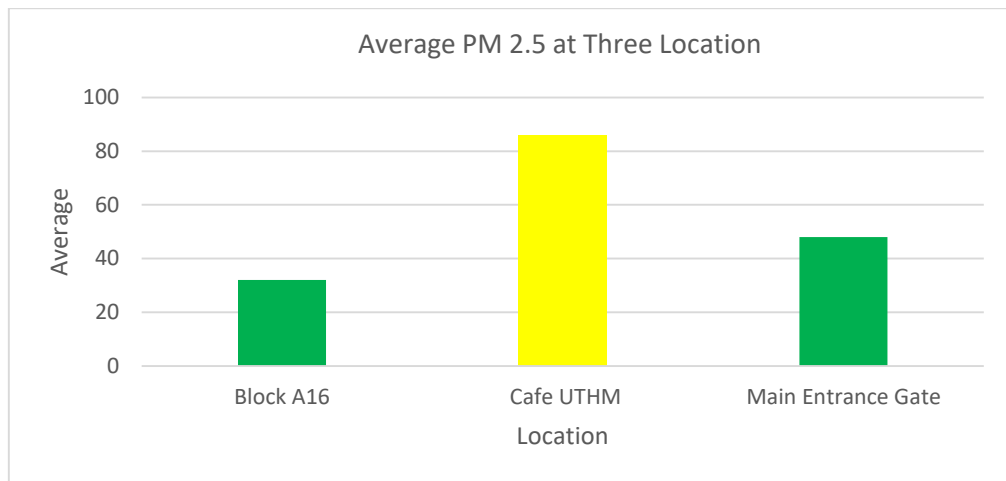
Figure 5: Average PM 2.5 At Three Location

Figure 5 shows the average particulate matter 2.5 at three locations. The average was collected at the main gate UTHM, student residential college block A16, and cafe residential college UTHM. Figure 5 show the averages during the entire period of 24 hours can be classified into good air quality index category at block A16 and main entrance Gate UTHM which the air pollution is in level 1 using US EPA Standard. The consequences have no effect on human health due to green category index rating.

For cafe residential college UTHM, the average of the entire period 24 hours is in moderate value. Using US EPA Standard, the air quality index category is in level 2. Moderate air quality can penetrate deep into the lungs and occasionally into the bloodstream, and long-term exposure can result in increased respiratory issues, asthma, and early death as a result of heart and lung disease. The air is in good condition. But for some people, especially those who have very high sensitivity to air pollution, there might be a risk. For PM 2.5 and PM 10 the populations most at risk are those with heart or lung illness, elderly persons, kids, and those from poor socioeconomic backgrounds [4].

3.1   Summary of Gases

Table 6: Average of Gases in Three Location

Location	PM 2.5 (mg/m^3)	AQI Result	PM 10 (mg/m^3)	AQI Result	CO_2 (ppm)	NAAQS Result	CO (ppm)	NAAQS Result
Student Residential College Block A16 UTHM	32	Good	24	Good	474	Good	0.8	Good
Cafe Residential College UTHM	86	Moderate	33	Good	529	Good	1.05	Good
Entrance Gate UTHM	48	Good	17	Good	433	Good	0.4	Good
Standard	US EPA	US EPA	US EPA	US EPA	NAAQS	NAAQS	NAAQS	NAAQS

As a result of this study, three areas were observed to determine the air quality index at Campus Pagoh Universiti Tun Hussein Malaysia by evaluating four parameter PM 10, PM 2.5, CO, and CO_2. Two tools were used to obtain the data gases. PM 10 and PM 2.5 gases are detected by E-Sampler, while CO and CO_2 concentration gases are detected by Ambient Air Quality.

There are high-value concentrations, and the highest location to collect concentration gases is at Cafe Residential College UTHM. The concentration is high due to the surrounding area produces transport emission and cooking fumes. When this pollutant has an AQI above 100 this will effect to

sensitive group. For PM2.5 and PM10 the populations most at risk are those with heart or lung illness, elderly persons, kids, and those from poor socioeconomic backgrounds. For carbon dioxide and carbon monoxide the group most at danger is those with heart problems [4].

4. Conclusion

From the analysis data, there are measure the data of E-Sampler and Ambient Air Quality which contain the presence of air pollution gases. The analysis indicated that the concentration of Ambient Air Quality in the period of 12 hours was in the good category. This consequence has no effect on human health because include in green category index rating. The concentration was stated three categories in index value for the data analysis using E- Sampler tool. According to the raw data analysis, students from Residential College Block A16 UTHM and Entrance Gate UTHM are in the good category in terms of index value for particulate matter 2.5 and 10. The range between 0 - 50 mg/m^3, indicating an excellent air quality index score. At Cafe Residential College UTHM, a few concentrations are highly valued. The concentration gases for particulate matter 2.5 and 10 have been classified five category as moderate and hazardous index value. The range was between 51 - 500 mg/m^3, which is harmful to human health. This outcome may have an impact on human health.

Air pollution is the most serious issue for living things, with disastrous consequences for human health. Most of studies on identifying the air quality index and predictive analysis on the air quality index is insufficient to solve health-related issues, but it does aid in understanding the level of air pollution in the air. It is critical to understand which air particles can cause problems so that preventive measures or essential actions can be taken before venturing out.

5. Recommendation

Suggestions that can be used to improve the study were made as a result of this research:

i. Declare a "action day" to encourage people to take voluntary action to reduce air pollution, such as using public transportation. This will result in lower particulate matter levels, hence lowering fugitive dust
ii. Avoid outdoor exercise for populations at risk such as the elderly, children, and those with respiratory or cardiovascular disorders.
iii. Emission inventories must be made, and related control strategies must be put into practice
iv. Cafe college can use less of electricity especially when it comes to burning gas that create emission. Encourage the cafe owner to use low emission cooking equipment such as induction cooker instead of gas stove.
v. Upgraded the kitchen café exhaust system and use air purifier that can remove particulate matter in air.
vi. Encourage student to use bicycle then other transportation to reduce fumes emission.

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