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Environmetric Study on Air Quality Pattern for Assessment in Klang Valley, Malaysia

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Abstract: ***Air pollution had turned into one of the major environmental issues in Malaysia due to the heavy transportation activities in logistics and automobile dependencies, industrial activities and transboundary pollution from the neighbouring countries. The emission from such events such as infrastructure works, traffic (road, sea, air) and industry are directly responsible for air pollution. The objective of this study was to determine the significant pollutant parameters contributing to air quality issues and to identify air quality pattern at five air monitoring stations in Klang Valley, Malaysia for the years of 2010 until 2014 (five years). This dataset was derived from the Department of Environment, Malaysia (DOE). Air pollution index (API) such as SO_2, CO_2, NO_2, O_3, and PM_{10} were examined in this study. Environmental metric techniques used was cluster analysis (CA) to determine the air quality pattern based on yearly and specific monthly basis. Discriminant analysis (DA) was applied to a distinctive different class. The study identifies that there were different variables or predictors between each class. Principal component analysis (PCA) was used to identify the significant pollutant parameters based on five pollutants in air pollution index (API) which cause by many activities either internal or external factors. This study identified that SO_2, CO_2, NO_2, and PM_{10} are the primary pollutants contributing to the deteriorating of air pollution in Klang Valley. By using the environmetric technique for analysing the data, it contributes to a better understanding of air quality pattern and clearly identified the vital of atmospheric pollutant parameters.***

Index Terms**:** ***Keywords: Air Pollution, API Index, Environmentric Techniques, Pollution Parameters, Principle Component Analysis.***

I. INTRODUCTION

Malaysia had a long history of rapid, inclusive growth, reducing its dependence on agriculture and commodity exports to grow into a more diversified and open economy [1]. The high levels of atmospheric pollutants in the southern region of Peninsular Malaysia were contributed by the imbalanced urbanization and rapid industrial growth over the years of the country's transformation [2]. In urban areas, the rigid separation of employment, commercial, housing, and recreational areas forms a reliance on the road-based transport, which contributes to greenhouse emissions and high levels of urban air pollution that was slowly affecting the quality of the urban living environment [3]. The World Health Organization (WHO) (2013) has estimated that in developing countries, increasing urban air pollution has led to more than 2 million deaths per annum along with numerous cases of respiratory diseases. Due to nature of air pollution and its sources are easily spread out not only within the boundary of a megacity but exposed to a wider range of surrounded megacities, air quality becomes a regional issue to concerned [5]–[7].

In order for Malaysia to achieve its mission to be a developed country and in line with the global mission of Sustainable Development Goals (SDGs 17), healthy air quality is a major parameter of indicating the status [8]. Moreover, air quality and meteorology are key aspects of urban metabolism to sustain the cycle process of urban growth and development [9]. Malaysia has experienced the worst occurrence of transboundary haze episodes in 2005; by cause of enormous land and forest fires in neighboring countries of Sumatra and Kalimantan, Indonesia [10],[11]. Open biomass burning originated from Indonesia which generates transboundary smoke haze is an annual caution that causes declining in the local air quality in Malaysia [11]. Transboundary pollution from large biomass burning is likely to be a major source significance impact on ambient $PM_{2.5}$ in Malaysia [12]. Hence, macro-level environmental policies and solution approaches are necessary. Despite outside factors, the urban air pollution commonly produced by the inability of the public and environment to adapted with the level of waste produced by high population density and the concentration in relatively small areas [3]. Air pollution has become one of the major environmental issues in Malaysia due to the increasing number of transportation (motor vehicles), the industrial activities (stationary) and trans-boundary pollution from the neighbouring countries [3],[13],[14]. Based on the 2010 census, Klang Valley's population was approximately 6,071,644 people. Many studies of the air quality have focused on an urban area such as Kuala Lumpur as these areas have shown a significant number of populations, transportation, industrial and urban livelihood activities. One of the significant impacts due to urbanization was the growing number of migration to urban areas such as Johor Baharu, Penang, Kuala Lumpur, Shah Alam, Ipoh, and other areas [15]. These associated with dense in the urban centers with poor air quality and public health risks.

The air pollutant index (API) can be well-defined as a number that is used for recording and reporting the

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quality of air as it is an important tool to inform the public about the air quality that associated with health effects [16],[17]. Malaysian DOE has set up the air pollutant index (API) and established national air quality standards through the Recommended Malaysian Air Quality Guidelines (RMAQG) for each of five major air pollutants; ground-level ozone (O_3), particulate matter below 10 µm (PM_{10}), carbon monoxide (CO), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) to improve and maintain air quality and protect public health [17],[18]. In the year 2018, New Ambient Air Quality Standard was approved to mend the previous Malaysia Ambient Air Quality Guideline that has been referred to since 1989. The New Ambient Air Quality Standard adopts six air pollutants standards that consist of five existing air pollutants as well as one added parameter which is the particulate matter with the size of less than 2.5 microns ($PM_{2.5}$) [19]. The air pollutants' concentration limit will be strengthened in stages which divided into three interim targets, interim target 1 (IT-1) in 2015, interim target 2 (IT-2) in 2018 and the full implementation of the standard in 2020. These pollutants are likely to cause significant risks to health, environment, and property [20],[21].

In 2012, CO produced about 1,873,730 metric tons (MT) (Vehicles: 94.97%, power plants: 3.85% and industries: 0.5%). The NO_2 about 877,364 MT (Power plants: 60%, vehicles: 26% and industries: 6%). The SO_2 about 198,519 MT (Power plants: 48%, vehicles: 7% and industries: 10%). The PM_{10} about 6,049 MT (Vehicles: 76%, power plants: 15% and industries: 4%) [22]. In 2011, the Department of Environment (DOE), Malaysia announced its five strategies under "Clean Air Action Plan" which set a series of strict goals for emissions control, and promoted actions on developing cleaner industrial infrastructure, reducing emissions from vehicles, preventing haze from open burning and forest fires, improve self-efficacy and strengthening community engagement and awareness towards air pollution.

Currently, Malaysia government officials at both central and local level address individual behavioural modifications on continuous haze episodes. The guidelines broadcast during haze episodes, including reducing the emissions from vehicles, open burning, the industry as well as strengthening the community engagement and awareness with the aim to encourage citizens by reducing the exposure to poor air quality (Department of Environment, 2017). Furthermore, public participation in environmental issues is a vital aspect of policy formulation and enactment [24]. Accordingly, public complaint on environmental issues in Malaysia is a significant indicator in achieving a better quality of life [25]. The participatory involvements from the public in environmental management plan and policies formulation are manifested in their constructive complaint to the DOE. In the example, about 4,467 cases were received from the public in 2012 for air pollution [22]. It is conceivable that by having a good monitoring system, environmental management plan and public disclosure to urban air quality are fundamental to emerging a sustainable urban environmental system. Hence, the main objective of this study is to examine the significant atmospheric pollutant parameters partly responsible for air quality issues and to examine air quality pattern at five air monitoring stations in Klang Valley.

The constraint of analyzing environmental data due to reliable and demonstrative, gaps, samples, availability and timeliness [26]. In order to attain a good understanding of the result through big data, it needs a suitable statistical method based on the objectives of the study. Presently, there were many statistical analysis techniques to interpret the air pollution data using environmetrics technique, for instance, a cluster, discriminant and principal components [27]. This study shows the necessary of using environmetric techniques for the analysis of large datasets directing to attain better information about air quality patterns based on spatial and temporal characterizations at the selected air monitoring stations.

II. MATERIALS AND METHODOLOGY

A. *Description of Study Area*

Klang Valley is an area in Malaysia located at N 3.139003 and E101.686855, which is centered in Kuala Lumpur, and also includes its adjacent towns and cities in the state of Selangor. This area, with a size of 29,11.5 km2, consists of Rawang, Gombak, Selayang, Sepang, Petaling Jaya, Subang Jaya, Serdang, Cyberjaya, Klang, Kuala Lumpur, Ampang, Shah Alam, Kajang, and Puchong [28],[29]. Klang Valley is the mainstream economic region in Malaysia with the broad physical development of the urbanization, infrastructure, and industrialisation [28]. Based on [26], DOE Malaysia had classified air monitoring stations depend upon land use characteristics such as residential and near an industrial area. The air quality in the Klang Valley is determined by the standard Air Pollution Index (API). The sources of pollutant are by evaporation of volatiles, fuel burned in factories and power plants, transportation, and from multiform [30].

Presently, there are 52 air monitoring stations located around Malaysia. Basically, the air monitoring station is placed in the industrial area, urban as well as a sub-urban area for immense monitoring [22]. In this study, only five air monitoring stations were elected. Four locations are in Klang Valley and one other station was located adjacent to the area, which is Nilai (Table I and Fig. 1). The contrariety of locations of the stations will produce a different reading of air pollutant data in the area [30]. Furthermore, this selection included the probability of industrial emission and transportation changes on the road.

B. *Air Quality Data and Monitoring Station*

Alam Sekitar Malaysia Sdn Bhd (ASMA) has been assigned by Department of Environment (DOE), Malaysia to collect the data and run for monitoring of the air since 1995 [26]. The data set that has been produced by ASMA will be inspected and validated by the DOE before giving it to the stakeholders. The research would adhere to the API index provided by the DOE to arouse a better interpretation of the data as it would indicate the effects of air pollution on human health. The parameters used for this study were ozone (O_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), and particulates matter (PM_{10}). The ambient air gas analyzer instrument was used by

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ASMA to analyze SO_2, NO_2, O_3, and CO, while a particulate matter and meteorology analyzer were used for PM_{10} for the analysis [31]. The data managed by hourly data and were used to form the daily average. The overall air quality data used in this study were collected from January 2010 until December 2014 (5 years). The total data set of 9,125 were used at five monitoring stations for the analysis.

Table I: Location of selected Air Monitoring station

Site Id	Site Location	Area	Coordinates	Area Category
CA0010	Tmn. Semarak (Phase II), Nilai	Nilai		Industrial
CA0016	Sek. Keb. Bandar Utama, Petaling Jaya	Petaling Jaya	N 3.109474 E 101.638829	Industrial
CA0025	Sek. Keb. TTDI Jaya, Shah Alam	Shah Alam	N 3.104710 E 101.556179	Urban
CA0053	Sek. Keb. Putrajaya 8(2), Jln P8/E2, Presint 8, Putrajaya	Putrajaya	N 2.931862 E 101.681775	Urban
CA0054	Sek.Men.Keb. Seri Permaisuri, Cheras	Cheras	N 3.106222 E 101.717909	Urban

Source: Department of Environment, (2012)

Table II: Ambient Air Quality Guidelines

Pollutant	Averaging Time	Ambient Air Quality Standard			
		IT-1 (2015)		IT-1 (2018)	IT-1 (2020)
		ppm	(µg/m3)	(µg/m3)	(µg/m3)
Ground Level Ozone (O_3)	1 hour *8 hours*	0.10 0.06	200 120	200 120	180 100
Carbon Monoxide (CO) *mg/m3	1 hour *8 hours*	30.0 9.0	35 10	35 10	30 10
Nitrogen Dioxide (NO_2)	1 hour *24 hours*	0.17 0.04	320 75	300 75	280 70
Sulphur Dioxide (SO_2)	1 hour *24 hours*	0.13 0.04	350 105	300 90	250 80
Particulate Matter with the size of less than 10 microns (PM_{10})	1 Year *24 Hour*		50 150	45 120	40 100
Particulate Matter with the size of less than 2.5 microns ($PM_{2.5}$)	1 Year *24 Hour*		35 75	25 50	15 35

Source: [19]

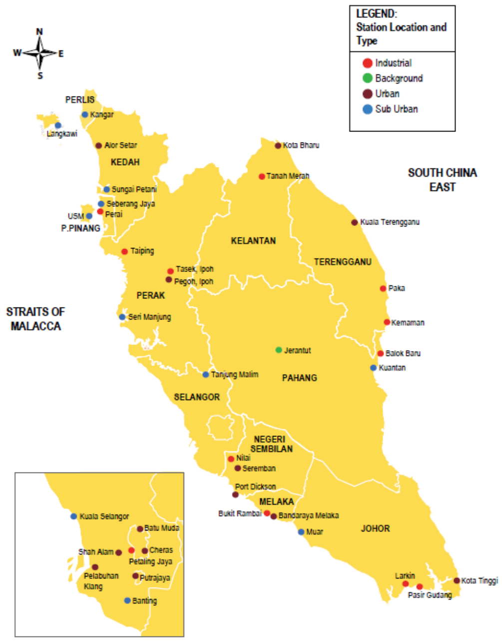

Fig. 1: Location Map of Monitoring Station in Klang Valley and adjacent area

Source: Department of Environment, (2012)

C. Statistical Analysis Method

This study has identified three methods for achieving the objective which were cluster analysis (CA), discriminant analysis (DA) and principal component analysis (PCA) via SPSS software. By using this approach and analysis, the chosen parameters and pattern could be determined. Cluster analysis basically refers to a class of data reduction ways used for sorting the variables or cases into a few numbers of homogeneous groups based on their similarities or differences [32],[33]. It is very important to illustrate dissimilarity from a large group of samples to profiling based on the pattern. The cluster analysis divides the group on the basis of distance (proximity)[34]. As for this study, it needs to classify five monitoring stations, which were placed at a different location for a small group. Normally, the hierarchal cluster was used as a method to identify the divergence relationship and illustrated as dendrogram graph [32].

This method similarly applied to classify air quality patterns from 2010 until 2014. The discriminant analysis (DA) was also applied in this study for validation. DA is usually applied in order to recognize the variables that best discriminate between groups in order to assess the spatial variation in atmospheric air quality [16]. After the clusterization, the next method was to determine the efficiency of the reliability of the result [26]. The principal component analysis (PCA) can be used to summarize the multivariate data. It is used to extract the most significant parameters by excluding the less significant parameters.

III. RESULTS AND FINDINGS

A. Descriptive Analysis of Air Quality

Descriptive analysis (DA) is one of the methods used to describe the number of variants, depending on the data collection and statistical analysis methods used [35]. In this study, descriptive statistics were applied to describe the parameters of the air pollution index (API). The basic descriptive presented such as mean, mode, median, maximum, skewness, and standard deviation. This data analysis was based on the average starting from the year 2010 until 2014 (5 years) and was compared with the Recommended Malaysia Air Quality Guideline issued by the Department of Environment (DOE) since 1989 as; good, moderate, unhealthy, very unhealthy and hazardous as in Table 02. As the data of the API were collected before the New Ambient Air Quality Standard was established in the year 2018, this analysis will be using Recommended Malaysia Air Quality Guideline as a guideline.

Based on the cluster analysis, the air monitoring stations have been divided by two class which were Class 1 (CA0010 and CA0053) and Class 2 (CA0016, CA0025, and CA0054). Class 1 shows a maximum value for PM_{10} in comparison with the Recommended Malaysia Air Quality Guideline which was approximately 308.00 µg/m3 and the average was 49.802 µg/m3. The average value for CO (0.562 ppm), O_3 (0.016 ppm), NO_2 (0.013 ppm) and SO_2 (0.003 ppm) respectively. All parameters for Class 1 were still under the limit of the air quality guideline. As for Class 2, the maximum value for PM_{10} was 379.250 µg/m3 which was higher compared to the guideline. The maximum values for CO (3.690 ppm), O_3 (0.050 ppm), NO_2 (0.057 ppm) and SO_2 (0.018 ppm) accordingly. The average values for CO, NO_2, SO_2, and O_3, were less than 1 ppm. From Table 03, the study identified that the average values for all parameters of API were under the Recommended Malaysia Air Quality Guideline for a total of five years as from 2010 until 2014. There was a certain period that the PM^{10} where contributed higher values (maximum values). It can be stated that there were huge differences between the average value and the maximum value. The average value of Class 2 was slightly higher than Class 1 as for Class 2, it consists of mixed land use (urban and industrial area) and anthropogenic activities.

Table III: Descriptive Analysis of API parameter based on the class of air monitoring station

Site Id	Statistic items	Parameters				
		PM (µg/m3)	CO (ppm)	O_3 (ppm)	NO_2 (ppm)	SO_2 (ppm)
Class 1	Mean	49.802	0.562	0.016	0.013	0.003
	Median	45.625	0.551	0.015	0.013	0.003
	Mode	39.500	0.589	0.014	0.013	0.002
	Max	308.00	4.020	0.056	0.040	0.015
	Std. Dev	24.619	0.209	0.007	0.005	0.002
	Skewness	2.744	3.399	0.665	-0.166	1.113
Class 2	Mean	49.170	0.907	0.016	0.022	0.003
	Median	45.042	0.877	0.016	0.022	0.003
	Mode	0.000	0.000	0.013	0.020	0.002
	Max	379.250	3.690	0.050	0.057	0.018
	Std. Dev	22.660	0.373	0.007	0.008	0.002
	Skewness	3.918	0.648	0.401	-0.025	1.444
Recommended Malaysia Air Quality Guideline		150.00	9.000	0.100	0.170	0.040

B. Air Quality Pattern Using Cluster Analysis (CA)

There are 52-monitoring station in Malaysia. For this study, only five stations located in Klang Valley and the adjacent area were analysed. Currently, DOE has categorized this monitoring station based on urban, sub-urban and industrial. As in 2014, the combined air pollutant emission load accumulated to 1,941,039 MT of carbon monoxide (CO); 836,708 MT of nitrogen oxides (NO_2); 221,471 MT of sulphur dioxide (SO_2) and 25,673 23,904 MT of particulate matter (PM) [18]. Figure 2 shows two pattern groups which clustered as Class 1 and Class 2. These two classes carrying dissimilarity of air pollution index (API). Class 1 indicates to an air monitoring station in Sek. Keb. Putrajaya 8(2), Jln P8/E2, Presint 8, Putrajaya (CA0053) and Tmn. Semarak (Phase II) Nilai (CA0010). Class 2 refers to air monitoring stations in Sek. Keb. Bandar Utama, Petaling Jaya (CA0016), Sek. Keb. TTDI Jaya, Shah Alam (CA0025) and Sek.Men.Keb.Seri Permaisuri, Cheras (CA0054). The location of the station should not be indicated as it is very difficult to differentiate between urban, sub-urban and industrial area [26].

By using the cluster analysis, the air quality patterns were achieved through dissimilarity for better understanding. It was based on air pollution index (API) trend and pattern from 2010 until 2014 and followed by monthly variation from January until December which refers to the selected reading of particular year (2014). The hierarchical cluster analysis was chosen to study the pattern of API index based on yearly and definite month. Class 2 contributed to the highest number of dissimilarities compared to Class 1. Many areas in Class 2 were having congested traffic as the area a mainly urban area and industry. The areas were circulated by busy main roads, a high number of population and comprise of urban areas such as Kuala Lumpur, Shah Alam, and Cheras. It is expected to face heavy traffic which means there will be a high level of emissions from the diesel engines of transport. The CO emissions are primarily due to partial combustion inside the motor vehicle exhaust [31]. In addition to that, the concentration of CO was high in several urban areas in Malaysia and contributed to 95% of the air pollution in 2009.

As for Class 1, the area consists of Putrajaya represent the urban area and Nilai represents the industrial area. Furthermore, approximately 80% of the population in Malaysia will be living in urban core areas like the Klang Valley in 2020 [29]. Due to the urbanization process in the Klang Valley, the demand for cars or vehicles is increasing accordingly. Respectively, the burning of fossil fuel from vehicles has a major impact on the quality of the air. Conversely, this large number of vehicles, poor settings of roads and inefficiency of public transport in Malaysia has directly caused major traffic jams in the main cities like the Klang Valley, which also contributes to the large amounts of air pollutants, such as carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs), and ozone (O3). Moreover, much of the dust and fine particulate matter was contributed by the inability of

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diesel-powered vehicles, on and off the road.

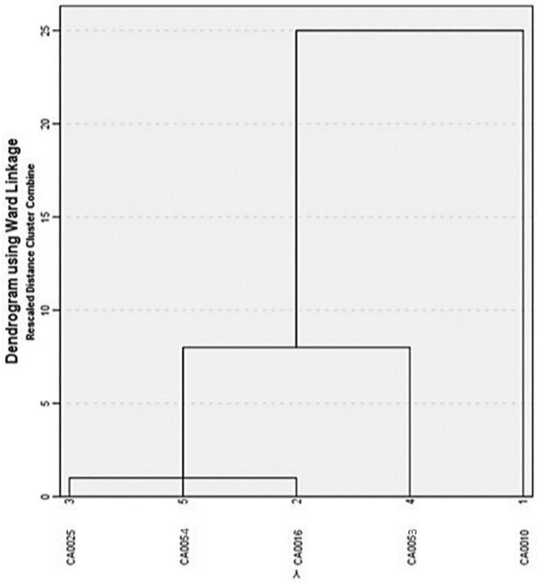

Fig. 2: Cluster analysis in dendrogram view based on Station Id

Based on Figure 3 until 6, from 2010 until 2014, Class 1 formed two groups. Group 1 (2010, 2011 and 2012) and group 2 (2013 and 2014). In a monthly basis, for 2014, the graph indicated three patterns of the group. Group 1 refers to (April, May, August, September, December, and February). Group 2 (January, June, and July), and Group 3 (March, October, November). Based on 2010 until 2014, Class 2 formed two groups, Group 1 (2010 and 2011) and Group 2 (2012, 2013 and 2014). In monthly basis for monthly 2014, the graph indicated that Group 1 refers to (January, June, and July), Group 2 (December, February, April, May, and September) and Group 3 (March, August, October, and November). Malaysia has encountered transboundary pollution for the year 2010 until 2014 based on the year of study, as a certain area has affected by the haze episodes. Essentially, in March 2014, it shows in the graph that the dissimilarity was slightly higher for Class 1 and Class 2 as, during the dry period between February and March 2014, Peninsular Malaysia had encountered moderate haze episode where air quality deteriorated to hazardous and unhealthy levels. The affected areas and states were the Klang Valley, Perak, Melaka, Negeri Sembilan and Johor (Department of Environment, 2017).

In addition to that, during Southwest Monsoon, the country had encountered transboundary haze pollution from June to October. The meteorological factor is one of the elements that contribute to the air quality and haze phenomena during dry months starting from February until March and Jun until October. The southwest monsoon season on June until September can blow the pollutant across the boundary of the area. It is also one of the aspects contributing to the haze phenomena especially from the neighbouring country. Particularly, the northeast monsoon from November until March transferring the wet season with the high raining event. As a result, open burning activities may be reduced. From 2010 until 2014, the years of 2010 and 2011 were affected by transboundary pollution. Studies show that haze has a high correlation with public health [11].

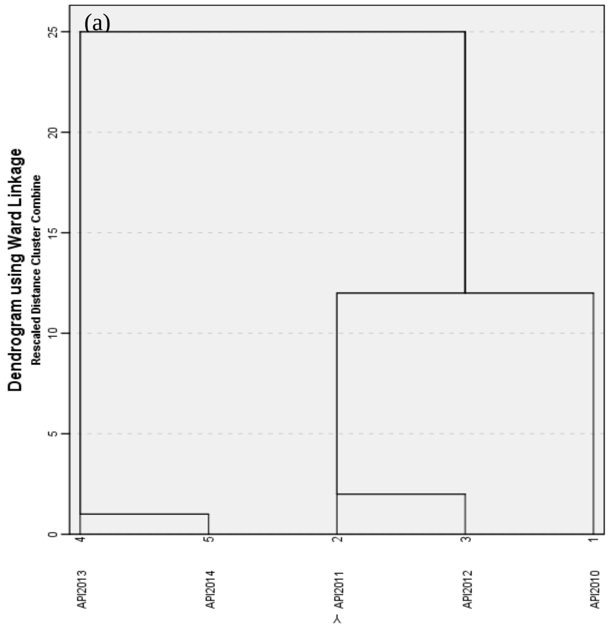

Fig. 3: Patterns of API based on yearly and specific monthly, (a) Class 1 (Yearly)

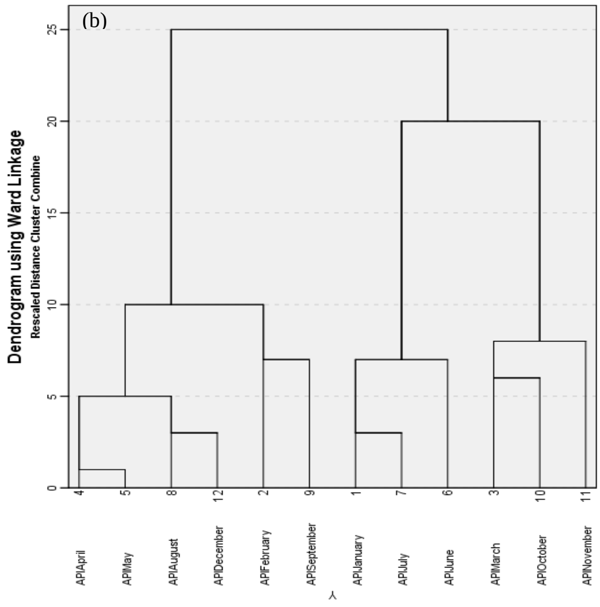

Fig. 4: Patterns of API based on yearly and specific monthly, (a) Class 1 (Monthly-2014)

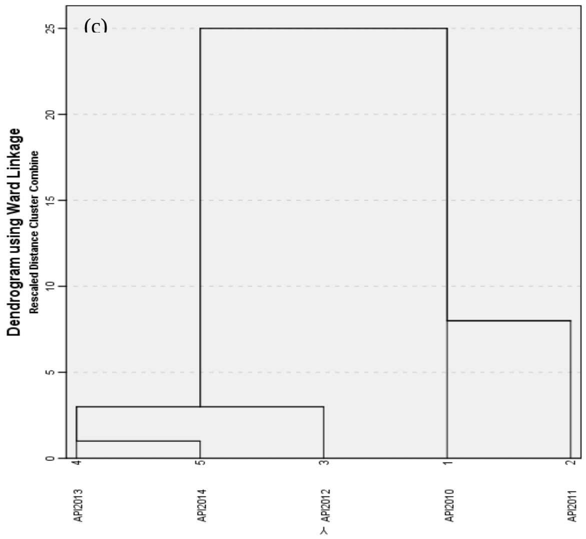

Fig. 5: Patterns of API based on yearly and specific monthly, (c) Class 2 (Yearly)

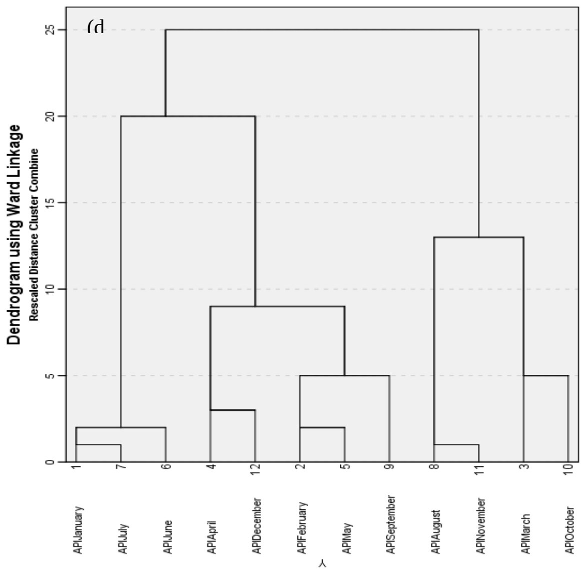

Fig. 6: Patterns of API based on yearly and specific monthly, (d) Class 2 (Monthly -2014)

C. Differentiate Between Classes using Discriminant Analysis (DA)

The study needs to identify the different classes by using discriminant analysis (DA). Based on the Wilks Lambda test, the study found a lambda value .110, refer $p<.000$ and $\alpha = .05$.

The hypothesis tested below:

Ho: The mean vectors of the two classes are equal

HA: At least one of the means vectors is dissimilar from another

The null hypothesis states that the means of the vector of the two groups, Class 1 (Nilai and Putrajaya) and Class 2 (Petaling Jaya, Cheras, and Shah Alam) are equal. The alternative hypothesis points out that the means of the vectors are different from one another. Since the calculated p-value is lower than the significance level of α =.05, one should reject the null hypothesis and accept the alternative hypothesis. Thus, the two groups are indisputably different from one another.

D. Identification of Air Pollution Sources using Principal Component Analysis (PCA)

Principal component analysis (PCA) was tested to extract the most significant parameters by rejecting the less significant parameters contribute to the air quality in Klang Valley. This analysis was based on the classes that have been already clustered at two patterns. The factor loading in Table 4 deliberated the highest and descending values. From the analyses, there were four values more than 1.0 which the maximum was 2.224. The cumulative on percentage values for each class was Class 1 (70.051%) and Class 2 (61.116%).

Table IV: Identification on pollution source of classes (after PCA varimax rotation)

Parameters	**Class 1**		**Class 2**	
	F1	**F2**	**F1**	**F2**
SO_2	0.435	0.580	0.210	0.679
NO_2	0.687	.0402	0.820	0.082
O_3	0.153	-0.870	-0.118	0.705
CO	0.852	0.057	0.852	-0.012
PM_{10}	0.902	-0.141	0.582	0.543
Eigenvalue	2.224	1.279	1.796	1.260
Variability (%)	44.479	25.573	35.912	25.204
Cumulative (%)	44.479	70.051	35.912	61.116

From the analyses, the study found that all the classes have been impacted by anthropogenic and industrial activities. For all classes of the F1, the major contribution was SO2, NO2, CO2, and proceed by PM10. Over the five years, these parameters have contributed to the air quality in Klang Valley. For Class 1, the first varimax factor, F1 explains 44.479% of the total variance, showing a strong positive factor loading on PM10 (0.902) and a moderate factor loading on CO (0.852). F2 explained 25.573% of the total variance and showing a strong negative factor on O3 (-0.870) and moderate factor loading on SO2 (0.580). For Class 2, F1 explains 35.912% of the total variance and showing a strong positive factor on CO (0.852) and a moderate factor loading on NO2 (0.820). As for F2, it explains about 25.204% of the total variance for Class 2 and showing a strong positive factor for O3 (0.705).

SO_2 is dioxide is an acidic gas in the air which sulfuric acid under moist conditions, or to sulfate in dry conditions [36]. SO_2 in ambient air can also affect as one of the risks to human health, predominantly in those suffering from asthma and chronic lung diseases. Major SO_2 problems nowadays only incline to occur in cities in which coal is still widely used for domestic heating, in the industry, and in power stations. As many power stations are now placed away from urban areas, SO_2 emissions may affect air quality in both rural and urban areas. Even moderate concentrations may effect in a fall in lung function in asthmatics [4]. When particulate and other pollution concentrations are high, SO2 is more harmful.

Particulate matter is a term that comprehends solid and aerosolised liquid particles suspended in the air. These particles are defined by the size of

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distribution in microns [37]. Carbon monoxide (CO) is a toxic gas which is emitted into the atmosphere due to the formation of oxidation of hydrocarbons and other organic compounds as well as combustion processes [38]. One of the utmost toxic gases contaminating the atmosphere is carbon monoxide (CO). Motor vehicles are the major source of CO, especially in urban areas. The most frequently designated exogenous sources of CO to include traffic exhaust, cigarette smoke, wood stoves, gas ovens, incomplete combustion of fossil fuels, mining industry and power plants [39]. The most important factors which determine the severity of the damage of CO include the duration of exposure, level in exhaled air, the existence of other toxic gases as well as overall health status. Additionally, particulate matter (PM) is a key indicator of air pollution brought into the air by a variety of natural and anthropogenic activities. The existence of PM carriages more danger to human health than that of ground-level ozone or other common air pollutants[40]. Certain studies have obtained a relationship on the level of airborne particulate and detrimental impacts such as increased respiratory illness and premature mortality [36].

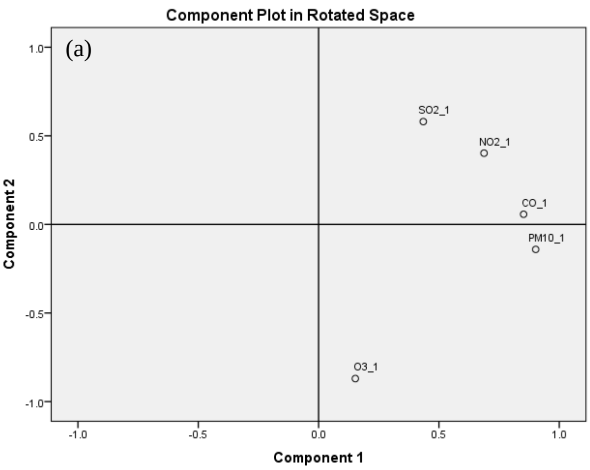

Fig. 7: Factor loading all classes by using PCA, (a) Class 1

Fig. 8: Factor loading all classes by using PCA, (b) Class 2

In the urban and suburban areas in Malaysia, the two major air pollutants are PM_{10} and O_3[17]. Ozone is colourless and odourless gas that exist both in the earth's upper atmosphere (stratosphere) and at ground level (troposphere). The ozone found in the troposphere is a major public health concern**.** The ozone found in the troposphere is a major public health concern [26]. Motor vehicles are significant contributors to air pollution, public health and problems global climate change by directly emitting significant amounts of criteria pollutants, including carbon monoxide (CO), and an important source of volatile organic compounds (VOC) and nitrogen oxides (NOx, which consist of both nitrogen oxide (NO) and nitrogen dioxide (NO2) [41]. As such, the growth of the megacities and an increasing percentage of the world's population live in the urban area have led to ambient air pollution that influences mostly health of the urban population.

IV. CONCLUSION

As a conclusion, an environmetric technique and study for environmental assessment successfully indicated the selected air quality parameters and pattern of air monitoring stations in Klang Valley, Malaysia. The Discriminant Analysis (DA) has presented the differences between the parameters and the clustering and were established significant value. Principal Component Analysis (PCA) could identify major air pollutants and describe the source of pollution in Klang Valley. The study identified the major air pollution that has contributed to degrading air quality in the Klang Valley were SO2, CO2. NO_2 and PM_{10} due to the vehicles, combustion process, and industries. The environmetric can be beneficial for the reference of current and future study. This method can also be applied to a different set of data and area to determine the significant pollutant parameter in Malaysia. The data on air pollution are presented in big amounts but the case studies are very scarce in Malaysia. Thus, this study presents the practicality of environmetric for the evaluation and interpretation of large data-sets to qualify us to get better material about the air quality pattern, especially in Malaysia.

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VI. REFERENCES

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