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Source Apportionment of Ozone Concentration in Klang Valley by using Principal Component Analysis

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INTRODUCTION

- Air pollution is one of the major issues throughout the world, in both developed and developing countries [1]. It is harmful to human health, vegetation, human resource or nature as well as created aesthetic insults in the form of brown or hazy air or unpleasant smell [2].
- Ozone (O3) is an important atmospheric constituent because it plays a main role as both an oxidant and a greenhouse gas [3, 4].
- In Malaysia, surface ozone or ground level ozone (O3) becomes one of the most significant air pollutants due to the increasing sources of ozone precursors [6]. This is due to the growth in population and rapid development, were it proved to negatively impact the air quality status around the world. Thus, O3 should has received substantial attention because of its negative effects to human health and the environment.

PROBLEM STATEMENT

- Ground level ozone is the potential problem on developing countries and has becoming worldwide problem.
- In Malaysia, the ground-level O_3 was found to be one of the **major pollutants** since 1997.
- The study of surface ozone is important due to its **long-term** and **short-term** impacts on human health, well-being, vegetation and the environment
- The rates of visit to hospital emergency room and hospital admissions are also increased [8].
- This study focused on developing the most appropriate prediction model for the surface O_3 concentration in selected urbanised areas.

OBJECTIVE

- To study the temporal characteristics of surface ozone concentration and its precursor.
- To determine the association between surface ozone concentration with its precursor, others gases and weather parameter.

MATERIAL AND METHOD

Data Collection

The descriptive statistic of ground level ozone (O_3) concentration

Associations of ground level ozone (O_3) concentration with its precursors

The correlation between ground level ozone (O_3) concentration with the weather parameters and other pollutants using Pearson Correlation

The influence between ground level ozone (O_3) concentration with the weather parameters and other pollutants using Principle Component Analysis (PCA).

CONCLUSIONS

- O3 concentration started to increase at 8.00 a.m., reached a peak at 1 p.m. - 4 p.m., and decreased after 4 p.m.
- Shah Alam recorded the highest number of O3 concentration that exceeded the limit of MAAQG compared than by Petaling Jaya (28 hours in 2004).
- Precursors of ozone (NO2, NMHC, CO) show the opposite diurnal variation pattern to the O3 production.

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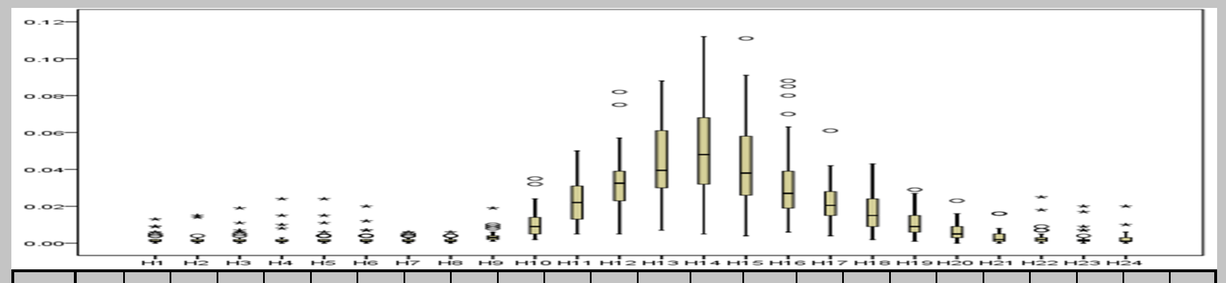
TECHNICAL DATA/RESULTS

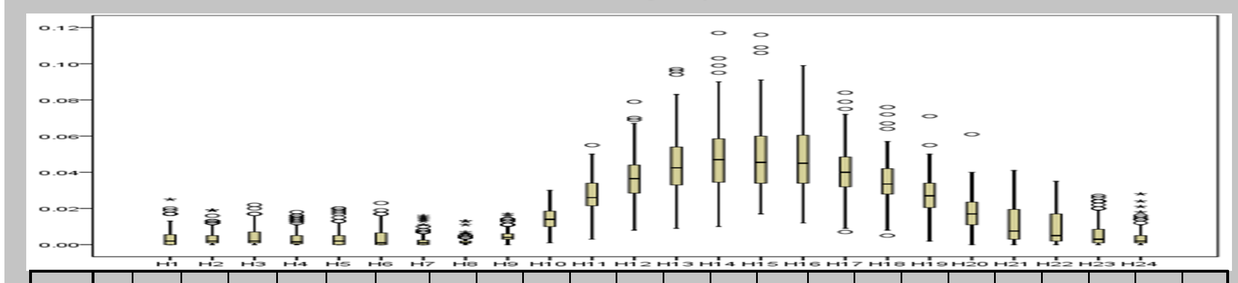
Descriptive Analysis

Figure 1 shows the boxplot and descriptive statistic of ground level ozone concentrations for Klang Valley which were Petaling Jaya and Shah Alam.



	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24
Mean	0.003	0.003	0.003	0.003	0.004	0.003	0.003	0.002	0.004	0.010	0.022	0.032	0.039	0.042	0.040	0.035	0.028	0.021	0.015	0.009	0.006	0.005	0.004	0.003
Median	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.003	0.010	0.021	0.031	0.037	0.039	0.036	0.031	0.026	0.019	0.013	0.007	0.004	0.002	0.002	0.002
Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max	0.055	0.058	0.055	0.057	0.060	0.051	0.038	0.040	0.042	0.038	0.071	0.091	**0.127**	**0.150**	**0.142**	**0.131**	**0.127**	**0.114**	0.071	0.057	0.049	0.045	0.049	0.044

- Petaling Jaya



	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24
Mean	0.005	0.005	0.005	0.005	0.005	0.004	0.004	0.003	0.006	0.015	0.030	0.043	0.053	0.058	0.057	0.052	0.045	0.036	0.027	0.019	0.012	0.009	0.006	0.005
Median	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.004	0.014	0.030	0.042	0.051	0.054	0.053	0.049	0.042	0.034	0.026	0.016	0.008	0.005	0.003	0.003
Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.001	0.002	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max	0.049	0.040	0.050	0.050	0.047	0.045	0.050	0.060	0.096	**0.113**	**0.102**	**0.132**	**0.158**	**0.161**	**0.165**	**0.172**	**0.155**	**0.153**	0.097	0.089	0.079	0.075	0.070	0.054

- Shah Alam

Pearson Correlation

Pearson correlation of ground level ozone concentrations for Klang Valley were Petaling Jaya and Shah Alam.

Petaling Jaya	WS	WD	T	UVB	H	NMHC	SO_2	NO_2	CO	PM_{10}	O_3
WS	1	0.126	0.094		-0.239		-0.214	-0.388	-0.361	-0.119	-0.050
WD		1	0.138		0.033		0.215	0.261	0.237	0.098	-0.108
T			1		-0.750		-0.073	-0.088	-0.081	0.091	0.071
H					1		0.123	0.188	0.164	-0.080	-0.137
SO2							1	0.575	0.611	0.351	
NO2								1	0.731	0.406	
CO									1	0.544	
PM10										1	0.091
O3											1
Shah Alam	**WS**	**WD**	**T**	**UVB**	**H**	**NMHC**	**SO_2**	**NO_2**	**CO**	**PM_{10}**	**O_3**
WS	1	0.132	0.047	0.139	-0.058	-0.176		-0.310	-0.162		-0.057
WD		1	-0.058	0.076	0.147	-0.153	0.087	-0.273	-0.153	-0.080	0.047
T			1	0.592	-0.860	-0.130		-0.227		0.135	0.130
UVB				1	-0.531	-0.265	-0.209	-0.461	-0.288	-0.242	0.152
H					1	0.166		0.211		-0.142	-0.161
NMHC						1	0.193	0.531	0.387	0.322	
SO2							1	0.330	0.090	0.180	
NO2								1	0.439	0.279	
CO									1	0.637	0.091
PM10										1	0.147
O3											1

Principal Component Analysis

- Kaisere Meyere Olkin Measure (KMO) - The value must be greater than 0.5
- Barlett's Test of Sphericity - Significant must ($p < 0.001$)

*mention by Zia et al. (2013) [9]

KMO and Bartlett's Test	Petaling Jaya	Shah Alam
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.663	0.716
Bartlett's Test of Sphericity Sig.	0.000	0.000

Kaiser (1958) [10]. Only components with an eigenvalue **greater than 1** that is considered as principal components

	Petaling Jaya			Shah Alam		
	Initial Eigenvalues			Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.842	35.531	35.531	3.221	32.209	32.209
2	2.167	27.086	62.617	2.607	26.074	58.283
3	1.010	12.624	75.241	1.058	10.579	68.862
4	0.704	8.801	84.042	0.913	9.134	77.995
5	0.452	5.646	89.688	0.728	7.281	85.277
6	0.432	5.401	95.090	0.490	4.903	90.180
7	0.226	2.827	97.917	0.368	3.676	93.856
8	0.167	2.083	100.000	0.287	2.866	96.722
9				0.183	1.834	98.557
10				0.144	1.443	100.000

Varimax with Kaiser Normalization

	Petaling Jaya			Shah Alam		
	PC1	PC2	PC3	PC1	PC2	PC3
TEMP		**.875**		**.928**		
HUMIDITY		**-.896**		**-.923**		
UVB				**.735**	-.433	
O3		**.769**	-.359	**.717**		
PM10	**.701**				**.824**	
CO	**.901**				**.812**	
NO2	**.823**				.647	.545
NmHC					.613	.481
SO2	**.777**				.486	
WS			**.932**			**-.883**

The bold signifies the best among the given value (>=0.7).

PM_{10} = particulate matter; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; WS = wind speed; TEMP = ambient temperature; NmHC = non-methane hydrocarbons; O3 = ozone; UVB = Ultraviolet B