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A STUDY ON AIR POLLUTION CONCENTRATION AT DESA PARKCITY CONSTRUCTION SITE

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ABSTRACT

This study assesses the effect of construction workers exposure towards the air pollution to the correlation between meteorological factor with the particulate matter and other gases concentration at a construction site in DesaParkcity. The concentration of PM was collected by using low volume sampler meanwhile CO, CO_2, SO_2 and NO_2 was measured by Gas Alert Micro 5 IR. The meteorological factor was measured using an anemeter. The result shows that the average concentrations of PM10 are 62.71 µg/m^3, concentration of PM2.5 is 18.32 µg/m^{3}and concentration of PM1.0 is 14.04 µg/m^3. PM10 shows the highest reading compared with PM2.5 and PM1.0. There is no significant association between meteorological factors with the particulate matter concentration. There is a significant association between meteorological factor with the concentration orCO, CO_2, SO_2 and NO_2at DesaParkcity construction site.

Keywords: air pollution; construction worker; meteorological factor.

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1. INTRODUCTION

Air pollution can be defined as the introduction of chemicals, particulate matter or biological materials that cause harm or discomfort to humans or other living organisms or cause damage to the natural environment or built environment into the atmosphere. World Health Organization (WHO) had recognized the main pollutant in the air are particulate matter, carbon monoxide, nitrogen dioxide, ozone, lead and sulphur dioxide [1]. Chemical compound present and they occur in unnaturally high concentration and have the potential to harm to the environment and human health [2].

Air pollution can occur indoor and outdoor. Outdoor air pollution often called that comes from car exhaust, smoke, road dust and factory emissions. Particle pollution can be high any time of year and are higher near busy roads and also large cities [3]. All large cities of the world are facing air pollution from motor vehicles and it had become a major problem for the physical and mental health of its citizens. The toxic chemical and gases release from vehicles emission produce irritation in the lung and air passage of the exposed population [4]. The two basic physical form or outdoor air pollutant are dust, smoke, sand, pollen, mist and fly ash. According to U.S Environmental Protection Agency (EPA), harmful gases include substances such as carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and volatile organic compound [5].

One type of air pollution is the release of PM particles into the air from burning fuel for energy. The particles are very small pieces of matter measuring about 2.5 microns or about 0.0001 inches. This type of pollution is sometimes referred as black carbon pollution [6].

The gases exhaust from burning fuels in automobiles, homes and industries is a major source of pollution in the air. Some international authorities believe that even the burning of wood and charcoal in fireplaces and barbeques can release significant quantities of soot into the air [7]. Another type of pollution is the release of noxious gases, such as SO_2, CO, NO and chemical vapors. These gases can take part in further chemical reactions once they are in the atmosphere, forming smog and acid rain [8]. This paper will describe the particulate and other toxic gas content and their association with humidity and temperature at a construction site in DesaParkcity

2. REVIEW OF LITERATURES

The term particulate matter (PM) includes both solid particles and liquid droplets found in air. Many man-made and natural sources of air pollutant can directly emit gases and particles that can react in the atmosphere to form PM. The emission of solid and liquid particles can come

in various sizes. Particles less than 2.5 micrometers in diameter are referred to as fine particles. Sources of fine particles include all types of combustion and some industrial processes [9].

Particles with diameters between 2.5 and 10 micrometers are referred to as coarse. Particles less than 10 micrometers in diameter tend to pose the greatest health concern because they can be easily inhaled and accumulate in the respiratory system [10].

Sources of coarse particles can come from the processing of crushing or grinding of bricks and dust from paved or unpaved roads. The Air Quality [17-25] Guidelines set for the first time a guideline value for particulate matter and the aim of the guidelines is to achieve the lowest concentrations of pollutant in atmosphere as possible [11].

PM becomes a great concern as it may affect the human health when exposed whether in short term or long term exposure. Particle pollution contains microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems [12]. The size of particles is directly linked to their potential for causing health problems. Small particles less than 10 micrometers in diameter pose the greatest problems because they can get deep into your lungs and some may even get into your bloodstream [13].

3. METHODOLOGY

The study design for this study was a cross-sectional study. The concentration of Particulate matter (PM) and other gases was observed and recorded for 15 minutes for each time, three times per day. The concentration measurement takes places for a week from 25th September 2012 to 2nd October 2012.

The study was conducted at DesaParkcity construction site and the name of the project is The Mansion. The Mansion includes area of 19.6-acre site, which is located 200ft above sea level and lies slightly below the ParkCity Heights bungalows and 30ft to 40ft above the Casaman homes. It consists of 127 units of 2½, 3 and 3½-storey park homes. There will be 33 units of 2½-storey homes, 25 units of 3-storey homes and 69 units of 3½-storey homes. The developer fir this construction site is Perdana Park city Construction Sdn Bhd. The duration of this construction site is from May 2011 until May 2014.

3.1. Particulate Matter Measurements

The concentration of PM of the location was collected by using low volume sampler meanwhile the concentration of other gases such as CO, CO_2, SO_2 and NO_2 was measured by Gas Alert Micro 5 IR. The readings of the PM were recorded for 15 minutes for each time, three times per day.

3.2. Meteorological Factor Measurement

The anemometer is used to measure the meteorological factor such as the temperature and humidity at the construction site. The data was analyzed using SPSS software version 17. Results were presented through frequency outputs and other descriptive statistics.

3.3. Data Analysis

The data was analyzed using SPSS software version 17. Results were presented through frequency outputs and other descriptive statistics.

4. RESULTS AND CONCLUSION

4.1. Particulate Matter Concentration

Air pollution concentration in express in μg/m^3 (Table1). The reading of each day represent the 15 minutes recording at three predetermined point around the construction site. The result shows that the average concentrations of PM10 are 62.71 μg/m^3, concentration of PM2.5 is 18.32 μg/m^3 and concentration of PM1.0 is 14.04 μg/m^3. Among the three particulate matter concentration, PM10 shows the highest reading compared with PM2.5 and PM1.0.

The particulate matter concentration has the highest level on day five and the lowest are on day two. For PM10 the highest reading is 153.62 μg/m^3 and the lowest reading recorded are 14.56 μg/m^3. For PM2.5, the highest reading is 32.47 μg/m^3 meanwhile the lowest reading is 5.29 μg/m^3. On the other hand, the highest concentration for PM1.0 is 21.37 μg/m^3. PM1.0 and it was recorded lowest on the second day with a reading 4.22 μg/m^3.

Table 1. Particulate matter concentration in (μg/m^3)

Day	PM_{10}	$PM_{2.5}$	$PM_{1.0}$
1	80.57	22.14	8.64
2	14.56	5.29	4.22
3	32.73	9.30	17.58
4	69.16	23.67	19.02
5	153.62	32.47	21.37
6	35.94	24.85	22.57
7	52.4	10.56	4.89
Average	62.71	18.32	14.04

Table 2. Other pollutants concentration in ppm

Day	CO_2	SO_2
1	550	0.3
2	550	0.0
3	316	0.2
4	383	0.0
5	300	0.0
6	316	0.0
7	300	0.2
Average	387	0.1

During the sampling the other air pollutants that are considered are CO_2, SO_2, CO and NO_2. The average concentration for CO_2 is 387 ppm. Meanwhile, the average concentration for SO_2 is 0.1 ppm. However, there is no CO and NO_2 concentration are recorded during the sampling duration of seven days. It clearly show that on day one and day two the concentration of CO_2 was the same with a reading of 550ppm.It is the highest reading recorded among the seven day of sampling. The lowest concentration of CO_2 is recorded on day five with the reading of 300ppm.

The concentration of SO_2 was only can be detected on day one, day three and day seven. However, no reading was recorder on day two, four, five and six. The concentration of SO_2 on day one is 0.3ppm, for the day three and day seven, the same amount of SO_2 was detected that are 0.2 ppm.

During the sampling the other air pollutants that are considered are CO2, SO_2, CO and NO_2. The average concentration for CO_2 is 387 ppm. Meanwhile, the average concentration for SO_2 is 0.1 ppm. However, there is no CO and NO_2 concentration are recorded during the sampling duration of seven days. It clearly show that on day one and day two the concentration of CO_2 was the same with a reading of 550ppm, it is the highest reading recorded among the seven day of sampling. The lowest concentration of CO_2 is recorded on day five with the reading of 300ppm.

The concentration of SO_2 was only can be detected on day one, day three and day seven. However, no reading was recorder on day two, four, five and six. The concentration of SO_2 on day one is 0.3ppm, for the day three and day seven, the same amount of SO_2 was detected that are 0.2 ppm.

Temperature and humidity during the seven day of sampling at DesaParkcity construction site is shown in Table 3. The average temperature for the seven days is 30.9 ^{0}C. The highest

temperatures recorded are on day three and day five with the reading of 32.9 ^{0}C, meanwhile the lowest temperature that are recorder is on day two with the reading of 26.2 ^{0}C. For the humidity, the average humidity that had been recorded for the seven day reading is 68.59 kg/m^3. The highest humidity was recorded on day two with the reading of 90 kg/m^3. Meanwhile, the lowest humidity was recorded on day five with the reading of 57.1kg/m^3.

From Table 4, for the correlation significant of temperature with the air pollutant, there is no significant association between temperature and particulate matter as well as other gases as all the p value is greater than 0.05. For the correlation between temperature and particulate matter, all the particulate matter shows positive correlation with the temperature. Therefore, it means that when temperature increases, there is an increasing concentration of particulate matter concentration. PM10 shows a fair positive correlation with temperature (r = 0.45).Meanwhile, PM2.5 and PM1.0 show a weak positive correlation with the r value 0.19 and 0.18 respectively.

CO_2 shows a moderate negative correlation between CO_2 with the temperature (r = -0.68). The temperature and CO_2 are inversely proportional with each otherwhen the temperature increase, the concentration of CO_2 will decrease and vice versa. For the temperature and SO_2, there is a fair positive correlation relationship between temperature and SO_2 with the r value of 0.42. The temperature and SO_2 are proportional with each other. When the temperature increases, the SO_2 concentration will also increase.

All the result show there is no significant association between humidity and air pollutant as all the p value is more than 0.05. However, there is a significant correlation between humidity and CO_2 (r=0.77, p=0.03). PM10 shows negative moderate correlation with the temperature with the p value of -0.54. PM2.5 shows a fair negative correlation with the temperature (p = -0.34) and PM1.0 shows a weak negative correlation with the temperature with the value of p = -0.25. So, it can be concluded that the humidity are inversely proportional to the PM concentration.When the humidity increase, the concentration of PM will decrease or vice versa.

CO_2 shows a strong positives correlation with the humidity with the value of r = 0.77. CO_2 are directly proportional with the humidity, the increasing of humidity will also increase the concentration of CO_2 at the construction site. The r value for SO_2 is -0.18, so it can be concluded that SO_2 have a weak negative correlation with the humidity. The SO_2 are inversely proportional with the humidity.When the humidity increase, the concentration of SO_2 will also increase and vice versa.

From Table 5, it can be concluded there is no significant association between PM and other air

pollutant as all the p value is greater than 0.05. From the finding, it can be concluded that CO_2 have a fair negative correlation with all type of PM10, PM2.5 and PM1.0 with the value of -0.27,-0.42 and -0.38 respectively. When the concentration of PM increase, the concentration of CO_2 will decrease and vice versa.

For the SO_2 with the PM, it is a weak positive correlation with the r value equal to 0.12. If the concentration of PM increases, the concentration of SO_2 will also increase. On the other hand, for the PM2.5 and PM1.0 with SO_2, it clearly shows that it has a fair negative correlation with the r value of -0.35 and -0.41. They are inversely proportional with each other.

From Table 5, it can be concluded that there is a significant correlation between PM10 and PM2.5 (r=0.75, p= 0.05). There is a significant correlation between PM2.5 and PM1.0 (r=0.85, p=0.01). However, there is no significant correlation between particulate matters with other gases.

From Table 5, there is a strong positive correlation between PM10 and PM2.5 with the r value of 0.75. There is also a strong positive correlation between PM2.5 and PM1 (r = 0.85). Meanwhile, there is a fair correlation between PM10 and PM1.0. All the correlation are positive, so the PM are directly proportional with each other.When one of the PM increase, the other types of PM will also increases.

4.2. DISCUSSION

Table 1 shows that air pollution concentration in $\mu g/m^3$. The reading of each day represent the 15 minutes recording at three selected point around the construction site. The result shows that the average concentrations of PM10 are 62.71 $\mu g/m^3$, concentration of PM2.5 is 18.32 $\mu g/m^3$ and concentration of PM1.0 is 14.04 $\mu g/m^3$. Among the three particulate matter concentration, PM10 shows the highest reading compared with PM2.5 and PM1.0. The PM concentration has the highest level on day five and the lowest are on day two. This result may be because on day five there is an extra worker that handling construction machinery and vehicles as the construction manager need to speed up the construction phase as instructed by the project initiator. On day five, there are two front loaders, three crane, three backhoes and two cement trucks. The temperature also play an important role in the reading of the PM at the construction site, as we can see the temperature on that day is the highest compared with the other days.

For PM10, the highest reading is 153.62 $\mu g/m^3$ and the lowest reading recorded are 14.56 $\mu g/m^3$. For PM2.5, the highest reading is 32.47 $\mu g/m^3$ meanwhile the lowest reading is 5.29 $\mu g/m^3$. On the other hand, the highest concentration for PM1.0 is 21.37 $\mu g/m^3$and it was

recorded lowest on the second day with a reading 4.22 μg/m^3. The lowest reading is on day two.This may be due to environmental factor as on that day the temperature and humidity are very low as it was raining in the morning. It causes the PM reading lower. This can be supported by a study that suggests temperature and humidity can affect the PM reading [14].

4.3. Other Gases Concentrations

During the sampling the other air pollutants that are considered is CO_2, SO_2, CO and NO_2. The average concentration for CO_2 is 387 ppm. Meanwhile, the average concentration for SO_2 is 0.1ppm. However, there is no CO and NO_2 concentration are recorded during the sampling duration of seven days. The concentration of CO_2 for the seven day of sampling clearly show that on day one and day two the concentration of CO_2 was the same with a reading of 550ppm, it is the highest reading recorded among the seven day of sampling. The lowest concentration of CO_2 is recorded on day five with the reading of 300ppm. The concentration of SO_2 was only can be detected on day one, day three and day seven. However, no reading was recorder on day two, four, five and six. The concentration of SO_2 on day one is 0.3ppm.For the day three and day seven, the same amount of SO_2 was detected that are 0.2 ppm.

4.4. Temperature and Humidity

Table 3 shows the temperature and humidity during the seven day of sampling at DesaParkcity construction site. The average temperature for the seven days are 30.9 ^{0}C. The highest temperatures recorded are on day three and day five with the reading of 32.9 ^{0}C, meanwhile the lowest temperature that are recorded is on day two with the reading of 26.2 ^{0}C. For the humidity, the average humidity that had been recorded for the seven day reading is 68.59 kg/m^3. The highest humidity was recorded on day two with the reading of 90 kg/m^3. Meanwhile, the lowest humidity was recorded on day five with the reading of 57.1 kg/m^3. Temperature and humidity was recorded in order to study the correlation between meteorological factors with the air pollution concentration at DesaParkcity construction site.

From Table 4, for the correlation significant of temperature with the air pollutant, there is no significant association between temperature and particulate matter as well as other gases as all the p value is greater than 0.05. For the correlation between temperature and particulate matter, all the particulate matter shows positive correlation with the temperature. Therefore, it means that when temperature increases, there is an increasing concentration of particulate matter concentration. PM10 show a fair positive correlation with temperature (r = 0.45), meanwhile PM2.5 and PM1.0 show a weak positive correlation with the r value 0.19 and 0.18 respectively.

CO_2 shows a moderate negative correlation between CO_2 with the temperature (r = -0.68).

The temperature and $CO_2$are inversely proportional with each other.When the temperature increase, the concentration of CO_2 will decrease and vice versa. For the temperature and SO_2, there is a fair positive correlation relationship between temperature and SO_2 with the r value of 0.42. The temperature and SO_2 are proportional with each other. When the temperature increases, the SO_2 concentration will also increase.

Table 4. Meteorological factor with all pollutant

Pollutant	Temperature		Humidity	
	r	p	r	p
PM_{10}	0.45	0.31	-0.54	0.21
$PM_{2.5}$	0.19	0.67	-0.34	0.45
$PM_{1.0}$	0.18	0.69	-0.25	0.58
CO_2	-0.68	0.11	0.77	0.03*
SO_2	0.42	0.34	-0.18	0.68

Table 5 shows that there is no significant association between humidity and air pollutant as all the p value is more than 0.05. However, there is a significant correlation between humidity and CO_2 ($r=0.77$, $p=0.03$). This can be supported by the study that had been done by [15-16].In [15] observed that carbon dioxide concentration show significantly positive correlation with humidity ($r=0.647$, $p<0.05$).

PM10 shows negative moderate correlation with the temperature with the p value of -0.54. PM2.5 show a fair negative correlation with the temperature (p = -0.34) and PM1.0 shows a weak negative correlation with the temperature with the value of p = -0.25. So, it can be concluded that the humidity are inversely proportional to the PM concentration.When the humidity increase, the concentration of PM will decrease or vice versa.

CO_2 shows a strong positives correlation with the humidity with the value of r = 0.77. CO_2 are directly proportional with the humidity.The increasing of humidity will also increase the concentration of CO_2 at the construction site. The r value for SO_2 is -0.18, so it can be concluded that SO_2 have a weak negative correlation with the humidity. The SO_2 are inversely proportional with the humidity.When the humidity increase, the concentration of SO_2 will also increase and vice versa.

Table 5. Particulate matter with other gases (n=7)

Pollutant	PM_{10}		$PM_{2.5}$		$PM_{1.0}$	
	r	p	r	p	r	p
PM_{10}			0.75	0.05	0.39	0.38
$PM_{2.5}$	0.75	0.05*			0.85	0.01*
$PM_{1.0}$	0.39	0.38	0.85	0.01*		
CO_2	-0.27	0.55	-0.42	0.34	-0.38	0.39
SO_2	0.12	0.79	-0.35	0.43	-0.41	0.35

*Spearman correlation test was applied

*correlation is significant at 0.05 levels

The result shows that the average concentrations of PM10 are 62.71 μg/m^3, concentration of PM2.5 is 18.32 μg/m^3 and concentration of PM1.0 is 14.04 μg/m^3. Among the three particulate matter concentration, PM10 shows the highest reading compared with PM2.5 and PM1.0. From the study, it can be concluded that there is no significant association between meteorological factors with the particulate matter concentration at DesaParkcity construction site. Thus, the hypothesis is rejected.

There is no significant association between temperature and particulate matter, as well as other gases. For the correlation between temperature and particulate matter, all the particulate matter shows significant association with the temperature. Therefore, it means that when temperature increases, there is an increasing concentration of particulate matter concentration.

For the correlation significant of humidity and air pollutant, there is a significant association between meteorological factor with the concentration or CO_2, CO, SO_2 and NO_2 at DesaParkcity construction site. This hypothesis is accepted for carbon dioxide association with humidity. There is a significant correlation between humidity and CO_2 (r=0.77, p=0.03).There is no significant association between particulate matter concentrations with other gases at DesaParkcity Construction site.

5. ACKNOWLEDGEMENTS

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