CHARACTERIZATION OF SULPHUR DIOXIDE, NITROGEN DIOXIDE AND CARBON MONOXIDE FROM URBAN AND RURAL SCHOOL ENVIRONMENT IN KELANTAN AND THEIR AFFILIATION WITH STUDENTS HEALTH

by

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DECLARATION

I declare that this thesis entitled "Characterization of Sulphur Dioxide, Nitrogen Dioxide and Carbon Monoxide from Urban and Rural School Environment in Kelantan and Their Affiliation with Students Health" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 11th JANUARY 2017

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LIST OF ABBREVIATIONS

SO_2	Sulfur Dioxide
NO_2	Nitrogen Dioxide
CO	Carbon Monoxide
H_2SO_4	Sulfuric Acid
SO_3	Sulfur Trioxide
PM	Particulate Matter
WHO	World Health Organization
DOE	Department of the Environment
O_3	Ozone
AQG	Air Quality Guidelines
ACS	American Cancer Society
API	Air Pollutant Index
RMAQG	Recommended Malaysia Air Quality Guidelines
IAQ	Indoor air quality
SPSS	Statistical Package for the Social Science
VOCs	Volatile organic compounds
n	Subject Size
N	Total number of population
ppm	Parts Per Million
$\mu g/m^3$	Micrograms per Cubic Meter of Air

LIST OF SYMBOL

%	Percentage

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Characterization of Sulphur Dioxide, Nitrogen Dioxide and Carbon Monoxide from Urban and Rural School Environment in Kelantan and Their Affiliation with Students Health

ABSTRACT

The aim of this study is to determine urban development and rural area affecting the human health. In this study, three criteria pollutants listed by Department of Environment Malaysia (DOE) had been selected, which were sulphur dioxides (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO). In addition, this study had been focused on two areas which are Kota Bharu (SMK Kubang Kerian 1) and Jeli (SK Batu Melintang). Triangulation method was adopted to achieve an understanding of respondent's health level and air quality indicator. This method adopted in this research to combine information about human health and air quality drawn from in-depth data gathered from a wider range of participants by a questionnaire session. Respondents were selected from each of the urban and rural school proximity area, using a stratified random sampling procedure. The Dräger X-am 5000 used to obtain the data for gases concentration in the school. The result showed that the concentration of gases which were SO_2, NO_2 and CO of school in urban area was higher than school in rural area. Rural school area had lower values of SO_2 concentration which was 0.042 ppm compared to the urban school area that had mean value of 0.058 ppm. Value of NO_2 concentration recorded in the sampling stations showed that the urban school area had higher values of NO_2 which was 0.067 ppm compared to the rural school area that had mean NO_2 value of 0.041 ppm. Concentration of the CO in urban school area found more polluted (6.389 ppm/6.098 ppm) compared to the rural area (4.543 ppm/4.564 ppm). In this study also it can be concluded that the student in urban school area experience greater health effects than student in rural school area. Health performance of student from rural school area was better than school children living in high pollution urban area. But, all the values were not exceeded the Recommended Malaysia Air Quality Guidelines (RMAQG) prescribed by Department of Environment (DOE) for residential and rural residential areas. Improvement was required on air quality on urban and rural school areas so that a better environment can be enhanced.

Pencirian Sulphur Dioksida, Nitrogen Dioksida, dan Karbon Monoksida daripada Persekitaran Sekolah di Bandar dan Luar Bandar dan Perkaitan dengan Kesihatan Pelajar

ABSTRAK

Kajian ini bertujuan untuk menilai kesan pembangunan di kawasan bandar dan luar bandar kepada kesihatan manusia. Dalam kajian ini, tiga kriteria pencemar udara yang disenaraikan oleh Jabatan Alam Sekitar Malaysia (JAS) telah diambil kira iaitu sulfur dioksida (SO_2), nitrogen dioksida (NO_2), dan karbon monoksida (CO). Kajian ini tertumpu kepada dua kawasan iaitu Kota Bharu (SMK Kubang Kerian 1) dan Jeli (SK Batu Melintang). Kaedah penyegitigaan diguna pakai untuk mendapat pemahaman tentang tahap kualiti udara dan penunjuk kesihatan responden. Kaedah yang diguna pakai ini menggabungkan maklumat tentang kesihatan manusia dan kualiti udara diambil daripada data yang dikumpul daripada peninjauan dan kajian soal selidik. Responden dipilih daripada setiap kawasan berdekatan sekolah bandar dan luar bandar dengan menggunakan prosedur persampelan rawak berstrata. Dräger X-am 5000 merupakan alat yang digunakan untuk mendapatkan data bagi kepekatan gas di sekolah. Hasil kajian menunjukkan bahawa kepekatan gas SO_2, NO_2 dan CO sekolah di kawasan bandar adalah lebih tinggi daripada sekolah di kawasan luar bandar. Kawasan sekolah luar bandar mempunyai nilai SO_2 yang lebih rendah iaitu 0.042 ppm berbanding kawasan sekolah bandar yang mempunyai nilai 0.058 ppm. Bagi kepekatan NO_2, nilai yang dicatatkan pada stesen persampelan menunjukkan bahawa kawasan sekolah bandar mempunyai nilai yang lebih tinggi iaitu 0.067 ppm berbanding kawasan sekolah luar bandar yang mempunyai nilai purata NO_2 iaitu 0.041 ppm. Kepekatan CO di kawasan sekolah bandar juga didapati lebih tercemar (6.389 ppm/6.098 ppm) berbanding kawasan luar bandar (4.543 ppm/4.564 ppm). Dalam kajian ini juga dapat disimpulkan bahawa pelajar di kawasan sekolah bandar mengalami kesan kesihatan yang lebih tinggi daripada pelajar di kawasan sekolah luar bandar. Prestasi kesihatan pelajar dari kawasan sekolah luar bandar adalah lebih baik berbanding pelajar di kawasan sekolah bandar yang mempunyai kadar pencemaran yang tinggi di kawasan bandar. Namun, semua nilai yang diperoleh tidak melebihi garis panduan yang disyorkan oleh Kualiti Udara Malaysia (RMAQG) yang ditetapkan oleh Jabatan Alam Sekitar (JAS) untuk kawasan kediaman bandar dan luar bandar. Peningkatan diperlukan pada kualiti udara di kawasan sekolah bandar dan luar bandar supaya persekitaran yang lebih baik boleh ditingkatkan.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Malaysia is a middle-income country that has transformed itself from 1971 through the late 1990s from a producer of raw materials into an emerging multi-sector economy (Wu et al., 2004). The goal of achieving industrial country status by the year 2020 and the associated rapid economic growth have started to impose costs in terms of industrial pollution and degradation of urban environment. Depletion of fisheries, air and water pollution, and contamination by industrial wastes has become more serious in Malaysia in recent years. Among the effects, air pollution is the major issue that has been affecting human health, agricultural crops, forest species, and ecosystems (Afroz et al., 2003).

Air pollution can harm human health, the environment, and cause property damage. Various researches have proven the connection of air quality and human health. Air environmental health indicators were defined operationally as a combination of "air quality" and "air-related health" indicators. At the same time, general environmental quality was replaced by "air quality indicators". Thus, the air environmental health indicators are consisting of air-related health indicators and air quality indicators. The epidemiology and laboratory studies demonstrated that ambient air pollutants (for example particulate matter (PM), ozone (O_3), sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) contributed to various health problems including bronchitis, emphysema and asthma (Mabahwi et al., 2014).

Environmental health has a very strong connection between the human health and healthy environment and it's often due to an imbalance resulting from poor adjustment between the individual and the environment (Botkin & Keller, 2007). It focuses on the external factors that cause disease, including elements of the natural, social, cultural, and technological of the world.

Unstoppable urban development cause continuously air pollution. Urban ambient air is more polluted than overall atmosphere, due to high density of human population and their activities in urban areas; it produces air pollutants with a higher rate as compared to less-developed areas and natural environment. Besides, the atmosphere has always been one of the most convenient spaces to dispose off unwanted materials, which includes the smoke from burning (Ling et al., 2010).

1.2 Problem Statement

The World Health Organization (WHO) defines air pollution as the presence of materials in the air in such concentration which are harmful to man and his environment (WHO, 1992). In fact air pollution is the occurrence or addition of foreign particles, gases and other pollutants into the air which have an adverse effect on human beings, animals, vegetation, buildings and other. Generally, air pollutants give different effect to student health between urban and rural school area. The intensity of pollution exposure depends on sources and type of in-situ pollution emission.

In general, an urban area is a human settlement with high population density and infrastructure of built environment while a rural area is a geographic area that is located outside towns and cities. Urban areas has also been characterized by high amounts of pollution, large-scale industrialization and faster lifestyles. Pollution in urban areas is high due to the large amount of people, cars, buses, train and industrialization includes factories, machines and offices. Rural areas are more dependent on natural resources and organic materials. Over the last decades, as the Kubang Kerian area has population more than 10 000, the development activities of Kubang Kerian as an urban area has elevated the risk of air pollution. This has cause detrimental effect to environment and human health because of the air pollution contamination. Literature search revealed that research only focusing in big and popular cities which contain high industrial activities rather than medium industrial due to possibilities of higher pollutants emission thus, through this research, eastern citizens will know their current state of air quality.

Particulate matter with aerodynamic diameter less than 10 micron (PM_{10}) is identified as the most significant air pollutants in Malaysia. However, there are a few gases air pollutants such as NO_2, SO_2 and CO were considered as criteria pollutants in Malaysia. These criteria pollutant were selected among various types of significant air pollutant and due to its health effect. In addition, these criteria pollutant also used as indicator in Air Pollution Index (API) and their sources were always monitored in order to ensure public health (Afroz et al., 2003; DOE, 2012).

School children are one of the susceptible groups due to air pollutants. Normally, children and young adults spend an average of 10 hours of their waking time in school environments (Ashmore et al., 2009). The scenario may lead to higher risk of health deterioration among school children due to their physical and availability of the gases in school environment. The purpose of the research is to investigate the relationship between air quality in urban and rural school area and student health effects. The relationship between gases concentration and student health is carried out by conducting questionnaire session with student that have range of environmental health experience.

1.3 Objectives

The objectives of this study are :

1. To determine the concentrations of sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO) of school in urban and rural area.
2. To compare the concentration of sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO) of school in urban and rural area.
3. To determine the relationship between air quality of school in urban and rural area towards school's student health.

1.4 Significance of Study

From this study, the concentration of gases which are SO_2, NO_2 and CO of school in urban area is higher than school in rural area. The student in urban areas will experience greater health effects than student in rural areas.

CHAPTER 2

LITERATURE REVIEW

2.1 Air Pollution

Air pollution is physical or chemical changes brought about by natural processes or human activities that result in air quality degradation (Cunnigham et al., 2005). Significance problem related to air pollution began when human populations became so concentrated that their waste materials could not be broken down as fast as they were produced. As the population increased, people began to congregate and establish cities. The release of large amounts of smoke and other forms of waste into the air caused an unhealthy condition because the pollutants were released faster than they could be absorbed and dispersed by the atmosphere (Enger & Smith, 2000). Air is invariably impure and is always contaminated with gases like SO_2, NO_2, CO, and others (which are poisonous in nature) and finely divided into solid, liquid particles and smog. Hence, air becomes polluted due to the presence of the above contaminants. The presence of these contaminants in the air is called air pollution and the materials which pollute the air are called air pollutants (Ahluwalia & Malhotra, 2008).

Clean air is essential to all living humans and animals for good health and well-being. However, due to unstoppable urban development, the air is continuously polluted. The World Health Organization (WHO) stated that urban air pollution is a critical public health problem, and more than 2 million premature deaths each year can be attributed by the effects of urban outdoor air pollutant and indoor air pollutant (WHO, 2006). However, the consequences of air pollution on public health are measured not only in terms of sickness and death, but also in terms of lost of productivity, missed educational and other human development opportunities (UN, 2001). The adverse health effects, such as respiratory morbidity, cardiovascular diseases and mortality have created a public awareness to the urban air pollution.

2.2 Air Quality in Malaysia

Ambient air quality standards identify individual pollutants and the concentrations at which they become harmful to the public health and the environment. The standards are typically set without regard to economic feasibility for attainment. Instead, it focus on public health, including the health of sensitive populations such as asthmatics, children and the elderly, and public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, aquatic resources, and buildings (Mabahwi et al., 2014).

Problems of waste disposal arise whenever people congregate in large numbers as they do in cities, as for airborne wastes emitted into the atmosphere in and above cities (Kemp, 2004). In reality many urban cities in the developed world have an urban structure which encourages unsustainable practices with regard to water management, biodiversity and air quality or greenhouse emissions (Enger & Smith, 2000).

Furthermore, Kemp (2004) also stated that air pollution was most common in large cities that had high seasonal heating requirements, were heavily industrialized, had large volumes of vehicular traffic or experienced a combination of all three. In cities, the rigid separation of housing, employment, commercial and recreational activities creates a dependency on road-based transport, which in turn contributes to high levels of urban air pollution and greenhouse emissions (Enger & Smith, 2000).

Urban air pollution caused by the inability of the local environment to accommodate the level of waste produced by large numbers of people concentrated in relatively small areas (Kemp, 2004).

2.3 Sources and Types of Air Pollutants in Malaysia

The three major sources of air pollution in Malaysia are mobile, stationary, and open burning. Emissions from mobile sources have been the major source of air pollution, contributing to at least 70-75% of the total air pollution. Emissions from stationary sources generally have contributed to 20–25% of the air pollution while open burning and forest fires have contributed approximately 3–5% (DOE, 1996 cited in Yahaya et al., 2006). Mobile sources include motor vehicles such as personal cars, commercial vehicles, and motorcycles. By the end of 2000, there were 10.6 million vehicles registered in Malaysia, compared to 7.7 million in 1996, an increase of almost 2.9 million vehicles or 26% (DOE, 2001).

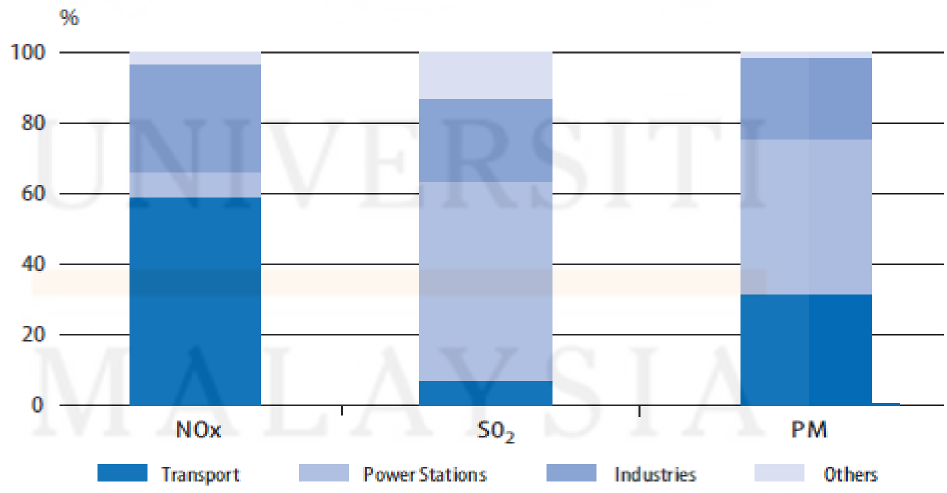

Figure 2.1 : Emissions Inventories of PM, SO_2, and NOx by sources in 2004 (Tons) (Source : ASMA, 2006)

Recent estimates of emissions in Malaysia are shown in Figure 2.1. The transport sector accounted for the majority of nitrogen oxide (NOx) emissions and about 35%

of the total particulate matter (PM) emissions in the country. The power sector and industries accounted for the majority of sulfur dioxide (SO_2) and PM emissions; the power sector accounted for about 60% of the total SO_2 emissions and almost 50% of the total PM emissions, while the industries accounted for about 20% of the total SO_2 and PM emissions (ASMA, 2006).

In Malaysia, air pollution has been recognized as one of the major concern that has high potential for deleterious effects on health (Zakaria et al., 2010). Five types of substances, known as primary pollutants, account for more than 90% of the nationwide air pollution problem are carbon monoxide (CO), nitrogen oxides (NOx), hydrocarbons (HC), sulfur oxides (SOx) and particulate matter (PM).

2.3.1 Sulfur Dioxide (SO_2)

Sulfur dioxide is a non-flammable, colourless gas that can exist in air either as a gas or dissolved in water droplets. It can be tested by most people at concentration of about 900 $\mu g/m^3$ or greater (WHO, 2000). Sulfur dioxide partially oxidizes in air to form sulfur trioxide (SO_3) which readily combines with water vapour to form sulfuric acid (H_2SO_4).

Sulfur dioxide produced from man-made sources such as the combustion of fossil fuels used for energy production is one of the major pollutants. Apart from that, other anthropogenic source of SO_2 is the burning of sulfur-containing fossil fuels for domestic heating, power generation and motor vehicles. Industrial processes such as smelting, sulfuric acid manufacture and petroleum refining also produce sulfur dioxide (WHO, 2000).

SO_2 can affect the respiratory system and the functions of the lungs, and causes irritation of the eyes. Inflammation of the respiratory tract causes coughing, mucus secretion, aggravation of asthma and chronic bronchitis and makes people more prone to infections of the respiratory tract. Hospital admissions for cardiac disease and mortality increase on days with higher SO_2 levels. Combination of SO_2 and water produced sulfuric acid which is the main component of acid rain that contributed to deforestation (WHO, 2000).

2.3.1 (a) Short-term exposures to human

Controlled studies involving exercising asthmatics indicate that a proportion experience changes in pulmonary function and respiratory symptoms after periods of exposure to SO_2 as short as 10 minutes. Based on this evidence, it is recommended that a SO_2 concentration of 500 $\mu g/m^3$ should not be exceeded over averaging periods of 10 minutes duration. Because short-term SO_2 exposure depends very much on the nature of local sources and the prevailing meteorological conditions, it is not possible to apply a simple factor to this value in order to estimate corresponding guideline values over longer time periods, such as one hour.

2.3.1 (b)Long-term exposures to human

Early estimates of day-to-day changes in mortality, morbidity or lung function in relation to 24 hour average concentrations of SO_2 were necessarily based on epidemiological studies in which people are typically exposed to a mixture of pollutants. As there was little basis for separating the contributions of individual pollutants to the observed health outcomes, prior to 1987, guideline values for SO_2 were linked to corresponding values for PM. This approach led to the setting of an

AQG (Air Quality Guidelines) value for SO_2 of 125 μg/m^3 as a 24 hour average, after applying an uncertainty factor of two to the lowest observed adverse effect level (WHO, 2010). In the second edition of the WHO Air quality guidelines for Europe (WHO, 2000), it was noted that later epidemiological studies documented separate and independent adverse public health effects for PM and SO_2, and this led to a separate WHO AQG for SO_2 of 125 μg/m^3 (24-hour mean).

The latest evidence to emerge includes a study conducted in Hong Kong (Medley et al., 2002) where a major reduction in the sulfur content of fuels has been achieved over a very short period of time. This has been linked to substantial reductions in health effects (e.g. childhood respiratory disease and all-age mortality). Recent time series studies on hospital admissions for cardiac disease in Hong Kong and London produced no evidence of a threshold for health effects at 24 hour SO_2 concentrations in the range of 5–40 μg/m^3 (Wong et al., 2002). 24 hour SO_2 levels were significantly associated with daily mortality rates in 12 Canadian cities, which had an average concentration of only 5 μg/m^3 (the highest mean SO_2 level was below 10 μg/m^3) (Burnett et al., 2004). In the American Cancer Society (ACS) study, significant associations between SO_2 and mortality were observed for the 1982–1998 cohort in 126 United States metropolitan areas, in which the mean SO_2 concentration recorded was 18 μg/m^3, and the highest mean, 85 μg/m^3 (Pope et al., 2002). If there were a threshold for effects in either of these two studies, it would have to be very low.

2.3.2 Nitrogen Dioxide (NO_2)

Nitrogen dioxide (NO_2) is a colourless, odourless gas that is slightly soluble in water. NO_2 is reddish-orange-brown gas that have pungent odour, corrosive and highly oxidizing. NO_2 is the most prevalent nitrogen oxide air pollutants. These pollutants are emitted from high temperature combustion processes with the major oxide in combustion emissions being NO. NO_2 is the main source of nitrate aerosols, which form an important fraction of PM 2.5 in the presence of ultraviolet light, of ozone. The major sources of anthropogenic emissions of NO_2 are combustion processes (heating, power generation, and engines in vehicles and ships).

As an air pollutant, nitrogen dioxide (NO_2) has multiple roles, which are often difficult or sometimes impossible to separate from one another. First, animal and human experimental studies indicate that NO_2 at short term concentrations exceeding 200 $\mu g/m^3$ is a toxic gas with significant health effects. Animal toxicological studies also suggest that long-term exposure to NO_2 at concentrations above current ambient concentrations has adverse effects. Second, numerous epidemiological studies have used NO_2 as a marker for the cocktail of combustion-related pollutants; in particular, those emitted by vehicular or indoor combustion sources. In these studies, any observed health effects could also have been associated with other combustion products, such as ultrafine particles, nitric oxide (NO), particulate matter or benzene. Although several studies both outdoors and indoors have attempted to focus on the health risks of NO_2, the contributing effects of these other, highly correlated co-pollutants were often difficult to rule out. Third, most atmospheric NO_2 is emitted as NO, which is rapidly oxidized by O_3 to NO_2. NO_2 in the presence of hydrocarbons and ultraviolet light is the main source of tropospheric ozone and of nitrate aerosols, which form an important fraction of the ambient air PM mass.

The current WHO guideline value of 40 μg/m^3 (annual mean) was set to protect the public from the health effects of gaseous NO_2. The rationale for this was that because most abatement methods are specific to NOx and not designed to control other co-pollutants, and may even increase their emissions. However, if NO_2 is monitored as a marker for complex combustion-generated pollution mixtures, a lower annual guideline value should be used (WHO, 2000).

2.3.2 (a) Long-term exposures to human

Epidemiological studies have shown that symptoms of bronchitis in asthmatic children increase in association with long-term exposure to NO_2. Reduced lung function grows also linked to NO_2 at concentrations measured (or observed) in cities of Europe and North America (Brook et al., 2004). There was a strong association between estimated NO_2 exposure per 10 μg/m^3 and lung function, especially expiratory flow when adjusted for age gender, height and weight, in linear regression model conducted by Rosenlund et al., (2009). Combustion products containing SO_2 were risk factors for the development of wheezing bronchitis in female children (Pershagen et al., 1995).

Recent indoor studies have provided evidence of effects on respiratory symptoms among infants at NO_2 concentrations below 40 μg/m^3. These associations cannot be completely explained by co-exposure to PM, but it has been suggested that other components in the mixture (such as organic carbon and nitrous acid vapour) might explain part of the observed association. The above findings provide some support for requirement a lowering of the current annual NO_2 guideline value.

2.3.2 (b)Short-term exposures to human

A number of short-term experimental human toxicology studies have reported acute health effects following exposure to 1 hour NO_2 concentrations in excess of 500 μg/m^3. Although, the lowest level of NO_2 exposure show direct effect on pulmonary function in asthmatics in more than one laboratory is 560 μg/m^3, studies of bronchial responsiveness among asthmatics suggest an increase in responsiveness at levels upwards from 200 μg/m^3.

Since the existing WHO AQG short-term NO_2 guideline value of 200 μg/m^3(1-hour) has not been challenged by more recent studies, it is retained. In conclusion, the guideline values for NO_2 remain unchanged in comparison to the existing WHO AQG levels which is 40 μg/m^3 for annual mean and 200 μg/$m^3$for 1 hour mean.

2.3.3 Carbon Monoxide (CO)

Carbon monoxide (CO) is a colourless, odourless, tasteless, stable gas, slightly lighter than air; in high concentrations it can cause many physiological changes and ultimately death. Exposure to relatively low level of CO may result in significant health effects after only a few hours.

CO is one of the most widely distributed and most commonly occurring air pollutants. Atmospheric CO is primarily produced by the incomplete combustion of carbonaceous materials used as fuels for vehicles, space heating and industrial processing.

2.3.3 (a)Long-term exposures to human

A single exposure to carbon monoxide can have long-term consequences. "Post CO syndrome" is characterized by headaches, nausea and weakness. This condition can present up to 40 days after an acute CO exposure and last for two to three weeks. In rare cases, severe delayed neurotoxicity following a single acute poisoning can cause permanent disability (Weaver & L. K., 2009).

The incidence of delayed effects varies depending on the severity of the initial exposure. A large study conducted by Choi & S. (1983) found that only 1% of patients whose CO exposures were not severe enough to cause coma developed delayed symptoms of neurological damage. This rate increased to 30% among patients whose CO induced comas lasted 6 days or longer. Delayed symptoms included mental deterioration, personality changes, autism, severe memory loss, fecal and urinary incontinence, tremor, visual loss, movement disorders, peripheral neuropathy, Tourette's syndrome and Parkinson syndrome. Neurological changes include bilateral basal ganglia lesions, diffuse white matter changes including demyelization and cerebella swelling with hydrocephalus (Choi & S., 1983).

The American Conference of Government Industrial Hygienists has developed a workplace standard of 25 ppm for CO (American Government Industrial Hygienists, 1995). This standard is intended to protect healthy workers who are exposed 8 hours a day, 5 days a week. Federal air quality standards require that CO levels in outdoor air be less than 9 ppm in residential areas (8-hour average) (Knobeloch et al., 1999). Air quality standards have not been established for homes. However, Underwriters Laboratory requires residential CO detectors to sound an 85 decibel alarm within 90 minutes if the CO concentration is at 100 ppm, within 35 minutes at 200 ppm, and 15 minutes at 400 ppm.

2.3.3(b) Short-term exposures to human

The effects of CO are related to the CO concentration in the air, the duration of the exposure, a person's health status, and the activity level of the individual. Symptoms in order of increasing severity of CO poisoning are headache, dizziness on exertion, fatigue, palpitations, nausea, vomiting, and difficulty breathing on exertion, mental confusion, rapid heartbeat, visual disturbance, and muscle twitch. However, symptoms may not always appear in the order given above.

Symptoms tend to become more severe as exposure and concentration increase, for example, mild headache or nausea progressing to more severe cases. At very high CO levels, unconsciousness and eventually death may result. Acute exposure to very high levels not resulting in death may cause permanent damage to the heart and brain. Because many of the adverse effects experienced at low to moderately high CO levels are also symptoms of common acute illnesses, people may not consider CO poisoning as a possible cause (Ernst et al., 1998).

Most people are not expected to experience symptoms below 70 ppm CO for acute exposure durations. As CO levels increase and remain above 70 ppm, symptoms may become noticeable. At levels approaching 200 ppm, symptoms become more severe. A concentration of 400 ppm will further intensify symptoms and is life threatening after three hours of exposure while 800 ppm results in unconsciousness within two hours and death within two to three hours. Exposure to about 13,000 ppm of CO can cause death after one to three minutes. CO exposure is the leading cause of immediate deaths due to building fires (Stewart & R. D., 1975).

2.4 Recommended Malaysia Air Quality Guidelines (RMAQG)

In Malaysia, the air quality is regulated by the Department of Environment (DOE) with collaboration of Meteorological Department. Malaysia is using Recommended Malaysia Air Quality Guidelines (RMAQG) for standard measurement of air quality. The pollutants listed in the guidelines only included ozone, sulphur dioxide, nitrogen dioxide, carbon monoxide, total suspended solid, lead and PM_{10}.

Based on the comparison of recommended standard for SO_2, NO_2 and CO by World Health Organization (WHO), United States Environmental Protection Agency (USEPA) and Recommended Malaysia Air Quality Guidelines (RMAQG) in Table 3.1, it has shown that the standard level of SO_2 for 24-hours mean in Malaysia (105 $\mu g/m^3$) is five times higher than the value of the recommended standards by WHO which is 20 $\mu g/m^3$ for 24-hours mean. For NO_2, the standard level for 1 hour mean in Malaysia (320 $\mu g/m^3$) is five times higher than the value of the recommended standards by WHO which is 200 $\mu g/m^3$ for 1 hour mean. But, for the standard level of CO for 1 hour mean in Malaysia (30 $\mu g/m^3$) is one time lower than the value that recommended standards by WHO which is 55 $\mu g/m^3$ for 1 hour mean (WHO, 2006).

Table 2.1 : Recommended Malaysia Air Quality Guidelines (RMAQG) (Source : DOE, 2000)

Pollutant	Averaging Time	ppm	$\mu g/m^3$
Sulphur dioxide	10 minutes	0.19	500
	1 hour	0.13	350
	24 hour	0.04	105
Nitrogen dioxide	1 hour	0.17	320
Carbon Monoxide	1 hour	30	35
	8 hour	9	10
Ozone	1 hour	0.10	200
	8 hour	0.06	120
Particle TSP	24 hour		260
	1 year		90
PM_{10}	24 hour		150
	1 year		50
Lead	3 month		1.5

2.5 Urban versus Rural

Children living and attending schools in urban areas are more likely to be highly exposed to air pollution and therefore are at high risk of experiencing chronic health effect due to air pollution exposure such as cognitive deficit. A study by Zailina et al. (1996) carried out in 1992 found that children who lived in the Kuala Lumpur city center were highly exposed to air pollution. According to the report by the Department of Environment (1996), and previous studies (Zailina et al., 1996), the main source of air pollution was motor vehicle exhausts. The dilute acid soluble of sulphur dioxide, nitrogen dioxide and carbon monoxide fraction in outdoor air was the highest compared to the strong acid and water soluble fractions, while in the indoor air, the water soluble sulphur dioxide, nitrogen dioxide and carbon monoxide fraction was the highest compared to other fractions. The dilute acid soluble fraction most likely contains halogenated species emitted from the combustion of leaded gasoline in motor vehicles (Zailina et al., 1996).

2.6 School Environment

The classrooms' indoor air quality has caught attention because children are more susceptible to poor air quality, which cause easily recognizable impacts on health (Jones et al., 2007). This is due to the fact that poor indoor air quality (IAQ) can reduce the student's health, productivity and ability to perform specific mental task requiring concentration as they may appear sleepy, coughing, dizzy and experienced other respiratory illnesses (Moglia et al., 2006).

Besides, physically developing and growing children are more vulnerable and likely to suffer from the consequences of indoor air quality. Children spend a large portion of their time in school during weekdays which exposed them to the indoor air pollutants in school (Meklin et al., 2002). The indoor particle generation and outdoor air filtration are key factors influencing the indoor particles' concentration. Indoor particle generation can due to the human activities or specific sources such as occupants of the building (Ramachandran et al., 2000).

Previous findings also have proven that indoor occupants increased the indoor particle levels (Poupard et al., 2005). Ismail et al., (2010) showed there were differences on particulate levels with time depending on the change of activities inside the classrooms. Human activities in coastal or industrial areas had higher ambient PM_{10} concentrations; however, the indoor PM_{10} was higher than the outdoor PM_{10} as measured due to the housekeeping activities inside the classrooms such as sweeping, cleaning habits or writing and erasing of blackboards. The indoor particle generation and outdoor air filtration are key factors influencing the indoor particles' concentration.

However, Ismail et al., (2010) found that indoor air quality in school was significantly influenced by outdoor air concentration as there was significant strong correlation between indoor air and outdoor air concentrations, besides the indoor air concentrations were influenced by human activities.

2.7 Health Effect of Air Pollution

The adverse health effects associated with air pollution, which include respiratory morbidity, cardiovascular diseases and mortality, have contributed in creating public awareness in this kind of pollution. Health risk evaluation and assessment have now become important since these serve as the basis for any reformulation or review of current air quality standards (Colls et al., 1997). The health effects mentioned regarding the bad air pollution in these cities are chronic coughing and susceptibility to infections, while deaths from air pollution occur primarily among the elderly, the infirm, and the very young. Bronchial inflammations, allergic reactions, and irritation of the mucous membranes of the eyes and nose all indicate that air pollution must be reduced (Enger et al., 2000).

In addition, WHO estimates that two million children under age 5 die each year from acute respiratory diseases exacerbated by air pollution (Cunningham et al, 2001). Air pollution cause health effects by inhalation, or direct absorption through the skin or contamination of food and water. These air pollutants elements are very strong oxidizing agents, sulphates, SO_2, NO_2, and O_3 act as irritants that damage delicate tissues in the eyes and respiratory passages (Cunningham et al., 2001). Proven by Marquez et al., (1999), particulates (PM10) and O_3, primarily resulting from emissions of oxides of nitrogen (NOx) and hydrocarbons/air toxins (HC or VOCs), destroy sensitive tissues (in people, animals and plants) and impair respiratory functions.

Research by Marquez et al., (1999) stated the significant impact of urban form (transportation and air quality). Bangkok has three times the rate of lung cancer as the rest of Thailand. This has been mostly attributed to transport-related miasmas. The haze and filth from the diesel exhausts in Manila and Calcutta are so thick that it is frequently difficult to breathe. Mexico City experiences O_3 levels up to three times the detrimental level set for Melbourne. The American Lung Association estimates that over 60,000 people die prematurely in the USA (by up to two years) due to exposure to PM_{10} particles (American Lung Association, 2005).

Evaluations and assessments on health is an important basis in order to carry out a reformulation or review on the current air quality standards (Colls et al., 1997). The Clean Air Act of 1970 regarded pollutants, such as sulphur dioxide, carbon monoxide, particulates, volatile hydrocarbons, photochemical oxidants, and lead, to be the greatest threats to human health (Cunningham et al., 2001).

Due to the unstoppable urbanization in this world and Malaysia especially, risk of getting affected by air pollution is high. More than 2 million premature deaths each year can be attributed to the effects of urban outdoor air pollution and indoor air pollution (caused by the burning of solid fuels). More than half of this disease burden is borne by the populations of developing countries (WHO, 2006). Heart attacks, respiratory diseases, and lung cancer are all significantly higher in people who breathe dirty air compared to matching groups in cleaner environments (Cunningham et al., 2001). Hundreds of deaths have been directly related to poor air quality in cities. No doubt, these pollutants have the capabilities to threat the human health and environment, and could cause significant damages to properties.

CHAPTER 3

METHODOLOGY

3.0 Methodology

The key aim of this study was to explore how urban development and rural area affecting the human health. Therefore, triangulation method was adopted to achieve an understanding of respondent's health level and air quality indicator. The triangulation method was an approach to research that uses a combination of more than one research strategy in a single investigation (Faisal, 2012).

This method adopted in this research to combine information about human health and urban air quality drawn from in-depth data gathered from a wider range of participants by a questionnaire session. Respondents were selected from each of the urban and rural school proximity area, using a stratified random sampling procedure. The stratified sampling method ensured that types of respondents' ages and gender were selected. Health data had been collected in this stage through questionnaire session from respondents in school at urban and rural area.

This study used stratified random sampling, where the populations were being splinted into strata/sections/segments/categories that relevant to this research. A stratified random sampling had been selected by randomly choosing respondent as sample in within the study area. Methods in this research include the theoretical analysis of Urban Air Quality and acquiring important information from key informants and public to scope the issues and problems using structured questionnaire.

In addition to the air quality data, the research requires a questionnaire session on health effects by the selected study area. It would focus to gather data on the symptoms or diseases related to air pollution in order to find the connections between the human health and urban air pollution and at the same time study the actual relationship shared by the human being and air quality.

3.1 Monitoring of Air Pollutants

Study had been focusing on the urban and rural context of Kelantan. This is because air quality is not localize and affected by several factors such as geography and wind, therefore study should better not to be focuses on one city only. Some air pollutants are able to travel far away from the sources even at regional scale due to the long atmospheric lifetimes. However, there were a number of previous study made by other scholar focusing on localize city. This study had been focus on the air quality of Kelantan.

In these study only three criteria pollutants listed by Department of Environment Malaysia (DOE) had been counted in, which were sulphur dioxides (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO). In addition, this study focused on two areas which were Kota Bharu and Jeli.

3.2 Study Area

Ambient air quality of school had been identified through air sampling. In this study, two ambient air quality monitoring stations had been identifying which was located at Kota Bharu for urban area and Jeli for rural area. Sekolah Menengah Kebangsaan Kubang Kerian 1 which located at Jalan Raja Perempuan Zainab 2, Kota

Bharu, Kelantan and Sekolah Kebangsaan Batu Melintang, Kampong Batu Melintang, Jeli, Kelantan had been selected as the main study areas.

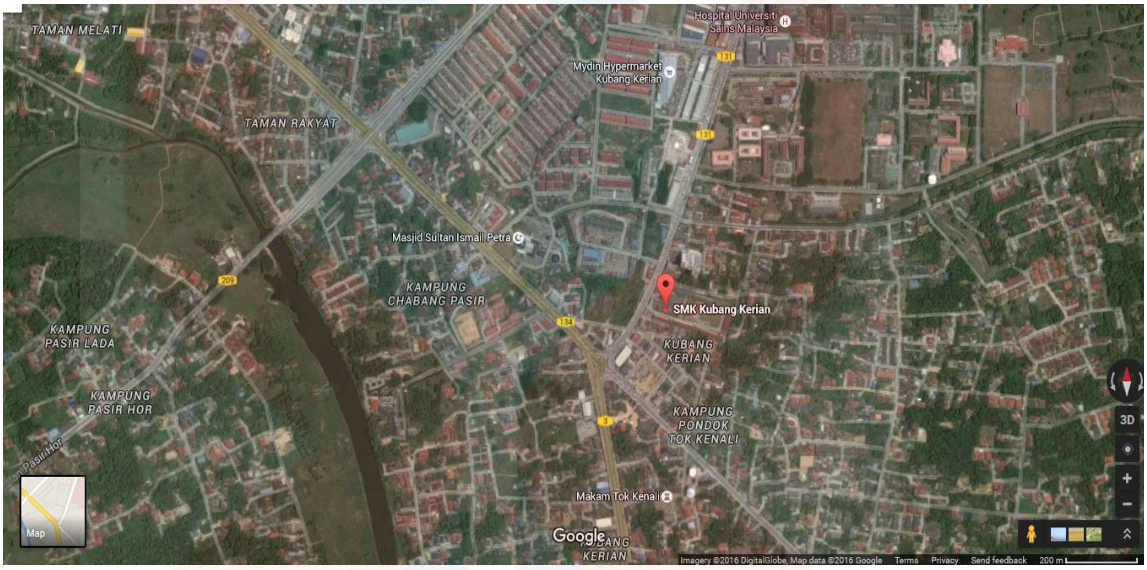

Figure 3.1 : Location of SMK Kubang Kerian 1, Kota Bharu, Kelantan (Latitude : 6.0925, Longitude : 102.2777) (Source : Google Maps, 2016)

Figure 3.2 : Location of SK Batu Melintang, Jeli, Kelantan (Latitude : 5.7086, Longitude : 101.7356) (Source : Google Maps, 2016)

3.3 Duration of Air Pollutants Monitoring

The collection of sulphur dioxides (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO) concentrations data obtained two month which started from July 2016 till August 2016 to get all 30 samples which is 15 samples from school at urban area and 15 samples from school at rural area for the different air pollutants to perform the study and analysis of data. This study initially employs monitoring technique known as purposive strategy. This offered the practical advantage of expanding the range of research participants that readily known their contribution. It facilitated exploration in qualitative research, in particular through interviews (Atkinson et al., 2001).

3.4 Collecting Data

For the purpose of indicating urban air quality for environmental health, the three pollutants (SO_2, NO_2, CO) were selected. In this study, The Dräger X-am 5000 used to obtain the data for gases concentration in the school. The Dräger X-am 5000 belongs to a new generation of gas detectors, developed especially for personal monitoring applications.

The Dräger X-am 5000 was an ergonomic mobile phone design. Despite its advanced functionality, the Dräger X-am 5000's practical mobile phone design and light weight makes it comfortable to carry. Reduced to its essentials, the two button control panel and easy to follow menu allow for intuitive use. The Dräger X-am 5000 was flexible sensor exchange. It was easy to exchange, upgrade or calibrate the sensors to other gases. The ability to customize the Dräger X-am 5000's sensors makes more applications possible, including rental equipment. The Dräger X-am

5000 was a hydrogen compensated sensor for reliable readouts. This new sensor CO compensates for hydrogen interference up to 2000 ppm with less than 1 % CO response, meaning it very reliable as can be. The Dräger X-am 5000 was water and dust resistant according to IP 67 standards. This means that the detector remains fully functional and ready for use even after being dropped into water. The integrated rubber protection and shock-proof sensors provide additional resistance to impact and vibration. Moreover, the Dräger X-am 5000 was resistant to electromagnetic interference.

Figure 3.3: Drager X-am 5000 (Source : Dräger X-am®5000 Multi-Gas Detector Guidelines, 2014)

3.5 Calculating Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2) and Carbon Monoxide (CO) Values

Air quality data for the three air pollutants (SO_2, NO_3, CO) had been collect continuously for sufficient averaging time periods. The necessary calibration, validation, quality control and quality assurances had been conduct in the process of data collection. The average concentration of the specific air pollutants for the specified averaging time periods had been calculated. At the same time, the value for each of the three air pollutants based on the average concentrations had been calculated.

3.6 Health symptoms questionnaire

The relationship between air quality of school in urban and rural area towards school's student health obtained by giving questionnaire to the respondent. Doing questionnaire had been conducted to obtain the data from the student especially to know about their health effect due to the air quality. The questionnaire divided into 4 sections; Section A consisted of general and demographic information. Information on respondents respiratory as allergy symptoms had been in section B. Section C consisted of question on disease and allergic conditions. Information on this section enabled to determine the potential risk factors associated with health status with their conditions. Section D included questionnaires on the indoor and outdoor environment. The information was important to access the potential environmental factors which may contribute to the severity of disease among the students.

3.7 Analysis of Data

This was the stage where raw data had been analyses and processed. The analyses involved were descriptive statistic, trend and quantitative analysis. Descriptive analysis was used to describe and explain more on the attributes analysis on the tables and figures.

Quantitative analysis had been carried out by using Statistical Package for Social Science (SPSS) Version 23 as the tools. The mean of the gas concentration had been calculated using SPSS Software to compare of gases concentration between urban and rural school area in Kelantan and their effect to the students health.

Then, the result of the data analysis had been compared to the Department of Environment (DOE) that formulated a set of air quality guidelines that defining the concentrations limits of selected air pollutants which might adversely affect the health of the student.

The trend analysis had been carried to get the relationship between air quality and health background. In addition to the air quality status data, questionnaire session had been made to the selected study area on health effects focusing on the symptoms or diseases relating the air pollution. Collection daily data of SO_2, NO_3, CO during the research, study on human health had been made as well through questionnaire session.

Only symptoms and diseases in relating to air pollution had been the case study of this research. Data gathered by questionnaire session had been used to find the relationship between human health and air pollution. In addition, data collected from respondent regarding their health was to get the health risk and health effects of air pollution. This was because, health risk evaluation and assessment have now become important since these serve as the basis for any reformulation or review of current air quality standards (Colls et al., 1997).

CHAPTER 4

RESULT AND DISCUSSION

4.1 Descriptive Statistics of SO_2, NO_2 and CO in Urban and Rural Area

Table 4.1 showed the descriptive statistics of SO_2, NO_2 and CO in SMK Kubang Kerian 1 and SK Batu Melintang. In Table 4.1, it showed that the concentration of the SO_2 recorded in the study areas ranged between 0.035 ppm to 0.078 ppm in urban school area while the concentration of the SO_2 recorded in rural school area ranged between 0.024 ppm to 0.057 ppm. Rural school area had a lower value of SO_2 which was 0.042 ppm compared to the urban school area that had mean value of 0.058 ppm. The standard deviation for SO_2 in urban school area was 0.012 ppm while in rural school area was 0.011 ppm respectively.

In Table 4.1, the concentration of the NO_2 recorded in the sampling stations ranged between 0.047 ppm to 0.094 ppm in urban school area while the concentration of NO_2 recorded in rural school area ranged between 0.023 ppm to 0.057 ppm. Urban school area had higher values of NO_2 which was 0.067 ppm compared to the rural area that had mean NO_2 value of 0.041 ppm. The standard deviation for NO_2 in urban school area was 0.013 ppm while in rural school area was 0.011 ppm respectively.

Concentration of the CO showed in Table 4.1 that was recorded in the sampling stations ranged between 4.53 ppm to 8.63 ppm (8 a.m. reading) and 3.29 ppm to 7.50 ppm (4 p.m. reading) in urban school area while the concentration of the CO recorded in rural school area ranged between 2.37 ppm to 6.48 ppm (8 a.m. reading) and 2.96 ppm to 6.83 ppm (4 p.m. reading). Urban school area found more polluted (6.389 ppm/6.096 ppm) compared to the rural area (4.543 ppm/4.564 ppm). The standard deviation for CO in urban school area was 1.317 ppm (8 a.m. reading) and 1.064 (4 p.m. reading) while in rural school area were 1.175 (8 a.m. reading) and 1.434 (4 p.m. reading) respectively.

Table 4.1: Descriptive Statistics of SO_2, NO_2 and CO in SMK Kubang Kerian 1 and SK Batu Melintang

	Minimum (ppm)	**Maximum (ppm)**	**Mean (ppm)**	**Standard Deviation (ppm)**
SMK Kubang Kerian 1				
SO_2	0.035	0.078	0.058	0.012
NO_2	0.047	0.094	0.067	0.013
CO (8 a.m.)	4.530	8.630	6.389	1.317
CO (4 p.m.)	3.290	7.500	6.098	1.064
SK Batu Melintang				
SO_2	0.024	0.057	0.042	0.011
NO_2	0.023	0.057	0.041	0.011
CO (8 a.m.)	2.370	6.480	4.543	1.175
CO (4 p.m.)	2.960	6.830	4.564	1.434

4.1.1 The Variation of SO_2 in Urban and Rural Area

Table 4.2 and 4.3 showed the concentration of the SO_2 recorded in the study areas ranged between 0.035 ppm to 0.078 ppm in urban school area while the concentration of the SO_2 recorded in rural school area ranged between 0.024 ppm to 0.057 ppm. Figure 4.1 and 4.2 showed that rural school area had a lower values of SO_2 which was 0.042 ppm compared to the urban school area that had mean value of 0.058 ppm. All these values not exceeded the Recommended Malaysia Air Quality Guidelines (RMAQG) prescribed 0.13 ppm for residential and rural residential by Department of Environment (DOE).

SO_2 was known to be one of the main pollutants in ambient air, especially in urban areas (Wrobel A et al., 2000). Normally, the major sources of this type of pollutant comes from motor vehicle usage and industrial activities, and since the study area in SMK Kubang Kerian 1 was one of the industrial towns with a high volume of heavy vehicles, (the monitoring site located just beside the major road of Kubang Kerian), SO_2 concentration in this particular area tends to be higher rather than rural study area in SK Batu Melintang in Jeli.

Table 4.2 : The reading of SO_2 concentrations at 8 a.m. in SMK Kubang Kerian 1

Date	PM_{10} concentration (ppm)
17/07/2016	0.044
18/07/2016	0.057
19/07/2016	0.068
20/07/2016	0.045
21/07/2016	0.035
22/07/2016	0.054
23/07/2016	0.078
24/07/2016	0.063
25/07/2016	0.071
26/07/2016	0.046
27/07/2016	0.063
28/07/2016	0.048
29/07/2016	0.059
30/07/2016	0.076
31/07/2016	0.056

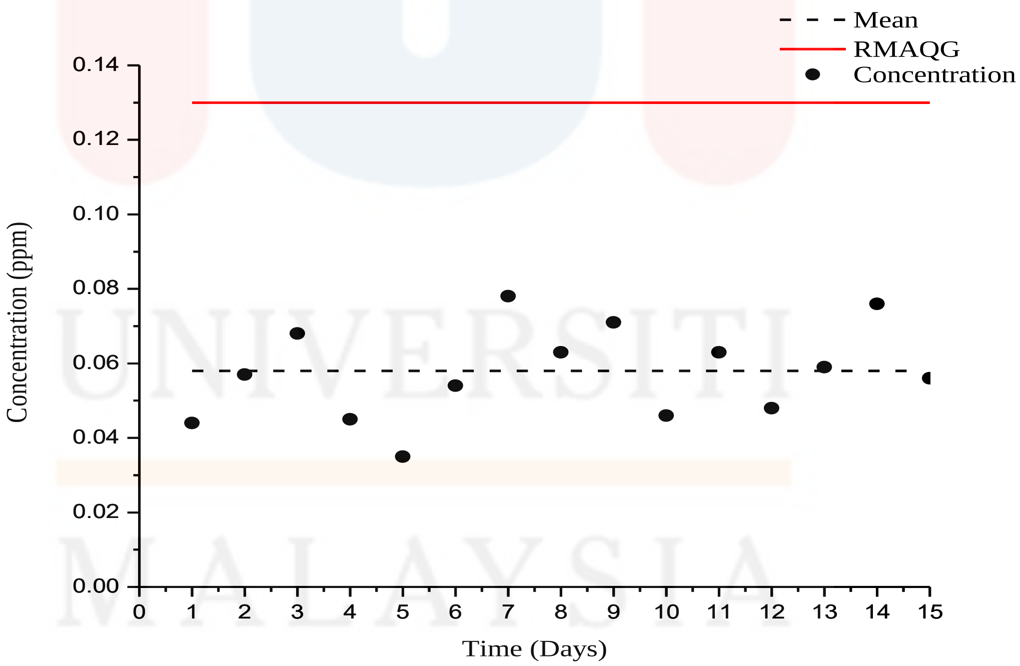

Figure 4.1 : Plot of concentration of SO_2 in SMK Kubang Kerian 1

Table 4.3 : The reading of SO_2 concentrations at 8 a.m. in SK Batu Melintang

Date	PM_{10} concentration (ppm)
02/08/2016	0.025
03/08/2016	0.043
04/08/2016	0.056
05/08/2016	0.032
06/08/2016	0.047
07/08/2016	0.052
08/08/2016	0.039
09/08/2016	0.047
10/08/2016	0.026
11/08/2016	0.041
12/08/2016	0.057
13/08/2016	0.041
14/08/2016	0.024
15/08/2016	0.049
16/08/2016	0.057

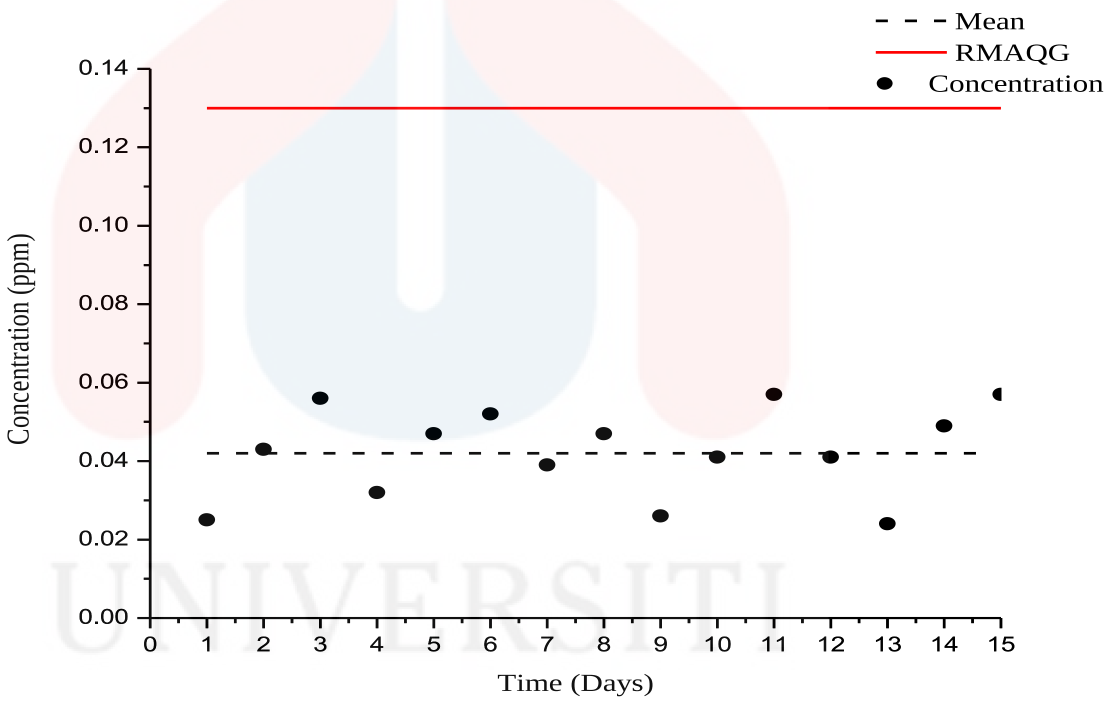

Figure 4.2 : Plot of concentration of SO_2 in SK Batu Melintang

4.1.2 The Variation of NO_2 in Urban and Rural Area

During the same period of sampling, concentration of the NO_2 showed in Table 4.4 and 4.5 ranged between 0.047 ppm to 0.094 ppm in urban school area while the concentration of NO_2 recorded in rural school area ranged between 0.023 ppm to 0.057 ppm. Figure 4.3 and 4.4 showed that urban school area had higher values of NO_2 which was 0.067 ppm compared to the rural area that had mean NO_2 value of 0.041 ppm. All these values were within the Recommended Malaysia Air Quality Guidelines (RMAQG) prescribed 0.17 ppm for residential and rural residential by Department of Environment (DOE).

The fluctuations of NO_2 concentration reveal that there was a mobilization of motor vehicles around that area, where the majority of people living there use motor vehicles as a means of transportation. In a process parallel to that of sulfur dioxide production during fuel combustion, nitrogen in fuels was converted to oxides of nitrogen in the combustion process (WHO, 2010).

Table 4.4 : The reading of NO_2 concentrations at 8 a.m. in SMK Kubang Kerian 1

Date	**PM_{10} concentration (ppm)**
17/07/2016	0.083
18/07/2016	0.065
19/07/2016	0.054
20/07/2016	0.079
21/07/2016	0.057
22/07/2016	0.049
23/07/2016	0.062
24/07/2016	0.075
25/07/2016	0.094
26/07/2016	0.081
27/07/2016	0.069
28/07/2016	0.047
29/07/2016	0.062
30/07/2016	0.058
31/07/2016	0.063

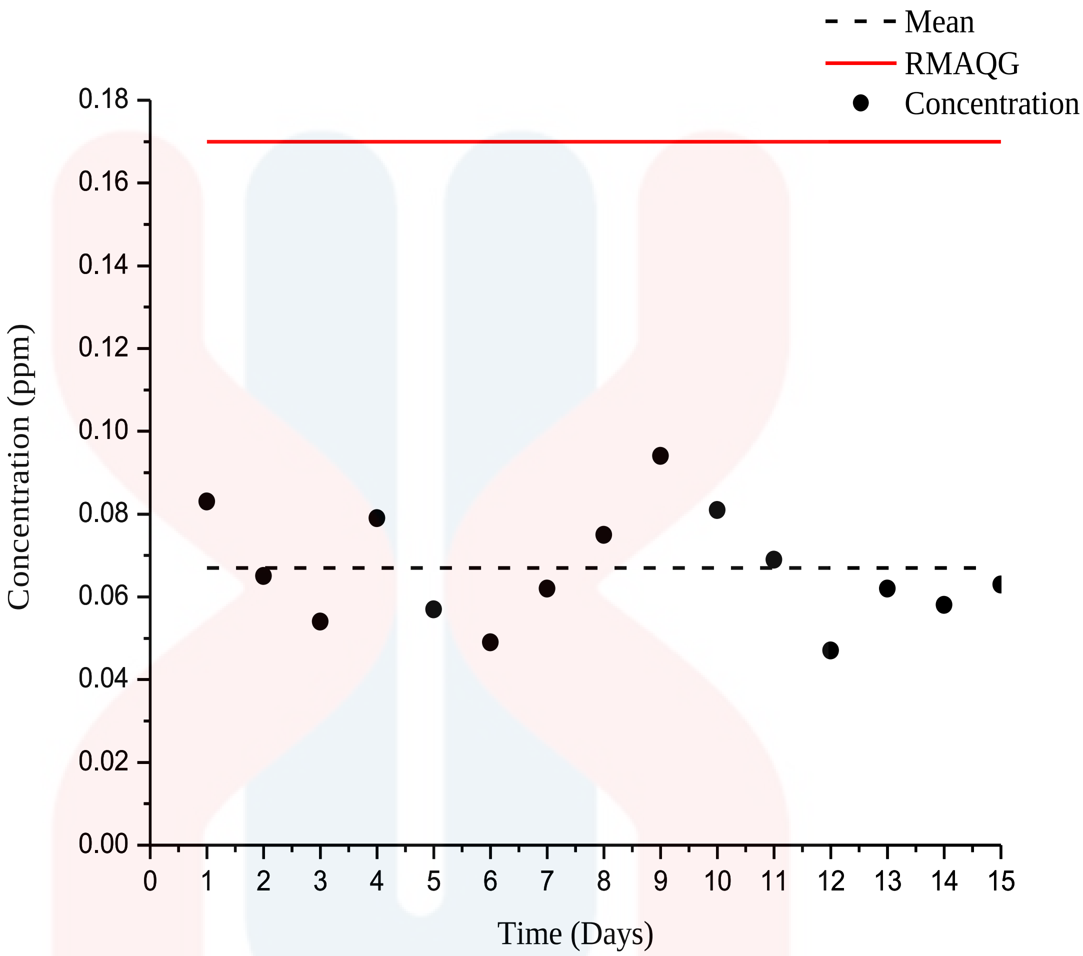

Figure 4.3 : Plot of concentration of NO_2 in SMK Kubang Kerian 1

Table 4.5 : The reading of NO_2 concentrations at 8 a.m. in SK Batu Melintang

Date	PM_{10} concentration (ppm)
02/08/2016	0.047
03/08/2016	0.051
04/08/2016	0.037
05/08/2016	0.028
06/08/2016	0.041
07/08/2016	0.053
08/08/2016	0.024
09/08/2016	0.037
10/08/2016	0.023
11/08/2016	0.047
12/08/2016	0.039
13/08/2016	0.057
14/08/2016	0.041
15/08/2016	0.035
16/08/2016	0.053

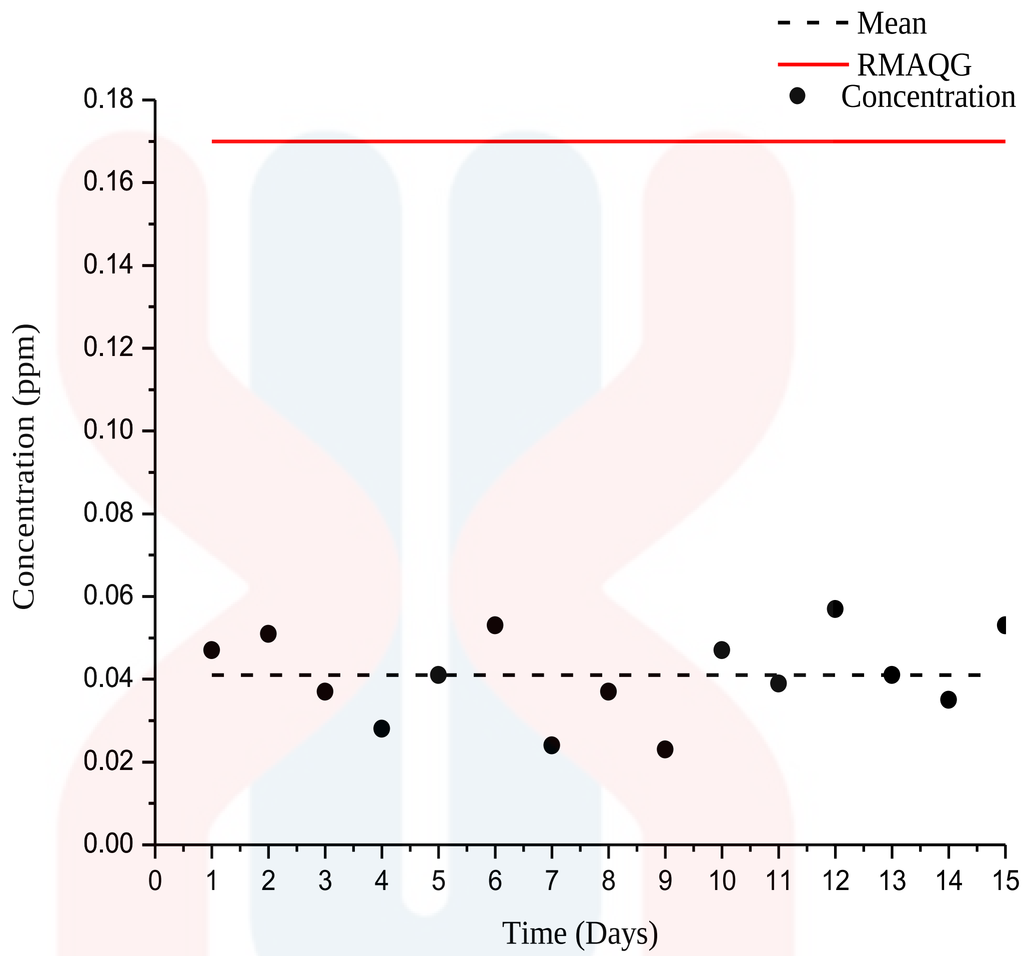

Figure 4.4 : Plot of concentration of NO_2 in SK Batu Melintang

4.1.3 The Variation of CO in Urban and Rural Area

Table 4.6 and 4.7 showed the concentration of the CO recorded in the sampling stations ranged between 4.53 ppm to 8.63 ppm (8 a.m. reading) and 3.29 ppm to 7.50 ppm (4 p.m. reading) in urban school area while the concentration of the CO recorded in rural school area ranged between 2.37 ppm to 6.48 ppm (8 a.m. reading) and 2.96 ppm to 6.83 ppm (4 p.m. reading). In Figure 4.5 and 4.6, it showed that urban school area found more polluted (6.389 ppm/6.096 ppm) compared to the rural area (4.543 ppm/4.564 ppm). The values of CO in both the study areas not exceeded the Recommended Malaysia Air Quality Guidelines (RMAQG) prescribed 30 ppm for residential and rural residential by Department of Environment (DOE).

The primary causes of the CO emission was due to the same reason reported by the (DOE, 2016) of which 97.1% of CO emission released into the atmosphere in Malaysia is dominantly caused by transportation activities that include emissions from motor vehicles (both private cars and businesses owned vehicles). In addition, the total estimation of emission released was over 1.4 million metric tons in 2008, of which was caused by the overwhelming number of registered vehicles (more than 19 million in the country) (DOE, 2016).

Table 4.6 : The reading of CO concentrations at 8 a.m. and 4 p.m. in SMK Kubang Kerian 1

Date	**(i) PM_{10} concentration (ppm) (8 a.m.)**	**(ii) PM_{10} concentration (ppm) (4 p.m.)**
17/07/2016	4.93	5.68
18/07/2016	6.67	5.72
19/07/2016	4.53	5.23
20/07/2016	5.95	6.73
21/07/2016	7.82	6.93
22/07/2016	8.36	7.50
23/07/2016	5.46	5.91
24/07/2016	4.67	3.29
25/07/2016	6.35	5.38
26/07/2016	7.83	6.41
27/07/2016	5.41	6.65
28/07/2016	6.93	7.17
29/07/2016	8.63	7.26
30/07/2016	6.48	5.48
31/07/2016	5.82	6.11

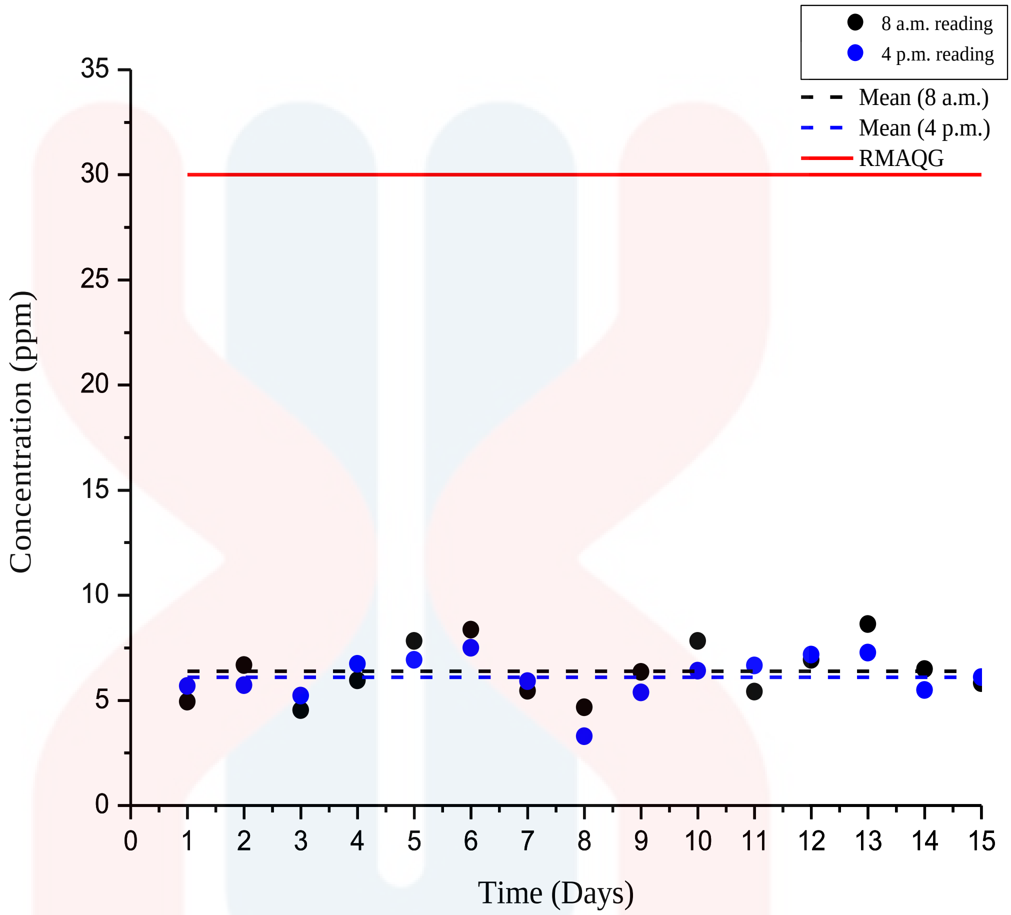

Figure 4.5 : Plot of concentration of CO in SMK Kubang Kerian 1

Table 4.7 : The reading of CO concentrations at 8 a.m. and 4 p.m. in SK Batu Melintang

Date	(i) PM_{10} concentration (ppm) (8 a.m.)	(ii) PM_{10} concentration (ppm) (4 p.m.)
02/08/2016	2.37	3.32
03/08/2016	4.86	4.16
04/08/2016	3.65	3.10
05/08/2016	5.71	6.37
06/08/2016	6.48	5.42
07/08/2016	4.85	5.87
08/08/2016	2.65	3.17
09/08/2016	3.56	2.96
10/08/2016	5.64	5.82
11/08/2016	4.31	3.19
12/08/2016	5.89	6.68
13/08/2016	4.63	3.67
14/08/2016	5.24	6.83
15/08/2016	4.33	3.72
16/08/2016	3.97	4.18

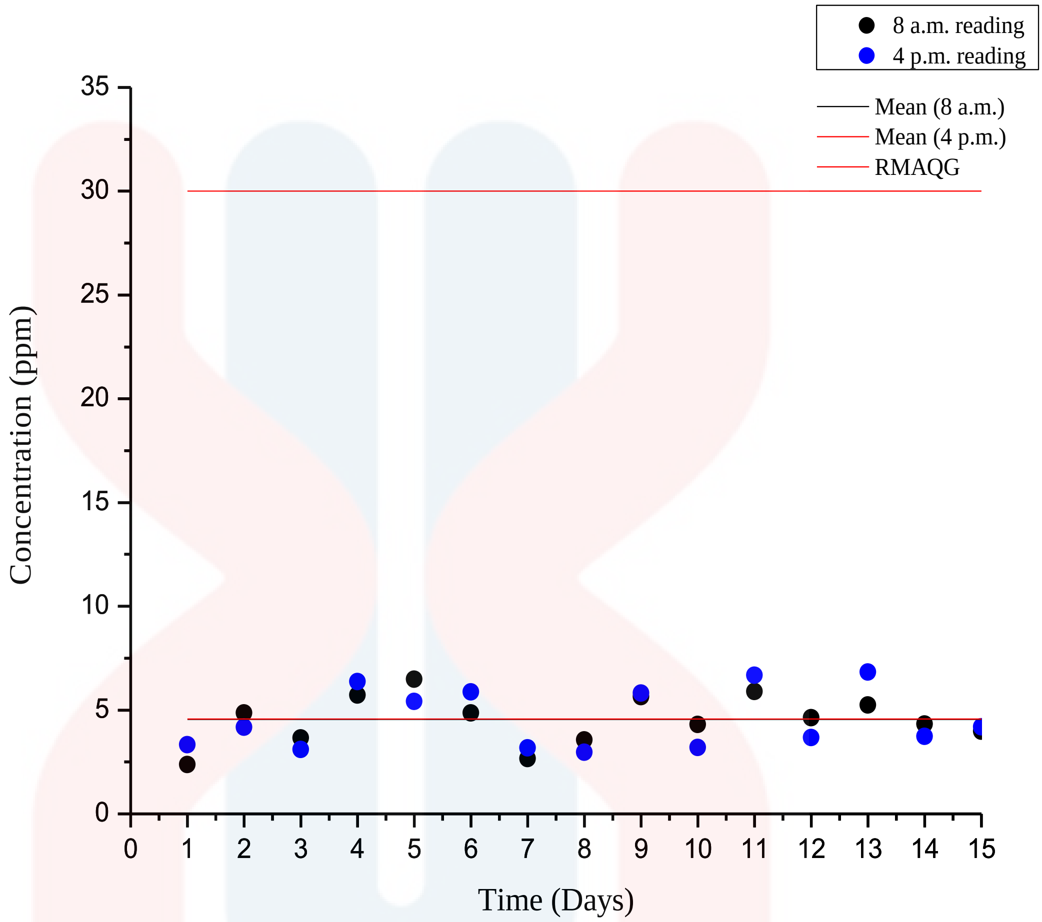

Figure 4.6 : Plot of concentration of CO in SK Batu Melintang

4.2 Validity Test

A validity test or known as pilot test was conducted to validate the questionnaire prior distributes to respondent. This is to validate the questionnaire and the accuracy of the questionnaire; hence the data that produced can be true, useful, reliable and trustworthy before the collection of the actual data started.

A total of 80 respondents (10% from total number of respondents) were selected to answer the questionnaire during the research pilot study. After conducting the pilot test, the validity of the questionnaire was analyzed using SPSS software.

Based on the questions tested in the questionnaire, a test in SPSS called Cronbach's Alpha showed a significant number 0.729 in the reliability statistics table as shown in Table 4.8. This suggested that the research was reliable and considered acceptable since the reliability was greater than 0.70 (Nunnally,1978)

Table 4.8 : Cronbach's Alpha Reliability Statistics

Cronbach's Alpha	N of items
0.729	16

N : Number of questions

4.3 Respondent of the questionnaire

Table 4.9 showed the frequency for respondent and subject size in SMK Kubang Kerian 1 and SK Batu Melintang. In SMK Kubang Kerian 1, the total population in the school is about 1202 students. After calculating using Raosoft calculator from International Statistical Services, the number of subject size in SMK Kubang Kerian 1 was 292 respondents.

In SK Batu Melintang, the total population in the school is about 441 students. After calculating using Raosoft calculator from International Statistical Services, the number of subject size in the school was 206 respondents respectively.

Table 4.9 : Frequency for respondent and subject size in SMK Kubang Kerian 1 and SK Batu Melintang

Study area	Total population, N	Number of subject size, n
SMK Kubang Kerian 1	1202	292
SK Batu Melintang	441	206

4.4 Demographic Data of Respondents

The parameters used in the demographic data are gender, smoking habit, position and period of presence in place of study.

4.4.1 Gender

Frequency and percentage for gender of respondents in SMK Kubang Kerian 1 in Table 4.10 showed that majority of the respondents or 20.5% individuals were male and the rest 79.5% were female.

In SK Batu Melintang, the frequency and percentage for gender of respondents in Table 4.10 showed that majority of the respondents or 83% individuals were female and the rest 17% were male.

Table 4.10 : Frequency and percentage for gender of respondents in SMK Kubang Kerian 1 and SK Batu Melintang

Gender	Frequency	Percentage (%)
SMK Kubang Kerian 1		
Male	60	20.5
Female	232	79.5
SK Batu Melintang		
Male	35	17
Female	171	83

4.4.2 Smoking habit

Frequency and percentage for respondents smoking habit in SMK Kubang Kerian 1 in Table 4.11 showed that majority of 94.9% respondents were not smoking while the other 5.1% respondents were smoking.

In SK Batu Melintang, frequency and percentage for respondents smoking habit in Table 4.11 showed that majority of 98.5% respondents were not smoking while the other 1.5% respondents were smoking.

Table 4.11 : Frequency and percentage for respondents smoking habit in SMK Kubang Kerian 1 and SK Batu Melintang

Smoke	Frequency	Percentage (%)
SMK Kubang Kerian 1		
Yes	15	5.1
No	277	94.9
SK Batu Melintang		
Yes	3	1.5
No	203	98.5

4.4.3 Position of the respondent

Table 4.12 showed that the frequency and percentage for position of respondents in SMK Kubang Kerian 1. It showed that majority of 63.7% respondent were in Form 4. There rest were 36.3% respondent were in Form 3.

In SK Batu Melintang, the frequency and percentage for position of respondents in Table 4.12 showed that majority of 69.9% respondent were in Year 6. There rest were 30.1% respondent were in Year 5.

Table 4.12 : Frequency and percentage for position of respondents in SMK Kubang Kerian 1 and SK Batu Melintang

Form	Frequency	Percentage (%)
SMK Kubang Kerian 1		
3	106	36.3
4	189	63.7
Year	**Frequency**	**Percentage (%)**
SK Batu Melintang		
5	62	30.1
6	144	69.9

4.5 Health Problems

Table 4.13 showed the frequency and percentage for health problem that respondents in SMK Kubang Kerian 1 and SK Batu Melintang had. In SMK Kubang Kerian 1, it showed that majority of 55.5% reported that they had suffered from fever. There were 20.5% and 15.8% stated that they had allergic problem and had suffered from eczema. The least health problem had become a concern as it had been related with the indoor allergens was asthmatic problem which is 15.1% respectively.

In SK Batu Melintang, the frequency and percentage for health problem that respondents had in Table 4.13 showed that majority of 18.9% reported that they had allergic problem. There were 16% and 14.6% stated that they had suffered from eczema and fever. The least health problem had become a concern as it has been related with the indoor allergens was asthmatic problem which is 4.4% respectively.

The role of fungi, mould and the school dust mite were suspected as being considered as producer of building allergens. People who had suffered from fever and asthma may become more severe due to these indoor allergens. Among the environmental influences that have been implicated in modifying the development of respiratory asthma were the conditions of exposure to allergens, indoor air quality and outdoor air pollution (Kimber & I., 1998, Cai et al., 2011, Hussin et al., 2011).

The different composition of air pollutants, the dose and time of exposure and the fact that human were usually exposed to pollutant mixture than to single substance can lead to diverse impact on human health (Pope et al., 1995, Curtis et al., 2006). A review by Tzivian (2011) concluded that outdoor air pollution affects the appearance and exacerbation of asthma in children.

Schools located in the urban areas tend to expose the students to dusts containing allergens, air particulates containing sulphate, heavy metals and others (Phipatanakul et al., 2011). Schools located in areas with the highest air pollution levels have the lowest attendance rates which potentially indicate poor health and a high proportion of the students did not perform well academically (Mohai et al., 2011).

Table 4.13 : Frequency and percentage for health problem that respondents had in SMK Kubang Kerian 1 and SK Batu Melintang

Health Problem	Frequency		Percentage (%)	
	Yes	No	Yes	No
SMK Kubang Kerian 1				
Asthmatic problem	44	248	15.1	84.9
Suffered from fever	162	130	55.5	44.5
Suffered from eczema	46	246	15.8	84.2
Allergic problem	60	232	20.5	79.5
SK Batu Melintang				
Asthmatic problem	9	197	4.4	95.6
Suffered from fever	30	176	14.6	85.4
Suffered from eczema	33	173	16.0	84.0
Allergic problem	39	167	18.9	81.1

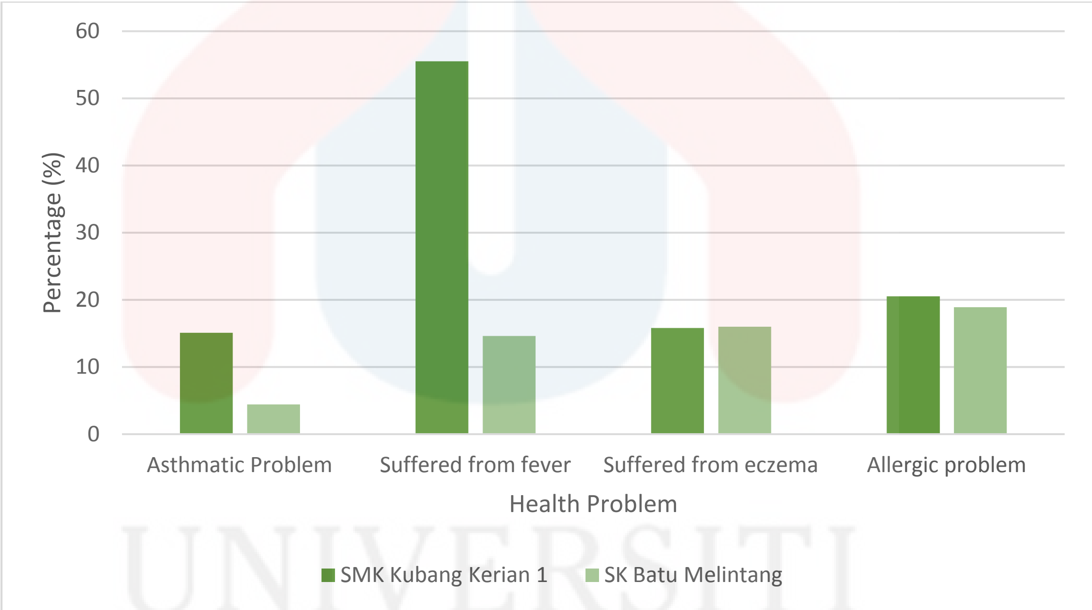

Figure 4.7 : Plot of percentage for health problem that respondents had in SMK Kubang Kerian 1 and SK Batu Melintang

4.6 Present Symptoms

Table 4.14 showed that the frequency and percentage of present symptoms in SMK Kubang Kerian 1 and and SK Batu Melintang. From Table 4.14, it can summarize that the respondents in SMK Kubang Kerian 1 and SK Batu Melintang experienced these symptoms while they were staying in school.

In SMK Kubang Kerian 1, the highest percentage was irritated/itchy nose (74.3%) followed by irritated/itchy eyes (69.5%), unusual tiredness, lethargy (68.8%), headache (64.4%), sore, irritated throat, cough (62.3%), congested, stuffy nose (57.2%), hoarseness (49.7%) and itching, skin rashes (31.8%).

Respondent in SK Batu Melintang showed that the highest percentage was headache (43.2%) followed by unusual tiredness, lethargy (41.7%), irritated/itchy nose (39.3%), hoarseness (38.8%), irritated/itchy eyes (37.9%), itching, skin rashes (36.9%), sore, irritated throat, cough (33.5%),%) and congested, stuffy nose (32%).

The respondents that had the irritation eyes, throat, nose and/or skin, hoarseness were identified as having health problem when they were allergic to the pollutants (Guidry, 2002). These symptoms occurred when there are lots of dust and dirt, which led to discomfort to the occupants.

Research findings reported possible health effects of school environment and microbial exposures in school as potential risk factors for respiratory symptoms, asthma and allergy among children (Kim et al., 2007, Meklin et al., 2002). Several studies had shown that the most common fungal genera in school buildings were *Penicilium*, yeast and *Cladosporium*and *Aspergillus* (Meklin et al., 2002).

Penicilium are common in ambient environment with high carbon dioxide (CO_2) concentration that frequently shows inadequate ventilation of a building which affects the students' concentration and teachers' productivity. High concentration of *Cladosporium* and *Aspergillus* had been proven to be associated with few allergic symptoms in respiratory systems (Fischer et al., 2003, Aydogdu & Asan, 2008).

Moreover, airborne concentrations of *Cladosporidium, Epicoccum, Coprinus* and *Fusarium* spores were associated with peak expiratory flow rates (PEFRs) deficiency in children showing decrease in lung function (Neas et al., 1996). Hussin et al., (2011) found high indoor bio-aerosol concentrations in schools which reflected their state of cleanliness and over crowdedness.

The itching and eye irritation may cause serious problems to occupants especially for those who were a contact lens user (Morris et al., 1998). Skin rashes/skin disease was one of the syndromes which usually hard to be determined but it more likely caused by the poor indoor environmental conditions by way of the disorders may only happen in future (Morris et al., 1998).

Table 4.14 : Frequency and percentage of present symptoms in SMK Kubang Kerian 1 and and SK Batu Melintang

Present Symptoms	Frequency		Percentage (%)	
	Yes	No	Yes	No
SMK Kubang Kerian 1				
Irritated/itchy eyes	203	89	69.5	30.5
Irritated/itchy nose	217	75	74.3	25.7
Congested, stuffy nose	167	125	57.2	42.8
Sore, irritated throat, cough	182	110	62.3	63.7
Hoarseness	145	147	49.7	50.3
Itching, skin rashes	93	199	31.8	68.2
Unusual tiredness, lethargy	201	91	68.8	31.2
Headache	88	104	64.4	35.6
SK Batu Melintang				
Irritated/itchy eyes	78	128	37.9	62.1
Irritated/itchy nose	81	125	39.3	60.7
Congested, stuffy nose	66	140	32.0	68.0
Sore, irritated throat, cough	69	137	33.5	66.5
Hoarseness	80	126	38.8	61.2
Itching, skin rashes	76	130	36.9	63.2
Unusual tiredness, lethargy	86	120	41.7	58.3
Headache	89	117	43.2	56.8

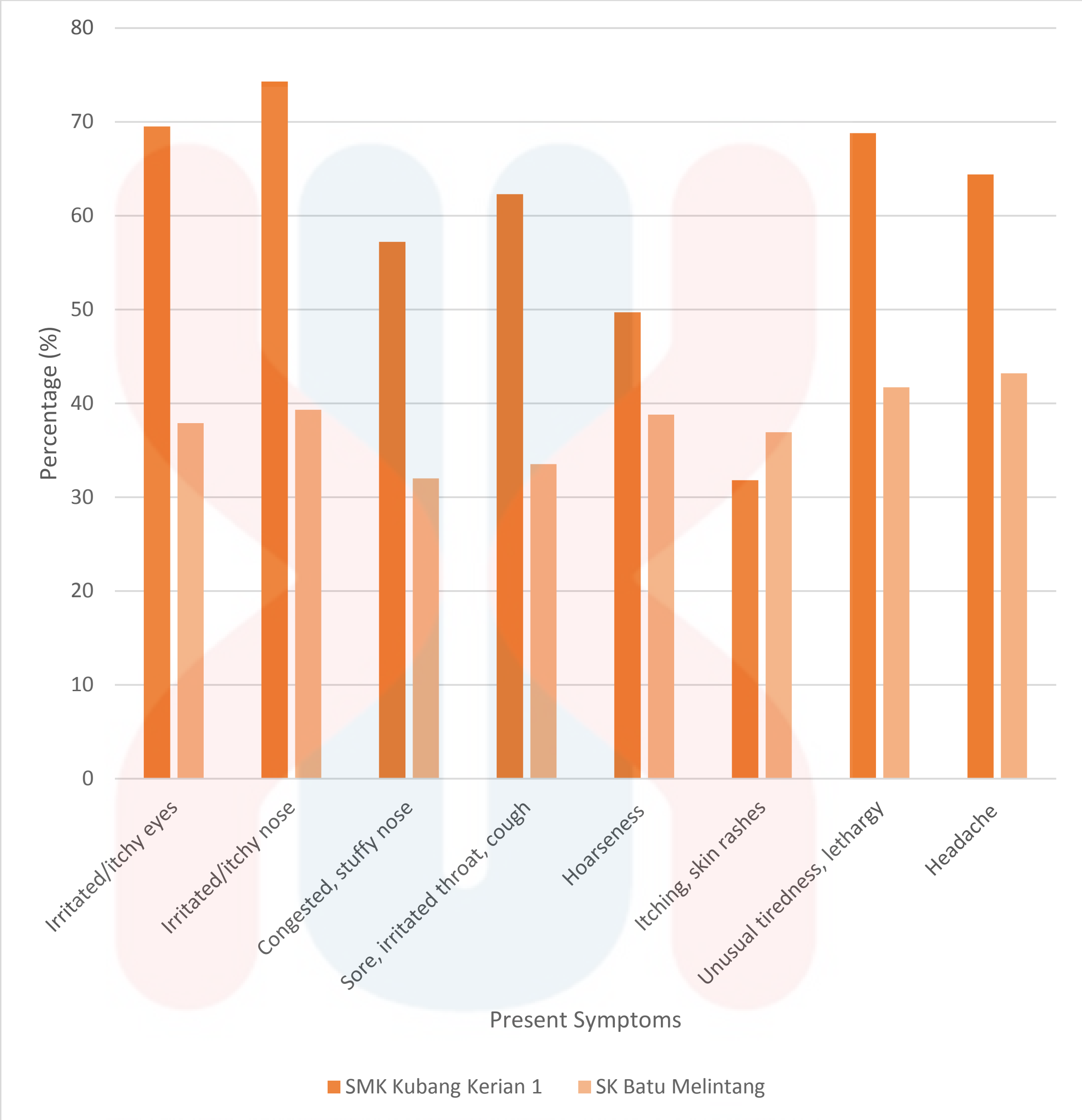

Figure 4.8 : Plot of percentage of present symptoms in SMK Kubang Kerian 1 and and SK Batu Melintang

4.7 Environment Quality That Disturbed the Respondent in School

Table 4.15 showed the environment quality that disturbed the respondents in SMK Kubang Kerian 1 and SK Batu Melintang. In SMK Kubang Kerian 1, the highest percentage was affected by the respondent was indoor and outdoor room temperature too high (76.7%) followed by varying indoor and outdoor room temperature (75.7%), low humidity (75%) and lack of air circulation (stuffy feeling) (63.7%) .

Respondent in SK Batu Melintang showed that the highest percentage was lack of air circulation (stuffy feeling) (42.7%) followed by varying indoor and outdoor room temperature (39.8%) and the same percentage for low humidity and indoor and outdoor room temperature too high (39.3%).

Exposure to these indoor air contaminants particularly among school children needs tremendous attention as the children were more susceptible to the infection as well as respiratory problem as they spend large portion of their weekday time in school. Schools had been considered as the most important indoor environment for children besides home.

Outdoor air bio-aerosol concentrations were contributed by the nearby activities. The indoor bacteria and fungi concentrations in schools with occupants were significantly higher than those without occupants, due to the contamination sources from the occupants. The ratio of indoor to outdoor bio-aerosol concentrations was below 1.0 except for some schools indicating the state of indoor conditions that would provide favourable conditions for both bacterial and fungal growth.

More than half of the indoor bacteria concentrations (56%) exceeded the ACGIH and WHO recommended level of 500 CFU/m^3 while 33.8% of the indoor fungal samples exceeded the recommended level of 200 CFU/m^3. This indicated poor microbial indoor air quality in the schools and inferring potential harmful effects to the children’s health.

Table 4.15 : Environment quality that disturbed the respondent in SMK Kubang Kerian 1 and SK Batu Melintang

Areas Affected	Frequency		Percentage (%)	
	Yes	No	Yes	No
SMK Kubang Kerian 1				
Indoor and outdoor room temperature too high	224	68	76.7	23.3
Varying indoor and outdoor room temperature	221	71	75.7	24.3
Low humidity	219	73	75.0	25.0
Lack of air circulation (stuffy feeling)	186	106	63.7	36.3
SK Batu Melintang				
Indoor and outdoor room temperature too high	81	125	39.3	60.7
Varying indoor and outdoor room temperature	82	124	39.8	60.2
Low humidity	81	125	39.3	60.7
Lack of air circulation (stuffy feeling)	88	118	42.7	57.3

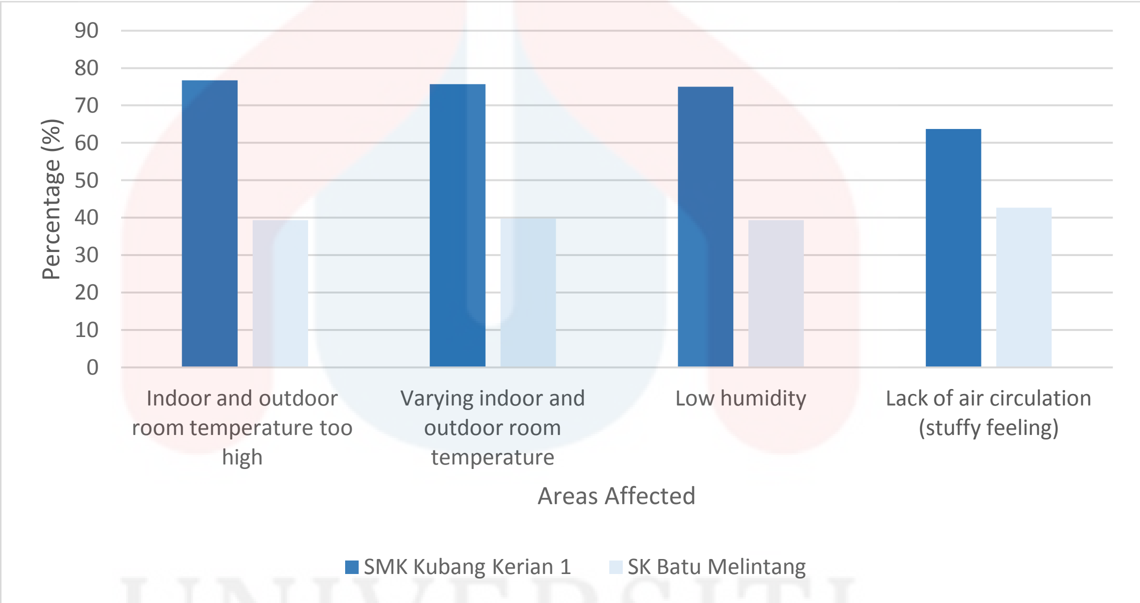

Figure 4.9 : Plot of environment quality that disturbed the respondent in SMK Kubang Kerian 1 and SK Batu Melintang

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From this study it can be concluded that the concentration of gases which were SO_2, NO_2 and CO of school in urban area was higher than school in rural area. Rural school area had lower values of SO_2 concentration which was 0.042 ppm compared to the urban school area that had mean value of 0.058 ppm. Value of NO_2 concentration recorded in the sampling stations showed that the urban school area had higher values of NO_2 which was 0.067 ppm compared to the rural school area that had mean NO_2 value of 0.041 ppm. Concentration of the CO in urban school area found more polluted (6.389 ppm/6.098 ppm) compared to the rural school area (4.543 ppm/4.564 ppm).

But all these values were not exceeded the Recommended Malaysia Air Quality Guidelines (RMAQG) prescribed by Department of Environment (DOE) which were SO_2 (0.13 ppm), NO_2 (0.17 ppm) and CO (30 ppm) for residential and rural residential areas.

In this study also it can be concluded that the student in urban school area experience greater health effects than student in rural school area. Health performance of student from rural school area was better than school children living in high pollution urban area. This difference can be attributable to levels of air pollution in respective areas. The most common symptoms found in urban school children were irritated/itchy nose and irritated/itchy eyes which were 74.3% and 69.5% both respectively.

5.2 Recommendation

We can suggest certain preventive measure for reducing the effect of air pollution such as prohibition of entry of heavy vehicles near school premises, diversion of heavy traffic away from school areas, use of protective mask for school children, creating green zone by tree plantation in school campuses, regular health checks-ups of school children and early diagnosis and treatment of respiratory problem so as to preserve lung health.

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APPENDIX 1

QUESTIONNAIRE OF AIR POLLUTION AND POSSIBLE SYMPTOMS

This questionnaire concerns your air pollution and possible symptoms you may experience.

Kajian selidik ini mengenai perihal pencemaran udara dan simptom-simptom yang mungkin anda alami.

SECTION A

BACKGROUND FACTORS *FAKTOR LATAR BELAKANG*

Tick that is related

Sex *Jantina*	☐	Male *Lelaki*	☐	Female *Perempuan*
Do you smoke? *Adakah anda merokok?*	☐	Yes *Ya*	☐	No *Tidak*
Position *Jawatan*	☐	Student *Pelajar*		

How long have you been at your present place of study ? _______ years

Berapa lama anda telah belajar di tempat belajar anda sekarang? _______ *tahun*

SECTION B

PAST/PRESENT DISEASE/SYMPTOMS

PENYAKIT/SIMPTOM YANG SEDANG DIALAMI/TELAH DIALAMI

	Yes *Ya*	**No** *Tidak*
Have you ever had asthmatic problems? *Pernahkan anda mengalami masalah asma?*		
Have you ever suffered from fever? *Pernahkan anda mengalami demam panas?*		
Have you ever suffered from eczema? *Pernahkah anda mengalami penyakit kulit ekzema?*		
Do you have allergic? *Adakah anda mempunyai alergik?*		

SECTION C

PRESENT SYMPTOMS *SIMPTOM YANG SEDANG DIALAMI*

During the time you are spending at the affected areas have you had any of the following symptoms?
(Answer every question even you have not had any symptom)
Sepanjang berada di kawasan yang terlibat, pernahkan anda mengalami simptom seperti di bawah?
(Sila jawab setiap soalan walaupun anda tidak mengalami apa-apa simptom)

AREAS AFFECTED	**Yes** *Ya*	**No** *Tidak*
Irritated /itchy eyes, watery eyes *Mata terasa gatal atau kurang selesam mata berair*		
Itching/irritated nose *Hidung terasa gatal atau kurang selesa*		
Congested, stuffy nose *Hidung berair dan tersumbat*		
Sore, irritated throat, cough *Tekak kering dan kurang selesa, batuk*		
Hoarseness *Serak*		
Itching, skin rashes *Kulit terasa gatal dan ruam*		
Unusual tiredness, lethargy *Keletihan yang luar biasa, lesu*		
Headache *Sakit kepala*		

SECTION D

ENVIRONMENT *PERSEKITARAN*

Have you been bothered by any of the following factors during the time you are spending at the affected areas?

(Answer every question even you have not been bothered)

Pernahkan anda berasa terganggu dalam keadaan-keadaan di bawah sepanjang berada di kawasan yang terlibat?

(Sila jawab setiap soalan walaupun anda tidak berasa terganggu dengan keadaan berkenaan)

AREAS AFFECTED	**Yes** *Ya*	**No** *Tidak*
Indoor and outdoor room temperature too high *Suhu bilik kawasan luar dan dalam terlalu tinggi*		
Varying indoor and outdoor temperature *Suhu bilik berubah-ubah*		
Low humidity *Udara yang kering*		
Lack of air circulation (stuffy feeling) *Kekurangan peredaran udara (berasa sesak)*		