DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

Signature : ______________________________

Name : FOONG JUN MING

ID No. : 10AGB04080

Date : 1 SEPTEMBER 2015

APPROVAL FOR SUBMISSION

I certify that this project report entitled "**EVALUATION OF AIR AND NOISE POLLUTION, AND BEHAVIOURAL EFFECTS ON EXPOSED SCHOOL CHILDREN: CASE STUDY IN KAMPAR, MALAYSIA** was prepared by **FOONG JUN MING** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of Engineering (Hons.) Environmental Engineering at Universiti Tunku Abdul Rahman.

Approved by,

Signature : ______________________________

Supervisor : Engr. Dr Sumathi a/p Sethupathi

Date : ______________________________

ACKNOWLEDGEMENTS

I would like to thank everyone who had contributed to the successful completion of this project. I would like to express my gratitude to my research supervisor, Engr. Dr Sumathi a/p Sethupathi for this invaluable advice, guidance and her enormous patience throughout the development of the research.

In addition, I would also like to express my gratitude to my loving parents and friends who had helped and given me encouragement.

EVALUATION OF AIR AND NOISE POLLUTION, AND BEHAVIOURAL EFFECTS ON EXPOSED SCHOOL CHILDREN: CASE STUDY IN KAMPAR, MALAYSIA

ABSTRACT

In recent decades, there have been abundant time series studies that suggested the air and noise pollution was associated with poor academic performance of students. Therefore, Kampar town has been selected as study area to evaluate the air and noise pollution level around school areas, and to determine the behavioural effects on the exposed school children. In this study, air and noise monitoring together with survey research were done to discover the findings. The results showed that the average concentrations of sulphur dioxide (SO_2) were not in compliance to the Malaysian Ambient Air Quality Guidelines (MAAQG); while the other air pollutants such as carbon monoxide (CO), nitrogen dioxide (NO_2) and ground – level ozone (O_3) were all well below the guidelines. The average noise levels of the selected schools have also exceeded the 50 dB (A) daytime limit from time to time as indicated by Department of Environment (DOE). On top of that, the majority of students have expressed that annoyance and stress were the main negative behavioural effects as a result of air and noise pollution.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS / ABBREVIATIONS

AQGs	Air Quality Guidelines
CO	Carbon Monoxide
COHb	Carboxyhemoglobin
dB	Decibel
DOE	Department Of Environment
EPA	Environmental Protection Agency
H_2O	Water
MAAQG	Malaysian Ambient Air Quality Guidelines
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
PLC	Programmable Logic Controller
PM	Particulate Matter
Ppb	Parts Per Billion
Ppm	Parts Per Million
O_2	Oxygen
O_3	Ozone
SO_2	Sulphur Dioxide
TARUC	Tunku Abdul Rahman University College
UNEP	United Nation Environment Programme
UTAR	Universiti Tunku Abdul Rahman
VOCs	Volatile Organic Compounds
WHO	World Health Organization
$\mu g / m^3$	Micrograms Per Cubic Meter

CHAPTER 1

INTRODUCTION

1.1 Overview

Over the last few decades, air pollution posed a serious threat to major cities all around the world, especially in developing countries such as Malaysia. Air pollution consists of solid particles and gases in the atmosphere which may be detrimental to human health and all other living creatures. Manoj, Paul and Ashutosh (2014) estimated that a quarter of the human population was exposed to hazardous concentrations of air pollutants, which may lead to breathing difficulties and respiratory illnesses. On top of that, the connection between the air pollution and respiratory morbidity had been acknowledged ever since the disastrous smog episode of 1952 in London, United Kingdom (Chauhan, et. al., 2003). Moreover, Gilliland, et al. (2001) demonstrated that there was a significant relationship between air pollution and school absenteeism, thus affecting the students' academic performance.

As the twentieth century ends, noise pollution has become increasingly critical particularly in industrial countries and the cost of reducing it in future years will be insuperable. Noise pollution can be defined as a form of air pollution that is an audible undesired sound that brings harmful effect to a person's health and well - being. Cohen, et al. (1981) stated that children from schools located in noisy settings were more likely to fail or take longer time to solve test puzzle than children from relatively quiet schools. Exposure to high noise levels may influence children's emotional and motivational states. On the basis of a research that had been done by

Moch - Sibony (1984), he observed that noisy – school teachers had more difficulties in motivating students to perform than quiet – school teachers, hence the quiet – school students performed better than the noisy – school students.

As of today, the deleterious health consequences of air and noise pollution remain a public health concern, notably the behavioural effects on exposed school students. This has led to a growing attention on the impacts of air and noise pollution on children's educational outcomes in recent years. Children will experience annoyance, stress, lower efficiency, loss of concentration, lack of motivation, and most importantly interference of daily activities in school. Therefore, ambient monitoring programme must be carried out at all places to assess the air quality and noise level, and to reduce the serious impacts on the current and future health of children worldwide.

1.2 Background of Study Area

Kampar has been selected as the study area to evaluate the air and noise pollution level near school areas, and also to determine its behavioural effects on exposed school children in this town. Kampar (101º 09' 0" E 4º 18' 0" N) is a small and peaceful town in the state of Perak Darul Ridzuan as shown in Figure 1.1. It was founded in year 1887 where the town was abundantly supplied with tin reserves. Kampar was a tin mining town which developed rapidly during the peak of tin mining industry. Most of the tin mines were established in the late 19th century, only to stagnate and decline following the collapse of the industry. As of 21 May 2009, Kampar was declared as the state's 10th district by the Sultan of Perak (Mahyidin, 2011).

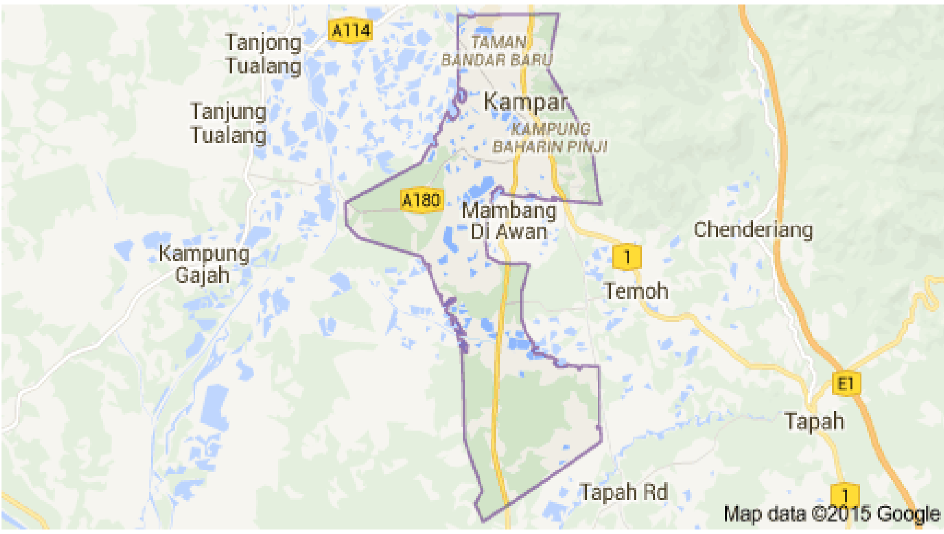

Figure 1.1: Map of Kampar (Google Maps, 2015)

In general, Kampar town can be separated into two areas; they are the old town area and new town area. The old town is made up of two main streets of pre - war shophouses, in which most of these historical buildings are still in its original appearance. Commerce in the old town area basically comprises coffee shops, goldsmiths and local retailers. On the contrary, the new town area primarily consists of new residential developments and some business servicing the flourishing education industry in Kampar (Mahyidin, 2011). Currently, the commercial and industrial sectors are the main driving forces of Kampar's economy.

Kampar is also known as the home of tertiary education for the campus of Tunku Abdul Rahman University College (TARUC) and Universiti Tunku Abdul Rahman (UTAR). According to Kampar District Council (2015), the population of Kampar town in year 2010 has reached approximately 90,000 due to the growing numbers of university students. With an estimated number of 25,000 students, these two educational institutions are set to restore the town to its former glory. Apart from that, there are a total of eight primary schools and seven secondary schools in Kampar, with an approximated capacity of 10,000 students gaining knowledge through education (Kampar District Council, 2015).

1.3 Problem Statements

A considerable number of scientific studies had reported negative health effects related to air pollution in the past forty years, in which children represented the biggest subgroup of world population vulnerable to the health consequences of air pollution. As compared to the adults, children are more susceptible to air pollutants because of their immature respiratory system (Environmental Protection Agency, 2006). Children breathe in a higher volume of air per body weight compared with adults (Oyana and Rivers, 2005); conveying a higher doses of air that may remain in the lung for a longer period of time (Bateson and Schwartz, 2008). Based on a study by Zakaria, et al. (2010), the prevalence of asthma disease was higher among the urban and industrial children due to air pollution. Particulate air pollution had also been found associated with increased respiratory symptoms and medication use for asthmatic children (Romieu, et al., 1996).

In our country, Department of Environment (DOE) monitors the nation's ambient air quality though a system of continuous air monitoring stations, to identify any crucial changes in the air quality which may jeopardize human health and bring adverse impacts to the environment. These stations are strategically located in industrial, rural, sub urban and urban areas as illustrated in Figure 1.2. Unfortunately, the closest air monitoring station for Kampar is located at Ipoh, which is almost 40 kilometers away from Kampar town, thus making it difficult to determine the air pollution level for this particular area. As revealed by DOE (2014), the overall air quality status in Malaysia for year 2013 was between good to moderate most of the time. However, Malaysia had also experienced a short period of serious haze event due to transboundary pollution from neighbouring country and this has resulted in the air quality to deteriorate to unhealthy and hazardous levels.

Figure 1.2: Location of Air Quality Monitoring Stations in Malaysia (DOE, 2014)

On the other hand, Chedd (1970) had expressed that serious and immediate action must be taken to control the noise pollution issue as the overall loudness of environmental noise had been doubled every ten years. For instance, a noise level of 82 dB (A) had been reported in some residential areas of Kuala Lumpur, the federal capital of Malaysia (Elfaig, 2002). Studies have also shown that children attending kindergartens which are situated in area with traffic noise tend to have higher mean systolic blood pressure and diastolic blood pressure than children attending kindergartens in quiet area (Regecova and Kellerova, 1995). Furthermore, various researches had indicated that there was a marked increase in the amount of children exposed to noise levels which were loud enough to damage hearing especially in developing countries (Evans, 1990).

In order to measure the noise levels throughout the country, DOE has conducted the ambient noise monitoring programme for three different categories of land use, namely noise sensitive areas, traffic areas and industry areas. The DOE state offices which consist of Kelantan, Melaka, Negeri Sembilan, Pahang, Perak, Perlis, Terengganu and Sarawak are responsible for these measurements. In year 2013, the valuable data from noise monitoring have exceeded the daytime limit and night time limit for most of the time (DOE, 2014). This has resulted in a severe health and environmental issue especially in noise sensitive areas which include schools. Students' concentration and their ability to learn could be affected if their schools are exposed to the noise levels that are higher than the recommended threshold level. As similar to air monitoring, there are no reliable source to prove the execution of any noise monitoring activities in Kampar area.

Thus in this study, monitoring of air quality and noise level was conducted in three selected vernacular schools in Kampar town to determine its harmful effects on exposed children. This study is imperative as no studies have been reported on the air and noise quality status of schools in this town. It will benefit the potentially affected students and teachers by raising awareness about these environmental issues to reduce the negative impacts on them. Besides raising awareness, this study will also encourage the local communities to start driving the efforts to conserve and protect the environment as little attention has been given by individuals concerning air and noise pollution.

1.4 Aims and Objectives

The objectives of the study are shown as following:

- To evaluate the level of air and noise pollution near three school areas in Kampar
- To analyse the impacts of air and noise pollution on exposed school children through survey
- To provide recommendations on ways to improve air quality and reduce noise level near the selected school areas

CHAPTER 2

LITERATURE REVIEW

2.1 Air Pollution

2.1.1 Definition

Ever since the Industrial Revolution took off in the 18th century, air pollution continues to pose a significant threat to human health worldwide. Air pollution can be defined as any atmospheric condition in which undesirable materials are largely present that may produce harmful effects to human and the surrounding environment. These unpleasant substances in the atmosphere include gases, particulate matters such as smoke and dust, radioactive materials and many others (Mengesha and Mamo, 2006). Most of these substances are naturally present in the air with low concentrations, thus they are generally considered to be harmless. However, a particular substance can be regarded as an air pollutant when its concentration is relatively higher compared to its original value and causes adverse impacts to human health (Mengesha and Mamo, 2006).

All anthropogenic releases into the atmosphere can be identified as air pollution, as they modified the natural characteristics of the atmosphere. Besides anthropogenic releases, it is practical to consider geogenic emissions and biogenic emissions as contributors to air pollution. emissions are defined as emissions caused by the non-living world, such as volcanic emissions and forest fires. While biogenic emissions come from the living world, for instance volatile organic compounds (VOCs) emissions from vegetation (Daly and Zannetti, 2007). Therefore, taking all of the above into account, air pollution can also be defined as any air pollutants released into the air from an anthropogenic, biogenic or geogenic source that are present in higher concentrations than the natural atmosphere, and may cause short - term or long - term adverse effects (Daly and Zannetti, 2007).

2.1.2 Source

Indoor air pollution and urban outdoor air pollution are acknowledged to be responsible for 3.1 million premature deaths and 3.2 % of the global burden of disease worldwide every year (World Health Organization, 2010). The major sources of indoor air pollution include indoor combustion of fossil fuels, tobacco smoking, emissions from construction materials and improper maintenance of ventilation systems. Even minor sources of air pollution such as gas cookers, new furnishings or household products can lead to significant exposures and recognized health effects. In opposition, outdoor sources of air pollutants include motor vehicles, community services and forest fires. Nature emissions including VOCs released from trees, wind - blown soil and dust storms can also be an important source of many trace gases and particles within the atmosphere (WHO, 2010).

2.2 Air Pollutants

2.2.1 Classification

Air pollutants may either be released into the atmosphere or formed within the atmosphere itself. Primary air pollutants are substances that are released from a source such as factory chimney, exhaust pipe, and through suspension of contaminated dusts by the wind. Therefore, it is possible to measure the amount emitted at the source itself in principle. On the other hand, secondary air pollutants are not directly emitted from sources. They arise from chemical reactions of primary air pollutants, very likely involving the natural components of the atmosphere, particularly oxygen (O_2) and water (H_2O) (WHO, 2005). In general, standard air quality measurements usually describe air pollutant concentrations in terms of micrograms per cubic meter (μg / m^3) or parts per million (ppm).

2.2.2 Particulate Matter

Particulate matter (PM) can be defined as a complex mixture of small particles suspended in the air, which includes dirt, dust, smoke and soot. PM can be classified into 3 categories, namely PM_{10}, $PM_{2.5}$ and $PM_{0.1}$. PM_{10} are particles with a diameter less than 10 micrometers, while $PM_{2.5}$ and $PM_{0.1}$ are particles with diameter less than 2.5 micrometers and 0.1 micrometers respectively. Compared with larger particles, fine particles can remain suspended in the atmosphere for longer periods and can be transported over long distances (WHO, 2014). Sources of PM include agricultural activities, construction activities, motor vehicles and fuel combustion. Long - term exposure to these pollutants contributes to the risk of developing cardiovascular and respiratory diseases, as well as of lung cancer. According to WHO (2014), by reducing PM_{10} from 70 to 20 μg / m^3, the global air pollution - related deaths could lower down by approximately 15 %.

2.2.3 Carbon Monoxide

Carbon dioxide (CO) is a colourless, tasteless and odourless gas produced from the incomplete combustion of fossil fuels due to the insufficient presence of O_2. CO pollution occurs primarily from emissions produced by fossil fuel – powered engines including motor vehicles, industrial processes and natural sources such as forest fires. CO substantially reduces the capacity of blood to carry oxygen to the body tissues and blocks important biochemical reactions in cells. Exposure to low levels of CO may cause headaches, fatigue and shortness of breath. Whereas the symptoms of exposing to high levels of CO may include dizziness, chest pain, poor vision and thinking difficulties (Manitoba, 2009). Horvath, et al. (1975) had reported that people with carboxyhemoglobin (COHb) levels between 2 to 3 % due to CO exposure are likely to perform routine task in an inefficient manner.

2.2.4 Nitrogen Dioxide

Nitrogen dioxide (NO_2) belongs to a family of highly reactive gases called nitrogen oxides (NOx). NO_2 is formed when fuels are burned at high temperatures, and come principally from motor vehicle exhaust and stationary sources such as electric utilities and industrial boilers. For environmental effect, NO_2 contributes to acid rain and nutrient enrichment of soil and surface water which is also known as eutrophication. Eutrophication occurs when a body of water suffers an increase in nutrients that leads to a reduction in the amount of oxygen in the water, producing an environment that is destructive to fish and many other animals (Environmental Protection Agency, 1995). Large concentrations of NO_2 can reduce visibility and increase the risk of acute and chronic respiratory disease. Epidemiological studies have also shown that NO_2 might contribute to depression because the air pollutant can significantly reduce visibility (Gary, 1982).

2.2.5 Ozone

Besides that, ozone (O_3) in the stratosphere and at ground level has become an important global air quality issue. Stratospheric ozone (O_3) occurs naturally in the Earth’s upper atmosphere and forms a protective layer that shields us from the sun’s harmful ultraviolet radiation. On the other hand, ground – level ozone (O_3) is formed by the reaction with sunlight of pollutants such as NOx and VOCs emitted by vehicles, solvents and industry. As a result, the highest levels of ozone pollution occur during periods of sunny weather (WHO, 2014). Excessive O_3 in the air can cause breathing problems, trigger asthma, and reduces lung functions. O_3 is also a greenhouse gas that contributes to the warming of the atmosphere, thus leading to greenhouse effect. Graff, Joshua and Matthew (2012) have investigated the relationship between O_3 and the productivity of workers in the United States, and they found that a 10 ppb (parts per billion) decrease in O_3 concentrations increased the workers’ productivity by 4.2 %.

2.2.6 Sulphur Dioxide

Sulphur dioxide (SO_2) is a colorless gas, but has a suffocating and pungent odour. It is mainly produced from the burning of sulphur – containing fossil fuels for domestic heating, power generation and motor vehicles. When SO_2 combines with water, it will form sulphuric acid; and this is the main constituent of acid rain which is a cause of deforestation (WHO, 2014). Acid rain also causes acidification of lakes and streams, corrosion of metals, and erosion on ancient monuments. SO_2 can adversely affect the respiratory system and the functions of the lungs, and causes irritation of the eyes. At very high levels, SO_2 may cause wheezing, chest tightness and shortness of breath in people who do not even have asthma disease. Longitudinal studies indicated that a group of asthmatic patient experience changes in pulmonary function and respiratory symptoms after periods of exposure to SO_2 as short as 10 minutes (WHO, 2014).

2.3 Air Quality Guidelines

Air quality guidelines are generally designed to protect those who are vulnerable to experiencing health effects when a particular air pollutant is inhaled. Table 2.1 depicts the Malaysian Ambient Air Quality Guidelines (MAAQG) as stipulated by Department of Environment (DOE) which aims to protect and improve the nation's health. Table 2.2 illustrates the Air Quality Guidelines (AQGs) which offers global guidance on the limits for significant air pollutants that pose health risks. The AQGs were introduced by WHO to provide appropriate targets for air quality management in different parts of the world. The maximum concentration within 1 hour of exposure period for CO, NO_2, O_3 and SO_2 are 30.00 ppm, 0.17 ppm, 0.10 ppm and 0.13 ppm respectively according to the MAAQG.

Table 2.1 Malaysian Ambient Air Quality Guidelines (DOE, 2014)

Pollutant	**Average Time**	**Malaysian Guidelines (ppm)**
Carbon Monoxide (CO)	1 hour 8 hours	30.00 9.00
Nitrogen Dioxide (NO_2)	1 hour 24 hours	0.17 0.04
Ozone (O_3)	1 hour 8 hours	0.10 0.06
Sulphur Dioxide (SO_2)	1 hour 24 hours	0.13 0.04

Table 2.2 Air Quality Guidelines (WHO, 2005)

Pollutant	Average Time	Global Guidelines (ppm)
Carbon Monoxide (CO)	1 hour 8 hours	25.00 9.00
Nitrogen Dioxide (NO_2)	1 hour 1 year	0.10 0.02
Ozone (O_3)	8 hours	0.05
Sulphur Dioxide (SO_2)	10 minutes 24 hours	0.18 0.01

2.4 Air Pollution Research Studies

Clean air is one of the fundamental requirements of human health and a basic necessity for sustenance of life. However, air pollution has been and continues to be a significant health hazard worldwide during the process of economic development. For the past decades, several hundred epidemiological studies have emerged showing adverse effects associated with short – term and long – term exposure to various air pollutants as illustrated in Table 2.3. The effects of air pollution can sometimes be observed even when the pollution level was below the level indicated by MAAQG and AQGs. Most importantly, children have demonstrated that they were more vulnerable to the side effects of air pollution as compared to adults.

Table 2.3: Air Pollution Research Studies by Various Researches

Scope	Result	Reference
Adverse effect of air pollution on respiratory health of primary school children in Taiwan	School children in urban communities had significantly more respiratory symptoms as compared to school children in rural communities	Chen, et al., 1998
Allergy to air pollution and frequency of asthmatic attacks among asthmatic primary school children	Urban and industrial asthmatic children were at greater risk of getting more frequent asthmatic attacks due to allergy to high levels of air pollutants	Zakaria, et al., 2010
The effects of ambient air pollution on school absenteeism due to respiratory illnesses	An increase of 20 ppb of O_3 was associated with an increase of 62.9 % illness - related absence rates, and 82.9 % for respiratory illnesses	Gilliland, et al., 2001
Air pollution and academic performance: Evidence from California schools	A 10 % decrease in outdoor NO_2 would raise math test scores by 0.18 %	Zweig, Ham and Avol, 2009
Air pollution increases school absences	There was a significant effect of concentrations of CO on school absences, especially when CO exceeds the air quality standards (AQS)	Currie, et al., 2008

2.5 Noise Pollution

2.5.1 Definition

Noise pollution is becoming increasingly severe especially in industrial nations although it has received much less attention than the air pollution issue. Noise pollution takes place when there is either excessive amount of noise or an unpleasant sound that causes temporary disruption in the natural balance. In general, acoustic signals that produce a pleasant sense such as music and bells are recognized as sound, while the unpleasant sounds which may be produced by a machine or plane are regarded as noise. Sound becomes unwanted when it either interferes with normal activities such as sleeping and conversation, or diminishes one’s quality of life. Therefore, noise can be defined as unwanted sound, which is perceived as an environmental stressor and nuisance (Stansfeld and Matheson, 2003).

2.5.2 Source

Noise pollution can be originated from numerous sources but may be broadly classified into 2 classes, specifically indoor and outdoor noise pollution. Indoor sources are those sources of noise pollution that occur within or at a particular place; they are the kind of unwanted sound caused by home appliances like television and radio, dog barking or children at play. In opposition, common sources of outdoor noise arise from transportation systems such as aircrafts, buses, cars and trains, social centres such as churches, markets, mosques and temples. Social centres located near to residential areas can cause annoyance, discomfort and irritation to the residents exposed to the noise that is inevitably produced (Puja, 2015). Like any normal day, it is difficult or almost impossible not to come into contact with pollution from any of these sources.

2.5.3 Measurement

Decibel (dB) is the standard unit for noise measurement, in which it can be divided into 3 categories namely dB (A), dB (B) and dB (C). The A – weighting measurement predicts the risk of hearing loss, B – weighting predicts the performance of loudspeaker while C – weighting predicts the industrial noise. The range for A – weighting scale is less than 55.0 dB (A), 55.0 to 85.0 dB (A) for B – weighting scale, and more than 85.0 dB (A) for C – weighting scale. Apart from that, hearing threshold is defined as the minimum efficient pressure that can be heard without background noise of a pure tone at a specific frequency (EPA, 1979). Lawton (2000) had mentioned that noise level of 75.0 dB (A) was appeared in an important recommendation from the EPA to establish sound levels which would not adversely affect public health. Exposure to continuous noise of 85.0 to 90.0 dB (A), particularly over a lifetime in industrial settings, can lead to a progressive loss of hearing. Hearing impairments due to noise are a direct consequence of the effects of sound energy on the inner ear (Stansfeld and Matheson, 2003).

2.6 Noise Level Guidelines

The aim of the noise level guidelines is to ensure that human hearing is protected from excessive noise at various places and locations. Table 2.4 shows the Malaysian noise level guidelines as stipulated by DOE which aims to minimize the exposure of citizens to the harmful behavioural effects of excessive noise. Table 2.5 depicts the global noise level guidelines which offers worldwide guidance on the threshold values for significant noise levels that are physically harmful and detrimental to individuals and community. For both noise limit standards, the permissible noise limit for noise sensitive area is 50.0 dB (A) during daytime.

Table 2.4: Malaysian Noise Level Guidelines (DOE, 2007)

Receiving Land Use Category	Noise Level, dB (A)	
	Day time	Night time
Noise Sensitive Area	50.0	45.0
Industrial Area	75.0	65.0
Commercial Area	55.0	50.0

Table 2.5: Global Noise Level Guidelines (WHO, 1999)

Receiving Land Use Category	Noise Level, dB (A)	
	Day time	Night time
Noise Sensitive Area	50.0	40.0
Industrial Area	65.0	55.0
Commercial Area	60.0	50.0

2.7 Noise Pollution Research Studies

Even though noise pollution is not fatal to human life, yet its importance must not be overlooked because repeated exposure to noise reduces sleeping hours and also productivity of a human being. The significance of noise pollution as environmental problem is being recognized as the ill effects on human health and environment are becoming evident with each passing day. In the past decades, there are an increasing numbers of observational studies that have demonstrated the associations between high noise levels and various health impacts as shown in Table 2.6. Furthermore, children have proven themselves to be one of the most susceptible groups to the negative impacts of noise pollution.

Table 2.6: Noise Pollution Research Studies by Various Researches

Scope	Result	Reference
Urban road – traffic noise and blood pressure in school children	Blood pressure was significantly higher in children exposed to noise level higher than 60.0 dB (A) around school	Belojevic et al., 2008
Monitored community noise pollution in selected sensitive areas of Kuala Lumpur	The noise levels for residential areas were ranged between 52.1 to 72.7 dB (A) while school area ranged between 68.2 to 73.7 dB (A)	Elfaig et al., 2014
Noise pollution at school environment located in residential area	The noise level on one of the selected primary school in Malaysia was very high and not suitable for study environment	Ibrahim and Richard, 2000
Effect of traffic noise on sleep: A case study in Serdang Raya, Selangor, Malaysia	Even though both measuring points have exceeded the Malaysian guideline values, surprisingly the residents were not annoyed by the traffic noise	Nadaraja, Wei and Abdullah, 2010
Effects of noise on blood pressure, heart rate and hearing threshold in school children	Significant associations were found between noise pollution level and blood pressure, heart rate, along with hearing threshold	Abdelraziq, Ali – Shytayeh and Abdelraziq, 2003

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Study Sample

A cross - sectional study was conducted on school students in the age group of 7 – 12 years old, who attended three different primary schools in Kampar. The selected schools were named school X, Y and Z as one of the school principals refused to disclose the identity of the school due to certain reasons. The number of students for primary school X, Y and Z were approximately 390, 340 and 300 respectively. From Figure 3.1, it can be observed that school X and Y are located beside a traffic junction representing old town area, while school Z is located next to a main road representing new town area.

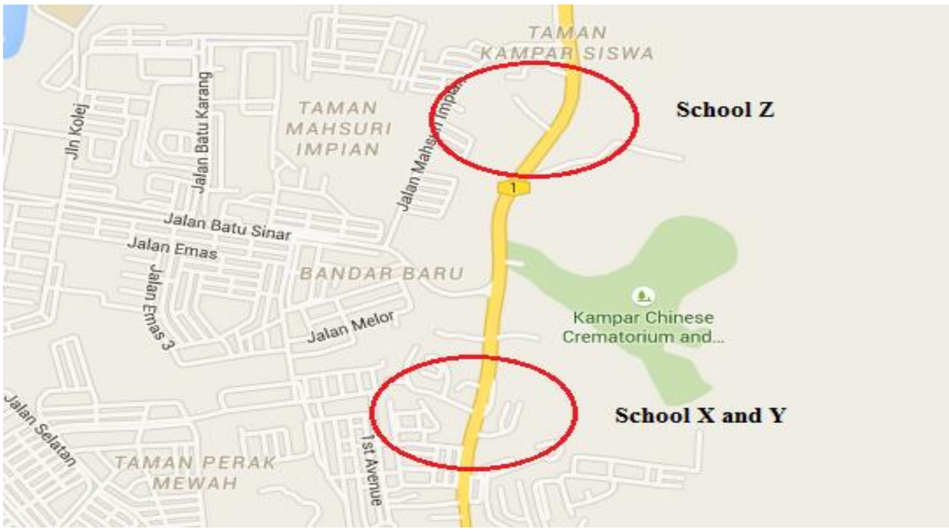

Figure 3.1: Location of Schools in Kampar (Google Maps, 2015)

In this study, the assessments of air and noise pollution in schools were conducted from 25 May 2015 to 8 August 2015, by continuously monitoring the air quality and noise level for five school days in a week. The study period of air and noise monitoring for each school was 7 hours, starting from 7.00 am to 2.00 pm daily. All of the tools and equipment used in this study were supplied by Universiti Tunku Abdul Rahman (UTAR). Permissions were obtained from school principals before performing any evaluation activities in their respective school compound. However, the permission to perform monitoring activities outside school compound X was not granted due to safety concerns. Therefore, the exposure data for outside school compound Y was used for the result of both school X and Y, since the two schools were located along the same road. The outside exposure data for school Y was assumed to be almost equivalent to that of school X.

3.2 Data Collection

3.2.1 Air Quality

The concentrations of air pollutants including carbon monoxide (CO), nitrogen dioxide (NO_2), ground – level ozone (O_3) and sulphur dioxide (SO_2) were continuously monitored and recorded by using the AQM60 Environmental Station as shown in Figure 3.2. AQM60 Environmental Station was manufactured by Aeroqual Limited in Auckland, New Zealand (Aeroqual Limited, 2014). Particulate matter (PM) was not included in this study as PM gas sensor modules was not installed in the air monitoring machine. Air pollution monitoring was performed in two different locations in each school compound; the first location was in front of school gates and the other location was near to classrooms. The concentrations of air pollutants for both inside and outside of schools' compounds were recorded every 2 minutes in terms of parts per million (ppm). The air quality trend for each selected school was computed by taking the weekly average measurement from the air monitoring machine and cross – referencing with the Malaysian Ambient Air Quality Guidelines (MAAQG).

Figure 3.2: Image of AQM60 Environmental Station (Aeroqual Limited, 2014)

3.2.2 Noise Level

The noise levels were continuously measured and recorded by using the Optimus Sound Level Meter as illustrated in Figure 3.3. Optimus Sound Level Meter was manufactured by Cirrus Research Plc (Programmable Logic Controller) based in United Kingdom (Cirrus Research, 2015). As similar to air monitoring, noise monitoring was carried out in two separate locations for each school compound. For every 2 minutes, the noise levels for both inside and outside of schools' compounds were recorded in terms of dB (A). All noise level readings have been measured under the A - weighted network because A – weighted network can effectively cut off the lower and higher frequencies like the human ear (Noise Meters Incorporated, 2015). The noise measuring equipment was calibrated before each use as the microphone is susceptible to minor damage from even small knocks. In order to get accurate readings, the equipment was placed on a stable surface and kept out of reach of school children. The noise level trend for each selected school was computed by taking the average measurement per week from the noise monitoring instrument and cross – referencing with the environmental noise limits as stipulated by Department of Environment (DOE).

Figure 3.3: Image of Optimus Sound Level Meter (Cirrus Research, 2015)

3.2.3 Survey Research

A total of 150 sets questionnaires were distributed evenly to the three selected primary schools, each school with 50 sets of questionnaires to obtain large amount of information regarding the air and noise pollution issue. The questionnaire was divided into 3 sections. The first section comprised of general and demographic information such as age and gender. The second part of the questionnaire contained questions relating to the air quality and noise level near school areas. The information was important to investigate the potential anthropogenic factors which may contribute to the interference of daily activities in school. Last but not least, the purpose of the last section was to examine the students' understanding of individual roles in environmental protection. Pre - test of questionnaire was also carried out to rephrase some of the questions for better understanding. Survey research was used in this study because it can acquire information or data needed in a effective, efficient and flexible way. One of the many disadvantages of survey research is the respondents' honesty in responding to the questions. Overall, survey research can be concluded as the well known research method applied by most researches (Burgess, 1993).

3.3 Data Analysis

For data analysis, all of the collected data were entered into a spreadsheet by using Microsoft Excel programme. Descriptive statistics for the air pollutants' concentrations and noise levels were calculated; including standard deviation, maximum and minimum. For air monitoring, the data was plotted into the concentrations of air pollutants (ppm) versus time measured (hour) graphical form; whereas the graphical form of noise levels, dB (A) against time measured (hour) was plotted for the noise readings. The data presented will depict the overall range of air pollutants' concentrations and noise levels, additionally their maximum and minimum readings. Furthermore, the air monitoring data for both inside and outside of schools' compounds were tabulated to show the average weekly concentrations of air pollutants for every 1 – hour period. These data were then used to cross – reference with the MAAQG to determine the air quality in school areas. While for noise monitoring, the data were tabulated to illustrate the average weekly noise levels for both inside and outside of schools' compounds of the selected primary schools. These data were then used to cross – reference with the environmental noise limits as stipulated by (DOE). Treatment of these physical data will give an insight into the air and noise pollution problems affecting the study area.

Apart from physical data measurements, a social survey in the form of questionnaire was given to the students. All the collected data were also entered into a spreadsheet for data analysis by using Microsoft Excel programme. Results from the questionnaires were helpful in the assessment of the behavioural effects on the school children due to air and noise pollution, and it will also aid in the search for the source of these alarming pollution issues. Failure to identify the source could lead to reduction in productivity of teachers and degradation of learning environment. The results obtained from the questionnaires were then presented in bar chart form for easy discussion and interpretation.

3.4 Summary of Methodology

`

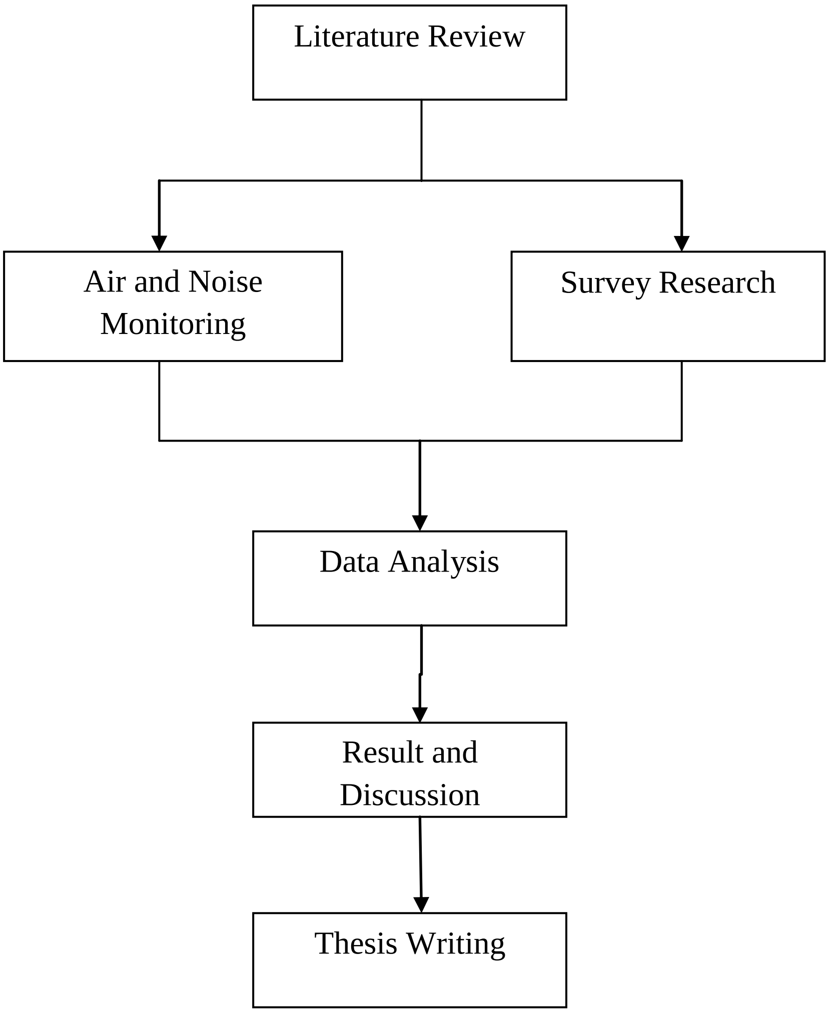

Figure 3.4: Flowchart of Study

Table 3.1: Gantt Chart of Study

Task	January 2015	February 2015	March 2015	April 2015	May 2015	June 2015	July 2015	August 2015	September 2015
1. Literature Review									
2. Data Collection									
3. Data Analysis									
4. Report Submission									
5. Presentation									

CHAPTER 4

RESULT AND DISCUSSION

4.1 Air Quality

4.1.1 Carbon Monoxide

Outdoor combustion generated activities which include automobiles exhaust from nearby main roads and parking areas were believed to be the main source of carbon monoxide (CO) concentration. The overall trends for the average CO concentrations per week for inside and outside of schools' compound were illustrated in Figure 4.1 and 4.2 respectively. From both figures, it was observed that the trends of the average weekly CO concentrations increased dramatically in the morning period then decreased slowly, and increased moderately again in the afternoon period. This was because most of the parents and bus drivers came to drop off school children in between 7.00 am to 8.00 am, and also to pick up school children in between 1.00 pm to 2.00 pm. Based on observation, the numbers of heavy trailers and lorries were higher in the morning period as compared to the afternoon period. This could be the main reason for the peak concentrations of CO in the morning period and slightly lower CO concentrations in the afternoon period.

As shown in the graphs below, the average concentrations of CO in school X and Y were higher as compared to school Z. This was because school X and Y were located beside a busier traffic junction with a higher traffic volume, while school Z was situated next to a less busy main road. For outdoor exposure data, school X was located along the same road as school Y thus the result for outside school compound

Y was assumed to be almost equivalent to that of school X. Besides that, it can be observed that the average concentrations of CO for inside school compound X and Z decreased to very low levels after the morning peak period. This may be due to CO have undergone some chemical reactions to transform into other gases. The average weekly concentrations of CO for inside and outside of schools' compounds ranged from 0.00 to 1.76 ppm for school X and school Y; and from 0.00 to 1.28 ppm for school Z. The standard deviation for CO concentrations inside schools' compounds was in between the range of 0.12 to 0.23 ppm, while for outside schools' compounds it was ranged from 0.29 to 0.35 ppm.

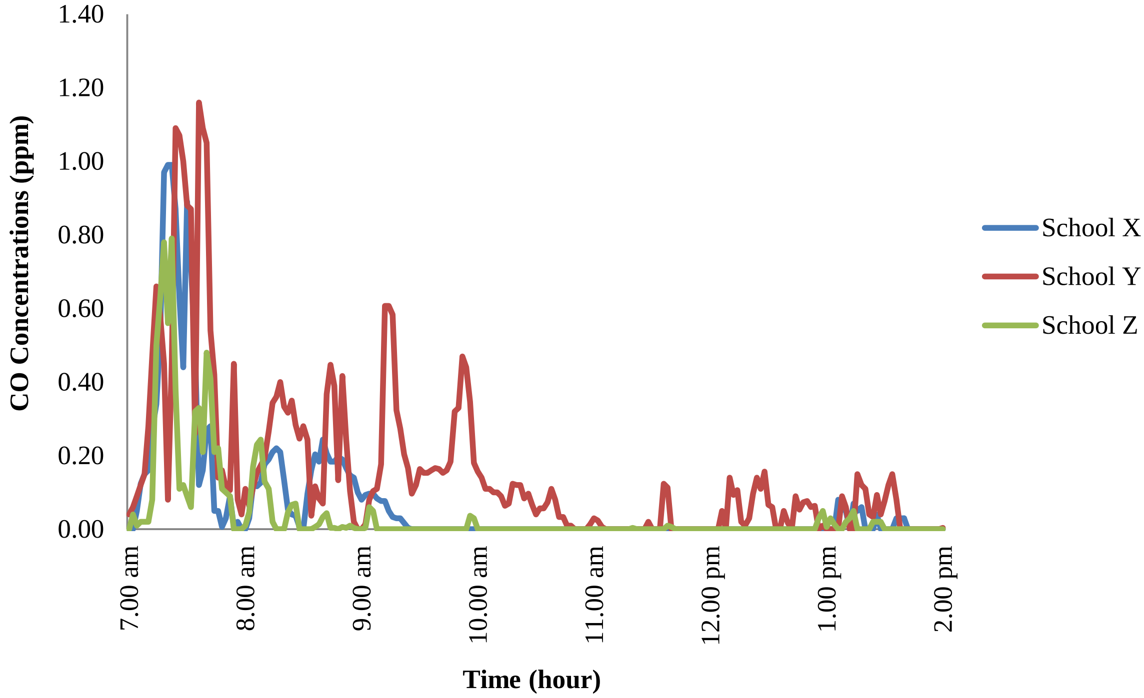

Figure 4.1: Average Weekly CO Concentrations Trends Inside Schools' Compounds

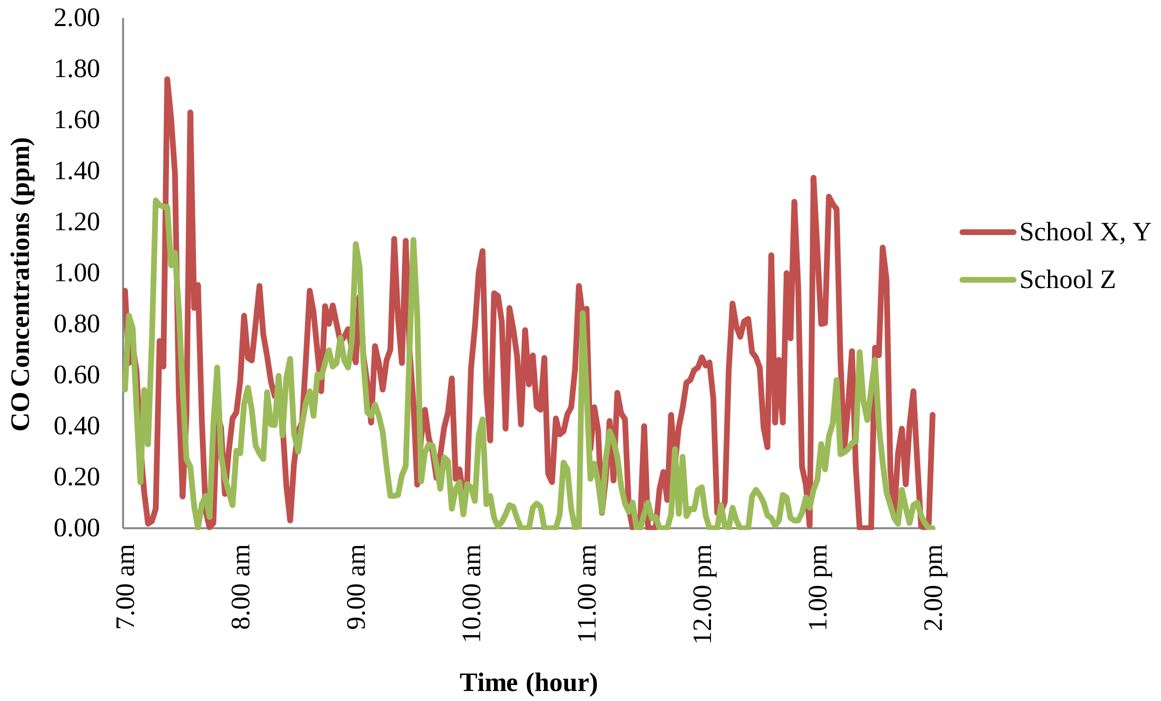

Figure 4.2: Average Weekly CO Concentrations Trends Outside Schools' Compounds

Generally, the recommended value of exposure for CO should not exceed 30.00 ppm for a 1 – hour period as indicated by DOE (DOE, 2014). From Table 4.1, the average weekly concentrations of CO for both inside and outside of all schools were well below the limit as stipulated in the MAAQG. The principal cause for moderate level of CO emissions from motor vehicles was due to catalytic converter that had been fitted in the exhaust of most motor vehicles on road. The nationwide implementation of the Euro 1 standard in 2000 required the fitting of catalytic converter to petrol and diesel cars to reduce CO emissions (Mahlia, Tohno, and Tezuka, 2012). Catalytic converter helps to convert over 90 % of hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxides (NOx) into the less harmful carbon dioxide (CO_2), nitrogen (N) and water vapour (H_2O). As a result, the students from the selected primary schools were not at risk of experiencing dizziness, headaches or facing difficulties to think clearly during classes.

Table 4.1: Average Weekly CO Concentrations (ppm) for Different Exposure Period

Exposure Period	School Compound X		School Compound Y		School Compound Z	
	Inside	Outside	Inside	Outside	Inside	Outside
7.00 am - 8.00 am	0.31 ± 0.34	0.56 ± 0.49	0.45 ± 0.39	0.56 ± 0.49	0.22 ± 0.24	0.50 ± 0.41
8.00 am - 9.00 am	0.13 ± 0.07	0.64 ± 0.22	0.21 ± 0.14	0.64 ± 0.22	0.04 ± 0.07	0.53 ± 0.18
9.00 am - 10.00 am	0.02 ± 0.04	0.53 ± 0.26	0.23 ± 0.16	0.53 ± 0.26	0.01 ± 0.02	0.37 ± 0.30
10.00 am - 11.00 am	0.00 ± 0.01	0.63 ± 0.24	0.07 ± 0.05	0.63 ± 0.24	0.00 ± 0.01	0.12 ± 0.19
11.00 am - 12.00 pm	0.00 ± 0.01	0.32 ± 0.24	0.01 ± 0.05	0.32 ± 0.24	0.00 ± 0.00	0.14 ± 0.13
12.00 pm - 1.00 pm	0.00 ± 0.01	0.63 ± 0.35	0.05 ± 0.05	0.63 ± 0.35	0.00 ± 0.01	0.06 ± 0.06
1.00 pm - 2.00 pm	0.02 ± 0.03	0.49 ± 0.42	0.04 ± 0.05	0.49 ± 0.42	0.01 ± 0.01	0.26 ± 0.20

4.1.2 Nitrogen Dioxide

Nitrogen dioxide (NO_2) principally came from motor vehicle exhaust and it was formed when fuel was burned at high temperatures. The overall trends for the average NO_2 concentrations per week for inside and outside of selected schools' compounds were shown respectively in Figure 4.3 and 4.4. From both figures, it was shown that the trends of the average weekly NO_2 concentrations increased sharply in the morning period then declined slowly, and increased slightly again in the afternoon period. This was due to the same reason as mentioned previously for the trends of the CO concentrations which was the arrival of parents and bus drivers during peak hours. The peak concentrations of NO_2 were moderately lower in the afternoon period due to the decreased numbers of heavy trailers and lorries as compared to the morning period.

As similar to CO concentrations, the average concentrations of NO_2 in school X and Y were relatively higher as both schools were located beside a busier traffic junction with higher traffic volume. The average weekly concentrations of NO_2 for inside and outside of schools' compounds ranged between 0.00 to 0.29 ppm for school X, 0.01 to 0.29 ppm for school Y; and 0.00 to 0.18 ppm for school Z. The standard deviation for NO_2 concentrations inside schools' compounds was in between the range of 0.01 to 0.02 ppm, while for outside schools' compounds it was ranged from 0.04 to 0.06 ppm.

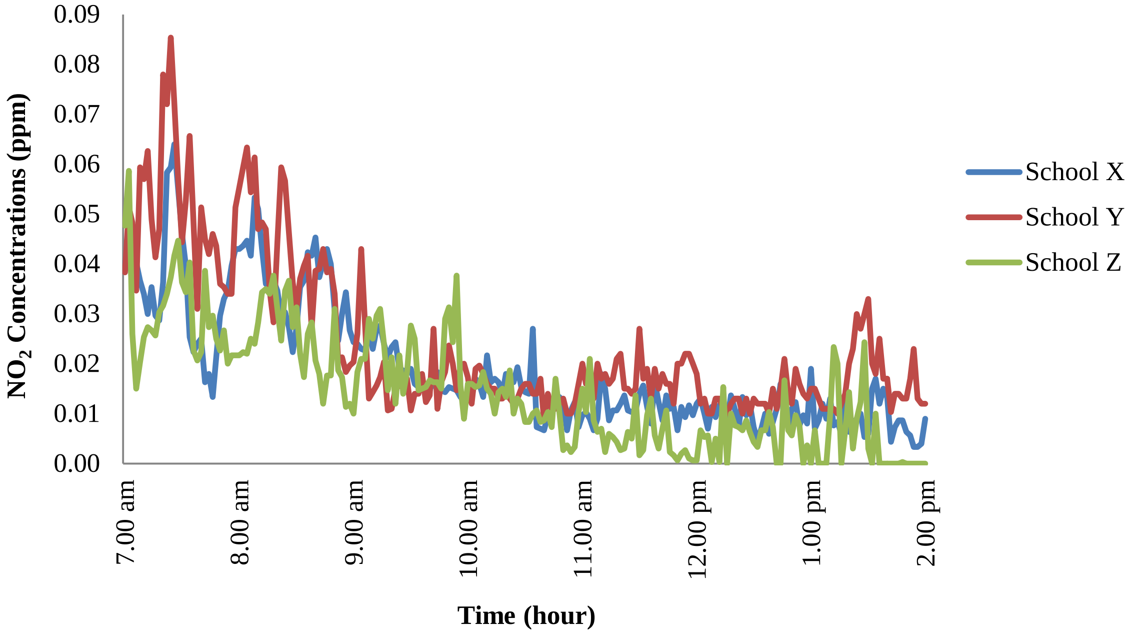

Figure 4.3: Average Weekly NO_2 Concentrations Trends Inside Schools' Compounds

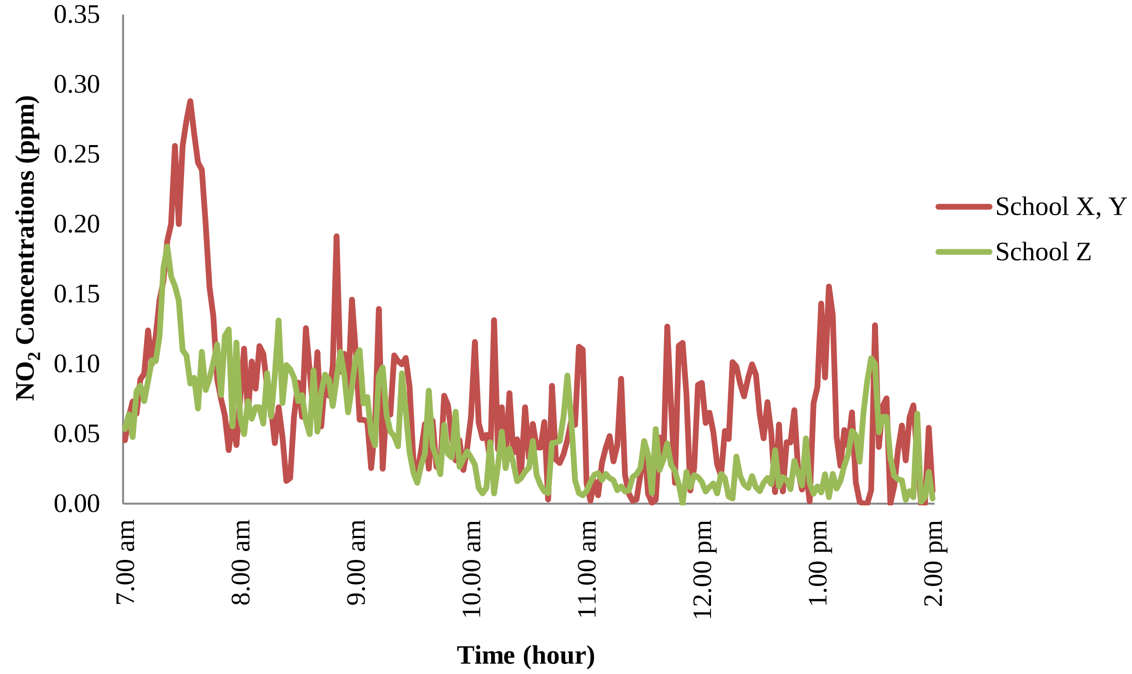

Figure 4.4: Average Weekly NO_2 Concentrations Trends Outside Schools' Compounds

In general, the recommended threshold value for NO_2 according to the DOE's guideline is 0.17 ppm for an exposure period of 1 hour (DOE, 2014). From Table 4.2, the average weekly concentrations of NO_2 for inside and outside compound of all schools were in compliance to the MAAQG. The main reason for modest level of anthropogenic NO_2 emissions from traffic vehicles may be due to the fitting of catalytic converter as mentioned earlier for air pollutant CO. Catalytic converter converts toxic pollutants in exhaust gas to less toxic pollutants by catalyzing oxidation and reduction reaction. Therefore, the concentrations of air pollutant NO_2 was considered to be acceptable and no behavioural effects were expected.

Table 4.2: Average Weekly NO_2 Concentrations (ppm) for Different Exposure Period

Exposure Period	School Compound X		School Compound Y		School Compound Z	
	Inside	Outside	Inside	Outside	Inside	Outside
7.00 am - 8.00 am	0.04 ± 0.01	0.14 ± 0.08	0.05 ± 0.01	0.14 ± 0.08	0.03 ± 0.01	0.10 ± 0.03
8.00 am - 9.00 am	0.04 ± 0.01	0.09 ± 0.04	0.04 ± 0.01	0.09 ± 0.04	0.02 ± 0.01	0.08 ± 0.02
9.00 am - 10.00 am	0.02 ± 0.01	0.06 ± 0.03	0.02 ± 0.01	0.06 ± 0.03	0.02 ± 0.01	0.05 ± 0.03
10.00 am - 11.00 am	0.01 ± 0.01	0.05 ± 0.03	0.01 ± 0.01	0.05 ± 0.03	0.01 ± 0.01	0.03 ± 0.02
11.00 am - 12.00 pm	0.01 ± 0.00	0.04 ± 0.04	0.02 ± 0.00	0.04 ± 0.04	0.01 ± 0.01	0.02 ± 0.01
12.00 pm - 1.00 pm	0.01 ± 0.00	0.06 ± 0.03	0.01 ± 0.00	0.06 ± 0.03	0.01 ± 0.01	0.02 ± 0.01
1.00 pm - 2.00 pm	0.01 ± 0.01	0.05 ± 0.05	0.02 ± 0.01	0.05 ± 0.05	0.00 ± 0.01	0.03 ± 0.03

4.1.3 Ozone

The products of fuel combustion were believed to be one of the common sources for the creation of ground – level ozone (O_3). The overall trends for the average O_3 concentrations per week for inside and outside compound of selected schools were shown respectively in Figure 4.5 and 4.6. From both figures, it was shown that the trends of the average weekly O_3 concentrations increased steadily from morning to afternoon due to the increasing temperature. Jeannie (2004) revealed that higher temperature could increase the formation of O_3 due to the acceleration of photochemical reaction rates between nitrogen oxides (NOx) and volatile organic compounds (VOCs). The average concentrations of O_3 per week for inside and outside of all three schools' compounds had the same range, in which the range was between 0.00 to 0.07 ppm. The standard deviation for O_3 concentrations inside schools' compounds was 0.02 ppm, while for outside schools' compounds it was ranged from 0.01 to 0.02 ppm.

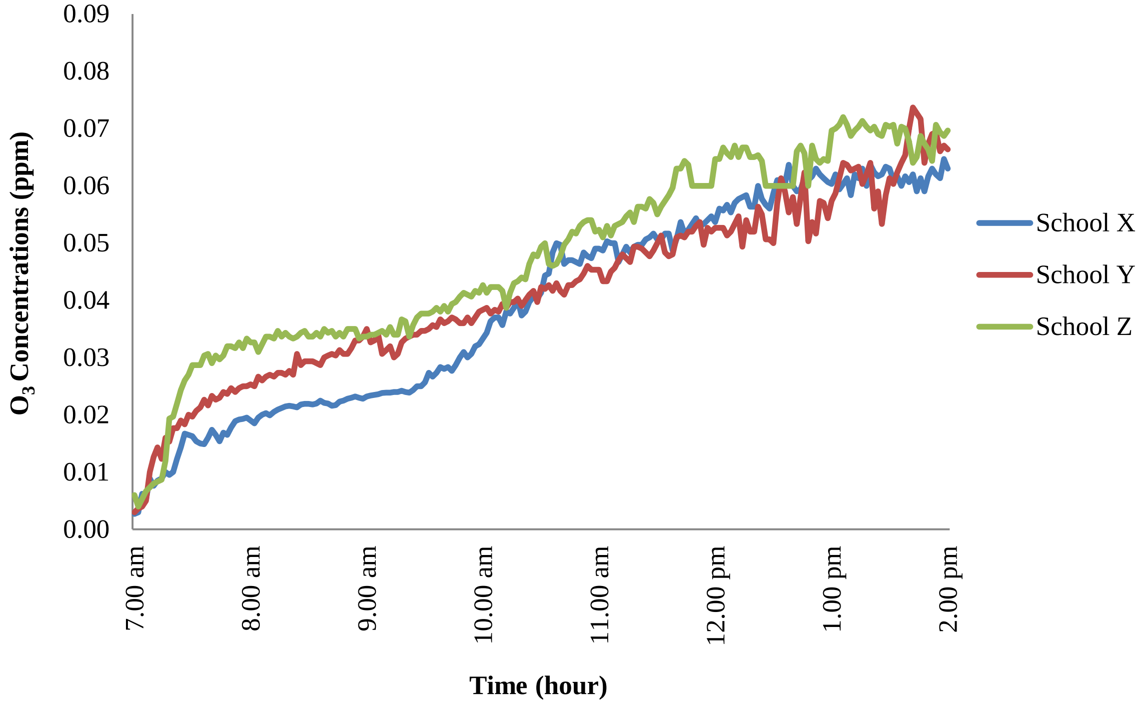

Figure 4.5: Average Weekly O_3 Concentrations Trends Inside Schools' Compounds

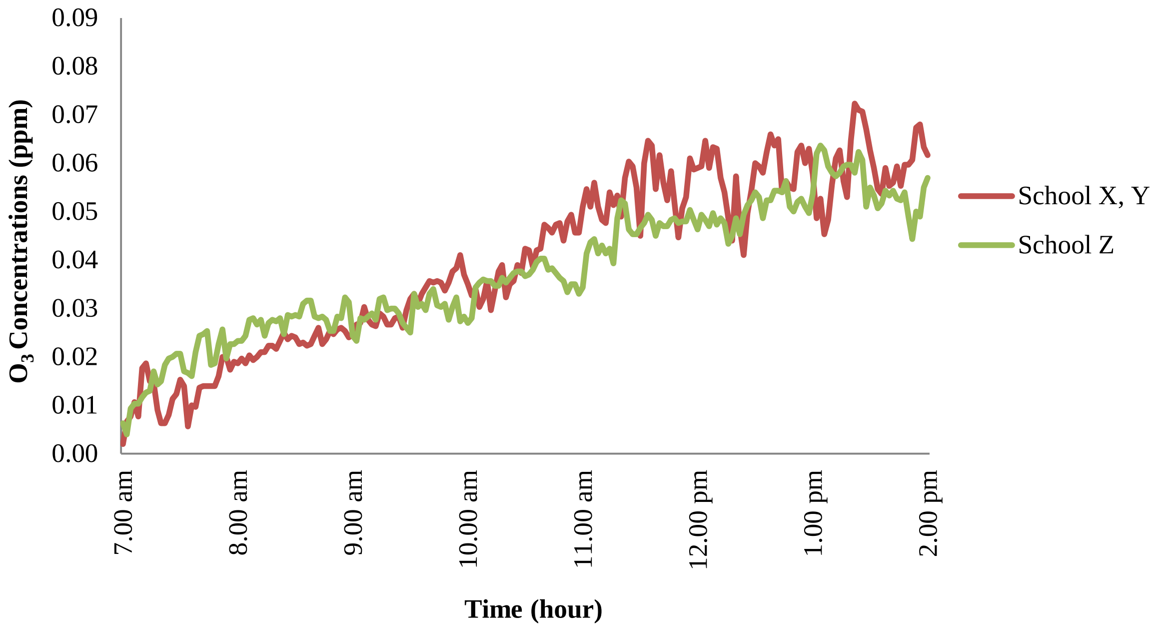

Figure 4.6: Average Weekly O_3 Concentrations Trends Outside Schools' Compounds

According to the DOE's guideline, the exposure of O_3 must not be higher than 0.10 ppm in an exposure period of 1 hour (DOE, 2014). From Table 4.3, the average weekly concentrations of O_3 for all selected schools varied very little and were in accordance with the MAAQG. The main reason for the low level of O_3 concentrations was may be due to the fact that O_3 was not emitted directly into the atmosphere, but was created by chemical reactions of ozone precursors primarily NOx and VOCs in the presence of sunlight. In other words, the formation of ground – level O_3 required the presence of ozone precursors and was not created directly through fossil fuel combustion. As a result, the exposed children in schools were not at risk of getting sore throats and coughing which could lead to uncomfortable learning environment.

Table 4.3: Average Weekly O_3 Concentrations (ppm) for Different Exposure Period

Exposure Period	School Compound X		School Compound Y		School Compound Z	
	Inside	Outside	Inside	Outside	Inside	Outside
7.00 am - 8.00 am	0.01 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	0.02 ± 0.01
8.00 am - 9.00 am	0.02 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.03 ± 0.00
9.00 am - 10.00 am	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.04 ± 0.00	0.03 ± 0.00
10.00 am - 11.00 am	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.00	0.04 ± 0.01	0.05 ± 0.00	0.04 ± 0.00
11.00 am - 12.00 pm	0.05 ± 0.00	0.05 ± 0.01	0.05 ± 0.00	0.05 ± 0.01	0.06 ± 0.00	0.05 ± 0.01
12.00 pm - 1.00 pm	0.06 ± 0.00	0.06 ± 0.01	0.05 ± 0.00	0.06 ± 0.01	0.06 ± 0.01	0.05 ± 0.00
1.00 pm - 2.00 pm	0.06 ± 0.00	0.06 ± 0.01	0.06 ± 0.01	0.06 ± 0.01	0.07 ± 0.00	0.06 ± 0.01

4.1.4 Sulphur Dioxide

Sulphur dioxide (SO_2) was believed to be present in motor vehicle emissions as the result of fuel combustion. The overall trends for the average SO_2 concentrations per week for inside and outside of the selected schools' compounds were illustrated in Figure 4.7 and 4.8 respectively. From both figures, it was observed that the trends of the average weekly SO_2 concentrations increased dramatically in the morning period then decreased slowly, and increased moderately again in the afternoon period. This was because most of the parents and bus drivers came to drop off and pick up their children during peak hours. As shown in the graphs below, the average concentrations of SO_2 in school X and Y were higher as both schools were located beside a traffic junction where a large numbers of cars and trucks passed by. The average concentrations of SO_2 per week for inside and outside of schools' compounds ranged from 0.01 to 0.33 ppm for school X; from 0.00 to 0.33 ppm for school Y; and from 0.00 to 0.19 ppm for school Z. The standard deviation for SO_2 concentrations inside schools' compounds was in between the range of 0.02 to 0.03 ppm, while for outside schools' compounds it was ranged from 0.04 to 0.06 ppm.

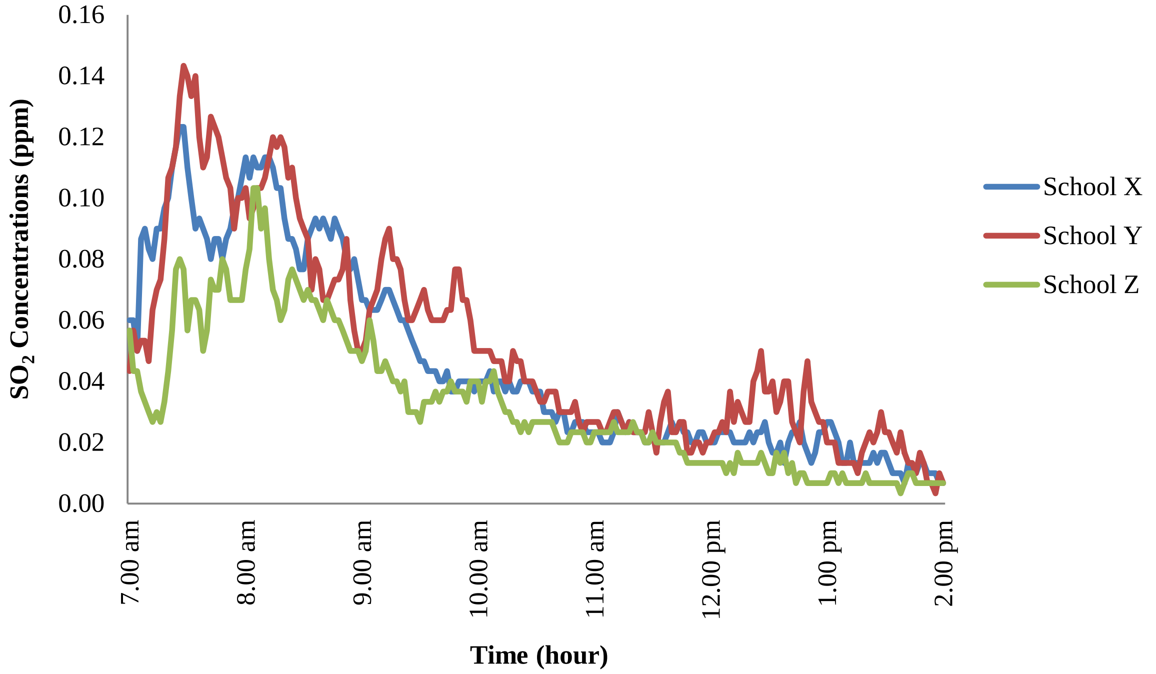

Figure 4.7: Average Weekly SO_2 Concentrations Trends Inside Schools' Compounds

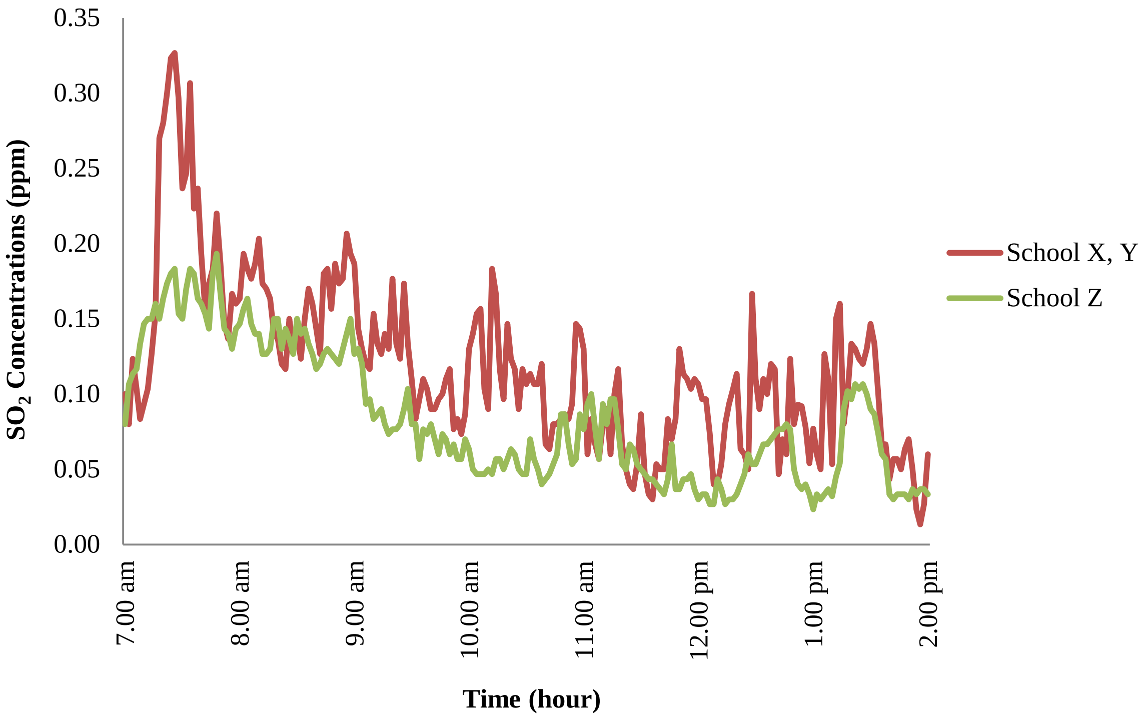

Figure 4.8: Average Weekly SO_2 Concentrations Trends Outside Schools' Compounds

Generally, the recommended value of exposure for SO_2 should not exceed 0.13 ppm for a 1 - hour period as indicated by DOE (DOE, 2014). From Table 4.4, the outside exposure data for all three schools particularly in the time period from 7.00 am to 9.00 am were not in compliance to the MAAQG. The principal cause for the high level of SO_2 emissions from motor vehicles may be caused by the diesel fuel. According to the United Nation Environment Programme (2008), sulphur levels in diesel are higher than in petrol fuel contributing to the formation of SO_2. A combination of high sulphur diesel with older vehicle technology leads to the worst case scenarios, emitting hazardous levels of smoke, soot and SO_2. Furthermore, the catalytic converter in cars and lorries does not convert SO_2 into less harmful gaseous pollutants. Therefore, the unhealthy levels of SO_2 in the morning period were attributable to the peak numbers of lorries and heavy trucks in the traffic junction. As a result, the exposed children were at risk of experiencing eye, nose or throat irritation which would disrupt their daily activities in schools.

Table 4.4: Average Weekly SO_2 Concentrations (ppm) for Different Exposure Period

Exposure Period	School Compound X		School Compound Y		School Compound Z	
	Inside	Outside	Inside	Outside	Inside	Outside
7.00 am - 8.00 am	0.09 ± 0.02	0.19 ± 0.08	0.10 ± 0.03	0.19 ± 0.08	0.06 ± 0.02	0.15 ± 0.01
8.00 am - 9.00 am	0.09 ± 0.01	0.16 ± 0.03	0.09 ± 0.02	0.16 ± 0.03	0.07 ± 0.01	0.14 ± 0.01
9.00 am - 10.00 am	0.05 ± 0.01	0.12 ± 0.03	0.07 ± 0.01	0.12 ± 0.03	0.04 ± 0.01	0.08 ± 0.02
10.00 am - 11.00 am	0.03 ± 0.01	0.11 ± 0.03	0.04 ± 0.01	0.11 ± 0.03	0.03 ± 0.01	0.06 ± 0.01
11.00 am - 12.00 pm	0.02 ± 0.00	0.08 ± 0.03	0.02 ± 0.01	0.08 ± 0.03	0.02 ± 0.01	0.06 ± 0.02
12.00 pm - 1.00 pm	0.02 ± 0.00	0.09 ± 0.03	0.03 ± 0.01	0.09 ± 0.03	0.01 ± 0.00	0.05 ± 0.02
1.00 pm - 2.00 pm	0.01 ± 0.01	0.08 ± 0.04	0.02 ± 0.01	0.08 ± 0.04	0.01 ± 0.00	0.06 ± 0.03

4.2 Noise Level

The noise monitoring revealed that the noise environment of the selected schools in Kampar was not satisfactory in terms of standard prescribed by DOE. It was observed that in these locations, the noise levels varied considerably due to the high volume of traffic flow and commercial activities. Moreover, the situation was deteriorating with exponential increase in population due to the emergence of higher education institutions, as well as the number of vehicles on road. The overall trends for the average noise levels per week for inside and outside of schools' compound were illustrated in Figure 4.9 and 4.10 respectively. From both figures, it was shown that the trends of the average weekly noise levels for all three primary schools fluctuated from morning period to afternoon period. Based on personal experience, the fluctuating trend may be due to the honking of vehicle horn and the noise from engine acceleration from time to time.

For indoor exposure data, the average noise levels for school X were the highest as compared to the other schools. This was because there was no barrier in between the noise source and the noise recipient. The noise produced by motor vehicles was transmitted directly to the students in school X without any obstruction. On the other hand, the surroundings of school Y and Z consisted of large tress and buildings that can be served as noise barrier to reduce the overall noise level. As shown in the graphs below, the weekly average noise levels for inside and outside of schools' compounds ranged from 51.6 to 79.6 dB (A) for school X; from 47.4 to 79.6 dB (A) for school Y; and from 42.1 to 76.5 dB (A) for school Z. The standard deviation for noise levels inside schools' compounds was in between the range of 3.0 to 7.3 dB (A), while for outside schools' compounds it was ranged from 4.4 to 5.5 dB (A).

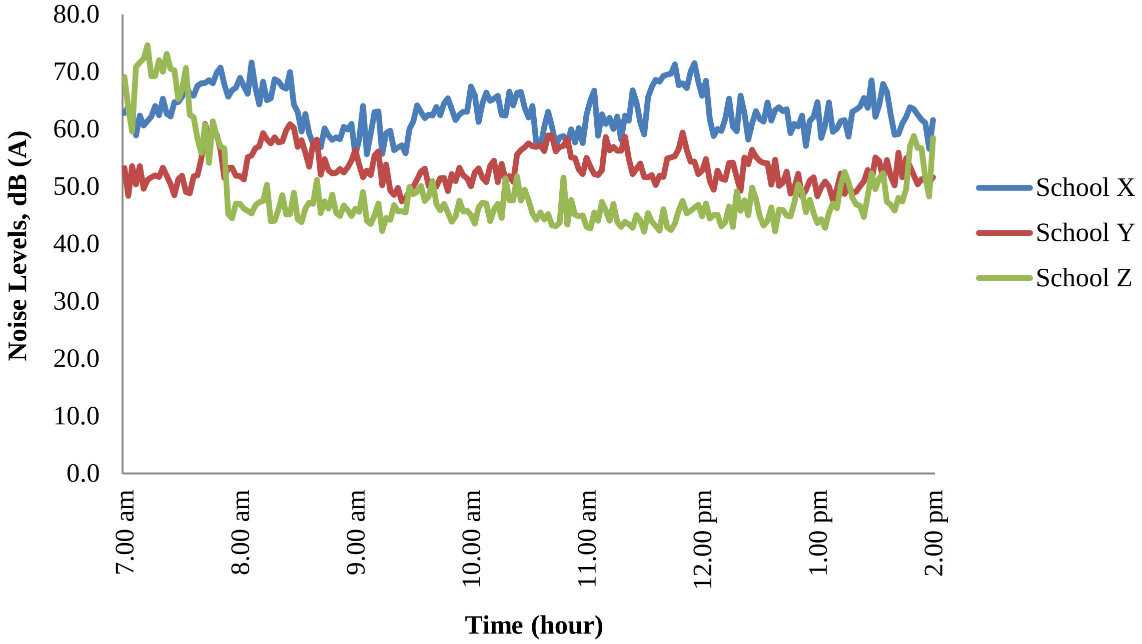

Figure 4.9: Average Weekly Noise Levels Trends Inside Schools' Compounds

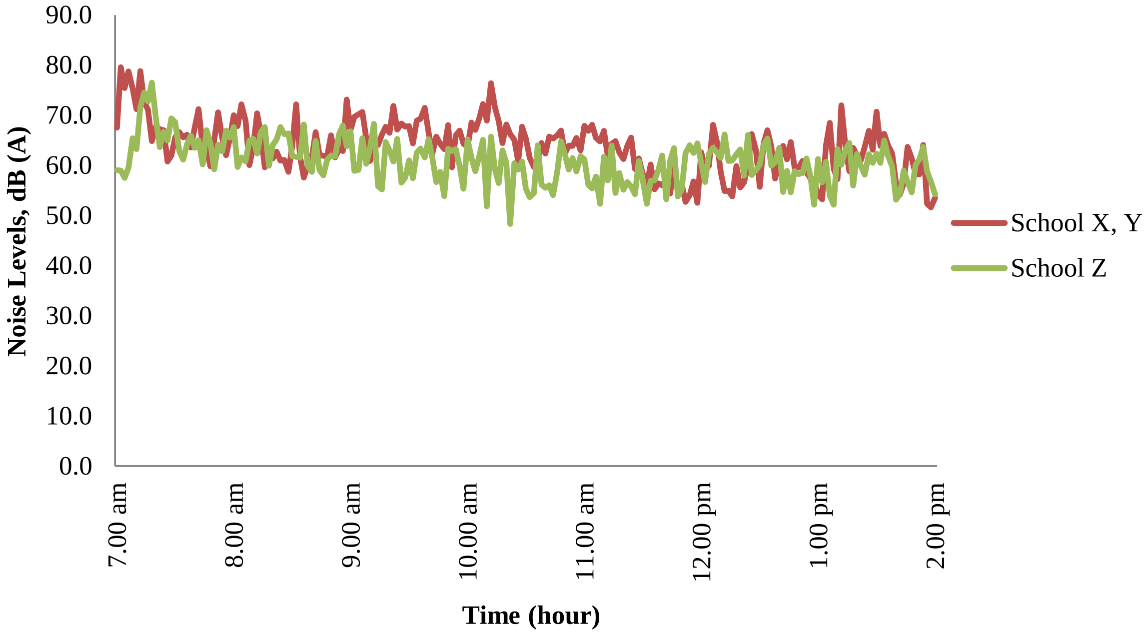

Figure 4.10: Average Weekly Noise Levels Trends Outside Schools' Compounds

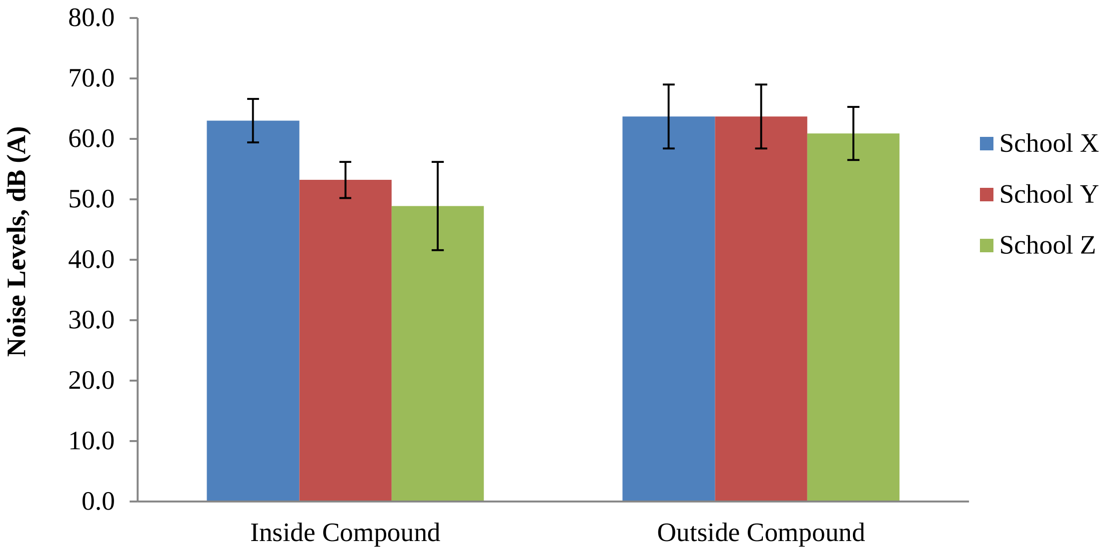

Figure 4.11: Average Weekly Ambient Noise Levels in Schools

The maximum permissible sound level for noise sensitive area such as schools are 50.0 dB (A) during daytime and 40.0 dB (A) during night time (DOE, 2007). In this study, only the noise exposure during day time will be focused as the study period was conducted from 7.00 am to 2.00 pm. From Figure 4.11, it can be concluded that most of the monitoring sites were badly affected with traffic noise as the average noise levels were higher as compared to the guidelines of DOE. All three schools were exposed to very high noise levels, which might cause nuisance to the students in addition to the adverse behavioural effects.

4.3 Survey Research

Questionnaire surveys were randomly distributed to male and female students in each primary school to determine the behavioural effects on the exposed students. Upon the collection of survey data, it was concluded that the road traffic was the major source of environmental air and noise pollution according to the respondents. From Figure 4.12, more than 60 % of students from the selected schools were aware of the air and noise pollution issue, while almost 10 % of the students were still unaware of these worrying environmental problems. Figure 4.13 illustrated that approximately 60 % of students in both school X and Y felt that their schools were affected by the poor air quality and high noise level, while only less than 40 % of students in school Z felt the same as students in school X and Y. Even though more than half of the respondents were aware of the air and noise pollution, however most of them were unsure whether they were being affected. This happened because the students may understand the definition of air and noise pollution, but they do not know what are the air pollutants or concentrations that could bring adverse impacts to human health. According to the respondents, the findings of the social survey as shown in Figure 4.14 revealed that motor vehicles were the main cause of air and noise pollution as compared to construction activities and commercial activities around school areas. Moreover, most of the students expressed that annoyance and stress were the main negative behavioural effects resulting from the poor environmental quality as depicted in Figure 4.15. Last but not least, Figure 4.16 showed that more than 45 % of respondents from all three primary schools stated that no action had been taken by their schools in overcoming these issues.

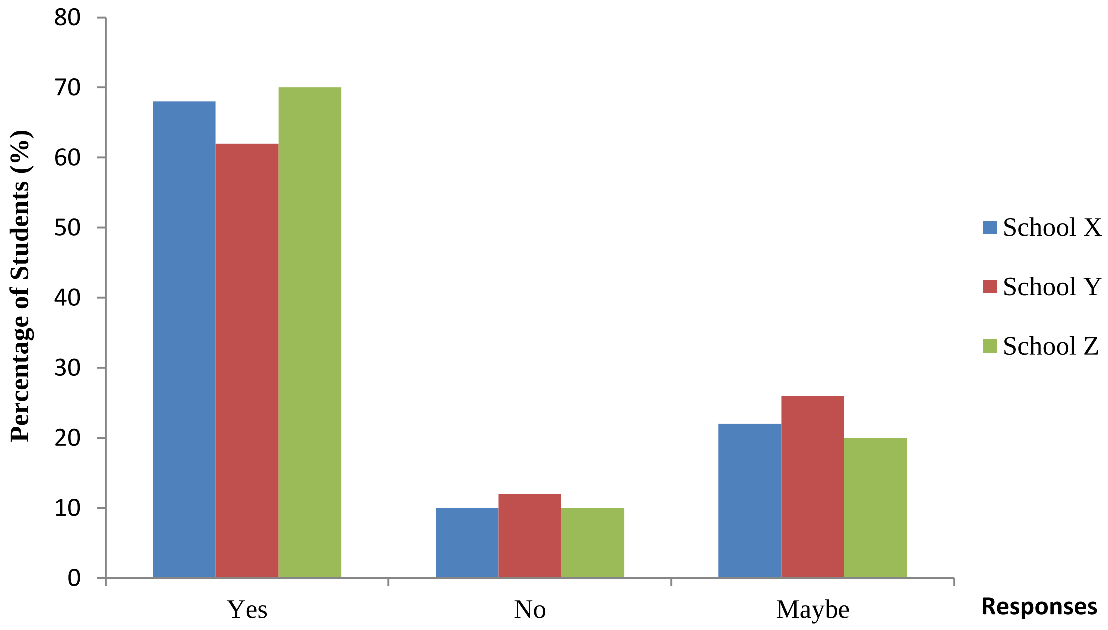

Figure 4.12: Awareness of Air and Noise Pollution Issue

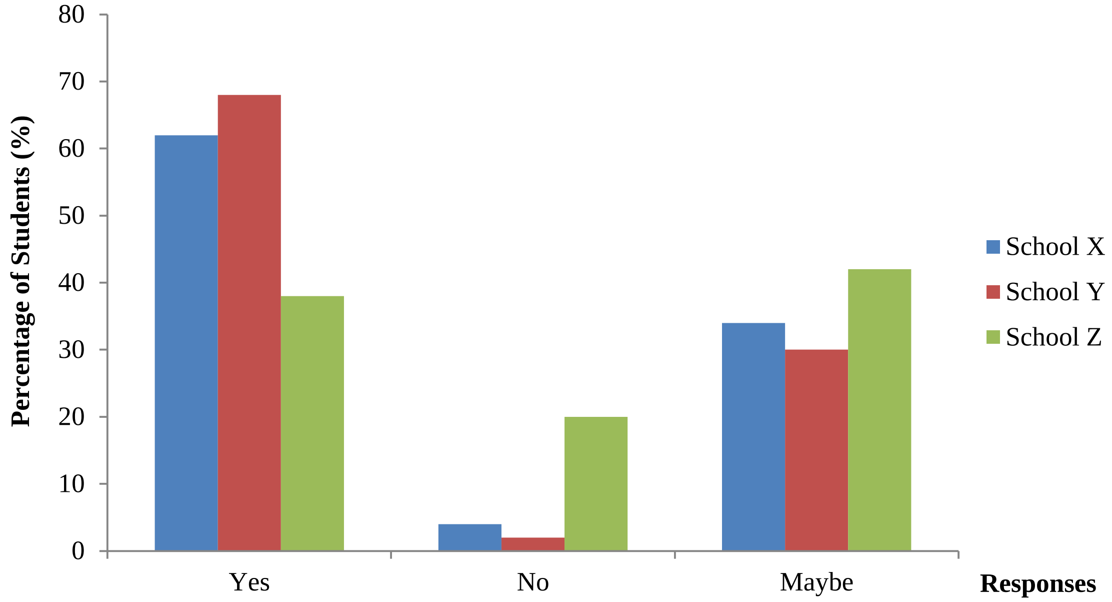

Figure 4.13: Students Affected by Air and Noise Pollution

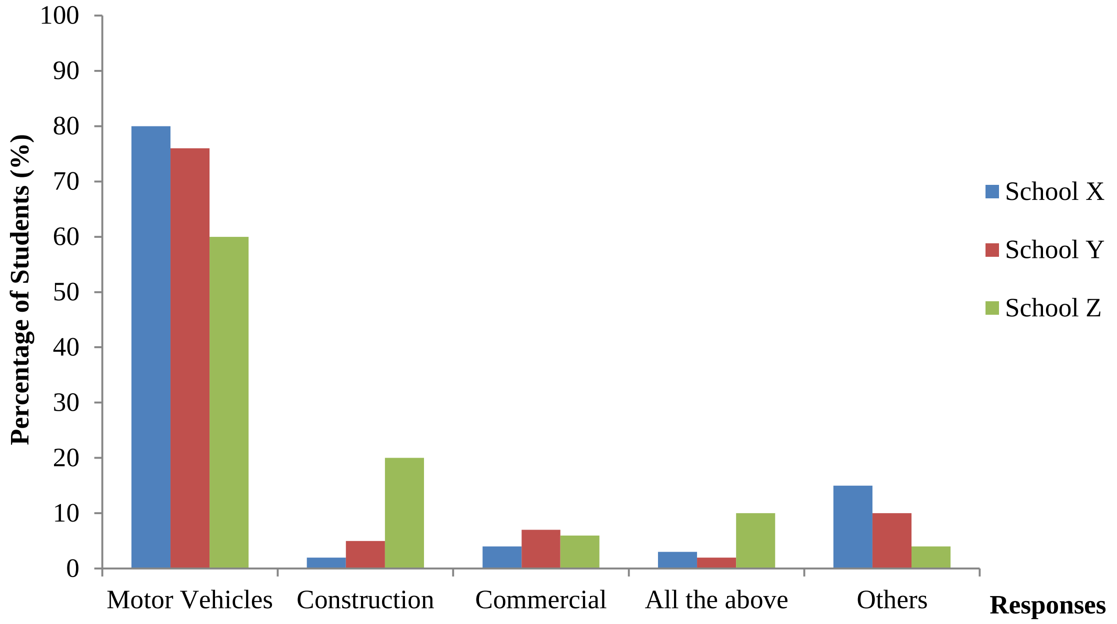

Figure 4.14: The Main Cause of Air and Noise Pollution

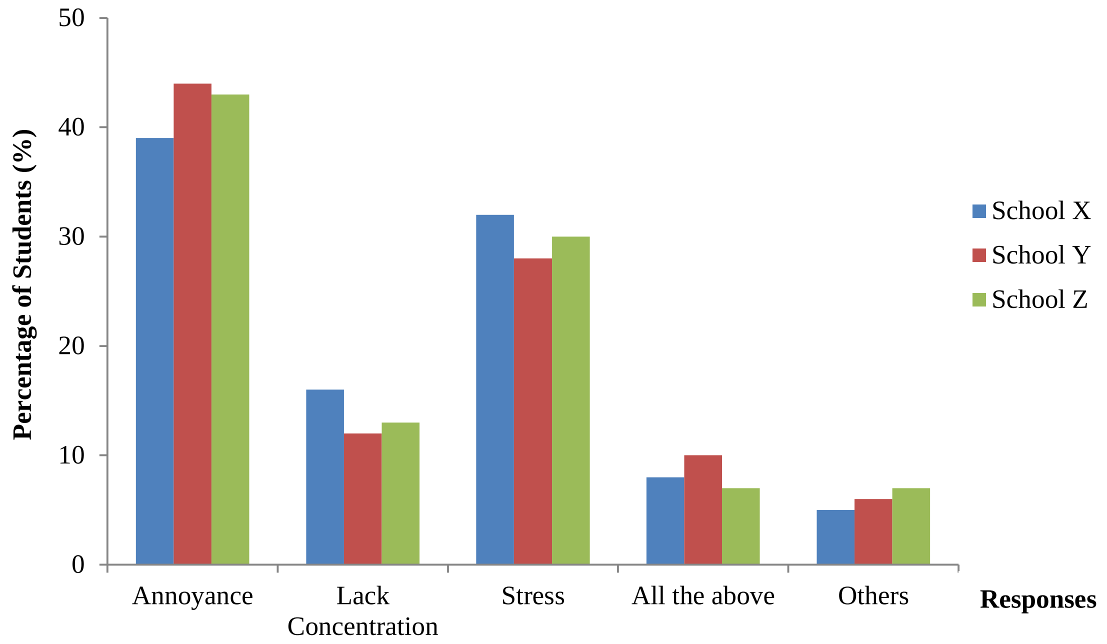

Figure 4.15: The Main Behavioural Effects of Air and Noise Pollution

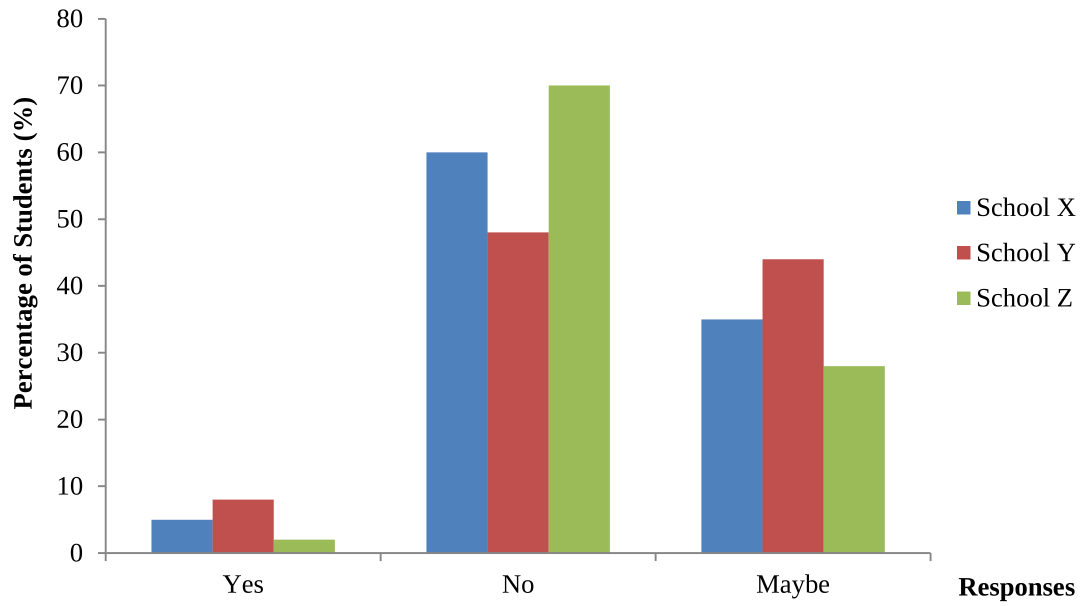

Figure 4.16: Action Taken by Schools to Overcome Air and Noise Pollution Issue

4.4 Recommendations

To reduce air and noise pollution at source point, students are advised to use public transport or join a carpool instead of relying on their parents or bus drivers to drive them to schools. Students may also consider cycling or walking with friends if their respective schools are just a walking distance away from home. Besides that, parents and bus drivers must play their parts by switching off vehicle engine while waiting for students to reduce the unnecessary sound produced. Parents and bus drivers may also consider switching to cleaner fuels to reduce the release of toxic air pollutants particularly SO_2. If more students are willing to reduce car use, the reduction in emissions of air pollutants and noise produced from traffic vehicles will be substantial.

In order to block the path of air and noise pollution, schools may consider increasing the number of fans or installing air ventilators to improve the ventilation in classrooms. Proper interior ventilation will improve indoor air quality by increasing the amount of outdoor air coming into the classrooms, diluting the concentrations of harmful air pollutants, and pushing stale indoor air out of the classrooms. Air purifier can also be installed near classrooms to remove airborne contaminants and produce a more conducive learning environment for the students. Apart from that, schools may also consider planting more trees and create more green areas around school compounds as trees help in noise reduction to a considerable extent. Vegetation has been proposed as a natural barrier to reduce outdoor noise. Belts of tress and bushed situated between the noise source and the receiver can reduce the noise level perceived by the receiver. Sound absorbing curtains can also be installed in all classrooms to further reduce the noise level.

According to the survey research, it appeared that there was still a small group of students were still unaware of the air and noise pollution issue. For that reason, it is important for schools to organize awareness campaigns to raise awareness among the students. Schools must facilitate access to information on the health effects of air pollution and noise pollution, and methods for reducing the health risks imposed by these environmental problems. Students should also take initiative action to look up for more information on the internet and to learn more about these environmental issues. Everyone in the school plays a part in curbing the threats of air and noise pollution and become part of the environmental solution.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on this research study, the average concentrations of sulphur dioxide (SO_2) were not in compliance to the Malaysian Ambient Air Quality Guidelines (MAAQG), which is 0.13 ppm for a 1 – hour exposure period; while the other air pollutants such as carbon monoxide (CO), nitrogen dioxide (NO_2) and ground – level ozone (O_3) were all well below the guidelines. As a result, the exposed children were at risk of experiencing eye, nose or throat irritation which would disrupt their daily activities in schools. The average noise levels of the selected schools have also exceeded the 50 dB (A) daytime limit almost the entire study period as indicated by Department of Environment (DOE). On top of that, the majority of students have stated that they were affected by air and noise pollution due to traffic vehicles. They have also expressed that annoyance and stress were the main negative behavioural effects resulting from these environmental pollution.

5.2 Recommendations

In future studies, the time period of air and noise monitoring should be extended to at least a few months to achieve a more conclusive result. A longer monitoring period better lends itself to accurate statistical analysis, and the results are thus more meaningful. Moreover, the numbers of schools selected as study area must be increased to obtain a larger sample size. This is because a larger sample size allows researchers to better determine the average values of their data, and avoid errors from testing a small number of possibly unrepresentative samples. To further improve the study result, the sample size should involve teachers and staff with a larger age group instead of limiting to just one age group. As a matter of fact, a good sample size consists of different age groups to reflect the full diversity and true distribution of population in schools.

REFERENCES

Abdelraziq, I. R., Ali – Shytayeh, M. S. and Abdelraziq, H. R., 2003. *Effects on noise pollution on blood pressure, heart rate and hearing threshold in school children*. Pakistan Journal of Applied Science 3, 10 (12), pp. 717 – 723.

Aeroqual Limited, 2014. *Aeroqual AQM 60 user guide.* [Online] Available at: http://www.aeroqual.com/wp-content/uploads/AQM-60-Air-Quality-Monitoring- Station-User-Guide.pdf [Accessed 24 July 2015].

Bateson, T. F. and Schwartz, J., 2008. *Children's response to air pollutants*. Journal of Toxicology and Environmental Health, 71 (3), pp. 238 – 243.

Belojevic, G., Jakovljevic, B., Paunovic, K., Stojanov, V. and Ilic, J., 2008. *Urban road- traffic noise and blood pressure in school children*. Institute of Hygiene and Medical Ecology, Serbia.

Burgess, R., 1993. *Research Methods*. Walton – On – Thames, Thomas Nelson.

Chauhan, A. J., Inskip, Linaker, H. M., Smith, C. H., Schreiber, S., et al., 2003. *Personal exposure to nitrogen dioxide and the severity of virus induced asthma in children*. The Lancet, 361, pp. 1939 – 1944.

Chedd, G., 1970. *Sound: From communication to noise pollution*. Doubleday and Company Inc., New York.

Chen, P. C., Lai, Y. M., Wang, J. D., Yang, C. Y., Hwang, J. S., Kuo, H. W., Huang, S. L. and Chan, C. C., 1998. *Adverse effect of air pollution on respiratory health of primary school children in Taiwan*. Environmental Health Perspectives, 106 (6), June.

Cirrus Research, 2015. *Optimus Red Sound Level Meter*. [Online] Available at: http://www.cirrusresearch.com/products/sound-level-meters/optimus-red-sound- level-meters/ [Accessed 20 July 2015].

Cohen, S., Krantz, D. S., Evans, G. W. and Stokols, D., 1981. *Cardiovascular and behavioral effects of community noise*. American Scientist, 69, pp. 528 - 535.

Currie, J., Hanushek, E. A., Kahn, E. M., Neidell, M. and Rivkin, S. G., 2008. *Does pollution increases school absences?* Columbia University.

Daly, A. and Zannetti, P., 2007. *An introduction to air pollution – Definitions, classifications, and history*. The Arab School for Science and Technology.

Department Of Environment (DOE), 2007. *The planning guidelines for environmental noise limits and control.* Ministry of Natural Resources and Environment.

Department Of Environment (DOE), 2014. *Malaysia Environmental Quality Report 2013*. Ministry of Natural Resources and Environment.

Elfaig, A. H. I., 2002. *Community noise pollution in Kuala Lumpur.* Analyses and Expert System Department Ph.D. Thesis. Universiti Pertanian Malaysia.

Elfaig, A. H. I., Duad, M., Adam, N. M., Bardaie, M. Z. and Abdullah, R., 2014. *Monitored community noise pollution in selected sensitive areas of Kuala Lumpur*. International Journal of Scientific and Technology Research, 3, February.

Environmental Protection Agency (EPA), 1979. *Noise effects handbook: National Association of Noise Control Officials.* United States of America.

Environmental Protection Agency (EPA), 1995. *Air trends 1995 summary: Nitrogen dioxide*. United States of America.

Environmental Protection Agency (EPA), 2006. *Children's environmental health: 2006 report*. United States of America.

Evans, G. W., 1990. *The non-auditory effects of noise on child development*. Swedish Council for Building Research, pp. 425 – 453.

Gary, W. E., 1982. *Environmental stress.* Press Syndicate of the University of Cambridge, United States of America.

Gilliland, F. D., Berhane, K., Rappaport, E. B., Thomas, D. C., Avol, E., Gauderman, W. J., et al., 2001. *The effects of ambient air pollution on school absenteeism due to respiratory illnesses.* Epidemiology, 12 (1), January.

Google Maps, 2015. Location of Kampar town. [Online] Available at: https://www.google.com.my/maps/@4.3257848,101.1508637,14.75z?hl=en [Accessed 24 June 2015].

Graff, Z., Joshua, S. and Matthew, J. N., 2012. *The impact of pollution on workers' productivity.* American Economic Review, 102 (7), pp. 3652 – 3673, December.

Horvath, S. M., Raven, P. B., Dahms, T. E. and Gray, D. J., 1975. *Maximal aerobic capacity at different levels of carboxyhemoglobin*. Journal of Applied Physiology, 28, pp. 300 – 303.

Ibrahim, Z. H. and Richard, H. K., 2000. *Noise pollution at school environment located in residential area.* Universiti Teknologi Malaysia, 12 (2).

Jeannie, A., 2004. Tango *in the atmosphere: Ozone and climate change*. [Online] Available at: http://www.giss.nasa.gov/research/features/200402_tango/ [Accessed 15 July 2015].

Kampar District Council, 2015. *Total population by ethnic group, local authority area and state, Malaysia, 2010.* [Online] Available at: http://www.mdkampar.gov.my/ [Accessed 28 March 2015].

Mahyidin, N. A., 2011. *The conservation of old shophouses in Kampar and economics relation due to the new development of Bandar Baru Kampar*. Universiti Teknologi Mara.

Mahlia, T. M. I., Tohno, S. and Tezuka, T., 2012. *A global review of success story on implementation of fuel economy standard for passenger cars: Lesson for other countries.* Energy Science and Research, 29 (2), pp. 947 – 972.

Manoj, S., Paul, W. B. and Ashutosh, A., 2014. *Introduction to community and public health*. 1st ed. Jossey – Bass Education.

Mengesha, A. and Mamo, W., 2006. *Air pollution*. Ethiopia Public Health Training Initiative.

Moch – Sibony, A., 1984. *Study of the effects of noise on personality and certain psychomotor and intellectual aspects of children after a prolonged exposure*. Travail Humane, 47, pp. 155 – 165.

Nadaraja, B., Wei, Y. X. and Abdullah, R., 2010. *Effect of traffic noise on sleep: A case study in Serdang Raya, Selangor, Malaysia*. EnvironmentAsia, 3, pp. 149 – 155.

Noise Meters Incorporated, 2015. *Frequency Weightings*. [Online] Available at: https://www.noisemeters.com/help/faq/frequency-weighting.asp [Accessed 18 July 2015].

Lawton, B. W., 2000. *The 75 dB (A) threshold level of physical agent's directive: A flawed evolution.* Proceedings of the Institute of Acoustics, 22 (5), pp. 61 – 68.

Manitoba, 2009. *Air quality guidelines for arena operations in Manitoba*. Canada, February.

Oyana, T. J. and Rivers, P. A., 2005. *Geographic variations of childhood asthma hospitalization and outpatient visits and proximity to ambient pollution sources at a U.S. – Canada border crossing*. International Journal of Health Geographics.

Puja, M., 2015. *Noise pollution: Definition, sources and effects of noise pollution.* [Online] Available at: http://www.yourarticlelibrary.com/speech/noise-pollution- definition-sources-and-effects-of-noise-pollution/28295/ [Accessed 13 July 2015].

Regecova, V. and Kellerova, V., 1995. *Effects of urban noise pollution on blood pressure and heart rate in preschool children*. National Institutes of Health, 13 (4), pp. 405 – 412.

Romieu, I., Meneses, F., Ruiz, S., Sienra, J. J., Huerta, J., et al., 1996. *Effects of air pollution on the respiratory health asthmatic children living in Mexico City*. Critical Care Medicine, 154, pp. 300 - 307.

Stansfeld, S. A. and Matheson, M. P., 2003. *Noise pollution: Non-auditory effects on health*. British Medical Bulletin, 68, pp. 234 – 257.

United Nation Environment Programme (UNEP), 2008. *Gulf cooperation council (GCC) policy development meeting on clean fuels and vehicles*. Nairobi, Kenya.

World Health Organization (WHO), 1999. *Guidelines for community noise*. WHO Document Production Services, Geneva, Switzerland.

World Health Organization (WHO), 2005. *Air quality guidelines: Globe update 2005*. WHO Regional Office for Europe, Copenhagen, Denmark.

World Health Organization (WHO), 2010. *Exposure to air pollution: A major public health concern.* WHO Document Production Services, Geneva, Switzerland.

World Health Organization (WHO), 2014. *Ambient outdoor air quality and health.* [Online] Available from: http://www.who.int/mediacentre/factsheets/fs313/en/ [Accessed 4 July 2015].

Zakaria, J., Lye, M. S., Hashim J. H. and Hashim Z., 2010. *Allergy to air pollution and frequency of asthma attacks asthmatic primary school children*. American - Eurasian Journal of Toxicological Sciences, 2 (2), pp. 83 – 92.

Zweig, J. S., Ham, J. C. and Avol, E. L., 2009. *Air pollution and academic performance: Evidence from California schools*. University of Southern California.

APPENDICES

Figure A1: Condition of Traffic Junction near School X and Y at 7.30 am

Figure A2: Condition of Traffic Junction near School X and Y at 1.30 pm