EXPLORATION ON TRAFFIC ACTIVITIES AT THE INTERSECTION AND THEIR IMPACTS TO THE ENVIRONMENT

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EXPLORATION ON TRAFFIC ACTIVITIES AT THE INTERSECTION AND THEIR IMPACTS TO THE ENVIRONMENT

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A thesis submitted in fulfilment of the requirement for award of the degree of

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This hard work is dedicated to my beloved family and my precious friends who love me and support me during my whole journey of education.

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ABSTRACT

The problem of traffic system is first appeared at intersection. At intersection, there is often a lot of traffic activity such as stop and go condition, turn left or right and change lane that can lead to vehicle emission that. This study was conducted to assess the association of vehicle speed and volume to CO emission at the intersection. Then, level of CO emission was formulated based on vehicle speed and volume of vehicle. To achieve this study, two intersections have been choosing as a study area. By means of correlation and multiple regression analysis, the associations between speed and volume to the level of emission were established. A correlation analysis was conducted using Pearson's R to determine the degree of association between speed and volume vehicle to CO emission. Traffic models were developed for the two of intersection evaluated in this work for morning, afternoon and evening peak periods at interval 15 minute every 2 hour during peak period. The models CO emission developed revealed that morning and evening peak produced strong relationship between speed and volume of vehicle towards CO emission at the intersection.

ABSTRAK

Masalah utama pada sistem trafik selalu berlaku di persimpangan. Di persimpangan, terdapat banyak aktiviti lalu lintas seperti berhenti dan pergi, ke kiri atau kanan dan perubahan lorong yang boleh menghasilkan pelepasan gas kenderaan (CO) yang akan memberi kesan kepada alam sekitar. Kajian ini dijalankan untuk menilai hubunkait antara kelajuan kenderaan dan jumlah aliran lalulintas terhadap pelepasan gas kenderaan (CO) di persimpangan. Oleh itu, tahap pelepasan gas kenderaan(CO) digubal berasaskan kelajuan kenderaan dan jumlah aliran lalu lintas. Untuk mencapai kajian ini, dua persimpangan telah dipilih sebagai kawasan kajian. Dengan cara korelasi dan analisis regresi berganda, hubungkait antara kelajuan dan jumlah aliran lalu lintas terhadap pelepasan telah dihasilkan. Analisis korelasi telah dijalankan menggunakan R Pearson untuk menentukan tahap hubungkait antara kelajuan kenderaan dan jumlah aliran lalu lintas terhadap pelepasan gas kenderaan (CO). Rumus trafik telah dihasilkan untuk kedua-dua persimpangan ini pada waktu pagi, tengah hari dan petang selang setiap 15 minit selama 2 jam pada waktu puncak. Rumus – rumus pelepasan gas kenderaan (CO) yang dihasilkan mendedahkan bahawa waktu pagi dan petang puncak menghasilkan hubungkait yang kuat antara kelajuan kenderaan dan jumlah aliran lalu lintas terhadap pelepasan gas kenderaan (CO) di persimpangan.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Malaysia has grown rapidly development in the field of transportation since 20 years ago. This development caused from the high rate of population growth, urbanization and economic progress. With this rate, the number of vehicles on the road increases, then the volume of traffic increases. According to statistics from the Jabatan Keselamatan Jalan Raya Malaysia (JKJR, 2009), statistic of road accidents in Malaysia showed that the rate of road accidents in Malaysia is increasing and concern. In addition, traffic congestion on the road also rises due to the increase in vehicle usage among Malaysians. This situation causes increased of CO emission from vehicle that affect on the environment in terms of speed and volume of vehicle. Transportation sector and transportation planning are the factor of cause air pollution and change the speed vehicle.

Transportation sector is one of the factors that contribute to air pollution happen especially in cities. Even in developing countries, the transport sector is a major contributor to air pollution. Pollution that occurred because of the vehicle comes from the importance part of the vehicle. Many type of pollutant release from the vehicle likes carbon monoxide, nitrogen oxide etc. This pollutant has many affect to the environment and also to human health. Air pollution by transport factor is causing use of fuel as a booster for the vehicle. It is the main ingredient of the transport sector. Evaporation of fuel, engine ventilation system and the main thing is a waste of fuel combustion, which is hundreds mixing gas and aerosol is a major cause of various pollution discharge of from transport sector.

Next, transportation planning involves of planning, functional design, operation and management in every aspect of transportation to provide safety, rapidity, comfort, convenience, economical and environmentally friendly to the movement of people (Gordon, 1979) and also affect the speed of vehicle. Road maintenance is one of the activities that are important to ensure the performance of a way to always be in good condition and suitable for use. Each roads built are carefully designed according to the characteristics and particular suitability to fulfil the needs and achieve a satisfactory level. The roads are built will have the characteristics such as wide an appropriate way, and there is an intersections and a strategic passage for users of vehicles in and out of the way.

1.2 PROBLEM STATEMENT

Intersection is the one of the traffic calming and the problem at traffic system is first appeared at intersection such as congestion and traffic accident. At intersection, there is often a lot of traffic activity such as stop and go condition, turn left or right and change lane can produce vehicle emission that will affect the environment.

Therefore, this study was to assess the association of vehicle speed and volume to CO emission at the intersection. Through this study, speed and volume vehicle when through the intersection are known and the value of CO emission from vehicle is record.

1.3 OBJECTIVE

This study was done to evaluate the effect of speed and volume of vehicle to CO emission at intersection. To achieve the aim of this study, the following objectives have been set:

i. To identify the association of vehicle speed & volume of vehicle to CO emission at the intersection
ii. To formulate level of CO emission based on vehicle speed and volume of vehicle

1.4 SCOPE OF STUDY

To ensure that the goals and objectives are achieved, the study was conducted on two intersections. There were signalized intersections at Indera Mahkota and Jalan Tanah Putih (Giant) in Kuantan. The study was conducted by collecting data of speed and volume of vehicle that passes through the intersection. Besides that, CO emission level also was gathered for intervals of 15 min at 2 hours during peak period.

These studies only focus the road heading to central business district (CBD) because CBD is area has attraction in term of facilities and entertainment. Factor gradient, the road width and the width of the intersection is ignored in this study. Data for these observations observed at peak hour; morning peak, afternoon peak and evening peak in weekday and weather factors were also considered in this study.

1.5 RESEARCH SIGNIFICANT

To achieve the aims and the objectives, the research is done on two intersections at Kuantan. The researches begin with speed and volume of vehicle data collection and CO emission of the vehicles that passing the intersection. After obtained the data, the data will be analyzed and the association between speed and volume to the level of CO emission will be determined and traffic models were developed.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Intersection is designed to enable drivers to cross traffic or move from one flow to another flow, to change the direction of its movement. However, the situation at the junction will slightly delay or an accident may occur if the driver does not have the competence to change the direction of movement and speed. This situation will definitely affect the speed of the vehicle. Speed is a measurement of the rate of travel which is usually measured in units of km / h. For motorists, the rate used to assess the quality of their journey. Speed is widely used to evaluate a section of the road. Every road was constructed normally be accessed through capacity analysis. The average speed for the trip is an important element in the analysis of traffic capacity. In addition to the analysis of capacity, the rate also has many other uses. The rate is also affected by many other factors. This chapter explains more about matters related with speed, and the effect of the accesses to the speed of the vehicle based on studies and research in the past.

2.2 DEFINITION OF TRAFFIC CALMING

According to Zegeer and Seiderman (1999), is a way to redesign streets so that traffic is tamed to a level that allows it to coexist more peacefully with people. Another definition of traffic calming is the application of traffic engineering and other physical measures designed to control traffic speeds and encourage driving behaviors appropriate to the environment. Devon County Council (1991) noted that the term 'traffic calming' is largely open to interpretation, although hit does convey the basic objective of the approach- to reduce the adverse effects of road traffic by adapting the volume, speed, and behaviour of traffic to the primary function of the streets through which it passes. Alternatively, Pharoahand Russell (1989) has defined traffic calming: “to achieve calm, safe, and environmentally improved conditions on streets. Apart from the definitions as stated, traffic calming is the combination of mainly physical measures that reduce the negative impacts of motor vehicle use, alter driver behaviours, and improve conditions for non-motorized street users (Schroll (1999).

Institute of Transportation Engineers (ITE) in 1999, the definition of traffic calming as a combination of physical measures that reduce the negative effects caused by the use of the motor, changing driver behaviour and improve conditions for road users (Bunte, 2000). According to Chow Kim Hoong (2008), in 2007, the Victoria Transport Policy Institute, definition of traffic calming as some design features and strategies aimed to reducing the speed and volume of vehicles on the road.

Bunte (2000) states that Build America in 1997 termed the traffic calming as the process people are encouraged to look for other alternative transport, driving slower, driving using alternative routes and driving with consideration to area residents. In 1999, Public Technology also believes that traffic calming is one of the ways to smooth traffic of vehicle control. It also as a way to increase the comfort and safety of residents are often disturbed by the noise of the speeding vehicle (Bunte, 2000).

2.3 HISTORY OF TRAFFIC CALMING

The first traffic calming called Living Yards or Woonerven and its use has been approved by European governments in 1976. The next year, this idea has spread to other countries and regulations and laws have been created to control the dimensions and location. It is effectively used on a small road and has a small volume. Woonerven used to reduce vehicle speed and volume of traffic by placing tables and chairs across the street. The idea of installing traffic calming technique has been improved with a reduction in cost and can be applied in a large way and have a high volume of traffic. After that, lane closures, one-way streets and humps have been used as a technique to smooth traffic.

According Bunte (2000), traffic calming is become more popular in Europe since 30 to 40 years ago. Traffic calming is begin in the Netherlands late 1960s as an attempt to change the behaviour of the driver to make the roads safe for children, pedestrians and cyclists. People in Europe were very disappointed with the attitude of drivers who like overtaking and make the streets an unsafe.

Traffic calming began in the early 1980s when Norway and Denmark meeting and discuss about the traffic problems. They've built full chicanes, roundabout, hump and other of traffic calming on the roads. Exist of traffic calming has reduced the velocity of the vehicle, accident and produce better air quality.

2.4 TYPES OF TRAFFIC CALMING

Traffic calming measures can be divided into two categories: vertical measures and horizontal measures. Under the horizontal deflections techniques, it includes chicane, choker, half closure, and mid-block island, narrowing lanes, neck down, on street parking and so on (Schroll,1999). While the vertical measures include speed humps, speed tables, raised intersections, and textured pavements. Intersection is a one way of slowing down the speed cars, especially in urban areas, and may help reduce accidents (ITE, 1993).

2.4.1 Road Hump

A road hump as shown in **figure 2.1** is a raised portion of carriageway laid at right angles to the direction of traffic. Humps generally have either a circular (round-top) profile or a trapezoidal (flat-top) profile with ramps leading up to and down from a plateau. Road humps are the most commonly used traffic calming measure in Britain (Hass-Klauet aL, 1992), and this is no doubt due to their effectiveness as speed-reducing devices. Round-top humps were first used in the UK in the 1980s (Baguley, 1981), though their design was tightly controlled.

Figure 2.1 Road hump

2.4.2 Speed Cushions

Speed cushions as shown in **figure 2.2** are raised areas in the carriage way which occupy only part of the traffic lane. Cars and other vehicles with narrow track widths cannot avoid them, and have to cross with at least one wheel of each axle on the cushion. Larger vehicles with wider axles can cross by straddling the raised area. Thus, buses, fire appliances, and some ambulances should be able to cross them relatively unimpeded, whilst car drivers have to slow down to avoid discomfort (Layfield, 1994).

Figure 2.2 Speed Cushions

2.4.3 Junction / Intersection

Webster (1993a) explained that raised junction area development of the flat-top hump. The whole junction is raised to road-hump level with ramps on all arms. Such features can make drivers more aware at problem junctions, can form an attractive speed-reducing feature, and can help pedestrians to cross the road if constructed to footway level. They are most useful in an area-wide scheme at junctions which are known to be hazardous, and where major reconstruction would not be justifiable or viable. **Figure 2.3** show an intersection.

Figure 2.3 Junction

2.4.4 Roundabout

Roundabout as shown in **figure 2.4** has been used as a traffic management device in Britain for many decades. They are used to reduce speeds, smooth the traffic flow, and reduce vehicle conflicts. The speed reduction results from the creation of a lateral shift in the carriageway, and priority being given to traffic approaching from the off-side. A disadvantage of roundabouts is the increased danger faced by cyclists as a result of conflicting movements. Also, pedestrians can find them difficult to negotiate

(Hass-Klauet aL, 1992).The design of conventional roundabouts tends to limit their use to larger roads, and therefore mini-roundabouts are often installed in residential areas (Devon County Council, 1991). These are an effective way of treating specific junctions with poor accident records.

Figure 2.4 Roundabout

2.5 DEFINITION OF SPEED

Speed is the distance travelled by a vehicle per unit time and unit commonly used is the meter per second or kilometres per hour. According to Everett and Wolfgang (1994), the rate or time travel, is a simple measurement of the road and highway. For drivers, they are measure the quality of the way through their ability to drive at the desired speed. Numerous studies show that the behaviour of the most important elements in the selection of routes to minimize delay time. The speed varies according to the characteristics of the driver and the vehicle, when, where, and environmental conditions (Che Madam Othman, 2008).

Speed is also part of the criteria used by the driver to assess the quality of their trips. In addition, speed is an important parameter in transport engineering as it relates to safety, time, comfort, convenience and economy. The speed of a vehicle on a road can change according to driver of characteristic and vehicle characteristics, time, place and situation. The term traffic speeds often used when describing the movement of traffic. For engineers and road traffic, there is a wide range of different speeds. In traffic engineering and highway, the speed is usually classified into five types: (Othman Che Puan, 2008)

i. Particular speed
ii. Speed travel
iii. Running Speed
iv. Speed min time
v. Speed min distance

2.5.1 Particular Speed

The particular speed of a vehicle is termed as the vehicle speed measured at a point on a road at a certain point (Othman, 2006). Study particular speed used to determine the distribution of the speed of traffic flow at certain locations. Particular speed data collected will be used to determine the percentage rate of the vehicle in which important decisions related to the rate.

The particular rate of data used for safety applications include the following (Robertson, 1994):

i. Determine the operation the existing traffic
ii. Evaluation of traffic control devices
iii. Reviewing the design elements geometric lines
iv. Speed traffic control with a systematic review
v. Analysis of road accidents
vi. Research

The method can be used to measure the particular rate is:

1. Endoscope
2. Video recording
3. Radar gun
4. Stopwatch

2.5.2 Speed Travel

Speed travel is the average speed of a vehicle between two points, the distance travelled divided by the time taken for such period of time because of traffic delays. (Othman, 2006).

As easy, the speed of travel is:

$$\text{The rate of trips} = \frac{distance}{total\ travel\ time}$$

Information and data rate of trips for a road or section of road is commonly used to assess the efficiency of the road network system. The method can be used to measure the speed of travel is:

1. Method observer moves
2. Method of matching vehicle registration number plate
3. Method observer in high places

2.5.3 Running Speed

The running speed can be defined as the average speed of the vehicle when in motion. This rate does not take into factor of delay (Othman, 2006).

As simple, the rate of runoff is:

$$\text{Running speed} = \frac{distance}{(journey\ time - time\ delay)}$$

Information and data for running speed normally for a road used for traffic planning and measurement to the level of congestion. The method can be used to measure the rate of run-off is a method of moving observer.

2.5.4 Speed min time

Speed min time is the average speed of vehicles crossing the point on a road in a certain period of time. It also is the arithmetic average speed of a vehicle passing observed passing a point on a road section. As simple, the speed min rate is the average rate at which the individual speed of a vehicle that passing the point is recorded and averaged arithmetically (Roger et al., 2007).

2.5.5 Speed min distance

Speed min distance is also termed as the average rate is calculated by dividing the total distance travelled by all vehicles with a total time taken by all those vehicles (Othman, 2006). It also is a statistical term that represents an average rate based on an average trips time of a vehicle that crosses a section of the road. It is also called the mean time because the average trips time to affect the average speed of the vehicle every time a predetermined way or space. Speed min is also average speed of particular speed but a large scale space provided instead of time.

2.6 IMPORTANT OF SPEED

Speed is one of the factors that are important for the user to choose a route or mode of transportation. To get effective traffic movement and safety is to control the speed. For example, studies have been made by a relatively Hauer (2000), the more the varying of velocity on the road, the higher an accident that happen. In addition, air pollution also increased if the velocity is high, especially type of traffic calming.

Speed is important to define the movement of a vehicle. It is an important to control the speed to gain traffic movements is effective and safe. Speed is also controlled to avoid accidents on the road caused by driving too fast or too slow. For example, according of Hauer (2000), the more varying velocity exist on the road, the more high accident occurred. In addition, the accident rate increased if the velocity is high, especially at a speed exceeding 60 km / h. Rate deaths will increase in velocity is too high and the speed too low.

The speed of a vehicle should be controlled to enable the driver can control of their vehicle when faced with various obstacles or situations. Speed used must be appropriate to the stopping sight distance so the driver can slow down or stop them secure. Besides stopping sight distance, passing sight distance also must be compatible with the speed of a vehicle, in order to avoid this happening any accident when overtaking is done (Pignataro et al., 1973).

The value for each speed used to determine the design of a wide way. The speed used and set is based on the road 85% of the maximum speed limit (Wikipedia, 2007). The speed limit that is safe to use for a vehicle in a certain way because it has the highest distribution safe vehicles driven at the speed limit of 85% of the design. For example, the North South Highway was designed with speed limits design of 130 km / h but the maximum allowable speed limit is 110 km / h. Limit speed used is based on the speed limit of the road design.

2.7 METHOD FOR MEASURE SPEED

Speed can be measured using various methods. Usually, the methods used to measure the particular speed data are different of speed travel. In addition, the particular speed more easily measured than the speed travel. Measurement for the speed is usually done based on a location on the road. There are various methods that can be used to gather data for the speed. Among them are:

1. Endoscope
2. Video recording
3. Radar gun
4. Stopwatch

2.7.1 Endoscope

Endoscope is representing old technology in the systems for recording speed. Among the tools used is a simple L-shaped box with open ends containing a mirror placed on the side of the road in order to keep the lines of observe can be aligned at 90 degrees. This is done to avoid any parallax error. Two of endoscope was installed on tripod known distance between them.

Observers will record the time of passage of a vehicle through endoscope by using a stopwatch. Distance is allowed to be in the range of three kilometres per hour to maintain the provision of data obtained. Endoscope reading becomes more difficult as the flow rate of the high traffic on different routes. This technique has been widely used for long periods of time and normally a trained observer easily obtained.

2.7.2 Video recording

The principle used in this method is the same as the recording speed endoscope. Time line of a vehicle is recorded using sensors. The ability to electronically recorded data means that the higher the accuracy of the data that will be obtained. This method involves recording the distance travelled by a vehicle in a short period of time. After that, speed the vehicle will be calculated.

At the time of this advanced technology, a lot of new equipment such as video cameras can be used to conduct traffic studies. This equipment is widely used especially for carrying out the study in addition flow way direction of delay, traffic jams along the way, the movement of vehicles turning at an intersection, pedestrian crossings etc. One of the advantages in using visualization through film or video is a recording made by the observer is permanent and can be played back repeatedly if necessary, and the activities in the field can also be observed.

However, the work analyzed the information recorded on film or video is complicated and takes a very long and boring. Now with the rapid technological advances, efforts are being made to facilitate further work to analyze the information that was recorded automatically.

2.7.3 Radar gun

This method operates by transmitting microwaves having a high frequency of a vehicle and its measurement is based on the change in frequency of a wave and the wave divergence respond. Distance most suitable for measurements using radar meter is between 60.96 meters up to 3,218 kilometres (Parma, 2001).

Changes in the frequency, also known as the Doppler Effect which is directly proportional to speed of a vehicle is compared with radar speed meter on. The observed rate is independent of the direction of movement of a vehicle. Meter distance for radar operation is dependent on the strength of the response signal received an order for any control on the meter.

Different vehicle sizes will affect the observation data obtained from radar gun (Currin, 2001). Large vehicles such as trucks and buses are a major reversal on the radar gun. This causes a small vehicle cannot be detected.

Therefore if there is a large vehicle, the observer must record the vehicle speed only and also if the vehicle is equipped with a radar detector it will keep the vehicles that the radar unit is operating. This is because for vehicles equipped with radar, they will drive slowly when they were warned by sensors on their vehicles.

2.7.4. Stopwatch

Stopwatch method can be used successfully to get speed by using a small sample size for comparison for a short period of time. Method stopwatch is faster and cheaper to observe the velocity readings.

Measures to observe the velocity readings by using the stopwatch are as follows:

1. Selection of the appropriate distance and location
2. Recorded observations form the observed data to the stopwatch
3. Vehicle velocity calculation
4. Providing frequency distribution table and determine the percentage of velocity

2.8 FACTORS AFFECTINF SPEED

Speed is also part of the criteria used by the driver to assess the quality of their journey, where speed is variable according to the characteristics of the driver, vehicle and the environment. This speed is different for every type of vehicle. However, the speed of a vehicle depends on several factors such as:

i. Road conditions
ii. Characteristic of drivers and vehicles
iii. The speed limit
iv. The width of the road
v. The volume of traffic

2.8.1 Road condition

Road conditions must also be in good condition, such as holey and others can affect the movement of the driver at the same time may cause an accident.

2.8.2 Characteristic of drivers and vehicles

The attitude of a person's driver also plays a role in influencing the speed of a vehicle. If a driver is driving with low speed over a one-lane road, this leads to another vehicle following that vehicle as long cannot identify safe conditions to make overtaking and this causes traffic runs smoothly. In a study conducted by BS Liu (2007) about the related of gender to show the speed with male drivers tend to drive faster than women. Moreover, Lander et al. (1993) states that men are more daring drivers to violate traffic rules than other drivers.

2.8.3 The speed limit

The speed limit for a road will affect the speed of a vehicle. Normally, the average speeds of vehicles drive on the road in excess of the speed limit. Based on previous studies that have been conducted, speed limit violation is a common thing to happen. One example is a study conducted by Nilson (1999) which showed that 50-55% of drivers speeding on the road 70 and 90km / hr

2.8.4 The width of the road

A narrow street or road obituary with two partitions can cause the driver to feel their movement faster than the movement in the streets and spacious for the same speed (Othman Che Puan, 2008). The driver reduces the speed of their vehicles when passing through a narrow passage (Transportation Research Board, 1985). If a width road more wide, the speeds of a vehicle also high and travelling more smoothly. (Transportation Research Board, 1985). Drivers feel their driving on the highway with a speed of 100 km / h slower than when they pass through the village streets with the same speed (Che Puan.Othman, 2006).

2.8.5 The volume of traffic

The volume of traffic also affects the speed of the vehicle. The volume is affected by the road and the driver's attitude. In the narrow lanes, drivers drive their vehicles lenis close to each other; it reduces vehicle speed or increase the distance longitude. The volume was reduced in both these situations (Satish et al, 2003).

According Pignataro et al. (1973), road width requirements are not the same, depending on the volume and type of traffic using each lane. Road width measuring 14 feet road, this road can accommodate a large volume of road. Meanwhile, the road width is 10 feet, suitable to new intersection. The width of the road up to 11 feet 12 feet is to use a high speed vehicle. For a limited, the road width is adequate by 8 feet 6 inches.

2.9 COMPONENT OF AIR POLLUTION

The main components of air pollutants are carbon monoxide (CO), sulphur oxide (SO), nitrogen oxides (NO), ozone (O3), and hydrocarbons. This study involved sub-urban areas only, this study focused on data intake for gasses CO, SO, and NO , will be discussed in detail in this chapter.

2.9.1 Carbon Monoxide (CO)

CO is a gas that is difficult to know because it is colourless at normal temperatures, odourless and tasteless. It is form naturally and anthropogenic. CO formation of the natural process is as process solid waste disposal, photolysis process methane (CH_4), volcanic eruption, the decomposition of chlorophyll, forest burning and microbial action in the ocean. But the main source CO from human activities such as motor vehicles emission by 70% using petrol engines.

Incomplete combustion O_2 will produce CO. This means incomplete combustion which the oxygen supply, the flame temperature, turbulence combustion chamber and a gas at high temperature remains insufficient. (Goddish, 1991).

2.9.1.1 The Effect of Carbon Monoxide to Humans

CO is harm for human life. It can reduce the ability of bloodstream to flow oxygen (O_2) to the body tissues during breathing. This is because the red blood cells or haemoglobin (Hb) has eliminated with O_2 then merged with CO more easily combined and form carboxyhemoglobin (Wolf, 1973). The amount of CO in Hb depends on the concentration of CO, exposure time of CO and rate of breathing that occurs.

The reaction of CO with haemoglobin is 220 times faster than O_2. Therefore, even if humans only inhale a gas CO, it is sufficient to have an adverse impact on humans (Nevers, 1995).

2.9.2 Sulphur Oxide (SO)

All living things contain sulphur elements. Sulphur in the form of sulphur oxides (SO) in the atmosphere and air pollutant most widely dispersed. Generally, there are 6 sulphur oxide compounds, which is sulphur monoxide (SO), sulphur dioxide (SO_2), sulphur trioxide (SO_3), sulphur tetra oxide (SO_4), sulphur trioxide (S_2O_3) and sulphur heptaoxide (S_2O_7). (Zaini Ujang, 1997)

Among the properties of sulphur dioxide is colourless, inflammable and does not erupt. It will produce an unpleasant smell like rotten egg smell. It is highly soluble in water, which is 11.3 g / 100ml. The molecular weight is 2,264, which is heavier than air and may scatter and hang in the atmosphere. This suspension process takes 2 to 4 days, and with the aid of the wind, it can move as far as 100km from the source of release (Zaini Ujang, 1997).

More than 8% of the sulphur oxides produced by anthropogenic through fuel combustion in station resources. Of the total amount of the SO, 85% produce of electric power plants and 2% of the motor plate. 13% are derived from petroleum refining, cement manufacturing and smelting of copper (Zaini Ujang, 1997).

Two sulphur oxides are important in this study of air pollution is sulphur dioxide (SO2) and sulphur trioxide (SO3). In fact, gas is often used by scientists to indicate the presence of pollutants, mainly caused by the burning of fossil fuels (Fairchild, 1975).

2.9.2.1 The Effect of Sulphur Oxide to Humans

SO2 is contained in the composition of air. In normal conditions, the concentration reaches 3 ppm to 5 ppm. Long exposure to this gas will cause a person to feel itchy and sore skin. Besides human, pollutants also give a bad impression on the plant.

SO2 is also known as corrosive nature. It can be seen through an experiment by placing a steel rod that is exposed to SO2 concentrations 0.12 ppm. After a year, the mass of the metal has been reduced by 16% due to the erosion of sulphur (Stern et al. 1984).

2.9.3 Nitrogen Oxide (NO)

Nitrogen Oxide (NO) is a generally exists in the seven major compound, which is nitric oxide (NO), nitrogen dioxide (NO2), nitrogen trioxide (NO3), nitrous oxide (N2O), nitrous trioxide (N2O3), nitrous tetra oxide (N2O4) and N2O5. However, only nitrogen dioxide (NO_2) and nitric oxide (NO) is important in the study of air pollution because both of the gas is known as an air pollutant.

The natural processes such as the action of bacteria in the soil to produce N_2O in the atmosphere at an initial stage. Next N_2O will be merge by oxygen atoms to form NO_2 molecule. NO also react with ozone to form N_2O.(Seinfield, 1975).

NO is a colourless, tasteless, odourless and harmless. NO gas can be formed by anthropogenic such as burning fuel at a high temperature which allows nitrogen in the air combines with oxygen directly. It is also produced by anaerobic biological process in soil and water. Even said to be one of nature that is not harmful, NO gas is easily oxidized by ozone No_2 with short rates (Chan, 2000).

NO_2 is a non-organic gas that has a foul odour, toxic and highly corrosive. At high concentrations, NO_2 turn in reddish brown and yellowish orange light colour at high concentrations.

2.9.3.1 The Effect of Nitrogen Oxide to Humans

NO and NO_2 gases are harmful to life. The experiment shows that NO_2 is four times more toxic than NO. NO_2 can cause damage to plants. Experiments on concentration of NO_2 give the effect of chlorophyll plant. The different concentration of gases is exposed to soybean plants. From the experiments, it was found at a concentration of 0.5 ppm, the chlorophyll in the leaves of soybean was decreased by 47%. If this continues, it will cause death in plants because chlorophyll is a major component for photosynthesis (Kennedy et al, 1988).

Meanwhile, the direct impact of NO_2 gas to human can be seen after several hours. Effects 'edema' when fluid accumulates in the cell, tissue or body cavities will be cause bumps on the skin. It can see after someone exposed for 72 hours to this gas. Other effects include coughing, dizziness and rust on human teeth (Chan, 2000).

2.10 RECOMMENDED MALAYSIA AIR QUALITY GUIDELINES (RMG)

RMG is one of the guidelines used by Bridge of Environment (DOE) in controlling the air pollution in Malaysia. It is used to calculate the Air Pollution Index (API). These standards are derived from data on human health and the existing scientific data or to reflect the 'safe level' in which no effect on the health will occur in the future. RMG basically coincided with its air quality standards recommended by the World Health Organization (WHO) and other countries.

Average time in the RMG is a variety. The time it takes from 1-24 hours for different pollutants. This period reflects a time where the effects on the health affected by certain pollutants that have been assessed. For this study, the average time spent is one hour. **Table 2.7** is a summary of some of the pollutants related with the study by an average time of one hour.

Table 2.7 Recommended Malaysia Guidelines (RMG)

Air Pollution	**Average Time**	**Malaysia Guidelines (ppm)**
Carbon Monoxide	1 hour	30
Nitrogen Dioxide	1 hour	0.17
Sulphur Dioxide	1 hour	0.13

(Sumber : JAS)

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter contains the methodology of exploration on traffic activities at the intersection and their impacts to environment. For this study, certain procedures have been defined and this section will focus on measures to fulfill the study. These procedures are very important to achieve the objectives that have been mentioned earlier.

The methodology must be planned carefully to avoid any problems and must be follow the specifications that have been set. The best results can be obtained if the procedures provided in detail before the study was conducted. Before the study, the comprehensive planning should be done to ensure satisfactory profitability in the work done.

3.2 RESEARCH PLANNING

To achieve the objective of this study, certain methods and procedures are used to collect the data. Research planning is necessary in order to make sure the progress is keep on track. The flows comprises of several stages starting from problem statement, objectives, data collection, data analysis, result and discussion. Finally a conclusion is derived and recommendation is made. **Figure 3.1** showed the flow chart of research planning used to achieve the objectives that have been set.

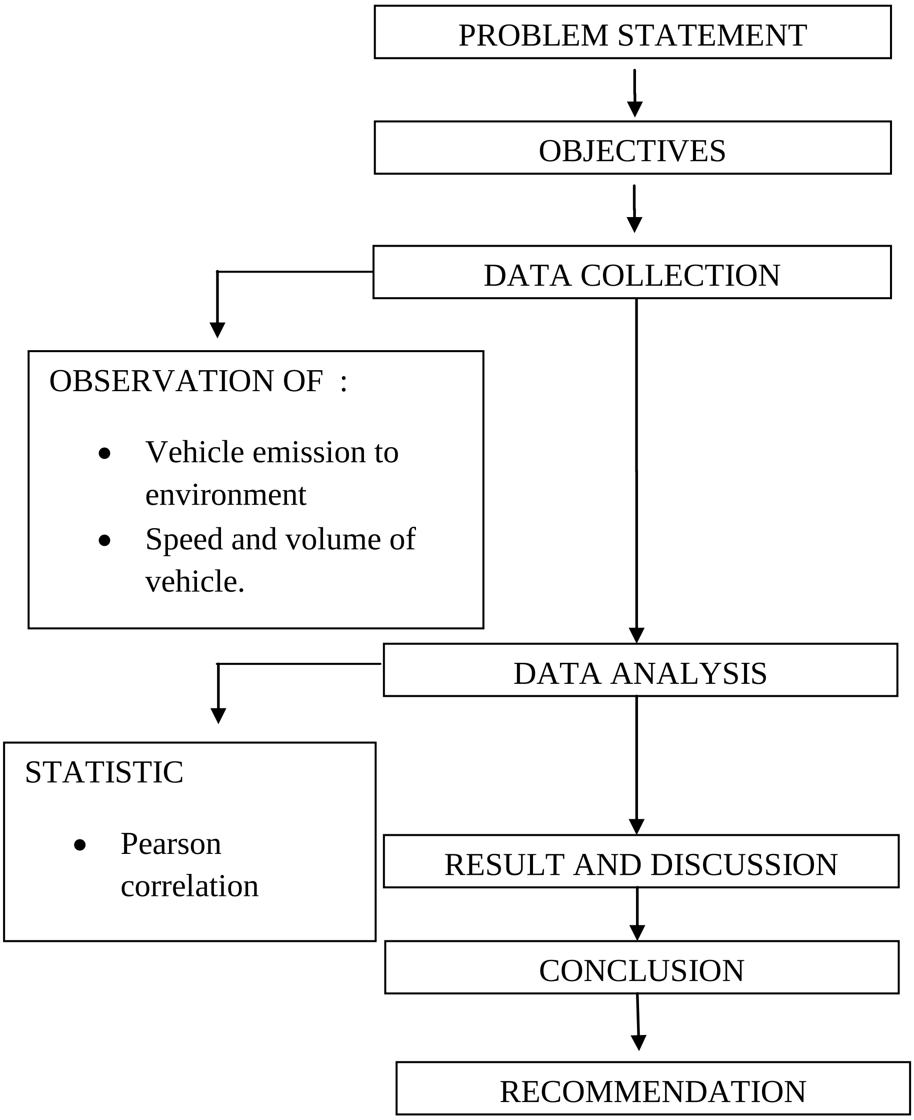


Figure 3.1 Research Planning

3.3 STUDY LOCATION

Location the path chosen to conduct the study include road heading towards the city centre only. This location was chosen because it fulfilled the criteria that have been set as discussed in the previous chapter. This study has selected two intersections heading to the city centre only. The site chosen is the intersection Indera Mahkota and Jalan Tanah Putih (Giant). Observation data has been done for the vehicle moving straight away. Distance under study is 100 meters long and the roads are in a straight condition. This study has also been done in the peak hours in the morning, noon and evening.

In order to achieve the objective of this study, two intersections heading to central business district (CBD) in Kuantan has been chosen as a study area. There were Indera Mahkota intersection and Jalan Tanah Putih (Giant) intersection. To conduct the study, there were several factors to be considered such as the study area.

Among the characteristics of the selected area are as follows:

i. A section of the road is not too long and not too short to easy get the data. Distance to determine the path valid is at least 500m and must be straight (Hall et al, 1994).
ii. Section path in this situation must straight to avoid another factor that affects the speed of the vehicle. The curved path will cause to decreasing vehicle speed.
iii. No defects on the road because the damage of the pavement as a holes or cracks in the road surface can affect the speed of vehicle.

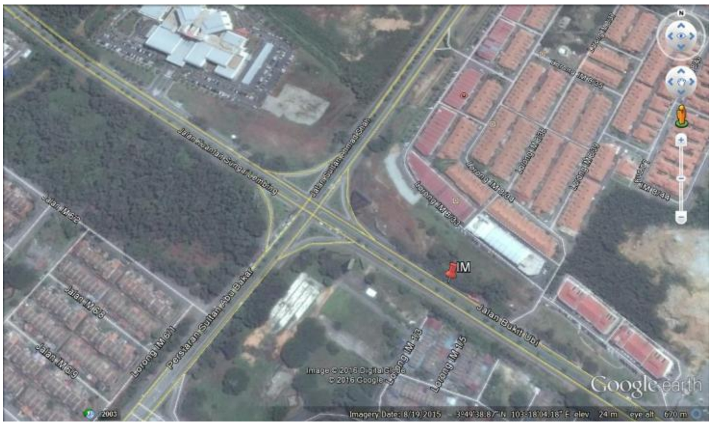


Figure 3.2 Junction of Indera Mahkota

Figure 3.3 Junction of Jalan Tanah Putih (Giant)

Figure 3.2 and **Figure 3.3** show a plan view of two intersections at Kuantan, Pahang. The site study was chosen at Indera Mahkota intersection and Jalan Tanah Putih (Giant) heading to Central Business District (CBD). The equipment was located at distance under study is 100 meters long and the roads are in a straight condition. This is because vehicle has reached constant speed beyond 100 meter from the intersection

3.4 DATA COLLECTION

The normal traffic flow means observation do during off peak hours, good weather conditions, no damage to the road surface, no road maintenance, and also not an accident occur during the observation data taken. The peak time means many vehicles on the road that can cause congestion and traffic flow becomes interrupted. Typically, the peak time is about between 7.00 to 9.00 in the morning and 5.00 until 7:00 in the evening.

Data collection has been done for two days on weekdays at two intersections for morning, afternoon and evening peak period. Data collection for speed, volume of vehicle and CO emission is measured in a set time. Readings are taken at interval 15 minute every 2 hour during peak period. The location and environmental conditions were also recorded in the same form.

Two sites were chosen for this study. The studies site were; intersection of Indera Mahkota and Jalan Tanah Putih (Giant). The study sites were chosen with a view to establish the baseline of the current situation regarding CO emission at intersection. The data were collected at the morning, afternoon, and evening peak traffic period, from 7:00 to 9:00 a.m.,12.00 to 2.00pm and 4.00 to 6.00 pm, on weekday during calm and dry weather conditions. Data that has been collected was speed of vehicle, volume of vehicle and CO emission.

An unclassified traffic volume count was conducted at the two intersections chosen for the study. Traffic volume counts were made at the approaches' stop lines by observing the number of vehicles passing the point for the chosen study period as specified by the Highway Capacity Manual. During the volume count, vehicle was count heading to the town only. The road focuses to town because the area has attraction in term of facilities and entertainment. A video recording system was employed for the data collection in which vehicle from the intersection approaches were video recorded and subsequently played back for extracting the traffic volumes.

This study involved use of two instruments; Radar Gun and Gray Wolf sense Solution (GWSS). It is to measure the speed profile and CO emission. Radar Gun capable of recording vehicle of speed (data recording once a second) is used for recording vehicle speed profile. According to Othman Che Puan (2008), the speed for a particular vehicle is termed as the vehicle speed measured at a point on a road at a certain point. The usual method is to measure the speed by using endoscope, video recordings and radar gun (Othman Che Puan, 2008). Vehicle speed was measured at one point and the average of the data was taken as the value of traffic speed flow while GWSS is an advanced emission detection system based on the power of mobile and embedded computers for superior environmental test (survey) such as measurements of Indoor Air Quality (IAQ), toxic gases, ambient air condition, etc. Vehicular emissions can be expressed in terms of grams of pollutants emitted per unit time, per unit distance travelled, or per unit fuel consumed.

3.4.1 Methods to Observe Data

Observation data for this study requires a total of two observers. First observer collects data of speed at a distance of 100m from the intersection. Second observers must noted that the data of speed for each vehicle in the form of observations that have been prepared.

3.4.2 Equipment

Equipment or tools used to observe the data manually is a radar gun, stopwatch, form the observed data, video camera and Gray Wolf Direct Sense (GWSS).In this study, Gray Wolf Direct Sense Solution (GWSS) is used to obtain data for air pollutant gases and a radar gun is used to obtain speed of vehicle while video camera to obtain data of volume of vehicle. The first equipment is radar gun.

Radar guns a function using high frequency radio wave. When the vehicle engine is shot, there are reflections of radio waves and the velocity of the vehicle viewed on the radar gun. Robertson in 1994 states that the effective distance to observe the velocity of the vehicle using a radar gun is up to 3 kilometres. However, increasing the distance it will result in the observed radar gun readings are less effective (Fazilah Hatta, 2006). **Figure 3.4** shows that a radar gun that was used to observe the speed of passing traffic relief in the study area

Figure 3.4 Radar Gun

The second equipment is stopwatch**.** Stopwatch is used to compute the time taken by vehicles passing through the point. **Figure 3.5** shows the stopwatch used in this study.

Figure 3.5 Stopwatch

Third equipment is video camera. Video camera used to record the number of vehicles passing through the traffic in the study area. Video recorded by observers is permanent and can be played back repeatedly if necessary. **Figure 3.6** shows the video camera used in study area.

Figure 3.6 Video Camera

Last equipment that I used is Gray Wolf Direct Sense TOX PPC Kit as shown in **figure 3.7**. It divided into two different component which is Probe (Model TG 501) and PC pocket. The equipment used to observe the pollutant gas data is Gray Wolf Direct Sense TOX PPC Kit. This device is a combination of technologies to detect various types of electrochemical gas pollutant with the computing system. Probe (Model TG 501) is a device used to measure the concentrations of the pollutants and PC Pocket is a device used to show the data obtained after the measurement of the concentration of gas .The equipment gets from the Environmental Laboratory of the Faculty of Civil Engineering.

Figure 3.7 Gray Wolf Sense Solutions (GWSS)

The first component is Probe (Model TG 501) as shown in **figure 3.8**. Probe (Model TG 501) is a component that used to detect and measure the concentration of pollutants include carbon monoxide (CO), sulphur dioxide (SO2) and nitrogen dioxide (NO2). In addition, the temperature can also observe. This part is easy to use with a nozzle pointing towards the area that you want to take readings either the device holds with hand or set it vertically on a flat position. There is a wire that connected to the pocket PC. This tool has a 5 cm diameter, 30 cm length and weighs up to 0.7 kg.

Figure 3.8 Probe (Model TG 501)

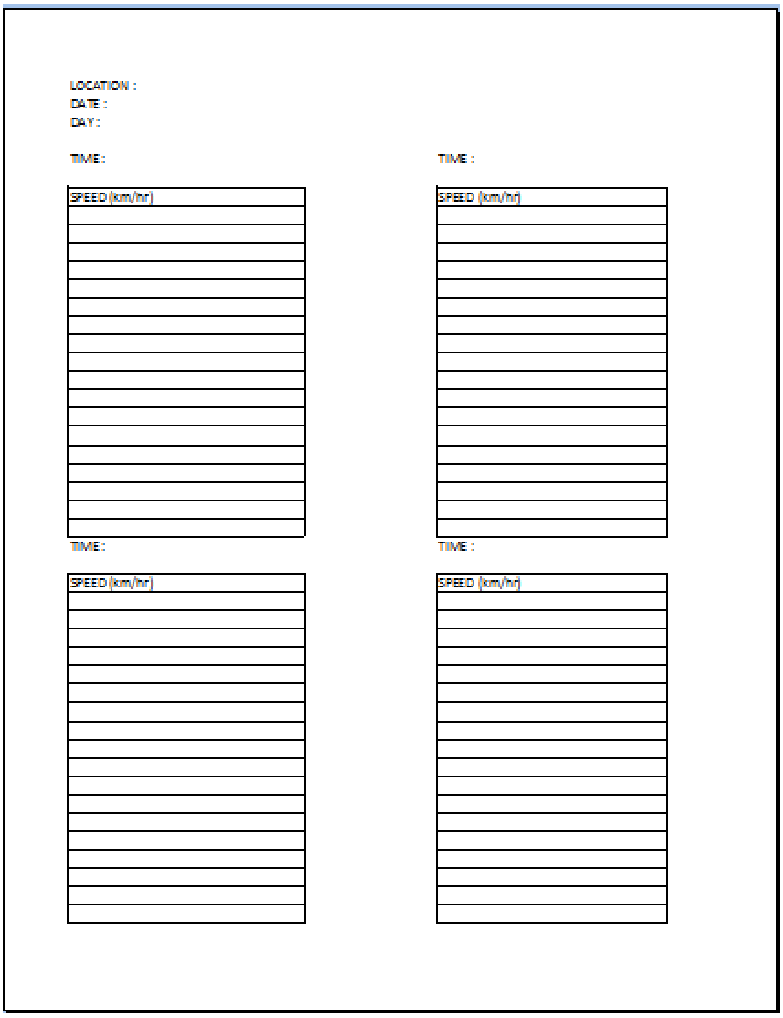
Second component is PC Pocket as shown in **figure 3.9** is a component that used to show the data temperature and gas that observatory by multi-gas monitor. It is rectangular in shape. The characteristic was thin and big as a palms ease to hold this pocket. These devices need to be connected to the wire with Probe (Model TG 501) to ensure the readings of gas detected by the sensor Probe (Model TG 501) can be show in the PC-pocket after on off switch is turned on. Reading pollutants will open in a few seconds after it is turned on. Functioning PC-Pocket with full battery power can last for 2 to 12 hours continuously after it is supplied with electrical power. To easy viewed and analyzed the data, PC-pocket can be connected to the computer with the specific software. In this study, the pollutant gas readings are taken in parts per million (ppm) and temperature unit Celsius (C).

Figure 3.9 PC Pocket

Next is observer, a total of 2 observers were to observe the data in this study. This is because the radar gun used does not have the memory to store the data that have been observed. The first observer will observe the speed of vehicles passing through the traffic relief while the second observer recorded a data that has been observed by the first observer to the form that has been provided. In addition, the second observer also noted the timing of the vehicle through the point to the research station.

3.4.3 Form observed data

Figure 3.10 and **figure 3.11** is the form data used in this study. The form was used to record the details of survey data.


LOCATION :
DATE :
DAY :

TIME :

SPEED (km/hr)

TIME :

SPEED (km/hr)

TIME :

SPEED (km/hr)

TIME :

SPEED (km/hr)

Figure 3.10 Form of speed of vehicle

Figure 3.10 show the form for speed of vehicle. This table is used to record the speed of vehicle that passing through the intersection heading to central business district at intervals of 15 minutes every two hours during the morning, afternoon and evening peak. This form also records the location and date.

LOCATION :
DATE :
DAY :

Time	CO(ppm)	SO(ppm)	NO(ppm)	temperature	total no. of vehicles

Figure 3.11 Form for CO emission and total volume of vehicle

Figure 3.11 show the form for CO emission and total volume of vehicle. This table is used to record CO emission and total volume of vehicle that passing through the intersection. Gaseous emissions from motor vehicles have variety of pollutants of which the common ones include carbon monoxide (CO), nitrogen oxides (NO), and sulfur oxide (SO).

3.5 DATA ANALYSIS

Once all data has been received, it is reviewed and re-analyzed in more detail to ensure that the objective of this study is reached. Data were analyzed using Pearson Correlation and Multiple Regression. Line chart and a bar chart used so that a clearer picture can be seen on the speed and volume of vehicle on CO emission when the vehicle through different traffic.

Pearson correlation is to measure of the strength of a linear association between speed and volume of vehicle to CO emission and multiple regressions is to explain the relationship between speed and volume vehicle to CO emission. This statistic analysis use for two intersections has been choosing as a study area. To find out the correlation and develop model between speed and volume of vehicle to CO emission, the data output from Microsoft Excel is use to test the significant correlation and develop model between speed and volume of vehicle on CO emission.

Figure 3.12 showed range of strength of association correlation value is from +1 to -1.

Strength of Association	**Correlation**
• No linear association	0
• Negligible positive	0 to 0.25
• Weak positive	0.25 to 0.5
• Moderate positive	0.5 to 0.75
• Very strong positive	>0.75

Figure 3.12 Table of strength association correlation

However, we need to perform a significance test to decide whether based upon this sample there is any or no evidence to suggest that linear correlation is present in the population.

In general, the multiple regression equation of Y on X_1, X_2, …, X_k is given by:

$$\boldsymbol{Y = b_0 + b_1 X_1 + b_2 X_2 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + b_k X_k}$$

Here b_0 is the intercept and b_1, b_2, b_3, …, b_k are analogous to the slope in linear regression equation and are also called regression coefficients. Once a multiple regression has been constructed, one can check how good it is (in terms of predictive ability) by examining the coefficient of determination (R^2).

R-squared is a statistical measure of how close the data are to the fitted regression line. It is also known as the coefficient of determination, or the coefficient of multiple determinations for multiple regressions.

The definition of R-squared is fairly straight-forward; it is the percentage of the response variable variation that is explained by a linear model.

R-squared is always between 0 and 100%:

- < 50% indicates that the model explains none of the variability of the response data around its mean.
- > 50% indicates that the model explains all the variability of the response data around its mean.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

In chapter 3 has described the methodology used to conduct this study. This chapter also discusses the process of analyzing the data of the observations that have been done. The data analysis process is one of the most important things in a study and the results obtained will be used to see whether the objectives are achieved or not. Data was analyzed based on parameters - parameters have been identified and are shown in graphical form using Microsoft Excel software and at the end of this chapter, the application of the appropriate statistic used to support the results obtained.

In this study, the main observation was based on the relationship between the increase and decrease the concentration of CO gas pollutants with the speed of the vehicle and the number of vehicles during data observed. However, SO and NO gas is not discussed in this analysis because there were no readings were recorded during the study. At the same time, the relationship between the concentration of gas produced by the speed of the vehicle and the number of vehicles also influenced by environmental conditions. The gas concentration is measured in parts per million (ppm) and the vehicle speed measured in kilometres per hour (km / hr)

4.2 RESULT

There is speed of vehicle, volume of vehicle and CO emission data that has been observed in two intersections. Data were collected and analyzed to determine the speed of vehicles and the total volume of vehicles on CO emission and presented in a form that is more easily understood as bar charts and line charts.

4.2.1 The level of CO emission at intersection between average of speed and volume of vehicle.

In this section, the discussion will be depictions of the observed value of the data obtained from two observation intersection were related with speed and volume vehicle on CO emission. This is important to assess the association of vehicle speed and volume to CO emission at the intersection. Hence, level CO emission was formulated based on vehicle speed and volume of vehicle.

Record data observations of speed and volume of vehicle and CO emission during inclement weather yield a different value as shown in **Table 4.1** to **Table 4.6**. Observation of speed and volume of vehicle on CO emission using the traffic light is recorded at the same time and the difference readings obtained on weekdays at the intersection of Indera Mahkota and Jalan Tanah Putig (Giant).

Table 4.1 Summary data observed at intersection Indera Mahkota

	7.00 am - 7.15 am	7.15 am - 7.30am	7.30 am - 7.45 am	7.45 am - 8.00 am	8.00 am - 8.15 am	8.15 am - 8.30 am	8.30 am - 8.45 am	8.45am - 9.00 am
avg. of speed (km/hr)	34	35	36	40	39	40	35	42
total vol. of vehicle	230	150	209	105	143	130	171	150
vehicle emission, CO (ppm)	27.8	24.2	21.6	18.5	17.5	18.5	22.4	12.8

Table 4.2 Summary data observed at intersection Indera Mahkota

	12.00pm - 12.15pm	12.15pm - 12.30pm	12.30pm - 12.45pm	12.45pm - 13.00pm	13.00pm - 13.15pm	13.15pm - 13.30pm	13.30pm - 13.45pm	13.45pm - 14.00pm
avg. of speed (km/hr)	37	41	38	36	42	39	37	40
total vol.of vehicle	143	122	164	103	193	155	80	119
vehicle of emission, CO (ppm)	11.9	24.3	18.2	15.4	26.3	13.8	16.8	21.2

Table 4.3 Summary data observed at intersection Indera Mahkota

	16.00pm - 16.15pm	16.15pm - 16.30pm	16.30pm - 16.45pm	16.45pm - 17.00pm	17.00pm - 17.15pm	17.15pm - 17.30pm	17.30pm - 17.45pm	17.45pm - 18.00pm
avg. of speed (km/hr)	40	38	36	46	40	41	31	43
total vol. of vehicle	216	73	101	154	175	115	131	210
vehicle of emission, CO (ppm)	20.3	18.2	16.4	23.4	25.4	27.8	22.7	28.9

From the table of intersection Indera Mahkota, show that, CO emission is the highest recorded in the morning and evening peak. A value in range of 18 to 29 (ppm) CO emission recorded in the morning and evening peak with the number of cars of 200 to 300 vehicles and variety value of speed vehicle in range of 31 to 42 (km/hr). On weekdays, most of the people start their routine daily for going to work and school in morning peak while in evening peak, most of the people done of their routine daily. In general, higher CO emission was observed at higher vehicle speeds, because vehicles have to consume more fuel to generate enough power and maintain engine operation at higher speeds.

Table 4.4 Summary data observed at intersection Tanah Jalan Putih (Giant)

	7.00 am - 7.15 am	7.15 am - 7.30 am	7.30 am - 7.45 am	7.45 am - 8.00 am	8.00 am - 8.15 am	8.15 am - 8.30 am	8.30 am - 8.45 am	8.45am - 9.00 am
avg. of speed (km/hr)	34	33	36	38	27	24	20	17
Total vol. of vehicle	140	156	216	224	107	177	157	123
vehicle emission, CO (ppm)	16.1	18.12	24.34	24.4	14.18	14.11	16.02	15.51

Table 4.5 Summary data observed at intersection Tanah Jalan Putih (Giant)

	12.00pm - 12.15pm	12.15pm - 12.30pm	12.30pm - 12.45pm	12.45pm - 13.00pm	13.00pm - 13.15pm	13.15pm - 13.30pm	13.30pm - 13.45pm	13.45pm - 14.00pm
avg. of speed (km/hr)	27	30	33	32	26	32	29	28
total vol.of vehicle	116	132	142	164	157	149	298	117
vehicle of emission, CO (ppm)	13.7	11.93	11.32	12.37	14.4	13.3	16.1	13.75

Table 4.6 Summary data observed at intersection Tanah Jalan Putih (Giant)

	16.15pm 16.00pm -	16.30pm 16.15pm -	16.45pm 16.30pm -	17.00pm 16.45pm -	17.15pm 17.00pm -	17.30pm 17.15pm -	17.45pm 17.30pm -	18.00pm 17.45pm -
avg. of speed (km/hr)	24	34	33	32	26	27	32	29
total vol. of vehicle	120	146	94	163	169	152	182	128
vehicle of emission, CO (ppm)	12.34	11.58	12.04	14.38	20.28	19.63	15.76	17.61

From the table of intersection Jalan Tanah Putih (Giant), show that, CO emission is the highest recorded in the morning peak. A value in range of 14 to 24 (ppm) CO emission recorded in the morning peak with the number of cars of 100 to 250 vehicles and variety value of speed vehicle in range of 17 to 38 (km/hr). On weekdays, most of the people start their routine daily for going to work and school in morning peak while in evening peak, most of the people done of their routine daily.

The environmental conditions at the time were cloudy and there is no wind factor during observations was carried out. When there is no wind factor, the CO emission produced by the vehicles is not dispersed to other areas quickly. This makes it easy the device to detect all pollutants quickly.

4.2.2 Evaluation on the association between speed and CO emission at intersection Indera Mahkota

Besides that, evaluation on the association between speed and CO emission were also analyzed to get an effect of speed vehicle on CO emission to the environment at intersection Indera Mahkota. This analysis is shown in **Figure 4.7** to **Figure 4.9**.

Table 4.7 Data observed of speed and CO emission at intersection Indera Mahkota

	7.00 am - 7.15 am	7.15 am - 7.30 am	7.30 am - 7.45 am	7.45 am - 8.00 am	8.00 am - 8.15 am	8.15 am - 8.30 am	8.30 am - 8.45 am	8.45am - 9.00 am
avg. of speed (km/hr)	34	35	36	40	39	40	35	42
vehicle of emission, CO (ppm)	27.8	24.2	21.6	18.5	17.5	18.5	22.4	12.8

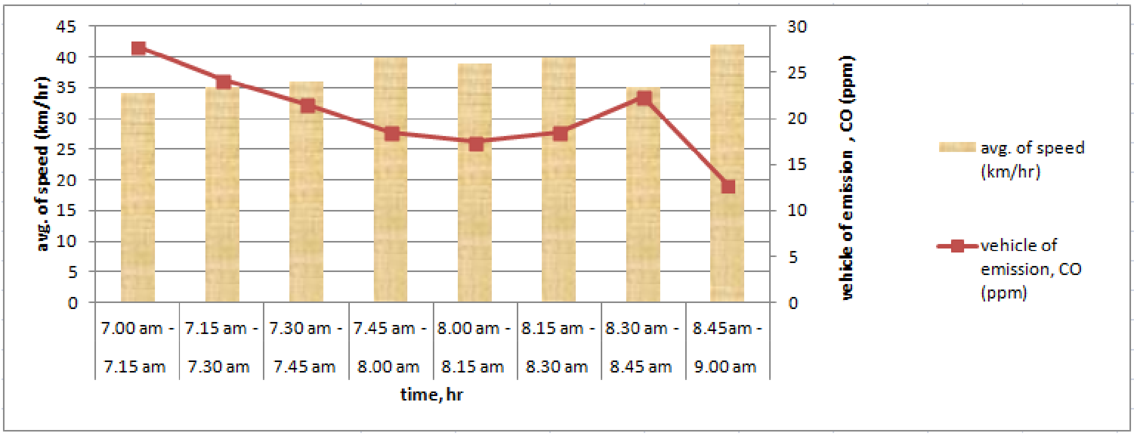


Figure 4.7 Pattern of speed and CO emission for morning peak

Figure 4.7 show, slow speed of vehicle has more CO emission. On weekday, CO emission in at 7.00 to 7.15 (am) is higher among of others, the reading is 27.8 (ppm) and the reading of speed is 34 (km/hr). At time 7.00 to 9.00 (am), most of the people start their routine daily for going work and school. The driver started to reduce their speed of vehicle because of traffic jams and can effect more CO emission. At time 8.00 to 8.15 (am), CO emission is lower among of others, the reading is 17.5 (ppm) and the reading of speed is 39 (km/hr). The speed vehicle reflects the CO emission, which is governed by many factor such as vehicle characteristic, fuel type and environment condition.

Table 4.8 Data observed of speed and CO emission at intersection Indera Mahkota

	12.00pm - 12.15pm	12.15pm - 12.30pm	12.30pm - 12.45pm	12.45pm - 13.00pm	13.00pm - 13.15pm	13.15pm - 13.30pm	13.30pm - 13.45pm	13.45pm - 14.00pm
avg. of speed (km/hr) (weekday)	37	41	38	36	42	39	37	40
vehicle of emission, CO (ppm) (weekday)	11.9	24.3	18.2	15.4	26.3	13.8	16.8	21.2

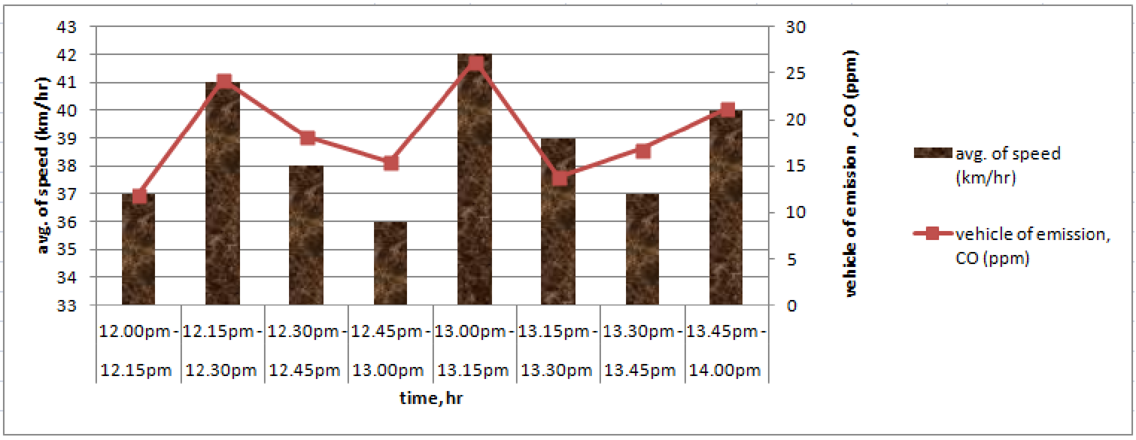


Figure 4.8 Pattern of speed and CO emission for afternoon peak

Figure 4.8 shows, slow speed of vehicle has a fewer of CO emission. From the graph, at 13.00 to 13.15 (pm), a reading for CO emission is 26.3 ppm with the average of speed is 42 (km/hr). This is the highest value among the others. Most of the workers take a break for lunch time and relax at home in afternoon peak, so the trip on the road very smoothly. The lower value of CO emission recorded at the time 13.15 to 13.30 (pm) is 13.8 ppm. These lower data because governed by many factor such as vehicle characteristic, fuel type, operating condition and environment condition. Weather at time was cloudy and windy.

Table 4.9 Data observed of speed and CO emission at intersection Indera Mahkota

	16.00pm - 16.15pm	16.15pm - 16.30pm	16.30pm - 16.45pm	16.45pm - 17.00pm	17.00pm - 17.15pm	17.15pm - 17.30pm	17.30pm - 17.45pm	17.45pm - 18.00pm
avg. of speed (km/hr) (weekday)	40	38	36	46	40	41	31	43
vehicle of emission, CO (ppm) (weekday)	20.3	18.2	16.4	23.4	25.4	27.8	22.7	28.9

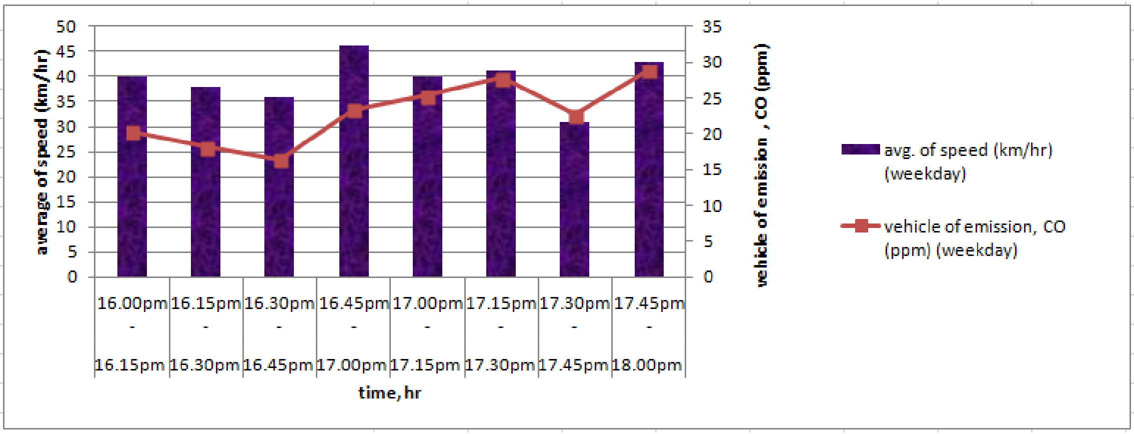


Figure 4.9 Pattern of speed and CO emission for evening peak

Figure 4.9 shows, slow speed of vehicle has a fewer of CO emission. At time 17.45 to 18.00 (pm), the CO emission is 28.9 ppm is highest among the others and the reading of speed is 43 km/hr. Most people done their daily routine at this time and spent their time do some activity in central business district with family and friends. At time 16.30 to 16.45 (pm), the lower CO emission is 16.4 ppm and the reading of speed is 36 km/hr. During deceleration, the engine does not necessarily generate power. However, the fuel flow rate cannot be stopped immediately when acceleration or cruising mode suddenly changes to deceleration mode.

4.2.3 Evaluation on the association between speed and CO emission at intersection Jalan Tanah Putih (Giant)

Besides that, evaluation on the association between speed and CO emission were also analyzed to get an effect of speed vehicle on CO emission to the environment at intersection Jalan Tanah Putih (Giant). This analysis is shown in **Figure 4.10** to **Figure 4.13**.

Table 4.10 Data observed of speed and CO emission at intersection Jalan Tanah Putih (Giant)

	7.00 am - 7.15 am	7.15 am - 7.30 am	7.30 am - 7.45 am	7.45 am - 8.00 am	8.00 am - 8.15 am	8.15 am - 8.30 am	8.30 am - 8.45 am	8.45am - 9.00 am
avg. of speed (km/hr)	34	33	36	38	27	24	20	17
vehicle of emission, CO (ppm)	16.1	18.12	24.34	24.4	14.18	14.11	16.02	15.51

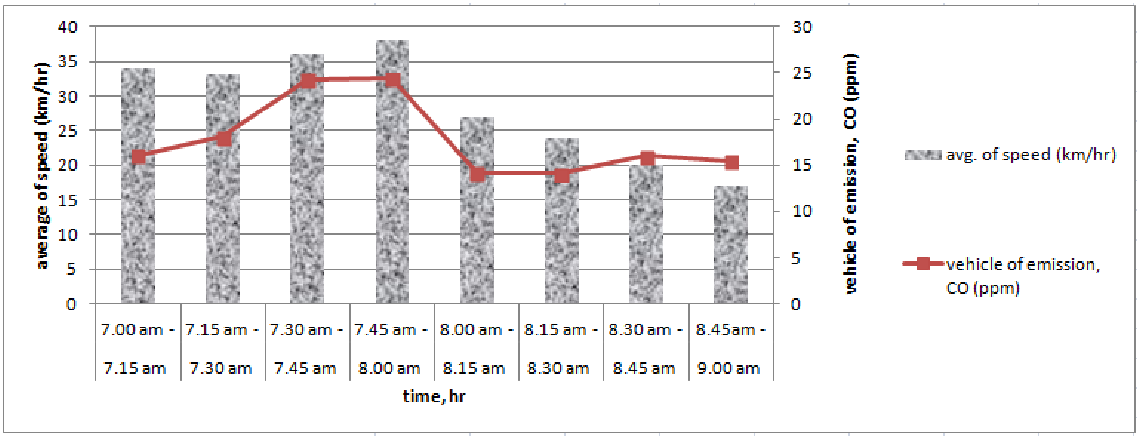


Figure 4.10 Pattern of speed and CO emission for morning peak

Figure 4.10 shows, highest speed of vehicle have more CO emission. The highest CO emission is 24.4 were recorded at time 7.45 to 8.00 (am) with the speed of vehicles is 38 km/hr. Most of people start their activity in this time and its cause of traffic congestion. Traffic congestion with frequent stop and go situations causes substantial increase of air pollutants. The lower value of CO emission recorded at the time 8.45 to 9.00 (am), a reading for CO emission is 15.51 ppm with the average of speed is 17 (km/hr). The value reading of speed vehicle and CO emission can affect governed by many factor such as vehicle characteristic, fuel type and environment condition (windy, raining or cloudy). In the acceleration process, the engine needs more fuel to generate enough power to accelerate. The higher the acceleration rate, the more fuel is needed. Therefore, speed vehicle and CO emission increase.

Table 4.11 Data observed of speed and CO emission at intersection Jalan Tanah Putih (Giant)

	12.00pm - 12.15pm	12.15pm - 12.30pm	12.30pm - 12.45pm	12.45pm - 13.00pm	13.00pm - 13.15pm	13.15pm - 13.30pm	13.30pm - 13.45pm	13.45pm - 14.00pm
avg. of speed (km/hr)	27	30	33	32	26	32	29	28
vehicle of emission, CO (ppm)	13.7	11.93	11.32	12.37	14.4	13.3	16.1	13.75

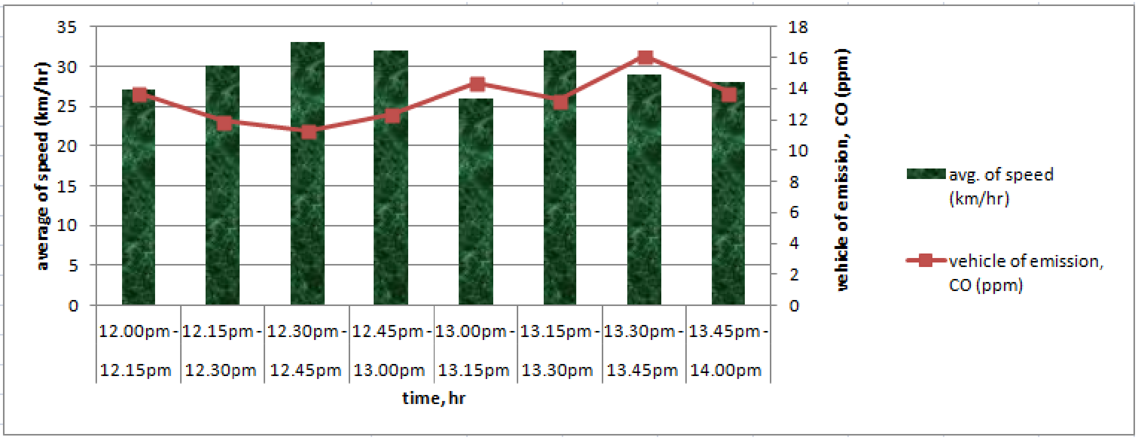


Figure 4.11 Pattern of speed and CO emission for afternoon peak

Figure 4.11 shows, highest speed have more CO emission. The reading of CO emission is 16.1 ppm with reading of speed is 29km/hr at time 13.30 to 13.45 (pm). Most of people take a lunch time in range on afternoon peak and most of shop open for business at 10 am o'clock and above. The lower value of CO emission recorded at the time 12.30 to 12.45 (am), a reading for CO emission is 11.31 ppm with the average of speed is 33 (km/hr). Driving pattern can affect the value of speed vehicle and CO emission. It showed that several drivers drove their vehicle lower at 100 meter after the intersection.

Table 4.12 Data observed of speed and CO emission at intersection Jalan Tanah Putih (Giant)

	16.00pm - 16.15pm	16.15pm - 16.30pm	16.30pm - 16.45pm	16.45pm - 17.00pm	17.00pm - 17.15pm	17.15pm - 17.30pm	17.30pm - 17.45pm	17.45pm - 18.00pm
avg. of speed (km/hr)	24	34	33	32	26	27	32	29
vehicle of emission, CO (ppm)	13.22	14.78	15.34	12.88	21.2	23.96	26.72	21.32

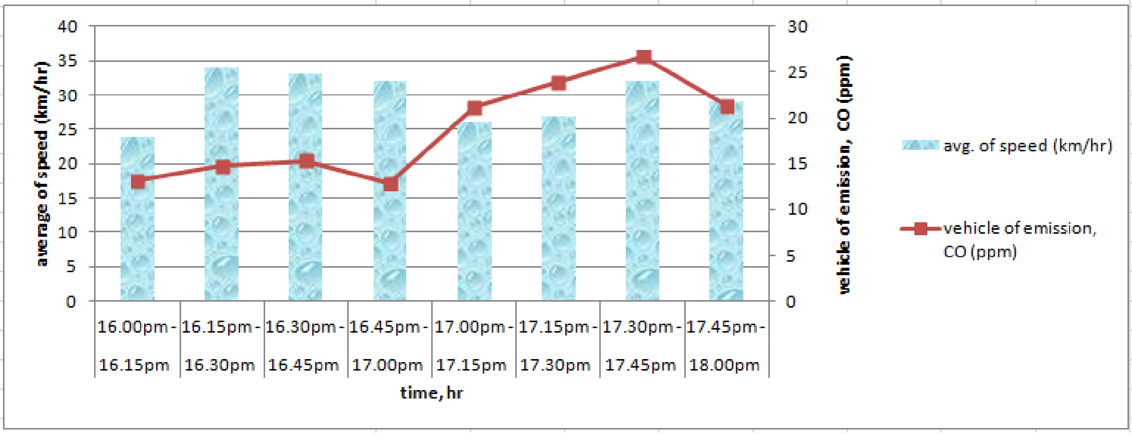


Figure 4.12 Pattern of speed and CO emission for evening peak

Figure 4.12 shows, highest speed of vehicle have less CO emission. At 17.30 to 17.45 (pm) has a highest of CO emission is 26.72 ppm with the value of speed is 32 km/hr. Most of people done do their activity daily and spent their time with friend at town in range at time 17.00 to 18.00 (PM). At time 16.45 to 17.00 (pm), the lower CO emission is 12.88 ppm and the reading of speed is 32 km/hr. During deceleration, the engine does not necessarily generate power. Excess fuel thus continues flowing at the early phase of deceleration, especially for hard acceleration/deceleration changes.

4.2.4 Evaluation on the association between traffic volume and CO emission at intersection Indera Mahkota

In addition, evaluation on the association between traffic volume and CO emission were also analyzed to get an effect of traffic volume on CO emission to the environment at intersection Indera Mahkota. This analysis is shown in **Figure 4.13** to **Figure 4.15**.

Data observations was conduct during unpredictable weather has produces a different graph in **Figure 4.13 to Figure 4.16,** the ratio between the CO emissions with total volume of vehicle through the intersection is recorded at the same time.

Table 4.13 Data observed of traffic volume and CO emission at intersection Indera Mahkota

	7.00 am - 7.15 am	7.15 am - 7.30am	7.30 am - 7.45 am	7.45 am - 8.00 am	8.00 am - 8.15 am	8.15 am - 8.30 am	8.30 am - 8.45 am	8.45am - 9.00 am
Total vol. of vehicle	230	150	209	105	143	130	171	150
vehicle emission, CO (ppm)	27.8	24.2	21.6	18.5	17.5	18.5	22.4	12.8

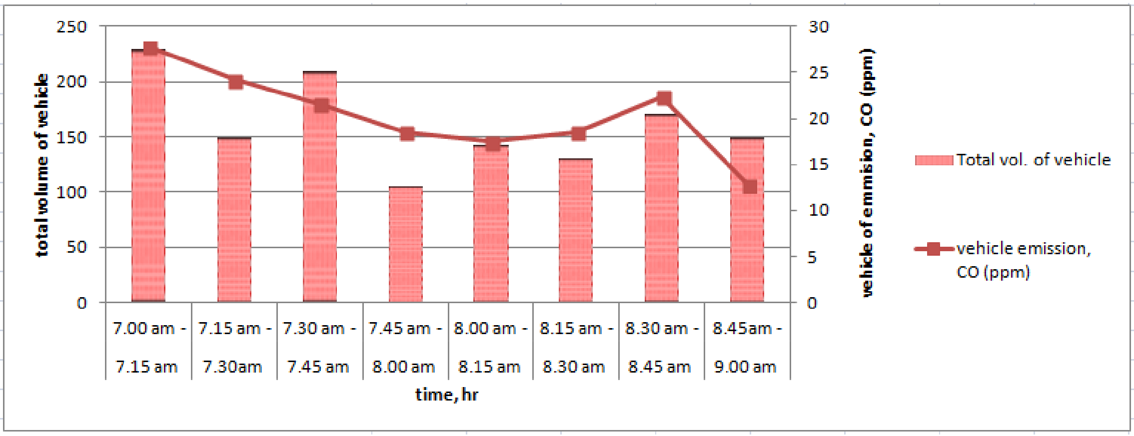


Figure 4.13 Pattern of traffic volume and CO emission for morning peak

Figure 4.13 show, CO emission is highest recorded of 27.8 ppm were recorded at time 7.00 to 8.00 (am) with the total volume of cars at this time is 270 vehicles. Most of people start their daily routine go to work and school. At Indera Mahkota, there have facilities such as shop lots, Kuantan Medical Centre and company. It also has a residential area. So, traffic volume on the road higher can make traffic congestion. At time 8.45 to 9.00 (pm), the lower CO emission is 12.8 ppm with the total volume of cars is 150. Most of shops open for their business at 10 o'clock and above.

Table 4.14 Data observed of traffic volume and CO emission at intersection Indera Mahkota

	12.00pm - 12.15pm	12.15pm - 12.30pm	12.30pm - 12.45pm	12.45pm - 13.00pm	13.00pm - 13.15pm	13.15pm - 13.30pm	13.30pm - 13.45pm	13.45pm - 14.00pm
total vol.of vehicle	143	122	164	103	193	155	80	119
vehicle of emission, CO (ppm)	11.9	24.3	18.2	15.4	26.3	13.8	16.8	21.2

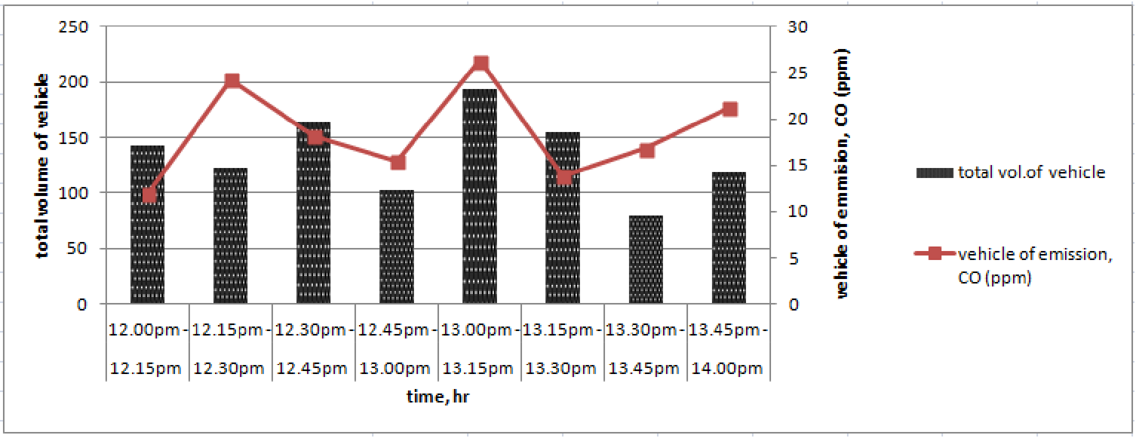


Figure 4.14 Pattern of traffic volume and CO emission for afternoon peak

Figure 4.14 shows, higher CO emission more of total volume of vehicle but sometime higher CO emission less of total volume of vehicle. This is because volume of vehicle can divide 5 of classes (car, motorcycle, light vehicle, heavy vehicle, bus). The CO emission is highest recorded is 26.3 ppm were recorded at time 13.00 to 13.15 (pm) with the total volume of vehicle is 193 vehicles. Most of the people take a lunch time and prefer rest at home at this time while the lower CO emission is recorded 11.9 ppm were recorded at time 12.00 to 12.15 (pm) with the total volume of vehicle is 143 vehicles. Different types of vehicle have a different value of CO emission. For the heavy vehicle, the CO emission and fuel consumption rates tended to increase with an increase in vehicle speed.

Table 4.15 Data observed of traffic volume and CO emission at intersection Indera Mahkota

	16.00pm - 16.15pm	16.15pm - 16.30pm	16.30pm - 16.45pm	16.45pm - 17.00pm	17.00pm - 17.15pm	17.15pm - 17.30pm	17.30pm - 17.45pm	17.45pm - 18.00pm
total vol. of vehicle	216	73	101	154	175	115	131	210
vehicle of emission, CO (ppm)	20.3	18.2	16.4	23.4	25.4	27.8	22.7	28.9

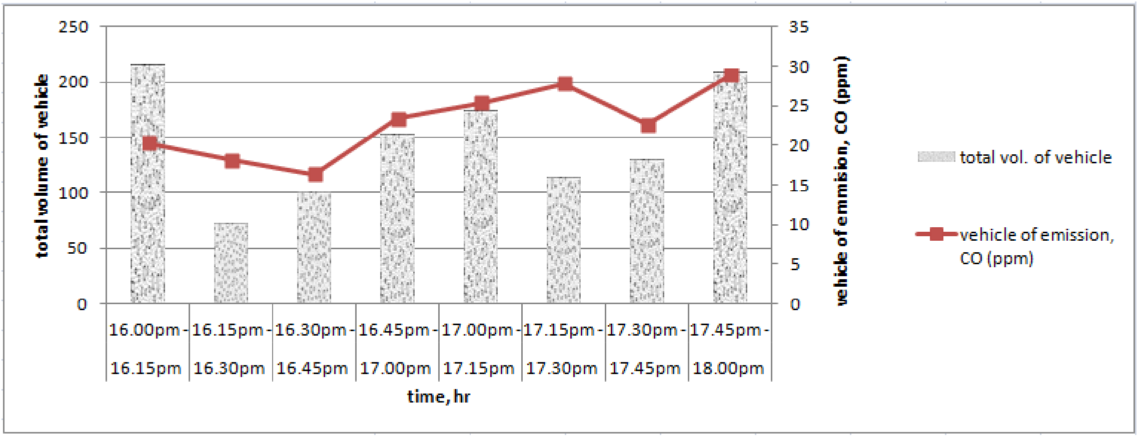


Figure 4.15 Pattern of traffic volume and CO emission for evening peak

Figure 4.15 shows the higher CO emission has more of total volume of vehicle. This is because volume of vehicle can divide into 5 classes (car, motorcycle, light vehicle, heavy vehicle, and bus). The CO emission is highest recorded is 28.9 ppm were recorded at time 17.45 to 18.00 (PM) with the total volume of vehicle is 210 vehicles. Most of the people done of work and school and some people prefer spent time in city because it has attraction in terms of facilities and entertainment. The lower CO emission is recorded 16.4 ppm were recorded at time 16.30 to 16.45 (pm) with the total volume of vehicle is 101 vehicles.

4.2.5 Evaluation on the association between traffic volume and CO emission at intersection Jalan Tanah Putih (Giant)

In addition, evaluation on the association between traffic volume and CO emission were also analyzed to get an effect of traffic volume on CO emission to the environment at intersection Jalan Tanah Putih (Giant). This analysis is shown in **Figure 4.16** to **Figure 4.18**.

Table 4.16 Data observed of traffic volume and CO emission at intersection Jalan Tanah Putih (Giant)

	7.00 am - 7.15 am	7.15 am - 7.30 am	7.30 am - 7.45 am	7.45 am - 8.00 am	8.00 am - 8.15 am	8.15 am - 8.30 am	8.30 am - 8.45 am	8.45am - 9.00 am
Total vol. of vehicle	140	156	216	224	107	177	157	123
vehicle emission, CO (ppm)	16.1	18.12	24.34	24.4	14.18	14.11	16.02	15.51

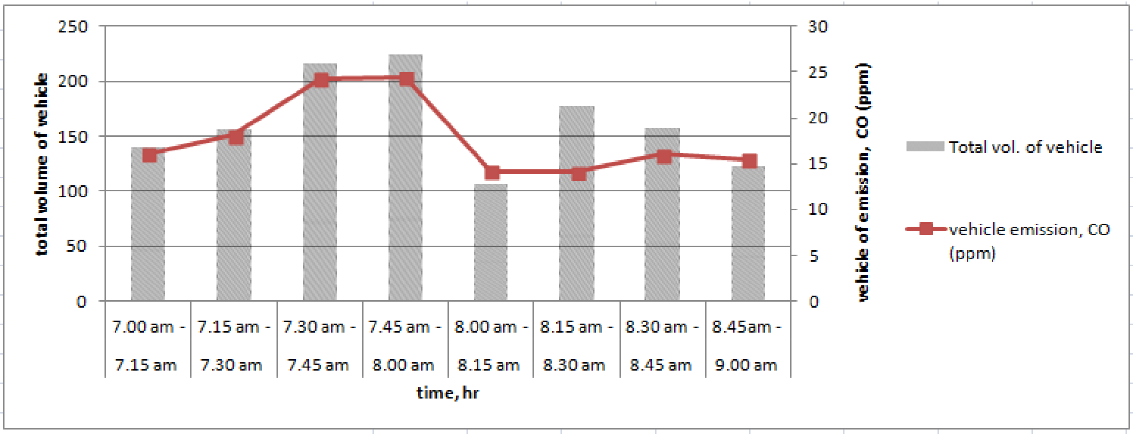


Figure 4.16 Pattern of traffic volume and CO emission for morning peak

Figure 4.16 shows the higher CO emissions have more of total volume of vehicle. This is because volume of vehicle has variety types of vehicle on road. CO emission is highest recorded is 24.4 ppm were recorded at time 7.45 to 8.00 (AM) with the volume of vehicle is 224 vehicles. Most of people start their daily routine in range 7.00 to 9.00 (AM). The lower CO emission is recorded 14.11 ppm were recorded at time 8.00 to 8.15 (am) with the total volume of vehicle is 177 vehicles. The traffic is very smooth because no stop and go condition after the intersection and the types of vehicle at this time is more than of car compare to heavy vehicle. Heavy vehicle has a more of CO emission and increased in vehicle speed.

Table 4.17 Data observed of traffic volume and CO emission at intersection Jalan Tanah Putih (Giant)

	12.00pm - 12.15pm	12.15pm - 12.30pm	12.30pm - 12.45pm	12.45pm - 13.00pm	13.00pm - 13.15pm	13.15pm - 13.30pm	13.30pm - 13.45pm	13.45pm - 14.00pm
total vol.of vehicle	116	132	142	164	157	149	298	117
vehicle of emission, CO (ppm)	13.7	11.93	11.32	12.37	14.4	13.3	16.1	13.75

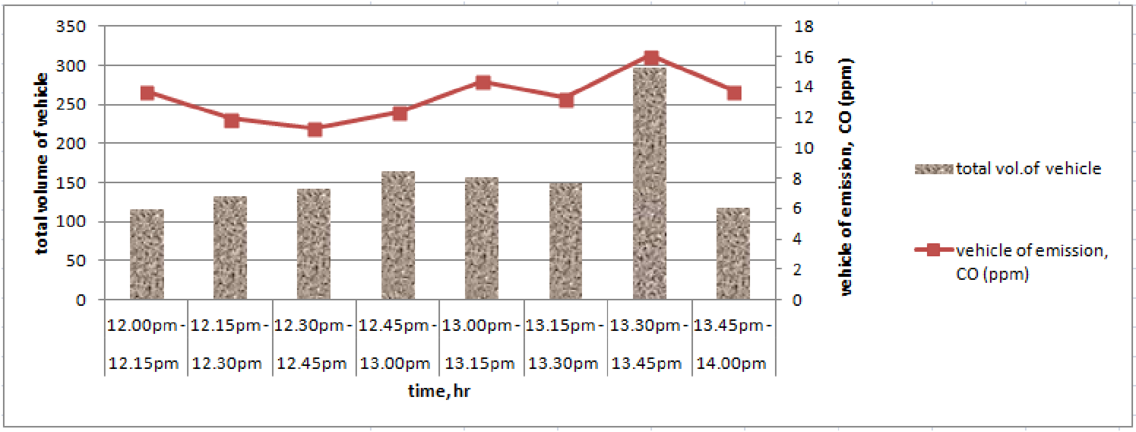


Figure 4.17 Pattern of traffic volume and CO emission for afternoon peak

Figure 4.17 shows highest total volume of vehicle has more of CO emission. CO emission is highest recorded is 16.1 ppm were recorded at time 13.30 to 13.45 (pm) with the volume of vehicle is 298 vehicles. At afternoon peak, most of the workers take a lunch time at 13.00 to 14.00 (pm) and most of people balance their activity either prefers rest at home or spent time with friend in city. The lower CO emission is recorded 11.32 ppm were recorded at time 12.30 to 12.45 (pm) with the total volume of vehicle is 142 vehicles. The traffic is very smooth because no stop and go condition after the intersection and the types of vehicle at this time is more than of car compare to heavy vehicle.

Table 4.18 Data observed of traffic volume and CO emission at intersection Jalan Tanah Putih (Giant)

	16.00pm - 16.15pm	16.15pm - 16.30pm	16.30pm - 16.45pm	16.45pm - 17.00pm	17.00pm - 17.15pm	17.15pm - 17.30pm	17.30pm - 17.45pm	17.45pm - 18.00pm
total vol. of vehicle	120	146	94	163	169	152	182	128
vehicle of emission, CO (ppm)	12.34	11.58	12.04	14.38	20.28	19.63	15.76	17.61

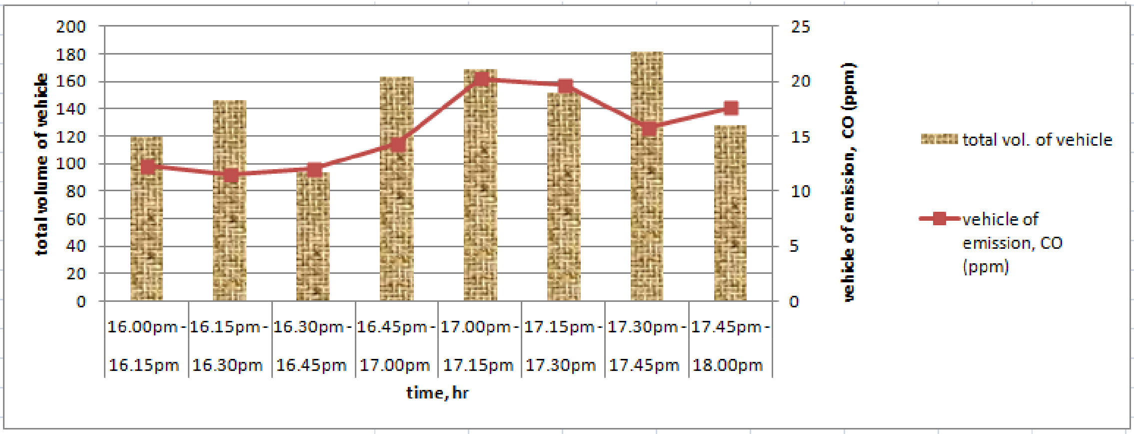


Figure 4.18 Pattern of traffic volume and CO emission for evening peak

Figure 4.18 shows the higher CO emissions have more of total volume of vehicle. CO emission is highest recorded is 20.28 ppm were recorded at time 17.00 to 17.15 (PM) with the total of vehicles is 169 vehicles while at 17.30 to 17.45 (PM) show that total volume of vehicle is highest recorded is 182 vehicles with the CO emission is 15.76 ppm. This is happen because factor of environment condition and volume vehicle has variety of vehicle. Most of people spent time with their family and friend using by car, motorcycle and car. Variety of vehicle makes a different reading of CO emission. For the environment condition at time is shaded and breezy.

4.3 STATISTIC ANALYSIS

After data analysis of observations is made, it can be stated that speed of vehicle, volume of vehicle and CO emission is different reading from morning, afternoon and evening peak at two intersections.

Next, the observed data are re-analyzed using appropriate statistical; Pearson correlation and Multiple Regression. Pearson correlation is to measure of the strength of a linear association between speed and volume of vehicle to CO emission and multiple regressions is to explain the relationship between speed and volume vehicle to CO emission. This statistic analysis use for two intersections has been choosing as a study area.

To find out the correlation and develop model between speed and volume of vehicle to CO emission, the data output from Microsoft Excel is use to test the significant correlation and develop model between speed and volume of vehicle on CO emission.

4.3.1 Pearson Correlation

Pearson's correlation coefficient is a statistical measure of the strength of a linear relationship between paired data. In a sample it is denoted by r and is by design constrained as follows

$$-1 \leq r \leq 1$$

Range of strength of association correlation value is from +1 to -1.

- Correlation 0; no linear association
- Correlation 0 to 0.25; negligible positive
- Correlation 0.25 to 0.5; weak positive
- Correlation 0.5 to 0.75; moderate positive
- Correlation >0.75; very strong positive association

However, we need to perform a significance test to decide whether based upon this sample there is any or no evidence to suggest that linear correlation is present in the population. To do this we test the null hypothesis, H0, that there is no correlation in the population against the alternative hypothesis, H1, that there is correlation; our data will indicate which of these opposing hypotheses is most likely to be true. We can thus express this test as.

$$H0 : \rho = 0$$

$$H1 : \rho \neq 0$$

i.e. the null hypothesis of no linear correlation present in population against the alternative that there is linear correlation present.

Results of this analysis were obtained from Microsoft excel to show through **Table 1** to **Table 6**.

Table 1 Measure association for morning peak for junction Indera Mahkota

Variable	CO emission (ppm)	Speed of vehicle (km/hr)	Total volume of vehicle
CO emission (ppm)	1		
Speed of vehicle (km/hr)	0.94 (0.01)	1	
Total volume of vehicle	0.89 (0.03)	0.65	1

Table 2 Measure association for daytime peak for junction Indera Mahkota

Variable	CO emission (ppm)	Speed of vehicle (km/hr)	Total volume of vehicle
CO emission (ppm)	1		
Speed of vehicle (km/hr)	0.85 (0.04)	1	
Total volume of vehicle	0.74 (0.08)	0.50	1

Table 3 Measure association for evening peak for junction Indera Mahkota

Variable	CO emission (ppm)	Speed of vehicle (km/hr)	Total volume of vehicle
CO emission (ppm)	1		
Speed of vehicle (km/hr)	0.80 (0.02)	1	
Total volume of vehicle	0.92 (0.01)	0.69	1

Figure 4.19 Measure association of speed and volume of vehicle to CO emission using a Pearson Correlation

Table 4 Measure association for morning peak for junction Jalan Tanah Putih (Giant)

Variable	CO emission (ppm)	Speed of vehicle (km/hr)	Total volume of vehicle
CO emission (ppm)	1		
Speed of vehicle (km/hr)	0.72 (0.06)	1	
Total volume of vehicle	0.71 (0.08)	0.57	1

Table 5 Measure association for daytime peak for junction Jalan Tanah Putih (Giant)

Variable	CO emission (ppm)	Speed of vehicle (km/hr)	Total volume of vehicle
CO emission (ppm)	1		
Speed of vehicle (km/hr)	0.70 (0.09)	1	
Total volume of vehicle	0.73 (0.07)	0.53	1

Table 6 Measure association for evening peak for junction Jalan Tanah Putih (Giant)

Variable	CO emission (ppm)	Speed of vehicle (km/hr)	Total volume of vehicle
CO emission (ppm)	1		
Speed of vehicle (km/hr)	0.98 (0.01)	1	
Total volume of vehicle	0.94 (0.01)	0.55	1

Figure 4.20 Measure association of speed and volume of vehicle to CO emission using a Pearson Correlation

First of all, one may see that there exists a strong linear relationship and significant between speed of vehicle and volume of vehicle on CO emission for morning peak and evening peak at intersection respectively table 1, 3 and 6. This fact is especially clear in table 6, where the value of R is 0.98 more than 0.75 and the p –value is 0.01 less than 0.05 for morning peak and evening peak.

It seems clear that speed of vehicle and volume of vehicle on CO emission criteria are much related. This fact conforms to reality since a very loaded traffic volume and change of speed vehicle is also likely to be a very pollutant one, and vice versa. Hence, we can use the two criteria in a hypothetical. We can either minimise the speed of vehicle while maximising the volume of vehicle or the reverse.

Secondly, as may be observed in table 2, 4 and 5, there exist a clear relationship between speed and volume of vehicle on CO emission. This is moderate linear relationship but a higher order one because the value of R is 0.70 less than 0.75 and the p –value is 0.08 more than 0.05. In further research we will explore this.

4.3.2 Multiple Regressions

Multiple regressions is the most common form of linear regressions analysis. As a predictive analysis, the multiple regressions is used to explain the relationship between one continuous dependent variable from two or more independent variables. More precisely, multiple regression analysis helps us to predict the value of Y for given value of X1, X2, ... Xj.

4.3.2.1 The Multiple Regression Model

In general, the multiple regression equation of Y on X_1, X_2, …, X_k is given by:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots + b_k X_k$$

Here b_0 is the intercept and b_1, b_2, b_3, …, b_k are analogous to the slope in linear regression equation and are also called regression coefficients. Once a multiple regression has been constructed, one can check how good it is (in terms of predictive ability) by examining the coefficient of determination (R^2).

R-squared is a statistical measure of how close the data are to the fitted regression line. It is also known as the coefficient of determination, or the coefficient of multiple determinations for multiple regressions.

The definition of R-squared is fairly straight-forward; it is the percentage of the response variable variation that is explained by a linear model.

R-squared is always between 0 and 100%:

- 0% indicates that the model explains none of the variability of the response data around its mean.
- 100% indicates that the model explains all the variability of the response data around its mean.

Table 7 regression model for Indera Mahkota					
Traffic Control	**Period**	**Model**	**R^2**	**F-statistic**	**F-critical**
IM	**AM**	CO = 1.041 speed + 0.016 vol. + 56.044	0.92	27.606	0.0198
	NOON	CO = 1.700 speed + 0.025 vol. – 53.967	0.73	0.231	0.802
	PM	CO = 0.439 speed + 0.039 vol. – 5.980	0.90	22.473	0.032

Table 8 regression model for Jalan Tanah Putih (Giant)					
Traffic Control	**Period**	**Model**	**R^2**	**F-statistic**	**F-critical**
IM	**AM**	CO = 0.356 speed + 0.045 vol. – 5.312	0.70	5.487	0.058
	NOON	CO = 0.264 speed + 0.015 vol. + 10.889	0.75	7.659	0.088
	PM	CO = 0.549 speed + 0.077 vol. + 3.024	0.97	96.512	0.01

Figure 4.21 Develop model using a multiple regression

Figure 4.21 present the models developed for the two intersections for morning, daytime, evening peak. Results presented in Table 7 and 8 show that the model developed for estimating CO emission at two intersections for morning and evening peak period is significant; implying that the independent variables have a significant effect on the dependent one. This is evidently confirmed by the value of F-statistics which is far greater than that of F-critical at 95% ($\alpha = 0.05$) confidence level.

However, the model for the same intersection for afternoon peak period was not found to be significant enough as the value of F-statistic is on the lower side of that of F-critical. This suggests that there is no convincing evidence that the CO emission have effect on the speed and volume of vehicle for the period evaluated. The resulting models were found to be significant as F-statistic values for the periods were both greater than those of F-critical ones.

CHAPTER 5

CONCLUSION AND RECOMMANDATION

5.1 INTRODUCTION

This chapter will summarize the studies that have been conducted and concluded based on the analysis and the results already obtained. Analysis based on 2 intersections has been chosen. In addition, the problems faced during the study were presented and some suggestions to improve the study of the future will also be made.

5.2 CONCLUSION

This study was carried out to estimate level of CO emission based on speed and volume at intersection by developing mathematical models for prediction of CO emission. Carbon-monoxide emissions were measured at two intersections using Gray Wolf Sensing Solutions (GWSS). The CO emission prediction models developed were evaluated using multiple regression analysis and thus found adequate. Traffic volumes and speed of vehicle were also found to be among the factors affecting CO emissions at the intersections.

From the analysis, it was found that the association between speed and volume of vehicle to CO emission is not the same and traffic models were developed for the two of intersection for morning, afternoon and evening peak.

From the Correlations table, it can be seen that the correlation coefficient (r) equals 0.98, indicating a strong relationship, as surmised earlier. $p < 0.001$ [NEVER write $p = 0.000$] and indicates that the coefficient is significantly different from 0. We can conclude that speed and volume of vehicle is related to CO emission. In particular, it seems that the more speed and volume of vehicle, the greater of CO emission intake is ($r = 0.98$, $p < 0.001$).

Statistical technique using multiple regression analysis was utilized to develop models for estimating carbon-monoxide emission at intersections based on easily observable traffic flow parameters.The value of R^2 is more than 50%. It's shown that all the variability of the response data around its mean. The resulting models were found to be significant as F-statistic values for the periods were both greater than those of F-critical ones.

On comparing the amount of predicted carbon emission obtained from the peak period hour; morning, afternoon and evening peak for the studied periods, it was found that morning and evening peak are more strong linear relationship between speed of vehicle and volume of vehicle on amount of the CO emission compare to afternoon peak at the intersection.

5.3 RECOMMENDATION

After conducting this study, there are some suggestions to improve this study in the future. Among the proposals is

i. Provide more radar gun in the laboratory that can provide a more accurate reading so Speed vehicles have no doubt observed. In addition, the radar gun provided preferably has a memory for data stores that were observed to enable observers to revise the data were collected.
ii. Providing video cameras to enable data were collected through repeated especially if there are many factors to be taken during the process of observation. In addition, the use of video cameras is also to ease the observation data is done manually using a stopwatch.
iii. Equipment that is used as radar gun, video camera and Gray Wolf Sense Solution (GWSS) must be in good condition and suitable with the purposes of the study. Location of equipment in a study should also be properly in order not to affect the speed of a vehicle.

iv. Factor environmental is one of the effects during the observed data in the study of speed vehicle and air pollution. Therefore, wind direction, wind speed and temperature of the environment whether rain or sunny should be considered in the study.

v. To get a clear view of speed of vehicle, volume of vehicle and CO emission in a study area, can see another types of traffic calming such as roundabout, road hump, full chicanes and others.

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APPENDIX A

RECOMMENDED MALAYSIA AIR QUALITY GUIDELINES (RMG)

Air Pollution	Average Time	Malaysia Guidelines (ppm)	
		ppm	µg/m³
Ozone	1 hour	0.10	200
	8 hour	0.06	120
Carbon Monoxide	1 hour	30	35
	8 hour	9	10
Nitrogen Dioxide	1 hour	0.17	320
Sulphur Dioxide	10 minute	0.19	500
	1 hour	0.13	350
	24 hour	0.04	105
Particle	24 hour		206
	1 year		90
PM 10	24 hour		105
	1 year		50
Plumbum	3 month		1.5

Source: JAS (Jambatan Alam Sekitar)

APPENDIX B1

FORM OF SPEED OF VEHICLE

Location: ....

Date: ....

Day: ....

Time: ....

Speed (km/hr)	

Time: ....

Speed (km/hr)	

Location: ....

Date: ....

Day: ....

Time: ....

Speed (km/hr)	

Time: ....

Speed (km/hr)	

APPENDIX B2

FORM FOR CO EMISSION AND TOTAL VOLUME OF VEHICLE

Location: ....

Date: ....

Day: ....

Time	CO (ppm)	SO (ppm)	NO (ppm)	Temperature	Total no. of vehicle