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INVESTIGATING THE POLLUTION OF CARBON MONOXIDE IN SCHOOLS NEAR TO MAIN ROADS IN MALAYSIA

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ABSTRACT

This paper aims to study carbon monoxide (CO) concentration in schools along Federal Road in Muallim, Perak.The quantitative approach with field survey and sampling methods used for the CO data.A sampling of CO data in Per million (ppm) value using Carbon Monoxide Meter AS8700A forthree stations, SMK Khir Johari, SMK Agama Slim River, and SMK Dato Zulkifli Muhammad. The CO was sampling for seven days,with data collection three times a day, from 7:00 am - 8:00 am, 9:00 am - 10:00 am, and 12:00 pm - 1:00 pm. This study applies a descriptive analysis. The resultsshowthe lowest level of CO concentration was in SMK Agama Slim River, which is 0 ppm, and the highest, which is 3.7 ppm. Meanwhile, the lowest CO level in SMK Dato Zulkifli Muhammad is 2.3 ppm, and the highest level is 5.7 ppm. The lowest CO concentration level in SMK Khir Johari is 2.3 ppm, and the highest is 4.3 ppm. The results show that the SMK Dato Zulkifli Muhammad recorded the highest CO concentration, 3.92 ppm higher than SMK Khir Johari, which recorded 3.57 ppm. SMK Agama Slim River is the lowest CO concentration station which is 1.62 ppm. In conclusion, transportation activities involving motor vehicles influenced the CO concentrations obtained by the researchers. For the implication, effective measures should be taken at the school near major roads to curb CO gas poisoning, ensure life comfort, and preserve the environment.

KEY WORDS : Concentration level, Carbon monoxide (CO), Transportation and school, pollution, Athmospheric

INTRODUCTION

The country's progress in the 21st century, which involves land development for various sectors, directly impacts society. Demographic development in Malaysia is also directly addicted to development to support the community's life such as industry, settlement, business. With development progress, the transportation sector also continues to grow with the need for the community to own vehicles (Nayan *et al.*, 2021). The development of transportation has resulted in the number of vehicles sold in Malaysia of 60,780 units, showing an increase of 41.42 percent in May 2019 than 42,977 vehicles sold last year (Hanani, 2019). The development of transportation has caused many environmental problems such as pollution, water, air, and noise (Mahat *et al.*, 2019; Nayan *et al.*, 2020a; Nayan, 2020b). Human activities have also led to the release of toxic gases that can threaten health (Nayan *et al.*, 2020a) , such as carbon

monoxide (CO). CO is an odorless, colorless gas and constitutes 6% or more resulting from the emission of smoke by motor vehicles (Ratnawati *et al.,* 2010). This CO gas is a gas derived from the imperfect combustion of fossil materials, industrial products, and others that contain oil. According to Siregar (2005), CO'sprimary source of air pollution comes from transportation that uses fuel to produce 60% CO. The 21st century has now proven that a good transportation network has led to increased vehicle purchases, thus resulting in vehicle consumption nowadays being very high and indirectly contributing to high CO emissions into the air. Air is a mixture of several different gas contents and is a necessity to live on earth. However,some have a negative impact on humans and other living things (Nayan *et al.,* 2019). These negatively impacted gases are gases emitted either from industry or from available transportation. Human activities now involve using machinery in development, such as delivering goods using heavy vehicles such as lorries. The matter is that there is a source of CO (CO) gas emissions that will have a negative impact on the environment and humans (Syafikah, 2016). The importance of exploratory research to find out the level of CO concentration in important locations such as schools or hospitals allows intervention in planning if the CO level is high because the harm to the community who inhales CO continuously is high. So this paper aims to investigate the level of CO concentration in schools along the Federal Road, which are in this Muallim District, which will experience continuous impact from this road transport activity.

BACKGROUND

CO is an odorless, colorless gas and constitutes 6% or more resulting from motor vehicle smoke emissions (Ratnawati *et al.,* 2010). This CO gas is a gas derived from the imperfect combustion of fossil materials, industrial products, and others that contain oil. According to Siregar (2005), CO'sprimary source of air pollution comes from transportation that uses fuel to produce 60% CO. The 21st century has now proven that a good transportation network has led to increased vehicle purchases, thus resulting in vehicle consumption nowadays being very high and indirectly contributing to high CO emissions into the air. Mahmud and Huraizah (2009) report that motor vehicles are a major CO contributor to air pollution. The locating is similarly evidenced through the boom in car purchases from 17,803 units to 60,780 units through 41.42 percentage in May 2019 in Malaysia (Hanani, 2019). This scenario has also been of the situation. Primary pollution refers to the pollutants produced through CO because of incomplete combustion that reasons quality debris to suspend within the air (Salmiah, 2015). Its main sources are smoke emitted through vehicle exhausts, smoke-generating industries, open burning, and the uncontrolled burning of coal.

Public awareness is very low on the effects of motor vehicle smoke emissions (Nayan *et al.,* 2020b) into the air containing pollutant components such as Carbon Monoxide (CO), Nitrogen Oxide (NO), and Carbon Dioxide (CO2) (Ratnawati *et al.,* 2010). Motor vehicles that contribute to CO include private cars, heavy vehicles, ships, airplanes, trains, and many others. These gas sources are dominant air pollution today and will continue. According to Jahangir (2015), scientific researchers have proven that vehicles emit greenhouse gases. Even more worryingly, when the engine of a non -moving vehicle is alive, it will produce twice the amount of greenhouse gases. The situation refers to the effects of CO on humans that this CO gas is a dangerous pollutant gas because it harms human health. According to Wadhwa (2009), if humans inhale air containing pollutant gas that is CO gas, then this CO is a pollutant gas that reacts very quickly to enter the blood stream and reduces the ability of human blood to deliver oxygen (O_2) to organs and tissues. Pollution will negatively impact human health, especially those suffering from Cardiovascular Disease, andaffect individuals. Wadhwa (2009) also stated that this is one of the factors that cause deterioration in workability, learning ability, and ability to perform complex tasks.

Apart from that, Federal Road is the main road that road users often use. Every day, Federal Road is never free from human activities such as the transportation of goods, such as heavy machinery that takes vehicles out of Proton city, the proton vehicle manufacturing and manufacturing plant. The situation is the same in the Kajang area, a relatively dense city with motor vehicles. Studies show high concentrations of total suspended particles in the area, especially those close to major roads, and these studies show CO gas shows concentrations between 1 to 9 ppm (Talib *et al.,* 2006). This study shows that vehicles are a significant contributor to carbon dioxide (CO) on the

road. CO is known as a pollutant gas because this gas is toxic that can silently kill humans. CO is grouped as an asphyxiate chemical as it will result in poisoning by poisoning the blood hemoglobin (Hb) (Basri *et al.,* 2014). The poison will obstructoxygen transport activity in the body if hemoglobin once exposed to CO. Based on Table 1 shows the effect if a lot of CO enters the human blood. Only 20 to 30 percent have caused humans to experience a decline in productivity in doing work. For example, students with this problem will cause them to be inactive in class due to a lack of oxygen in the blood. This study aims to examine CO in selected schools along Federal Road in Muallim district.

Methods

This study was conducted in three schools located adjacent to Federal Road in Muallim District, Perak. The selected schools are SMK Khir Johari, SMK Agama Slim River, and SMK Dato 'Zulkifli Muhammad. These three schools were selected as stations for data observation because of the school's location closest to Federal Road. The location of the school is as in Table 2. The observation station is in front of the school, where students' sending and picking up activities in front of the federal road.

This study has a quantitative approach. CO data were collected using the AS8700A Carbon Monoxide Meter instrument in a million units/part per million (ppm). According to Fardiaz (2010), the concentration of chemicals in the air is measured in units of ppm. Most pollutant gases are expressed or predicted in units per million (ppm) because certain gas concentrations are very low or small, where one ppm is equivalent to 1.146 mg/m^3. The use of this unit requires the researcher's skills in using the instrument. Each station takes 10 minutes to get a ppm reading. Sampling methods are used in obtaining primary data, especially in identifying factors that influence CO concentrations. Data collection takes place with the first sampling done from 7.00 am until 8.00 am, then the second sampling from 9.00 am until 10.00 am, and the last samplingfrom 12.00 pm to 1.00 pm. Observations were conducted simultaneously in three schools within a specified time frame. The analysis used is descriptive, and the standard used to determine the level of CO concentration is from the Department of Environment (DOE) (2015), which does not exceed nine ppm.

FINDINGS AND DISCUSSION

Carbon Monoxide Concentration Level at Schools
Table 3 shows the sampling values at all observation stations for seven consecutive days. Table 3 and Figure 1 show that the highest ppm reading is in SMK Khir Johari is seven ppm in the morning, approaching the maximum value by DOE (9 ppm). The CO value of the first day found that five ppm was obtained at 7–8 am, then decreased to 0 ppm at 9–10 am, and increased again to six ppm at 12–1 pm. The second observation found four ppm at 7-8 am and decreased to 0 ppm at 9-10 am but at 12-1 pm showed an increase of 7 ppm. The same happened on the third-day observation where at 7-8 am got five ppm and decreased to 0 ppm at 9-10 am but at 12-1 pm obtained a reading that increased from 0 ppm to 7 ppm.

Table 1. Carboxyhemoglobin concentration *(COHb)*

Blood COHb concentration (%)	Clinical manifestation
15-20	Mild headache
20-30	Severe headache, impaired agility, blurred vision, and irritability
30-40	Muscle dysfunction, nausea, vomiting, and mental confusion
40-50	*Tachardardia* dan *cardiac irritation*
50-60	Shortness of breath
> 60-70	Coma, respiratory failure, and death

Source: Mehta, Das and Singh (2007)

Table 2. Sampling Station Locations

School Name	Latitude	Longitude
SMK Khir Johari	3.695196	101.516848
SMK Agama Slim River	3.794351	101.435217
SMK Dato' Zulkifli Muhammad	3.836977	101.398417

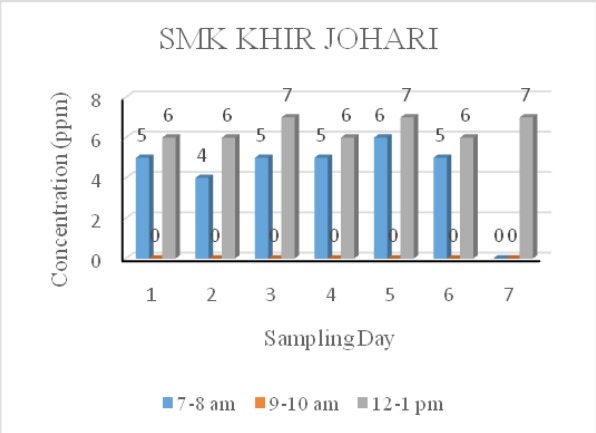

Fig. 1. COconcentration at SMK Khir Johari

On average, the CO concentration in these schools was only three ppm in the morning and six in the afternoon compared to 0 at 9-10 in the morning. The average value shown is still low and can be good because it is still far from the standard value of 9 ppm. It is only possible that sending students to school using motor vehicles contributes to this value in the morning and afternoon compared to 9-10 am. Day schools, namely SMK Khir Johari and SMK Dato 'Zulkifli Muhammad, where not all students are in hostels and have to use transportation to and from school, showed a high value of between 5 and 7 ppm. For these schools, the school session is in two sessions, the morning and evening sessions. The value of CO in the morning was only influenced by vehicles sending pupils and the entry of employee vehicles to school only. Compared to the afternoon, which involved two activities, namely sending students for the afternoon session, which collided with a vehicle to take students home for the morning session. So, the CO value at this time is higher than in the morning. Compared to SMKA Slim River, where all the students are in hostels. The only transportation activities involved are school staff vehicles. The result indicates that the transportation activities on the Federal Road do not contribute to the value of CO in the schools involved. The school CO value is influenced by the number of vehicles near the school that come from delivery and pick-up activities.

The maximum value found shows a variation between the value of five to nine ppm. The highest CO value in the morning is seven ppm (SMK Dato Zulkifli Muhammad, 8 Sept. 2019). The result is because this school's location is close to Slim River Town, which also accommodates the transportation activities of the residents to work. The same situation also happened at SMK Khir Johari Cuma with a smaller value. The clash of activities of sending pupils to school and residents to the

Table 3. CO Concentrations

School names	Sampling Date	Day		Time		
				7-8 am	9-10 am	12-1 pm
SMK Khir Johari	4 Sept. 2019	Rabu	1	5	0	6
	5 Sept. 2019	Khamis	2	4	0	6
	6 Sept. 2019	Jumaat	3	5	0	7
	7 Sept. 2019	Sabtu	4	5	0	6
	8 Sept. 2019	Ahad	5	6	0	7
	9 Sept. 2019	Isnin	6	5	0	6
	10 Sept. 2019	Selasa	7	0	0	7
SMK Agama	4 Sept. 2019	Rabu	1	0	0	6
	5 Sept. 2019	Khamis	2	0	0	6
	6 Sept. 2019	Jumaat	3	0	0	0
	7 Sept. 2019	Sabtu	4	0	0	6
	8 Sept. 2019	Ahad	5	5	0	6
	9 Sept. 2019	Isnin	6	5	0	6
	10 Sept. 2019	Selasa	7	0	0	5
SMK Dato Zulkifli	4 Sept. 2019	Rabu	1	6	5	6
	5 Sept. 2019	Khamis	2	5	0	7
	6 Sept. 2019	Jumaat	3	0	0	7
	7 Sept. 2019	Sabtu	4	6	0	6
	8 Sept. 2019	Ahad	5	7	0	9
	9 Sept. 2019	Isnin	6	0	0	6
	10 Sept. 2019	Selasa	7	5	0	5

workplace indirectly contributes to such values. The maximum value at noon shows a value equivalent to the DOE standard value of 9 ppm at SMK Dato 'Zulkifli Muhammad. The maximum value of CO obtained exceeds five ppm for day school. It shows values of 0 and six where sending and taking students do not occur for boarding schools. The result indicates that transportation activities on Federal Roads impact the value of CO. However, the location of SMKA Slim River, which is also close to the North-South Expressway (PLUS), also makes it possible that PLUS's transportation activities impact the increase in the value of CO here.

Figure 2 shows the observation data obtained from a field study conducted at SMK Agama Slim River. Observations on the first day found 0 ppm at 7-8 am and 9-10 am; however, at 12-1 pm, the CO concentration increased to 6 ppm. The second observation also obtained the same result of 0 ppm at 7-8 am and 9-10 am, then there was an increase to 6 ppm at 12-1 pm. There was no release or presence of CO on the third day as it only got 0 ppm at 7-8 am, 9-10 am, and 12-1 pm. The result may be because there were no passing vehicles or those stopping around the area on the day of the observation. Observations on the fourth day obtained different readings at 7-8 am and 9-10 am; the value is 0 ppm, but observations from 12-1 pm increased to 6 ppm. Next, the observation on the fifth day, which is on Friday, obtained a reading of 5 ppm at 7-8 am, while on 9-10 am, there was a decrease to 0 ppm or no presence of pollutant gases, and at 12-1 pm there was an increase by finding six ppm. Observations on the sixth day (Saturday), the value is 0 ppm at 7-8 am and 9-10 am decreased and increased to 6 ppm on observations made at 12-1 pm. The opposite occurred on the last day of observation, Sunday, and the value is 0 ppm at 7-8 am, 9-10 am, and 12-1 pm. The result is the same as that of the value on Wednesday. In conclusion, the CO concentration in SMK Agama Slim River in the afternoon (12-1 pm) recorded the highest CO reading (six ppm). However, the CO concentration in this area is much lower than in the two selected stations.

Figure 3 shows the CO concentration in SMK Dato Zulkifli Muhammad due to a field study carried out over seven days with a CO concentration detection instrument. On Monday, the first day's observations showed six ppm at 78 a.m., while it dropped to 5 ppm at 910 a.m. and rose to 6 ppm at 121 a.m. On the second day, the researcher went into the field and acquired an analysis of five ppm at 78 a.m., at the same time as a lower to zero ppm became measured at 910 a.m. and seven ppm at 121 a.m., in which there has been a boom withinside the afternoon.On the third day, the researcher obtained 0 ppm at 7-8 am and 9-10 am, while the observation at noon at 12-1 pm increased to 7 ppm. On Thursday, the fourth day's observation found six ppm at 7-8 am, then the observation at 9-10 am found a decrease to 0 ppm, and the observation conducted at 12-1 pm found an increase to 6 ppm. This fifth observation recorded the highest reading at 7-8 am,which is six ppm and 9-10 am there was a decrease to 0 ppm or no to the presence of CO pollutant gas then increased to 9 ppm at 12-1 pm which showed an increase in ppm in the afternoon. The highest readings due to traffic factors and a large number of vehicles, unlike the ordinary day of the researcher conducting the field study. Values on the sixth day (Saturday) found five ppm at 7-8 am and decreased to 0 ppm at 9-10 am while at 12-1 pm increased to 6 ppm. On Sunday, the last observation found five ppm at 12-1 pm while at 7-8 am, 9-10, 0 ppm. In conclusion, the noontime (12-1 pm) will be the highest CO concentration based on the fieldwork

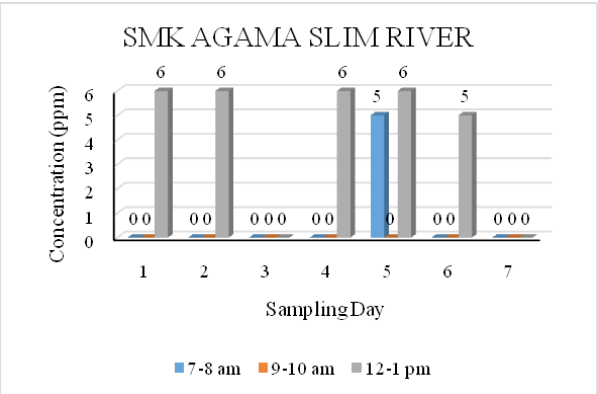

Fig. 2. COconcentrations at SMK Agama Slim River

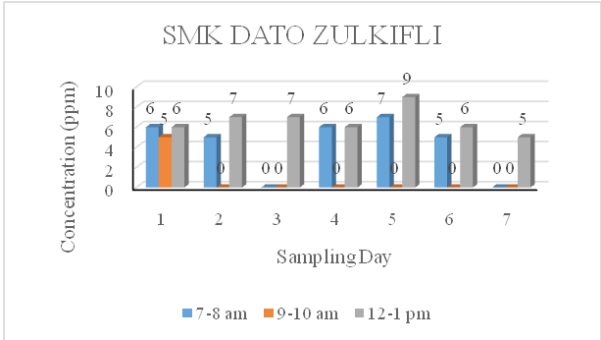

Fig. 3. CO concentrations at SMK Dato' Zulkifli Muhammad

sampling data. Each data obtained shows that noon has a higher concentration of CO compared to other times.

Figure 4 shows the average concentration of CO concentration according to the sampling time. Based on the figure, the trend of CO concentration where in the morning, which is 7-8 am, shows the concentration of CO in SMK Khir Johari, which is 4.4 ppm, and SMK Dato Zulkifli Muhammad is four ppm, and SMK Agama Slim River is the lowest which is 0.71 ppm. Furthermore, the CO concentration at 9-10 shown a drastic decrease for SMK Khir Johari and SMK Dato Zulkifli Muhammad. For SMK Khir Johari and SMK Agama Slim River, it is 0 ppm with no CO concentration. However, SMK Dato Zulkifli Muhammad found 0.71 ppm. The result indicates that past vehicle activity at this station was minimal at 9-10 am. The CO concentration at the time of the last observation at 12-1 pm showed an increase from 9-10 is. Figure 4 also shows the highest concentration compared to the other two observation times. The CO concentration in SMK Dato Zulkifli Muhammad is 6.57 ppm, while SMK Khir Johari found that the concentration of 6.43 ppm and the lowest CO concentration at present is 4.14 ppm. In conclusion, CO concentrations are more likely at 12–1 pm. While at 9-10 am, CO is very low or no pollutant gases because the two stations found 0 ppm at that time.

Figure 5 shows the average overall CO concentration data from the seven observation days by the school. The average overall CO concentration data presented in the figure show the schools with the highest CO density. Based on the researcher's analysis, the concentration of CO in SMK Dato Zulkifli Muhammad Muhammad is high. The situation can be seen in Figure 5, which shows that this station recorded 3.92 ppm. The results of the analysis made by the researcher also showed that SMK Khir Johari has a moderate level of CO concentration. The proof, Figure 5 shows that SMK Khir Johari recorded 3.57 ppm lower than the CO concentration in SMK Dato Zulkifli Muhammad Muhammad. The analysis also shows that SMK Agama Slim River is the station that recorded the lowest CO concentration of 1.62 ppm. In conclusion, SMK Dato Zulkifli Muhammad Muhammad recorded the highest CO concentration. The CO concentration at a moderate level is SMK Khir Johari, and SMK Agama Slim River is the station with the lowest CO concentration.

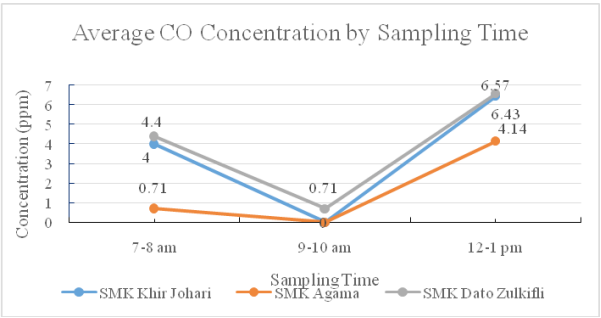

Fig. 4. Average CO concentration by sampling time.

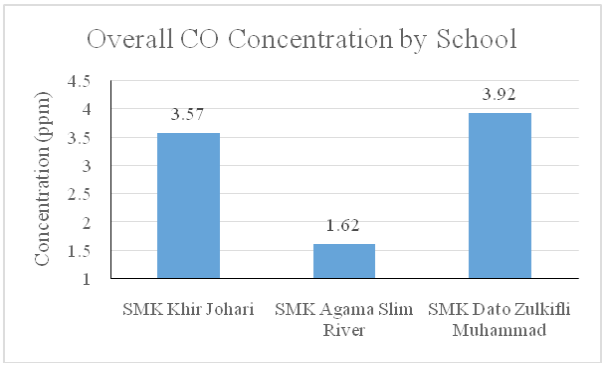

Fig. 5. Average overall CO concentration at each station

The CO concentration levels at the selected stations showed very significant differences. This significant difference can be compared to stations with CO concentrations by looking at maximum and minimum values. The maximum value is the highest at the station at the time of observation, and the minimum value is the lowest value of CO concentration. Table 3 shows that the maximum value in SMK Khir Johari is 4.3 ppm while SMK Agama Slim River is 3.7 ppm and SMK Dato Zulkifli Muhammad 5.7. Friday is the day where maximum CO concentration was detected, which was the fifth observation. Then, the minimum CO concentration in SMK Khir Johari detected in the seventh observation and SMK Dato Zulkifli Muhammad on the third observation is 2.3 ppm. In comparison, the minimum CO concentration in SMK Agama Slim River in the third and seventh observation is 0 ppm, where there is no pollutant gas CO. The maximum and minimum CO concentrations in SMK Khir Johari is 3.57 ppm, while SMK Agama Slim River is 1.62 ppm, and SMK Dato Zulkifli Muhammad is 3.92 ppm. Then the standard deviation for CO concentration data in SMK Khir Johari is 0.63957, then SMK Agama Slim River is 1.29192, and SMK Dato Zulkifli Muhammad is 1.27634.

CONCLUSION

In conclusion, the data obtained shows that the CO concentration is still at a level that is not alarming because the CO concentration does not exceed eight ppm. Based on WHO (1999), the exposure limit of CO concentration must be below eight ppm for 8 hours. CO concentrations are more likely on weekdays and in the afternoon (12-1 pm). The concentration of CO in this location is due to transportation activities and activities at school, namely activities to pick up children from school, especially on Fridays. Schools near Federal Road are less suitable from a safety and health aspect, especially for students.

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