

Estimation of Vehicles Carbon Dioxide (CO₂) Emission

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Abstract

Transportation is a sector that has a dependency on fossil fuel production and will produce carbon dioxide (CO₂) emissions. Carbon Dioxide (CO₂) is a pollutant produced by vehicles which causes air pollution. The increase in vehicle demand causes an increase in CO₂ emissions, which is the cause of global warming. But vehicles with fossil fuels are still a necessity for community mobilization. Because most vehicles used today are fossil fuel vehicles, the measurement of the efficiency of fossil fuel use is very important. The measure used to see the efficiency of fuel use by vehicles is Vehicle Kilometer Traveled (VKT). By using mobilev software, carbon dioxide (CO₂) emissions from fossil fuel vehicles can be predicted. CO₂ emissions that occur in an industrial area are caused by several types of motor vehicles, namely motorcycles, LDV and HDV cars. From the analysis of the correlation between CO₂ emissions with each type of vehicle obtained that the motor and LDV have a strong correlation with CO₂ emissions, but the correlation with HDV is weak. This shows that CO₂ emissions from each vehicle will contribute to CO₂ emissions, the number of motorcycles correlates very closely with CO₂ emissions ($r = 0.9$), the number of LDV correlates closely with CO₂ emissions ($r = 0.7$) and the number of HDV correlates weakly with CO₂ emissions ($r = 0.1$).

Keywords: Carbon Dioxide Emission, motorcycle, LDV, HDV

Abstrak

Transportasi adalah sektor yang memiliki ketergantungan pada produksi bahan bakar fosil dan akan menghasilkan emisi karbondioksida (CO₂). Karbon Dioksida (CO₂) merupakan polutan yang dihasilkan oleh kendaraan yang menyebabkan pencemaran udara. Peningkatan permintaan kendaraan menyebabkan peningkatan emisi CO₂, yang merupakan penyebab pemanasan global. Akan tetapi kendaraan dengan bahan bakar fosil masih merupakan kebutuhan untuk mobilisasi masyarakat. Oleh karena kendaraan yang kebanyakan digunakan sekarang adalah kendaraan berbahan bakar fosil, maka pengukuran mengenai efisiensi penggunaan bahan bakar fosil menjadi sangat penting. Ukuran yang digunakan untuk melihat efisiensi penggunaan bahan bakar oleh kendaraan adalah Vehicle Kilometer Traveled (VKT). Dengan menggunakan software mobilev, emisi gas karbondioksida (CO₂) dari kendaraan berbahan bakar fosil dapat diprediksi. Emisi CO₂ yang terjadi pada suatu kawasan industri ditimbulkan oleh beberapa jenis kendaraan bermotor, yaitu motor, mobil LDV dan HDV. Dari analisis korelasi antara emisi CO₂ dengan setiap jenis kendaraan diperoleh bahwa motor dan LDV memiliki korelasi yang kuat dengan emisi CO₂, namun korelasi dengan HDV lemah. Hal ini menunjukkan bahwa emisi CO₂ dari setiap kendaraan akan berkontribusi terhadap emisi CO₂, banyaknya motor berkorelasi sangat erat dengan emisi CO₂ ($r=0.9$), banyaknya LDV berkorelasi erat dengan emisi CO₂ ($r=0.7$) dan banyak HDV berkorelasi lemah dengan emisi CO₂ ($r=0.1$).

Kata Kunci: Emisi CO₂, motor, LDV, HDV

1. Introduction

Presently, our world has undergone many transformations, beginning with either the earth's structure as well as the living things in it. The world also reflects the transitions caused by human activities. Human-Environment has faced changes. That is not as natural as usual. Because it is including the more variant pollutions as normal today, along with the climate that is constantly changing due to different influences. For a long time, we have experienced significant changes in air pollution around us. Air pollution is that over time will lead to changes in air temperature and effect on climate.

What causes climate change currently or perhaps continuously? It is not only caused by the amount of gas produced from the earth itself. Instead, from the gas produced from artificial tools and human activities, one of the important parts is transportation, which the things that used every day by all of us. There are many sectors cause global carbon dioxide (CO₂) emission including

residential, commercial and public services, electricity and heat production sectors, other energy industries' use, manufacturing and construction industries, and also the transportation sector. All the sectors that have been described, that the transportation sector has a significant percentage after electricity and heat, productivity of 24% which has contributed 7,738 million metric tons of carbon dioxide in producing from the use of fuel around 2015-2016 worldwide (Akinyemi & Ramonu, 2019).

In reality indeed, almost all the countries around the world applied the vehicle as their medium to get something or transfer many things as much as the goods' sizes both small and big. With a carbon dioxide (CO₂) emission measurement from the vehicle, people can find out just how much gas each vehicle releases. This would be related to the way or lifestyle that might gradually injure nature, especially on the climate change (Chang & Lin, 2018).

Vehicle that produces the main gas is carbon dioxide (CO₂), such as cars, motorcycles, bus, ships that using non-renewable energy. Those vehicles are the things categorized fossil fuels consumption. It is widely known that vehicle produces this gas is used in all parts of the world (Yoon, Yang, & Kim, 2018). Carbon emissions progressively increases with the increasing of number of vehicles will cause negative effects on the environment. Global warming is one of the real impacts caused by carbon emissions from motor vehicles significantly (Kusumawardani & Navastara, 2017). The activities of people nowadays would not separate with the transportation sector. Because, of the simple way that we can go everywhere as long as comfortable and fast by the vehicle. People can use vehicle for carrying people or things from place to another place with all capacity. It is also known that many people are affected by air pollution caused by vehicles, which causes health impact or even death as in the Kathmandu Valley area, Nepal. It is due to the increasing volume of vehicles that emit carbon dioxide (CO₂) emissions (Shrestha, Shrestha, & Shrestha, 2017).

Different methods of estimating traffic-related emissions of carbon dioxide (CO₂) are accurate when faced with the right database. Therefore, the approach chosen reflected the outlook, advantages, limitations, and drawbacks of the measurement of carbon dioxide (CO₂) gas emission. As time goes by, data on the entire vehicle kilometer traveled (VKT) in Jakarta was insufficient. To develop an accurate method of traffic-related Carbon Dioxide (CO₂) emissions, the entire VKT information collected is mostly needed (Adhi, 2018).

By carrying out a method that leads to this Vehicle Kilometers Traveled (VKT), vehicle on abroad can also apply it. Because this is related to today's technology, which is increasingly sophisticated so that it can continue to develop and assist in the preparation of making vehicles that are environmentally friendly, and can also be the mainstay for long-distance travel (Akinyemi & Ramonu, 2019). When this approach is applied and extended to different types of vehicle, companies and technicians who are employed in the field of machinery industry can become directives to produce fewer vehicles in issuing carbon dioxide (CO₂) emissions, this means they should consider that matter deeper.

It cannot be separated from several considerations, including the other variables that can be calculated is based on the volume of traffic flow, the speed of the vehicle, the inside of the vehicle like machine, the age of the vehicle, the engine used, the energy capacity expended and needed, as well as important parts in vehicles that influence the use of the fuel (Adhi, 2018).

Besides that, the other source also explained that the measurement of kilometers in vehicle can be the forecasts data. There are some countries in Southeast Asia that can be implemented this method, because of the demand of using transportation dominantly in developing countries (Ng, 2018). It has been applied for the estimation hence, which that method would be modified to different policy but same strategy, which is using the kilometers of each vehicle. Indonesia not only provides information on estimates of carbon dioxide emissions in Surabaya. The district of Tampan, Pekanbaru, Riau, has its own system of calculation and also contains the same variables (Maulana, Sasmita, & Elystia, 2016).

The estimation of carbon dioxide gas emissions, China particularly in the Xinzhuang area also has results that prove that with the distance of individuals using transportation to work, the easier access and proximity, the less gas emissions are produced. In fact, using railroad access has resulted in a reduction in carbon dioxide gas emitters in the region (Wei & Pan, 2017).

This also ensures the future generations will be able to bring out the latest ideas or newest theories and innovations on the replacement of fuel that continuously being used to become a renewable fuel that is easy to obtain and does not harm the environment. Nowadays, many of shipping abroad uses a ship for the transportation. It would be the one factor of the climate change, and it's all has related to this matter (Tatar & Özer, 2018). For the measurement of distance in maritime transportation, regarding the mileage of ships at sea can be used and can be a reference to be able to develop a substitute fuel.

United States has created the renewable-energy that can face those impacts relating the emission (Akinyemi & Ramonu, 2019). In this case, it also states that in order to reduce gas emissions that occur. It can be by providing filters on motorized vehicles. From sources that do research in the town of Blitar, Indonesia, this is also supported by heavy traffic volumes and displays the results of mapping with concentration of gas emissions in the same unit (Sutanhaji, Anugroho, & Ramadhina, 2018).

The Mobilev Software and Vehicle Kilometer Traveled (VKT) have different variables to calculate, in reality the measurement is not only applied in big city, the developing country can do that too. It was a good concept that implement in Surabaya and Jakarta, even if all those implemented in Indonesia region that has many vehicles users that addicted and cannot be separated by human. All of the activities might be easier when human can reach their goals faster.

With this paper, human need to self-acknowledge that the vehicle is one of the factors that can affect air pollution. This encourages transportation companies, communities, environmentalists, and governments to become more conscientious about selecting and using a vehicle. The objective of this paper is show the correlation between number of motorcycles, LDV car and HDV and CO₂ emission.

2. Methods

This paper used the secondary data from research of Kusumawardani & Navastara, 2017 that measured CO₂ emission of vehicles at SIER industrial estate, Surabaya. In this research, counted the number of vehicles that thru some roads at SIER industrial estate and measured CO₂ emission at those roads too. Analysis data used coefficient correlation, Pearson Product Moment (ppm).

Measured the CO₂ emission at Kusumawardani & Navastara, 2017 research used Mobilev Software with inputs are the length of the road, the type/category of roads, the position of the road, the direction of the road, the number of road lanes, and the slope of the road. After the data obtained Mobilev Software be processed the amount of carbon dioxide (CO₂) gas emissions in vehicles

3. Result and Discussion

The distribution of CO₂ emission from Kusumawardani & Navastara, 2017 research showed by Fig. 1. Fig. 1 showed that at some road CO₂ emission classified high that showed with red color. At this industrial estate, all categorized of CO₂ emission occurred. The red classification occurs around the main roads, which is Raya Rungkut Road especially at an entry part. This road thru by many vehicles, motorcycles, car, bus and truck.

Data about the road of SIER industrial estate as a location of the research showing at Table 1, that showed the length of the road, the total road lanes and the direction of road.

Traffic counting data showed by Table 2, that showed number of motorcycles, car LDV, HDV and number of bus thru the road at SIER industrial estate.

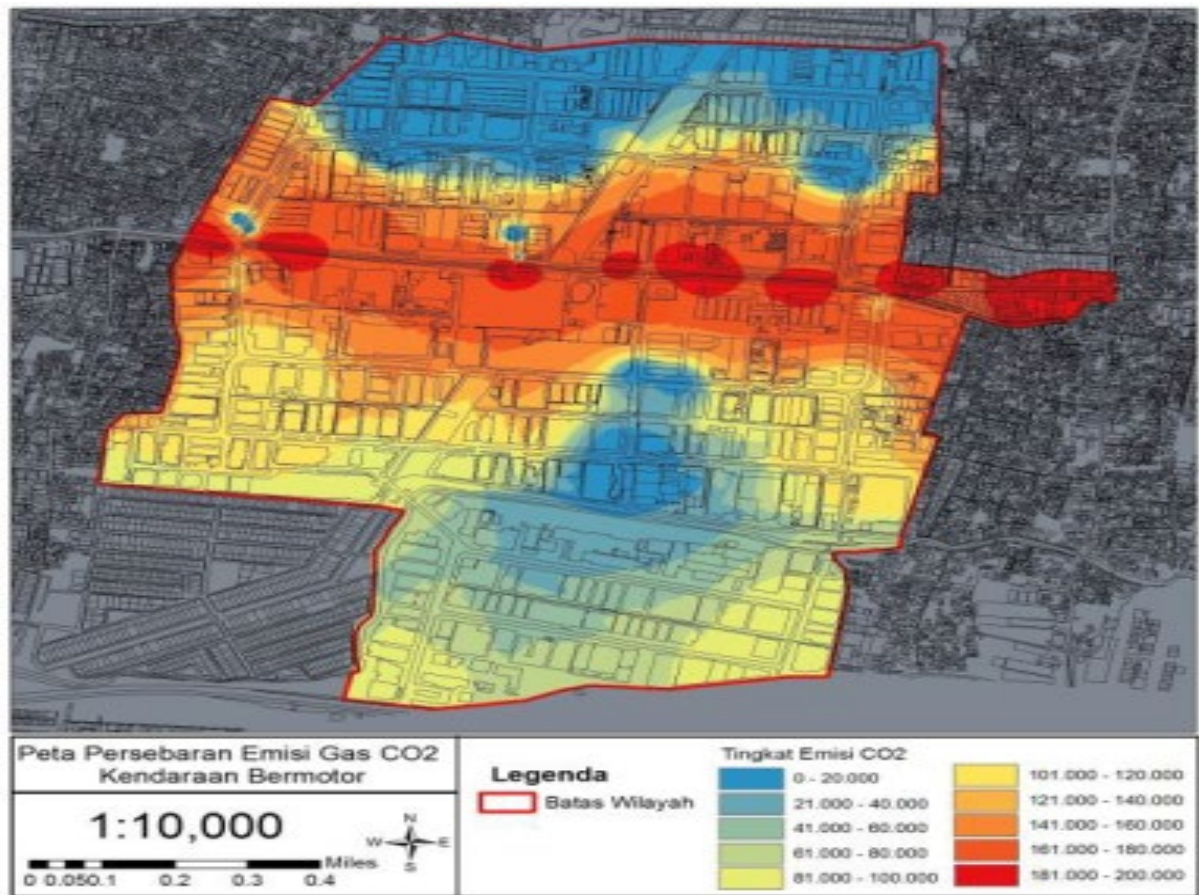


Figure 1. Distribution Map of CO2 Emissions of Motor Vehicles
Source: (Kusumawardani & Navastara, 2017)

Table 1. Distribution Road on the Area of Study

Road Part	Road's Name	The Length of Road (meter)	The Total of Road Lanes	The Direction of Road
Part 1	Raya Rungkut Street	600	2	2
Part 2	Raya Rungkut Industri Street	1360	4	2
Part 3	Kendangsari Industri Street	600	2	2
Part 4	Rungkut Industri III Street	260	2	2
Part 5	Berbek Industri III Street	980	2	2
Part 6	Rungkut Industri IV Street	1500	2	2
Part 7	Rungkut Industri V Street	570	2	2
Part 8	Rungkut Industri II Street	2000	2	2
Part 9	Rungkut Industri I Street	1680	4	2
Part 10	Rungkut Industri VI Street	760	2	2

Source: (Kusumawardani & Navastara, 2017)

Table 2. Traffic Counting Data

Observation Point	Motorcycle	LDV	HDV	Bus
Point 1 and 2 (Raya Rungkut Road)				
Rungkut Direction	12.742	5.827	39	12
SIER Direction	16.364	4.193	51	24
Point 3 and 4 (Raya Rungkut Industry Road)				
A Yani Direction	10.518	4.892	105	-
SIER Direction	8.902	5.683	97	-

<i>Observation Point</i>	<i>Motorcycle</i>	<i>LDV</i>	<i>HDV</i>	<i>Bus</i>
Point 5 and 6 (Kendangsari Industry Road)				
A Yani Direction	4.952	749	21	-
SIER Direction	3.991	698	14	-
Point 7 and 8 (Rungkut Industri III Road)				
Toll Berbek Direction	2.376	756	50	-
SIER Direction	2.674	825	41	-
Point 9 and 10 (Berebek Industri III Road)				
Toll Berbek Direction	2.132	705	38	-
SIER Direction	2.162	657	46	-

Source: (Kusumawardani & Navastara, 2017)

Data calculation resource by Mobilev Software on some roads in SIER industry area, this table below showed the information of total carbon dioxide (CO₂) gas emission from the vehicles.

Table 3. The Total Calculation of Carbon Dioxide (CO₂) Gas Emission on SIER Industry Area

<i>Road's Name</i>	<i>Total Emission (kg/hour)</i>
Raya Rungkut Street	106.06
Raya Rungkut Industri Street	199.68
Kendangsari Industri Street	21
Rungkut Industri III Street	73.80
Berebek Industri III Street	23.80
Rungkut Industri IV Street	13.03
Rungkut Industri V Street	2.22
Rungkut Industri II Street	6.76
Rungkut Industri I Street	6.92
Rungkut Industri VI Street	3
Total	426.27

Source: (Kusumawardani & Navastara, 2017)

From that showed at Table 2 and Table 3, correlation between CO₂ emission with number of motorcycle, LDV and HDV showed at Table 4, 5 and 6 respectively.

Table 4. Correlation Between Number of Motorcycle with CO₂ Emission

	<i>Number of Motorcycle</i>	<i>Total Emission (kg/hour)</i>
<i>Number of Motorcycle</i>	1	
Total Emission (kg/hour)	0.900589292	1

Table 5. Correlation Between Number of LDV with CO₂ Emission

	<i>Number of LDV</i>	<i>Total Emission (kg/hour)</i>
<i>Number of LDV</i>	1	
Total Emission (kg/hour)	0.655051882	1

Table 6. Correlation Between Number of HDV with CO₂ Emission

	<i>Number of HDV</i>	<i>Total Emission (kg/hour)</i>
<i>Number of HDV</i>	1	
Total Emission (kg/hour)	0.132999862	1

Table 4 showed the correlation between number of motorcycle and CO₂ emission is 0.9006. This correlation is very closed, each motorcycle become as a source of CO₂ emission, and capacity of road that could thru by motorcycle is high. In another word, road with 2 or more road lanes could support more motorcycles.

For number of LDV with CO₂ emission showed quite closed with *r* is 0.6551 (Table 5). The number of LDV sometimes not showed the number of passenger that used the vehicles. This is because, each LDV just used by 1 or 2 people. The number of LDV at the same time at the road

could as caused of traffic jam. If the traffic jam occurred, the emission of CO₂ would increase too. Different situation showed between number of HDV with CO₂ emission, the correlation is not closed ($r=0.1330$). Number of HDV could not be too many at the road, because the capacity of the road itself. But, if the HDV have too many at the road, traffic jam could occurred.

4. Conclusion

Emission of CO₂ caused by vehicles were important consideration for greenhouse gas. The correlation between number of motorcycle, LDV and HDV with CO₂ emission showed that emission CO₂ from vehicles was very important. The correlation between number of motorcycles and CO₂ showed very closed ($r=0.9$), the correlation between number of LDV with CO₂ emission was closed and correlation between number of HDV and CO₂ emission was weak.

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