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Traffic-related air pollution implication on environment and economics

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ABSTRACT

The objective of the study was to identify the effects of traffic-related air pollution on environmental and economic conditions and quality based on the parameters particulate matter with sizes of 10 μm (PM10), particulate matter with sizes of 2.5 μm (PM2.5), particulate matter with sizes of 1 μm (PM1), carbon dioxide (CO_2), and carbon monoxide (CO). In conducting this study, we measured the parameters (CO, CO_2, PM1, PM2.5, and PM10) in one day with a specific vulnerable time and also counted the number of vehicles that passed at the same time as a study in that period. The study is conducted in one of the strategic locations in the city of Bandung. Based on the study conducted, it is shown that Dipatiukur, Bandung, has a high level of air pollution even though it was still below the threshold. Implications for the environment and the economy, namely, the air quality around the location, had decreased due to service activities, population density, and overcrowding of transportation throughout the study period. The study concluded that there needs to be a policy in environmental management, especially for the availability of a wider green open space, because it was based on consideration of study locations that were central to service and density of transportation and residents in the city of Bandung. Then, there needed to be a community contribution to preserving the surrounding environment.

Keywords: Air pollution; Bandung; economy; environment; traffic-related.

INTRODUCTION

The environment is an essential aspect of human life. Increasingly complex human activities, along with technological developments, will provide many changes to the environment. The implications of this can damage the environment and disrupt human activities in the economy, which is quite high environmental pollution. In general, air pollution can be produced by several components, including industrial process waste, vehicle emissions, combustion of waste and chemicals, and other electronic materials that produce gas emissions. Also, according to Brook (2008), it comes from burning fossil fuels with sizes ranging from several nanometers to 10 μm in diameter. Künzli *et al.* (2000) described that Air pollution associated with traffic is the main objective that is also used for economic valuation. Then, according to Houston *et al.* (2004), the minority and poverty environments are affected by double exposure to vehicle pollutants because the minority and high poverty environments are very concentrated near major highways. Havard *et al.* (2009) explained that groups with low socioeconomic status are more likely to be exposed to higher levels of air pollution. Ponce *et al.* (2005) explained variations in exposure to traffic-related pollution - measured by traffic density, using a social, environmental framework that is poorly described as an environment with a low socioeconomic status group (SES). Then the physical environment is poorly described in winter, when thermal inversion traps motor vehicle pollutants, increasing traffic-related air pollution.

According to Martinez *et al.* (2018), air pollution in urban spaces is the cause of health problems, taking into account the concentration of particulate matter (PM) from PM 2.5 conducted at five air quality monitoring stations in the metropolitan area of Skopje, the Yugoslav Republic of Macedonia, and it was found that in 2012 social impacts were estimated as deaths caused by Long-term exposure to PM2.5 (49.2 μg/m^3) caused around 1,199 early deaths (CI95% 821-1519). Munasinghe (1999) stated that in addition to having an impact on mortality, PM2.5 also had an impact on the number of hospitalized patients, namely, 547 hospitalizations (CI95% 104-977) from cardiovascular disease and 937 hospitalizations (CI95% 937-1869) for respiratory diseases in that year. According to Briggs (2000), it is therefore vital to reduce the level of PM2.5 to EU boundaries (25 μg/m^3), so according to Han and Naeher (2006), it can prevent a decrease in the mortality rate of around 45% of deaths caused by PM, regarding the implications of air pollution related to environmental and economic impacts. Al-Mulali *et al.* (2012) explained that there are still shortcomings regarding environmental impacts and policies and significant economic impacts due to pollution, while Naz *et al.* (2019) stated that the relationship between renewable energy consumption, economy, and CO_2 emissions can be seen from per capita income and foreign direct investment (FDI) in a country or region. In the research conducted by Brugha *et al.* (2018) on respiratory and cardiovascular diseases, because of polluted air, there are particles and proinflammatory gases. This research was supported by Li *et al.* (2018) who found that poor air quality has major consequences for several diseases as cancer, stroke, asthma or heart disease, and other social diseases. Using the Granger Causality air pollution model seen from the ambient PM2.5 pollutant concentration, traffic, meteorology, and urban morphology use estimates of fine-grained air pollution in HK at a spatial resolution of 100 x 100 m, achieving an accuracy of 82%.

Previous studies have discussed the implications of air pollution related to traffic, environment, and economy, caused by including industrial process waste, vehicle emissions, combustion of waste and chemicals, other electronic materials that produce gas emissions, and socio-economic status. In addition, previous research tends to discuss the effects of pollution and health conditions; therefore, this study aimed to identify environmental and economic conditions caused by pollution, based on measurements of parameters CO, CO_2, PM1, PM2.5, and PM10, with the advantage of research data about the conditions before and after the rain at the study site and supported by using calculations on the number of vehicles passing at the time of the study. So this study aimed to identify environmental and economic conditions caused by pollution, based on measurements on the parameters of CO, CO_2, PM1, PM2.5, and PM10 gases. The location of this study was on the Dipatiukur road because the Dipatiukur road has a high level of air pollution even though it was still below the threshold. Implications for the environment and economy, namely, the air quality around the site, have decreased due to service activities, population density, and transportation density that have passed through the entire period of the study.

METHOD

This study was conducted to measure air quality in urban areas, especially in the city of Bandung.

The study location was chosen precisely in the Dipatiukur road area, which covers the front yard of Universitas Komputer Indonesia (see Figure 1), which is in front of the sidewalk of the Universitas Komputer Indonesia campus, which is conducted every one hour from 6:30 to 10:30 in the morning of March 30, 2019. This study used an HT -200 (CO_2 meter) type measuring instrument, Beneteeh GM8805 (carbon monoxide monitor), and air quality monitor. This study was conducted to measure air quality in urban areas, especially in the city of Bandung. This study used the HT-200 type (CO_2 meter), Beneteeh GM8805 (Carbon monoxide monitor), and air quality monitor; the equipment used was produced in China, using 5 measured parameters, namely, CO, PMI, CO_2, PM10, and PM 2.5, and reviewed based on the volume of vehicles passing at the research location.

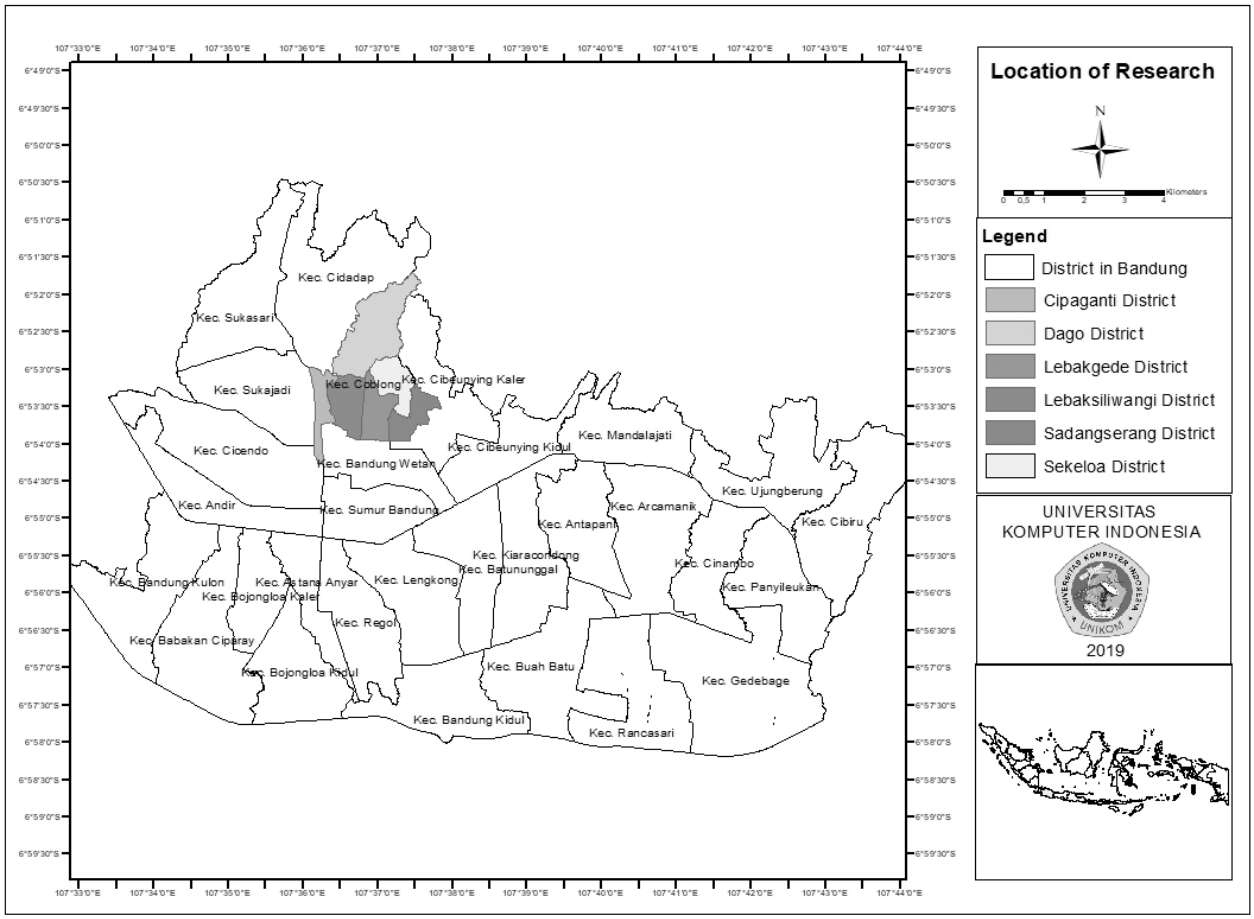

Fig. 1. Location of research.

This study was conducted at the Universitas Komputer Indonesia because the location was on Dipatiukur road, which is one of 55 locations (see Figure 2) for traffic jams in the city of Bandung, and the high volume of vehicles on Dipatiukur road was caused by trade activities and services, such as restaurants, universities, and printing place.

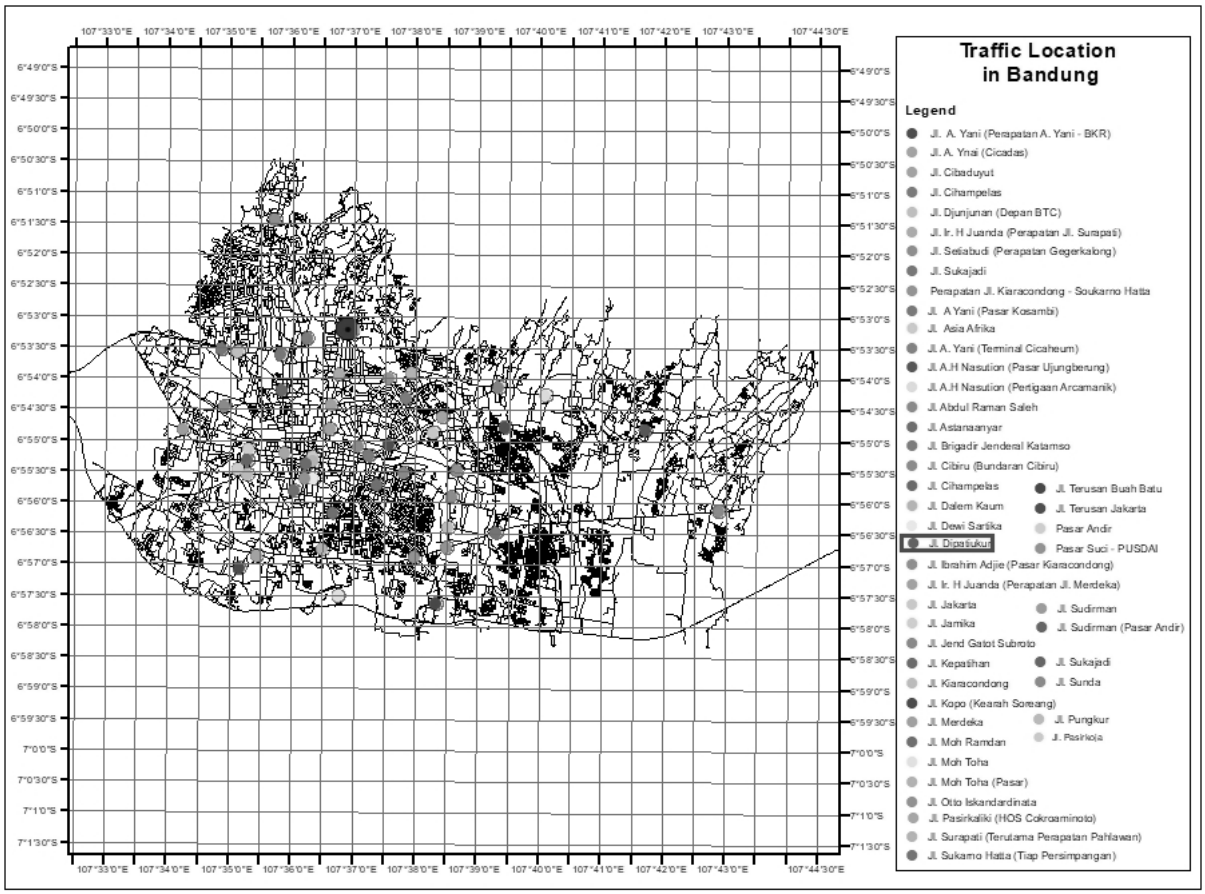

Fig. 2. Traffic Location in Bandung.

RESULTS AND DISCUSSION

According to Murtadho *et al.* (2018), Bandung can be classified as a Metropolitan City because, based on its population, the city of Bandung has a population of more than 1,000,000 million and is the core of the surrounding cities such as Cimahi City, Bandung Regency, West Bandung Regency, and Sumedang Regency.

Economic conditions

The relation with the economy comes from activities on Dipatiukur road, which is dominated by trade and service activities along the Dipatiukur road, which triggers the high number of vehicles passing on Dipatiukur road and has an impact on air pollution released by vehicle fumes. Central and industrial services at research sites and vehicle traffic that produce emissions have a significant impact on the number of pollutants contained in the air. As seen on the following map, activities in the study area (Dipatiukur road) are areas with land use as trading and service areas, and housing with moderate to high levels of population integrity. This resulted in the high movement of vehicles that crossed Dipatiukur road due to its strategic location in the city center and was supported by educational activities (Universitas Komputer Indonesia and Institut Teknologi Harapan Bangsa) and trade activities such as restaurants and food. The high activity of land use as trade and services, as well as residence, also has an impact on the minimum availability of Green Open Space on Dipatiukur road, which will directly have an impact on air and environmental quality on Dipatiukur road. The map of land use for the measured road area can be seen in Figure 3.

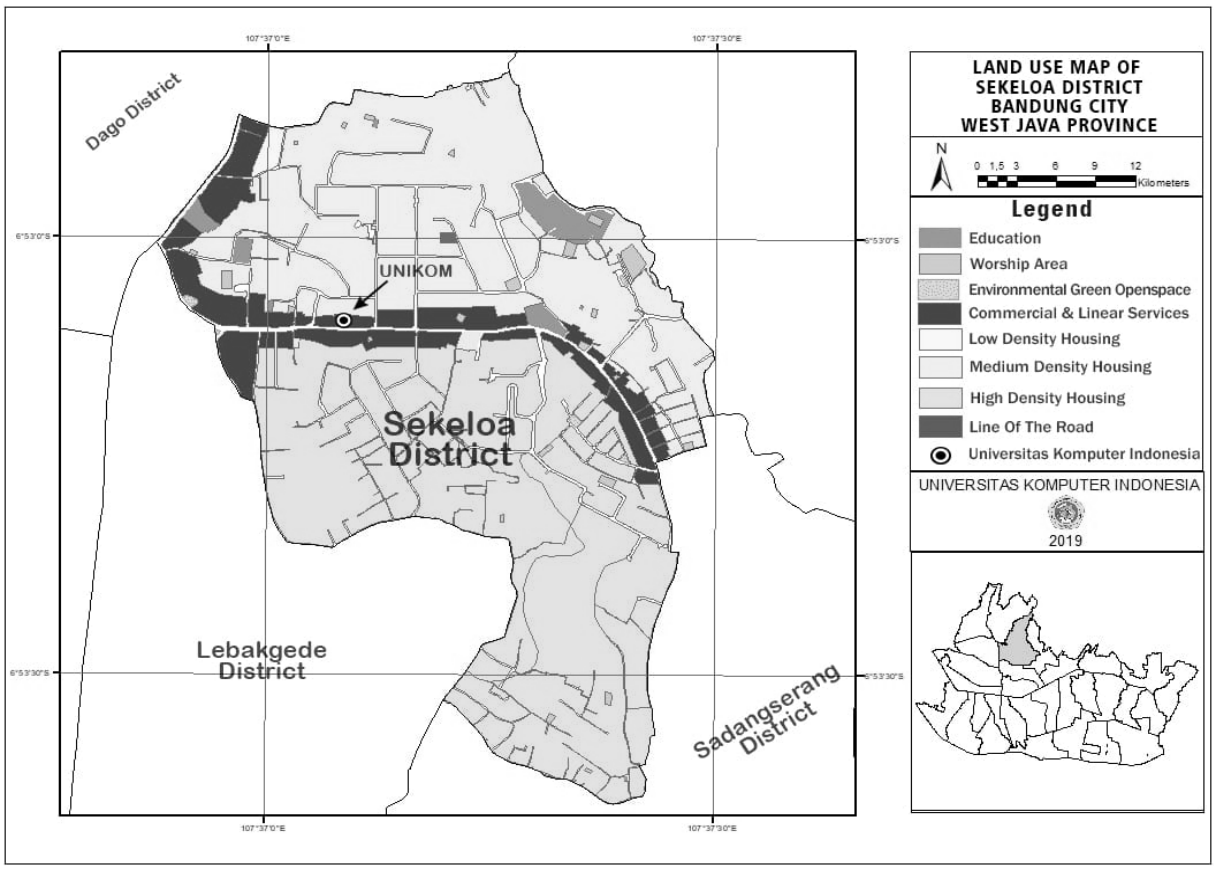

Fig. 3. Map of land use for the Dipatiukur road area.

Vehicle volume at the research location

Congestion is a condition when there is an increase in the number of vehicles on the road that makes roads cannot accommodate the number of vehicles available so that there is no road movement on the road, and this can be overcome by providing a balanced transportation system.

Then according to Munawar (2010), the indicator used to state the road segment that is going on is the vehicle volume> road capacity, the absence of vehicle movement or the movement of the vehicle that tends to slow down compared to before.

The study was conducted at 6:30 a.m., 7:30 a.m., 10:30 a.m., 10:30 a.m., and 10:30 a.m., in every hour for vehicles such as motorbikes; there was an increase in vehicle volume, because at that time there was a movement for work and educational activities on Dipatiukur road and its surroundings. As for the types of vehicles such as cars, at 6:30 a.m. to 8:30 a.m., the vehicle volume increases, while at 09:30 the volume of motor vehicles decreases slightly and increases again at 10:30 (see Figure 4).

Fig. 4. Congestion situation in front of Universitas Komputer Indonesia.

However, for vehicles such as trucks, the volume of passing vehicles tended to be unstable (up and down every hour). However, because at 10:30 a.m. to 11:35 a change in the weather became cloudy and it starts to rain, and this affects the volume of vehicles passing even in the current conditions, it did not rain, but the weather was still cloudy; so for types of vehicles such as motorbikes and volume cars are reduced from 11.40 to 13.40, but for vehicles such as trucks there was no significant change compared to the case before the rain (see Figure 5).

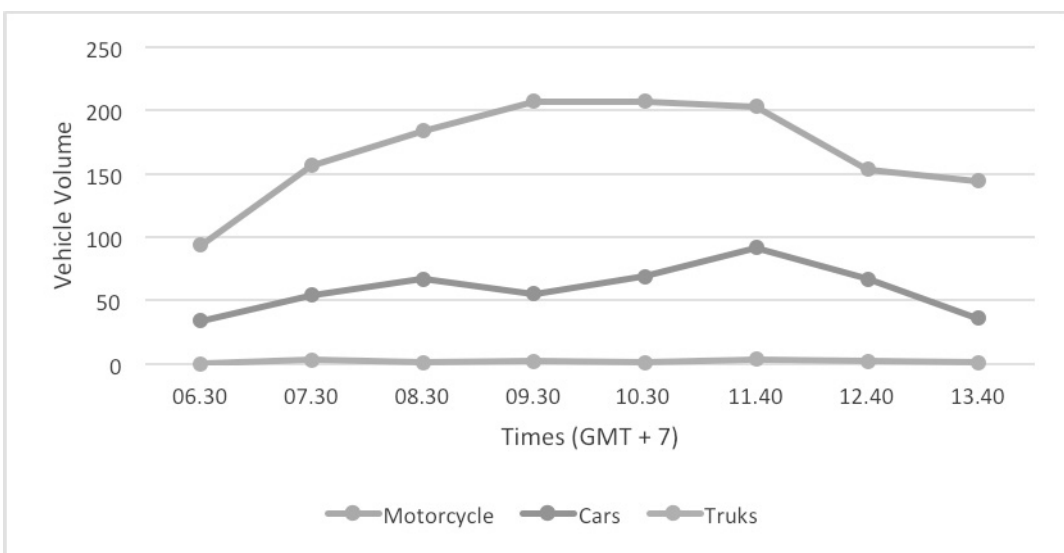

Fig. 5. Vehicle volume.

Air quality

According to Mol (2002), the concept of ecological modernization considers the consequences of the globalization process for ideas and perspectives on ecological modernization. This is implemented in terms of environmental conditions and economic aspects in the smallest part, one of which is the city of Bandung and pollution conditions.

Based on the above assumptions, Natanael *et al*. (2016) described healthy air indication, if particulates are present in a particular place or location in the range of 0 - 50, based on the parameters of CO, CO_2, and PM.10. Based on information from the Indonesian Meteorology, Climatology and Geophysics Agency (2019), the Threshold Value (NAB) of Particulates (PM) allowed to be in ambient air (NAB PM10) is 150 µgram / m3. Effendy *et al.* (2006) explained that temperature is not only related to Relative Humidity (RH) but also directly related to various physical elements of the city, and roads, while Relative Humidity (RH) is the ratio between water vapor, which is the pressure or amount of water vapor found at a certain temperature, and the pressure of saturated water vapor at that temperature.

The results of this study indicated that the average air temperature at Dipatiukur road from 6:30 - 10:30 a.m. was taken every one hour, ranging from 22OC to 28OC. The air temperature from 06.30 to 09.30 tended to increase the temperature from 22OC to the highest temperature at 09.30, which was 28 OC, because of the high volume of vehicles passing on Dipatiukur road. However, at 10:30 the temperature dropped to 27 OC because the weather conditions at 10:30 tended to be cloudy and rainy, although at 10:30 a.m. the volume of vehicles passing was still not different than that at 09.30. The study location affected the humidity level on Dipatiukur Road. This was because the higher the air temperature, the more the water content will be. In this study, the air humidity used was relative humidity, in the form of a per cent number as a ratio between the content of water vapor in the air and the maximum amount of water vapor contained in the air.

From the results of the study it was found that the relative average humidity from 6:30 a.m. to 9:30 a.m. conducted every one hour reduced the relative humidity level from 89.8% to 64.7% at 6:30 a.m. to 10:30 p.m. This relative humidity level was influenced by the increasing number of vehicles travelling on Dipatiukur Road, which had an impact on reducing water content in the air due to vehicle air pollution and weather conditions where the sun rose before noon. However, at 10:30 a.m., the air humidity increased to 66.05% due to weather conditions that tended to be cloudy, although the number of vehicles passing was not different from the previous hour. It is shown in Figure 6.

After the weather change (Rain) results in changes in air temperature and relative humidity on Dipatiukur Road, it could be seen that, after a rain of air temperature on Dipatiukur road at 11:40 a.m., the range was 27°C (the number of vehicles passing by as many as 203 motorbikes, 92 cars, and four trucks) and at 12:40 a.m., it tended to increase.

The temperature was up to 29°C (the number of vehicles passing 192 motorbikes and 60 cars). Likewise, at 13.40, the air temperature tended to be the same as that at 12:40 a.m., which was around 29°C, even though the number of passing vehicles increased, namely, 224 motorbikes, 58 cars, and two trucks. This also affected the relative air humidity level on Dipatiukur road, which had dropped from 11:40 to 13:40, which was from 74.75to 64.2%, respectively. It was affected by weather conditions that started brighter than 11:40. The smallest number of vehicles from 11:40 to 13.40 was the number of vehicles at 12:40 a.m., namely, 252 vehicles, at 11:40 a.m., the number of vehicles passing is 299 vehicles, and at 13:40 there are 284 vehicles (see Figure 6).

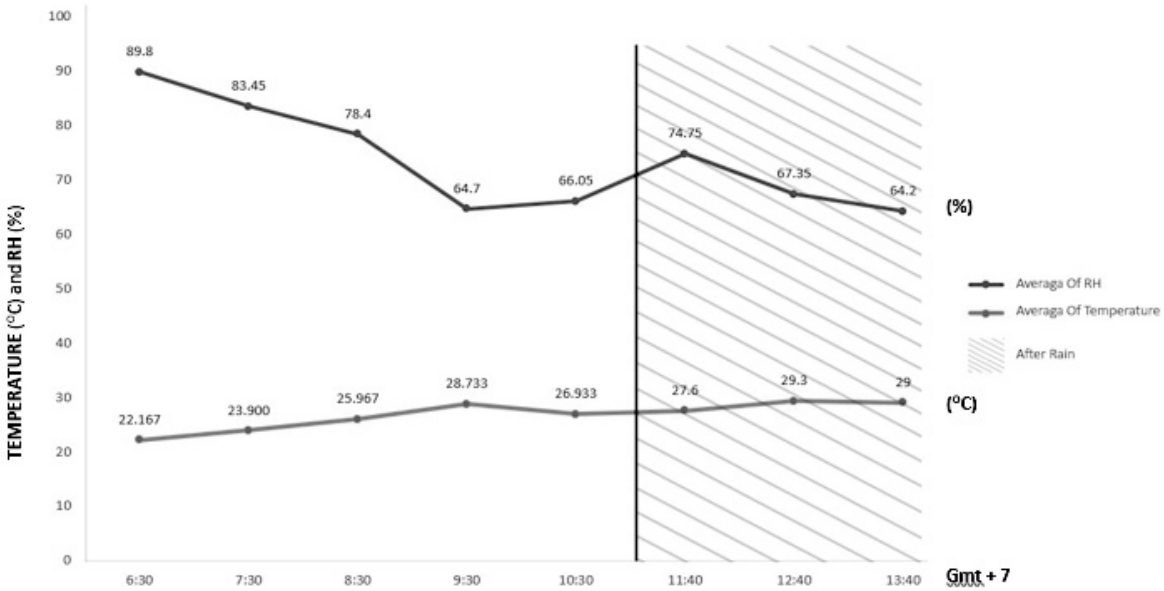

Fig. 6. Air temperature chart and Relative Humidity (RH) before and after the rain.

According to Liu *et al.* (2019) in a study conducted in China, the indicator used to determine environmental pollution is the content of sulfur dioxide, smoke and dust, wastewater conditions, and emissions produced from solid waste. This was also supported by Liévanos (2018) research, which explained that, in addition to being seen from the content in the air, indicators to see environmental pollution could be seen from the density of traffic and industrial zoning in the environment, while good air quality or air temperature is the air that feels fresh and cool, has a high content of Oxygen (O_2) compared to the content of CO_2 or other toxic particles and gases, and is generally colorless. The results of this study indicated that the air quality in Dipatiukur road was relatively good, as seen from relatively normal air temperatures (not hot and cold). However, it was seen from the relative humidity that air was classified as not too moist. This was because the air quality on Dipatiukur road was influenced by pollutants originating from the smoke of passing vehicles; this was a problem that must be considered because if the air quality gets damaged, various diseases will emerge and this will increase the cost of care for everyone. Broadly speaking, the study findings, the factors that influenced air pollution on the environment, and the economy in the research location, namely, (1) the existence of a service center that causes many vehicles to cross the research site, (2) density of houses, and (3) lack of green open spaces such as trees and other plants.

CONCLUSION

This study has measured air quality at the research site in a certain period. By paying attention to the highest level of pollution, which could affect economic and environmental conditions simultaneously. In this case, there needed to be policies related to environmental stability because it could affect economic activities, especially at the level of tourism and industrial activities. This was important because of its influence on building the image of Bandung as a pollution-free city. This study was expected to be used as a reference in making green open land and environmental and economic policies and for other studies to be able to increase knowledge about traffic-related air pollution and its implications for the environment and economy.

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