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Analysis of simple, rapid and portable tools for analyzing air pollution (i.e., PM1, PM2.5, PM10, CO, and CO_2)

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ABSTRACT

The research aims to show a simple, rapid, portable, and inexpensive analysis of an air quality measurer tool. In contrast to others, these three tools consisted by air quality measurer tool based on particulates, CO_2 meters for measuring the quality of carbon dioxide, and carbon monoxide meters as carbon monoxide quality measurer tool. The advantages of these three tools are being easy to use and used anywhere (portable). The total analysis costs less than 1,100 USD, while the price of air quality measurer tool that is commonly used by researchers can reach more than 6,000 USD. So, these three tools are worth to be used and effective as supporting media in developing countries. This research method used qualitative analysis by analyzing air quality using these three tools by focusing on functional water quality meters. The results of this study indicate that the use of portable tools makes it easier to retrieve air quality measurement data because it is more efficient in terms of cost and time. In conclusion, this study can be used as a reference information for further studies in examining air pollution.

Keywords: Air pollution; air quality; measure tool.

INTRODUCTION

Air pollution is the presence of one or more physical, chemical, or biological substances at the atmosphere in high amounts that endanger the health of humans, animals, and plants, disrupting aesthetics and comfort, or property damage (Nurbiantara, S., 2010). Pun *et al*. analysed the correlation between death rate and particle size and stated that the correlation between death rate and PM2.5 is strong (Pun, Kazemiparkouhi *et al*. 2017). PM2.5 has so much side effects on human health, because particulate mode PM2.5-10 could be trapped in the trachea and human bronchi, whether it is swallowed or taken out while coughing. Nevertheless, important particulate mode - PM2.5 could easily reassure lungs alveolar and move it to the blood (Araji *et al.*, 2017). Epidemiology studies that have been done this last decade show that there is a positive correlation between particle concentrate and morbidity from respiratory system with heart and lungs disease, especially for population part that is more susceptible such as kids and elderly (Seungchul *et al.*, 2014). Therefore, it is very important to take precautionary measures, control pollution and environmental damage, and restore damage to environmental quality whether in land, water, or air (Sugiarta, A. A. G., 2008). Air pollution does not only come from the smoke of industrial chimneys and exhaust gases from motorized vehicles but also from

domestic waste (Gusnita, D., 2012). Respiratory particulates are 2-5 μm particulates that can endanger human health because their aerodynamic properties can enter the respiratory tract, deposit in the lungs, and damage the alveoli (Zannaria *et al*., 2013): Particulate Matter 2.5 (PM2.5) and Particulate Coarse Dust Particles Matter 10 (PM10). Particulate exposure PM10 is an indicator for measuring airborne particulate pollution associated with effects on the respiratory tract since PM10 is a small group of particulates 0-10 μm, and these small particulates are the biggest health risk among various particulate sizes as they are inhaled through the respiratory tract to the lower respiratory tract and deposited in the lungs (Cahyadi *et al*., 2016). The level of air pollution can be measured using several tools according to their needs, because in the air there are various kinds of components. In this study we used Air Quality monitors as a measurer of air quality based on particular, CO_2 meters as a measurer of the content of carbon dioxide in air, and carbon monoxide meters to determine the level of carbon monoxide in the air. The results show that Bandung has a high level of air pollution, even though Bandung still has healthy enough air to be a habitable place. In terms of the development, Bandung has a fairly rapid development. Therefore, it must be balanced with environmental preservation in order to maintain the existing air quality. In conclusion, this study can be used as a reference for policy makers so that we can protect the environment.

The purpose of this research is to show a simple, fast, portable, and cheap analysis of an air quality measurer tool. This research method used an air quality monitor consisting of 3 devices, namely, HT-200 (CO_2 Meter), air quality monitor, and Benetech GM8805 (carbon monoxide monitor).

METHOD

This research was conducted on March 30, 2019 at 6:30 a.m. - 1:40 p.m. (West Indonesian time), with the time taken once every hour. We conducted this research with 3 tools, namely, HT-200 (CO_2 Meter), air quality monitor, and Benetech GM8805 (carbon monoxide monitor); the study was conducted at Universitas Komputer Indonesia, Bandung. We choose Bandung as a study case because Bandung is one of the metropolitan cities in Indonesia, so the activity of vehicles is very dense, especially when it comes to weekends (Figure 1).

Fig. 1. Map of Indonesia.

We choose one of the cities in Indonesia, namely, Bandung (Figure 2).

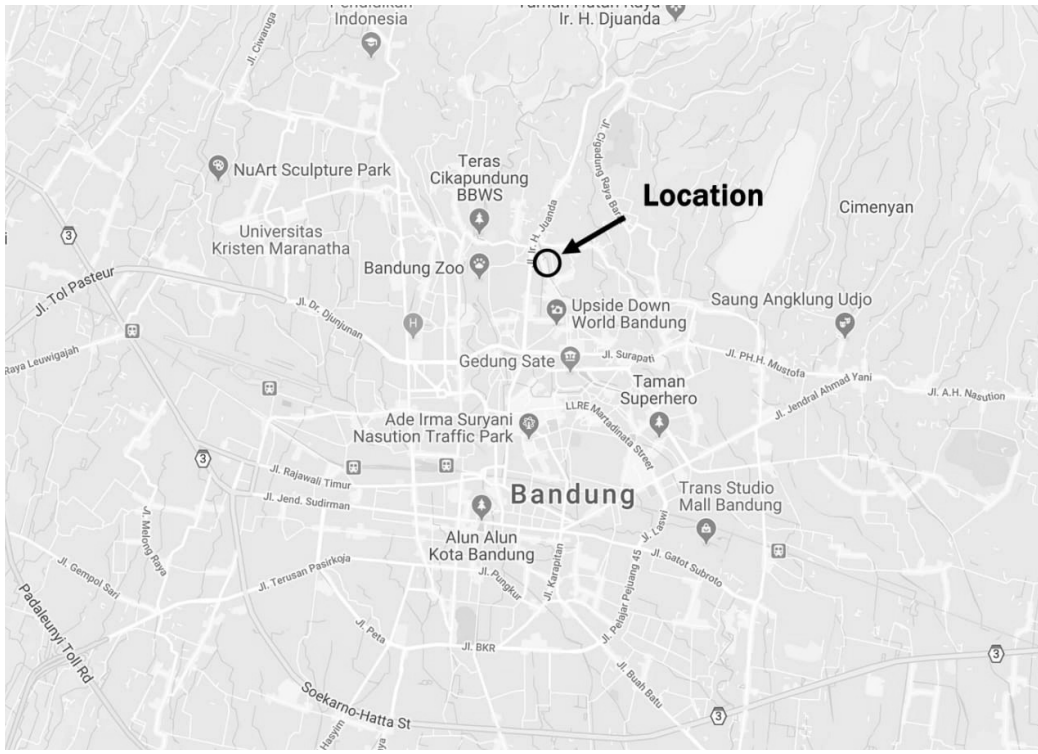

Fig. 2. Map of Bandung.

In Bandung there are a lot of locations frequently visited by many people; one of the locations is UNIKOM campus area (Figure 3).

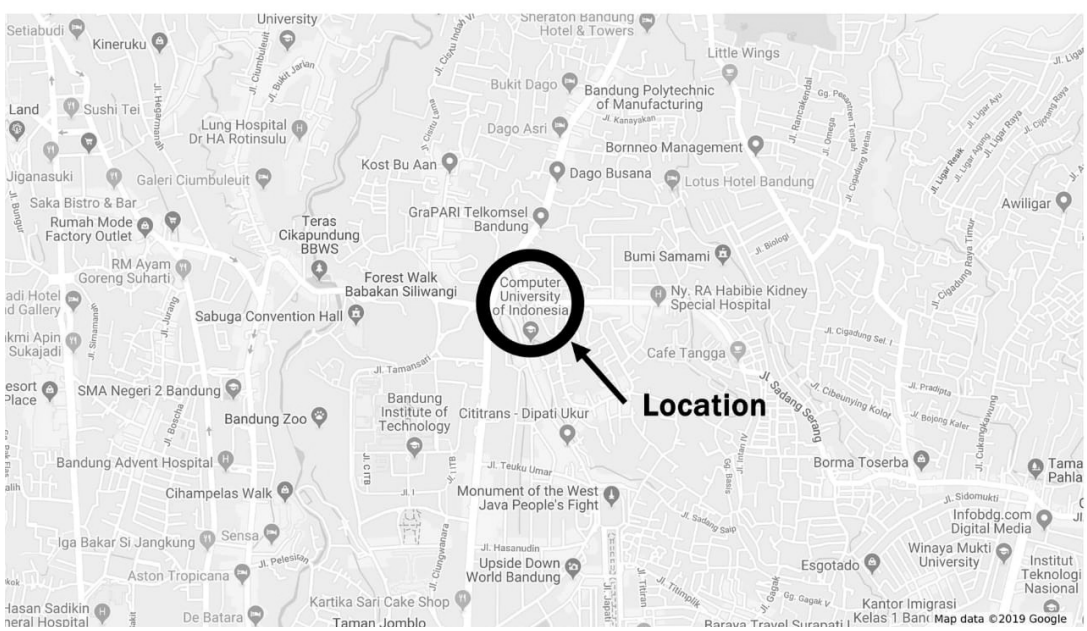

Fig. 3. Universitas Komputer Indonesia Map.

In this study, we conducted research by using several parameters (CO_2, CO, PM1, PM2.5, and PM10) before and after rain. We chose Bandung as a research place, as a representation of big cities in Indonesia.

RESULTS AND DISCUSSION

Air quality monitor is a tool that has several functions as a measurer of air quality; by measuring and monitoring the environment, concrete data will be obtained to control air pollution in the community environment. By using this tool, the data obtained is measured whether the air produced is still within the tolerance limit or pollution has occurred. The air quality monitor has 8 parameters: HCHO Formaldehyde, Formaldehyde as gas, small molecules (HCHO, from which -CHO is a group of aldehydes) that dissolve rapidly in water (Kiernan, J. A., 2000), TVOC as a risk index for health and comfort effects on buildings (Andersson *et al*, 1997), PM1.0, PM2.5, PM10, and atmospheric particles (PM) that consisted of very small particles of solid or liquid substances, ranging in diameter from 0.001 to 100 μm.

The time when PM is delayed in the atmosphere ranges from a few hours to several weeks. The smaller the particles are, the longer they will stay in the air. The atmospheric particles can affect the climate with direct and indirect radiation power (Li *et al*, 2015): Air Pressure, Humidity, Temperature, and AQI (Air Quality Index), AQI's main goal is to measure air quality in relation to its impact on human health (Bishoi *et al*, 2009). This tool is easy to operate; the test hole is designed to provide cross ventilation, to be easily grasped, and to have a short test time. This tool can work continuously for 300 minutes and has a Lithium polymer type 2000 mAh battery, input voltage 5.0 V / 1000 mA, and charging temperature -10°C - 45°C. Carbon dioxide monitors are used to measure the concentration of carbon dioxide (CO_2), temperature, humidity, dew point temperature, and wet bulb temperature. High levels of carbon dioxide in the room will cause fatigue, lack of concentration, building sickness syndrome; carbon dioxide also has an important function in agriculture, such as vegetable greenhouses. CO_2 Meters are widely used in factories, workshops, greenhouses, clean rooms, industry and agriculture, wine bars, hotels, hospitals, shop markets, airports, train stations, entertainment halls, and cinemas. This tool has a stable NDIR (Non-Dispersive Infrared) Sensor for CO_2 concentrations, WAVEGUIDE WITH ABC TECHNOLOGY (Automatic back-ground calibration), High and low threshold settings, equipped with power adapter, 12700 data collection memory, CO_2 Level Warning, large LCD simultaneously displaying and recording CO_2 Levels, Temperature, Relative Humidity, Calendar (Y / M / D), and Time (Hour).

The compensation is long, considering from the Max and Min. Carbon monoxide meters are used to detect harmful gases and notify operators of precautions in bad situations. These are widely used in petroleum, chemistry, coal mining, metallurgy, paper making, fire fighter, city administration, telecommunications, food, textiles, and other industries. Carbon monoxide meters have functional parameters and technical air gas detection such as carbon monoxide, Measure range: 0 – 1000 ppm, Resolution: 1 ppm, Minimum reading: 1 ppm, Basic errors: ± 5% (FS), ± 10ppm, Response time: 60 seconds, Sensor Type: Electrochemical CO sensor. It can check the highest concentration of carbon monoxide, has a buzzer alarm limit setting, set the highest and lowest carbon monoxide concentration, has maximum and average data storage, auto turn off functions, low power indicator, and –LCD backlight display. Work environment: 0 – 50 °C, 32 - 122 °F, 10 - 90% RH, Dimensions: 55.7 x 29.9 x 135.5 mm, Power: 2 x 1.5 V AAA batteries. From the research conducted, there were several results that showed the air quality that existed in Bandung, especially in the environment of Universitas Komputer Indonesia (See Figure 4).

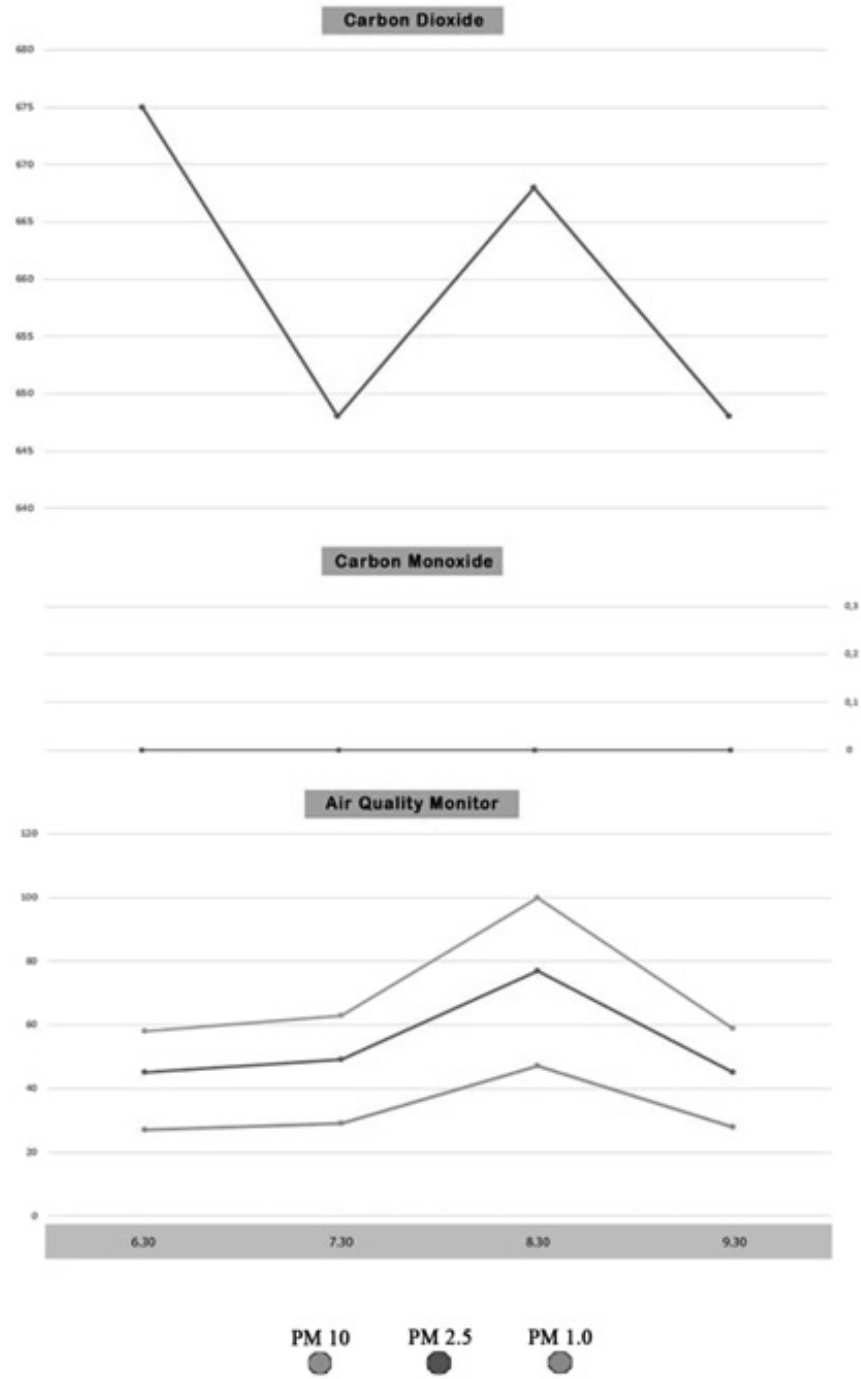

Fig. 4. Air quality monitor, CO_2, and CO meter.

The data above explains the air quality that exists within one hour in the range of 6.30 AM - 09.30 PM. The highest ppm CO_2 level is at 6.30, whereas the CO content of the data obtained from the range 6.30 - 9.30 has very significant similarities. On Air Quality Monitor, namely, PM 1.0, PM 2.5, and PM 10, the three pieces of data increase at 8.30 and drop back at 9.30.

From Table 1, we can see vehicles data taken from the survey directly on the UNIKOM sidewalk.

Table 1. Data taken from the survey directly on the UNIKOM sidewalk.

Time	**Total Vehicles**		
	Motorcycle	Car	Truck
06.30	94	34	0
07.30	157	54	3
08.30	184	67	1
09.30	208	55	2
10.30	208	69	1
After Rained			
11.40	203	92	4
12.40	192	60	0
13.40	224	58	2

From Table 2 we can see vehicles data taken from a survey directly on the front sidewalk of a Honda dealer.

Table 2. Data taken from a survey directly on the front sidewalk of a Honda dealer.

Time	**Total Vehicles**		
	Motorcycle	Car	Truck
06.30	54	26	0
07.30	230	40	5
08.30	170	41	2
09.30	161	53	4
10.30	151	40	1
After Rained			
11.40	203	92	4
12.40	154	67	2
13.40	145	36	1

From Table 3, we can see several pieces of data containing the results of air quality surveys including CO_2, CO, PM2.5, PM1.0, PM10, HCHO, and TVOC. This data takes location for the studies at the Unikom Sidewalk.

Table 3. Data that contains the results of air quality surveys including CO_2, CO, PM2.5, PM1.0, PM10, HCHO, and TVOC.

CO_2			**CO**		**Air Quality Monitor**						
ppm	Celsius	%RH	ppm	Celsius	PM2.5	PM1.0	PM10	HCHO	TVOC	Temperature	HUM
675	23,7	80,6	0	25,4	45	27	58	0,023	0,361	17,4	99%
648	25,5	75,9	0	27	49	29	63	0,015	0,14	19,2	91%
668	27,8	69,8	0	28,7	77	47	100	0,017	0,107	21,4	87%
648	30	59,4	0	32	45	28	59	0,022	0,214	24,2	70%
658	28,9	59,1	0	29,7	35	23	47	0,013	0,015	22,2	73%
Setelah Hujan											
662	29,3	67,5	0	30,7	45	58	27	0,025	0,524	22,7	82%
672	29,8	62,7	0	32,5	28	17	36	0,017	0,065	25,6	72%
636	31,1	60,4	0	33,3	25	14	31	0,022	0,038	22,8	68%

From Table 4, we see data data containing the results of air quality surveys including CO_2, CO, PM2.5, PM1.0, PM10, HCHO, and TVOC. This data's location of the study is at the front sidewalks of Honda dealers.

Table 4. Data containing the results of air quality surveys including CO_2, CO, PM2.5, PM1.0, PM10, HCHO, and TVOC.

CO_2			**CO**		**Air Quality Monitor**						
ppm	Celsius	%RH	ppm	Celsius	PM2.5	PM1.0	PM10	HCHO	TVOC	Temperature	HUM
563	24,5	78,9	0	27,2	34	22	45	0,038	0,016	19,3	86
561	25,7	77,4	0	29,9	48	27	59	0,023	0,194	20,9	80
565	25,9	74,5	5	30,7	72	44	93	0,01	0,397	21,7	78
557	29,1	64,1	0	32,9	40	22	49	0,046	0,024	23,6	69
539	27,3	64,7	2	29,6	35	20	44	0,016	0,222	23,3	68
After Rained											
626	29,5	67,2	0	32,6	42	26	54	0,03	0,155	25,6	72%
525	29,2	64	1	32	24	15	31	0,025	0,115	24,4	70%
526	31,3	59,6	0	32,7	34	22	45	0,032	0,041	25,5	68%

From Table 5, we see several pieces of data that contain the results of air quality surveys including CO_2, CO, PM2.5, PM1.0, PM10, HCHO, and TVOC. This data's location place we took for this study is on the 16th Floor of the UNIKOM Campus' New Building. In a scale of each metropolitan region, analysis concentration factor for PM2.5 is used for statistically estimate the contribution of emission's source sector for several sequences of measurement (Brinkman *et al*., 2006; Lee *et al*., 2008).

Table 5. Data that contain the results of air quality surveys including CO_2, CO, PM2.5, PM1.0, PM10, HCHO, and TVOC.

CO_2			CO		Air Quality Monitor						
ppm	Celsius	%RH	ppm	Celsius	PM2.5	PM1.0	PM10	HCHO	TVOC	Temperature	HUM
619	28,9	68,5	0	27	34	21	45	0,025	0,078	21,2	77%
624	28,9	75,4	0	27,5	51	30	65	0,023	0,092	21	78%
610	28,5	87,3	0	28,7	60	35	76	0,022	0,059	22	77%
602	28,9	62,4	0	30,5	46	26	58	0,019	0,024	22	70%
599	28,8	62,4	0	27,7	38	24	50	0,017	0,024	21,2	78%
After Rained											
574	30,5	59,8	0	33,4	26	34	16	0,016	0,324	23,9	68%
585	29,4	62,6	0	32	18	11	23	0,014	0,188	23,7	69%
594	29,8	59,4	0	30,6	22	12	27	0,014	0,209	23,4	71%

CONCLUSION

This study succeeded in measuring air quality in a specified period so that it can be used as a reference for taking a policy that focuses on the environment. The policy that we mean is the need for consideration in discussing the air quality in Bandung, where if this one is forgotten, it might have a negative impact on the livable environment. There are not many references that can be used to be a basis of concrete data for taking environmental policy. This research is expected to be used as a reference in taking policies that affect livable environments.

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