



Analysis of the level of CO parameter air pollution on the road of Makassar City

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ABSTRACT

Background: Air pollution comes from gas emissions from motor vehicle combustion, human daily activities, or from industrial and residential activities. Transportation routes in the form of roads that are dense with motorized vehicles are places with a high level of pollution. Gas emissions from vehicles that come from combustion in the engine does not burn completely to produce carbon monoxide gas. Carbon monoxide gas is one of the most dangerous pollutants for health. Air Pollution Level CO parameters on Jalan AP Pettarani Makassar City were measured to assess the impact of exposure to carbon monoxide. **Methods.** The type of research used is an observational quantitative analytic study with a cross sectional approach. The population in this study was all ambient air on Jalan AP. Pettarani with a sample of 378 samples from 6 points 3 measurements, morning, afternoon, evening, for 7 days of the study. **Results.** The results of the Pearson Correlation test obtained -value of 0.000 (<0.05) indicating that there is a significant relationship between CO and Air Pollution Levels (ISPU). The correlation coefficient for Morning Co is $r=0.980$, Afternoon CO $r=0.985$ and Afternoon CO $r=0.993$ which shows a very strong relationship and a positive direction. **Conclusion.** For further researchers, it can be added with other parameter measurements and in data collection more attention to wind, temperature, humidity, and number of vehicles in air quality measurements.

Keywords: carbon monoxide; air pollution level; air pollution

ABSTRAK

Latar Belakang: Pencemaran udara berasal dari gas emisi pembakaran kendaraan bermotor, aktivitas keseharian manusia, ataupun dari aktivitas industry dan perumahan. Jalur transportasi berupa jalanan yang padat akan kendaraan bermotor merupakan tempat yang tinggi tingkat pencemarannya. Gas emisi dari kendaraan berasal dari pembakaran pada mesin tidak terbakar sempurna menghasilkan gas karbon monoksida. Gas karbon merupakan salah satu polutan yang paling berbahaya bagi kesehatan. Tingkat pencemaran udara parameter CO di jalan AP. Pettarani Makassar diukur untuk menilai dampak pajanan yang dihasilkan oleh karbon monoksida. **Metode.** Jenis penelitian yang digunakan adalah penelitian kuantitatif dengan desain analitik dan menggunakan pendekatan cross-sectional. Populasi pada penelitian ini yaitu seluruh udara ambien yang berada di Jalan AP. Pettarani dengan sampel sebanyak 378 sampel dari 6 titik 3 kali pengukuran, pagi, siang, sore, selama 7 hari penelitian. **Hasil.** Hasil uji Korelasi Person diperoleh p-value sebesar 0,000 (<0,05) menunjukkan ada hubungan yang bermakna antara CO dengan Tingkat Pencemaran udara (ISPU). Koefisien korelasi CO Pagi diperoleh $r=0,980$, CO Siang $r=0,985$ dan CO Sore $r=0,993$ yang menunjukkan hubungan yang sangat kuat dan arah positif. **Kesimpulan.** Untuk peneliti selanjutnya dapat ditambah dengan pengukuran parameter lain serta dalam pengambilan data lebih memperhatikan faktor angin, suhu, kelembaban, dan jumlah kendaraan dalam pengukuran kualitas udara.

Kata Kunci: karbon monoksida, ispu, polusi udara

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INTRODUCTION

Air pollution is a condition in which the presence of one or more chemical, physical or biological substances in the atmosphere in harmful amounts. Harmful to human, animal, and plant health, interfere with aesthetics and comfort, and damage property. Air pollution is one type of environmental pollution in addition to soil pollution, water pollution, noise pollution. Air pollution is a damage to air quality. This quality damage is caused by various sources, both biological and non-biological sources. Air pollution can be sourced from various kinds, namely: motor vehicle fumes, factory fumes, industrial waste, household waste and so on. This type of source can be a source of soil pollution.

Air pollution is a global problem that poses a threat to health and climate around the world. Air pollution affects all countries in the world both low, middle and high income countries. Based on the world's latest air quality data, 97% of cities in low- and middle-income countries with more than 100,000 inhabitants do not meet WHO air quality standards ($10\mu\text{g}/\text{m}^3$). In 2016, approximately 7 million deaths globally (18% of all global deaths) were caused by indoor and outdoor air pollution. (WHO –Air Pollution, 2018).

The COVID-19 pandemic has been a major and extraordinary factor affecting air quality in 2020. Known by some as the largest air quality experiment ever. The global blockade has led to a temporary reduction in fossil fuel consumption and has been linked to a significant decline in air quality. Compared to the previous year, air pollution in 2020, 65% of the world's cities experienced a significant improvement in air quality compared to 2019, and 84% of countries have improved overall. Due to this state of improvement, pollutant concentrations tend to recover.

The cause of air pollution in Indonesia is around more than 70% is the result of motor vehicle emissions. Motor vehicles produce harmful substances that can cause negative impacts, both on human health and on the environment. Hazardous substances such as lead (Pb), suspended particulate matter (SPM), oxides of nitrogen (NO_x), hydrocarbons (HC), carbon monoxide (CO), and photochemical oxides (Ox). Motor vehicles contribute nearly 100 percent lead, 13-44% suspended particulate matter (SPM), 71-89% hydrocarbons, 34-73% NO_x, and almost all carbon monoxide (CO) to the air.

For Makassar City, pollution produced from vehicle fumes over time is increasing and based on data from the Makassar City Samsat, in 2018 there were 1,425,151 units or an increase of 87,009 units compared to 2017. Meanwhile, in 2016 the number of motorized vehicles in Makassar City was only around 1,252,755 units. That is, in two years there were 172,395 additional units.

One sector that plays an important role in the decline in air quality around the world is transportation. Transportation is considered as the main problem of air pollution because until now most vehicles still use fossil fuels. Even in 2011, fossil fuels represented 82% based on the world's total primary energy supply. In China and India, the link between pollutants from the transport sector is 5% and 12% each year, respectively.

METHODS

The type of research used in this study is quantitative research with analytical design. The approach taken in this study is a cross-sectional approach. The population in this study is all ambient air located on AP Road. Pettarani with 378 samples from 6 points 3 measurements, morning, afternoon, evening, for 7 days of study, From November 22 to November 28, 2021. Ambient air with parameters of Carbon Monoxide (CO) levels on Jalan A.P Pettarani are as many as 6 points, namely location I at the intersection of Jalan AP Pettarani with Jalan Sultan Alauddin, location II in front of MAN 2 Makassar, location III at the intersection of Jalan AP Pettarani with Jalan Boulevard, location IV in front of the POS office, location V at the intersection of Jalan AP Pettarani with Jalan Urip Sumaharjo, location VI around POS POLANTAS. The data used in this study are primary data and secondary data. The primary data in question is the result of ambient air quality measurements with Carbon Monoxide (CO) parameters. Meanwhile, the secondary data used include data obtained based on government agencies and previous studies related to ambient air quality with CO parameters. This secondary data includes ambient air quality data, ambient air quality standard values, and method specifications. Data processing using SPSS. The stages of data processing start from coding data, editing data, entering data and cleaning data. Data analysis techniques by analyzing data with simple regression tests.

RESULTS

Based on the results of measuring Carbon Monoxide (CO) levels for seven days in the field, the concentration of CO obtained in ppm units is converted into units of $\mu\text{g} / \text{Nm}^3$ according to equation. The results of CO concentration measurement can be seen in table 1.

In this output, the value of the coefficient of the regression equation is stated. In this case, the simple regression equation used is:

$$Y = 25.019 + 8.713 X$$

Where Y = Air Pollution Level, and X = independent Variable

Table 1.

ISPU Calculation Results Morning, Noon and Evening

Day/Point	Measurement Time ($\mu\text{g}/\text{Nm}^3$)								
	Morning			Noon			Afternoon		
	CO	$\mu\text{g}/\text{Nm}^3$	Category	CO	$\mu\text{g}/\text{Nm}^3$	Category	CO	$\mu\text{g}/\text{Nm}^3$	Category
Monday									
I	17.529	202,9	Very unhealthy	7.304	73	Moderate	27.754	262,9	Very unhealthy
II	10.225	102,8	Unhealthy	5.843	58	Moderate	56.968	494,7	Danger
III	16.068	185,7	Unhealthy	5.843	58	Moderate	61.35	533,6	Danger
IV	10.225	102,8	Unhealthy	10.225	102,8	Unhealthy	23.371	237	Very unhealthy
V	14.607	165,7	Unhealthy	14.607	165,7	Unhealthy	11.686	122,8	Unhealthy
VI	5.843	58	Moderate	8.764	87	Moderate	11.686	122,8	Unhealthy
Tuesday									
I	21.911	228,8	Very unhealthy	5.843	58	Moderate	37.979	322,5	Danger
II	23.371	237	Very unhealthy	4.382	43	Good	5.843	58	Moderate
III	26.293	254,1	Very unhealthy	17.529	202,9	Very unhealthy	52.586	456,5	Danger
IV	40.900	357,5	Danger	27.754	262,9	Very unhealthy	32.136	288,8	Very unhealthy
V	37.979	332,5	Danger	17.529	202,9	Very unhealthy	11.686	122,8	Unhealthy
VI	20.450	220	Very unhealthy	17.529	202,9	Very unhealthy	0	0	-
Wednesday									
I	18.989	211	Very unhealthy	5.843	58	Moderate	46.743	406	Danger
II	14.607	165,7	Unhealthy	10.225	102,8	Unhealthy	54.046	469,5	Danger
III	20.450	220	Very unhealthy	5.843	58	Moderate	43.821	380,8	Danger
IV	26.293	254,1	Very unhealthy	11.686	122,8	Unhealthy	27.754	262,9	Unhealthy
V	36.518	320,8	Danger	37.979	332,5	Danger	20.45	220	Very unhealthy
VI	35.057	308,3	Danger	0	0	-	0	0	-
Thursday									
I	18.989	211	Very unhealthy	11.686	122,8	Unhealthy	30.675	280	Very unhealthy
II	20.45	220	Very unhealthy	5.843	58	Moderate	24.832	245,8	Very unhealthy
III	10.225	102,8	Unhealthy	7.304	73	Moderate	45.282	393,3	Danger
IV	32.136	288,8	Very unhealthy	37.979	332,5	Danger	40.9	357,5	Danger
V	20.450	220	Very unhealthy	8.764	87	Moderate	21.911	228,8	Very unhealthy
VI	20.450	220	Very unhealthy	14.607	165,7	Unhealthy	8.764	87	Moderate
Friday									
I	26.293	254,1	Very unhealthy	5.843	58	Moderate	20.45	220	Very unhealthy
II	5.000	58	Moderate	4.382	43	Good	20.45	220	Very unhealthy
III	7.304	73	Moderate	5.843	58	Moderate	20.45	220	Very unhealthy
IV	20.450	220	Very unhealthy	20.45	220	Very unhealthy	10.225	102,8	Unhealthy
V	26.293	254,1	Very unhealthy	24.832	245,8	Very unhealthy	14.607	165,7	Unhealthy
VI	1.461	14	Good	2.921	29	Good	0	0	-
Saturday									
I	14.607	165,7	Unhealthy	7.304	73	Moderate	21.911	228,8	Very unhealthy
II	14.607	165,7	Unhealthy	5.843	58	Moderate	14.607	165,7	Unhealthy
III	5.843	58	Moderate	5.843	58	Moderate	14.607	165,7	Unhealthy
IV	20.450	220	Very unhealthy	7.304	73	Moderate	11.686	122,8	Unhealthy
V	27.754	262,9	Very unhealthy	14.607	165,7	Unhealthy	8.764	87	Moderate
VI	1.461	14	Good	0	-	0	0	0	-
Sunday									
I	11.686	122,8	Unhealthy	11.686	122,8	Unhealthy	20.45	220	Very unhealthy
II	4.382	43	Good	4.382	43	Good	16.068	185,7	Unhealthy
III	4.382	43	Good	17.529	202,9	Very unhealthy	14.607	165,7	Unhealthy
IV	8.764	87	Moderate	11.686	122,8	Unhealthy	16.068	185,7	Unhealthy
V	29.214	271	Very unhealthy	10.225	102,8	Unhealthy	8.764	87	Moderate
VI	2.921	29	Good	2.921	29	Good	0	0	-

In the table the value ρ of the variable CO Morning is more than 0.05. That is, Morning CO means as an independent variable. At the nonstandard coefficient, the intercept value is 25.019, while the Morning CO slope value is 8.713. Thus, we can make a regression equation Air Pollution Level = 25.019 + 8.713CO morning. In the standard coefficient, a correlation coefficient of Morning CO with Air Pollution Level of 0.980 was obtained.

That is, CO Noon means as an independent variable. At the non-standard coefficient, the intercept value is 8.264, while the slope value of CO Siang is 9.446. Thus, we can make a regression equation Air Pollution Level = 8.264+9.446CO day. In the standard coefficient, a correlation coefficient of CO noon with Air Pollution Level of 0.985 was obtained. That is, CO afternoon is meaningful as an independent variable. At nonstandard coefficients, the intercept value is 25.434 while the afternoon CO slope value is 8.400. Thus, we can make the regression equation Air Pollution Level=25,434+8,400CO afternoon. In the standard coefficient, a correlation coefficient of afternoon CO with Air Pollution Level of 0.993 was obtained. The correlation coefficient between Morning CO and Air Pollution Level (ISPU) is positive, amounting to 0.980 which is statistically meaningful ($\rho < 0.001$ value). The correlation coefficient between Daytime CO and Air Pollution Level (ISPU) is positive, amounting to 0.985 which is statistically meaningful ($\rho < 0.001$ value). The correlation coefficient between Afternoon CO and Air Pollution Level (ISPU) is positive, amounting to 0.993 which is statistically meaningful ($\rho < 0.001$ value). The correlation coefficient obtained value $r = 0.980$ shows a very strong relationship and positive direction, meaning that the higher the CO concentration, the higher the Air Pollution Level (ISPU). The results of the Pearson Correlation test obtained ρ -value of 0.000 (< 0.05) show that there is a significant relationship between morning CO and Air Pollution Level (ISPU).

DISCUSSION

Morning CO Carbon Monoxide Concentration on AP street. Pettarani pointed out that there is a relationship between CO and Air Pollution Levels (ISPU) on AP roads. Pettarani Makassar, because the higher the measurement of CO parameters, the higher the ISPU. In terms of air pollution, the Air Pollution Standard Index (ISPU) determines whether or not an area is healthy. The ISPU category is divided into five, including Good (0-50), medium (51-100), unhealthy (101-199), very unhealthy (200-299), and dangerous (300-500).

At point I, namely the intersection of Jl AP Pettarani with Jl Sultan Alauddin, there is a MAN 2 Model Makassar school building, gas stations, workshops, food stations, police posts, stalls and street vendors. The highest concentration of CO at point I was on Wednesday in the afternoon, which was 46,743 $\mu\text{g} / \text{Nm}^3$. This is influenced by heavy traffic conditions in the afternoon because at that time many people return home from work, school and other activities. The road situation is crowded with various types of vehicles, both private vehicles in the form of cars and motorcycles, as well as public vehicles such as city transportation, motor rickshaws, buses and found several trucks passing through the road.

At point II, which is in front of the Samsat South Sulawesi office where there is a U-turn area, there are also buildings such as Telkom offices, MTSN Model, other offices and many 5 street vendors selling around it. The highest concentration of CO at this point occurred on Monday in the afternoon at 56,968 $\mu\text{g}/\text{Nm}^3$. The traffic condition at this point when measurements are made is busy smoothly in the morning and afternoon but in the afternoon experiencing vehicle congestion due to commuting hours and other activities simultaneously.

Point III is the intersection of Jalan AP Pettarani with Jalan Boulevard where there are traffic lights that make vehicles stop for a moment. There are also buildings including car and motorcycle dealerships, restaurants, shopping centers and offices. In the area is crowded with public vehicles such as buses, motor rickshaws, city transportation and private vehicles such as cars and motorbikes which are more dominant because the area is an office area. The highest concentration at this point occurred in the afternoon on Monday at 61,350 $\mu\text{g}/\text{Nm}^3$. The concentration at this point was the highest during the 1-week measurement because the traffic conditions at the time of measurement were very dense plus the area was a crowded area found with offices and shopping centers so that in the afternoon there was a traffic jam dominated by motorists returning home from work.

At point IV, which is the direction of the U-turn in front of the Regional POS office in Makassar, where at this point it is a U-turn lane that is quite crowded used by the public to turn around so that it usually causes excessive vehicle density. This point is the location where people make a living as pak ogah and many offices are located around this area and the direction of the elevated toll entrance. The highest concentration of CO at this point was on Tuesday in the morning and Thursday in the afternoon at 40,900 $\mu\text{g}/\text{Nm}^3$. High concentration is influenced by the density of vehicles turning direction.

At point V is at the intersection of Urip Sumoharjo road with AP road. Pettarani Makassar city where at this point there are traffic lights, offices, Pos Lintas and banyak are also found people selling in the area around the traffic lights. The highest concentration at this point was on Tuesday in the morning and on Wednesday in the afternoon which was $37,979 \mu\text{g} / \text{Nm}^3$.

Point VI is in front of the traffic Police Post office where the point is a place of exposure to pollutants occupied by the police from morning to evening. In addition to the police, there are also traders who sell and park guards around AP Pettarani street who live resting around the police post. The highest concentration at this point was on Wednesday in the morning at $35,057 \mu\text{g}/\text{Nm}^3$. This point is a location where the average concentration is not too high because of the division of roads leading to Urip Sumoharjo road and the direction of the road to the Toll Road.

The results of this study are not in line with Ahmad's 2019 research on AP street. Pettarani Makassar obtained ambient air quality standards for CO pollutants on weekdays exceeding the threshold value with an average value of $31,832 \mu\text{g} / \text{Nm}^3$ and holidays did not exceed the threshold value with an average value of $23,930 \mu\text{g} / \text{Nm}^3$. While the results of the ISPU analysis on the AP Pettarani road with the type of CO pollutants on weekdays are included in the dangerous category with an ISPU value of 358 and on holidays are included in the very unhealthy category with a value of $23,930 \mu\text{g}/\text{Nm}^3$. While the results of the ISPU analysis on the AP Pettarani road with the type of CO pollutants on weekdays are included in the dangerous category with an ISPU value of 358 and on holidays are included in the very unhealthy category with a value of ISPU 281. Meanwhile, in Ayu's research, 2020 during the new normal period and there was already an elevated toll road, the results of analysis were found on weekdays (Monday) with an ISPU value of 43 including the Good category, on holidays (Sunday) with an ISPU value of 29 also included the Good category, while on weekdays (Wednesday) with an ISPU value of 58 including the medium category.

The air temperature on the street AP. Pettarani at the time of measurement in the morning averages 31°C - 32°C , during the day 32°C - 37°C and in the afternoon 31°C - 32°C . CO is a colorless, odorless, and tasteless gas with a small amount in the air of about 0.1 ppm in the atmosphere, therefore the environment polluted by CO gas cannot be seen by the eye.

Research conducted by Irma Dita Kurniawati et al, where the title of research on air pollution indicators based on the number of vehicles and climatic conditions with observational analytical research methods with a cross sectional approach. The results obtained most of the vehicles were not solid (65.0%) with a p value of 0.000, mostly low air temperature (55.0%) with a p value of 0.221, high air humidity (100%) with a p value of 0.006, and calm wind speed (100%) with a p value of 0.597.

Therefore maintaining the environment in Islam is part of the totality of human worship, therefore Islam becomes rahmatan lil "alamin (mercy for all nature) which encourages the ummah not to make damage or accelerate the rate of damage done by humans on earth and the universe. Religious ethics towards nature lead man to be responsible so that he does not commit damage or in other words any damage to the environment must be assessed as damage to man himself. Allah Almighty commands us to repair and not do any damage to it. Allah said QS. Al-Baqarah/2:11 which translates:

"And when it is said unto them, Do no mischief on the earth! They answered, "Surely we are and the ones who make improvements".

In that verse it is mentioned that these hypocrites are indeed mischiefs on this earth, by obeying Allah breaking His prohibitions and ignoring the obligations bestowed upon them. They doubt the religion of God where a person is not accepted by charity except by justifying it and believing in its essence.

Makassar City is one of the cities that has experienced very rapid progress. As a city that is experiencing rapid progress, it must have several urban problems, one of which is the problem of traffic congestion on the highway. This congestion arises due to the increasing volume of private vehicles which is not accompanied by rapid infrastructure development and lack of discipline for motorists in using their vehicles. In the city of Makassar the number of 2-wheeled vehicles increased by 13-14% per year and 4-wheeled vehicles increased by 8-10% per year. The number of two-wheeled and four-wheeled vehicles reached 2.4 million (1.1 million motorcycles and 1.3 million cars) higher than the population of Makassar City of 1.7 million people in 2017 (Data and Information Center of the Ministry of Transportation Makassar City, 2017).

The results of Dedy Alif Utama's research (2019) at Malengkeri Terminal Makassar City, there was an increase in CO concentration by 22.44% between the beginning of the week and the weekend for both 1-hour and 8-hour measurements. The average concentration of carbon monoxide in a week for all sample points with 8-hour measurements was $252.29 \mu\text{g} / \text{m}^3$, with the highest value owned by sample point 4 which was $454.02 \mu\text{g} / \text{m}^3$. The ISPU value of CO pollutants at Malengkeri Terminal Makassar City is 2,193.84. The value

is categorized as harmful to every living thing that breathes it. The highest ISPU value comes from point 4 which is 3,948.03 and is categorized as dangerous. This value is about 44.43% higher than the average ISPU value for all measurement points.

In the morning and evening with high temperature and humidity conditions due to sunlight received, it will result in air expansion. This causes the dispersion of pollutants so that the concentration of CO will be high, and wind speed is an important factor in dispersing pollutants. When the wind speed is stable, the spread of pollutants due to vehicle density occurs faster and concentration accumulates around dense areas of vehicles.

Kurniawati, (2017) in her research shows that there is a relationship between air humidity and CO concentration at Mangkang Terminal and Semarang Panggaron Terminal. This research is in line with research conducted by Istirokhatu, (2016) which states that when air humidity is low NO₂ concentration will be low and when high concentration occurs when air humidity is high.

Air pollution will increase the probability of health problems in healthy humans because in general air pollutants are gaseous and cannot be seen with the ordinary eye. Even for the pollutant Carbon monoxide, it does not produce an odor. Healthy humans will be exposed to carbon monoxide unconsciously but slowly experience symptoms of mild pain such as dizziness, headache or nausea. Symptoms of exposure to carbon monoxide that resemble other diseases will cause the human being to be increasingly unaware that he has been exposed and can misdiagnose the illness he suffers because what individuals need when exposed to carbon monoxide is clean and fresh air to replace carbon monoxide bound to hemoglobin.

Hemoglobin serves to transport oxygen in the blood then forms carboxyhemoglobin (COHb). Carbon monoxide is able to bind hemoglobin as much as 220 times stronger than the binding force between hemoglobin and oxygen, causing a reduction in the capacity of blood to transport oxygen. This directly causes the supply of oxygen throughout the body to decrease, thus weakening heart contractions and decreasing the volume of blood distributed. This will then affect the function of body organs such as the brain, liver, and nerve centers. 70% or more of COHb in the blood will cause death.

Caring for the environment in Islam is part of the totality of human worship, therefore Islam becomes rahmatan lil_amin (mercy for all nature) which encourages people not to make damage or accelerate the rate of damage done by humans on earth and the universe. Religious ethics towards nature lead man to be responsible so that he does not commit damage or in other words any damage to the environment must be assessed as damage to man himself. (Shihab, 1994:297) as mentioned in the translated verse Ar'Ruum/30:41:

"It has been seen that corruption on land and at sea is caused by human hands, so that Allah feels to them a part of their deeds, so that they may return (to the right path)."

It is wise to think about how to prevent the increase in CO concentration in the air from now on. Increasing the number and quality of roads, regulating transportation patterns, planting trees along roads are things that must be done. It is necessary to encourage to improve air quality, especially in areas with heavy traffic by increasing urban greening or increasing the planting of green lanes or green open spaces to reduce air pollution.

Various corruption on land and at sea is one of the consequences of the wickedness of sinners. Droughts, floods, all of these are not only factors of natural disasters, but also the result of the ignorance of human hands, as well as the many actions made.

CONCLUSION

The study found that there was a meaningful association between morning, afternoon and afternoon CO with the Air Pollution Standard Index with a very strong relationship and positive direction. Advice for the community is to better maintain air quality by reducing the use of motorized vehicles if the distance is close, using more environmentally friendly fuel, and always using masks when driving. For further researchers, it can be added with measurements of other parameters and in data collection pay more attention to wind factors, temperature, humidity, and the number of vehicles in air quality measurements.

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