

ENVIRONMENTAL RISK ANALYSIS DUE TO EXPOSURE TO CARBON MONOXIDE (CO) IN THE GORONTALO CITY AREA

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Abstract

Air is necessary for the continuity of creature life, especially man. Air cleaning has benefits, but the most important and foremost thing is For the Respiratory man. Motorized vehicles have the biggest influence on worsening air pollution. The primary pollutants _ contained in exhaust gases in vehicles are carbon monoxide (CO) and particulate dust. Research purposes This knowledge of Carbon Monoxide (CO) concentration Analyzes risk ecological (HQ) consequences of CO exposure, analyzing the grand average exposure (*intake*) and level *realtime* risk (RQ). Carbon monoxide (CO) exposure is around the Gorontalo City area: Fifth Lake, Front Gorontalo State University campus, and shopping center. Types of research This is an observational study with an approach to *Ecological Risk Assessment* (ERA) and *Health Risk Assessment* (HRA) through study field (*field studies*). Research results show 3 locations are showing Carbon Monoxide (CO) levels have exceeded border brother or standard quality air ambient, with the presentation highest at location three, namely the shopping centers, with results of 39,568 $\mu\text{g}/\text{Nm}^3$. Based on the results, it can be known that CO levels in Gorontalo City are already included in category No safe because 100% of the sample location exceeds the Threshold Limit Value (NAV) based on PP No. 22 of 2021 concerning maintenance Protection and Management Environment for _ value (CO) is 10,000 $\mu\text{g}/\text{Nm}^3$ (10 mg/m^3). The calculation results in *intake* CO exposure *realtime* big risk health For all locations Good of the CO parameters incl in category risky with $\text{RQ} > 1$. People living in the area location taking samples are expected to care more about health and prevention, like getting used to using a mask when working and reducing the habit smoke To minimize exposure to carbon monoxide and TSP.

Keywords: CO; ERA; HRA.

INTRODUCTION

High transportation activity has implications for reducing quality air consequences of the existence of pollutants in the air (1). According to CREA and Greenpeace, 2020 (in Kautsar & Herlinda, 2021), Jakarta is one of the cities with polluted air worst take. Note that the most significant contributors to pollution are 75% transportation land, 8% industry, 9% generator electricity and heating, and 8% burning in Indonesia. PDPI shows that polluted air relates to problems in healthy lungs, like declining function lungs (21- 24%), asthma (1.3%), COPD (prevalence 6.3% in Non-smokers), And 4% from case cancer lungs. Consequently, pollution in Indonesia suffers a loss of Rp 150 trillion (2).

According to BPS City Gorontalo, 2020 (in Ibrahim, 2021), the enhancement in vehicle motorized average from 2016- 2020 was as much as 2% in Gorontalo City, with the enhancement highest happening in 2017-2018, namely 21%. Matter This could cause a decline in the quality of air as a result of perspective. Enhancement here is that It can cause traffic congestion and increase air pollution, resulting in the consequence of activity transportation (3).

Based on a study done by Pamungkas et al. (2017) related to exposure to carbon monoxide (CO) through inhalation in traffickers, who carried out at 19 points, there

are 10 points (57.89%) (4). Which concentration of carbon monoxide already exceed standard quality which hinted in Regulation Government R.I Number 41 Year 1999 about control pollution ambient national as significant as 30 mg/m³ per hour (5). Exposure intake of carbon monoxide (CO) in realtime own mark averages 2.94 mg/kg/day, whereas intake on lifetime own mark averages 4.76 mg/g/day. Good on characteristics risk noncarcinogenic or risk quotient (RQ) realtime nor lifetime, there are five-person respondents (8.6%) no safe or risky from total 58 respondents (6).

Based on the survey beginning which done researcher obtained data on health parking attendants with visual impairment of as much as 0.4%, Sick head of 0.84%, And difficulty breathing as much as 0.2%, so there is a possibility of officer parking in the City of Gorontalo exposed to gas carbon monoxide (CO) produced by vehicle emission.

METHODS

Location And Time Study

Perlimaan Telaga did a location study in front of the Gorontalo State University campus and the Gorontalo City shopping center. Time research was carried out from 25 May until 28 August 2023.

Type Study

This is an observational investigation with an *ecological risk assessment* (ERA) and

health risk assessment (HRA) approach through field studies (*field study*).

Population and Sample

Population in study this includes all parking attendants who work at segment Road City Gorontalo. With a sample of as many as 120 respondents who use the get-through technique of *purposive sampling*, Sample air was taken in as many as 3 locations.

Technique Data collection

Source Data Primary

Primary data in this research is collected through interviews and observation directly by using questionnaires/questionnaires on the concentration of carbon monoxide (CO) in ambient air.

Source Data Secondary

Data secondary which obtained researcher sourced from studies literature,

thesis, articles/journals Which related with study This And from Service Relations City Gorontalo.

Technique Analysis Data

Technique analysis data on study, this uses the method of ecological risk analysis or *ecological risk assessment* (ERA) and health risk assessment (HRA).

RESULTS AND DISCUSSION

Research Results

Characteristics Anthropometrics Respondent

1. Age

Based on results study, which has done, obtained distribution age respondent based on point location on table 1 as following :

Table 1. Distribution Respondent Based on Age

No.	Location	Age			
		n	Min	Max	Mean
1.	Jl. General Sudirman (Front UNG Campus)	40	17	49	27.48
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	40	14	76	33.68
3.	Jl. S. Parman (Shopping Center)	40	18	61	37.18
Amount		120	-	-	-

Source : Data Primary, 2023

From table 1 it is known that of the 3 locations in Gorontalo City roads, the highest *mean* (average) age of respondents is at resident respondents _ on Jl. S. Parman (centre shopping) that is 37 .18 year with age The maximum age is 61 years and the

minimum age is 18 years.

2. Type Sex

Based on the results of the study, which has done, the distribution type sex respondents based on point location in Table 2 is as follows:

Table 2. Distribution Respondent By Gender

No.	Location	Gender		
		Man	Woman	Amount
1.	Jl. General Sudirman (Front UNG Campus)	20	20	40
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	24	16	40
3.	Jl. S. Parman (Shopping Center)	22	18	40
Total		66	54	120

Source: Data Primary, 2023

It is known that from 3 locations research, respondents of various types sex man as many as 66 people and women as many as 54 people.

3. Body Weight

Table 3. Distribution Respondent Based on Body Weight

No.	Location	Weight			
		n	Min	Max	Mean
1.	Jl. General Sudirman (Front UNG Campus)	40	40	95	57.47
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	40	43	82	60.62
3.	Jl. S. Parman (Shopping Center)	40	30	85	56.97
Amount		120	-	-	-

Source: Data Primary, 2023

From table 3 can is known that respondents with heavy body The highest is at the location Jl. General Sudirman (Front UNG Campus) which is 95 kg with mark *mean* (average) 57.47 kg. Whereas heavy body Which Lowest namely 30 kg on location Jl. S.

Based on the results of the study, which has to do with getting distribution heavy body respondents based on point location in Table 3 as follows:

Parman (Shopping Center) with mark *mean* (average) 56.97 kg .

Pattern Activity Respondent

1. Duration Exposure

Based on the results study which has done, the distribution duration exposure is as following:

Table 4. Distribution of Respondents' Exposure Duration on City Roads Gorontalo

No.	Location	Duration Exposure (year)			
		n	Min	Max	Mean
1.	Jl. General Sudirman (Front UNG Campus)	40	1	49	8.80
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	40	1	76	11.53
3.	Jl. S. Parman (Shopping Center)	40	1	52	19,18
Amount		60	-	-	-

Source: Data Primary, 2023

From Table 4, it is known that the highest duration of exposure was 76 years in

location Jl. Ahmad Wahab (Perlimaan Telaga) with the *mean* value is 11.53.

2. Time Exposure

Based on the results of the study
Which has done, obtained distribution

exposure time (hours/day) of respondents
based on location points in Table 5 as
follows :

Table 5. Distribution of Respondents' Exposure Time on City Roads Gorontalo

No.	Location	Time Exposure (hours/day)			
		n	Min	Max	Mean
1.	Jl. General Sudirman (Front UNG Campus)	40	1	24	10.68
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	40	1	24	11.05
3.	Jl. S. Parman (Shopping Center)	40	2	16	11.15
Amount		60	-	-	-

Source: Data Primary, 2023

Table 5 shows that time exposure is most prevalent among respondents at Jl. General Sudirman (Front UNG Campus) and on Jl. Ahmad Wahab (Perlimaan Telaga) is for 24 hours/day with a mean (average) of 10.68 hours/day And 11.05 hours/day.

3. Frequency Exposure

Based on the results of the study which has done, obtained distribution frequency exposure (day/year) based on point location in Table 6 as follows :

Table 6. Distribution Frequency Exposure Respondent In Section Road City Gorontalo

No.	Location	Frequency Exposure (day/year)			
		n	Min	Max	Mean
1.	Jl. General Sudirman (Front UNG Campus)	40	52	365	342.70
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	40	104	365	329.53
3.	Jl. S. Parman (Shopping Center)	40	104	365	345.28
Amount		60	-	-	-

Source: Data Primary, 2023

Table 6 shows that frequency exposure is highest in every location flat- an average of 3 65 days/year and lowest as many as 52 days/year.

Based on the results of research conducted on Gorontalo City roads, in get concentration results in gas CO at 3 location points, as follows:

Carbon Concentration Monoxide (Co) in the air

Table 7. Distribution Concentration Carbon Monoxide On AirIn Section Road City Gorontalo

No.	Location	Average Concentration ($\mu\text{g}/\text{Nm}^3$)	NAB (10 mg/m^3)
1.	Jl. General Sudirman (Front UNG Campus)	31,491	Not safe
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	17,429	No Safe
3.	Jl. S. Parman (Shopping Center)	39,568	No Safe

Source : Data Primary, 2023

Based on Table 7, the results of measuring CO concentrations in 3 varying measurement locations are known. From the measurement results above, if compared with the threshold value set by Government Regulation Number 22 Year 2021 About Raw Quality Air Ambien Carbon Monoxide is 10,000 $\mu\text{g}/\text{Nm}^3$ or 10 mg/m^3 , so that there is all over location have CO concentration

exceeds the Threshold Limit Value (NAB) or is unsafe.

Analysis Risk Ecological CO

Ratio exposure is estimated against the concentration of the effect that represents the concentration environment, Which is safe or rejects measuring screening.

Following is a table of values *Hazard Quotient* (HQ) in each location study :

Table 8. Levels of Ecological Risk at Each Location Point on the Road City Gorontalo

No.	Location	Mark Concentration CO (mg/m^3)	Screening Benchmarks (mg/m^3)	HQ CO	Criteria
1.	Jl. General Sudirman (Front UNG Campus)	31,491	10	3.1	Danger Currently
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	17,429	10	1.7	Danger Currently
3.	Jl. S. Parman (Shopping Center)	39,568	10	3.9	Danger Currently

Source : Data Primary, 2023

Based on Table 8 is known that there is 3 location is within the danger criteria currently or HQ 1.1-10.

Analysis of Risk Health For recognizing source risk. Stages This identifies specific dangerous risk agents from the environment and health symptoms. The following table identifies the dangers of CO :

Analysis Risk Health CO

1. Identification Danger

Identification of danger (hazard identification) is the stage beginning with

Table 9. Identification Danger CO

Identification	Description
Agent risk Specific	Carbon Monoxide (CO)
Media environment potential	Air Ambien
Concentration Risk	10000 $\mu\text{g}/\text{Nm}^3$ (10 mg/m^3) and 230 $\mu\text{g}/\text{Nm}^3$
Danger health Which potential	Effect period long shared become effect sub I And effect chronic. Effect period long cause platelets And cell endothelium vessels blood drain free radicals. Symptoms of chronic exposure include: Sick head (90%), nauseous And vomit (50%), vertigo (50%), feel confused and feel weak (Kresnawati, 2018).

2. Analysis of dose-response Carbon Monoxide

After identifying the dangers of CO, the next stage is to do an analysis of dose-response that looks for mark RFC from CO. RFC is the dose of a risk agent that is used as a reference for the safe value for the patient body on non-carcinogenic effects (7).

The RfC value in this study can use the intake formula with values concentration taken based on standard quality according to PP No. 22, the Year 2021, which is 10,000 µg/Nm³ (10 mg/m³) and R-value = 0.83 m³/hour. t_E = 8 hours/day, f_E = 250 days/year, D_t = 30 years, W_b = 55 kg, tag = 365 days/year x 30 years, figures- This number is obtained according to the default value which refers to ARKL guidelines by the Ministry of Health, the RfC value is used to determine risk CO exposure as follows :

$$RFC = \frac{CXR X t_E X f_E X D_t}{W_b X t_{avg}}$$

So, mark RFC For determination risk exposure CO is 0.83 mg/kg/day.

3. Analysis Exposure to Carbon Monoxide

Analysis exposure (intake) CO is the amount of concentration risk agent accepted And entered into the body average sample per heavy body average samples per day. The intake calculations adjust the minimum and maximum intake to the CO concentration measurement results. Calculation intake differentiated location For exposure realtime or long respondents do activity in area study.

The following is a statistical summary table of the variable values for respondents' activity patterns as exposure factors:

Table 10. Individual Characteristics and Respondents Activity

No.	Location	Mark				
		Body Weigh (W _b)	Duration Exposure (D _t)	Time Exposure (t _E)	Frequency Exposure (f _E)	Rate Inhalation (R)
1.	Jl. General Sudirman (Front Campus)	57	8.8	10.7	343	0.83
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	61	11.5	11.0	330	0.83
3.	Jl. S. Parman (Shopping Center)	57	19.2	11.2	345	0.83

Source: Data Primary, 2023

Carcinogenic intake is calculated in real-time, using the amount of information (input), anthropometric values, and activity patterns used in the study. This is counted with the use of variable heavy body (W_b), duration exposure (D_t), time exposure (t_E), frequency exposure (f_E) For mark tag CO

noncarcinogenic that is using value 30 year x 365 days.

For count intake value CO with enter values characteristics anthropometry And pattern activity use equality following :

$$I_{nk} = \frac{CXR X t_E X f_E X D_t}{W_b X t_{avg}}$$

The following are the results of roads with three sampling locations. calculating the *intake value* for Gorontalo City

Table 11. Results Analysis Intakes realtime CO On Respondent inSection Road City Gorontalo Based on Point Location

No.	Location	Intakes realtine (mg/kg/day)
1.	Jl. General Sudirman (Front UNG Campus)	1.337014464
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	0.914484339
3.	Jl. S. Parman (Shopping Center)	3.885967037

Source : Data Primary, 2023

Based on table 3 .1 1, it is known that the *real-time intake value* is the highest there is on location Jl. S. Parman (Shopping Center) with mark 3.885967037 mg/kg/day and the lowest *real-time intake was at the location* Jl. Ahmad Wahab (Perlimaan Telaga) 0.914484339 mg/kg/day.

4. Characterization CO risk

Level risk For effect non carcinogenic can stated in notation *Risk Quotients (RQ)* . For do characterization risk on effect non Carcinogenicity is calculated by

comparing/dividing *intake* with *RFC* or *RFD* . Formula Which can used For determine RQ as following:

$$RQ = \frac{I}{RFC}$$

If the RQ value ≤ 1 means CO exposure is still safe for health humans, whereas if the RQ value > 1 means CO exposure is unsafe for them health man and needs to be controlled.

The following is a table of risk level values or *risk quotient (RQ)*. every point location study :

Table 12. Realtime Risk Quotient (RQ) Value Analysis Results for Each Point Location in Ruas Road City Gorontalo

No.	Location	RQ	Characterization Risk
1.	Jl. General Sudirman (Front UNG Campus)	1.61086080	Risky
2.	Jl. Ahmad Wahab (Perlimaan Telaga)	1.10178836	Risky
3.	Jl. S. Parman (Shopping Center)	4.681887996	Risky

Source: Data Primary, 2023

Based on Table 12, It is known that from 3 locations, own mark $RQ \leq 1$, which means No there is a risk to health for resident respondents _ or those who work in areas the

3.2 Discussion

3.2.1 Concentration Carbon Monoxide in Air Ambien

Results measurement Concentration CO which done that the CO concentration in 3 varying measurement locations. From the measurement results above, if compared with the threshold value set by Government Regulation Number 22 Year 2021 About Raw Quality Air Ambien Carbon Monoxide is

10,000 $\mu\text{g}/\text{Nm}^3$ or 10 mg/m^3 , so that there is all over location have CO concentration exceeds the Threshold Limit Value (NAB) or is unsafe.

His height concentration CO caused by amount vehicle Which crossing the area is busier than usual, the measurement time is carried out on rest hours office from the clock 13.00-14.00 WITA so Lots person Which carry out activities at that location, to shop at shopping centers, and as a place where gatherings often occur, a place to hang out for lunch so there are several vehicles passing through the area like wheeled vehicle two, wheel three And wheel four (8).

Matter This in line with study which done by Hamzah (2020) that the relationship between the number of vehicles and the concentration of carbon monoxide (CO) in The city of Gorontalo shows a positive relationship pattern, meaning it is getting higher the number of vehicles means the higher the concentration of carbon monoxide (CO) (9). Matter This in accordance with study Which in do by Novalia, Sudarno And Bi, 2013 (in Risa, 2019) states that vehicle density is proportional straight with concentration CO, Which It means concentration CO will increase along with increase or increase number amount vehicle (7). According to Hasairin & Siregar, (2018) density then cross And concentration CO is positive correlation, where the higher traffic density then concentration CO will become

more so tall (10).

Apart from that, factors that can influence high CO concentrations are temperature, humidity and speed wind (11). Temperature air influential Because in cause exists reaction chemistry some pollutants which will goes on more rapidly at high temperatures while humidity is closely related to deposition various types of pollutants (7). Humidity measurements range between 58.00 m/s up to 66.25 m/s. In line with research conducted by Faradina, 2012 (12). The higher the air humidity so will the more tall also concentration gas carbon monoxide in air.

3.2.2 Characterization Risk Ecological

The research results show CO concentrations in the 3 research locations with an HQ value <1 , which means each location has potential risk ecologically acceptable. Average ecological risk from carbon exposure monoxide at any location has HQ value 0.1-1.0 with danger criteria low that is location with mark HQ 0.8, location shops Jln. Suprpto with an HQ value of 0.75, shopping location Jln. S. Parman with HQ value 0.85 and the shopping location is Jln. MT Haryono with an HQ value of 0.95, which means risk ecological exposure carbon monoxide on air ambient around location officer parking is located on that level can be in accept (13).

There are 8 research locations with a value of $\text{HQ} > 1$, which means that each each location has the potential to pose ecological risks. Average HQ value 1.0-10 with moderate

danger criteria namely the location of the Setia Budi Pharmacy with value HQ 1.2, Double Dipples with an HQ value of 3.2, Jamu Solo shop with an HQ value of 2.2, Main Source location with HQ value of 1.85, City Park complex location with HQ 3 value, location in front of Gorontalo mall with value HQ 3,4, shop location Jln. Imam Bonjol with an HQ value of 1.75 and shops Jln. King Eyato with The HQ value is 1.85, which means that carbon monoxide exposure has the potential to cause risk ecological on air ambient around officer's location parking (14).

Similar research examining ecological risks was carried out by Al-Zboon et al. (2021) show mark danger quotient (HQ) For exposure carbon monoxide (CO) in the 4 research locations ranged from 0.0032-0.036, meaning $HQ < 1$ which indicates that there are no potential significant health effects which in expect from every pollutant in a way individual (2). Matter This in line with research conducted by Mitmark & Jinsart (2020) where concentration carbon monoxide (CO) in Northern Thailand has a value of $HQ < 1$ which means nothere is potential effect health harm from carbon monoxide (CO) (15).

Risk ecological can estimated with use approach *Hazard Quotient* (HQ). If $HQ < 0.1$, there is no danger. $HQ 0.1 - 1.0$ danger low. $HQ 1.1 - 10$, medium danger and if $HQ > 10$, high danger Lemly, 1996 (in Mallongi et al., 2015). Health *risk analysis method assessment* (HRA) is used to provide an estimate of risk

health public based on concentration from carbon monoxide (CO). The size mark potency risk ecological is comparison between on-site environmental contaminant concentration (EEC) and effect level concentration no harm (Screeneng benchmarks). *Screeneng benchmarks* values are in used in this research is based on Government Regulation Number 22 Year 2021 for Carbon Monoxide $10,000 \mu\text{g}/\text{Nm}^3$ or $10 \text{ mg}/\text{m}^3$.

3.2.3 Analysis Big Exposure (Intake) and Characterization Risk Health

CO exposure *intake in the air is calculated in real time*. *Realtime exposure intake* aims to describe the amount of exposure that has been in accept respondents from from beginning become officer parking until time study in do (16). The amount of *intake* value is directly proportional to the concentration of pollutants, rate intake, duration of exposure, frequency of exposure, and duration of exposure which means more The greater this value, the greater the intake received by the individual. Meanwhile, intake values are inversely proportional to body weight and period values average time, meaning that the greater the body weight, the smaller the meal will be risk health (7).

Calculation of risk levels is one part of the ARKL study Which done on population risky in 3 points location in city Gorontalo. The size level risk obtained from results comparison between mark *intake* with Mark

Dose Reference (RFC) Which in get from calculation using the intake formula with concentration values taken based on standards quality according to PP No. 22 years 2021 that is $10,000 \mu\text{g}/\text{Nm}^3$ ($10 \text{ mg}/\text{m}^3$).

If you look at the comparison of each research location, there are differences significant mark intake Good on location 1 until with location 3 . If seen mark *intake* biggest is at on location 1 that is shop jamu solo as big as $1.8501799100 \text{ mg}/\text{kg}/\text{day}$. His height mark *intake* in location shop Jamu Solo influenced by the high concentration of CO, namely $22 \text{ mg}/\text{m}^3$, although the concentration CO Still classified low in compare location other will but pattern activity officer parking greatly affects value *intake*. This is in line with research conducted by E. Wahyuni et al., (2018) Although the concentration of carbon monoxide gas on Jalan Setia Budi is still at below the quality standards that have been set, but exposure that occurs continuously will affect the amount of carbon monoxide gas intake which inhaled into in merchant body (12).

The duration of exposure of parking attendants at the Jamu Solo shop location has value the average is higher than other locations, namely for 15 years accompanied by frequency of exposure in one year for 317 days then for work time officer parking in jamu solo average during 14 hour/day, matter This very affect the high value *intake* in that location (2).

Meanwhile, the lowest *intake value* of all locations was at the Extra location Bakeries $0.0746788000 \text{ mg}/\text{kg}/\text{day}$. Matter This in influence by low concentration CO that is $8 \text{ mg}/\text{m}^3$. Average age officer parking Which is at inEktra Bakery location 41.25 years old with an average body weight of 59 kg, apart from that For officer exposure time parking is average 12 hours/day and average duration exposure for 3.5 years. When compared to other Extra Bakery locations is location Which own mark average Lowest, so that small it is possible that the parking attendant at the Extra Bakery location is at risk No safe against CO exposure (17).

The results of research conducted by Lestari et al., (2021) traders with Low *intake* results occur in traders with high body weight and short exposure time (8). Results of trader *intake* by body weight 124.35 kg shows the *intake value* received is $0.665 \text{ mg}/\text{kg}/\text{day}$, shows that the higher the trader's weight, the smaller the value intake received (8). This is in line with research conducted by Falahdina, (2017) stated that the large amount of intake received by people with heavy body excessive produce mark intake which the more small (3).

Intake is directly proportional to the RQ value so that *the intake* is of value high, the RQ will also have high value (6). RQ value for Jamu Solo shop location is 2.2291324200. From the results of this research it can be seen see that the RQ value >1 . Meanwhile, the

intake value is low at the Extra Bakery location causes the RQ value ≤ 1 , the RQ value obtained from the research results is 0.0899744600 according to Fitra, 2019 (in Lestari et al., 2021) if $RQ > 1$ so mark exposure carbon monoxide own risk to disturbance health, whereas if the RQ value ≤ 1 then carbon monoxide exposure is consider it safe (8).

CONCLUSION

Based on the results of research conducted on Risk Analysis Ecology and Health Due to Exposure to Carbon Monoxide (CO) and (TSP) on Gorontalo City Roads, the conclusions of the research are as follows: following:

1. Results measurement concentration CO in a number of point segment roads City In Gorontalo, there are 3 locations showing Carbon Monoxide (CO) levels that have exceeded the threshold or ambient air quality standards, with the highest presentation at the third location, namely the shopping center with results of 39,568 $\mu\text{g}/\text{Nm}^3$. Based on these results, it can be done. Please note that CO levels in Gorontalo City are included in the category unsafe because 100% of the location sampling points exceed the Value Threshold Limit (NAB) based on PP No. 22 Year 2021 about the implementation of Environmental Protection and Management for mark (CO) which is 10,000 $\mu\text{g}/\text{Nm}^3$ (10 mg/m³).

2. Calculation results in the characterization of ecological risks due to CO exposure in sections of Gorontalo City roads, which are classified as dangerous for the environment in 3 locations with a medium danger category (HQ 1.1-10). At the same time, Ecological risks resulting from TSP exposure are included in the category of low hazard (HQ 0.1-1.0).
3. The results of the calculation of *intake* CO exposure *real-time* big risk health for all locations is good from all CO parameters, including in category risky with $RQ > 1$.

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