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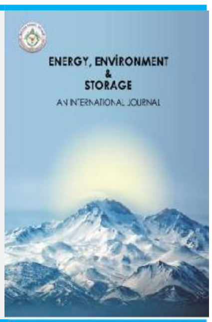

Assessment of CO and NO_2 pollutants concentration in the parking area and its relation to the occupancy percentage in the city of Makassar, Indonesia

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ABSTRACT: One of the sources of air pollution is exhaust emissions from vehicles during transportation activities. Due to the lack of parking spaces and the increase of thevehicles, many people park on the main roads, causing congestion on the side of the main roads. .When the engine is running and the vehicle is on stationed the engine's power is not used to turn the wheels, the combustion quality of the vehicle's engine is not so perfect and the exhaust gas is concentrated on a part of the road. To do, affects the ambient air quality of the location. The purpose of this study was to measure CO and NO_2concentrations using the Impinger Air Sampler. Measurements were taken on the road bodies used for vehicle parking at four locations in Makassar city: Sombaopu street, Nusantara street, Mesjid Raya streetand Jenderal Sudirman street. The data analysis used is a simple linear regression statistic to calculate occupancy. The analytical result obtained for the effect on occupancy and CO concentration was R^2= 0.51/51%, $p<0.001$, we can conclude that the effect of occupancy on CO concentration is significant. We can then conclude that at a value of R^2=0.64, $p<0.001$, the contribution of occupancy to changes in NO_2 concentration is also significant. we conclude that the contribution of this predictive model is 68%. Occupancy has a significant impact on CO and NO_2 concentrations in curbside parking areas.

Keywords:On the Street Parking, Vehicles, Air Pollution, Occupancy, Makassar City
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1. INTRODUCTION

Today's transport sector is developing so fast that with an increasing number of city dwellers needing transport. The transport in the form of motorized traffic is being plagued by congestion, accidents, air pollution, noise pollution and land transport. It may lead to other effects caused road damage [1,2]. Stopping and starting motorized vehicles on city roads has a very large impact on hydrocarbon gas and carbon monoxide emissions[3,4]. Air pollution in many large cities is generally associated with the development of activities in the transport and industrial sectors, although the commercial and residential sectors still make important contributions [5]. One of them is caused by engine car exhaust gases that pollute the air, especially his Pb pollutants, CO, and dust in the form of coarse and fine particles [6,7].

The rapid growth of urbanization and industry in the Makassar city area as the largest city in Eastern Indonesia is inevitable, so that Makassar becomes a mixed commercial-residential-industrial area accompanied by an increase in the transportation sector which will cause air pollution problemsincludingdustparticlesandalsoCarbon Black [8,9].

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In line with that it was stated that air pollution due to transportation is mainly centered around urban areas and is principally caused by traffic in urban areas [10]. Improved transportation systems can also increase $CO_2$and other greenhouse gas (GHG) emissions as well as VOCs [11].The mostsignificantincreases in energyuseand GHG emissionsoccur in metropolitan citieswhichhave a rapidrateofpopulationgrowthwith a higherstandardoflivingand level ofaffluencecomparedtoruralareasorsmallercities[12].These conditions distinguish one city from another metropolitan city. Several things that affect air quality are population, traffic density and fuel consumption as well as the area of green open space [13].Becausethetendencyof air pollutionisworryingfromyeartoyear, itisveryimportanttocarryoutpreventionandcontrolefforts. Air pollutionfromtransportationsourcesistotrytoreducepollutionemissionsfromthesource. Reducingpollutionemissionsatthesourcethroughtechnologicalimprovementsregardingenvironmentalproblemssuch as thedevelopmentofelectricpropulsionsystems, theuseofvegetableoilfuelsortheuseofenvironmentallyfriendlyalternativefuelsandsoon, besidesthatitcanalsobedonebydeveloping[14].

Another effort that can be done is to develop an urban mass rapid transit system.

Several studies have also reported that an effective method for reducing pollution is to control the quantity (g) of air pollutants produced. Government legislation has been a driving force in reducing the amount of emissions of these pollutants with bans on coal and smoking, introduction of congestion charges and improving public transport to reduce the number of private vehicles on the roads [15,16]. It has been reported that a study on congestion in London in 2003 required significant resources in terms of implementation, infrastructure and policy enforcement and achieved a reduction of only 5-10% in the concentration of air pollution in the city [17]. Each control mechanism provides its own benefits with respect to improving air quality in urban environments. Implementing new government policies and laws is the basis for the continued success of current and proposed air pollution control strategies [18,19].

This study presents the concentrations of carbon monoxide and sodium hydroxide in the ambient air of a parking lot on four major streets of Makassar city: SombaOpu Street, Nusantara Street, Mesjid Raya Street and Jenderal Sudirman Street. Research on the relationship between air pollution and urban transport sector in Makassar city is still very limited. This study was conducted to find the level of air quality on highways used as parking lots and to solve some of the problems that arise when parking on the street due to parking difficulties. increase. The results are intended to inform the implementation of new policies by the city of Makassar and stakeholders, banning vehicles from stopping or even parking on certain roads, which are believed to cause congestion and worsening air quality. It is intended to enforce new regulations in place.

MATERIAL AND METHOD

Study Area

This research is about parking along the street body in the Makassar City area which causes congestion and air pollution in relation to environmental health. The location selection for the road is the parking area point in Makassar City which is determined purposively. The locations of this study are on the road in the center of Makassar, namely SombaOpuStreet, Nusantara Street, Masjid Raya Street and JenderalSudiman Street as shown in **Figure 1.**

Considerations when deciding on street parking for motorized vehicles in Makassar city center include:

1. Observation deck on a log road with heavy traffic and many parking lots.
2. Observation sites are also centers of public activity such as commerce, catering and public utilities.
3. Areas of interest for trade and service zoning have been declared in sub-areas within the city of Makassar.

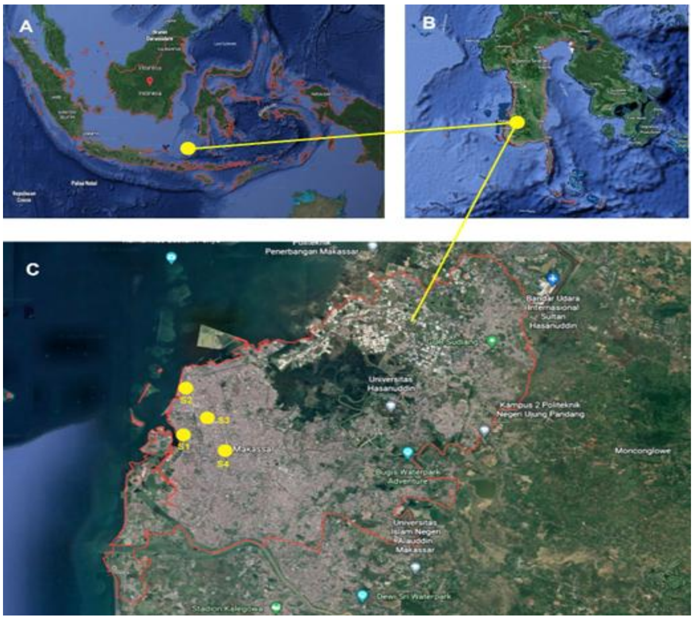

Figure 1. Location of sampling sites in Makassar City; A.Mapof Indonesia, B. Map ofSouth Sulawesi Province, C.Mapof Makassar City.

Data Collection

This research was conducted to measure the concentrations of CO and NO_2 by using an Impinger Air Sampler(Model: MD-51MP). Impinger is an air sampling tool for ambient air. The accuracy of the analysis results is sufficient and this sampling method can be combined with measurement methods in the laboratory. Based on the principle of the chemical reaction of the capture solution with pollutant gas, an analysis is carried out on the results of the reactions that occur. In this method a certain amount of air is pulled by the impinger through a certain stable flow path. The adsorbent liquid reacts with the captured gas components and forms a specific and stable substance. The success of the impinger sampling method is influenced by several factors, including the perfection of gas absorption by the capturing solution, the accuracy of measuring air volume which is affected by pump stability, laboratory analysis and calculation and maintenance of equipment. Impinger equipment as a whole consists of:

- Vacuum pump: serves to draw air samples into the impinger.
- Impinger tube: where the reaction between airborne contaminants and the catcher solution
- Moisture adsorber: a tube containing a desiccant for protection pump from corrosion.
- Flow meter which measures the speed of air flow.

The standards used in sampling and analysis, namely for measuring the concentration of Carbon Monoxide, refer to the guidelines for measuring the Non-Dispersive Infra Red (NDIR) method listed on the Indonesian National Standard (SNI 7119.10.2005), while for measuring the concentration of Sodium Dioxide, it refers to measurement guidelines with the Griess_Salzman Method listed on the Indonesian National Standard (SNI 7119.2.2017).

Data Analysis

The data analysis used is descriptive analysis, namely by providing a description of the field data descriptively by interpreting the primary data into tabulations. This descriptive analysis aims to obtain an overview of the conditions and characteristics of the variables studied in each selected street parking lot (4 roads). Then analyzed with Occupancy analysis which includes calculation of travel time data, vehicle speed, vehicle dimensions, number of vehicles, occupancy time and parking area. Furthermore, Occupancy percentage is used to compare the four street parking locations that are used as data collection sites. Occupancy analysis results are associated with CO and NO_2 concentrations.

RESULTS AND DISCUSSION

In this section, the researcher describes the occupancy percentage rate at each observation location and its impact on environmental quality. The thing that needs to be understood again is that roadside parking barriers cause an increase in the time and percent occupancy of vehicles when crossing the road. Occupancy of vehicles on this road is the result of roadside obstacles that occur. The following graph illustrates the relationship between percent occupancy and environmental quality:

a.Comparison of Occupancy Percentage and Carbon Monoxide.

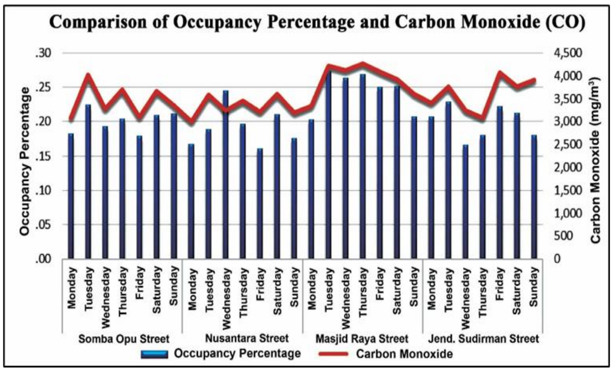

Fig 2. Comparison of occupancy percentage and CO

Figure 2 shows a comparison of utilization and CO. It can also be seen that, in general, the trend of day-to-day occupancy changes also follows changes in CO. Occupancy did not match changes in CO. However, Masjid Raya Street peak occupancy points also show the CO peak points for the four observed weeks. Occupancy Percentage and Nitrogen Dioxide (NO_2)

b. Comparison of Occupancy Percentage and Nitrogen Dioxide.

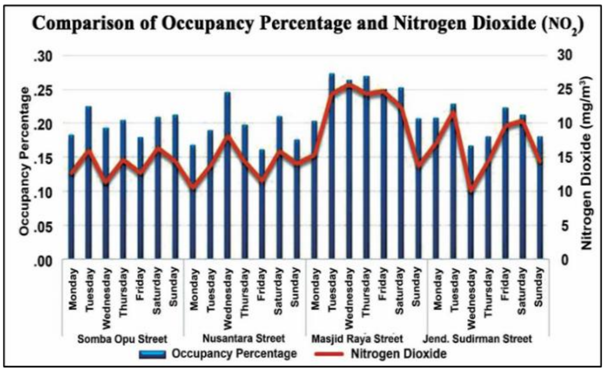

Fig 2. Occupancy Percentage and NO2

In Figure 2, it can be seen that the trend of occupancy percentage and NO_2 also shows indications of the same direction. At many observation points, an increase in percent occupancy also indicates an increase in NO_2. For example, on Jalan Masjid Raya on Tuesday, Wednesday and Thursday there was an increase in occupancy percentage which also showed a sharp increase in NO_2. The peak occupancy point on Jalan Masjid Raya is also the peak point for NO_2 during the observation.

Statistical Test of the Effect of Percent Occupancy on Air Quality with a Simple Linear Regression Test

The results of previous research have shown that there is a tendency that the occupancy dynamics on each street andevery day of observation move in the same direction as the dynamics of air quality. In order to be able to detect the impact of percent occupancy on changes in pollutants that occurs, the researchers tested it statistically using a simple linear regression technique. The following are the results of testing the effect of percent occupancy of roads on environmental quality:

1. Occupancy Percentage Impact towards CO

Table1. Regression Analysis of Occupancy Percentage Impact towards CO

Predictor	β	t	R	R^2	Adj. R^2	F
Persen Occupancy	0.713***	10.321	0.713	0.508***	0.504	106.5

Note: Dependent Variable : CO, N= 105; ***p< .001, **p< .01 and *p< .05

The results of observations on the impact of percent occupancy on CO showed a significant impact (R2 = 0.51/ 51%, p < 0.001). Similar to the previous analysis, this also shows the strong influence of percent occupancy on CO in the road. Furthermore, the analysis results also show that β = 0.71 (p < 0.001), which means that a 1% increase in percent occupancy results in an increase in CO up to 0.71 standard deviation. In general, it can also be concluded that the effect of percent occupancy on CO is significant.

2. Occupancy Percentage Impact towards NO_2

Table 2. Regression Analysis on Occupancy Percentage Impact towards NO_2

Predictor	β	t	R	R^2	Adj. R^2
Persen Occupancy	0.827***	8.092	0.827	0.684***	0.827

Note: Dependent Variable : NO_2, N= 105; ***p< .001, **p< .01 and *p< .05

The results of observations on the analysis in table 2 also show similar results. The contribution of the percent occupancy to changes in NO_2 is also quite significant (R2 = 0.64, p <0.001) or in other words the contribution of this prediction model is 68%. In addition, the results of the analysis also show that the effect of percent occupancy on NO_2 is also relatively high (β= 0.83, p < 0.001). These results indicate that the role of vehicle occupancy percentage on the road makes a rapid increase of NO_2 in the environment.

All the results of the regression analysis above show the impact of percent occupancy which consistently has an impact on air quality and noise. Based on the results of this analysis, it can be concluded that the percent of road occupancy that occurred in the four research locations can have a significant impact on changes in air quality and noise. In general, it can also be concluded that the presence of roadside parking barriers can trigger an increase in occupancy percentage, which in turn impacts air quality.

The results of this analysis then become a guide for further researchers to conduct research to examine the impact of parking changes on decreasing occupancy percent to changes in air quality and noise. Further researchers conducted a parking intervention by changing.

The results of this study emphasize that vehicles concentrating on one point of the road section caused by side barriers can worsen air quality. This means that every additional percent occupancy has the potential to also increase NO_2 and CO. Roadside parking conditions that impede vehicle movement can be one of the triggers for increased pollutant concentrations. Although this study found the impact of the position of the occupancy percentage on environmental quality, this study did not find any exhaust gas that exceeded the tolerance limit. The results of this study are in line with the findings of previous researchers regarding the impact of transportation conditions on vehicle exhaust emissions so that they affect the quality of the air people breathe[5]. Research conducted by Baumbach [20] found that several locations such as markets, bus stations, and traffic flows trigger increased concentrations of pollution due to exhaust gases such as CO and NO_2. The study also found that under certain conditions the combustion in a vehicle's engine is imperfect so that it produces far more exhaust emissions than when the vehicle is running normally.

The results of this study are in line with the researchers' initial assumption that when traffic jams occur and vehicle volume increases on a road section, at that time the occupancy percentage also increases. At the same time, vehicles are immobilized and traffic flow slows down. When this condition occurs, the combustion that occurs in the engine becomes incomplete, resulting in more exhaust emissions that pollute air quality. Based on this explanation, a high occupancy percentage can result in the production of high exhaust emissions on roads, thereby reducing air quality. Furthermore, the spread of pollutants can also occur around the area experiencing the congestion. Based on the results of previous research, it was found that the size, shape, and variety of vehicles on the road causes the spread of pollutants to be lifted into the air and eventually spread [21]. Conditions can be exacerbated if the congestion occurs on narrow roads, especially in a tunnel [22]. The impact of this pollution does not only affect air quality but further worsens the health of the people living around the street [20].

The results of this study is in line the with previous studies [23,24] show that air quality measurements near congested roads show a significant association. At the same time, slowing the flow of vehicles increases the amount of vehicles on the road. As a result, the exhaust gases are concentrated in the same place. In addition, the combustion quality of the vehicle engine is not perfect, which eventually leads to the concentration of exhaust gases in one segment. The exhaust gases are then lifted into the air and diffused, degrading air quality [4].

Based on the findings of this study and studies from previous studies, it can be understood that there is a relationship between roadside barriers and reduced traffic speed. The slowed traffic flow then increases the occupancy percentage. The high percentage of occupancy concentrated in an area can have an impact on increasing air and noise pollution. Therefore, this study concludes that there is a strong positive relationship between roadside barriers to percent occupancy which then impacts the environment.

CONCLUSION

The results of this study show that there is a relationship between road barriers and reduced traffic speeds. The slower the traffic flow, the higher the occupancy. High area occupancy can increase air and noise pollution. Therefore, this study concludes that there is a strong positive relationship between roadside obstacles and occupancy affecting the environment. The high occupancy percentage as a result of the high concentration of the number of vehicles on one road has a significant contribution to environmental pollution. Environmental pollution in question is in the form of CO and NO_2 levels. The higher the occupancy percentage on the road, the higher the level of pollution due to vehicle exhaust emissions.

NOMENCLATURE

CO CarbonMonoxide
NO_2SodiumDioxide
VOCsVolatileOrganicCompounds
GHG Greenhouse Gas

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