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Study of CO2 Absorbent Plants at The Signalized Intersection (Case Study : Intersection at Jl. S.Saddang Baru – Jl. Veteran, Makassar)

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ABSTRACT : *Intersections are part of the urban road network which tends to experience congestion due to an increase in the number of motorized vehicles and uncoordinated traffic lights between the other intersection arms. In this condition it will increase the number of victims of CO2 dioxide in motor vehicles from incomplete fuel combustion at signalized intersections. The number of victims of dioxide (CO2) at the intersection of Jl. S. Saddang Baru – Jl, Veteran in the city of Makassar due to motorized vehicles during queues and delays.With the Biomass method (Brown, 1997) the plant absorption capacity at the intersection arm Jl, S. Saddang – Jl, Veteran was 488.63 kg. The arm of the intersection of Jl, Veteran Utara is 1,720.32 Kg. The arm of the intersection of Jl, S. SaddanG is 100,,41 Kg. arm intersection Jl. Southern veterans 1,720.32 kg. The difference in CO2 absorption of plants is influenced by the type and number of trees as well as the CO2 absorption capacity of each tree in the arm of each intersection. For Jl. North Veterans – Jl. Veterans tree position is located on the median road, while Jl S. Saddang Baru and Jl, S saddang are located on the left and right shoulders. Number of trees and size of tree diameter at the intersection arm of Jl, North Veteran and Jl. Southern veterans are relatively numerous and have a relatively medium diameter so that they have a large CO2 absorption capacity.From the results of the analysis of each type of plant that is in each arm of the intersection is a value that will be compared to the value of the results of motor vehicle CO2 exhaust emissions to obtain a value for the needs of absorbent plants. The arrangement and selection of plants at the signalized intersection is based on the type and potential for CO2 absorption and land suitability at the signalized intersection.It is recommended for the selection and arrangement of plants at signalized intersections based on the Minister of Public Works Regulation No. 5/PRT/M/2012 and Road Landscape Engineering Planning so as to produce a sustainable signalized intersection.*

KEYWORDS:* *Signalized Intersection, CO2 Emissions, CO2 Absorbing Plants.

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I. INTRODUCTION

The transporation sector is one of the sectors that is of concern related to climate change. The high growth of vehicle ownership in developing countries is allegedly contributing to high greenhouse gases (wright and Fulton 2005). In Indonesia, the growth of motor vehicles every year increased, based on “Badan Pusat Statistik (BPS)” 2020 showed the number of motor vehicles in 2019 as many as 133.811.462 vehicles and in 2020 as many as 136,316 726 vehicles. The ratio of increasing the number of vehicles throughout Indonesia by 1.84% nationally. In general, motorized vehicle emissions with fossil fuels produce 14% carbon dioxide, 50-60% carbon dioxide and hydro carbon, nitrogen oxide emissions about 30% (Hawng 2007 in Edwin Hidayat 2013).

Due to the increase in the number of vehicles one of the crossroads in Makassar City is the intersection of Jl. S.Saddang and Jl. Veteran often occurs the vehicle of the intersection during rush hours. The performance of the reservoir is categorized as very poor based on the ratio of vehicle flow ratio (Q) with capacity (C) more than 1. The occurrence of long delays and long queues at intersections cause vehicle exhaust emissions in the form of carbon monoxide (CO) due to incomplete combustion that can provide a decrease in air quality around the reservoir. Carbon monoxide released through the exhaust of motor vehicles at certain limits can cause health problems both motorcycle vehicle users, pedestrians and people who live and practice the safety of the vehicle.

One way to lower air pollution levels due to CO_2 carbon dioxide from motor vehicles at intersections is the way of vegetation. Vegetation activities in the form of greening to stabilize CO_2 concentrations (Sarmiento 2003 in Edwin hiadyat, 2013). Greening is the most widely available in areas of road-owned space provided as an ecological function including crossroads areas.

The problem is the type and ability of air pollutant absorption, number of plants and arrangement of suitability of space function. On the other side, to measure the uptake of CO_2 in the space around the crossroads there are how many ways there is a way between them is to use the Biomass method. For the tree biomass method this is done using almetric equations of Brown's research (1997) However, there has been no study of the needs of CO_2 absorbent plants and the arrangement of the suitability of space functions in the street in makassar city.

II. METHODOLOGY

This study uses a quantitative descriptive method by examining the amount of vehicle emissions as a vehicle emission factor, based on the approach method per fuel consumption as follows

$$\text{Exhaust Emissions } CO_2 = F \times E * 10^{-9}$$

where :
CO_2 = Carbon dioxide exhaust emissions
F = Emissions factor, gasoline = 69.300 kg/TJ,
Solar = 74,100 Kg/Tj
E = Value of Energy, gasoline = 33,66 MJ/l, Solar = 36,9 MJ/I

In a matter of units of CO_2 converted in units of kg/l. After that, to calculate vehicle emissions per consumption of fuel oil at the intersection of S.Saddang – Jl. Veterans can be done with the following formula:

$$VE = C \times EF\ Fuel \times Cons.\ Fuel$$

where :
VE = Vehicle Emissions
C = Storage capacity based on green time (smp/hours) level of fuel consumption at the time of queue (litre / smp-hours), taken d =1,4 vehicles at idle. Cons. Fuel = d*D/3600*NQ
D = Congestion (second/smp)
NQ = Number Of Queue (smp)

The next step is calculation of biomass, because the rainfall research area < 1500 mm / year. So based on [22], the biomass can calculated with the following formula:

$$Y = \exp(-1{,}996 + 2{,}32 * \ln(D))$$

where :
Y = Biomass per tree (kg)
D = DBH = Diameter of the chest (cm)

Then, to find out the amount of carbon stores (C) use equality below :

$$Cb = Y \times \%\ C$$

where:
Cb = Carbon content of biomass (kg)
Y = Biomass per tree (kg)
% C organic = perentase value of carbon content, taken at 0,47-0,5

After that, to find out the amount of CO_2 uptake after the amount of carbon stores are known, the following equation is used:

$$CO_2 = 3{,}6667 \times Cb$$

where :
CO_2 = uptake of carbon dioxide (kg/tree)
Cb = Carbon Content of biomass (g).

Next, the final step is selection of the right types of plants to absorb CO2 at the crossroads based on the planning procedure for landscape engineering and the PU Ministerial Decree No. 05/PRT/M/2012 about guidelines for planting trees on the road network system.

III. RESULT AND DISCUSSION

CO2 calculation based on traffic conditions at Jl. S, Saddang – Jl Veteran at three times, namely peak hours in the morning (06.00-11.00), noon (12.00-14.00) and afternoon (16.00-19.00). The types of vehicles surveyed, namely motorcycles (MC), Light Vehicles (LV) and heavy vehicles (HV) are then categorized into two categories, namely vehicles using gasoline fuel and vehicles using solar fuel. Therefore, the results are obtained according to the Table 1, Table 2, and Table 3.

Table 1. Amount of motor vehicle CO2 exhaust emissions in the morning peak hours (Kg/smp)

intersection	**Amount of exhaust emissions (CO_2)**		
	Morning		
	Gasoline	**Solar**	**Amount**
	(kg/smp)	**(kg/smp)**	**(kg/smp)**
Jl. S.Saddang Baru (T)	0,497	0,583	1,082
Jl. Veteran Utara (U)	0,001	0,002	0,003
Jl. S Saddang Lama (B)	0,410	0,481	0,481
Jl. Veteran selatan (S)	0,106	0,106	0,124

Source: Analysis Results

Table 2. Amount of motor vehicle CO2 exhaust emissions at peak hours of Noon (Kg/smp)

intersection	**Amount of exhaust emissions (CO_2)**		
	Noon		
	Gasoline	**Solar**	**Amount**
	(kg/smp)	**(kg/smp)**	**(kg/smp)**
Jl. S.Saddang Baru (T)	0,004	0,005	0,009
Jl. Veteran Utara (U)	0,005	0,006	0,011
Jl. S Saddang Lama (B)	0,872	1,022	1,894
Jl. Veteran selatan (S)	0,093	0,108	0,201

Source: Analysis Results

Table 3. Amount of motor vehicle CO2 exhaust emissions in peak afternoon hours (Kg/smp)

intersection	**Amount of exhaust emissions (CO_2)**		
	Noon		
	Gasoline		**Gasoline**
	(kg/smp)	**(kg/smp)**	**(kg/smp)**
Jl. S.Saddang Baru (T)	0,499	0,585	1,083
intersection	**Amount of exhaust emissions (CO_2)**		
	Noon		
	Gasoline		**Gasoline**

	(kg/smp)	(kg/smp)	(kg/smp)
Jl. Veteran Utara (U)	0,002	0,003	0,005
Jl. S Saddang Lama (B)	0,475	0,557	1,033
Jl. Veteran selatan (S)	0,379	0,444	0,823

Source: Analysis Results

From the results of the CO_2 calculation, the largest value is selected from the peak time of morning, afternoon and evening to be included in the analysis of the calculation of the number of vehicle emissions at each intersection as follows.

Table 4. CO_2 Emissions and CO_2 Absorption of Existing Trees

Intersection	CO2 Exhaust Emissions	Existing Tree CO2 Uptake	Difference
	(Kg/Jam)	(Kg)	(kg)
Jl. S.Saddang Baru (T)	1.363,78	488,63	875,15
Jl. Veteran Utara (U)	6,27	1.720,32	- 1.714,05
Jl. S Saddang Lama (B)	616,85	516,44	100,41
Jl. Veteran selatan (S)	552,46	1.153,19	- 1.153,19

Source: Analysis Results

From the results of the analysis with the method per fuel consumption, obtained the amount of exhaust emissions of CO_2 motor vehicles each arm is different, the intersection from the east is Jl. S.Saddang Baru total emission of CO_2 exhaust gases which is 1,363.78 Kg / hour, the intersection from the north is Jl. Veteran north which is 6.27 Kg. The intersection from the West is jl. S.Saddang long ago the total emission of CO_2 exhaust gases is 616.85 Kg / hour. The intersection from the south is Jl, Veteran South total CO_2 exhaust emissions are 552.46 kg / hour. Of the four intersections, the new Jl. S.Saddang intersection has the highest volume of exhaust emissions. This is influenced by the volume of traffic at the peak afternoon hours which is greater. In addition, Jl. S.Saddang is a one-way road with four lanes. The intersection of Jl. Veteran North has a smaller volume of CO_2 exhaust gases than the four intersections, this is influenced by the condition of smaller traffic volume in the afternoon, where jl, Veteran North is a two-lane road separated by the median. Jl. Veterans north is a road connecting to the city activity center so that in the afternoon it is quieter than the morning where people use this road to work. The intersection of Jl. S.Saddang and Jl. Veteran Utara is relatively the same volume of vehicles in the afternoon, this is influenced by road users returning from work.

The CO_2 absorption from the results of the analysis of each type of plant at each intersection is a value that will be compared to the value of motor vehicle CO_2 exhaust emissions to get the value of absorbent plant needs. From the results of the analysis of CO_2 absorption there is a difference in the value of each intersection, the absorption of CO_2 in plants at the junction. S.Saddang – Jl. Veteran amounting to 488.63 kg. Intersection of Jl. Veteran North amounted to 1,720.32 Kg. Intersection jl.S.Saddan amounted to 100.41 Kg. Intersection jl. Veteran South amounted to 1,153.19 kg. Differences in plant CO_2 absorption are influenced by the type and number of trees and the CO_2 absorption of each tree in each plant. For Jl. Veteran north – Jl. Veteran tree position is located on the median of the road while Jl.S.saddang baru and Jl.S saddang are located on the left and right of the roadside. The number of trees and the size of the diameter of trees at the intersection of Jl. Veteran North and Jl. Veteran south relatively many and relatively moderate diameter so that it has a large co2 absorption on the road.

The relationship between motor vehicle CO_2 exhaust emissions in each arm and CO_2 absorption in existing plants greatly affects. Where there is a difference between the emission of MOTOR VEHICLE CO_2 exhaust gases and the CO_2 absorption of existing plants. At the intersection of S.Saddang Baru has a difference of 875.15 kg means that at this intersection requires additional trees to absorb the difference in CO2 caused by the capacity of the intersection. At the intersection jl. Northern veterans and Jl. Northern veterans showed a minus difference which means that the required CO2 exhaust emissions are less than the CO2 absorption of existing plants at the intersection so no additional CO2 absorbent trees are needed. But in the implementation of the structuring of the street to provide comfort it is recommended to follow the Regulation of the Minister of Public Works Number .5/PRT/M/2012 and Road Landscape Engineering Planning.

IV. CONCLUSIONS AND SUGGESTIONS

I. Conclusions

The results of this research study can be concluded:

a) Motor vehicle CO2 exhaust emissions at the intersection of Jalan S.Saddang – Jl, Veteran does not show the value of similarities between the arms. This condition is greatly influenced by the volume of traffic on different road junctions.
b) The difference between the amount of MOTOR VEHICLE CO2 exhaust gas and plant absorption at certain intersections that show a positive value (+), then additional plants / trees are needed to reduce the residual value. When there is a difference that shows a negative value (-), then no additional / additional trees are needed..
c) The number of additional plants at the intersection of Jl.S.Saddang baru and Jl.S.Saddang junction is based on the $_{CO2}$ absorption capacity of plants/trees and suitable tree species in the crossroads area.

II. Suggestion

After conducting the study and conclusions in this study, it is recommended:

a) At each signalized intersection, capacity optimization is carried out based on the green light so that traffic light coordination occurs between intersections so that the CO2 concentration at signalized intersections is not too high at certain intersections.
b) In order to avoid the difference between the needs of CO2-absorbing plants and the relatively large CO2 exhaust emissions, it is advisable to plan a projection of the needs of CO2-absorbing plants with the level of CO2 emissions of motorized vehicles that occur so as to create a continuous signalized intersection.
c) In the selection and arrangement of trees in the signalized intersection area, it is necessary to adjust the available land conditions and the appropriate tree species so as to provide the aesthetics of the signalized intersection.
d) For further research, it is recommended to coordinate signalized intersections and include conditions of wind direction, humidity and other methods

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