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STUDY OF ROAD ENVIRONMENTAL CAPACITY IN THE SCHOOL AREA IN BANDA ACEH CITY

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Abstract The study discusses the relationship between the environmental capacity of the road in terms of the impact of noise and air pollution caused by vehicles traveling on the road around the school area, namely Jalan T Panglima Nyak Makam in Banda Aceh. The level of noise and air pollution is greatly influenced by the geometric of the road, the volume and, the speed of the vehicle. The traffic volume average of 486.8 pcu/hour/direction and an average speed of 33.19 km/hour. The capacity of this road is 1455.3 pcu/hour. From the research results obtained Leq values ranged from 72.8 dB (A) - 78.2 dB (A), with an average value of 76.00 dB (A). This Leq value indicates a noise level that has an impact on the community that is greater than 70 dB (A), and is still within the maximum noise threshold of 85 dB (A) and has passed the noise standard in the school area of 55 dB (A), then This road section is no longer feasible for school areas if assessed from the noise that occurs, for CO pollutants (LV) 1,301 ppm, CO (HV) 0.016 ppm, NOX 0.096 ppm, and HC 0.063 ppm. This shows that is still feasible because the DS limit for urban roads is 0.85 and classified as this road is still able to accommodate the traffic volume with the estimated air pollution provided.
Keywords: Road environmental capacity, noise, air pollution, school area

1. INTRODUCTION

Congestion that occurs in the city of Banda Aceh has become a new problem. ratio 0.98) or LOS D with the meaning that the flow is not stable and dominant stop, (Fadhly,AASEC, 2018)[1] this will also have an impact on the capacity of the road environment which in this study will be examined concerning the capacity of the road to the capacity of the road environment consisting of noise and air pollution, which were examined in the education and commercial trade area Fadhly, AASEC 2019)[2].
The high level of traffic growth in the city of Banda Aceh is due to an increase in economic growth based on constant prices in the city of Banda Aceh by 2.22% in 2019 this is one of the causes of traffic growth continues to increase every year which is an interaction of increasing living standards and needs population mobility in the city of Banda Aceh (Fadhly, ICoPS2019)[3]. This study looks at the relationship between road capacity and noise and air pollution which are gases containing pollutants such as CO, CO2, SO2, NO, HC and particles consisting of smoke, lead, dust and a mixture of gases and particles that are oxidized by the sun which is due to the volume of traffic that passes through secondary arterial roads with the type 6/2 D road in front of the education area.

2. LITERATURE REVIEW

2.1. **Banda Aceh City Space Structure**

The development of the city of Banda Aceh can be categorized as a "Multi Nuclei Model" growth pattern or which has several growth points. The growth pattern of the growing points turns out to have a linear pattern tendency and develops along with the road network so that it shows the pattern of spatial development with the Linear Growth Model. The effect of this pattern causes the flow of traffic to accumulate on a main road or arteries only compared to the secondary road so a traffic jam. (Fadhly, Journal of Physics: Conference Series,2018)[4]
Figure 2.1 Spatial Pattern of Banda

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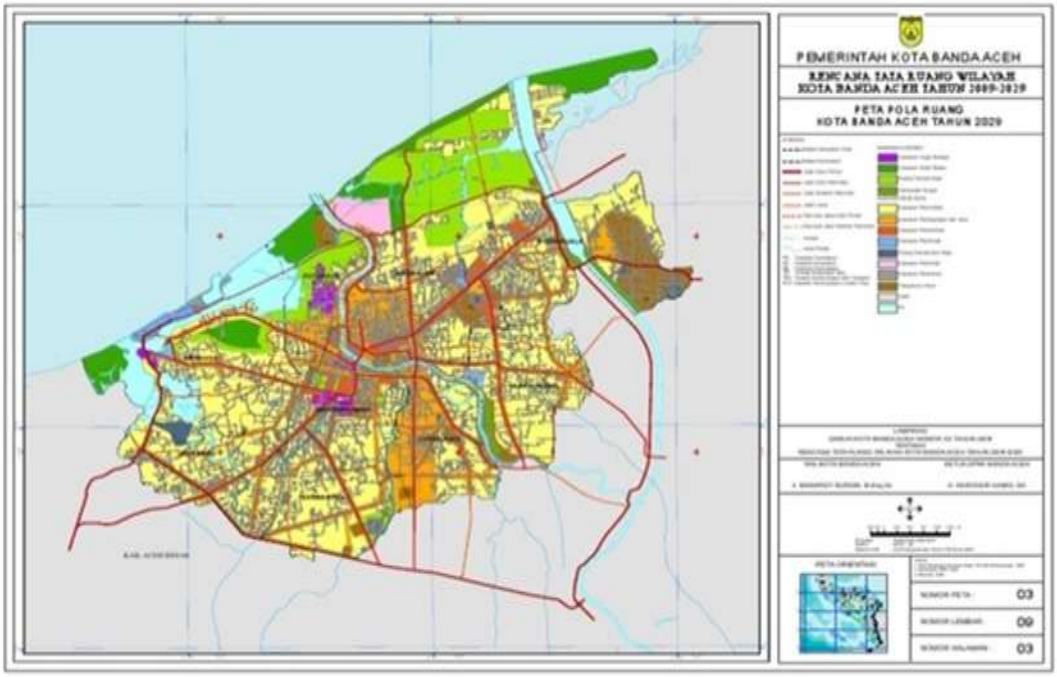

Figure 2.1 Spatial Pattern of Banda Aceh City
Source: Banda Aceh City RTRW 2020[5]

2.2. Service Level Analysis (Road Capacity)

Capacity is stated in passenger car units (SMP). The equation for determining capacity is as follows (MKJI, 1997)[6]

C = CO x FCW x FCSPx FCSFx FCCS …… .2.1

Information :

C = Capacity (junior high / hour)
C0 = Basic capacity (junior high / hour)
FCw = Adjustment factor for the width of the traffic lane
FCsp = Directional separator adjustment factor
FCsf = Adjustment factor of side and shoulder obstacles
FCcs = City size adjustment factor

2.3. Road Environment Capacity

The capacity of the road environment is the number of vehicles that can be allowed to pass a road without crossing the environmental quality standard limits, in its assessment the calculation uses a multi-factor method by reviewing various environmental impacts such as air pollution. The research to be conducted is to predict air pollution and noise.

2.3.1 Prediction of Air Pollution

The method for predicting air pollution is the model of the general motor, while the general motors model equation is as follows (Boubel, 1994):

$$C=\frac{Q}{\sqrt{2\pi U\sigma z}}\left\{\exp\left[-\frac{1}{2}\left(\frac{z+h0}{\sigma z}\right)2\right]+\exp\left[-\frac{1}{2}\left(\frac{z-h0}{\sigma z}\right)2\right]\right\}\text{……..2.2}$$

Information :

C = pollutant concentration (ppm)
Q = estimated average emission level (g / km)
U = effective wind speed (m / sec)
ho = building height at distance x from road (m)
σz = vertical dispersion parameter

Table 2.1Air Quality Standards

Pollutant	Limitation	Institutions
Suspended matter	40 µg/m3 (annual mean)	WHO
Total suspended particulates	90 µg/m3 (annual mean)	AHRMC
	0,26 µg/m3 (24 hour max)	Indonesia
Particulate Matter < 10 µm	50 µg/m3 (annual mean)	US EPA
	150 µg/m3 (24 hour max)	

Lead	µm (90 day average)	AHRMC
Carbon monoxide	87 ppm (15 minuttes max)	WHO
	25 ppm (1 hour max)	WHO
	9 ppm (8 hour max)	AHRMC
	8 ppm (8 hour)	Indonesia
Nitrogen dioxide	16 ppm (1 hour max)	AHRMC
	5 ppm (annual mean)	US EPA
	92,5 µm/m3 (3 hr)	Indonesia
Non methane	160 µm/m3 (3 hr max/year)	US EPA
Hydro carbons	0,25 ppm (3 hr)	Indonesia
Ozone	12 pphm (1 hour max)	AHRMC

(Source: Murwono, 1999)[7]

2.3.2 Noise

Minister of the Environment Decree No. 48 of 1996 concerning Standard Noise Levels carried out every 10 seconds for 10 minutes. The next noise level is determined by the equation:

Leq = 10 Logs {1 T $[(t1x100.1L1) + (t2\ x100.1L2) + ... (tnx100.1Ln]\}$ …… ..2.3

Information:

Leq = continuous sound pressure level is equivalent

L1 = sound pressure level in period t1

Ln = sound pressure level in the period tn

T = total measurement time (t1 + t2 + ... + tn)

2.3.3 Traffic Noise

Traffic noise comes from the sound produced by motorized vehicles, especially from vehicle engines, exhausts, as well as due to interactions between wheels and roads. (Aziz, 2002)[8]

Table 2.2 Standard Noise Levels

	Allotment of Area / Environment Activities	**Noise level dB (A)**
1.	**Allotment of Regions**	
a.	Housing and Settlements	55
b.	Trade and Service	70
c.	Office and Trade	65
d.	Green open space	50
e.	Industry	70
f.	Government and Public Facilities	60
g.	Recreation	70
2.	**Activity Environment**	
a.	Hospital or the like	55
b.	School or the like	55
c.	Place of Worship or the like	55

Source: Decree of the Minister of Environment No. 48 of 1996 concerning[9]

3. RESEARCH METHODOLOGY

Figure 3.1 Research Methodology

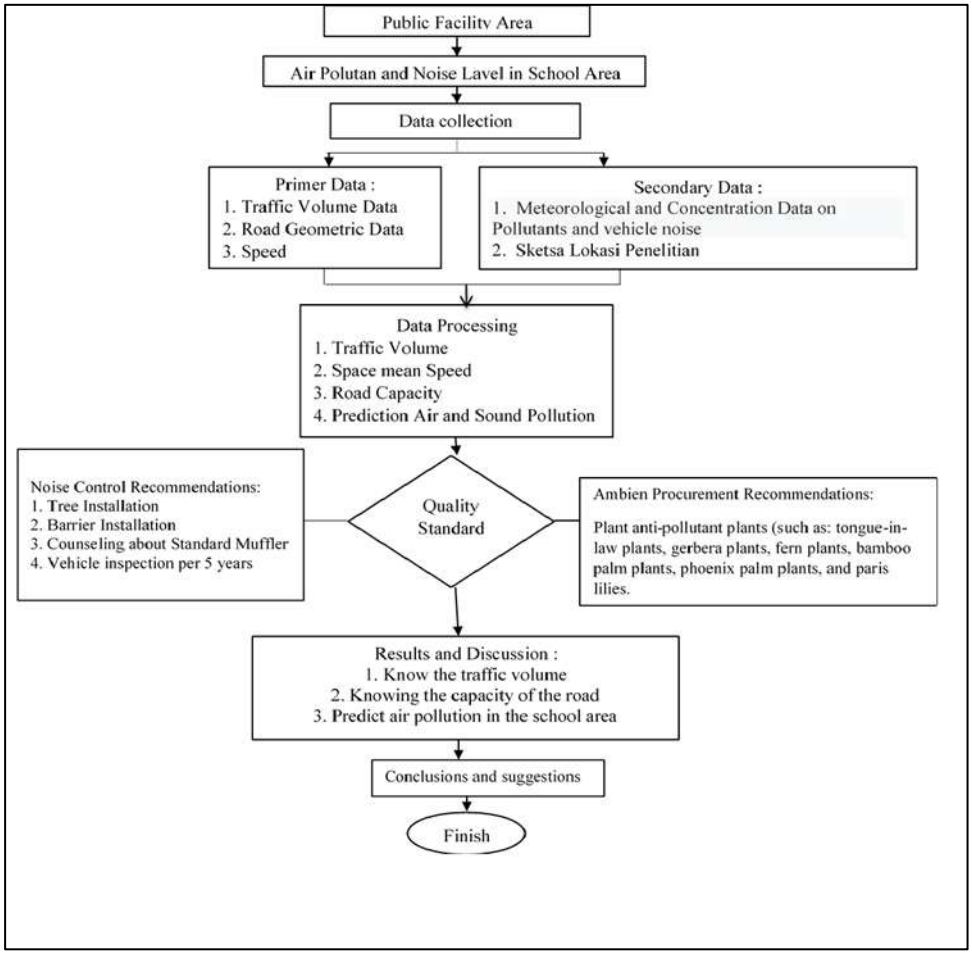

Figure 3.1 Research Methodology

3.1. Research Hypothesis

Increasing the volume of traffic on the environmental quality, namely noise pollution, and air pollution, with the capacity of the road environment will be able to limit the number of vehicles that can pass a road so that the environment is not disturbed by air pollution and noise pollution caused by vehicles

3.2. Data Analysis

The data obtained in the form of traffic volume, vehicle speed, and road capacity using a model from the general motor will get a prediction of air pollution, and noise pollution by using a sound level, to obtain the concentration of each noise and air pollution.

4. RESEARCH RESULT

Road capacity on the Jalan T. Panglima Nyak Makam Banda Aceh City with six two-way lanes divided:

Tabel 4.1 Road Capacity Recapitulation (6/2 D) and Degree of Saturation

Observation Day	Total Vehicle (PCU/Hour)	Total Traffic Volume (PCU/Hour)	Capacity PCU/Hour	DS
Wednesday 29-01-2020	19846	558,245	1455,3	0,38
Sunday 02-02-2020	11925	235,904	1455,3	0,16
Monday 03-02-2020	23713	666,034	1455,3	0,46

The following shows the overall research results of the Relationship between the Number of Vehicles, Volume, Capacity, Degree of Saturation, Motorized Vehicle Noise and Environmental Standard Standards for both directions on Jalan T. Panglima Nyak Makam

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Table 4.2 Recapitulation of the relationship between noise, number of vehicles, traffic volume, road capacity and degree of saturation

Day.Date	Vehicle Noise dB(A)	Number of vehicles	Traffic Volume (PCU/Hour)	Road Capacity (PCU/Hour)	Degree of Saturation (DS)
Wed, 29 Januariy 2020	76,1	19846	558,245	1455,3	0,38
Environmental Standard Standards	55,0	14343	403,462	1051,8	0,27
Sun, 2 February 2020	74,7	11925	235,904	1455,3	0,16
Environmental Standard Standards	55,0	8780	173,689	1071,5	0,11
Mon, 3 February 2020	77,2	23713	666,034	1455,3	0,46
Environmental Standard Standards	55,0	16894	474,506	1036,8	0,33

Source: Research Results, 2020

Then the relationship between traffic volume and road capacity to air pollution from the results of traffic volume data, road capacity, degree of saturation, and also the results of air pollution predictions for 3 days of observation, can be seen in the table below.

Table 4.3. Ideal Data on Average Air Pollution Per Day

Observation Day	Air Pollution Standards	Air pollution (C)		Total vehicle (Veh/jam)	Traffic Volume (PCU/Hour)	Capacity (PCU/Hour)	DS
Wednesday 29-01-2020	25 ppm	CO (LV)	1,301	19846	558,245	1455,3	0,38
		CO (HV)	0,016				
	16 ppm	Nox	0,096				
	0,25ppm	HC	0,063				
	Ideal	CO (LV)	1,879	21132	822,277	1100	0,75
		CO (HV)	0,035				
		Nox	0,141				
		HC	0,091				
Sunday 02-02-2020	25 ppm	CO (LV)	0,324	11925	235,245	1455,3	0,16
		CO (HV)	0,007				
	16 ppm	Nox	0,026				
	0,25ppm	HC	0,016				
	Ideal	CO (LV)	0,720	13211	499,277	1100	0,45
		CO (HV)	0,013				
		Nox	0,056				
		HC	0,035				
Monday 03-02-2020	25 ppm	CO (LV)	1,133	23713	666,034	1455,3	0,46
		CO (HV)	0,021				
	16 ppm	Nox	0,084				
	0,25ppm	HC	0,055				
	Ideal	CO (LV)	1,607	24999	930,066	1100	0,85
		CO (HV)	0,030				
		Nox	0,117				
		HC	0,078				

5. CONCLUSIONS

The level of noise pollution on Jalan T. Panglima Nyak Makam Banda Aceh has exceeded the noise limit because of the high traffic volume and the very varied traffic composition has resulted in noise levels that have caused a reaction in the community that is greater than 70 dB (A) (Thurman & Miller; 1986 quoted from Aziz; 2002) but have not yet exceeded the highway noise level threshold of 85 dB (A) (Azis 2002)[8].
And for air pollution with DS of 0.85 has a road capacity of 1100 pcu / hour and a traffic volume of 930,066 pcu / hour, so for the level of air pollution in the CO pollutant concentration of light vehicles by 1,607 ppm, CO of heavy vehicles by 0,030, NOx of 0.117 ppm, and HC 0.078 ppm. All pollutant concentration values if the DS is maximum but the air pollution standards of all pollutant concentrations are still classified as safe.

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