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Analysis of the Effects of Traffic Volume on the Pavement Condition in the Educational Zone of Merauke Regency

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***Abstract*—Among types of land use vital for the development of Merauke Regency is the land use intended to provide its population with education. Land use for educational purposes (the educational zone) in Merauke Regency, such as the one in Pendidikan Road, Kamizaun Road, and Ternate Road, constitutes important access to schools and universities in the region. As a result, there is a fairly high volume of vehicles every day due to public activities to meet their educational needs. As a result of an increasing number of vehicle movements, there is an increase in the traffic volume, which includes motorcycles, light vehicles, and heavy vehicles in particular roads. Road damage results from several factors, one of which is the traffic volume** [1]**. In the event of damage to the road taken, the word "easy" will certainly be interpreted otherwise. This is descriptive quantitative research. This research describes the actual conditions of the research object using numbers. Based on the scores for the road condition index and traffic classes, it is revealed that the priority scores for Jl. Pendidikan, Jl. Kamizaun, and Jl. Ternate are 4 3, and 5, respectively. Based on those results, it is necessary to include Jl.Pendidikan and Jl.Ternate in the periodic maintenance program while Jl.Kamizaun needs to be included in the improvement program.Based on the whole data analysis undertaken, a model for the relationshipid179 between the traffic volume and the score for the pavement condition index was then examined. The analysis of the relationship model was undertaken using the application *Microsoft Excel*. The variables used in the analysis were the score for the pavement condition index as the dependent variable and the traffic volume as the independent variable. Results of the analysis undertaken using regression generated a multiple R value of 0.4124, which means that the traffic volume does not exercise a significant effect on the score for the pavement condition index, the R square by 0.1701 means that the model's goodness of fit is not really good.**

Keywords—traffic volume; road class; educational zone; pavement conditions

I. INTRODUCTION

Transportation always plays a vital role in the development of a region at national to regional level, especially in developing countries with population growth that continues to increase every year. This leads to an increasing demand for transportation services, thus it is definitely true that transportation plays a significant role in a developing region.

An increase in population growth in a region is always followed by an increase in the number of vehicles. The increasing number of vehicles will affect the rate of vehicle movements in the region. Basically, the movement of vehicle depends on their respective destination/ the movement of the subject making such a movement.

Merauke Regency is a developing region. This is evident from an increase in its population for the last five year, with an annual increase of 1.85%[2]. In the event of increasing population, the demand for a means of transportation will increase as well. Such a demand can be seen from the increasing number of vehicles. Based on data from SAMSAT, it is revealed that in 2017, the number of vehicles increases by9.74% every year. This results in increasing vehicle movements in particular land use. The impact can be seen in the level of violation of speed limiting signs at the points surveyed in Merauke District is very high, especially the speed of vehicles 20-25 km / hour. [3]

One of the factors that affect the rate of movements of a city is land use development. Land use also indirectly influences side barriers in certain road conditions, activities can grow which can cause side barriers that greatly affect the characteristics of the road itself.[4] To meet his/ he needs, one will move from the first land use to the other land use, thereby resulting in the so-called trip generation and attraction, thus it can be concluded that traffic may be affected by land use and vice versa [5]. This suggests a strong relationship between land use and transportation.

Among types of land use vital for the development of Merauke Regency is the land use intended to provide its population with education. Land use for educational purposes inMerauke Regency, such as the one inJl. Pendidikan, Jl. Kamizaun, andJl. Ternate, constitutes important access to schools and universities in the region. As a result, there is a fairly high volume of vehicles every day due to public activities to meet their educational needs.

As a result of an increasing number of vehicle movements, there is an increase in the traffic volume, which includes motorcycles, light vehicles, and heavy vehicles in particular roads. Pavement damage results from several factors, one of which is the traffic volume [1]. Such an increase in the traffic

volume will cause problems in the event of damage to the road taken.

Accessibility is a measure to determine the extent to which land use locations is deemed comfortable or convenient to interact one another, and the extent to which the access to those locations is deemed easy or not by a means of transportation. In the event of damage to the road taken, the word "easy" will be interpreted the opposite. This gets worse in the absence of routine road maintenance/ repairs that are not carried out in a timely manner due to certain constraints.

II. METHOD

A. Research Type

This is descriptive quantitative research. This research describesthe actual conditions of the research object using numbers. It aims to describe such conditions just the way they are.

B. Research Site

Surveys to collect data were undertaken in Jl. Pendidikan, Jl. Kamizaun, and Jl.Ternate in Merauke Regency. These roadslead to land use which fits the educational zone.

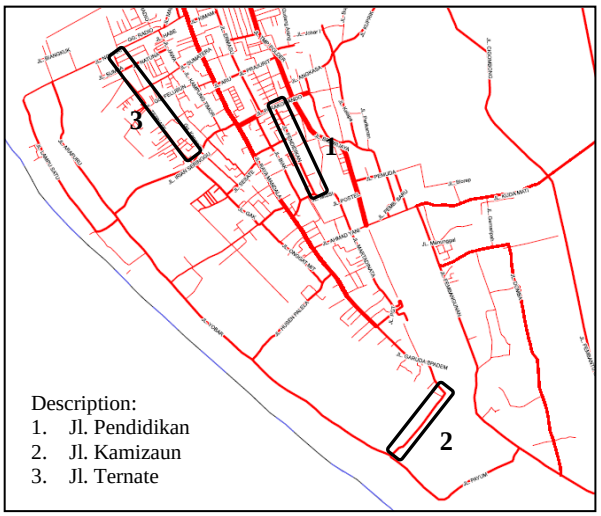

Fig. 1. Research Site

C. Research Setting

Measurement of the traffic volume was undertaken during peak hours for 7 days, starting from 06:00 – 18:00 Eastern Indonesia Time.Peak hours are used among others as the basis for geometric designing to determine the width of a lane, an intersection, and so on.

D. Data Collection

These surveys aim to determine the types and dimensions of road damage, road dimensions, and the traffic volume of vehicles moving along the roads surveyed. The data measured include: (1) road dimensions; (2) the traffic volume for motorcycles, light vehicles, and heavy vehicles; (3) pavement damage types; and (4) pavement damage dimensions.

The surveys were undertaken by a total of 3 surveyors, each conducted a survey in one of the three roads. Measurement of road dimensions was performed while measuring the traffic volume. Measurement of road damage was undertaken by a total of 3 surveyors, each conducted a survey in one of the three roads.

E. Data Analysis

Volume was calculated by multiplying the number of vehicles by the Passenger Car Equivalent (PCE) based on the vehicle type classification. Road condition scores can be calculated using Procedures for City Road Maintenance Program Development 1990 [6] then analyzing traffic vehicle and pavement damage by regression method [7].

III. RESULTS AND DISCUSSION

A. Traffic Volume and Average Daily Traffic

Traffic volume refers to the number of vehicles moving along a particular road under a particular unit of time. The traffic volume was calculated by multiplying the number of vehicles moving along the road by the Passenger Car Equivalent (PCE)based on the type of vehicle[5].

TABLE I. PASSENGER CAR EQUIVALENTS

Type of Vehicle	PCE
Light Vehicle $(LV)^3$	1
Heavy Vehicle $(HV)^3$	1.3
Motorcycle $(MC)^3$	0.5

The following are data on the traffic volume during the busiest day based on results of field measurement.

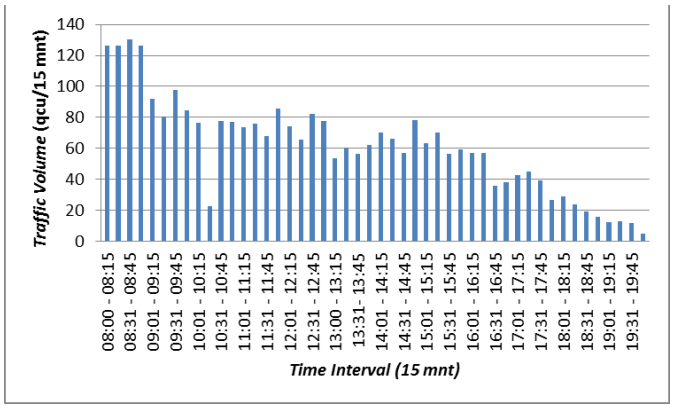

Fig. 2. Volume Data on the Busiest Day forJl. Kamizaun

Based on the traffic volume data in "Figure 2", the average daily traffic can be calculated, which is by 5101 passenger car unit/ day.

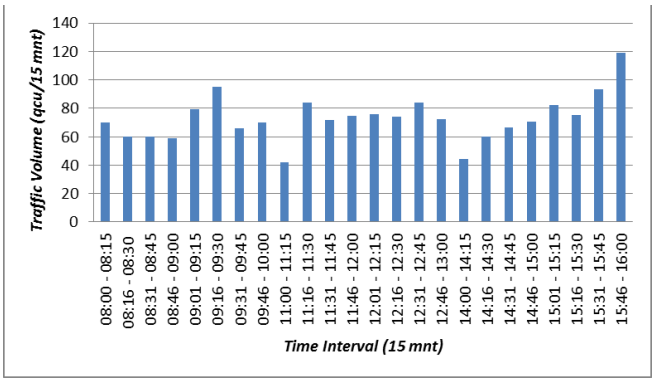

Fig. 3. Volume Data on the Busiest Day for Jl. Ternate

Based on the traffic volume data in "Figure 3", the average daily traffic can be calculated, which is by 3695passenger car unit/ day.

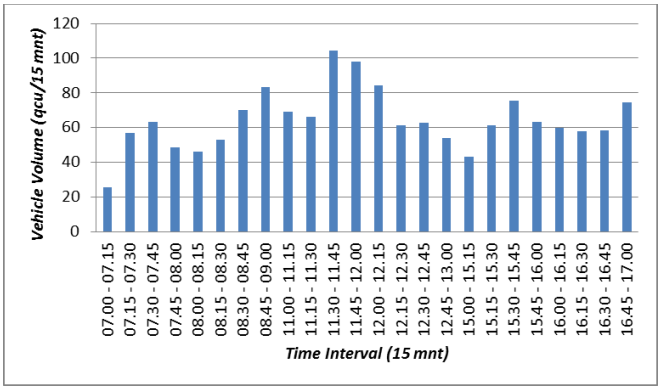

Fig. 4. Volume Data on the Busiest Day for Jl. Pendidikan

Based on the traffic volume data in "Figure 4", the average daily traffic can be calculated, which is by 3525 passenger car unit/ day.

The road length and width of Jl. Pendidikan, Jl. Kamizaun, and Jl. Ternate are equal to 1,150 m x 3.5 m; 750 m x 7 m; and 1,700 m x 5 m, respectively.

B. Pavement Damage

Pavement damage conditions are important to determine countermeasures the authorities need to take.

1) Scores for Pavement Damage Conditions

Based on the score for the average daily traffic, traffic classes were determined based on data on the Average Daily Traffic as shown in Table 2 [8][6].

TABLE II. TRAFFIC CLASSES

Traffic Class	Average Daily Traffic
0	< 20
1	20 – 50
2	50 – 200
3	200 – 500
4	500 – 2,000
5	2,000 – 5,000
6	5,000 – 20,000
7	20,000 – 50,000
8	>50,000

Pavement damage assessment based on the damage score of each type of damage is shown in Table 3[6,7].

TABLE III. PAVEMENT DAMAGE VALUES

Pavement Condition Assessment	
Score	Value
26 – 29	9
22 – 25	8
19 – 21	7
16 – 18	6
13 – 15	5
10 -12	4
7 – 9	3
4 – 6	2
0 - 3	1
Cracking	
Type	Score
Alligator	5
Random	4
Transversal	3
Longitudinal	2
None	1
Width	Score
>2mm	3
1 – 2 mm	2
< 1 mm	1
None	0
Total Quantity of Damage	
Area	Score
>30%	3
10% – 30%	2
<10%	1
0	0
Rutting	
Depth	Score
>20 mm	7
11 – 20 mm	5
6 – 10 mm	3
0 – 5 mm	1
None	0
Patching and Pothole	
Area	Score
>30%	3
20% – 30%	2
10% – 20%	1
<10%	0
Surface Roughness	
Disintegration	4
Raveling	3
Rough	2
Fatty	1
Close Texture	0
Depression	Score
> 5/100 m	4
2 – 5/100 m	2
0 – 2/100 m	1
None	0

2) Pavement Damage Data

Types of damage and dimensions for such damage based on measurement results are shown in Tables 4 to 6.

TABLE IV. TYPE OF PAVEMENTDAMAGE IN JL.PENDIDIKAN

No	Type of Damage	Jl. Pendidikan			
		Depth	Quantity	Area	Unit
1	Edge Cracking			49.87	m^2
2	Longitudinal Cracking			0.11	m^2
3	Transversal Cracking			0.03	m^2
4	Alligator Cracking			1	m^2
5	Block Cracking			1.8	m^2
6	Pothole			33.57	m^2
7	Patching			19.31	m^2
8	Rutting	5			mm
9	Depression		2		

TABLE V. TYPE OF PAVEMENT DAMAGE IN JL.KAMIZAUN

No	Type of Damage	Jl. Kamizaun			
		Depth	Quantity	Area	Unit
1	Edge Cracking				m^2
2	Longitudinal Cracking			10.89	m^2
3	Transversal Cracking			0.41	m^2
4	Alligator Cracking			4.54	m^2
5	Block Cracking			163.77	m^2
6	Pothole			160.14	m^2
7	Rutting	10			Mm
8	Depression		3		

TABLE VI. TYPE OF PAVEMENT DAMAGE IN JL. TERNATE

No	Type of Damage	Jl. Ternate			
		Depth	Quantity	Area	Unit
1	Edge Cracking				m^2
2	Longitudinal Cracking			0.79	m^2
3	Transversal Cracking			0.29	m^2
4	Alligator Cracking			27	m^2
5	Block Cracking			8.79	m^2
6	Pothole			205.50	m^2
7	Patching			57.46	m^2
8	Rutting	5			mm
9	Depression		2		

Scores for the pavement condition index were determined by calculating the mean for all damage scores and scores for each type of damage. Results of the damage score analysis for each road are shown in Tables 7 to 10. The scores for the pavement condition index based on damage scores are shown in Table 7.

TABLE VII. TYPE OF PAVEMENT DAMAGE IN JL.PENDIDIKAN

Type of Damage	Score for Type	Score for Width	Score for Area	Score for Depth	Score for Depression Length	Score for Damage
Polished Aggregate						0
Shoving	-	-	0	-	-	0
Raveling	3	-	-	-	-	3
Edge Cracking	1	2	1	-	-	2
Longitudinal Cracking	1	3	1	-	-	3
Transversal Cracking	3	3	0	-	-	3
Alligator Cracking	5	1	1	-	-	5
Block Cracking	5	1	1	-	-	5
Pothole	-	-	0	-	-	0
Patching	-	-	0	-	-	0
Rutting					1	1
Depression					1	1
Total						23

TABLE VIII. TYPE OF PAVEMENT DAMAGE IN JL. KAMIZAUN

Type of Damage	Score for Type	Score for Width	Score for Area	Score for Depth	Score for Depression Length	Score for Damage
Polished Aggregate	-	-	-	-	-	0
Shoving	-	-	0	-	-	0
Raveling	3	-	-	-	-	3
Edge Cracking				-	-	0
Longitudinal Cracking	1	3	1	-	-	3
Transversal Cracking	3	3	1	-	-	3
Alligator Cracking	5	3	1	-	-	5
Block Cracking	5	3	1	-	-	5
Pothole	-	-	0	-	-	0
Patching	-	-	-	-	-	0
Rutting	-	-	-	3	-	3
Depression	-	-	-	-	2	2
Total						24

TABLE IX. TYPE OF PAVEMENT DAMAGE IN JL. TERNATE

Type of Damage	Score for Type	Score for Width	Score For Area	Score for Depth	Score for Depression Length	Score for Damage
Polished Aggregate	4	-	-	-	-	3
Shoving	-	-	-	-	-	0
Raveling	-	-	-	-	-	0
Edge Cracking	-	-	-	-	-	0
Longitudinal Cracking	1	3	1	-	-	3
Transversal Cracking	3	3	1	-	-	3
Alligator Cracking	5	3	1	-	-	5
Block Cracking	5	3	1	-	-	5
Pothole	-	-	0	-	-	0
Patching	-	-	0	-	-	0
Rutting	-	-	-	1	-	1
Depression	-	-	-	-	1	1
Total						21

TABLE X. SCORES FOR THE PAVEMENT CONDITION INDEX

Road Name	Score for Damage	Score for the Pavement Condition Index
Jl. Pendidikan	23	8
Jl. Kamizaun	24	8
Jl . Ternate	21	7

Based on the scores for the road condition index and traffic classes, it is revealed that the priority scores for Jl. Pendidikan, Jl. Kamizaun, and Jl. Ternate are 4 3, and 5, respectively. Based on those results,it is necessary to include Jl. Pendidikan and Jl. Ternate in the periodic maintenance program while Jl. Kamizaun needs to be included in the improvement program.

Based on the whole data analysis undertaken, a model for the relationship between the traffic volume and the score for the pavement condition index was then examined. The analysis of the relationship model was undertaken using the application *Microsoft Excel*. The variables used in the analysis were the score for the pavement condition index as the dependent variable (y) and the traffic volume as the independent variable (x). Results of the analysis undertaken using regression generated a multiple R value of 0.4124, which means that the traffic volume does not exercise a significant effect on the score for the pavement condition index, the R square by 0.1701 means that the model's goodness of fit is not really good. The resulting model equation is y = 6.53597 + 0.00027x. Results of the pavement condition assessment using the equaltion above are shown in Table 11.

TABLE XI. SCORES FOR THE ROAD CONDITION INDEX BASED ON THE MODEL EQUATION

Road Name	Traffic Volume	Score for Pavement Condition
Jl. Pendidikan	3525	7.5
Jl. Kamizaun	5101	7.9
Jl.Ternate	3695	7.5

IV. CONCLUSIONS

Based on field measurement results, it is revealed that the volume of traffic in Jl. Pendidikan, Jl. Kamizaun, and Jl. Ternate reaches 3525 pcu/ day; 5101 pcu/ day; and 3695 pcu/ day, respectively. The road length and width of Jl. Pendidikan, Jl. Kamizaun, and Jl. Ternate are equal to 1150 m x 3.5 m; 750m x 7m; and 1700m x 5m, respectively. The types of damage identified include polished aggregate, shoving, raveling, edge cracking, longitudinal cracking, transversal cracking, crocodile cracking, block cracking, pothole, patching, rutting, and depression. Scores for the Pavement Condition Index are 8 for Jl. Pendidikan, 8 for Jl. Kamizaun, and 7 for Jl. Ternate. The model equation generated based on analysis results is y = 6.53597 + 0.00027x with the value of R-squared by 0.1701. Scores for the Pavement Condition Index generated based on the model equation are 7.5 for Jl. Pendidikan, 7.9 for Jl. Kamizaun, and 7.5 for Jl. Ternate.

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