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ANALYSIS OF THE EFFECT OF SCHOOL SAFETY ZONE (ZOSS) ON-ROAD PERFORMANCE (Case Study of Veteran Street SDN 1,2,6 Dirgahayu Pulau Laut Utara Sub-district Kotabaru Regency)

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ABSTRACT

The ZoSS that was reviewed was the ZoSS on Jl. Veteran in front of SDN 1,2,6 Dirgahayu, Kotabaru Regency. ZoSS itself can affect traffic conditions, ranging from volume, speed, and density. This study aimed to determine the effect of the presence of ZoSS and the absence of ZoSS and to determine the Traffic Performance on Jl. Veteran which has a ZoSS area. The research conducted was a field survey to find data on volume, speed, and side obstacles. The survey was taken with three conditions, namely the condition of the influence of ZoSS, before the influence of ZoSS, and after ZoSS. Calculations using the Greenshield Model Analysis method, Greenberg Model, Underwood Model, and Bell Model, to determine the Capacity of the road section supported by daily Traffic Volume Data, and Vehicle Speed to get the density of the road section. From the modeling analysis, the Greenshield model was selected. From the calculation results, in the area before ZoSS to the ZoSS effect area, the maximum volume decreased by 17.67%, the average speed decreased by 0.18%, and the maximum density, decreased by 17.52%. In the area after ZoSS, the maximum volume increased by 8.78%, the average speed increased by 4.98%, and the maximum density increased by 3.62%. ITP values were obtained with V/C comparisons during ZoSS operating hours, in the area before ZoSS influence, DS 0.90 was obtained, the area affected by ZoSS was DS 0.97, and the area after ZoSS influence was DS 0.86. The same ITP value was obtained in all three areas, namely, E, which means that the traffic volume is close to/at capacity, the flow is unstable, and the speed is stopped.

Keywords: Safe School Zone (ZoSS), Road Performance, Greenshield Model, Capacity Analysis.

1. INTRODUCTION

Kotabaru Regency is one of the regencies in South Kalimantan. North Island Sub-district, which is the center of Kotabaru Regency Government, has 28 elementary schools, 11 junior high schools (SMP), and 9 senior high schools/vocational schools (SMA/SMK). The number of schools located on the edge of the main road where many high-speed vehicles drive makes school students vulnerable to traffic accidents.

The Indonesian government through the Central Department of Transportation implemented the Zone Safe School (ZoSS), according to the Decree of the Director General of Land Transportation Number 3236/AJ.403/DRDJ/2006, then with the Decree

of the Director General of Land Transportation Number 1828/AJ.403/DRDJ/2008 stated that the Zone Safe School (ZoSS) applies throughout Indonesia, including in South Kalimantan.

Safe School Zone (ZoSS) is an effort to control traffic activities by regulating speed by placing road markings and traffic signs on roads in the area around the school environment. The goal itself is to prevent accidents and ensure the safety of children at school. In Kotabaru Regency, one Safe School Zone (ZoSS) has been installed, in front of SD Negeri 1,2,6 Dirgahayu Kotabaru Regency. The Safe School Zone (ZoSS) design based on the Decree of the Director General of Land Transportation Number 3582/AJ.403/DRDJ/2018 requires vehicles entering this zone to drive at a slow speed (maximum 30 km/hour). It aims to provide reaction time to anticipate spontaneous movements for road users. School Safety Zone (ZoSS) activities will create obstacles on the road that will certainly affect road performance, especially when it enters the main hours of school activities such as entering and leaving school.

Therefore, research is necessary to analyze the Safe School Zone (ZoSS) effect on on-road performance, especially on Veteran Street, North Laut Island District, Kotabaru Regency.

2. THEORETICAL STUDY

Roads are land transportation infrastructure that includes all parts of the road, including complementary buildings and equipment intended for traffic, which are on the surface of the land, above the surface of the land, below the surface of the land, and/or water, and above the surface of the water, except railways, lorry roads and cable roads (Source: Article 1 of Government Regulation No. 34 of 2006).

The School Safety Zone, hereinafter referred to as ZoSS, is part of traffic management and engineering activities in the form of giving priority to pedestrian safety and comfort in school areas (Source: Regulation of the Director General of Land Transportation 2018).

Vehicles are the elements of traffic on wheels while objects or pedestrians as part of traffic are referred to as elements of traffic (MKJI 1997).

The Greenshields model is a model of the relationship between speed and density proposed by Greenshield in 1934. This model assumes that the relationship between speed

and density is linear. This model is simple and uncomplicated, and the maximum speed and density can be easily determined. However, later studies have shown that the relationship between speed and density is not strictly linear.

The Greenberg model proposes a logarithmic relationship between speed and density. The disadvantage of this model is that it does not represent traffic well at low densities because, at densities close to zero, the speed is infinitely large.

Underwood's model proposes an exponential relationship between velocity and density. This model improves the weakness of Greenberg's model at low densities, but at high densities, the velocity will drop asymptotically without touching the velocity = 0 line, so the maximum density is not reached.

The Bell model proposes a quadratic exponential relationship between speed and density. This model is consistent with some traffic data in some overseas studies. However, it has the same drawback as Underwood's model: at high density, the speed drops asymptotically without touching the speed = 0 line, so the maximum density is not reached.

The degree of Saturation is the ratio of traffic flow (SMP/hr) to capacity (SMP/hr) on a particular section of road. It is used as the main factor in determining the level of service of a road. The degree of saturation value indicates whether the road segment has a capacity problem or not.

3. METHOD

This research will be conducted at the School Safety Zone in front of SD Negeri 1,2,6 Dirgahayu, Veteran Street, Kotabaru City, North Laut Island District, Kotabaru Regency, South Kalimantan. Observations are made when school students actively use the School Safety Zone (ZoSS), namely when students go to and from school. Traffic flow data collection was carried out starting from 06.00 WITA to 18.00 WITA, data collection was carried out on weekdays. The surveyors needed are 6 people.

The data obtained from the field is an input for calculating road sections' performance using the Greenshield, Greenberg, Underwood, and Bell Models. The overall research methodology can be seen in Figure 3.1.

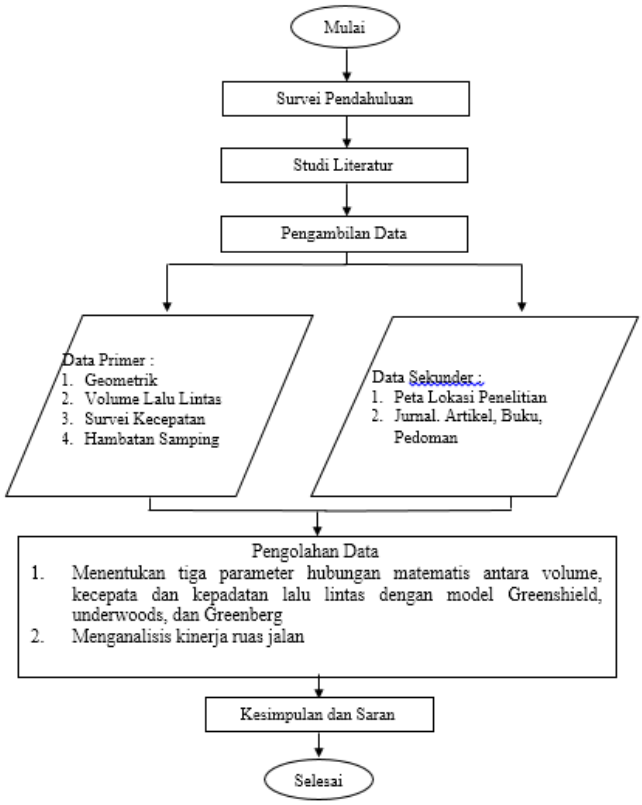

Figure 3.1 Water Chart of Research Method

4. RESULT AND DISCUSSION

4.1 Side Barriers

The side obstacle classes of the three areas studied can be seen in Tables 4.1, 4.2, and 4.3.

Table 4.1. Side Barriers of ZoSS Area

Time	Volume	Code
06:00-07:00	35	VL
07:00-08:00	140,7	L
08:00-09:00	41,1	VL
09:00-10:00	82,8	VL
10:00-11:00	55,4	VL
11:00-12:00	139,2	L
12:00-13:00	18,4	VL
13:00-14:00	4,8	VL
14:00-15:00	9	VL
15:00-16:00	11,9	VL
16:00-17:00	71,3	VL
17:00-18:00	82,2	VL

Table 4.2. Side Barriers Before ZoSS Area

Time	Volume	Code
06:00-07:00	40,4	VL
07:00-08:00	49,3	VL
08:00-09:00	44,1	VL
09:00-10:00	87	VL
10:00-11:00	53,4	VL
11:00-12:00	64,3	VL
12:00-13:00	33,7	VL
13:00-14:00	9,6	VL
14:00-15:00	13,6	VL
15:00-16:00	14,5	VL
16:00-17:00	65,4	VL
17:00-18:00	80,2	VL

Table 4.3. Side Barriers After ZoSS Area

Time	Volume	Code
06:00-07:00	34	VL
07:00-08:00	87,9	VL
08:00-09:00	125,3	L
09:00-10:00	94,5	VL
10:00-11:00	85,5	VL
11:00-12:00	123,6	L
12:00-13:00	35	VL
13:00-14:00	4,1	VL
14:00-15:00	12,2	VL
15:00-16:00	13,8	VL
16:00-17:00	100,9	L
17:00-18:00	139,4	L

4.2 Speed

The results of the traffic speed analysis in the area before the Safe School Zone at 07.00 - 08.00 Wita, the speed is 41 km / h with a volume of 1401.8 SMP / hour. In the Safe School Zone area at 07.00 - 08.00 Wita, the speed is 33 km / h with a volume of 1214.9 SMP / hour. and in the area after the Safe School Zone at 07.00 - 08.00 Wita, the speed is 44 km / h with a volume of 1078.80 SMP / hour.

4.3 Data Analysis

Data analysis before the ZoSS area was conducted by comparing the Greenshield, Greenberg, Underwood, and Bell equation models. The equation model can be seen in Table 4.4

Table 4.4 Equation Model of Speed – Density, and Correlation before ZoSS area

Relationship	Model Equation	Model Equation	R^2	R	X (SMP/km)	Desc.
Greenshield	y = (-0.503x) + 56.088	x = 111,552	0,913	0,956	111,552	V.High
Greenberg	y = -11.079ln(x) +78.147	Ln(x) = 7.053	0,847	0,920	1156,650	V.High
Underwood	$y = 1{,}766e^{-,0002x}$	$e^{-0,002x} = 1.766$	0,924	0,961	49,375	V.High
Bell	$y = 50{,}488e^{-,0002x\wedge 2}$	$e^{-,0002x\wedge 2} = 50{,}488$	0,906	0,952	92,282	V.High

The Greenshield equation model of the relationship between traffic characteristics can be seen in table 4.5.

Table 4.5 Equation Model of Relationship between Traffic Flow Characteristics before ZoSS area

Model	Relationship	Equation	
Greenshield	S - D	S =	56,088 - (56,088/111,552)*D)
	F - D	F =	(56,088 *D - (56,088/111,552)*D^2)
	F - S	F =	(111,552*S - (111,552/56,088)*S^2)

From the results of the model analysis, the free speed value (Smax) on the road section under review is 56.088 km / h and the maximum volume value (Fc) is 1564.189 SMP / hour.

ZoSS area data were analyzed by comparing the Greenshield, Greenberg, Underwood, and Bell equation models. The equation model can be seen in Table 4.6

Table 4.6 Equation Model of Speed – Density, and Correlation before ZoSS area

Relationship	Model Equation	Model Equation	R^2	R	X (SMP/km)	Desc.
Greenshield	y = (-0,609x)+55,989	x =92,004	0,583	0,763	92,004	High
Greenberg	y = -11.895ln(x)+78.557	ln(x) =6,604	0,538	0,734	738,179	High
Underwood	$y = 1.765e^{-0,006x}$	$e^{-0,006x} = 1,765$	0,629	0,793	41,125	High
Bell	$y = 50,533e^{-0,003x^2}$	$e^{-0,003x^2} = 50,533$	0,645	0,803	72,332	High

The Greenshield equation model of the relationship between traffic characteristics can be seen in table 4.7.

Table 4.7 Equation Model of Relationship between Traffic Flow Characteristics of ZoSS Area

Model	Relationship	Equation	
Greenshield	S - D	S =	(55,989 - (55,989/92,004)*D)
	F - D	F =	(55,989 *D - (55,989/92,004)*D^2)
	F - S	F =	(92,004*S - (92,004/55,989)*S^2)

From the results of the model analysis, the free speed value (Smax) on the road section under review is 55.989 km/h and the maximum volume value (Fc) is 1287.807 smp/h.

Data analysis of the Area After ZoSS was carried out by comparing the Greenshield, Greenberg, Underwood, and Bell equation models. The equation model can be seen in Table 4.8

Table 4.8 Equation Model of Speed - Density and Correlation after ZoSS Area

Relationship	Model Equation	Model Equation	R^2	R	X (SMP/km)	Desc.
Greenshield	y = (-0,617x)+58,776	x = 95,333	0,833	0,913	95,333	V.High
Greenberg	y = -10.890ln(x)+ 78.426	ln(x) = 7,202	0,816	0,904	1341,624	V.High
Underwood	$y = 1.780e^{-,0,006x}$	e-0.003x = 1,780	0,852	0,923	41,725	V.High
Bell	$y = 53,223e^{-,0003x\wedge2}$	$e^{-,0003x\wedge2}$= 53,223	0,811	0,901	75,853	V.High

The Greenshield equation model of the relationship between traffic characteristics can be seen in table 4.9.

Table 4.9 Equation Model of Relationship between Traffic Flow Characteristics After ZoSS Area

Model	Relationship	Equation	
Greenshield	S - D	S =	(58,776 -(58,776/95,333)*D)
	F - D	F =	(58,776*D - (58,773/95,333)*D^2)
	F - S	F =	(95,333*S - (95,333/58,776)*S^2)

From the results of the model analysis, the free speed value (Smax) on the road section under review is 58.776 km / h and the maximum volume value (Fc) is 1400.819 SMP / hour. The maximum volume value (Fc) obtained also illustrates the value of the road capacity.

4.4 Comparison of Before, ZoSS Area, and After ZoSS Area Conditions

The model between traffic speed (S) - traffic density (D) so that the Volume (F) value was obtained as can be seen in Table 4.10.

Table 4.10 Maximum Volume, Speed, and Density Values of the Greenshied Model

Scenario	Smax	Fmax	Dmax
Before ZoSS Area	56.088 km/h	1564.189 SMP/hour	111,552 SMP/km
ZoSS Area	55.989 km/h	1287.807 SMP/hour	92,004 SMP/km
After ZoSS Area	58.776 km/h	1400.819 SMP/hour	95.333 SMP/km
Percentage of Before ZoSS Area to ZoSS Area	0,18 % (Decrease)	17,67 % (Decrease)	17,52 % (Decrease)
Percentage of ZoSS Area to After ZoSS Area	4,98 % (Improvement)	8,78 % (Improvement)	3,62 % (Improvement)

4.5 Calculation of Level of Service Analysis and Degree of Saturation

The level of service at the main hour of operation of the Selamat Sekolah Zone at 07.00 - 08.00 Wita in the area before the Selamat Sekolah Zone obtained a DS value of 0.90 while in the ZoSS area obtained a DS of 0.97 and the area after ZoSS obtained a DS value of 0.86. All areas got an ITP value of E.

5. CONCLUSIONS

5.1 Conclusion

Based on the results of data processing and performance analysis on Jalan Veteran with the Safe School Zone as follows:

1. The Safe School Zone has a significant effect on the performance of the road section. Based on observations that have been made in the area before the Safe School Zone there is a decrease with the maximum volume decreasing by 17.67%, for the average speed there is a decrease of 0.18%, and for the maximum density, there is a decrease of 17.52%. The area after the Safe School Zone experienced an increase from the Safe School Zone area such as a maximum volume of 8.78%, an average speed increase of 4.98%, and a maximum density increase of 3.62%. This can occur due to the influence of activities in the Safe School Zone, starting from the activities of people crossing the road, stopping public vehicles, and also the entry and exit of vehicles into the road, making the flow unstable.
2. The road performance obtained from the Greenshield Modeling Analysis obtained the ITP value with the comparison of V/C in the operating hours of the Safe School Zone, in the area before the Safe School Zone obtained a DS value of 0.90 with an ITP value of E, in the area affected by the Safe School Zone obtained a DS of 0.97 with an ITP value of E, while in the area after the influence of the Safe School Zone obtained a DS value of 0.86 with an ITP value of E. ITP value E according to the Minister of Transportation Regulation No. KM 14 the Year 2006 means that the traffic volume is close to/at capacity, the flow is unstable, and the speed is stopped.

6. LITERATURE

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