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THE EFFECT OF MERGER FLOW CURRENT ON *U-TURN* ON TRAFFIC FLOW CHARACTERISTICS ON A. YANI ROAD KM. 35 IN BANJARBARU CITY

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ABSTRACT

The denser an area is, the denser the traffic movement will be. When the vehicle makes a u-turn movement, it can cause congestion because the vehicle doing a u-turn causes the vehicle volume to get higher and the vehicle speed lower. Jalan A. Yani Km. 35 in Banjarbaru city South Kalimantan province is one of the road sections that connect people to and from the city center. The road has median and median openings to coordinate the u-turn movement. This study aims to determine the performance of traffic that is affected by u-turn and not affected by u-turn. The research was conducted using a field survey method that included traffic volume, vehicle speed and geometric road conditions. The method for analyzing data uses conventional methods (Greenshield, Greenberg, and Underwood models), and the best model relationship is obtained, namely the Greenshield model. From the calculation results of the Level of Service, for road conditions affected by the u-turn LOS the dominant E was 68% with a saturation degree value ranging from 0.88 – 1.00, which occurred at 16.00 – 17.30 CIT and 17.30 – 21.00 CIT. Meanwhile, road conditions that are not affected by the u-turn LOS obtained C of 72% with a saturation degree value ranging from 0.45 – 0.60.

Keywords: Level of Service, Merger, Traffic Flow Characteristics, U-Turn

1. INTRODUCTION

On major roads, a road median is needed, which is made as a separator of traffic lanes to minimize traffic movement problems from the opposite direction. In the median, there is a U-turn movement involving several stages of events that affect traffic flow conditions. There are two types of traffic movement encounters on the u-turn, namely merger (joining) and divergent (splitting) flow. Based on observations, on the A. Yani Km. 35 road section, it can be seen that there are often traffic jams during peak hours, especially during weekends, because there are vehicles that cannot move the u-turn smoothly, causing other vehicles to stop both from the same direction and the opposite direction. This can lead to long vehicle queues. This research is expected to provide an overview of the effect of the merger flow caused by the u-turn on road performance, as well as the level of service at the u-turn facility on the A. Yani Km. 35 road section.

2. BIBLIOGRAPHY REVIEW

2.1 U-Turn Movement

There are two types of traffic movement encounters on a u-turn as follows :

1. Diverging motion

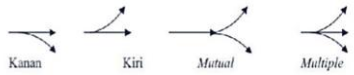

Figure 1. Types of Diverging Traffic Flow Movement Encounters (Hobbs, 1995)

2. Merging

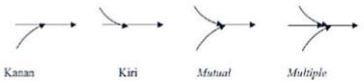

Figure 2. Types of Merging Traffic Flow Movement Encounters (Hobbs, 1995)

2.2 U-Turn Facilities

Several parts are specifically located in the turnaround facility, including openings in the median. In a two-way road network divided (devided), usually at a certain length or distance, the median is given an opening, which is referred to as a median opening that functions to serve a U-turn motion for part of the flow of vehicle traffic to change lanes or directions to reach the destination of the trip.

2.3 Traffic Flow Characteristics

Traffic flow is formed from the movement of vehicles that interact with each other on a section of the road. Traffic flow is expressed in units of passenger cars (smp) by a conversion value called the passenger car equivalence value (emp). The equivalent factor of a passenger car (emp) can be seen in Table 1.

Table 1. emp factors for urban roads (Radam, 2008)

No	Jenis Kendaraan	Ekivalen Mobil Penumpang (EMP)
1	Mobil Penumpang	1,0
2	Mikrobus	1,8
3	Bus	2,0
4	Truk Ringan	1,5
5	Truk Sedang *)	2,0
6	Truk Berat	2,5
7	Sepeda Motor	0,33
8	Sepeda (Tergabung)*)	0,5
9	Kendaraan Roda Tiga	1,0

Traffic flow characteristics used to describe traffic characteristics are volume, speed, and density.

2.4 Relationship Model of Speed, Volume, and Solids

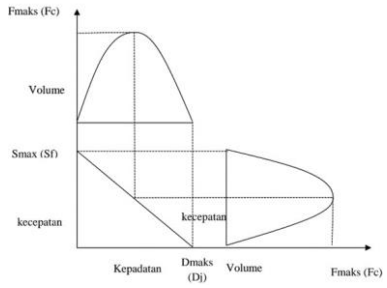

Figure 3. Graph of the Relationship between Volume, Speed, and Density (Radam, 2008)

Dari Figure 3 can be seen as a general form of the mathematical relationship between Speed – Density (S – D), Volume – Density (F – D) and Volume – Speed (F – S). The models used to describe the characteristic relationships of traffic flows are the Greenshields model (linear), the Greenberg model (logarithmic) and the Underwood model (exponential).

2.5 Degree of Saturation

The degree of saturation can be calculated by the formula : $Dj = {}^{F}/_{C}$

2.6 Regression and Correlation Analysis

Regression analysis is a study that studies the functional relationship between variables expressed in the form of mathematical equations; such mathematical equations are called regression equations. Correlation analysis is a method used to determine the closeness of the relationship between two or more different variables described by the size of the correlation coefficient (Telussa, Elvinus & Zeth, 2013). Results, the calculation obtained is integrated with the guideline table to give an interplay to the correlates coefficients can be seen in Table 2.

Table 2. Inter-achievement of R-value (Radam, et al, (2015))

Nilai Absolut Koefisien Korelasi (r)	Interpretasi
0,00 – 0,199	Korelasi sedikit; hubungan yang nyaris diabaikan
0,20 – 0,399	Korelasi rendah; hubungan pasti tapi kecil
0,40 – 0,699	Korelasi sedang; hubungan substansial
0,70 – 0.,899	Korelasi kuat; hubungan yang ditandai
0,90 – 1,00	Korelasi yang sangat kuat; hubungan yang bisa diandalkan

2.7 Service Level Jalan

The level of service of the road is defined to what extent the ability of the road to perform its functions. The level of service (Los) is carried out by the equation: $\text{Los} = \frac{V}{C}$. The parameters of road service levels based on MKJI 1997 can be seen in table 3.

Table 3. Road Service Level Value (MKJI, 1997)

Tingkat Pelayanan	Karakteristik Lalu Lintas	Batas Lingkup V/C
A	Kondisi arus lalu lintas bebas dengan kecepatan tinggi dan volume lalu lintas rendah	0,00 – 0,20
B	Arus stabil, tetapi kecepatan kendaraan mulai dibatasi oleh kondisi lalu lintas	0,20 – 0,44
C	Arus stabil, tetapi kecepatan dan gerak kendaraan dikendalikan	0,45 – 0,69
D	Arus mendekati tidak stabil, kecepatan masih dikendalikan, V/C masih dapat ditolerir.	0,70 – 0,84
E	Arus tidak stabil kecepatan terkadang terhenti, permintaan sudah mendekati kapasitas	0,85 – 1,00
F	Arus dipaksakan, kecepatan rendah, volume diatas kapasitas, antrian panjang (macet)	≥ 100

3. METHODOLOGY

The location of this study was carried out on the A road section. Yani km. 35 in Banjarbaru city, South Kalimantan province. The road is the main road that accesses Banjarbaru to Banjarmasin and is a road to get to the center of activity in Banjarbaru City. Location map and street sketch A. Yani km.35 in Banjarbaru city of South Kalimantan province can be seen in Figure 1 and Figure 2.

Figure 1. Location Map of A. Yani km. 35 road in Banjarbaru city, South Kalimantan province (Google Maps, 08-02-2022)

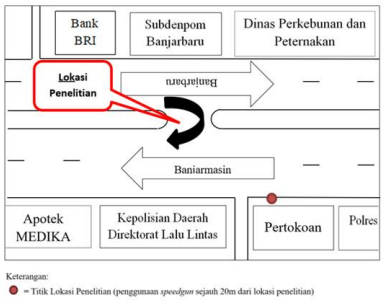

Figure 2. A. Yani road sketch km. 35 in Banjarbaru city, South Kalimantan province

The method for analyzing data uses regression analysis and conventional methods (Greenshield, Greenberg, and Underwood models) and is analyzed using software, namely Microsoft Office Excel. And obtained the value of the characteristic relationship, the efficacy is made a comparison of the values when the u-turn is open and when the u-turn. After that, calculate the Service Level Index of each road section under review.

4. RESULTS AND DISCUSSION

4.1 Road Geometric Data

The geometry data of the road under study can be seen in Figure 1 and Figure 2.

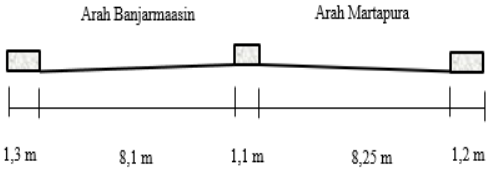

Figure 1. Cross Section of the Research Site

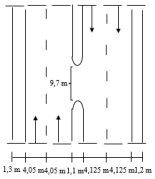

Figure 2. Top View of Geometric Research Location

4.2 Traffic Volume Data

A graph of traffic volume when the u-turn opens and closes can be seen in Figure 3.

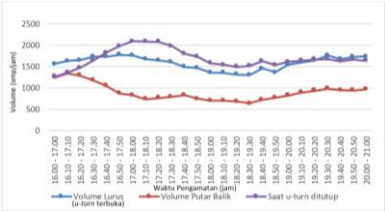

Figure 3. Graph of Traffic Volume Fluctuations When U-Turn Is Open and When U-Turn Is Closed

From Figure 3, it is found that the highest reversal volume occurs at 16.10-17.10 WITA of 1343.07 smp/hour and the highest straight volume occurs at 16.50-17.50 WITA of 1770.56 smp / hour. The highest traffic volume when the u-turn was closed occurred at 17.00-18.00 WITA at 2091.99 smp / hour.

4.3 Vehicle Speed Data

The graph of traffic speed when the u-turn is open and when closed can be seen in Figure 4.

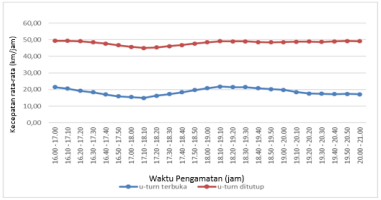

Figure 4. Graph of Average Speed Fluctuations When U-Turn Is Open and When U-Turn Is Closed

From Figure 4, it is found that the highest average speed when the u-turn is open occurs at 18.10-19.10 WITA of 21.72 km / h, and the highest average speed when the u-turn closes occurs at 16.00-17.00 and 16.10-17.10 WITA of 49.28 km/hour.

4.4 Delay Data

A graph of the average delay when the u-turn is open can be seen in Figure 5, while the average chart of the delay time can be seen in Figure 6.

Figure 5. Graph of Average Fluctuations in the Number of Cars Experiencing Delays When the U-Turn Is Open

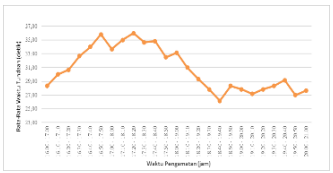

Figure 6. Graph of Average Fluctuations in Delay Time When U-Turn Opens

From Figure 5, it is found that the highest average delay when the u-turn is open occurs at 16.50-17.50 WITA, as many as 15 cars. Meanwhile, from Figure 6, it was found that the highest average delay when the u-turn was open was 36.00 seconds which occurred at 17.20-18.20 WITA.

4.5 Relationship Model Characteristics Affected By U-Turn and Unaffected By U-Turn

The first step to obtaining a relationship between traffic flow characteristics is to determine the density value. Then create the basic equation of the relationship between velocity (S) and density (D) and its correlation. The correlation value should describe the relationship between variables that are strong (> 0.7) and have a realistic free variable (x). From the coefficient values obtained, the equations are formed, and the interpretation of the correlations of the three equations can be seen in Table 1 and Table 2.

Table 1. Model Equations of Relationship of Characteristics Affected By U-Turn

Hubungan	Model Persamaan	r^2	R	X	Keterangan
Greenshields	y = 28,391 - 0,1138.x	0,9558	0,9777	249,482	Sangat Kuat
Greenberg	y = 60,659 – 9,484ln(x)	0,9478	0,9736	559,400	Sangat Kuat
Underwood	$y = 31,444e^{-0,006x}$	0,9492	0,9743	574,701	Sangat Kuat

Table 2. Model Equations of Relationships of Characteristics Unaffected By U-Turn

Hubungan	Model Persamaan	r^2	R	X	Keterangan
Greenshields	y = 55,923 - 0,2233.x	0,9024	0,9499	250,439	Sangat Kuat
Greenberg	y = 76,189 – 7,924ln(x)	0,8607	0,9277	14987,4	Sangat Kuat
Underwood	$y = 56,723e^{-0,005x}$	0,9013	0,9494	807,636	Sangat Kuat

The formed equation can be described in the form of a graph of the relationship between the characteristics of the traffic flow, which can be seen in Figure 7 and Figure 8.

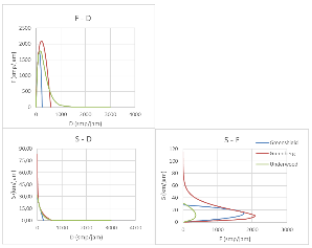

Figure 7. Graph of Relationships Between Traffic Flow Characters Affected By U-Turn

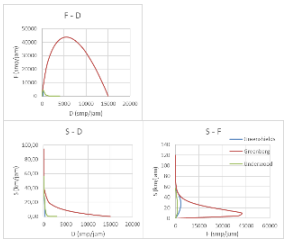

Figure 8. Graph of Relationships Between Traffic Flow Characters Unaffected By U-Turn

A comparison of the values of the traffic flow characteristics of each model can be seen in Table 3 and Table 4.

Table 3. Comparison of Values of Traffic Flow Characteristics Affected By U-Turn

KARAKTERISTIK	Model		
	Greenshield	*Greenberg*	*Underwood*
Sf (km/jam)	28,39	82,50	31,44
Sm (km/jam)	14,19	9,48	11,57
Dj (smp/jam)	249,48	599,40	574,70
Dm (smp/jam)	124,74	220,51	156,99
Fc (smp/jam)	1770,77	2091,29	1815,95
Koef. Korelasi)	0,978	0,974	0,974

Table 4. Comparison of Values of Traffic Flow Characteristics Unaffected By U-Turn

KARAKTERISTIK	Model		
	Greenshield	*Greenberg*	*Underwood*
Sf (km/jam)	55,92	94,44	56,72
Sm (km/jam)	27,96	7,92	20,87
Dj (smp/jam)	250,44	14987,43	807,64
Dm (smp/jam)	125,22	5513,56	211,86
Fc (smp/jam)	3501,32	43689,51	4421,02
Koef. Korelasi)	0,950	0,949	0,928

4.6 Effect of U-Turn on Traffic Characteristics

Under each condition, one model is selected where the model has a correlation coefficient that shows the strongest relationship and the most realistic x value. Taking into account the 2/1D road type with a road width of 8.1 m, then the most relevant model when the u-turn is open and when the u-turn is closed is the Greenshields model. The results of the selected model can be described in the form of a graph of the relationships between the characteristics of the traffic flow, which can be seen in Figure 9.

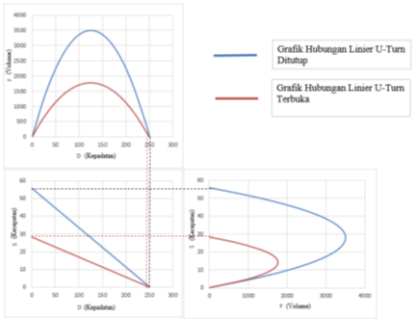

Figure 9. Graph of Relationships Between Traffic Flows in Each Condition with the Selected Model

4.7 Service Level Index

The graph of the division of ITP when the u-turn opens and closes can be seen in Figure 3.

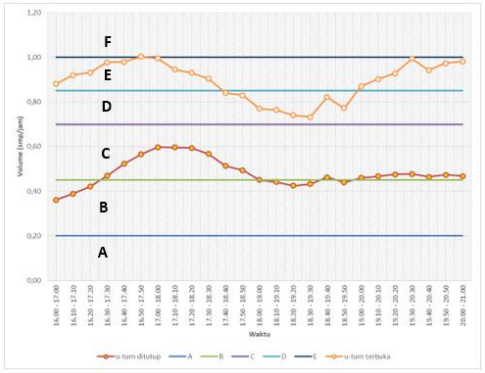

Figure 10. Service Level Index Conditions When U-Turn Is Open and When U-Turn Is Closed

From Figure 10, it can be found that the road conditions when the u-turn is open throughout the observation time show an ITP E of 68%. Road conditions above 0.85 occurred in the 16.50 – 17.50 WITA and 19.00–21.00 WITA. Meanwhile, road conditions when the u-turn was closed during the observation time showed an ITP C of 72%. Road conditions above 0.45 occurred in the 16.30–19.00 WITA and 18.40–21.00 WITA.

4.8 Effect of U-Turn on Saturation Degree

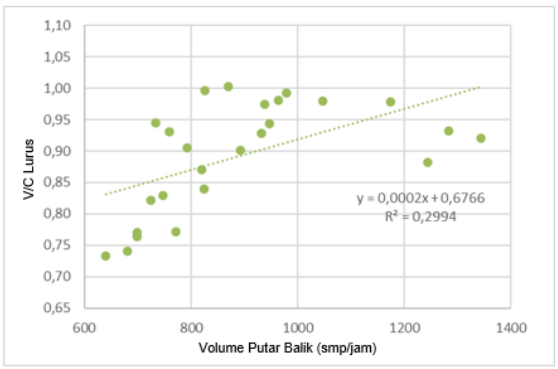

Figure 4. 1 **1** Relationship Between D_J and Reverse Volume

From Figure 4.11, it can be seen that the relationship between the degree of saturation and the volume of the reversal cannot be made in an equation model because the value obtained is so low that it does not have a significant effect.

5. CONCLUSION

Based on the results of the survey and data analysis in the study, the following conclusions can be obtained:

1. When the u-turn is open, the selected characteristic relationship model is the Greenshield model with an Sm of 14.196 km/h and an F C of 1770.770 smp/h. The service level index is at level E of 68%, with a saturation rate above 0.85.
2. When the u-turn was closed, the selected characteristic relationship model was the Greenshield model with an Sm of 27,962 km/h and an F_C of 3501,323 smp/h. The service level index is at level C at 72%, with a saturation rate above 0.45.
3. Comparison of conditions when the u-turn is open and when the u-turn closes has decreased in speed by 49.23% in volume, there was a decrease of 49.43%, and density decreased by 0.38%.

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