The Effect of One-Way System Implementation on Traffic Performance on Arif Rahman Hakim Road, Depok City, Indonesia

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ABSTRACT

Depok City has traffic movement characteristics that are no different from other cities. Traffic movements in Depok City are quite busy and even tend to be congested at certain hours, such as when people go to work and return from work as happened on Arif Rahman Hakim Road which is a 4/2D road type (4 lanes 2 divided directions) which often experiences traffic jams. Efforts to overcome traffic jams are by implementing a system change from 4/2 to 2/1 (two lanes one way) which is expected to improve traffic performance. Observing this phenomenon, this study intends to determine the effect of implementing a one-way system on traffic performance. The findings in the field show that the application of a one-way system can improve traffic performance with an increase in the level of road service in one lane. The results of multiple regression analysis using vehicle situation, side barriers, and road situations simultaneously have a significant effect on traffic performance with an effect value of 10.3%.

Keywords: vehicle situation; side barriers; road situation; one-way system; traffic performance.

INTRODUCTION

In essence, the city is a place for individuals to live or settle (Sitanala, 2005). Along with the development of the city, it will lead to an increase in community mobility. This increase in community mobility requires adequate transportation facilities and infrastructure (Syaiful et al., 2022). For example, in land transportation infrastructure where roads play an important role in transportation activities (Jalil, 2021) and community mobility (Saputra & Muhtadi, 2022). In line with the increase in mobility, it indirectly triggers traffic problems (Paikun et al., 2021). This is because the transportation system network has a significant impact on traffic performance (Amini et al., 2016).

Developments in an area will affect the traffic around it because of changes in land use which result in the movement of traffic flows in and out of the region and affect the pattern of transportation movement (Aldiansyah, 2022). For example, what happened in Depok City, West Java. Depok City has traffic movement characteristics that are no different from other cities. Traffic movements in Depok City are quite busy and even tend to be congested at certain hours, such as when people go to work and come home from work. In addition, there is an imbalance between the development of urban road space and the number of vehicles that pass, as well as the movement of public transportation within the city (Ginting & Widyaningsih, 2022). Imbalance to movement demands has an impact on traffic delays (Omarov et al., 2022).

The increase in the volume of vehicles from year to year certainly creates new problems (Syaiful et al., 2021). For example, the problem of traffic volume that is not in accordance with the geometric capacity of the road which has an impact on decreasing road service performance and indirectly increasing the risk of traffic accidents (Paikun et al., 2021; Ulak et al., 2019). As happened on Arif Rahman Hakim Road which is one of the main roads in Depok City with a 4/2D road type (4 lanes 2 divided directions. Congestion that occurs on Arif Rahman Hakim Road is because Dewi Sartika Road applies a one-way system so that traffic on Arif Rahman Hakim Road is congested during working hours. In addition, along Arif Rahman Hakim Road is a shopping/office and place of business environment which makes the road congested and the road capacity is no longer able to

accommodate passing vehicles. Another problem is that there are quite large side barriers due to the lack of parking facilities which causes vehicles to park on sidewalks and on the roadside, as well as city transportation waiting and dropping off passengers at any place resulting in traffic jams (Ginting & Widyaningsih, 2022).

Based on the phenomenon that occurred on Arif Rahman Hakim Road, the Government Depok City through the Depok City Transportation Service implemented changes to n the traffic system from a 4/2D system to a one-way 2/1D system at 15.00 – 22.00 WIB with the hope of being able to balance the rate of traffic movement and improve road performance (Ginting & Widyaningsih, 2022). The description of the changes in the system can be seen in Figure 1 and Figure 2. With the change in the lane system on the road, the purpose of study is to analyze the effect of vehicle situation, side barriers, and road situations in a one-way system on traffic performance on Arif Rahman Hakim Road.
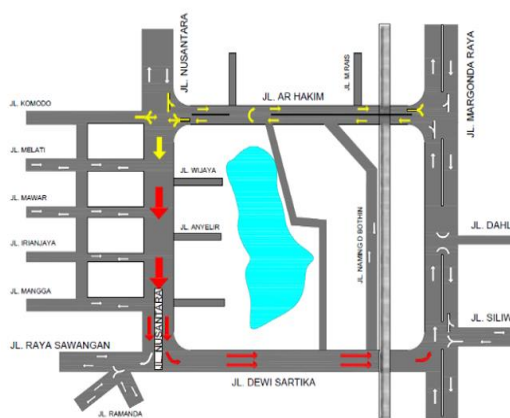

Figure 1. Two Way System Arif Rahman Hakim Road, Depok City Source: Ginting & Widyaningsih (2022)
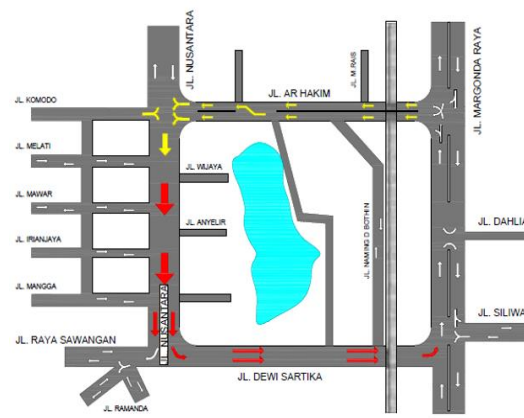
Figure 2. One Way System Arif Rahman Hakim Road, Depok City. Source: Ginting & Widyaningsih (2022)

Congestion theory and traffic performance

Congestion is a condition that occurs where the traffic flow that passes through the road being reviewed exceeds the planned road capacity and results in free road speeds approaching 0 km/hour resulting in queues (PU, 1997). Congestion is a condition where there is a buildup of vehicles on the road due to a large volume of vehicles that are not balanced with traffic infrastructure (Bergkamp, 2011). he occurrence of congestion is the result of an increase in transportation facilities while the transportation infrastructure is inadequate so that infrastructure does not function properly (Triantoni et al., 2020). Or in other words, congestion is the result of high population density with the growth of motorized vehicles that are not supported by infrastructure growth, as well as the increasing growth of online transportation and delivery services (Afrin & Yodo, 2020). The high volume of vehicles on the road, the behavior of public transport drivers waiting to pick up/drop off passengers at any place, as well as the disorderly pedestrians in crossing create queues of vehicles and result in congestion (Mardia & Widyaningsih, 2019). What can be done to reduce congestion is to apply the concept of Transport Demand Management (TDM) which functions in reducing trips, alternative work scheduling, and vehicle restrictions (Widyaningsih, 2013). Therefore, the change to the pattern of traffic movement from a two-way system to a one-way system is to increase the level of road service and traffic smoothness (Wikibuku, 2017).

Road performance is the ability of roads to serve the needs of traffic flows according to their functions and can be measured and compared with the level of road service standards (Ginting & Widyaningsih, 2022). The value of the road service level is used to measure road performance parameters (Suwardi, 2010), and in general the level of road service is used as a measure of limitation due to an increase in traffic volume as indicated by the letter A with the highest level of service to

letter F with the lowest level of service (Peraturan Menteri Perhubungan Nomor 14, 2006). So that the level of road service reflects the condition of service and the quality of service obtained by road users (Wadu, 2020). Road performance is a quantitative measure of the operational conditions of traffic facilities which are influenced by traffic volume, speed, density, side barriers, degree of saturation, and travel speed (PU, 1997).

In this study, the factors that may affect traffic performance due to the change of a two-way system into a one-way system on Arif Rahman Hakim Road are one-way system vehicle situation, one-way system side obstacle, and one-way system road. situations. The description of the relationship between the independent variables and the dependent variable in this study is shown in Figure 3 and the hypothesis proposed based on Figure 3 is shown in Table 1.
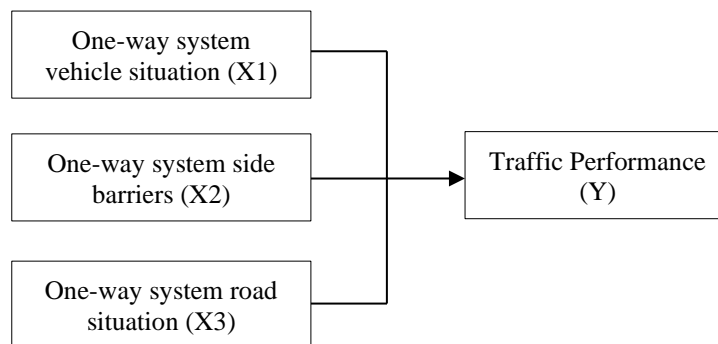

Figure 3. The effect of the one-way system vehicle situation, side barriers in one-way system and road situations in one-way system on road traffic performance.

Table 1. Hypothesis Path

Hypothesis		Path	
1	One-way system vehicle situation	→	Traffic Performance
2	One-way system side barriers	→	Traffic Performance
3	One-way system road situation	→	Traffic Performance

From Table 1, it can be seen the relationship of variables in this study are (1) for determine the effect of the one-way system vehicle situation (X1) on traffic performance, (5) to determine the effect of the side barriers on the one-way system (X2) on traffic performance, and (6) to determine the effect of the road situation on the one-way system (X3) on traffic performance.

RESEARCH METHODS
Place and time of research

The location of the research is on Arif Rahman Hakim Road, Depok City and has been carried out in August 2021 – October 2021.

Method of collecting data

The collection method used in this study was to distribute closed questionnaires via google form which was distributed to 100 respondents using Arif Rahman Hakim Road. The variables studied are one-way vehicle situations (X1), one-way side barriers (X2), one-way road situations (X3) which are all independent variables, and the dependent variable is traffic performance (Y). The scale used in measuring the question items is likert with 5 levels of alternative answers. Level 1 is used for strongly disagree statements, and level 5 for statements strongly agree. The reason for using the likert scale is because it is more accurate than multiple choice (Jalaludin et al., 2022; Jalaludin & Widyaningsih, 2022). The variables studied are described by operational concepts through dimensions and indicators as in Table 2.

Table 2. Measurement Item

Variabel	Sumber	Indicator	
one-way system vehicle situation	Ginting & Widyaningsih (2022)	[1]	Traffic flow
		[2]	Traffic volume
		[3]	Vehicle speed
		[4]	Average speed of vehicle
		[5]	Vehicle queue
one-way system side barriers	Ginting & Widyaningsih (2022)	[1]	Parked vehicles
		[2]	Slow moving vehicle
		[3]	Pedestrian
		[4]	Parked public vehicles
		[5]	Vehicles entering/exiting on the side of the road
one-way system road situation	Ginting & Widyaningsih (2022)	[1]	Degree of saturation
		[2]	Service level
		[3]	Road capacity
		[4]	Traffic Direction width
		[5]	Traffic Composition
Traffic performance	Ginting & Widyaningsih (2022)	[1]	Road safety management
		[2]	Vehicle safety
		[3]	Degree of saturation
		[4]	Service Level
		[5]	Environmental conditions in congested areas

Data processing

This study uses a quantitative approach to measure the effect of independent variables on dependent variables as shown in Figure 3, as well as the measurement items in Table 2 to be further processed with statistical data.

Data analysis

Multiple linear regression analysis was used as the basis for data analysis using SPSS. The steps taken are to test the prerequisites including validity and reliability tests, normality tests, linearity tests, multicollinearity tests, and heteroscedasticity test.

RESULTS AND DISCUSSION

Existing condition Arif Rahman Hakim Road

The results of the calculation of service level based on basic capacity and degree of saturation are shown in Table 3.

Table 3. Road Service Level

No.	System	Traffic Direction	Capacity Street (pcu/ hour)	Volume (pcu/ hour)	Degrees Saturation (pcu/ hour)	Level Service (LoS)
1	Two-way direction	**Lane 1,** Ramanda Interchange – PLN	3069	1458.31	0.48	C
		Lane 2, PLN – Ramanda Interchange	3069	1311.59	0.43	C
2	One-way direction	**Lane 1**, Ramanda Interchange – PLN	3069	2015.55	0.66	C
		Lane 2, Ramanda Interchange - PLN	3069	892.80	0.29	B

Source: Ginting & Widyaningsih (2022)

Characteristics of respondents

Characteristics of 100 respondents who using the road on Arif Rahman Hakim Road, Depok city can be seen in the Table 4.

Table 4. Characteristics of Respondents

No	Respondent Data Overview	Number of Voter Respondents	Percentage
1	Using Vehicle		
	Car	62	62%
	Motorcycle	38	38%
	City transport	-	-
	Other Transportation	-	-
2	Residence		
	Depok City	82	82%
	Outside Depok	18	18%
3	Passing on Arif Rahman Hakim Road on the Two-Way System		
	Often (5 to 7 days a week)	60	60%
	Rarely (3 to 4 days during one week)	29	29%
	Very Rarely (1 to 2 days per week)	11	11%
4	Passing on Arif Rahman Hakim Road on One Way System		
	Often (5 to 7 days a week)	62	62%

No	Respondent Data Overview	Number of Voter Respondents	Percentage
	Rarely (3 to 4 days during one week)	27	27%
	Very Rarely (1 to 2 days per week)	11	11%

Source: Ginting & Widyaningsih (2022)

Validity and reliability test results

Validity test is evidence that the instruments, techniques, and or processes used in measuring a question are truly in accordance with the intended concept. This test aims to measure whether or not a question item is valid. An item is said to be valid if the corrected item total correlation (r_{count}) is greater than r_{table}. The results of the instrument validity test for the variables X1, X2, X3, and Y are shown in Table 5.

Table 5. Validity Test Results

Item	r_{count}	Item	r_{count}	Item	r_{count}	Item	r_{count}	Description
X1.1	0.243	X2.1	0.449	X3.1	0.681	Y.1	0.651	Valid
X1.2	0.344	X2.2	0.383	X3.2	0.512	Y.2	0.663	Valid
X1.3	0.589	X2.3	0.342	X3.3	0.538	Y.3	0.662	Valid
X1.4	0.476	X2.4	0.470	X3.4	0.673	Y.4	0.613	Valid
X1.5	0.686	X2.5	0.550	X3.5	0.668	Y.5	0.705	Valid
X1.6	0.625	X2.6	0.521	X3.6	0.741	Y.6	0.591	Valid
X1.7	0.639	X2.7	0.396	X3.7	0.676	Y.7	0.615	Valid
X1.8	0.689	X2.8	0.562	X3.8	0.748	Y.8	0.622	Valid
X1.9	0.600	X2.9	0.255	X3.9	0.545	Y.9	0.437	Valid
X1.10	0.348	X2.10	0.646	X3.10	0.529	Y.10	0.638	Valid
X1.11	0.677	X2.11	0.415	X3.11	0.706	Y.11	0.638	Valid
X1.12	0.453	X2.12	0.634	X3.12	0.654	Y.12	0.701	Valid
X1.13	0.441	X2.13	0.584	X3.13	0.647	Y.13	0.561	Valid
X1.14	0.573	X2.14	0.269	X3.14	0.684	Y.14	0.709	Valid
X1.15	0.527	X2.15	0.472	X3.15	0.683	Y.15	0.678	Valid

It is known that the value of r_{table} which is used as the basis for determining the standard validity value in Table 5 is df = 100 − 2 = 98 with a significance 95%, the value of r_{tabel} is 0,1966. Based on Table 5, because the r_{count} correlation value for all question items is greater than the validity standard value, then all question items are valid.

Reliability test is a test that aims to measure the consistency of respondents ' answers to the question items in the questionnaire. In this study, the instrument reliability test was carried out on all the variables used, namely the X1, X2, X3, and Y questionnaires using Cronbach's Alpha value calculations.

Table 6. Reliability Test Results

Variable	Cronbach's Alpha if Item Deleted	Reliability Standard Value	Description
X1	0.818	0.600	Reliable
X2	0.716	0.600	Reliable
X3	0.900	0.600	Reliable
Y	0.891	0.600	Reliable

Based on information shown in Table 6, all variables have a Cronbach Alpha calculation value > 0, 60. Thus, all variables are reliable.

Normality test results

The normality test in this study was to use the Kolmogorov Smirnov/KS test to prove that the free samples came from the same population. KS test results are shown in Table 7.

Table 7. Kolmogorov Smirnov Test Results

One-Sample Kolmogorov Smirnov Test		Unstandarized Residual			
		X1	X2	X3	Y
N		100	100	100	100
Normal Parameter	Mean	47.76	43.91	51.12	51.30
	Std. Deviation	7.27	6.18	8.62	7.84
Test Statstic		0.078	0.081	0.064	0.088
Asymp. Sig. (2-tailed)		0.140	0.101	0.200	0.053

The information shown in Table 7 shows the significance (Asymp. Sig. (2-tailed)) for all variables valued above 0,05. Thus, the variables X1, X2, X3, and Y meet the assumption of normality because they have a significance value > 0,05.

Linearity test results

The linearity test generally aims to determine whether two variables have a significant linear relationship or not. The results of the linearity test for each variable X1, X2, and X3 on the Y variable in this study are shown in Table 8.

The SPSS output linearity test for each variable X to Y in Table 8 shows a significance value (deviation from linearity) > 0,05. So it can be concluded that there is a significant linear relationship between each variable X and variable Y. As for the value if $F_{count} < F_{table}$ then it meets the requirements for linearity. It is known F_{table} X1 to Y is 1.650 (df deviation from linearity as the numerator and df within groups as denominator), F_{table} X2 to Y is 1.657, F_{table} X3 to Y is 1.612, F_{count} X1 to Y is 1.353 (F deviation value from linearity), F_{count} X2 against Y is 1.190, and F_{count} X3 against Y is 0.779. Because the value of all of $F_{count} < F_{table}$, then the data meets the linearity requirements.

Multicollinearity test results

The multicollinearity test in this study was used to test whether there was a strong correlation between the regression models between the independent variables or not. Basically, a good regression model should not have a correlation between independent variables or there should be no multicollinearity symptoms. The results of the multicollinearity test are shown in Table 9.

The SPSS output of the multicollinearity test as shown in Table 9, the variables X1, X2, and X3 have a tolerance value of more than 0,1. The VIF value for all variables X1, X2, and X3 is less than 10. Therefore, because the tolerance value is > 0,1 and the VIF value is < 10, there is no multicollinearity.

Table 8. Linearity Test Results

			Df	F	Sig.
Traffic Performance (Y)*One-way system vehicle situation (X1)	Between Groups	(Combined)	27	1.387	0.138
		Linearity	1	2.272	0.136
		Deviation from Linearity	26	1.353	0.159
	Within Groups		72		
	Total		99		
Traffic Performance (Y)*One-way	Between Groups	(Combined)	26	1.155	0.309
		Linearity	1	0.274	0.602

system side barriers (X2)		Deviation from Linearity	25	1.190	0.278
	Within Groups		73		
	Total		99		
Traffic Performance (Y)*One-way system road situation (X3)	Between Groups	(Combined)	35	1.003	0.484
		Linearity	1	8.620	0.005
		Deviation from Linearity	34	0.779	0.784
	Within Groups		64		
	Total		99		

Table 9. Multicollinearity test results

Model		Collinearity Statistics	
		Tolerance	VIF
1	One-way system vehicle situation (X1)	0.477	2.098
	One-way system side barriers (X2)	0.963	1.038
	One-way system road situation (X3)	0.478	2.090

Heteroscedasticity test results

A good regression model is a model that does not experience symptoms of heteroscedasticity. If there is heteroscedasticity, it will result in doubts about the results of the regression analysis carried out. This heteroscedasticity test aims to test the occurrence of differences in variance from the residual value in one observation period to another observation period. Heteroscedasticity test in this study was using the Glejser model. The test results of the model are shown in Table 10.

Table 10. Heteroscedasticity Test Results with Glejser

Model		t	Sig.
1	(Constant)	-0.095	0.924
	One-way system vehicle situation (X1)	0.267	0.790
	One-way system side barriers (X2)	1.552	0.124
	One-way system road situation (X3)	0.309	0.758

Based on the output of the SPSS glejser test in table 10, it is known the significance value (Sig.) of each independent variable is 0.79 for X1, 0.124 for X2, and 0.758 for X3. These values are greater than 0.05. Thus, it can be concluded that in these data there are no symptoms of heteroscedasticity in the regression model.

Multiple Regression Analysis
t test results

The t-test was conducted to determine the effect of the independent variable partially on the dependent variable. The results of the t test are shown in Table 11

Table 11. t test results

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	45.2	7.716		5.858	0.000
One-way system vehicle situation (X1)	-0.169	0.151	-0.157	-1.121	0.265
One-way system side barriers (X2)	-0.113	0.125	-0.089	-0.908	0.366
One-way system road situation (X3)	0.378	0.127	0.412	2.948	0.004

Is known: $t_{table} = 2.276$

F Test Results

The F test or simultaneous test is used to determine whether or not there is a joint influence of the independent variables on the dependent variable. The results of the F test in this study are shown in Table 12, and the results of the calculation of the values of R and R square are shown in Table 13.

Table 12. The results of the F Test

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	629.898	3	209.97	3.694	0.014
Residual	5457.102	96	56.85		
Total	6087.000	99			

Is known $F_{table} = 2.699$

Table 13. Value of R and R Square

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.322	0.103	0.075	7.54

The Existing Condition of Traffic on Arif Rahman Hakim Road, Depok city.

Based on the information shown in Table 3, the traffic conditions on Arif Rahman Hakim Road, Depok City when observed from the results of the calculation of capacity, degree of saturation, and value of service level, it can be concluded that in the application of a two-way system in lane one and lane two, capacity and degree Saturation on both lanes is high enough to affect traffic performance with road service level C or the flow is still in the fairly good/stable category. Meanwhile, if the application of a one-way system is applied, the capacity conditions and the degree of traffic saturation in lane one cannot improve traffic performance, where the service level is still C. As for the implementation of a one-way system in lane two, capacity and degree of saturation have a better effect on traffic performance, where the level of service is getting better, namely category B/traffic flow in the stable/good category.

The Effect of One-Way System Implementation on Traffic Performance

Based on the results of the t-test as shown in Table 11, the resulting regression equation is:
$$Y = 42,5 - 0.169(X1) - 0,113(X2) + 0,375(X3)$$
The interpretation of the resulting regression equation is as follows:
[1] The value of the regression coefficient X1 shows a negative value of $-0,169$. This value means that if the value of the One-way system vehicle situation (X1) increases by one unit, then Traffic performance (Y) will decrease by $-0,169(X1)$.

[2]   The value of the regression coefficient X2 shows a negative value of $-0,113$. This value means that if the value of One-way system side barriers (X2) increases by one unit, then Traffic performance (Y) will decrease by $-0,113(X1)$.

[3]   he value of the regression coefficient X3 shows a positive value of 0,375. This value means that if the value of One-way system road situation (X3) increases by one unit, then Traffic performance (Y) will increase by $0,375(X3)$.

Furthermore, based on the results of the F test in Table 12, the significance of the correlation coefficient simultaneously shows the value of $F_{count} = 3.694$. When compared with the F_{table} of 2,699, it is certain that the One-way system vehicle situation (X1), One-way system side barriers (X2), and One-way system road situation (X3) simultaneously have a significant effect on traffic performance (Y). Thus, because $F_{count} > F_{table}$, the resulting multiple regression model is feasible to use. Meanwhile, based on Table 13, the value of the coefficient of determination (R Square) resulting from the equation is 0,103. These results show that all independents in this study simultaneously have an effect of 10,3% on traffic performance (Y), and the rest are influenced by other variables not tested in this study.

Hypothesis test results

Testing of the 3 hypotheses proposed in table 1 uses the results of the t test with a significance level of 5%. The research hypothesis is accepted if the value of $t_{count} > t_{table}$. The level of significance is determined by the value of Sig. resulting from. When Sig. < 0,05, it is certain that this variable has a significant effect. The results of hypothesis testing are shown in Table 14.

Table 14. Hypothesis Test Results

	Hypothesis	Path		t_{count}	t_{table}	Sig.	Description
1	One-way system vehicle situation	→	Traffic Performance	-1.121	2.276	0.265	Rejected
2	One-way system side barriers	→	Traffic Performance	-0.908	2.276	0.366	Rejected
3	One-way system road situation	→	Traffic Performance	2.948	2.276	0.004	Accepted

Information from Table 14, of the three proposed hypotheses, only the third hypothesis was accepted while the others were rejected. Thus, the One-way system road situation (X3) has a significant positive effect on traffic performance (Y) Arif Rahman Hakim Road, Depok City.

CONCLUSION

There are various ways of doing traffic engineering to improve the level of road service. As happened on Arif Rahman Hakim Road which is one of the main roads in Depok City with a 4/2D road type (4 lanes 2 divided directions) engineered into a 2/1D one-way system at 15.00 – 22.00 WIB with the hope of being able to balance the speed of movement traffic and road performance improvement. This study found that the application of a one-way system on the road was able to improve traffic performance by increasing the level of service in one lane. The results of the analysis also found that the three independent variables in this study include the situation of one-way system vehicles, one-way system side barriers, and one-way system road situations simultaneously have a significant influence on traffic performance.

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