Effect of Side Frictions on Level of Service of DI Panjaitan Street in Cawang - East Jakarta

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Abstract. DI Panjaitan street has a heavy traffic congestion on the-day-of -workday especially during peak periods from 7 am to 9 am and 5 pm to 7 pm. This research aims to determine the level of service of DI Panjaitan street especially during peak hours that caused by the traffic flow and the side friction of road. The level of service was determined by using Indonesian Highway Capacity Guidance or IHCG 2014 and the most influential variable of the side friction was determined by using multiple linear regression analysis in SPSS. The research shows that DI Panjaitan street has the level F on Monday during peak hours from 7 am to 9 am and between 5 pm to 7 pm and level from C to D occurred from Tuesday to Friday. The most influential variable of the side friction was determined by equation 0.157+ 0.002 X1 + 0.001 X2 + 0.002 X3. The research shows that the park & stop vehicle, exits + enters, not motorized vehicle, strongly correlates to the value of degree saturation with a correlation coefficient (R) of 0.792.

Keyword: Side Friction, service level of road, Multiple linier regression, IHCG 2014, DI Panjaitan street

1. Introduction

Indonesia is a developing country that has a faster population growth rate and significant economic growth. Jakarta, as a capital city and Indonesia's economic center, has been a strong magnet for most people in the country to work or to run a business. Its impact, Jakarta have been increasing in population and in traffic congestion. Efficient transportation system is a crucial factor for the growth of a nation's economy [1].

A high proportion commuter who works in Jakarta reside in Jakarta's peripheral. At present, public transportations such as Commuter Line, TransJabodetabek, TransJakarta, MRT service commuters in the Jakarta greater area. Commuter Line is a public transportation which reaches out the Jakarta greater area with big capacity to move commuters and good quality of services [2]. Up to now, this mode is not yet fully integrated with other public transportations. Therefore, the pattern of travelling commuters in the Jakarta greater depend on most of private vehicles such as motorcycle and car [3]. Increase in vehicular population along with shortage of urban road space is manifested in the form of road side frictions [4]. Its impact, the unavoidable daily massive traffic jam has been occurred on the road network of Jakarta especially during peak-hours.

Cawang is an area and includes one of the strategic areas in Jakarta. This area has been the strategic area in Jakarta for two reasons, 1) increasing land use intensity; 2) the primary access point to Jakarta

from Jakarta's peripheral. In this area is also available many commercial and office buildings, hotels, entertainment centers, shopping centers, schools and campuses. The high- intensity land use has effect on roadside frictions such as the movement of vehicles enter to and exit office buildings, entertainment and shopping centers, schools, campuses, and those that stop on roads in the area. Side friction greatly affect the level of service in a road segment. The most obvious effect is reduced road capacity [5].

DI Panjaitan street is one of the main street in Cawang and connected with Mayjen Sutoyo street, and with many roads from Bekasi, Bogor, Depok, and Cikampek toll road. High-land use causes big impact on the road side friction in DI. Panjaitan street. Furthermore, the movement of vehicles turning to Kalimalang street accuse the friction to the road segment. Likewise, many vehicles entering into all directions will increase the traffic load. These factors cause decreasing the level-of-services (LOS) of DI Panjaitan street.

Research was conduct to determine the impact of roadside frictions on LOS for road. Side friction has been interrupted continuity flow of traffic because the road that should be used for traffic flows are occupied for vehicles to stop. In addition, sidewalks that should be used for pedestrians are interrupted by the number of access in and out of vehicles from the land along the road. Its effect is further increasing the road density [6].

2. Methods

This research uses two methods in order to determine the level of service of DI Panjaitan street and the most influential variable of its side friction. Researchers using Indonesian Highway Capacity Guidance or IHCG 2014 to determine LOS of road and multiple linear regression determine the most influential variable of roadside frictions.

Research on the correlation of data collection activities is to determine whether there is available a relationship between variables in the subject or object of concern for research. This correlation research aims to determine the relationship between two or more variables in one study [7]. This research uses a quantitative research paradigm, where quantitative research is used in scientific research with theories that have been accepted as truth and can be used as a reference for seeking further truth. In the quantitative tradition, the instruments used are predetermined and well-ordered so that they do not provide much opportunity for flexibility, imaginative input and reflexivity [8].

In this research, collecting traffic data covers data of roadside friction and of the number of vehicles from Monday to Friday and from July 6 to 10, 2020 during peak periods from 7.45 am to 9. 00 am and between 5 pm to 7 pm.

Traffic survey was divided into the two kinds of survey, namely primary traffic survey and secondary traffic survey. The primary traffic survey covers 1) measuring road geometric dimension; 2) counting traffic flows [Light Vehicle (LV); 3) motorcycle (MC); 4) heavy Vehicle (HV)]; 5) counting frequency of roadside friction, including parking, stopped vehicle (PSV); 6) enter + Exit Vehicle (EEV); 7) Slow Moving Vehicle (SMV), and 8) measuring conditions on both sides of the road segment.

In this research, secondary data can be obtained from different sources, including 1) Central Bureau of Statistics Jakarta; and 2) Open data sources. The secondary data covers total population of the East Jakarta, and the length of the road segment of the research location.

Traffic survey results was processed by using IHCG 2014 and the side friction survey using multiple linear regression equation in SPSS. Regression analysis is a statistical tool that provides an explanation of the relationship pattern (model) between two or more variables [9]. Multiple Linear Regression equation is used to determine the correlation coefficient value between dependent and independent variables, meanwhile IHCG 2014 was used to determine Degree of Saturation of road, then then interpreted as level-of-service (LOS). Level of service (LOS) is a quantitative stratification of a performance measure or measures that represent quality of service. The LOS concept facilitates the presentation of results, through the use of a familiar A (best) to F (worst) scale. LOS is defined by one or more service measures that both reflect the traveler perspective and are useful to operating agencies [10].

2.1. Data Processing

The traffic survey results were processed in order to calculate traffic flow, roadside friction class and road capacity. The equation for determining the traffic flow is as follows:

$$Q = [(LVlve \times LV) + (MClve \times MC) + (HVlve \times HV)] \quad (1)$$

To examine the combined effects of all the activities the weighing factors (sfw) are used to determine total value of side friction on the road [11]. the equation for determining the side friction weighted frequency (SFWF):

$$SFWF = [(PSVsfw \times PSV) + (EEVsfw \times EEV) + (SMVsfw \times SMV) \quad (2)$$

Here is the equation for determining road capacity:

$$C_O = FC_{LJ} \times FC_{PA} \times FC_{HS} \times FC_{UK} \quad (3)$$

2.2. Data analysis

The output of data processing using IHCG 2014, such as traffic flow and road segment capacity, which can determine the degree of saturation (D_J) as an interpretation of LOS of a road with the equation:

$$D_J = \frac{Q}{C} \quad (4)$$

Analysis of the capacity of the existing or to be upgraded Urban Roads should always maintain the $D_J \leq 0.85$ [12]. Then after getting DJ, continued data analysis using multiple linear regression modeling in SPSS. The regression model used is as follows:

$$Y = b0 + b1X_1 + b2X_2 + b3X_3 \quad (5)$$

Where Y is LOS of road which is an interpretation of the degree of saturation (DJ), while X_1 (PSV), X_2 (EEV), X_3 (SMV) are side friction weighted frequency per kind of side friction. After determining a multiple linear regression equation model, then is followed by the T-test and F-test.

3. Results and discussions

The research shows that the heavy congestion on DI Panjaitan street occurs daily during peak hours. During off-peak hours, the traffic congestion was not significantly. In other words, the level of service of Sudirman street is suitable with LOS designed. It is different during peak hours, the peak traffic flow is relatively high and overloaded. The rush peak traffic congestion is caused by decreasing the volume of vehicles and the level of service. Decreasing the level of road service is caused by rising side friction of street which was caused by many activities such as the mobility of vehicles entry and exit office building and the small intersection, and also the activity of many people using far left lane.

Figure 2. Research Area

3.1. Traffic flow

The result of counting the peak traffic flow from Monday to Friday is showed in table 1.

Table 1. Traffic flow (Q)

Time	Traffic Flow (Q) (lvu/hour)				
	Monday	Tuesday	Wednesday	Thursday	Friday
7 am to 9 am	1568	1223	1358	1189	1063
5 pm to 7 am	1548	999	1181	1190	1181

Table 1 shows that daily the traffic flow fluctuated from Monday to Friday. The highest traffic flow occurred on Monday and the lowest occurred on Friday and on Tuesday. In other words, the traffic flow decreases relatively from Monday to Friday.

3.2. Side friction

The highest level of side friction affecting decreased road performance in the form of vehicles in and out the side road area [13]. Moving vehicles that exits/enters creates conflict points and is added to its high frequency. Vehicles that are turning left and others are turning right to the middle lane to avoid vehicles that turned left has interrupted oncoming traffic flow.

Picking up and dropping off commuters on the left lane have not a significant effect to interrupt moving vehicles on DI Panjaitan street segment. The result of determining the weighted side friction from Monday to Friday during *peak period is* showed in table *2.*

Table 2. Side friction class

Time		weighted frequency	Side friction class
Monday	7 am to 9 am	619	High, H
	5 pm to 7 pm	626	High, H
Tuesday	7 am to 9 am	548	High, H
	5 pm to 7 pm	398	Medium, M
Wednesday	7 am to 9 am	444	Medium, M
	5 pm to 7 pm	456	Medium, M
Thursday	7 am to 9 am	442	Medium, M
	5 pm to 7 pm	407	Medium, M
Friday	7 am to 9 am	434	Medium, M
	5 pm to 7 pm	359	Medium, M

Table 2 shows the highest weighted side friction occurred on Monday during peak periods from 7 am to 9 am and between 5 pm to 7 pm. From Tuesday to Friday was the medium weighted side friction.

3.3. LOS of DI Panjaitan street

Determining the level-of-service of DI Panjaitan street is showed in table 3. According to HCM 2010, the level A presents the best level of road service and the level F is the worst.

Table 3. LOS of DI Panjaitan street

Level of service					
Time	Monday	Tuesday	Wednesday	Thursday	Friday
7 am to 9 am	F	D	D	C	C
5 pm to 7 pm	F	C	C	C	C

The study shows that the level F occurred on Monday. In other words, the traffic flow on Monday was unstable due to queueing vehicles from the traffic light at the intersection of Kalimalang with Degree of Saturation >1, which means a traffic engineering is needed. The Level D occurred on Tuesday and Wednesday during peak hours from 7 pm to 9 pm with Degree of Saturation 0.75-0.84.

3.4. Multiple linear regression

The most influential variables of side friction can be determined by using multiple linier regression and the equation of its multiple linier regression is

$$Y = 0.157 + 0.002X1 + 0.001X2 + 0.002X3$$

3.4.1 Student's T-test. The selection of independent variables which have effect on the volume-to-capacity ratio (V/C) is based on T-test.

- Variable X_1 (public and private vehicles stopped) don't has significant effect on D_J due to $T_{Count} = 0.515 > T_{Table} = 2.447$ (not qualify) and Sig. = 0.625> 0.05 (not qualify)
- Variable X_2 (vehicles entering/leaving the side or the land side of the road) has significant effect on D_J due to $T_{Count} = 2.940 > T_{Table} = 2.447$ (qualify) and Sig. = 0.026> 0.05 (qualify)
- Variable X_3 (slow moving such as non-motorized vehicles) don't has significant effect on D_J due to $T_{Count} = 0.076 > T_{Table} = 2.447$ (not qualify) Sig. = 0.942> 0.05 (not qualify

3.4.2 F test. The SPV, EEV and SMV has an effect on traffic performance simultaneously due to $F_{Count} = 7.609 > F_{Table} = 4.35$ (qualify), Sig. = 0.018 <0.05 (qualify). Although partially, stopped vehicles and non-motorized vehicles do not have a significant effect on Y. The correlation coefficient value (R) = 0.792

4. Conclusion

The highest-peak-hour traffic flow occurred during peak hours on Monday and the lowest occurred at the same peak hours on Friday. The highest weighted Side Friction occurred during peak hours from 7 am to 9 am on Monday and between 5 pm to 7 pm. The service level of DI Panjaitan street segment varies per day between C to F. The lowest service level (LOS F) occurred on Monday, which means it requires a special traffic engineering, based on IHCG 2014. The only X2 variable (vehicles enter/exit the side of the road has a significant effect on Y (Degree of Saturation Value). The Side Friction and the Degree of Saturation value have a strong correlation with R = 0.792.

5. References

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Acknowledgments
First, thank God for the blessings that have been given to us and for my family who have supported me. I as the first author to thank my promotor is **Ir. Efendy Tambunan, Lic.rer.reg** who has helped and guided me while doing my research in the Department of Civil Engineering Program in Universitas Kristen Indonesia, especially in this paper. Hopefully the results of this paper will benefit the academic world, especially Civil Engineering.