Advances in Engineering Research, volume 208
Proceedings of the International Conference on Innovation in Science and Technology (ICIST 2020)

Effect of Oesapa Commercial Activities Towards Traffic Performance on Timor Raya Street Kupang

Mateus R. Sodanango*, Amy Wadu, Yohan A. A. Lada, Jusuf W. M. Rafael
Civil Engineering Department
Politeknik Negeri Kupang
Kupang, Indonesia
*mateus.sodanango@pnk.ac.id

***Abstract*—Increased traffic flow will have an impact on the traffic performance on urban road which results in traffic congestion. Factors supporting the occurrence of congestion is side friction. The Timor Raya Street in Kupang, Indonesia, which at some points is a commercial area with a high level of activity during peak hours, causes traffic congestion problems. One of them is Oesapa commercial area. Therefore, it is necessary to do research Impact of Commercial Activity of Oesapa Towards traffic performance of Timor Raya Street Kupang. Analysis of traffic flow and capacity is carried out based on the Indonesia Road Capacity Guidelines (PKJI). The results of the study show that the v/c ratio has a 66.38% effect on vehicle speed, while side friction like PED, PSV, EEV, SMV simultaneously have a 96.46% effect on average traffic speed flat on the Timor Raya Street.**

Keywords—capacity, speed, urban road, vehicle

I. INTRODUCTION

An efficient urban transportation system is an indispensable component of a developing economy. Around the world, the growth of the transportation sector is considered a key element in economic development. Increased overall economic growth is always accompanied by greater movement of people and goods and greater investment in vehicles and transportation infrastructure [1]. Most arterial roads in many developing countries show deteriorating capacity and poor performance.

Urban land use patterns always have a significant impact on the highway performance of developing countries. One of the factors causing a decrease in the Level of Service (LoS) is the presence of side obstacles along the highway [2]. Traffic congestion problems occur in some developing countries because there are many activities along this road, which affect the performance of the road sections [3]. Roadside activities affect road performance and result in increased inconvenience for road users [4].

Kupang City is the capital of the Province of East Nusa Tenggara which has increased economic growth, trade, and education from year to year. The rate of population growth in 2010-2017 was 2.97% with the rate of economic growth in 2017 of 6.83% [5]. Therefore, it needs to be balanced with adequate road infrastructure to meet the increasing transportation needs of the citizens of Kupang City. The number of vehicles in Kupang City which is increasing every year has the potential to cause serious problems in terms of traffic congestion in the coming years. The latest data on the growth of the total number of vehicles in the city of Kupang has increased by 7.99% each year with the largest percentage increase in the type of motorcycle vehicles of 8.22% [5]. An increase in the number of vehicles causes an increase in the movement of traffic flow that is not matched by an increase in infrastructure will cause congestion. In addition, the main problem that occurs in the presence of side obstacles in large numbers. Including on-street parking, bus stops, roadside access, trading activities, turning movements, pedestrian movements, non-motorized vehicles, slow moving vehicles. This affects starting from reducing speed, reducing road capacity, and harming the safety of motorists and other road users [6].

East Timor roads are classified as national roads which are arterial roads and collector roads in the primary road network system that connects districts and national strategic roads [7]. Some road segments of Timor raya street are in commercial areas so that activities on the side of the road are very disruptive to the movement of traffic. Congestion often occurs during rush hour. Not to mention the added buses and private cars used as rentals, parking on the road to raise and lower passengers makes traffic worse. In 2018 road widening has been carried out to increase road capacity but congestion still occurs in commercial areas due to several socio-economic factors and prevailing land use patterns [8]. Therefore, this study focuses on the effects of existing conditions on the characteristics of urban road traffic in heterogeneous conditions and helps policymakers in making appropriate decisions in terms of design, operation, and law enforcement to effectively manage traffic lanes on the road network and reduce the effects of side barriers. This study was conducted on Timor Raya Street, Kupang.

II. LITERATURE REVIEW

A. Roadway Geometric

Road conditions can consist of various geometric parameters that describe the road, such as the type of facility, track width, shoulder width, and horizontal and vertical alignment. Horizontal alignment, especially the characteristics of horizontal curves, can have a large impact on traffic flow [9]. Horizontal alignment consists of straight elements (tangents) or curved elements. Each of these elements has its own geometrical characteristics which can be achieved. Therefore, flow capacity can vary from one element to another. These data were collected directly from the location survey which included lane width, lateral distance, number of lanes in each direction, median width, and sidewalk width and road shoulder [10].

In the study of Semeida [10] the most influential variable on road capacity was lane width, followed by median width. Increased lane width from 3.6 m to 3.7 m caused an increase in capacity from 1940 to 2115 vehicles / hour / lane. In addition, the increase in median width from 8 m to 10 m caused an increase in capacity from 1900 to 1990 vehicles / hour / lane.

B. Capacity

Capacity means that the maximum traffic volume at some point in the road can pass the unit of time under actual road and traffic conditions. The level of service associated with capacity varies depending on the setting and functional class of the road [11]. Design capacity is the service volume of road traffic that carries out and is generally used as a basis for road planning and design [12].

Effect of activity in an area is very influential on the capacity of the road section. In the study [6] on Jalan Piet A. Tallo, Kupang there was a significant decrease in road capacity during the peak hours of the afternoon at 12.00 - 14.00 which is a midday break for employees and employees and a peak hour at night at 17.00-19.00 which is an office home hour for the community. The location of the road that is in a commercial environment certainly results in a decrease in road capacity.

In the study of Golakiya et al [13] the road capacity was reduced by 32% when the pedestrian crossing reached 1550 people / hour. Research conducted the impact of side barriers on the decrease in road capacity has an impact on traffic performance on the Matraman Raya-Kp. Malay on weekdays is in category E. The dominant factors of the influence of parking facilities and side barriers on the road performance in sequence are vehicles entering the market, slow vehicles, vehicles entering and exiting the parking lot, vehicles stopping and pedestrians.

Patan City has a lane width of 10.5 m but because of parking that utilizes the side of the road, an effective lane is only 7.0 m which results in a reduction in road capacity by 57% [14]. Also due to side obstacles and the presence of non-motorized vehicles, there was a 14% reduction in speed. In the city of Daka, India, there was a reduction in road width due to illegal parking up to 24.20% due to cars, 16.56% due to motorcycle parking, 37.08 ^ due to bus parking and 44.49% due to the application of double parking [15].

C. Side Friction

Side barriers are defined as activities that occur on the side of the road starting from the activity of transporting the way down which affects the normal traffic through the roads [16]. Roadside activities affect traffic flow operations and can cause delays, there are several references that try to measure their effects directly, especially for developing countries where the effects tend to be high [17].

When the side obstacles are in the most severe conditions the road capacity is also reduced which results in traffic congestion problems. In the study [2] the capacity of the road section decreased to 800 vehicles / hour from 1,950 vehicles / hour when the side drag level increased from 50 events to 130 events. Capacity in the city of Warangal, India was estimated at 2909 vehicles per hour for road conditions with side constraints [18]. And the capacity with no side barriers is 3173 vehicles / hour. There was a 9% reduction in capacity due to side barriers. Parking on the street decreases road capacity [19]. In general, side barriers can be in the form of buses that stop at stops, pedestrians walk along the side of the train line and cross randomly, park on the road, exit and entry from the approach road, slow moving vehicles [20].

D. Road Service Level

The level of service (LOS) is a qualitative measure used to indicate traffic conditions in terms of speed, travel time, freedom to maneuver, comfort, comfort, traffic disruption, safety etc. The more ratios, the greater the congestion. A value of 1.0 indicates heavy traffic. LOS that are suitable for various scenarios are presented to deal with existing traffic problems [21].

Salini and Ashalatha [22] state that the presence of various side barriers along the side of an urban road causes a decrease in speed and a decrease in capacity. When the volume reaches 2000-3000 vehicles / hour, which corresponds to the normal peak hour volume of an urban road, the volume of pedestrians greater than 9 people per minute LOS levels from C to D.

III. RESEARCH METHODOLOGY

This research was conducted on the Timor Raya Street, particularly in the commercial area of the Oesapa, Kelapa Lima, Kupang. Secondary data collection methods use literature studies while primary data is obtained using manual traffic count methods. The manual traffic count survey is carried out from Monday to Saturday starting at 06.00 to 19.00. Considering motorcycles, light vehicles, and heavy vehicles. Likewise, the side friction survey was conducted from 06.00 to 19.00. Then the highest peak hour of the 6-day serving was selected as the traffic data used in the analysis.

The method of data analysis uses Indonesian Road Capacity Guidelines, PKJI 2014 formulation which is equipped with a regression analysis to get the relationship of side friction frequency to speed mean space (SMS) and side friction frequency to volume/capacity (v/c) ratio of the road. Based on the resulting model, it can be seen what side friction event have the most influence on the traffic performance of Timor Raya Street. The research flowchart is presented in Figure 1.

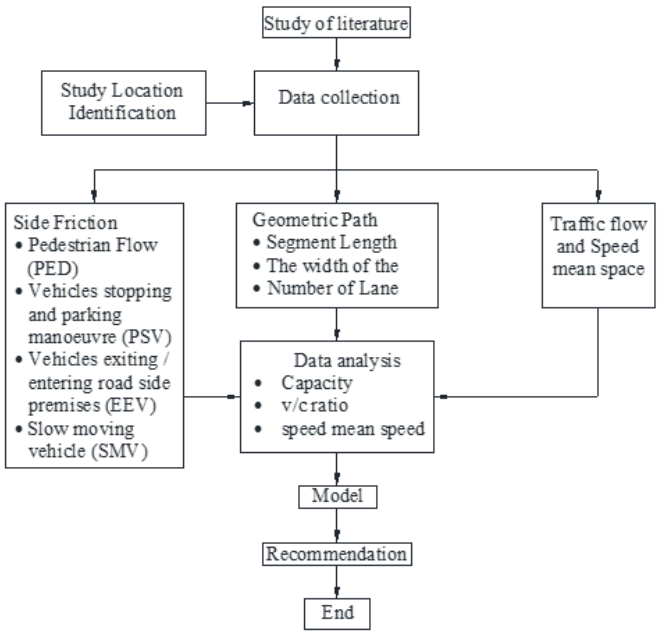

Fig. 1. Flowchart of research.

The aim of this study was to determine the condition of the existing road performance and find a model of side friction effects on vehicle speed on Timor Raya Street in the commercial area of Oesapa. To achieve this aim, there are five main variables that must be examined in this study include: 1) Geometric Roads, 2) Traffic Flow (Q), 3) Road Capacity (C), 4) Speed mean space (SMS), and 5) Side Friction (SF).

$$C = C_0 \times FC_{LJ} \times FC_{PA} \times FC_{HS} \times FC_{UK} \quad (1)$$

Where,
C : Capacity (pcu / hour)
C_0 : Basic capacity (pcu / hour)
FC_{LJ} : Road width adjustment factor
FC_{PA} : Direction separator adjustment factor
FC_{HS} : Factors adjusting side obstacles and road shoulder
FC_{UK} : City size adjustment factor

$$D_S = \frac{Q}{C} \quad (2)$$

D_S : Degree of Saturation
Q : Maximum traffic flow (pcu / hour)
C: Capacity (pcu/hour)

$$\overline{U}_S = \frac{L}{\frac{1}{n}\sum t_i} \quad (3)$$

Where,
Us : Speed mean space (m/s)
L : Length of road section (m)
n : Number of vehicle samples
ti : Vehicle travel time (seconds)

Mathematical models are found from the results of multiple regression analysis based on relevant variables and independent variables and intermediate variables: 1) Dependent variable is speed mean space (SMS). 2) The independent variable is the side friction (parking of vehicles, vehicles and exiting access roads, stopping vehicles, crossing roads).

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 \quad (4)$$

Where,
Y : space mean speed, km/h
a : dependent variable
b_1 : coefficient of determination
x_1 : Pedestrian Flow (PED), Walking ped/hr. +Crossing ped/hr.
x_2 : Vehicles stopping and parking manoeuvres (PSV), events/hr.
x_3 : Vehicles exiting / entering roadside premises (EEV), veh/hr
x_4 : Slow moving vehicle (SMV), veh/hr

IV. Results and Discussion

Timor Raya street is one of the densest street that is traversed by many types of vehicles (Figure 1). On this road, especially in KM + 09 urban village of Oesapa, there is a commercial area whose activity level is very influential on the smooth transportation of the road. This area consists of banks, supermarkets and shops that sell a variety of daily necessities and this area is quite congested with travel cars that use road sides to park vehicles and public transportation that drops passengers along the road. In addition, the number of pedestrians walking or crossing along the road segment is added, and the number of motorized vehicles entering and leaving the side of the road as well as the flow of slow moving vehicles. This is what often causes overcrowding so that congestion often occurs on the Timor Raya Street.

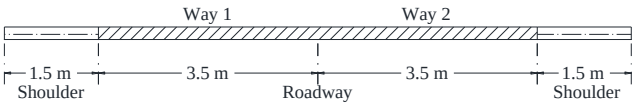

Fig. 2. Cross section of road.

Traffic flow is the number of vehicles that pass a single observation point during one unit of time (hours). Then do the calculation by multiplying the traffic volume with the equivalent value of light vehicles (ekr) of each type of vehicle. To get the total vehicle value in units of light vehicles per hour

(pcu / hr). In Figure 3 it is known that peak traffic flow occurs at 10:00 to 11:00 with 1823 pcu/hr, this is due to dense commercial activity at that hour. Keep in mind at 10:00 also the stores have started operating, this is in unison with the freight transport that is pick up which began to increase at that time. But at 14.00-15.00 the traffic flow reaches the lowest point which is 793 pcu/hour. This is because some stores take a break during the day so that it affects the flow of traffic on these roads. Then in the afternoon the traffic flow conditions start to increase again, because the stores who finished resting.

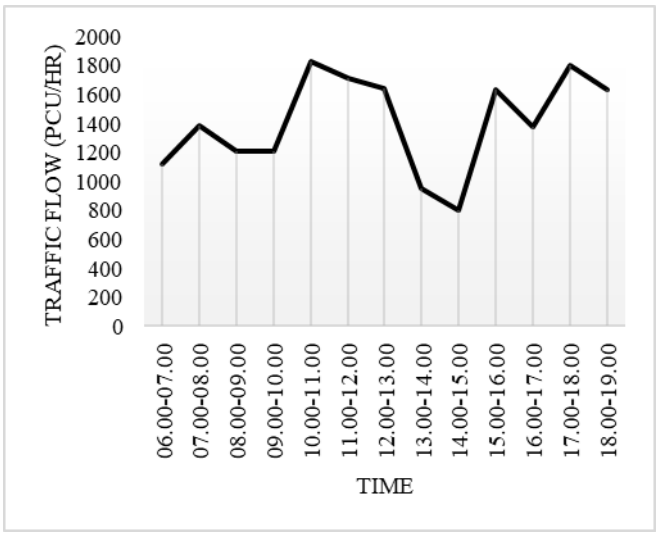

Fig. 3. Traffic flow.

Fig. 4. Oesapa commercial area.

The Side friction data taken in this survey are vehicles that stop and park on the shoulder of the road, pedestrians (which are parallel and cross the road), vehicles entering and leaving the road and slow vehicles (figure 4). After obtaining data from the next study multiplied by each of the side friction weighting factors (parking vehicles, PSV = 1, slow vehicles, SMV = 0.4, pedestrians, PED = 0.5 and vehicles in and out + in, EEV = 0, 7), then the total results of side friction can be seen in Figure 5.

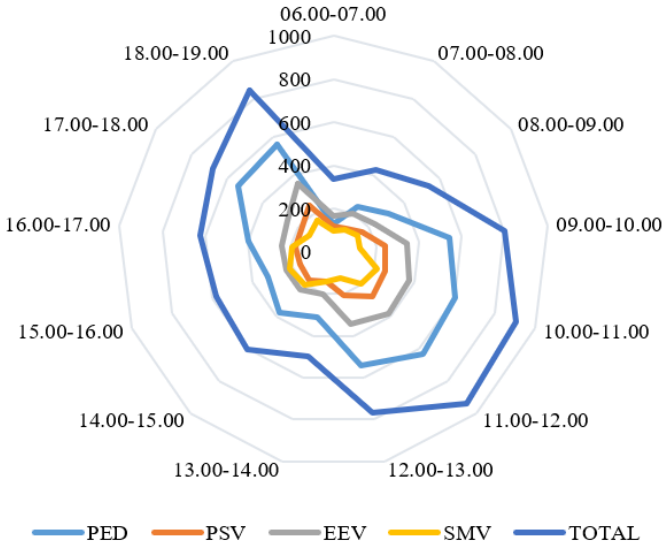

Fig. 5. Side friction frequency.

In figure 5, it is known that at 10-12 the side of road activity increased to more than 900 frequency events. This happened because at that time the shopping activities around the Timor Raya Street section increased coupled with illegal travel cars which parked on the side of the road. This also happens when at 18.00-19.00 the side friction activity reaches 843 frequencies of occurrence, where at that time visitors shopping places tend to increase, slightly decreases when compared to 10.00-12.00 because in the afternoon the building shop is not operational. Whereas at 06.00-07.00 the activity of 300-400 side friction occurred because the shopping centre at that time was not yet operational.

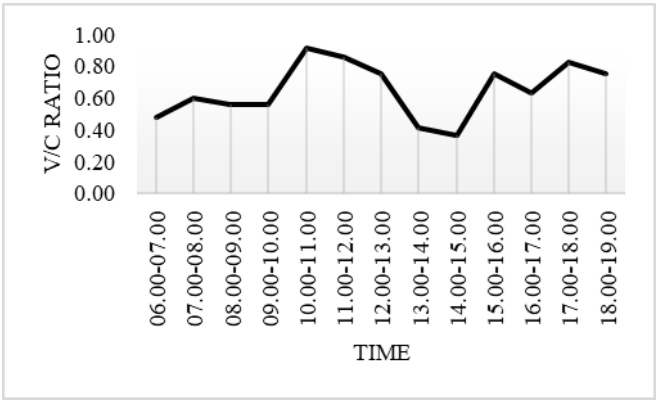

Fig. 6. V.C Ratio.

Based on the results of calculations and analysis during the observation both the traffic volume and side frictions that occur on Timor Raya Street show that the side friction in the area affect the road performance, it can be seen from the large degree of saturation (D_S) that occurs. In Figure 6 it is known that the highest v / c ratio occurs at 10:00 - 11:00 with numbers reaching 0.91. This is because the conditions on the Timor Raya Street at 10.00-12.00 in the Figure 6 of activity beside the

road or along the shoulder of the road are relatively high. so that the influence of side friction on road performance is very large.

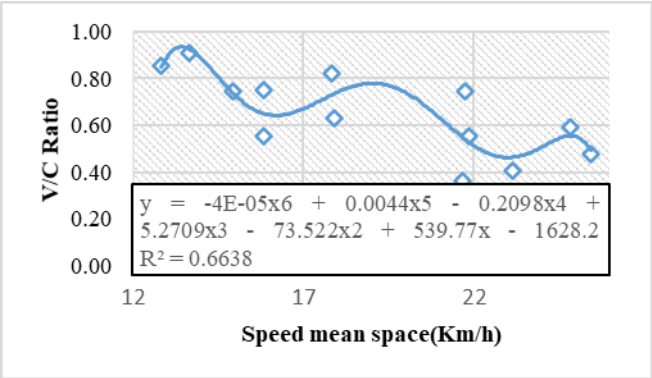

Fig. 7. Average vehicle speed vs V/C ratio.

By using the order 7 polynomial regression model as shown in Figure 7, it is known that the relationship between v / c ratio and the average speed of vehicles on the Greater Timor Road only influences 66.38%. Next try to use the relationship between each type of side friction event and the average speed of the vehicle.

Using multiple linear regression models obtained the effect of side friction on the average traffic speed on Timor Raya Street.

Y = 32.76 - 1.44E-02X1 - 2.51E-02X2 - 1.03E-02X3 - 3.09E-04X4

With a significance value (Sig.) In the F test of 7.49E-06 <0.05, it can be concluded that the PED, PSV, EEV, SMV simultaneously influence 96.46% of the average traffic speed on the Greater Timor Road section, while 3.52% was influenced by other factors which were not considered in this study. From the model above also shows that X2 which is the frequency of occurrence of parking vehicles and stop vehicles (PSV) has the greatest contribution when compared with other variables.

V. Conclusions and Recommendations

A. *Conclusions*

Based on the results and discussion, it can be concluded that:

- The highest v/c ratio occurs at 10:00 - 11:00 with the figure reaching 0.91. This is because the conditions on the Timor Raya street at 10.00-12.00 activity alongside the road or along the shoulder of the road are relatively high. so that the influence of side friction on road performance is very large.
- The impact of v/c ratio to the average speed of the vehicle is 66.38%.
- Side friction events including PED, PSV, EEV, SMV simultaneously have a 96.46% impact on the average traffic speed on the Timor Raya Street and the frequency of parking and stop vehicles (PSV) have the greatest contribution to change when compared to another variable.

B. *Recommendations*

Based on the conclusions that have been described, the activities on the side of the road greatly affect the speed of traffic on the east coast street, therefore the following recommendations are given :

- To institutions involved in infrastructure and transportation systems in order to organize activities on the side of the road so that the convenience of road users is created.
- To motorists and the community on the side of the road to be able to obey the traffic signs that exist along the Timor Raya Street.

Acknowledgment

Thanks to Politeknik Negeri Kupang who support this research and to all of academics in Civil Engineering Department Politeknik Negeri Kupang who have supported the implementation of this research.

References

[1] S. Salini, S. George and R. Ashalatha, “Effect of Side frictions on Traffic Characteristics of urban arterials,” Transportation research procedia, vol. 17, pp. 636-643, 2016.

[2] S. Pal ans S.K. Roy, “Impact of side friction on performance of rural highways in India,” Journal of infrastructure systems, vol. 25, no. (2), pp. 04019006, 2019.

[3] A.M. Rao, S. Velmurugan and K.M.V.N. Lakshmi, “Evaluation of influence of roadside frictions on the capacity of roads in Delhi, India,” Transportation research procedía, vol. 25, pp. 4771-4782, 2017.

[4] Chauhan, R., Dhamaniya, A., Arkatkar, S., Sahu, P. K., & Vikram, D. (2019). Effect of side friction parameter on urban road traffic: under mixed traffic scenario. Journal of the Eastern Asia Society for Transportation Studies, 13, 314-330.

[5] Badan Pusat Statistik Kota Kupang, *Kota Kupang Dalam Angka*. Badan Pus. Stat. Kota Kupang, 2018.

[6] A. Wadu, R. Kusumawardhani and I. Suherminingsih, “Manajemen Lalu Lintas Di Jalan Lingkar Kampus Universitas Brawijaya,” JUTEKS: Jurnal Teknik Sipil, vol. 3, no. (2), pp. 266-272, 2018.

[7] G.A. Funan, R. Cornelis and E. Hunggurami, “Studi Kinerja Jalan Akibat Hambatan Samping Di Jalan Timor Raya Depan Pasar Oesao Kabupaten Kupang,” Jurnal Teknik Sipil, vol. 3, no. (1), pp. 1-12, 2014.

[8] S. Pal and S.K. Roy, “Impact of roadside friction on Travel Speed and LOS of rural highways in India,” Transportation in Developing Economies, vol. 2, no. (2), pp. 9, 2016.

[9] I.H. Hashim and T.A. Abdel-Wahed, “Effect of highway geometric characteristics on capacity loss,” Journal of Transportation Systems Engineering and Information Technology, vol. 12, no. (5), pp. 65-75, 2012.

[10] A.M. Semeida, "New models to evaluate the level of service and capacity for rural multi-lane highways in Egypt," Alexandria Engineering Journal, vol. 52, no. (3), pp. 455-466, 2013.

[11] D.J. Findley, B. Schroeder, C.M. Cunningham and T.H. Brown Jr, Highway engineering: planning, design, and operations. Oxford: Butterworth-Heinemann, 2015.

[12] X.P. Wu and X.H. Du, "Research and Practice on Equilibrium Theory of Road Capacity," Procedia-Social and Behavioral Sciences, vol. 96, pp. 1513-1521, 2013.

[13] H.D. Golakiya, M. Patkar and A. Dhamaniya, "Impact of midblock pedestrian crossing on speed characteristics and capacity of urban arterials," Arabian Journal for Science and Engineering, vol. 44, no. (10), pp. 8675-8689, 2019.

[14] G.J. Joshi and C.R. Patel, "Mixed traffic speed–flow behavior under influence of road side friction and non-motorized vehicles: a comparative study of Arterial roads in India," World Acad Sci Eng Technol Int J Civil, Environ Struct Const Architectural Eng, vol. 8, no. (1), 2014.

[15] M.M. Islam, M.S. Al Razib, M.M. Hasan, M.S. Ali, M.O. Monir and M. Hasan, "Cause of reduction of effective roadway width due to side friction in Dhaka City," American journal of traffic and transportation engineering, vol. 3, no. (1), pp. 6-17, 2018.

[16] A. Forde and J. Daniel, "Performance evaluation of the HCM 2010 platoon dispersion model under midblock pedestrian and truck traffic friction conditions," Journal of traffic and transportation engineering (English edition), vol. 4, no. (6), pp. 522-534, 2017.

[17] Transportation Research Board National Research Council, Highway capacity manual. TRB Business Office, 2000.

[18] P. Gulivindala and A. Mehar, "Analysis of side friction on urban arterials," Transport and Telecommunication Journal, vol. 19, no. (1), pp. 21-30, 2018.

[19] J. Chen, Z. Li, H. Jiang, S. Zhu and W. Wang, "Simulating the impacts of on-street vehicle parking on traffic operations on urban streets using cellular automation," Physica A: statistical mechanics and its applications, vol. 468, pp. 880-891, 2017.

[20] P. Li and J. He, "Geometric design safety estimation based on tire–road side friction," Transportation Research Part C: Emerging Technologies, vol. 63, pp. 114-125, 2016.

[21] R. Gajjar and D. Mohandas, "Critical Assessment of Road Capacities on Urban Roads–A Mumbai Case-Study," Transportation Research Procedia, vol. 17, pp. 685-692, 2016.

[22] S. Salini and R. Ashalatha, "Analysis of traffic characteristics of urban roads under the influence of roadside frictions," Case studies on transport policy, vol. 8, no. (1), pp. 94-100, 2020.