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Feasibility of on-Street Parking Based on Degree of Saturation

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Abstract–On-street parking leads to reduce road capacity and decrease traffic performance of the certain roads. Peunayong, one of busiest area of Central Business District of Banda Aceh City, Indonesia, is facing traffic congestion in certain hours due to parking lot along the roads. This study was conducted to evaluate the feasibility of on-street parking based on road performance. The study was conducted in Peunayong, Banda Aceh, Indonesia. The Indonesian Highway Capacity Manual mention that one of the performance parameter values of traffic condition is Degree of Saturation. The data needed for calculation of Degree of Saturation are the geometric conditions, traffic volume and the side frictions. The results show that on-street parking facilities on segment 2 of Khairil Anwar Street should be evaluated, as the Degree Saturation value is greater than 0.75 (unstable road condition), by changing parking patterns into a parallel configuration or eliminating parking facilities. Furthermore, the parking configuration of R.A. Kartini Street also needs to be rearranged. Despite the stable road performance, this road is uncomfortable to pass because there is only one lane remaining due to unfeasible parking patterns and existence of street market along the segment. The road performance of Khairil Anwar Street (segment 1), Ahmad Yani Street, W.R Supratman Street, T.P. Polem Street, Twk. Daudsyah Street and Ratu Safiatuddin Street is in stable condition, with DS < 0.75. This indicating that on-street parking facilities can be maintained. While as for the W.R. Supratman Street should be evaluated in year of 2017 to avoid traffic jam along this corridor.

Keywords: IHCM, On-street parking, Degree of Saturation, Parking patterns, Traffic jam.

Introduction

Car ownership and car usage have grown rapidly throughout the current decade in Indonesia. Consequently, most urban areas are suffering from unmaintained externalities such as excessive travel times, air pollution, unnecessary energy consumption, and even serious economic loss due to the extraordinary traffic congestion (Sugiarto *et al.*, 2012; Sofyan *et al.*, 2017). Aforementioned phenomena also have evoked urban transportation problem in several big cities in Indonesia including Banda Aceh, a capital city of Aceh province.

To date, the number of vehicles in Banda Aceh has risen hastily due to the enormous public demand for reliable transportation. Furthermore, the inadequate facilities and limited access to public transport, reflects to people using private vehicles, in particular, motorcycle (Anggraini *et al.*, 2017). Motorcycle ownership is highly correlated with the mandatory activity trips as motorcycle is predominant mode used by people in Aceh (Hikmi *et al.*, 2018). As a result, increasing traffic volume leads to rising requirements of parking spaces, which is incompatible with its availability, resulting in on-street parking. However, these vehicles, both two-wheeled and four-wheeled, are not well organized, making it one of the main causes of congestion, especially at peak hour. One of the dense areas in Banda Aceh is the old CBD area at Peunayong, Banda Aceh, which is a crowded area full of native and nonnative visitors. This area is dominated by trading activities providing various society needs, either food or clothing. In addition, there are a lot of machine shops centered in Twk. Daudsyah Street, and five hotels spreading around the area, which are often visited by foreign visitors. At night, this area becomes the most visited culinary spot. These activities have caused a high trip number to Peunayong, consisting of various transportation modes, such as cars and motorcycles. Due to the escalating number of vehicles parking on street, there is no off-street parking in Peunayong. The

parking types applied are different, either angle or parallel parking. On-street parking brings about reduced road capacity, and provokes vehicular traffic at peak hours.

Research of Mutiawati (2011) recommends that on street parking at Peunayong is still maintained. This is due to the dominant vehicles parking in short duration (less than 1 hour). On street parking is suitable for vehicle that park in short duration. Meanwhile for vehicle that park in long duration, it better to use off street parking. Furthermore, Sugiarto *et al* (2013) examined the impact of presence on-street parking on deterioration both travel speed and capacity. It found that capacity diminished slightly 10-13% (275-368vph) compared to the pre-breakdown condition. Likewise, during the breakdown, speed dropped about 13-19% (3-5kph) controlled by pre-breakdown as well. The simulation software so called VISSIM 5.30 was governed to estimate the measurement of effectiveness (MOEs) by removing on-street parking from a site of study. The MOEs reveal that removing on-street parking able to reduce average delay approximately 12 sec/veh (32%) and increase speed about 5kph (24%). According to Sugiarto *et al* (2015) the Indonesian Highway Capacity Manual (IHCM, 1997) is used to assess urban arterial systems till current days. IHCM provides a static method for examining the capacity and does not systematically take into account of bottleneck activities due to on-street parking or median opening section. However, bottleneck activities create interruption smooth traffic flow along arterial streets, and this condition could happen simultaneously; mostly repetitive and predictable in same peak hour demands. They summarize on the existing methodologies considering required data, handled data processing and expected output of each proposed of analysis. The dynamic approach could be more appropriated for analyzing temporal congestion segments (median opening, on street parking, etc.).

Based on the background and the issues mention above, a study on parking condition in Peunayong was conducted. The purposes of study are:

1. To determine on-street parking patterns in the Peunayong, Banda Aceh presently.
2. To evaluate the feasibility of on-street parking patterns in Peunayong, Banda Aceh.

The result is expected to be a reference to evaluate the feasibility of on-street parking at Peunayong.

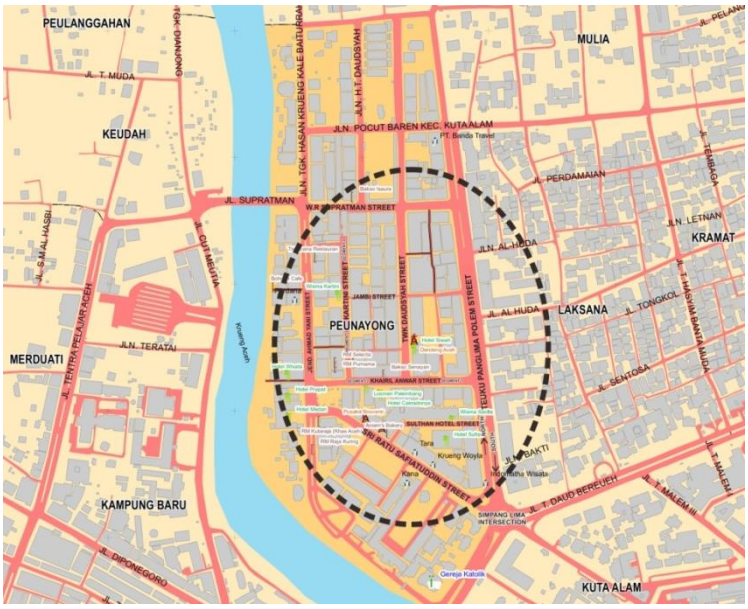

Figure 1. Map of Research Location
Source: Agency for Regional Development (2017)

Materials and Methods

To evaluate the feasibility of on street parking in Peunayong, Indonesian Highway Capacity Manual (1997) was utilized as a reference. This method has been used in many studies such as to evaluate the performance Yogya–Solo street in Yogyakarta and Ir. H. Juanda-Imam Bonjol intersection in Medan. Road performance of Yogya-Solo is poor because DS value is higher than 0.75 and the speed is less than 60 km/jam (Firdausi, 2013). Meanwhile, intersection performance by using IHCM (1997) obtained value of delay 76 second at Level of Service F (Lasthreeida, 2013).

The research location is lies in Peunayong Banda Aceh on seven roads namely T. P. Polem Street (1), W.R**.** Supratman Street, Ahmad Yani Street, R.A. Kartini Street at segment 1 and at segment 2, Twk. Twk. Daudsyah Street, Khairil Anwar Street at segment number one and at segment number two, and Ratu Safiatuddin Street. The map of research sites is shoen in figure 1.

All reviewed streets in this research are one-way direction, except Ratu Safiatuddin Street (two-way direction). The streets are located in Peunayong area, old Central Business District of Banda Aceh. R. A Kartini street is divided into two segments because different in characteristic (road width and the dominant activity). Total width of segment one and two are 11.6 m and 8.1 m. The dominant activity on segment number one is culinary area at afternoon and night meanwhile on segment number two is market area in the morning. Twk. Daudsyah street is the street that dominated by vehicle workshop. Characteristic of dominant activities of Sri Ratu Safiatuddin, T. Panglima Polem, Khairil Anwar, W.R. Supratman and Ahmad Yani streets are almost the same (trading or shopping complex). In these areas, there are some hotels located on Khairil Anwar and Ahmad Yani Streets.

Data used in this research were:

1. Geometric Roads and Existing Parking Patterns
2. The total and the effective of width of road also parking pattern are taken based on measurement and observation in field. This research is using the dominant parking pattern then measured the rest road that effective used by vehicles. Due to the car use space of road wider than motor cycle so that the effective width is based on parking of car.
3. Traffic Volume
   Traffic volume is obtained by calculating all vehicles type and moving direction each street. Observation is done based on type of vehicle (Motor Cycle=MC, Light Vehicle=LV, Heavy Vehicle=HV). Observation is done by using handycam and then calculating. Collecting data of traffic volume has done for 8 hours (on peak hours in the morning, noon, afternoon and night. Peak hour is determined based on visual observation. The chosen observation day is three days i.e two weekdays (Monday and Thursday) and one day off (Saturday or Sunday).
4. The amount of vehicle in Banda Aceh city at least three years.
   This data is needed to predict traffic volume five years ahead.
5. Condition of the environment consists of data of city size, type of road environment and side friction. Condition of the environment consists of data of city size, type of road environment and side friction. The activities of side friction are pedestrian (PED), Parking and Stop Vehicle (PSV), Exit and Entry Vehicle (EEV), Slow Moving Vehicle (SMV) like public transportation and un-motorized (IHCM, 1997). Side friction rate as illustrated in table 1.

Table 1. Side Friction Rate for Urban Street

Side Friction Rate	Code	Range of side friction activities (200 m per hour)
Very Low	VL	< 100
Low	L	100 – 299
Medium	M	300 – 499
High	H	500 – 899
Very High	VH	> 900

Source: IHCM (1997)

Data processing was performed to obtain traffic volume of parking per hour, parking capacity and performance road (DS/*Degree of Saturation*). Calculation of DS is through the following steps:

Traffic Volume Counts

The total volume of vehicles in PCU (passenger car unit) will be calculated according to Indonesian Highway Capacity Manual (IHCM) 1997 by multiplying the number of vehicles of each type with a conversion factor. These conversion factor as described in Table 2.

Table 2. Passenger Car Equivalent for Urban Road

Road Type: One Way devided	Traffic Flow per Lane (vehicle/hour)	Passanger Car Equivalent		
		Heavy Vehicle (HV)	Motor Cycle (MC)	Light Vehicle (LV)
2 lane-1 way (2/1) and 4 lane devided (4/2D)	0	1.3	0.40	1.0
	≥ 1050	1.2	0.25	1.0
3 lane-1 way (3/1) and 6 lane devided (6/2D)	0	1.3	0.40	1.0
	≥ 1100	1.2	0.25	1.0

Source: IHCM (1997)

Table 3. Base Capacity for Urban Road (Co)

Road Type	Base Capacity (pcu/hour)	Remark
4 lane divided or one way	1650	per lane
4 lane undivided	1500	per lane
2 lane undivided	2900	total for 2 way

Source: IHCM (1997)

Table 4. Coefficient factor of road width for capacity (FC_W)

Road type	Effective road width per lane (m)	FCw
4 lane divided or one way	3.00	0.92
	3.25	0.96
	3.50	1.00
	3.75	1.04
	4.00	1.08
	per lane	FCw
4 lane undivided	3.00	0.91
	3.25	0.95
	3.50	1.00
	3.75	1.05
	4.00	1.09
	Two way	FCw
2 lane undivided	5	0.56
	6	0.87
	7	1.00
	8	1.14
	9	1.25
	10	1.29
	11	1.34

Source : IHCM (1997)

Road Capacity Calculations

The steps to get IHCM road capacity by 1997 is as follows:

a. Determining the capacity optimization (Co) per rate that illustrated in Table 3.
b. Determining the coefficient factor of road width for capacity (FC_W) that illustrated in Table 4.
c. Determining the coefficient factor of separator for capacity (FC_{SP}) that illustrated in Table 5.
d. Determining the coefficient factor of side friction for capacity (FC_{SF}) that illustrated in Table 6.
e. Determining the coefficient factor of city size for capacity (FC_{CS}) that illustrated in Table 7.
f. Inserting the data into the equation 1 to obtain road capacity on each street in the study area.

Table 5 Coefficient factor of separator for capacity (FC_{SP})

	Separator (%-%)	50 – 50	55 – 45	60 - 40	65 – 35	70 - 30
FCsp	2-lane 2-way undivided (2/2 UD)	1.00	0.97	0.94	0.91	0.88
	4-lane 2-way undivided (2/2 UD) (4/2 UD)	1.00	0.985	0.97	0.955	0.94
For one way of road and road without separator/undivided, FC_{SP} is 1.00						

Source : IHCM (1997)

Table 6. Coefficient of factor of side friction for capacity (FC_{SF})

Road Type	Side Friction rate	≤ 0.5	1.0	1.5	≥2.0
		Shoulder of road			
4-lane 2 way divided (4/2D)	Very low	0.96	0.98	1.01	1.03
	Low	0.94	0.97	1.00	1.02
	Medium	0.92	0.95	0.98	1.00
	High	0.88	0.92	0.95	0.98
	Very high	0.84	0.88	0.92	0.96
4-lane 2 way undivided (4/2 UD)	Very low	0.96	0.99	1.01	1.03
	Low	0.94	0.97	1.00	1.02
	Medium	0.92	0.95	0.98	1.00
	High	0.87	0.91	0.94	0.98
	Very high	0.80	0.86	0.90	0.95
2-lane 2 way undivided (2/2 UD) or one way	Very low	0.94	0.96	0.99	1.01
	Low	0.92	0.94	0.97	1.00
	Medium	0.89	0.92	0.95	0.98
	High	0.82	0.86	0.90	0.95
	Very high	0.73	0.79	0.85	0.91

Source :IHCM (1997)

Table 7. Coefficient Factor of City Size for Capacity (FC_{CS})

City Size (population)	FC_{CS}
< 0.1	0.86
0.1 – 0.5	0.90
0.5 – 1.0	0.94
1.0 – 1.3	1.00
> 1.3	1.03

Source :IHCM (1997)

Determining the Degree of Saturation (DS)

Indicator of road performance is *Degree of Saturation*/DS. The degree of saturation (DS) is the value ratio between the volume of traffic and capacity of road in units (pcu/hour). DS value is the basis for determining the feasibility of implementation of on street parking.

$$DS = Q/C \quad (1)$$

Remark: DS= degree of saturation
Q = traffic volume (pcu/h)
C = road capacity (pcu/h)

Predicting traffic flow

Predicting traffic volume is based on the growth of vehicle, the amount of local revenue, and population of Banda Aceh city and Aceh Besar District. Traffic volume prediction is calculating by:

$$Tn = To \times (1 + r)^n \quad (2)$$

Remark:
Tn = Predicting traffic volume
To = Existing traffic volume
r = Growth factor
n = Plan year

Parking Feasibility Analysis of Existing Parking Conditions

This analysis will evaluate the feasibility of parking based on road performance at segment roads reviewed. The degree of saturation (DS) will be a reference in determining the feasibility of street parking in the study area. The value of DS which indicates the good performance is shown in DS≤0.75 value then on-street parking facilities can still be retained by the parking patterns. While DS>0.75 shown unstable, the value of travel time (T_t) of vehicles occasionally stop, demand is approaching capacity. Therefore, street with on-street parking facilities is not feasible.

Table 7 Geometric of Road Segment on Existing Condition

No	Name of Street	Type of road	Total of Width (m)	Effective Width (m)	Width of Shoulder (m)	Parking Pattern	
						Light Vehicle	Motor Cycle
1	Sri Ratu Safiatuddin	2/2 UD	13,5	7,0	< 0,5	45°	90°
2	Khairil Anwar (segment 1)	2/1 UD	16,7	6,2	1,0	45°	90°
	Khairil Anwar (segment 2)	2/1 UD	10,5	6,0	1,0	45°	90°
3	Ahmad Yani	2/1 UD	16,0	7,0	1,0	45°	90°
4	W.R. Supratman	2/1 UD	14,0	6,0	< 0,5	45°	90°
5	Twk. Daudsyah	2/1 UD	15,5	6,0	< 0,5	45°	-
6	R. A. Kartini (Segment 1)	2/1 UD	11,6	3,0	< 0,5	30°	90°
	R. A. Kartini (Segment 2)	2/1 UD	8,1	4,0	< 0,5	30°	90°
7	T. P. Polem (North)	4/2 D	11,5	6,0	< 0,5	45°	90°
	T. P. Polem (South)		11,5	6,0	< 0,5	45°	90°

Result and Discussion

Geometric of Road on Existing Condition

Existing geometric conditions of the roads at Peunayong region, an area of study can be seen in Tabel 7. At R. A. Kartini street, effective road width minus parking lot is insufficient for two-lane road. The Effective width of R.A. Kartini street in segment number one and number two are three and four-meters width. Minimum standard width for two lanes is five-meter width. (IHCM, 1997). This is due to the placement of parking and parking patterns that do not appropriate. Cars were supposed to use the patterns of parallel parking but most of the cars were used the angled parking pattern. Determination of the type of vehicle parking is also not appropriate, such as the use of a motorcycle parking lot to the car park. Therefore, it is necessary to curb the pattern of vehicle parking and traffic directions that pass through these roads. Parallel parking patterns which are applied will lead to increase the roads capacity but meanwhile reduced

parking vehicles capacity. The vehicles that can not be accommodated on the road can use Ahmad Yani streets and Khairil Anwar Segment number one streets and Twk. Daudsyah road.

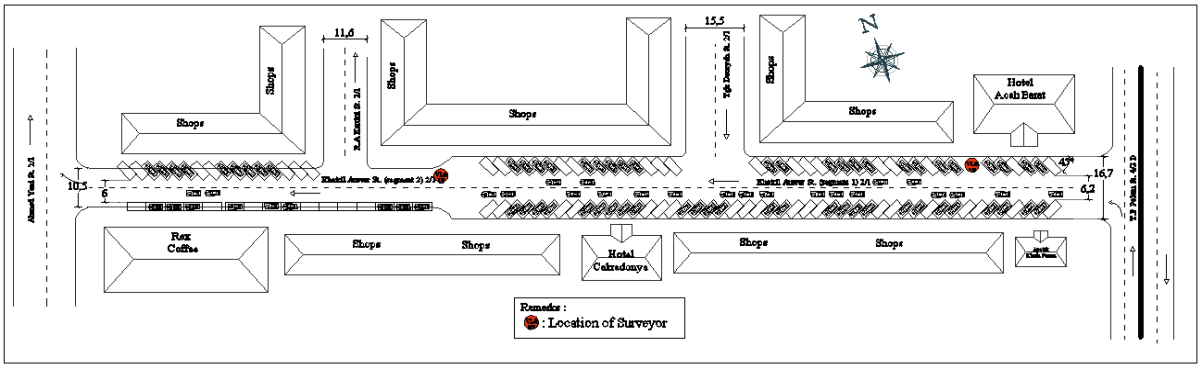

Figure 2. Khairil Anwar Street

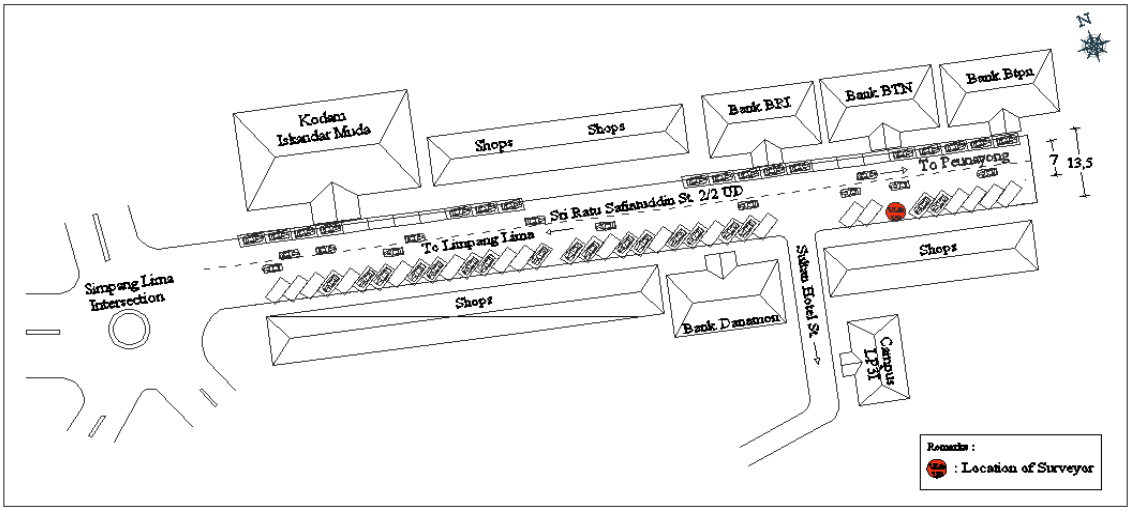

Figure 3. Sri Ratu Safiatuddin Street

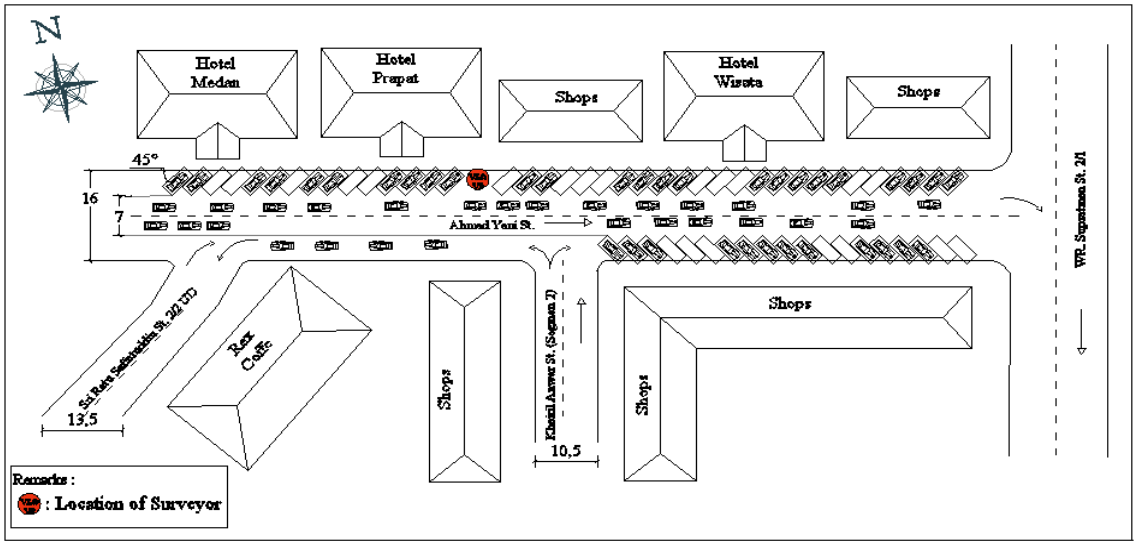

Figure 4. Ahmad Yani Street

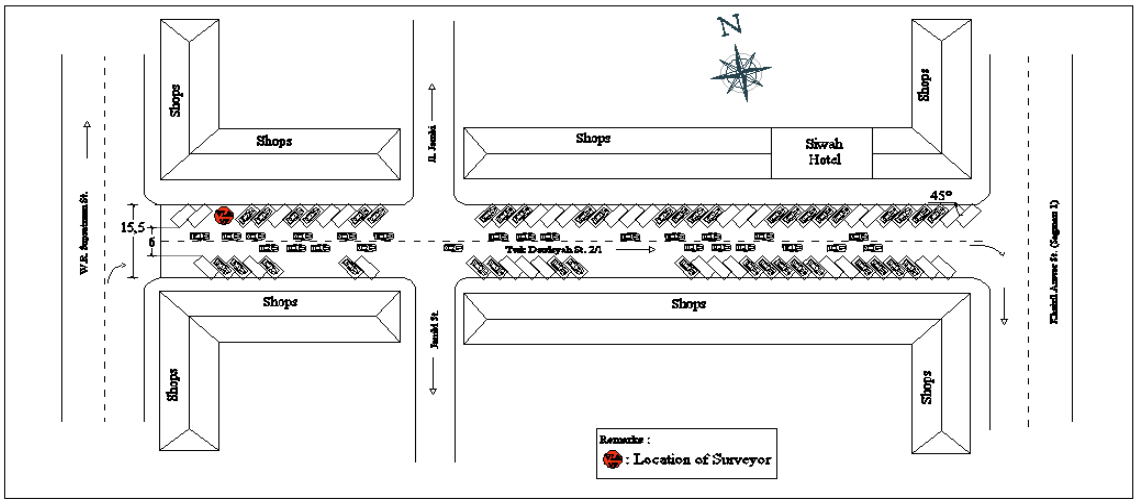

Figure 5. Twk Daudsyah Street

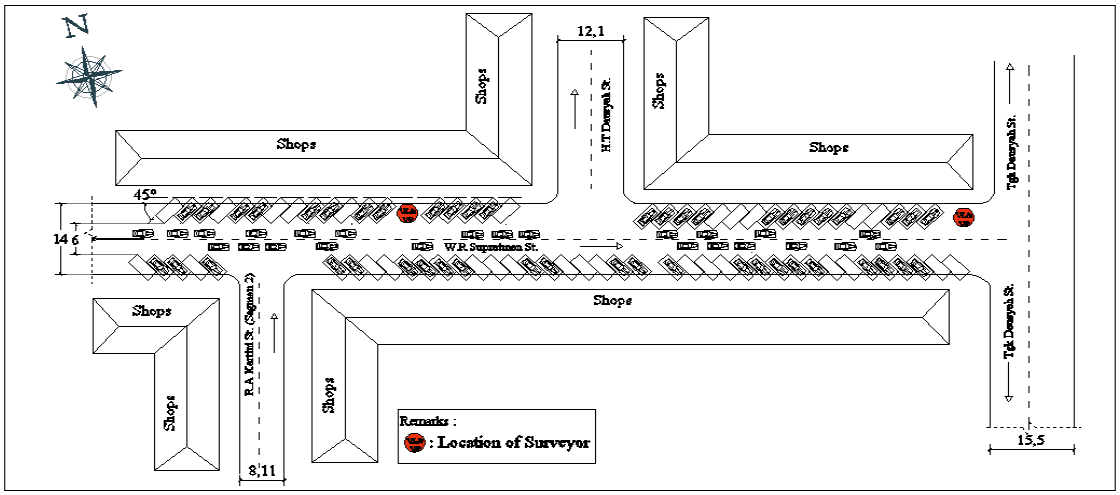

Figure 6. W.R Supratman Street

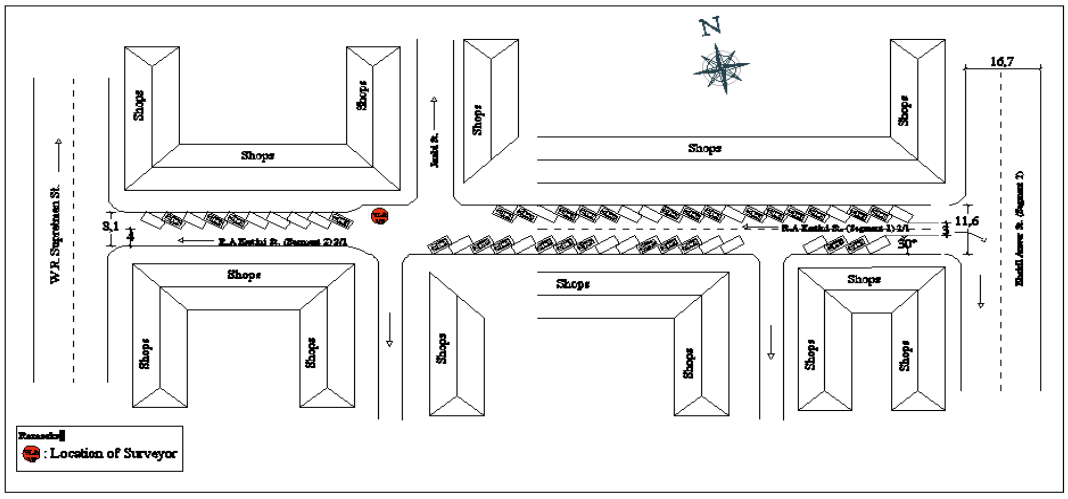

Figure 7. R.A. Kartini Street

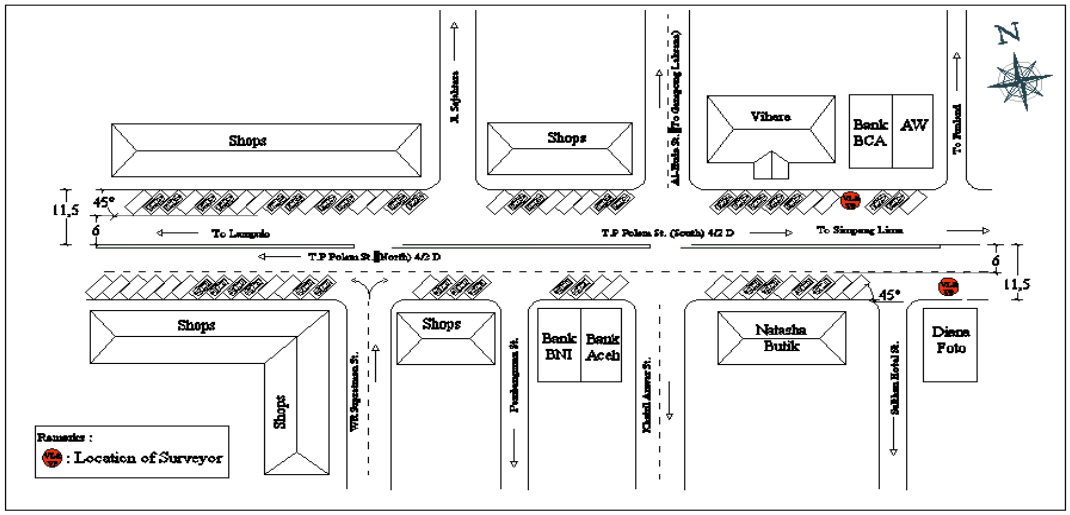

Figure 8. Panglima Polem Street

Traffic Volume at Peak Hours

The result of traffic volume calculation on the roads in Peunayong area obtained a vary peak flow as shown in Table 8. This is due to the different activities around the streets. There are shops and offices on the left and right side of Ratu Safiatuddin street, whereas at the end of the road there is a culinary activity which is open in the afternoons and evenings. So the peak hours occurred in the afternoon at 05:00 pm to 06:00 pm.

As for Khairil Anwar street, Ahmad Yani street, and R. A. Kartini segment number one street, peak hour occurs at night (08.00 pm to 09.00 pm). This is because Khairil Anwar street is one of the main access road to the location of the culinary contained in Ahmad Yani street and R. A. Kartini street, segment number one are open in the afternoon and evening. W.R. Supratman street and R. A. Kartini street, segment number two street are a shopping area and the lively traditional market in the morning at 7:00 a.m. to 8:00 am. Twk Daudsyah street has the same peak hour as W.R. Supratman street and R. A. Kartini street, segment number two, but with different activities. This street is the workshop area of cars and motorcycles that start from early morning until late afternoon. The peak hours are obtained in early morning at 7:00 am to 08:00 am.

The peak hours at T. P. Polem street was obtained during day hours at 12:00 am to 01:00 pm on the side of the road towards the north and 01:00 pm to 02: 00 pm on the side of the road towards the south. This is because there are shops, restaurants, hotels, arcades around the street. With a variety of activities in the morning until late in the evening and mostly at night so that the peak hours in this region occurred during the day. Those traffic volumes at peak hours then used to calculate the road performance.

Table 8.Traffic Volumes on Peak Hours on Streets at Peunayong Area

No	Name of Road Segment	Peak Day	Peak Hour	Volume (pcu/h)
1	Sri Ratu Safiatuddin	Thursday	17.00-18.00	1.129
2	Khairil Anwar (segment 1)	Saturday	20.00-21.00	1.406
	Khairil Anwar (segment 2)	Saturday	20.00-21.00	1.679
3	Ahmad Yani	Saturday	20.00-21.00	1.457
4	W.R. Supratman	Monday	07.00-08.00	1.624
5	Twk. Daudsyah	Saturday	07.00-08.00	556
6	R. A. Kartini (Segment 1)	Saturday	20.00-21.00	473
	R. A. Kartini (Segment 2)	Saturday	07.00-08.00	362
7	T. P. Polem (North)	Thursday	12.00-13.00	1.101
	T. P. Polem (South)	Thursday	13.00-14.00	1.418

Side Friction

Calculation of the side frictions class using side constraints data at peak hours based on the volume of traffic. Calculation of side constraints class derived from the total sum of the number of events per hour with each their respective weights. The results of the calculation of the side frictions can be seen in Table 9.

Table 9. Class of Side Friction on Streets at Peunayong Area

Name of Street	Side Friction					Weight					Total of Weight (event/h)	Class
	PED	SMV	PKL	PSV	EEV	PED 0,5	SMV 0,4	PKL 1,0	PSV 1,0	EEV 0,7		
Sri RatuSafiatuddin	43	18	0	657	0	21,5	7,2	0	657	0	685,7	H
Khairil Anwar (segment 1)	129	93	8	91	122	64,5	37,2	8	91	85,4	286,1	L
Khairil Anwar (segment 2)	233	108	50	73	300	117	20,4	50	73	210	492,7	M
Ahmad Yani	325	44	31	241	173	162,5	17,6	31	241	121,1	573,2	H
W.R. Supratman	230	27	19	385	157	110	10,8	19	385	110	634,7	H
Twk. Daudsyah	154	47	11	437	190	77	18,8	11	437	133	676,8	H
R. A. Kartini (Segment 1)	188	26	0	277	46	94	10,4	0	277	32,2	413,6	M
R. A. Kartini (Segment 2)	820	66	26	157	247	410	26,4	26	157	173	792,3	H
T. P. Polem (North)	69	0	0	118	0	34,5	0,8	0	118	0	152,5	L
T. P. Polem (South)	71	1	0	168	0	35,5	0,4	0	168	0	203,9	L

Remark: PED= pedestrian; SMV= slow moving vehicles; EEV= entry exit vehicles;
PSV= parking and stops vehicles; PKL= street vendor; M= Medium; H= High,

These results indicate that the side frictions class dominant "high/H" especially at Sri Ratu Safiatuddin street, Ahmad Yani street, W.R. Supratman street, Twk. Daudsyah street, and R.A. Kartini Street, segment number two. Sri Ratu Safiatuddin street and Ahmad Yani street are directly related to the culinary activities in the area of Peunayong which operationaly active from afternoon until night. R.A. Kartini street, segment number two and W.R. Supratman street are traditional market areas which are active in the morning.

Many pedestrians and street hawkers held their wares on the streets, either the left or the right side of the road as well as entry and exit vehicles for transporting merchandise. This causes the function of the road becomes narrow. While at Twk. Daudsyah street, the peak hours happened in the morning which had the highest side constraints, especially in the number of vehicles parked in accordance with the predominant activity contained on these roads namely the car repair shop. The cars were parked along both sides of the road. While the side frictions on Khairil Anwar street, segment number two, the road which is one of the main access to the center of culinary activity had "moderate / M" side frictions class close to the "high / H". Likewise R.A. Kartini street, segment number one street is a culinary territory with "moderate / M" side frictions class close to the "high / H". To improve convenience for users of each of the road, then these side constraints need to be curbed. Control of these side constraints will lead the way into better performance.

Feasibility On Street Parking on Existing Condition

Feasibility on street parking in this research measured by Degree of Saturation (DS). Degree of Saturation (DS) is obtained from the quotient of traffic volume by the capacity of the road. The result on existing condition is shown in Table 10. Based on the results of the degree of saturation (DS) acquired a street performance in Peunayong areas still in a state of "stable" with DS <0.75, only in segment 2 of Khairil Anwar street, the performance was "not good" with DS> 0.75. Therefore 45^0 angle parking pattern on the street is not worth, so it needs to be rearranged to parallel parking pattern (alternative 1) or without parking (alternative 2). Thus the width of the road becomes larger, the side frictions (the number of parked vehicles) decreased. It resulting in road capacity will be increased so that the road performance can be improved by DS≤0,75. The results of calculations with these two alternatives is shown in Table 10.

Recommendation for Improvement

Khairil Anwar street, based on the degree of saturation (DS) parameters, has a poor road performance in serving the existing traffic volume. One of the reasons of poor road performance is due to the reduced capacity of the road width which is caused by the on-street parking activity. Therefore, this study recommends to perform repairs on the parking patterns condition from 45^0 existing parking pattern to alternative parallel parking pattern (0^0) and without parking facilities. The results of the performance calculation show that the value of DS <0.75 which indicates a good road performance with a pattern of parallel parking and no parking facilities. The results of these calculations are presented in Table 11.

Table 10. Feasibility On Street Parking on Existing Condition (2015)

Name of Street	Code of Street	Traffic Volume pcu/hour	Road Capacity (pcu/hour)	DS	Feasibility of Parking
		1	2	3=1/2	4
Sri RatuSafiatuddin	7	1129	2411	0,47	< 0,75 Feasible
Khairil Anwar (segment 1)	6	*1405*	*2405*	*0,58*	*< 0,75 Feasible*
Khairil Anwar (segment 2)	6'	***1678***	***2214***	***0,76***	***> 0,75 Not feasible***
Ahmad Yani	3	*1457*	*2406*	*0,61*	*< 0,75 Feasible*
W.R. Supratman	2	*1624*	*2406*	*0,68*	*<0,75 Feasible*
Twk.Daudsyah	5	555	1300	0,43	< 0,75 Feasible
R. A. Kartini (Segment 1)	4	473	1412	0,34	< 0,75 Feasible
R. A. Kartini (Segment 2)	4'	362	1300	0,28	< 0,75 Feasible
T. P. Polem (North)	1	1418	2787	0,51	*< 0,75 Feasible*
T. P. Polem (South)		1101	2787	0,39	< 0,75 Feasible

Table 11. Capacity and Degree of Saturation (DS) Khairil Anwar Street Segment 2

Parking Pattern	Width of Road (m)	Traffic Volume pcu/hour	Road Capacity (pcu/hour)	DS
Parking pattern 45^0 (Existing)	6,0	1678	2213,2	0,76
Alternative 1 (angled parking pattern, angled 0^0)	8,0	1678	2822,7	0,59
Alternative 2 (without parking)	10,5	1678	3920,4	0,43

Khairil Anwar street performance on segment number two at existing condition is "not good" to serve the existing traffic volume. It due to the volume of traffic on this road is greater than the volume of traffic on the segment number one. The high volume of traffic is due to the additional volume of traffic from Twk. Daudsyah street and R.A. Kartini street. Traffic volume of R.A. Kartini street should not burden Khairil Anwar segment number two street because it was the one-way road / it was not headed to Khairil Anwar street, segment number two, yet many motorists who violate the direction. In addition to the second segment of the course is narrower than the first segment so that the second segment has a lower capacity. The performance of Khairil Anwar street on segment number one, Ahmad Yani street, W.R. Supratman street and T.P. Polem street towards the south is relatively high with DS>0.5 but still safe for DS <0.75. These roads have a greater capacity, both in terms of greater width road or the lower side frictions. Thus, on street parking of the four streets can be maintained.

The performance of R.A Kartini street is also "good", with the low DS, but visually dense as the road becomes narrow due to unfeasible parking. Therefore, the road that supposed to be two lanes become only one effective lane with four-meter width. The reduced width of the road causing capacity is also reduced. However, the traffic condition does not lead to a poor street performance because the volume of traffic that passed this way was low. A low volume of traffic occurs because the road was only used by drivers with the goal of these roads, especially to enjoy the culinary. Even some riders who want to go to R.A Kartini street prefer parking on Khairil Anwar and Ahmad Yani street due to limited parking capacity on R.A Kartini street which is narrow and irregular. In addition, many motorcycles come from the opposite direction. Thus, the road is not attractive to be passed by the motorcycle riders. The pattern of parallel parking needs to be applied to refund the amount of 2 lanes in accordance conditions. Sri Ratu Safiatuddin street, Twk. Daudsyah street and T.P. Polem street towards the north are still feasible with on-street parking facilities because the road is still in a good performance with DS<0.75. However, the parking arrangements need to be reinforced, especially in the separation of parking facilities for motorcycles and car.

Feasibility On Street Parking on Predicting Condition

Feasibility on street parking on predicting condition is shown in Table 12-14. The result illustrates that in 2016 the road performance is still the same with existing condition. In 2017 to 2018 the performance of Khairil Anwar segment number two street and W.R. Supratman street is unstable with DS>0.75 and have to evaluated. If this condition is not corrected, the road performance is getting worse and cause congestion. The condition can be evaluated by changing the on street parking type to increase width of the road.

Increasing the width of the road will increase road capacity and decrease degree of saturation (DS) value (DS<0.75). Therefore, congestion can be avoided.

Table 12. Prediction of Feasibility On Street Parking (2016)

Name of Street	Traffic Volume pcu/hour	Road Capacity (pcu/hour)	DS	Feasibility of Parking
	1	2	3=1/2	4
Sri RatuSafiatuddin	1.196	2.411	0,50	< 0,75 Feasible
Khairil Anwar (segment 1)	*1.490*	*2.405*	*0,62*	*< 0,75 Feasible*
Khairil Anwar (segment 2)	***1.779***	***2.214***	***0,80***	***> 0,75 Not feasible***
Ahmad Yani	*1.543*	*2.406*	*0,64*	*< 0,75 Feasible*
W.R. Supratman	*1.720*	*2.406*	*0,71*	*< 0,75 Feasible*
Twk. Daudsyah	590	1.300	0,45	< 0,75 Feasible
R. A. Kartini (Segment 1)	502	1.412	0,36	< 0,75 Feasible
R. A. Kartini (Segment 2)	384	1.300	0,30	< 0,75 Feasible
T. P. Polem (North)	1.481	2.787	0,53	*< 0,75 Feasible*
T. P. Polem (South)	1.167	2.787	0,42	< 0,75 Feasible

Table 13. Prediction of Feasibility On Street Parking (2017)

Name of Street	Traffic Volume pcu/hour	Road Capacity (pcu/hour)	DS	Feasibility of Parking
	1	2	3=1/2	4
Sri RatuSafiatuddin	*1268*	*2411*	*0,53*	*< 0,75 Feasible*
Khairil Anwar (segment 1)	*1578*	*2405*	*0,62*	*< 0,75 Feasible*
Khairil Anwar (segment 2)	***1883***	***2214***	***0,85***	***> 0,75 Not feasible***
Ahmad Yani	*1635*	*2406*	*0,68*	*< 0,75 Feasible*
W.R. Supratman	*1822*	*2406*	*0,76*	***> 0,75 Not feasible***
Twk. Daudsyah	625	1300	0,48	< 0,75 Feasible
R. A. Kartini (Segment 1)	531	1412	0,38	< 0,75 Feasible
R. A. Kartini (Segment 2)	406	1300	0,31	< 0,75 Feasible
T. P. Polem (North)	*1568*	*2787*	*0,56*	*< 0,75 Feasible*
T. P. Polem (South)	1236	2787	0,44	< 0,75 Feasible

Table 14. Prediction of Feasibility On Street Parking (2018)

Name of Street	Traffic Volume pcu/hour	Road Capacity (pcu/hour)	DS	Feasibility of Parking
	1	2	3=1/2	4
Sri RatuSafiatuddin	*1343*	*2411*	*0,56*	*< 0,75 Feasible*
Khairil Anwar (segment 1)	*1671*	*2405*	*0,69*	*< 0,75 Feasible*
Khairil Anwar (segment 2)	***1996***	***2214***	***0,90***	***> 0,75 Not feasible***
Ahmad Yani	*1732*	*2406*	*0,72*	*< 0,75 Feasible*
W.R. Supratman	*1931*	*2406*	*0,80*	***> 0,75 Not feasible***
Twk.Daudsyah	*662*	*1300*	*0,51*	*< 0,75 Feasible*
R. A. Kartini (Segment 1)	563	1412	0,40	< 0,75 Feasible
R. A. Kartini (Segment 2)	431	1300	0,33	< 0,75 Feasible
T. P. Polem (North)	*1660*	*2787*	*0,60*	*< 0,75 Feasible*
T. P. Polem (South)	1308	2787	0,47	< 0,75 Feasible

Conclusions

Based on the results and the discussion, it can be concluded and suggested about several things related to the feasibility of on-street parking according to the Degree of Saturation (DS) parameter. On-street parking facilities at Khairil Anwar street, segment number two should be evaluated by changing in a parallel parking pattern or parking facility has been omitted in order to increase street capacity and its performance becomes better with DS <0.75. On predicting condition, W.R. Supratman Street should be evaluated in 2017 by changing the on street parking pattern. The parking lot at R.A. Kartini street also needs to be rearrange although based on the value of DS the street performance is considered good but visually the road is not convenient to pass because the narrowness of its. Only one of two lanes is left due

to wrong parking patterns (parallel parking pattern should be used instead of angled parking patterns) and also due to the presence of street hawkers along the side road of the segment number two in the morning. The on-street parking facilities performance at Khairil Anwar Street segment number one, Ahmad Yani street, W.R. Supratman street, T.P. Polem street, Twk. Daudsyah street and Sri Ratu Safiatuddin street can be maintained with "good" street performance by DS <0.75.

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