Analysis of the Impact of Parking on Traffic Performance on the Roads Around the Cisaat Market

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ABSTRACT

The Cisaat Sukamanah highway is one of the arterial road segments that pass through Sukamanah Village, Cisaat District, Sukabumi Regency, West Java and is the main road connecting Cisaat Regency with Sukabumi City. This road belongs to the category of arterial road, for urban road conditions it is designed with a speed of 60 km/hour. In addition, on arterial roads, traffic should not be disturbed by local activities.

The purpose of this study is to determine the performance of the Cisaat Sukamanah Highway, especially in front of the Cisaat Baru Market, in its current (existing) condition, to estimate the conditions on the Cisaat Highway. -12.00 wib with a total of 995.1 smp/hour vehicles. And the average speed is 192.3. For the highest side friction incident occurred on Monday at 06.45-07.45 with 453.3 hourly weighted events. Overall, the performance of the Cisaat Sukamanah highway is B.

The highest accumulation results in the on street parking area of Jalan Pasar Baru on Sunday, March 21, 2021 for motorcycles were 681 vehicles occurring at 16.00-17.00 WIB and car vehicles were 230 vehicles occurring at 13.00-14.00. The results of observations in this study indicate that the overall parking volume on Sundays for motorbikes is 4709 and for cars is 2210. And the parking turnover rate obtained from the calculation results shows that the use of parking spaces, the parking turnover rate (Parking Turn Over) for motorbikes is 8, 4 vehicles/space and 17 vehicles/space for 11 hours of observation. And the average percentage of the parking index using motorcycle and car parking spaces on Sundays exceeds 100%. Thus, it can be concluded that the parking area is not efficient in accommodating parking vehicles.
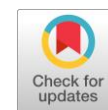
1. Introduction

As a transportation infrastructure, roads are essentially an important element in realizing economic growth and achieving healthy and dynamic social stability [1] [2]. Therefore, the performance of the road section needs to be considered [3]. The performance of the road segment can be defined, the extent to which the road's ability to carry out its function [4]. The level of road service in accommodating the need for movement can be expressed by the parameter of road capacity or by the speed of traffic on the road [5] [6]. Road capacity is the maximum traffic flow that can be maintained along a section of the road under certain conditions [7]. Road capacity is influenced by the main characteristics of the road, which include road geometry, traffic flow characteristics, and roadside activities (side barriers)[8].

Cisaat Sukamanah Street is one of the roads that has an important role in supporting the development of the trade sectors. However, Cisaat Sukamanah Street cannot be separated from the problem of congestion caused by market activities that use the road as a selling area and also a parking area. Coupled with activities that can cause traffic jams, including people going to work,

going to school, and other needs that usually occur in the morning to coincide with Cisaat market activities.

The phenomenon of Congestion is an interesting thing to study [9], as is the case with congestion caused by the influence of trade center activities on traffic on Jalan Cisaat Sukamanah where there are many Side Barriers which greatly affect the performance of the road [10] [11]. This causes traffic jams. One of the most common side barriers in market and shopping areas is parking activities using the road (On Street Parking) [12] [13].

Based on observations, motorbike riders who want to visit Market and Shops at Cisaat Market prefer to park on the road in the corridor of the road [14] , as well as those who want to visit shops and other trading places on Cisaat Market Road Sukamanah which is crowded. For vehicles that are parked, because the parking area is not sufficient for vehicle capacity, parking is carried out on the road, thus hampering traffic performance and eventually congestion occurs [15].

2.Method

2.1.Research Sites

This research takes a case study of on-street parking activities on Cisaat New Market Road Sukamanah. By taking the boundary of the research area in the Cisaat New Market Road. The total length of 1,400 meters of the entire Cisaat Market Road, only 890 meters were used as the study location.

2.2.Research methods

The method used is the direct observation method, because the Congestion Phenomenon is an interesting thing to study [16], as is the case with congestion caused by the influence of trade center activities on traffic on Cisaat Road Sukamanah where the number of side obstacles greatly affects the performance of the section road. This causes traffic jams. One of the most common side barriers in market and shopping areas is parking activities using the road (On Street Parking).

2.3.Data Analysis Method

Based on the data collected, the data processing is generally divided into 3 parts, namely:

1. Data processing related to traffic volume.

Traffic volume data processing is carried out by converting each type of vehicle recorded into passenger car units (pcu) in accordance with their respective emp values based on the provisions of the 1997 MKJI. Furthermore, the data is presented in graphical form so that it can be seen the fluctuations every hour clearly [7].

2. Data processing related to parking conditions.

Parking data that has been recapitulated will calculate the value of parking accumulation, parking index and parking volume so that solutions can be found for handling parking problems on the road body [17].

3. Data processing to determine the V/C Ratio or Degree of Saturation.

Data from the traffic volume that has been obtained is divided by the existing road capacity and the degree of saturation is found at the busiest hour with the highest traffic volume (vehicles/hour) on Sundays and Mondays [18].

4. Determine the Level of Road Service.

The data that has been surveyed, processed and analyzed, then determines what level of road service is at what level [19]

2.4. Research Flowchart

Below is the research flow which is described in the Flowchart diagram on figure 1:
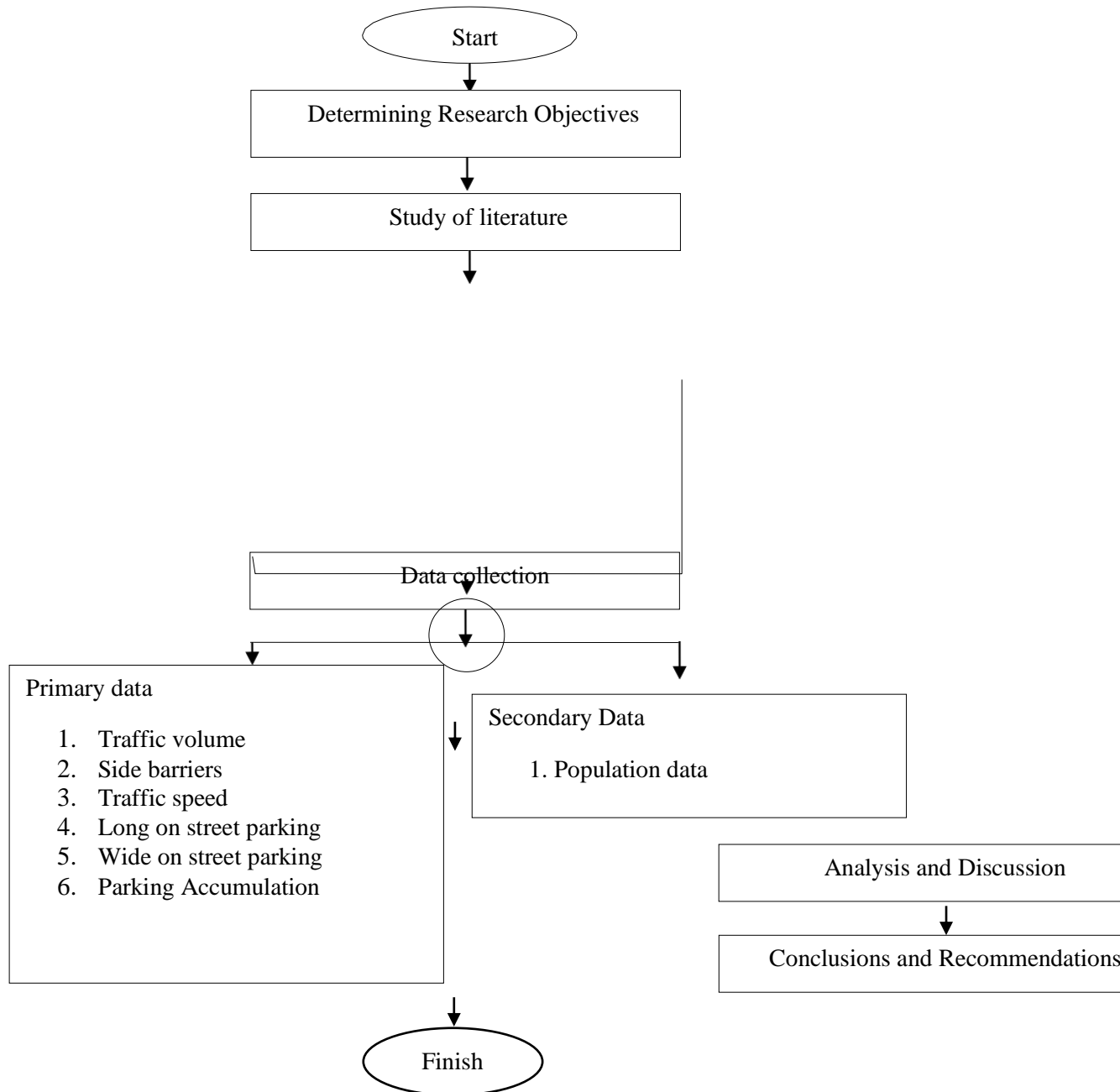

Fig. 1. Research Flowchart

3. Results and Discussion

3.1. Physical Characteristics of the Cisaat New Market Road Section

The physical characteristics of this road segment consist of geometric road sections and road profiles. The geometric conditions of the road sections are described in cross sections and

alignments, while what is meant by road section profiles are road utilization, availability of on street parking, and land use patterns around the road sections.

Based on the road classification according to its hierarchy, Cisaat New Market Road is an arterial road in Sukabumi Regency [20] [21]. In general, the road condition is good with asphalt surface. If you look at the existing conditions along the new market road, there is parking on the shoulder of the road. With a relatively dense traffic volume, it is one of the roads that connects activity centers and there are several activities along the road, including restaurants, shops, supermarkets, and other trading facilities. In general, the characteristics of Cisaat New Market Road are as follows:

1. The Cisaat New Market Road section is an Arterial Road with a total length of 1,200 meters, while

the study site is 420 meters long,

2. The width of the pavement is 10 meters, the width of the parking material on the road shoulder is 2.3 meters and the width of the right/left shoulder is 1.20 meters,
3. Some of the New Market Roads still feel unable to serve the needs of the relatively dense traffic volume.
4. Based on the type of urban road, the New Market Road segment is a 2-lane, 2-way undivided road

(2/2 UD).

3.2. Traffic Characteristics of the Cisaat New Market Road

Traffic flow data on Cisaat New Market Road is the result of a survey conducted from 06.00 to 18.00. The traffic flow observed was vehicular traffic with the classification of private cars and pickups, motorcycles, medium trucks, large trucks and public transportation.

The hourly traffic data can be seen in the attached tables in the appendix. Processing hourly data by classifying each type of vehicle (vehicles/hour) with Passenger Car Equivalence (emp) based on the 1997 Indonesian Road Capacity Manual (MKJI) with values, among others, for private vehicles/LV (1), motorcycles/MC (00, 5), Heavy Vehicle/HV (1.3), and ME (0.5) [7]. So the traffic volume is obtained in passenger car units (pcu). Traffic Volume on Cisaat New Market Road (Sunday, March 21, 2020)

After obtaining traffic volume data per day, it can be seen the number of vehicles on Cisaat New Market Road Sukamanah which is also listed in the Attachment.

In table 1, the traffic volume carried out on Monday, March 15, 2021, shows the total volume at 06.30-08.30 at 387 pcu/hour. Then at 11.30-13.30, the peak hour volume is 995.1 pcu/hour. the traffic volume at 16.00-18.00 shows a figure of 1081.3 smp/hour. Title, Figure and Table.

Table 1. The Traffic Volume on Monday, March 15, 2021

Interval	LV	HV	MC	LVx1	HVx1.2	MCx0.35	Volume SMP/Jam
06.30-07.30	2	0	211	2	0	73.9	75.9
06.45-07.45	2	0	187	2	0	65.5	67.5
07.00-08.00	3	2	202	3	2.4	72.5	75.5
07.15-08.15	3	0	217	3	0	77	80
07.30-08.30	3	0	240	3	0	85.1	88.1

Total						**387**
11.30-12.30	16	4	451	16	4.8	157.9	173.9
11.45-12.45	21	2	411	21	2.4	143.9	164.9
12.00-13.00	14	3	512	14	3.6	179.2	193.2
12.15-13.15	26	3	560	26	3.6	196	222
12.30-13.30	29	3	606	29	3.6	212.1	241.1
Total						**995.1**
16.00-17.00	31	7	476	31	8.4	166.6	197.6
16.15-17.15	37	4	540	37	4.8	189	226
16.30-17.30	40	6	535	40	7.2	187.3	227.3
16.45-17.45	31	5	480	31	6	168	199
17.00-18.00	28	4	581	28	4.8	203.4	231.4
Total						**1081.3**

Meanwhile, in table 2, the traffic volume on Sunday, March 21, 2021, shows the total volume at 06.30-08.30 is 460.9 pcu/hour. Then at 11.30-13.30, the peak hour volume was 891.6 pcu/hour. And the volume of traffic at 16.00-18.00 shows a figure of 1105.6 pcu/hour.

Table 2. The Traffic Volume on Sunday, March 21, 2021

Interval	LV	HV	MC	LVx1	HVx1.2	MCx0.35	Volume SMP/Jam
06.30-07.30	2	2	212	2	2.4	74.2	76.2
06.45-07.45	2	0	261	2	0	91.4	93.4
07.00-08.00	1	0	224	1	0	78.4	79.4
07.15-08.15	3	1	271	3	1.2	94.9	97.9
07.30-08.30	2	2	320	2	2.4	112	114
Total							**460.9**
11.30-12.30	21	3	401	21	3.6	140.4	161.4
11.45-12.45	17	2	432	17	2.4	151.2	168.2
12.00-13.00	12	3	444	12	3.6	155.4	167.4
12.15-13.15	21	2	501	21	2.4	175.4	196.4
12.30-13.30	19	2	512	19	2.4	179.2	198.2
Total							**891.6**

3.3. Characteristics of Parking on Cisaat New Market Road Section

3.3.1. Parking Pattern

From the results of a field survey on the Cisaat New Market Road, Sukabumi Regency, the shoulder side of the New Market Road is used as on street parking. On Street Parking condition, directly reduces the road capacity and effective road width from 10 meters without parking to 6.7 with parking. Where the parking pattern used is 90º for motorbikes with 2 rows back and 60º for cars.

3.3.2. Parking Capacity

Static Capacity (Parking Space) is the number of parking spaces available for parking [22]. The currently available on Street Parking on Cisaat New Market Road, Sukabumi Regency, is the effective area of a motorcycle parking area of ±420 m, an effective car parking area of ±300 m and a

maneuvering area of ±3 m. Then the capacity of the existing parking space on Cisaat New Market Road is shown on table 3:

Table 3. The capacity of the existing parking space on New Market Road

Transportation Type	Parking Space Capacity
Motorcyle	420 / 0,75 = 560 SRP
Car	300/2,3 =130 SRP

Source: Analysis Results

3.3.3. Parking Accumulation

Parking accumulation is the total number of vehicles parked in an area in a certain time [23]. From the results of the accumulation carried out per 1 hour for 11 hours it can be seen the number of parked vehicles and peak times.

Data analysis Accumulation of parking for motorbikes and cars on street parking on Cisaat New Market Road on Mondays can be seen in the attachment

The table 4 below will clearly show the fluctuations in parking accumulation that occurred on Cisaat New Market Road on Sunday, March 21, 2021.

Table 4. The Fluctuations in Parking Accumulation on Sunday, March 21, 2021

NO	Time	Motorcycle			Car		
		In	Out	Parking Accumulation	In	Out	Parking Accumulation
1	07.00-08.00	231	34	197	98	24	74
2	08.00-09.00	446	176	278	132	98	128
3	09.00-10.00	396	234	674	265	202	191
4	10.00-11.00	451	511	614	197	187	201
5	11.00-12.00	475	562	527	232	217	216
6	12.00-13.00	521	423	625	214	223	207
7	13.00-14.00	432	397	660	226	203	230
8	14.00-15.00	343	354	649	198	232	196
9	15.00-16.00	456	462	643	235	221	210
10	16.00-17.00	551	513	681	224	213	221
11	17.00-18.00	326	564	443	186	227	180

Source: Field Observation Results

The highest accumulation on the street parking area of Cisaat New Market Road on Sundays for motorcycles was 681 vehicles occurred at 16.00-17.00 WIB and car vehicles were 230 vehicles occurred at 13.00-14.00.

3.3.4. Parking Volume Parking Turn Over Rate (Parking Turn Over)

The volume of parking for motorcycles and cars on Cisaat New Market Road can be seen in the attachment.

The results of observations in this study indicate that the overall parking volume on Mondays for motorbikes is 4709 and for cars is 2210.

3.3.5. Parking Turn Over Rate (Parking Turn Over)

Parking turnover rate or parking space usage rate, which is intended to see the level of vehicle parking space usage during the survey period [24].

The replacement rate for motorbike and car parking on Cisaat New Market Road can be seen in Table 5. The available parking space is based on the number of parking spaces for motorbikes and cars.

Table 5. Change rate of parking on the new market Street

Vehicle Type	Turn Over
	Parking volume÷parking space
Motorcycle	4709 ÷ 560 = 8,4 SRP
Car	2210 ÷ 130 = 17 SRP

Source: Analysis Results

The parking turnover rate obtained from the results of the calculation shows that the use of parking spaces, the motorcycle parking turnover rate is 8.4 vehicles/space for 11 hours and the car is 17 vehicles/space.

3.3.6. Parking Index

Parking Index is the percentage of vehicles that use the parking lot with the number of available parking areas in a certain time period [25] [26]. In a study conducted in the New Market Road parking area, parking calculations used an interval of 1 hour. The index of parking for motorbikes and cars on Sundays can be seen in table 6 the calculation of the maximum and average parking index on Monday as follows.

a) Calculation of Motorcycle Parking Index

$$Maximum\ Parking\ Index = \frac{Maximum\ Accumulation}{Parking\ Space} \times 100\% \tag{1}$$

$$Maximum\ Parking\ Index = \frac{681}{560} \times 100\% = 121\%$$

$$Avarage\ Parking\ Index = \frac{Avarage\ Accumulated}{Parking\ Space} \times 100\% \tag{2}$$

$$Avarage\ Parking\ Index = \frac{531,091}{560} \times 100\% = 95\%$$

b) Calculation of Car Parking Index

$$Maximum\ Parking\ Index = \frac{Maximum\ Accumulation}{Parking\ Space} \times 100\%$$

$$Maximum\ Parking\ Index = \frac{230}{130} \times 100\% = 177\%$$

$$Avarage\ Parking\ Index = \frac{Avarage\ Accumulated}{Parking\ Space} \times 100\%$$

$$Avarage\ Parking\ Index = \frac{184,909}{130} \times 100\% = 162\%$$

Table 6. Motorcycle and car parking index on Monday

Motorcycle parking index (%)		Car parking index(%)	
Average	Maximal	Average	Maximal
95	122	162	177

Source: Analysis Results

From the calculation above, it is known that the average percentage of motorbike and car parking spaces on Monday exceeds 100%. So, it can be concluded that the parking area is not efficient in accommodating parking vehicles.

3.3.7. Traffic Volume

Based on the results of the field survey conducted on Monday as a sample of weekdays and Sunday as a sample of holidays, the average volume of vehicles passing through Cisaat New Market Road can be seen in table 7 and so on.

1. Vehicle with conditions without a street parking

Vehicle speed data in this condition is vehicle speed data taken by means of analysis on the Indonesian Road Capacity Manual with the following calculation results and based on the free speed formula, the results of the free speed are obtained as shown in the following table 7:

Table 7. Vehicle Speed Data

FVo	FVw	FVo+FVw	Adjustment Factor		FV
(km/hour)	(km/hour)	(km/hour)	FFVsf	FFVcs	(km/hour)
44	6	50	0,89	0,93	41,385

Source: Analysis Results

2. Vehicle Speed Condition with On Street Parking

The average vehicle speed data in this condition is obtained from observations with vehicles moving hourly where the speed is taken once every fifteen minutes with a sample distance of 20 meters on the Cisaat market road and is carried out only during rush hour.

It can be concluded, on the Cisaat New Market Road with a road length of 0.201 km with the highest traffic volume, it can be reached at a speed of 7 km/hour and for Cisaat New Market Road with a road length of 0.343 km, it can be reached at a speed of 15 km/hour. Table 8 will provide the information of Average Vehicle Speed during the day at peak hours (Sundays).

Table 8. Average Vehicle Speed during the day at peak hours (Sundays)

No	Cisaat New Market Road	Length (Km)	Highest Road Traffic Volume	Speed
			(Sunday) Vehicle/hour	(km/hour)
1	Parking Area	0.201 km	1674	10 km/hour

Source: Analysis Results

3.3.8. Traffic Density

Density is the number of vehicles occupying the observed road length divided by the observed road length. Density is difficult to measure precisely. Density can be calculated based on speed and volume. Table 9 shows the traffic density on Sunday.

Table 9. Traffic Density Sunday, March 21, 2021

No	Cisaat New Market Road	Highest Road Traffic Volume	Speed (U)	Density
		(Sunday) Vehicle/hour	(km/hour)	(D=Q/U)
1	Parking Area	1674	10 km/hour	167 vehicle/km

Source: Analysis Results

If you use the Sunday average speed to measure the density on Monday, you will get the density as shown in the table 10 below.

Table 10. Traffic Density Monday, March 15, 2021

No	Cisaat New Market Road	Highest Road Traffic Volume	Speed (U)	Density
		(Sunday) Vehicle/hour	(km/hour)	(D=Q/U)
1	Parking Area	1064	10 km/hour	106 vehicle/km

Source: Analysis Results

3.3.9. Analysis of Road Capacity According to MKJI Method

Based on the MKJI method in determining road capacity, there are several variables that must be reviewed first [7].

1. Base capacity (Co)

Cisaat new market road is a 2-lane undivided road, which means it has a basic capacity (Co) = 2900 smp/hour.

2. Capacity adjustment factor due to the width of the road (FCw)

The width of the new market road is reduced by the width of the existing parking space, which is 2.3 meters. Then the width of Cisaat new market road with parking is 7.7.

3. Capacity adjustment factor for Direction separator(FCsp)

The direction separator (PA) on Cisaat new market road is 60%-40%, so the value is 0.94.

4. Capacity adjustment factor due to side barriers (FCsf)

The level of side barriers that exist on Cisaat new market road is moderate for Cisaat market road has a barrier clearance of 0.5 (Wk)(m).

5. City size adjustment factor (FCcs)

Based on data from the Sukabumi Regency Statistics Center, the latest data is the number of Sukabumi Regency is ± 2,551,440 people in 2018 and the size of the district is 419,970 Ha. Then the FCcs value is 0.90.

After determining the Values for determining Road Capacity based on Geometrics and existing road classifications. The following is the capacity of the road at the parking location of the Cisaat new market road, which can be seen in Table 11 below:

Table 11. New Cisaat Market Road Capacity with Parking

No	New Cisaat Market Road	Road Width (m)	Road Width with Parking (m)	Co	FCw	FCsp	FCsf	FCcs	Capacity (smp/hour)
1	**Parking Area**	**10**	**7.7**	**2900**	**1**	**0.94**	**0.86**	**0.9**	**2110**

Source: Analysis Results

3.3.10. Road Service Level

Based on the results of field analysis and calculations, the degree of saturation and level of road service will be obtained on Mondays (weekdays) and Sundays (holidays) at Cisaat new market road. The indicator of looking for the degree of saturation is using the traffic volume (pcu/hour) by taking the highest volume of all hours during field observations on the Cisaat new market road.

The following are from table 12 and table 13 of the degree of saturation and the level of road service on Cisaat new market road.

Table 12. Degree of Saturation and Level of Road Service on Sundays (Holidays)

Cisaat new market road	Road capacity smp/hour (C)	Road traffic volume Vehic/hour	Traffic volume smp/hour (Q)	Degree of Saturation (DS=Q/C)	Road Service Level
Parking Area	**2110**	**1674**	**981**	**0,46**	**C**

Source:Analysis Results

On Sunday, March 21, 2021, on Cisaat new market road, it can be seen that it has an average road service level of C because it has a degree of saturation between 0.45-0.75 with stable flow characteristics, but the speed and motion of the vehicle is controlled, and the driver is limited in selecting speed.

Table 13. Degree of Saturation and Level of Road Service on Mondays (Working Days)

Cisaat new market road	Road capacity smp/hour (C)	Road traffic volume Vehic/hour	Traffic volume smp/hour (Q)	Degree of Saturation (DS=Q/C)	Road Service Level
Parking Area	2110	1064	666,3	0,32	B

Source:Analysis Results

On Monday, March 15, 2021, the Road Service Level Condition on Cisaat new market road has a degree of saturation between 0.21 – 0.44 which means that the Service Level for Road B with traffic flow characteristics is stable, but the operating speed is starting to be limited by traffic conditions and the driver has sufficient freedom to choose the speed. The average speed at peak hours is 15 km/hour.

4. Conclusion

In accordance with the research objectives that have been revealed in the previous chapter, data collection, processing and analysis can ultimately be concluded as a result of research on street parking on Cisaat new market road Sukamanah as follows:

1. Based on the results of direct observations, the highest level of traffic volume is shown on Sunday,
March 21, 2021, showing the total volume at 06.30-08.30 at 460.9 pcu/hour. Then at 11.30-13.30, the peak hour volume is 891.6 smp/hour. And the traffic volume at 16.00-18.00 shows a figure of 1105.6 smp/hour. While the side resistance class showed the highest number on Sunday, March 21, 2021, at 06.30 – 08.30 at 3451.1. At 11.30 – 13.30 which is 3212.3 and at 16.00 – 18.00 which is 2519.7. While the lowest level of Traffic Volume, which is aimed at Monday, March 15, 2021, shows the total volume at 06.30-08.30 at 387 pcu/hour. Then at 11.30-13.30, the peak hour volume is 995.1 smp/hour. And the rush hour volume at 16.00-18.00 shows a figure of 1081.3 smp/hour.
2. Degree of Saturation on Cisaat market road segment On Sunday, March 21, 2021, on Cisaat new market road it can be seen that the road service level is C on average because it has a degree of saturation value between 0.45-0.75 with stable current characteristics, but the speed and motion of the vehicle is controlled, the driver is restricted in choosing the speed. Meanwhile, on Monday, March 15, 2021, the condition of the road service level on Cisaat new market road has a degree of saturation between 0.21–0.44 which means that the Service Level for Road B with traffic flow characteristics is stable, but the operating speed is starting to be limited. by traffic conditions and the driver has sufficient freedom to choose the speed. The average speed at peak hours is 15 km/hour.
3. Parking patterns and conditions of On Street Parking in Cisaat new market road are parking calculations. The results show that the available parking space capacity in new market road is 560 SRP for motorbikes and 130 SRP for cars. The highest accumulation in the on-street parking area of new market road on Sunday, March 21, 2021 for motorcycles was 681 vehicles occurring at 16.00-7.00 WIB and car vehicles were 230 vehicles occurring at 13.00-14.00. The results of observations in this study indicate that the overall parking volume on Sundays for motorbikes is 4709 and cars is 2210. And the parking turnover rate obtained from the calculation results shows that the use of parking spaces, the parking turnover rate (Parking Turn Over) for motorbikes is 8, 4 vehicles/space and 17 vehicles/space for 11 hours of observation. And the average percentage of the parking index using motorbike and car parking spaces on Sundays exceeds 100%. So, it can be concluded that the parking area is not efficient in accommodating parking vehicles.

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