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THE STUDY OF LAND PARKING MALL BOGOR INDAH PLAZA

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Abstract: The development of big cities in Indonesia especially the city of Bogor is the density of motor vehicle users. Users of this motor vehicle have a strong impact on the progress of transportation infrastructure. The need for parking is a very valuable resource for the city, especially for the central trading area in the city of Bogor. The increasing number of population and the increase of motor vehicle users, so the comparison between the number of roads, parking lots and parking requirements is not balanced. The increasingly poor trend in parking problems in the city of Bogor. To reduce the existing transportation burden, the city government of Bogor continues to encourage the growth of the transportation sector. Strategic transport sector within the next 15 years such as the construction of fly over along jalan KH Sholeh Iskandar-Pertigaan Yasmin. The fly-over project aims to unravel the congestion along this segment due to the heavy traffic of vehicles passing through this route. Density of vehicles is also confirmed the performance of this road segment is higher. The researchers looked at and conducted a study on parking capacity at Bogor Indah Plaza Mall between jalan KH. Sholeh Iskandar-Pertigaan Yasmin. The study was conducted to assume the parking capacity at Mall Bogor Indah Plaza whether still able to meet the standard or not (Direktorat Jenderal Perhubungan Darat, 1996).
Keywords: Motor vehicle, congestion, parking lot requirement

Introduction

In the city of Bogor the use of transportation is very high. The number of users of motor vehicles makes the city jam. This congestion can also be with side barriers such as parking carelessly. Parking of vehicles stops in the long run and within a certain time. By stopping the car for a while (Teguh Hirtanto, 2005). Parking is a vehicle's temporary and transient nature, and the availability of land, capacity and absorption (KBBI online, 2016). Unit of parking space is used to measure parking space capacity requirement. But to determine the unit of parking space, can not be separated from the considerations such as units of parking space. In general, parking in the central trade area divides into two parts for workers and visitors. Workers for long term parking, as well as visitors for temporary parking. As a reference determination of parking needs is the area of trade area (Kementerian Perhubungan 2010). Side barriers and congestion that occur

in the city the number of vehicles and public transportation on the highway (Syaiful, Rulhendri, 2014; Syaiful, 2005; Syaiful, 2015; Syaiful, January, 2016). Parking is also with a car stop some time (Ofyar Z Tamim, 1998). Irregular parking lot because some aspects such as land area do not meet. Because of the need for parking is a valuable resource for the City, building and transportation, so it needs to be managed efficiently. Therefore, the needs of the parking lot should be taken into account for the construction of buildings, especially for Mall Bogor Indah Plaza. Of course, with sufficient facilities require adequate parking space. The construction of the parking lot for the availability of Mall Bogor Indah Plaza parking lot must meet the prevailing standards. Of course, by counting the number of vehicles entering the Mall Bogor Indah Plaza building. The higher the price and quality of service together, the higher the customer satisfaction (Haryono, H., Wahyuni, R., & Darunanto, D, 2016). High continuous activity in shopping centers indicates high population density (Sidjabat, S, 2016). Good performance quality shows satisfaction of customer satisfaction (Yuzal, I., & Wiratama, A, 2016). Periodic maintenance of public facilities is absolutely necessary (Najoan, D, Pahala, Y, & Yunandyan, K, 2016). Human resources are an important factor in producing service according to its purpose (Sembiring, H, & Edi, D, 2017). The parking area Mall Bogor Indah Plaza construction using paving blocks so easy to drain rain water that falls on it (Syaiful, Setiana Mulyawan, 2013). So parking service at Mall Bogor Indah Plaza will depend on several things such as the number of pengungjung, quality of service, good performance of the manager, reliable human resources, regular maintenance, and a safe and secure parking area.

Research purposes

Based on the above background then the purpose of this study is to obtain parking needs at Mall Bogor Indah Plaza is sufficient or not yet meet the requirements of parking.

Unit of Parking Space

The determination of vehicle parking space is, of course, based on predetermined considerations, namely the standard vehicle dimensions for passenger cars shown in Figure 1 below;

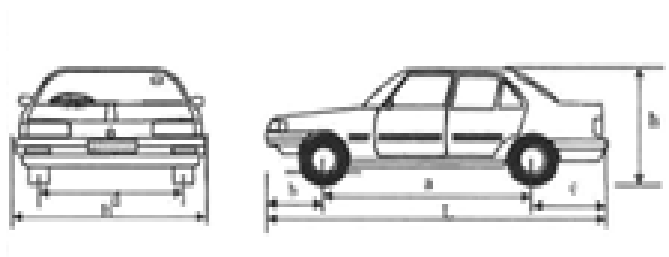

Figure 1. Figure dimension of passenger vehicle

a	= axle distace	b	= fron overhang	c	= rear overhang
d	= trail width	h	= total height	B	= total width
L	= total length				

Parking Characteristics

Information on the characteristics of parking is necessary when we are planning a parking lot. Some parking characteristic parameters that must be known are:

Parking Accumulation

Accumulation = Qs + Q*in* – Q*out*.....(1)

Where; Qs : Number of vehicles that have been in the parking location before the observation do.

Q*in* : Number of vehicles entering location

Q*out* : Number of vehicles out of the location

Parking Duration

Duration = T*out* – T*in*.....(2)

Average parking duration;

$$D = \frac{\sum_{1-n}^{n} di}{n} \quad \text{.....(3)}$$

Where; D : Parking duration average

T*in* : Time when the vehicle enters the parking lot

T*out* : The time when the vehicle got out of the parking lot

di : The duration of the i-th vehicle (from vehicle i to n)

i = n : Number of vehicles

Usage rate and turnover rate

Parking capacity for passenger cars

Turnover= $\frac{(Parking\ Volume)}{(Parking\ Space)}$.....(4)

The value of parking usage level can be obtained with the following formula;

Usage rate = $\frac{(parking\ Accumulation)}{(Parking\ Space)}$ X 100%.....(5)

Parking Capacity

Parking capacity for passenger cars

$N = \frac{L}{P}$.....(6)

Where; N : Number of vehicles or parking capacity

L : Parking area is available

P : SRP for four-wheel vehicles (2,50 m x 5,00 m)

SRP for motorcycle (0,75 m x 2,00 m)

Parking Index

Parking index is the percentage of parking vehicles occupying the parking area is the percentage

Parking Index (%) = (Parking accumulation/Parking capacity) x..(7)

Parking area extensive regquirement

LLP = JPP x UPP .....(8)

Where ; LPP : Parking Area Parking Required

JPP : The number of parking vehicles needed

UPP : Parking Pool Size (0,75 m x 2,00 m) for motorcycle

UPP : Parking Pool Size (2,50 m x 5,00 m) for car

Dynamic Capacity

The dynamic capacity of this parking space depends on the average amount of duration or duration of parking vehicles. The shorter the duration the more dynamic capacity of parking space or the longer the longer the duration the less dynamic capacity of parking space. How to calculate:

$$\text{Dinamic capacity} = \frac{Parking\ capacity\ area\ X\ Survey\ periode}{Average\ duration}$$

Parking space requirement (Z)

The equation for calculating parking space requirement based on the approximate formula is: and parking space requirement $Z = \frac{Y \ x \ D}{T}$

Where : Z : Parking space requirement (SRP)

Y : Number of vehicles parking / Volume parking

D : Average duration of parking vehicles

Q : The length of the parking survey(Direktorat Jenderal Perhubungan Darat, 1996; Kementerian Perhubungan, 2014).

Method

Time and place of study

This research was conducted in Nopember 2016 - May 2017. The research was conducted at Mall Bogor Indah Plaza, jalan KH. Sholeh Iskandar 16330, Bogor City, West Java, Indonesia. The location of the study is shown in Figure 2 below:

Figure 2. Place of study

(▬ ▬ ▪) = Research location and boundary area Mall Bogor Indah Plaza

Research methode show in Figure 3 below;

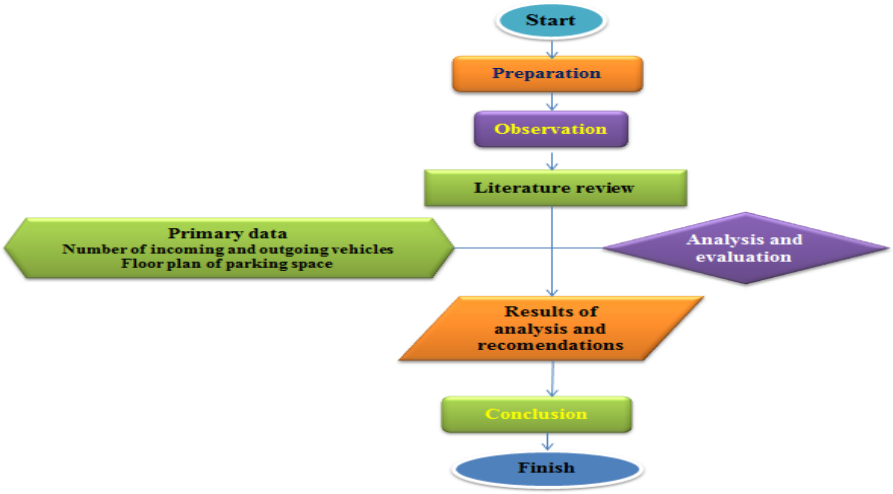

Figure 3. Research Methodology

Mall Bogor Indah Plaza is one of the shops that has an area of about ± **7,279 m²** and is located in the city of Bogor. To make it easier to review the data, this shopping area will be divided into several zones. Each zone division has an adequate parking area. The division of zones within the study area is based on the division of the region made by the researcher in order to facilitate the data review process shown in Figure 4 below;

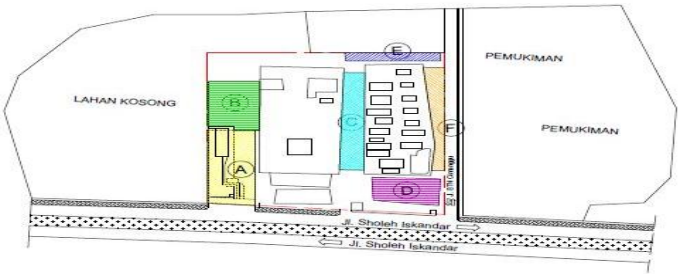

Figure 4. Existing Mall Bogor Indah Plaza

Figure 5. Front of view and Parking Area Mall Bogor Indah Plaza

The total parking area is **± 3,413 m².** In each zone is divided into 3 types of parking models. aims to collect the amount of parking available in the area.

The parking quantities of each zone are manually calculated based on data in the field and also using Microsoft Excell. Based on the picture of 4 existing conditions of the area, and the results are presented in Table 1 below.

Table 1. Data on the amount of available parking currently at Mall Bogor Indah Plaza

ZONE	Parking Model			Total area
	Parking pararel	Parking 45^0	Parking 90^0	
Zone A Car	3	9	0	12
Zone B (first) Car	0	15	38	53
Zone C	0	52	0	52
Zone D	0	10	0	10
Zone E	0	25	0	25
Zone F	0	42	0	42
Total number of parking areas available at this time (Car)				**194**
Zone A Motorcycle	0	150	35	185
Zona B (second) Motorcycle	80	248	31	359
Total number of parking areas available at this time (Motorcycle)				**544**

Result and Discussion

Data analysis is expected to be a solution or an alternative. Alternative search problem, to know the existing parking problems. in the area of Mall Bogor Indah Plaza must be made limits indikato-indicators that exist, among others, namely:

Parking Accumulation

Parking accumulation represents the number of vehicles parked in an area at any given time. Peak parking time and the number of vehicles can be obtained from the amount of parking accumulation. The data obtained during 3 days carried out recording the number of incoming and outgoing vehicles, then grouped in 15-minute interval time, so that the percentage of vehicle distribution in and out and parking accumulation number. Can be seen in the formula (1), Parking Accumulation Formulas are = Qs + Q*in* -

Q*out*, Where; Qs = The number of vehicles already in the parking lot before the observation is done.

Q*in* = Number of vehicles entering the parking lot

Q*out* = Number of vehicles out of parking location)

Based on Table 2 of parking accumulation and the number of cars in and out of Mall Bogor Indah Plaza mall shopping area in the attachment, it can be seen that the vehicle distribution is available for every 15 minute survey interval. The following is the result of parking accumulation that has been calculated based on the survey that has been done.

Table 2. Accumulated maximum parking of wheeled vehicles

No.	Day/Date survey	Maximum accumulation parking (car)	Peak hour
1	Friday/May 14, 2017	98	12:00 - 12:15
2	Sunday/May 16, 2017	123	12:45 - 13:00
3	Saturday/July 1, 2017	114	12:45 - 13:15

Table 3. Accumulated maximum parking of motorcycle

No.	Day/Date survey	Maximum accumulation parking (motorcycle)	Peak hour
1	Friday/May 14, 2017	118	13:45 – 13:59
2	Sunday/May 16, 2017	185	12:45 – 12:59
3	Saturday/July 1, 2017	162	13:30 – 13:44

Parking volume

Parking volume is the number of vehicles involved in a parking load (vehicles per particular time period usually per day). The amount of parking volume can be seen in the recap of parking survey data in the attachment. For more details the calculation results can be seen in Table 4 below.

Table 4. Survey results of car parking volume

No.	Day/Date survey	Time of survey	Number of Vehicles (car)
1	Friday/May 14, 2017	08:00 - 16:00	460
2	Sunday/May 16, 2017	08:00 - 16:00	450
3	Saturday/July 1, 2017	08:00 - 16:00	561

From the table we can conclude that the maximum parking volume of 4 wheeled vehicles occurs on Saturday, July 1, 2017 based on Table 5 below.

Table 5. Motorcycle volume survey results

No.	Day/Date survey	Time of survey	Number of vehicle (motorcycle)
1	Friday/May 14, 2017	08:00 - 16:00	566
2	Sunday/May 16, 2017	08:00 - 16:00	696
3	Saturday/July 1, 2017	08:00 - 16:00	525

From the table we can conclude that the maximum parking volume of motorcycle occurred on Sunday, May 16, 2017.

Parking Duration

Based on the survey results table, we can know the maximum parking duration, minimum and average on each survey day presented in Table 6 below:

Table 6. Parking duration

No.	Day/Date survey	Transportation type	Maximum duration	Minimum duration	Average duration (minute)
1	Friday/May 14, 2017	Car	480	0	76,38
		Motorcycle	480	0	82,1
2	Sunday/May 16, 2017	Car	480	0	85,87
		Motorcycle	480	0	77,79
3	Saturday/July 1, 2017	Car	465	0	85,04
		Motorcycle	465	0	96,94

From Table 6 above we can see that the maximum duration occurs on Friday 14 May 2017 and Sunday 16 May 2017 of 480 minutes. And for the maximum average duration of 4-wheeled vehicles, occurred on Sunday 16 May 2017 of 85.87 minutes, and for 2-wheeled vehicles on Saturday 1 July 2017 of 96.94 minutes. The following is the percentage table of the number of the carvehicles arranged based on the duration of parking on the peak day, which is dated May 16, 2017.

Table 7. Percentage of parking duration of four wheeled vehicles at peak hour

No	Parking Duration (per-minute)	Number of Vehicles	Percentage Number of Vehicles (%)
1	15	113	27,29
2	30	40	9,66
3	45	34	8,21
4	60	29	7,00

Table 7, Cont. Percentage of parking duration of four wheeled vehicles at peak hour

5	75	28	6,76
6	90	31	7,49
7	105	29	7,00
8	120	23	5,56
9	135	20	4,83
10	150	9	2,17
11	165	13	3,14
12	180	15	3,62
13	195	7	1,69
14	210	5	1,21
15	225	5	1,21
16	240	1	0,24
17	255	1	0,24
18	270	2	0,48
19	285	1	0,24
20	300	1	0,24

Based on Table 7 we can see that the parking duration of 0 to 15 minutes has the largest percentage of 27.29% with a total of 113 vehicles. The amount of parking duration has an effect on the determination of SRP value. SRP value for shopping centers and shops according to the Direktorat Jenderal Perhubungan Darat 1996 has a number between 3.5 - 7.5. The 3.5 number limit is the minimum parking minimum time interval, while the 7.5 point limit is the maximum parking time interval. SRP values are taken based on the maximum number of vehicles in the long range of parking. Parking availability rate is 39.52% of parking lot available in parking of Plaza Ekalokasari Bogor (Syaiful, & Elvira, Y, 2017).

Turnover Rate (Turn Over)

Turn Over is a number that shows the level of parking space usage. The value of vehicle replacement rate in Bogor Plaza Indah area is searched using formula (2.4), that is by dividing the parking volume by the amount of available parking (static capacity). By knowing the value of parking turnover, it can be seen the level of parking space usage, as shown in Table 8 below:

Table 8. Level Turn Over Vehicle Parking

No.	Day/Date survey	Transportation type	Parking capacity	Parking volume	Parking Turn Over
1	Friday/May 14, 2017	Car	194	480	2,47
		Motorcycle	588	566	0,96

Table 8, Cont. Level Turn Over Vehicle Parking

2	Sunday/May 16, 2017	Car	194	450	2,32
		Motorcycle	588	696	1,18
3	Saturday/July 1, 2017	Car	194	561	2,89
		Motorcycle	588	525	0,89
Average Turn Over					1,79 = 2

From the table above we can see that the turnover rate of the car park ranged up to 2 times in one day. This indicates that the vehicle parking performance is rather high.

Parking Index

Parking performance can also be seen based on parking index figures. Parking index is the percentage of the number of parking vehicles occupying the parking area with the amount of parking space available in the parking area. The value of the parking index is obtained by using the formula (7). Parking index of Mall Bogor Indah Plaza area after going through the calculation phase as follows:

Table 9. Parking Vehicle Index

No.	Day/Date survey	Transportation type	Parking capacity	Parking maximum accumulation	Parking Index
1	Friday/May 14, 2017	Car	194	99	51,03
		Motorcycle	588	118	20,06
2	Sunday/May 16, 2017	Car	194	123	63,40
		Motorcycle	588	185	31,46
3	Saturday/July 1, 2017	Car	194	114	58,76
		Motorcycle	588	162	27,55

From the table above, the parking index ranges from 20.06% to 63.4% (based on maximum accumulation).

From the parking index value obtained, it turns out the parking area of cars and motorcycles in the mall Bogor Indah Plaza still can meet the needs of

parking when the parking conditions reach maximum accumulation. This is indicated by the parking index value that does not exceed 100%.

Parking Space Requirement Analysis

The amount of dynamic parking space required today can be calculated by:

Approach Formula

Example calculation:

Parking Space Requirement

$$Z = \frac{480\ X\ 1{,}16}{7} = 79{,}54\ \approx 80\ \text{SRP}$$

From the calculation results with the formula then obtained recapitulation of parking space requirement (Z) in Mall Bogor Indah Plaza, as shown in the following table10;

Table 10. Parking Space Requirements

No	Day/Date survey	Transportation type	Duration Survey (hours)	Parking volume	Average duration (hour)	Parking space requirement (Z)
1	Friday/May 14, 2017	Car	7	480	1,16	79,54 = 80
		Motorcycle	7	579	1,22	98,65 = 99
2	Sunday/May 16, 2017	Car	7	450	1,258	80,87 = 81
		Motorcycle	7	696	1,17	116,33 = 117
3	Saturday/July 1, 2017	Car	**7**	561	1,25	100,18 = 101
		Motorcycle	**7**	525	1,36	102,00 = 102

From the table above shows that the need for the most parking space for cars occurred on Saturday, July 1, 2107 for 101 SRP. And the need for the most parking space for motorcycles occurred on Sunday, May 16, 2017 of 117 SRP.

Method Directorate General of Land Transportation 1996

According to the Directorate General of Land Transportation 1996, for shopping centers and shops (as can be seen in Table 1) SRP needs for Mall Bogor Indah Plaza with an area of ± 7.279 m² has a total:

$$\text{KRP Total} = 88 + \frac{(7279-5000)}{(10000-5000)} x(415-125) = 220{,}18 \approx 221\ \text{SRP}$$

Based on minimum requirement of parking space requirement at supermarkets from Directorate General of Land Transportation 1996, car parking space at supermarket center has fulfilled minimum requirement of car parking space at trading center which is equal to 221 SRP because of total parking area which ranged from 5,000 m² up to 10,000 m² then the required PPP is about 88 - 415 SRP.

Standard of Parking Space Requirement

Based on data analysis conducted, available parking capacity and parking space requirement can be known by analyzing the number of vehicle yag parking to the amount of available parking space. If parking space requirements are greater than the available parking capacity, then the amount of available parking space is insufficient. If parking space requirement is smaller than available parking capacity, it means that the amount of available parking space is still able to accommodate the vehicle that will be parked in the parking area.

The need for parking space based on the approach of formula (Z) is defined as the value of parking space requirement that must be met by the management of the parking lot. If parking space requirement is determined based on research result in the field, then the value of parking space requirement taken is at the time of maximum accumulation.

Here is a comparison of the need for parking spaces against the capacity of existing parking spaces (based on calculations according to the Direktorat Jenderal Perhubungan Darat 1996).

Table 11. Comparison of parking space requirements to parking space capacity

Transportation type	Parking area Capacity		Capacity parking requirement	Comparison of Parking Space Requirement to Parking Space Capacity			
				Z		KRP	
	Z	KRP		Difference	(+/-)	Difference	(+/-)
Car	80	221	194	114	+	-27	-
Motorcycle	101	221	588	487	+	367	+
Car	81	221	194	113	+	-27	-

Table 11, Cont. Comparison of parking space requirements to parking space capacity

Motorcycle	116	221	588	472	+	367	+
Car	100	221	194	94	+	-27	-
Motorcycle	102	221	588	486	+	367	+

The table above shows the value of parking space requirement of four wheel based on formula (Z) is smaller than static capacity. If the value of the parking space requirement is determined based on the maximum accumulation that occurred from the field survey results, then the parking space requirement for static capacity does not require the addition or in other words the parking space for now is enough to meet.

Discussion and Results

Discussion of this research discusses the results of research that has been done. Some of the things discussed from the discussion of this research are:

Car Parking Accumulation Research

The maximum accumulation that occurred during the survey from May 14, 2017, May 16, 2017 and July 1, 2017 for car vehicles is 123 vehicles, occurred on Sunday, May 16, 2017. While for motorcycle is 185 vehicles that occurred on the day Sunday May 16, 2017.

Parking Volume

Based on the results of research conducted during 7 hours of research on Friday, May 14, 2017, Sunday 16 May 2017 and Saturday, July 1, 2017. Maximum parking volume occurred on the car occurred on Saturday, July 1, 2017 of 561 vehicles. As for the maximum parking volume of motorcycle occurred on Sunday, May 16, 2017 which amounted to 696 vehicles.

Parking Duration

Based on research conducted, found the maximum duration of parking. For the car, the maximum duration is 480 minutes or 7 hours, and the minimum duration is less than 15 minutes. While for motorcycle, the maximum duration is 480 minutes on Friday, May 14, 2017, while on Sunday, May 16,

2017 and Saturday, July 1, 2017, the maximum duration is 465 minutes. And the minimum duration for motorcycle is less than 15 minutes.

In the accumulation of parking duration, from the results of the study we can see that the duration of parking for the car at most is the duration of parking between 0 to 15 minutes, with the number of 113 vehicles with a percentage of 27,29%.

Turn Over Parking

In this study also found the results of research number of turn over parking. on the results of the study found that the average turnover rate of vehicles that occurred was as much as 1,79 ≈ 2 vehicles. This value indicates that the activity of parking turnover that happened rather high.

Parking Index

Based on the results of the research, we can see that the average parking index that occurred in the Mall area bogor Indah Plaza either the car or motorcycle ranged from 20,07% to 63,4%. This value indicates that parking area of Mall area bogor Indah Plaza still can fulfill requirement of parking space. this is evidenced by the average value of the parking index that does not exceed 100%.

Parking Space Requirement (Z)

Based on the results of the above research, it is found the results of the parking space (KRP) maximum requirement, that is equal to 101 SRP for the car, and for 117 SRP for motorcycle.

Based on the standard parking space requirement according to the Directorate General of Land Transportation 1996, for a commercial center area of 5,000 m² to 10,000 m² requires about 88 ~ 415 SRP, or more precisely at 221 SRP. Based on the results of the survey conducted, the capacity of motorcycle parking space available today is very meet the needs of parking spaces (Z). As for the capacity of the car parking space that exist today we can take the conclusion is acceptable. This is because the value The maximum parking space requirement for the car does not exceed the existing static capacity, although actual based on the standard parking space requirement the existing SRP value is not enough to meet the standard. That

in the area of Mall Bogor Indah Plaza is still enough to meet the needs of existing parking spaces.

Conclusion

Based on the results of parking discussions in the area of Mall Bogor Indah Plaza as follows:

- Maximum parking volume that occurs on car vehicles is **561** vehicles, while for two wheels that is equal to **696** vehicles.
- The capacity of car parking space and motorcycle parking space in Mall Bogor Indah Plaza area can still fulfill the existing parking requirement. This is shown by looking at the parking index ranging from **20,07% to 63,4%,** not exceeding 100%.
- Maximum parking requirement for Mall Bogor Indah Plaza area obtained from direct survey results in 117 SRP, while actual static capacity in Mall Bogor Indah Plaza is **194 SRP** for fcars, and **588** for motorcycle. The total parking area of ± **7,279 m²** then the required parking space is **221 SRP**. That is, for the capacity of motorcycle parking space is enough to meet, while for the capacity of car parking space is still not meet the standards of parking requirements, if parking space requirements are determined based on the accumulated capacity of parking spaces at the peak hours of the parking area in the area of Mall Bogor Indah Plaza still can meet the needs of existing parking, which means the capacity of parking space for motorcycle vehicles can still be said to adequately meet the needs of existing parking spaces.

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