Parking Analysis on Bogor Agricultural University Campus

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ABSTRACT

Andi Hakim Nasution Building is a facility located at Bogor Agricultural University. Andi Hakim Nasution Building is located in the main campus area of Bogor Agricultural University, Jl, Meranti, Babakan Village, Dramaga District, Bogor Regency. This building is used for the offices of lecturers, staff, and leaders, so one of the motorized vehicle parking facilities is one of the needs of this building, but the existing parking facilities are still not neatly arranged. then it is necessary to study the analysis of parking on the Bogor Agricultural University campus. So that it can provide alternative parking control at the Andi Hakim Nasution Building so that no more motorized vehicles are found that are not neatly parked. This study aims to obtain the existing capacity of parking locations in the Andi Hakim Nasution Building and obtain parking characteristics (accumulation, duration of each vehicle, parking space turnover rate, and parking index) of motorized vehicles in the Andi Hakim Nasution Building area. This study uses quantitative methods, this data collection is carried out by observation as primary data, among others, data on the number of vehicles entering, data on the number of vehicles out, data representing peak hours, peak days, normal hours, normal days, the number of Parking Space Units (SRP). The secondary data obtained by researchers through sources that have become data; conforms with the data that researchers are looking for in the study area, namely the area of parking area space. The result of this study is that the existing parking lot obtained secondary data with a survey method so as to produce existing data covering an area of $630m^2$ motorcycle parking area with a capacity of 180 (Parking Space Unit) SRP and a tilt angle of 90 ° at the Andi Hakim Nasution Building. In this analysis study, the largest accumulated stasis capacity was 251 vehicles with an average parking duration of 9:57 hours on Tuesday, May 30, 2023. During the ten days of the survey conducted, it was found that the maximum parking volume was 403 vehicles with a maximum vehicle parking accumulation of 351 vehicles which occurred on Monday 5 June 2023, the highest motorcycle parking turnover at the Andi Hakim Nasution Building reached 223.89%, indicating that the performance of motorcycle parking was quite high. The capacity of motorcycle parking spaces at the Andi Hakim Nasution Building cannot meet existing parking needs.

Keyword: analysts parking; Parking Space Unit (SRP); parking space needs; parking capacity; parking accumulation.

INTRODUCTION

Bogor Agricultural University is one of the leading universities in Indonesia to further improve its advantages. One of the most important aspects of creating a competitive advantage is to improve the human resource facilities owned. Employees as human resources owned by institutions are humans who have various human natures, feelings, and needs. These needs are physical and non-physical, these needs include parking spaces that must be available. Andi Hakim Nasution Building is a facility located at Bogor Agricultural University. Andi Hakim Nasution Building is located in the main campus area of Bogor Agricultural University, Jl, Meranti, Babakan Village, Dramaga District, Bogor Regency. This building is used for the offices of lecturers, staff, and leaders, so one of the motorized vehicle parking facilities is one of the needs of this building, but the existing parking facilities are still not neatly arranged. Therefore, it is necessary to study the analysis of parking on the Bogor Agricultural University campus. So that it can provide alternative parking control at the Andi Hakim Nasution Building so that no more motorized vehicles are found that are not neatly

parked. This of course aims to create security comfort and smooth parking at the Andi Hakim Nasution Building.

The speed of traffic vehicles is influenced by how much and how smooth the road is. If the road being traversed is free from parking activities on the left and right of the road shoulder then vehicle speed will not be disturbed (Ganda CF et.al, 2019; Karimah H, Akbardin J, 2019; Syaiful S et.al, 2022; Syaiful S, Rusfana H, 2022). Parking vehicles in any place will disrupt travel patterns with a very strict concept. The speed of traffic will affect field conditions. This condition will support the behavior of motor vehicle drivers to increase speed or regulate vehicle speed according to driver behavior (Syaiful S, Rusfana H, 2022; Syaiful S, Pratama Y, 2019; Syaiful S, Hariyadi D, 2019; Syaiful S et.al, 2020; Syaiful S, Fadly A, 2020).

Pedestrians will be helped by the absence of vehicles parking on the side of the road. They will be very free to enjoy roads that are free from parking conditions or uncontrolled vehicle speeds if the road conditions are quiet (Syaiful S et.al, 2021; Syaiful S et.al, 2023; Syaiful S et.al, 2023).

RESEARCH METHODS
Parking Definition

Parking is the state of a vehicle stopped or not moving for a while and abandoned by the driver. (Government Regulation, Number 30 of 2021). Based on the definition above, it can be concluded that parking is an immovable state of a motorized or non-motorized vehicle which can be the beginning of a trip with a certain period of time in accordance with the circumstances and needs that require an area as a stopping place organized by both the government and other parties which can be individuals or business entities.

Parking Unit

Parking space units are used to measure parking space needs based on considerations such as standard vehicle dimensions for motor vehicles and free parking space set when the vehicle position is open. Free space is given so that there is no collision between the vehicle door and the vehicle parked next to it when passengers get out of the vehicle.

Place and Time of Research

The research was conducted at the Andi Hakim Nasution Building, Bogor Agricultural University, Dramaga District, Bogor Regency. The study was conducted within 4 months, starting in March 2023 until July 2023. The time of this research was carried out for four weeks, one week conducting research in four days, namely Monday, Tuesday, Wednesday, and Thursday at 06.00-18.00 WIB, the map of the research location is presented in Figure 1.
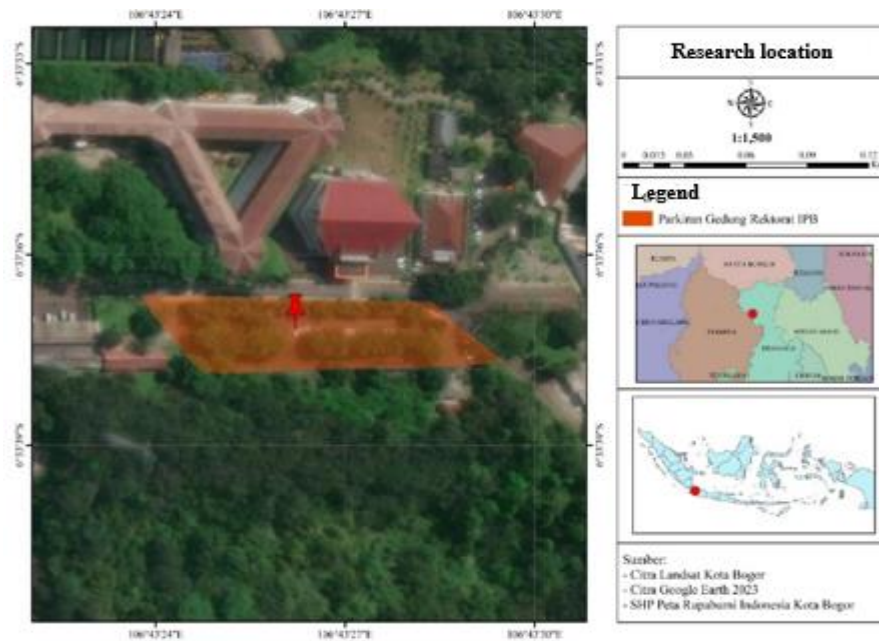
Figure 1. Map of the research location (Source: ArcGIS)

Data Processing

In conducting a study, an array of research steps will be needed first to facilitate analysis. In this study, it is necessary to plan the steps taken so that the research process can be carried out effectively. Here are the steps in the study:

a. Primary data in the form of vehicle license plate data and the time matched between entering and exiting the vehicle using the formula approach equation will obtain the results of parking characteristics and parking space needs. The data is then grouped into groups of time units, namely 30 minutes, then calculate the number of vehicles according to the time interval group and to obtain the right number of parking space needs for the Andi Hakim Nasution Building, find the group of parking time intervals that have the highest number of parking motorcycles. The selected and appropriate parking space requirement figure is used to calculate the need for Parking Space Units (SRP) using a formula approach from the Technical Guidelines for Parking Implementation of the Directorate General of Land Transportation Number 272 / KH.105 1996.
b. Primary data is the number of vehicles in a day and the number of parking spaces available and secondary data is the area of parking spaces in the Andi Hakim Nasution Building calculated using equations and the Directorate General of Land Transportation Number 272 / KH.105 1996 produces problems and parking capacity.
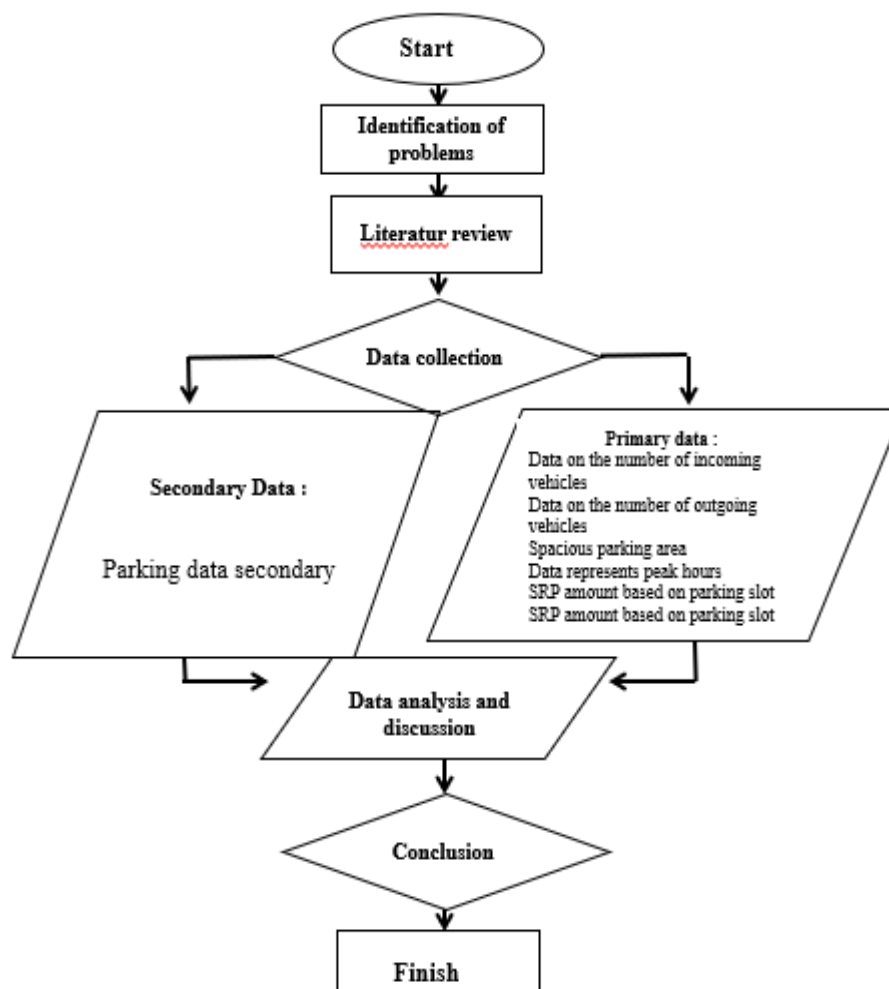c. Data processing with Microsoft Excel program.

Figure 2. Research flow chart

Research result
Calculation of parking characteristics

Parking area floor plan data
The existing condition of parking at the Andi Hakim Nasution Building

Based on observations that have been made at the Andi Hakim Nasution Building, the parking needs at the Andi Hakim Nasution Building are not able to accommodate vehicles that will park. The number of parking spaces for motorcycles is 180 SRP, so many motorcycle users prefer to park carelessly and irregularly in the area. The existing condition of parking at the Andi Hakim Nasution Building is presented in Figure 3 below.

Figure 3. The existing condition of parking at the Andi Hakim Nasution building

Research data

The research, which was carried out at the Andi Hakim Nasution Building, was carried out from March 25, 2023, to July 20, 2023, while the vehicle volume data collection was carried out for ten days, namely Monday, May 29, 2023, to Friday, June 9, 2023.

Research variables

In order to meet the needs of parking spaces, there are several variables that can affect the need for parking spaces including:

Number of vehicles

Based on the results of research and vehicle accumulation calculations, it was found that the highest average number of motorcycle parking occurred on Wednesdays at 07:40-08:00 with 59 vehicles.

Parking area

The parking area contained in the Andi Hakim Nasution Building is 630m^2.

Vehicle planning in and out

Parking volume is the number of vehicles parked at the study site during a certain period of time, in this case, the calculation is grouped every 20 minutes. By knowing the volume of parking vehicles from a parking facility, it can be determined the amount of parking space needed to accommodate the volume of parking vehicles that occur. The greater the volume of vehicles, the need for parking spaces will increase as well. Furthermore, analysis of survey data was carried out to obtain parking volume at the study location for 11 hours of observation as presented in Table 1 and Figure 1 the following:

Table 1. Vehicle parking volume

No	Day/Date	Time	Number of Vehicles
1	Monday, 29 May 2023	06:00 - 17:00	403
2	Tuesday, 30 May 2023	06:00 - 17:00	356
3	Wednesday, 31 May 2023	06:00 - 17:00	373
4	Thursday, 1 June 2023	06:00 - 17:00	285
5	Friday, 2 June 2023	06:00 - 17:00	331
6	Monday, 5 June 2023	06:00 - 17:00	397
7	Tuesday, 6 June 2023	06:00 - 17:00	256
8	Wednesday, 7 June 2023	06:00 - 17:00	358

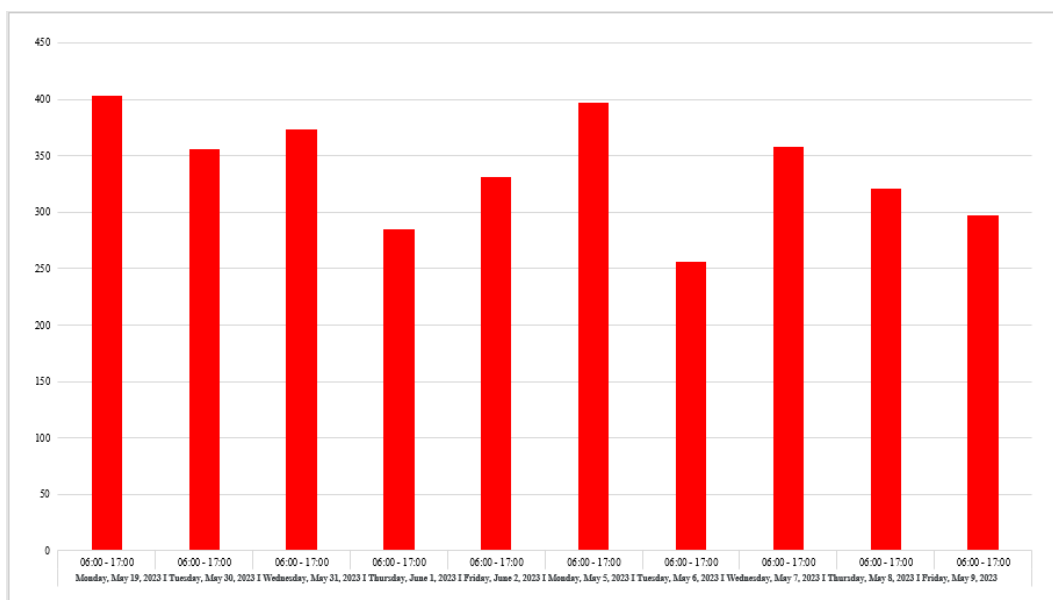| 9 | Thursday, 8 June 2023 | 06:00 - 17:00 | 321 |
| 10 | Friday, 9 June 2023 | 06:00 - 17:00 | 297 |

Figure 4. Vehicle parking volume

Peak vehicle entry hours

Peak vehicle entry hours are the most frequent time periods when motorists enter the parking area. In this case, peak vehicle entry hours are grouped based on the highest number in the period per day as presented in Table 2 and Figure 3 below:

Table 2. Peak vehicle entry hours

No	Day/Date	Time	Number of Vehicles
1	Monday, 29 May 2023	08:00 - 08:20	51
2	Tuesday, 30 May 2023	07:40 - 08:00	35
3	Wednesday, 31 May 2023	07:40 - 08:00	59
4	Thursday, 1 June 2023	08:20 - 08:40	25
5	Friday, 2 June 2023	08:00 - 08:20	42
6	Monday, 5 June 2023	07:40 - 08:00	55
7	Tuesday, 6 June 2023	08:40 - 09:00	28
8	Wednesday, 7 June 2023	07:40 - 08:00	49
9	Thursday, 8 June 2023	07:40 - 08:00	50
10	Friday, 9 June 2023	08:00 - 08:20	42
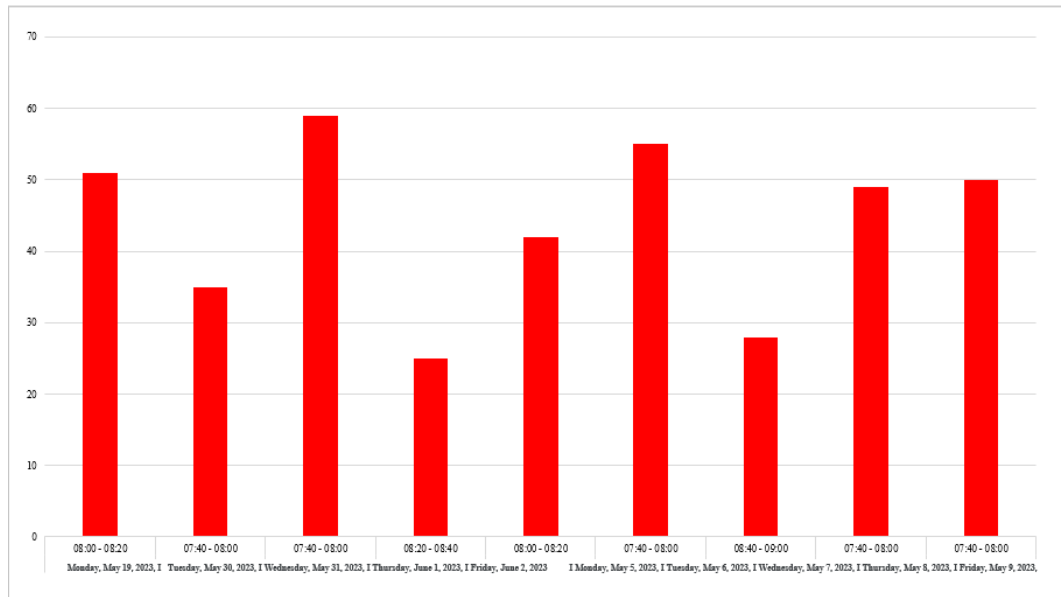
Figure 5. Peak vehicle entry hours

Based on Table 2 and Figure 5 above, it can be seen that the highest peak vehicle entry hour period occurred on Wednesday, May 31, 2021, with a total of 59 vehicles.

Peak vehicle exit hours

The peak vehicle exit hour is the most time period when drivers exit the parking area. In this case, peak vehicle exit hours are grouped based on the highest number in the period per day as presented in Table 3 and Figure 6 below:

Table 3. Peak vehicle exit hours

| No	Day/Date	Time	Number of Vehicles
1	Monday, 29 May 2023	15:20 - 15:40	49
2	Tuesday, 30 May 2023	15:20 - 15:40	51
3	Wednesday, 31 May 2023	16:00 - 16:20	62
4	Thursday, 1 June 2023	16:20 - 16:40	45
5	Friday, 2 June 2023	15:40 - 16:00	46
6	Monday, 5 June 2023	16:20 - 16:40	52
7	Tuesday, 6 June 2023	16:00 - 16:20	33
8	Wednesday, 7 June 2023	16:00 - 16:20	57
9	Thursday, 8 June 2023	15:40 - 16:00	47
10	Friday, 9 June 2023	16:00 - 16:20	48
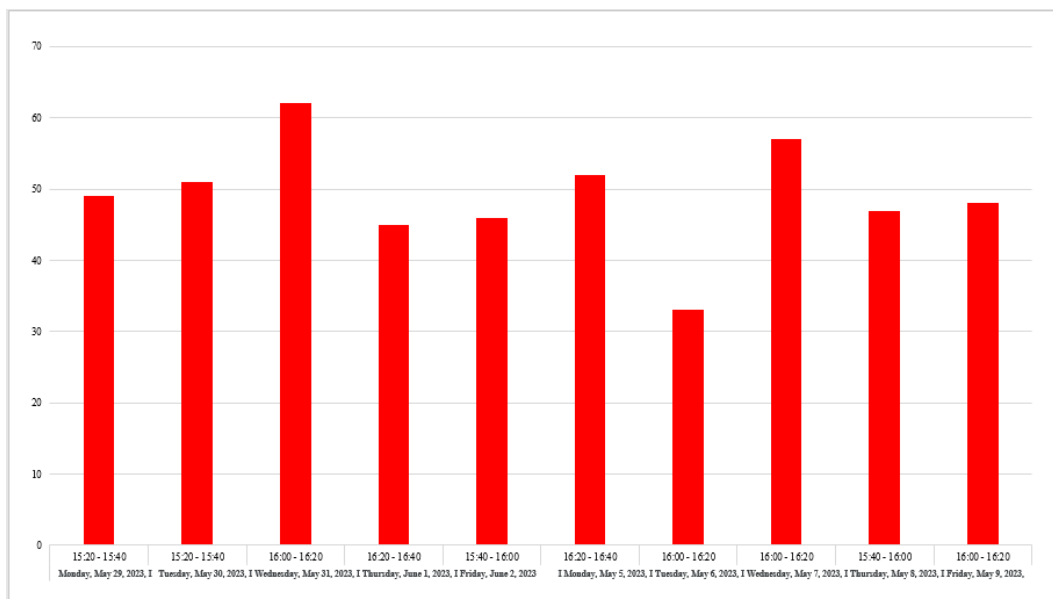
Figure 6. Peak vehicle exit hours

Based on Table 3 and Figure 6 above, it can be seen that the highest vehicle exit peak hour period occurred on Wednesday, May 31, 2021, with a total of 62 vehicles.

Matching incoming and outgoing vehicle data

Accumulated parking

Accumulated parking is the number of vehicles parked at a place at a certain time and can be divided according to the category of type and purpose of travel. Peak parking times and the number of parking vehicles can be obtained from the accumulated parking results. The data obtained for ten days recorded the number of vehicles entering and leaving and then grouped in 20-minute time intervals so that the percentage of vehicle distribution in and out and the number of parking accumulation was obtained. Based on the table of parking accumulation and the number of riders' motorcycles in and out of the Andi Hakim Nasution Building, it can be seen the magnitude of the distribution of the number of vehicles available for each 20-minute survey interval. The following is the maximum accumulation of parking presented in Table 4 and Figure 7.

Table 4. Maximum accumulation

| No	Day/Date	Peak Hours (WIB)	Maximum Accumulation(vehicle)
1	Monday, 29 May 2023	10:00 - 10:20	344
2	Tuesday, 30 May 2023	13:00 - 13:20	280
3	Wednesday, 31 May 2023	10:00 - 10:20	327
4	Thursday, 1 June 2023	12:00 - 12:20	178
5	Friday, 2 June 2023	12:40 - 13:00	289
6	Monday, 5 June 2023	11:40 - 12:00	351
7	Tuesday, 6 June 2023	10:20 - 10:40	207
8	Wednesday, 7 June 2023	10:00 - 10:20	310
9	Thursday, 8 June 2023	11:20 - 11:40	293
10	Friday, 9 June 2023	11:20 - 11:40	236
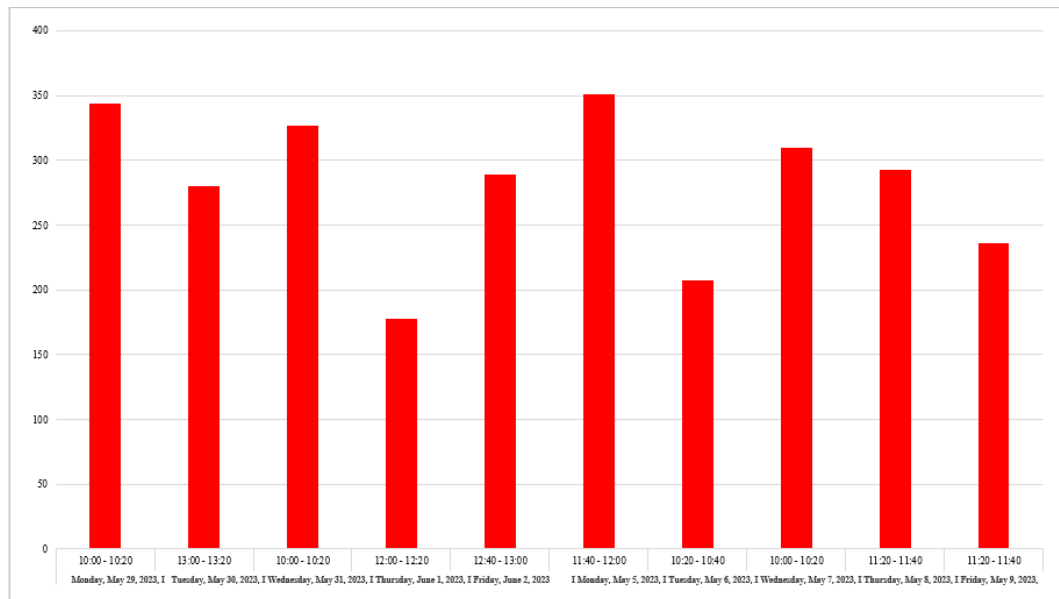
Figure 7. Maximum accumulation of parking

The maximum number of motorcycles entering and exiting on Monday 29 May 2023 can be seen in Table 4 and Figure 7 parking accumulation, for the number of exiting motorcycle vehicles can be seen in Table 3 and Figure 6, hours of peak exit of vehicles, while for the number of entry of motorcycle vehicles can be seen in Table 2 and Figure 5, hours of peak entry of vehicles. The maximum number of motorcycles entering the parking lot was 51 vehicles (12.655%) occurring between 08:00-08:20. The maximum number of motorcycles exiting the parking lot was 49 vehicles (12.159%) occurring between 3:20 p.m. and 3:40 p.m. For maximum parking accumulation with the amount of 344 vehicles is at 10:00-10:20.

Parking duration

Parking duration is the span of time a vehicle parks somewhere (in hours). Based on the results of the above study, it was obtained that the average parking duration with a time interval of 20 minutes, as presented in Table 5 and Figure 8 as follows:

Table 5. Parking duration

| No	Day/Date	Observation Time (WIB)	Maximum Duration (hours)	Minimum Duration (hours)	Average Duration (hours)
1	Monday, 29 May 2023	06:00 - 17:00	9:52	0:19	5:55
2	Tuesday, 30 May 2023	06:00 - 17:00	9:57	0:35	5:41
3	Wednesday, 31 May 2023	06:00 - 17:00	9:01	1:05	6:10
4	Thursday, 1 June 2023	06:00 - 17:00	9:20	0:20	4:56
5	Friday, 2 June 2023	06:00 - 17:00	9:49	0:43	5:54
6	Monday, 5 June 2023	06:00 - 17:00	9:31	0:34	6:19
7	Tuesday, 6 June 2023	06:00 - 17:00	9:14	1:44	5:52
8	Wednesday, 7 June 2023	06:00 - 17:00	9:43	1:18	6:18
9	Thursday, 8 June 2023	06:00 - 17:00	9:26	1:17	6:33
10	Friday, 9 June 2023	06:00 - 17:00	9:20	0:53	5:51
		Max	9:57		
		Average	6:33		
		Min	0:19		
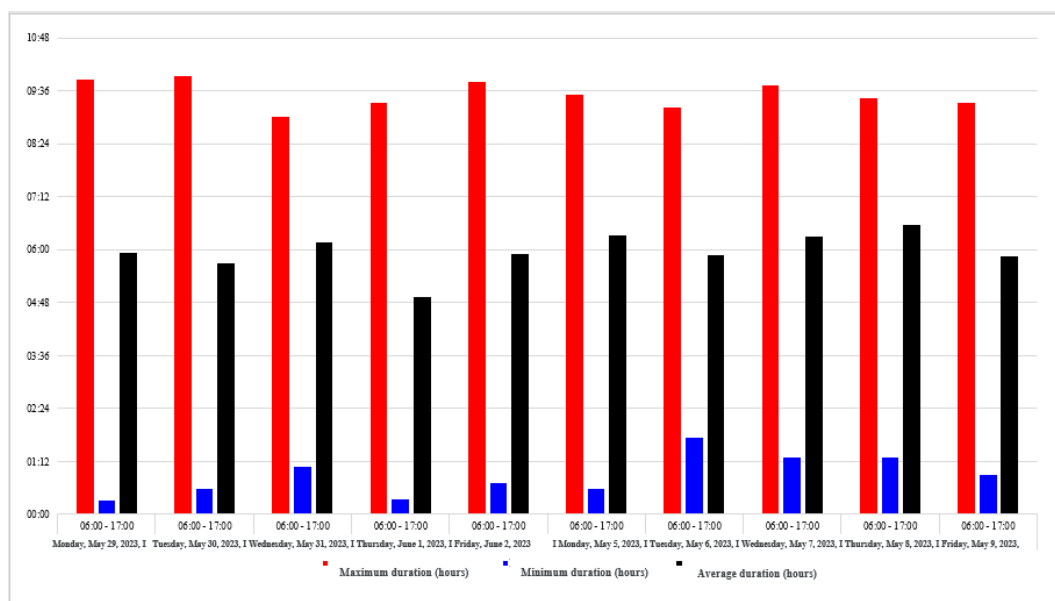
Figure 8. Parking duration

Based on Table 5 and Figure 8 above, the maximum duration is obtained on Tuesday, May 30, 2023, at 9:57 hours. The maximum average duration occurs on Thursday 8 June 2023 at 06:33 hours, and the minimum duration occurs on Monday 29 May 2023 at 0:19 hours.

Turnover parking change

Parking turn is the increase in the use of parking spaces and is obtained by dividing the parking volume by the number of parking spaces for a given period. By knowing the value of parking turnover, it can be known the level of parking space usage as presented in Table 6 and Figure 9 below:

Table 6. Turnover parking changes

| No	Day/Date	Parking Capacity (SRP)	Parking Volume (vehicle)	Turn Over Parking (%)
1	Monday, 29 May 2023	180	403	223.89
2	Tuesday, 30 May 2023	180	356	197.78
3	Wednesday, 31 May 2023	180	373	207.22
4	Thursday, 1 June 2023	180	285	158.33
5	Friday, 2 June 2023	180	331	183.89
6	Monday, 5 June 2023	180	397	220.56
7	Tuesday, 6 June 2023	180	256	142.22
8	Wednesday, 7 June 2023	180	358	198.89
9	Thursday, 8 June 2023	180	321	178.33
10	Friday, 9 June 2023	180	297	165.00
			Max	223.89
			Average	187.61
			Min	142.22
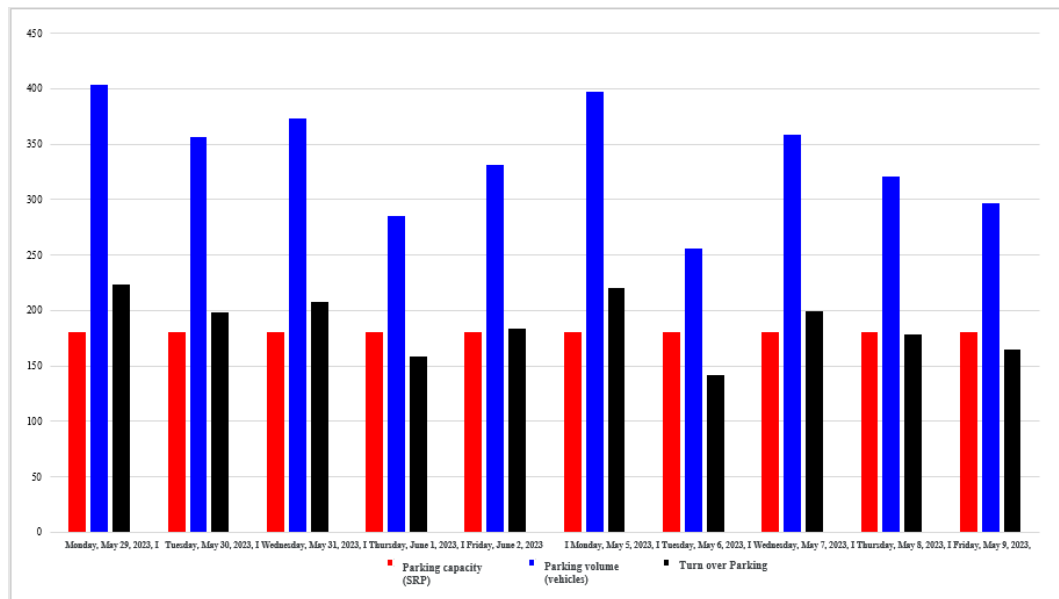
Figure 9. Turn over parking

Based on Table 6 and Figure 9 above, it can be seen that the motorcycle parking turnover rate with the highest value is 223.89%, the average value is 187.61%, and the minimum value is 142.22%. This shows that the performance of motorcycle parking is quite high by exceeding 100% lift.

Parking index

Parking performance can also be seen based on parking index numbers. The value of the motorcycle parking index at the Andi Hakim Nasution Building is based on the maximum parking accumulation. The parking index after going through the calculation stage is presented in Table 7 and Figure 10 as follows:

Table 7. Parking index

| No	Day/Date	Parking Capacity (SRP)	Parking Accumulation (maximum)	Parking Index (%)
1	Monday, 29 May 2023	180	344	191.11
2	Tuesday, 30 May 2023	180	280	155.56
3	Wednesday, 31 May 2023	180	327	181.67
4	Thursday, 1 June 2023	180	178	98.89
5	Friday, 2 June 2023	180	289	160.56
6	Monday, 5 June 2023	180	351	195.00
7	Tuesday, 6 June 2023	180	207	115.00
8	Wednesday, 7 June 2023	180	310	172.22
9	Thursday, 8 June 2023	180	293	162.78
10	Friday, 9 June 2023	180	236	131.11
			Max	195.00
			Average	156.39
			Min	98.89
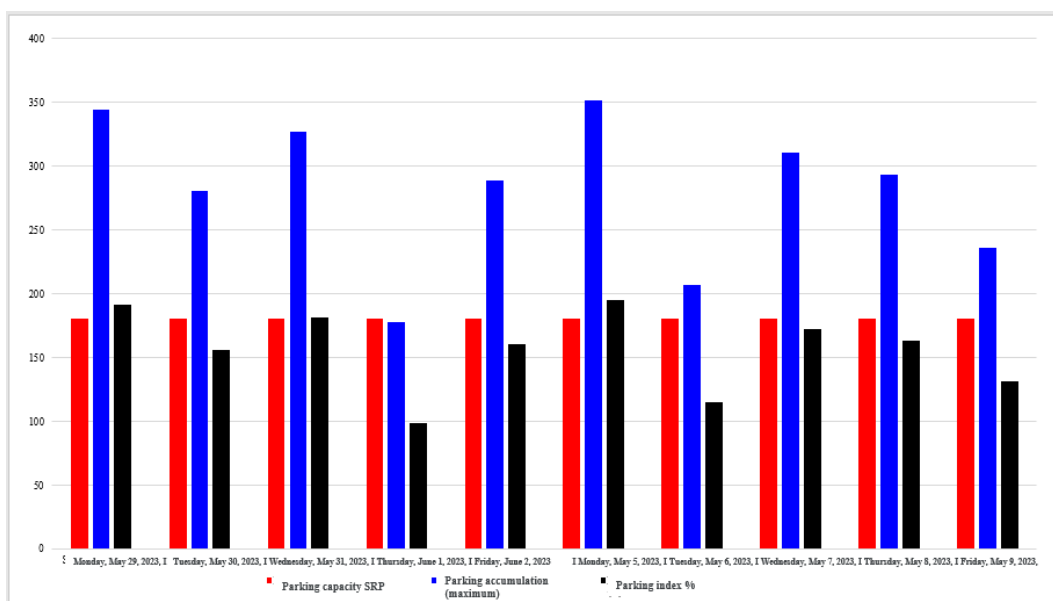
Figure 10. Parking index

Based on Table 7 and Figure 10 above the motorcycle parking index occurs at the maximum value is 195.00%, with an average value is 156.39%, and a minimum value is 98.89% (based on maximum accumulation). From the parking index value obtained, it is stated that the demand for parking spaces is greater than the parking capacity because it has an index value of more than 100%.

Analysis of parking space needs
Parking space needs

From the calculation a recapitulation of parking space needs at the Andi Hakim Nasution Building is obtained as presented in Table 8 and Figure 11 as follows:

Table 8. Parking space requirement

| No	Day/Date	Survey Length (hours)	Parking Volume (vehicle)	Average Duration (hours)	Parking Space Needs
1	Monday, 29 May 2023	11	403	5:55	238
2	Tuesday, 30 May 2023	11	356	5:41	202
3	Wednesday, 31 May 2023	11	373	6:10	230
4	Thursday, 1 June 2023	11	285	4:56	141
5	Friday, 2 June 2023	11	331	5:54	195
6	Monday, 5 June 2023	11	397	6:19	251
7	Tuesday, 6 June 2023	11	256	5:52	150
8	Wednesday, 7 June 2023	11	358	6:18	226
9	Thursday, 8 June 2023	11	321	6:33	210
10	Friday, 9 June 2023	11	297	5:51	174
				Max	251
				Average	202
				Min	141
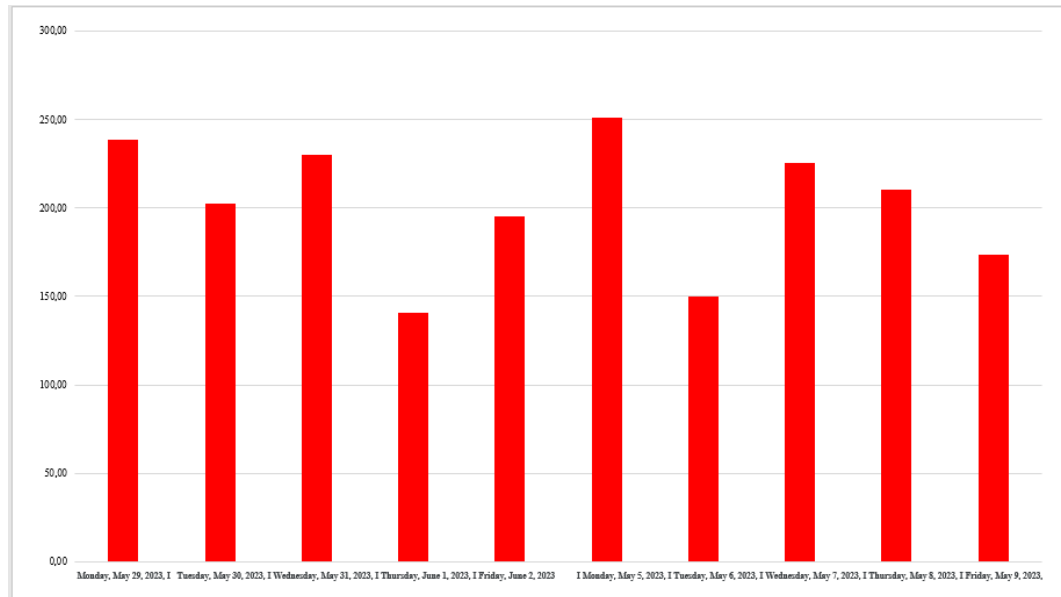
Figure 11. Parking space requirement

Based on Table 8 and Figure 11 above, show that the most parking space needed for motorcycles at the Andi Hakim Nasution Building occurred on Monday, June 5, 2023, amounting to 251 SRP.

Standard parking space capacity requirements

Based on the data analysis that has been carried out, the available parking capacity and parking space needs can be determined by analyzing the number of vehicles parked against the number of available parking spaces, if the need for parking spaces is greater than the available parking capacity, the number of available parking spaces is insufficient. If the need for parking spaces is smaller than the available parking capacity, the number of available parking spaces is still able to accommodate vehicles that will park in the parking area. The need for parking spaces based on the largest equation 2.8 approach is determined as the value of parking space needs that must be met by the Bogor Agricultural University. If the need for parking space is determined based on the results of research in the field, then the value of parking space needs to be taken is at the time of maximum accumulation. The following is a comparison of parking space needs against parking space capacity presented in Table 9 and Figure 12.

Table 9. Parking Space Capacity Requirements

No	Day/Date	Parking space needs	Parking Space Capacity	Parking Space Capacity Difference (+/-)
1	Monday, 29 May 2023	238	180	-58
2	Tuesday, 30 May 2023	202	180	-22
3	Wednesday, 31 May 2023	230	180	-50
4	Thursday, 1 June 2023	141	180	39
5	Friday, 2 June 2023	195	180	-15
6	Monday, 5 June 2023	251	180	-71
7	Tuesday, 6 June 2023	150	180	30
8	Wednesday, 7 June 2023	226	180	-46
9	Thursday, 8 June 2023	210	180	-30
10	Friday, 9 June 2023	174	180	6
			Max	39

Average	-22
Min	-71

Description: (+) = Parking Space Capacity still meets

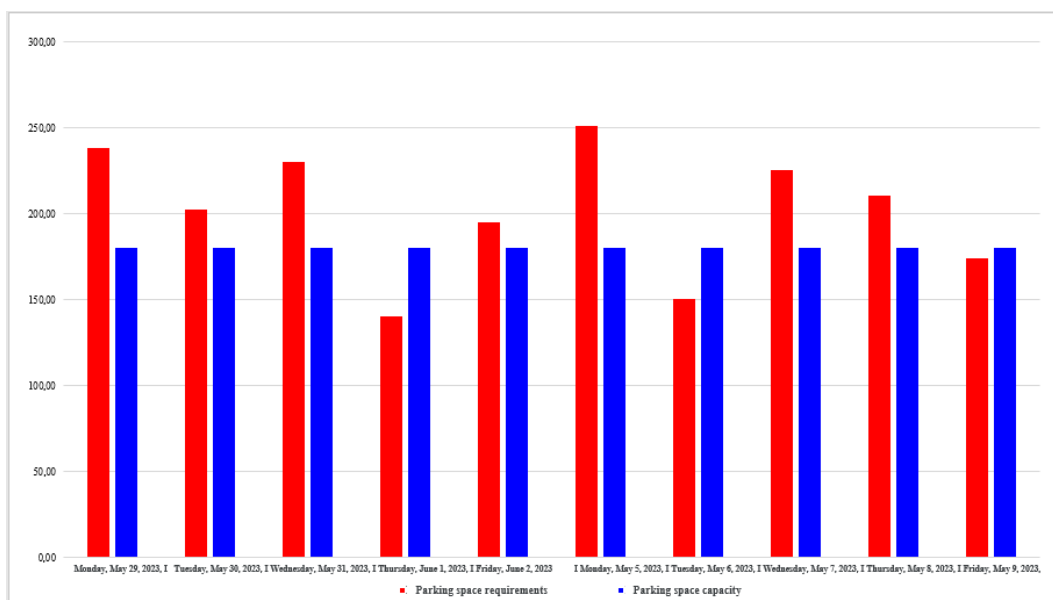(-) = Parking Space Capacity does not meet

Figure 12. Parking space capacity requirements

Based on Table 9 and Figure 12, parking space capacity requirements were shown on Monday, May 29, 2023. The need for parking spaces is 238 SRP, while the parking capacity available at the research location is 180 SRP, so the difference between parking space needs and parking capacity is -51 SRP.

CONCLUSION

Based on the survey results **and data analysis obtained, namely the existing condition of the parking lot obtained secondary data with the survey method so as to produce existing data** covering an area of 630m^2 area motorcycle parking with a capacity of 180 (Units of Parking Space) SRP and a tilt angle of 90 ° at Andi Hakim Nasution Building. In this analysis study, the largest accumulated stasis capacity results were 251 vehicles with an average parking duration of 9:57 hours on Tuesday, May 30, 2023. During the ten days of the survey conducted, it was found that the maximum parking volume was 403 vehicles with a maximum vehicle parking accumulation of 351 vehicles which occurred on Monday 5 June 2023, the highest motorcycle parking turnover at the Andi Hakim Nasution Building reached 223.89%, indicating that the performance of motorcycle parking was quite high. The capacity of motorcycle parking spaces at the Andi Hakim Nasution Building cannot meet existing parking needs. This is shown by seeing the parking index exceed 100%.

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