Evaluation of the Parking Space Capacity of Two-Wheeled Vehicle at the State Polytechnic of Sriwijaya

Yusri Bermawi[1], Nadra Mutiara Sari[2], Dimas Ariezky Susetyo[3]*, Fany Fadhila[4], Ruspina Idella Ompusunggu[5]

[1-5]Civil Engineering Dapartement, State Polytechnic of Sriwijaya, Palembang, Indonesia
nadra.mutiara.sari@polsri.ac.id

Abstract. Changes in land functions at the State Polytechnic of Sriwijaya, which was originally a parking lot turned into buildings or other facilities, caused a lack of adequate parking area capacity. Therefore, it is necessary to analyze the parking space units in the campus area. The purpose of this research is to determine the need for parking spaces, especially for two-wheeled vehicles. The data analysis method is quantitative analysis with descriptive graphics and analytically using parking calculation formulas, namely parking capacity, parking characteristics (volume, accumulation, duration, turnover rate), parking index, and parking space units. The results showed that the volume of motorcycles entering the parking area was greater than the available parking capacity, with a maximum motorcycle parking accumulation of 891 veh/hour, a parking turnover rate of 3,13 veh/PSU/hour, and the parking index that exceeded the maximum limit of 132,36% with a need for parking space of 3648.06 m^2. From the results of the analysis, it can be concluded that parking requirements are greater than the number of available parking spaces, which is only 2962.4 m^2. In order for the need for parking space to be met, an additional 686 m^2 of land is needed specifically for two-wheeled vehicle parking.

Keywords: Characteristics of parking, parking index, parking space units.

1 Introduction

Initially, the main campus of the State Polytechnic of Sriwijaya had a parking area that was very sufficient to accommodate parking for two-wheeled and four-wheeled vehicles. Along with the development every year, changes in land use change what was originally a parking area into a building or educational facility, which causes a lack of sufficient parking space capacity. The impact of reducing the capacity of the parking area is the occurrence of parking conditions that are clustered without obeying the signs made for single-layer parking, and not obeying the markings of existing parking space units results in a buildup of two-wheeled vehicles.

It can be known that campus regulations have also issued a policy that students are prohibited from bringing four-wheeled vehicles, only lecturers and campus staff are allowed, but the regulation has caused a new problem that causes a surge in two-wheeled vehicles that often park out of place. This is what causes four-wheeled vehicle

N. L. Husni et al. (eds.), *Proceedings of the 7th FIRST 2023 International Conference on Global Innovations (FIRST-ESCSI 2023)*, Advances in Engineering Research 232,
https://doi.org/10.2991/978-94-6463-386-3_27

parking to be on the road along the path of the State Polytechnic of Sriwijaya campus area. The campus has also made a one-level parking building facility for two-wheelers in the campus area, but it is not a solution because the number of two-wheeled vehicles is still very large (see Fig. 1).

Fig. 1. Parking conditions on the main campus of the State Polytechnic of Sriwijaya

As a step to overcome problems that will occur in the future, it is necessary to evaluate and re-examine the need for two-wheeled vehicle parking spaces at the main campus of the State Polytechnic of Sriwijaya Palembang.

2 Theoritical Foundation

2.1 Literature Review

There is research analyzing vehicle parking performance at Sultan Hasanudin International Airport with post COVID-19 pandemic conditions using calculations of parking accumulation, parking duration, parking volume, parking turnover rate, and parking index. The results showed that an analysis of the characteristics of vehicle parking requirements at airports can still accommodate vehicle parking spaces [9].

There is research analyzing the need for motorized vehicle parking in the Padang State University campus area using calculations based on PSU (parking space units). The results were obtained by analyzing parking characteristics such as parking accumulation, parking duration, parakeet turnover rate, and parking index [8]

There is research on analyzing parking characteristics and parking space requirements at SIT Bina Ilmi Palembang using quantitative analysis methods and applying the calculation of the highest accumulated difference between off-street parking and on-street parking by planning trip generation in a descriptive graphic manner with the help of the PTV Vissim 8.0 program. The results of the analysis of the study showed the buildup of access points for vehicles, parking cars, passengers, and motorcycles due to limited parking space capacity, which was required to create alternative scenarios, change new routes, and expand land planning for the construction of parking space to accommodate the parking space capacity of vehicles going to the school [2][4].

2.2 Parking

Parking is a vehicle that is stopped for a while or long enough and does not move [4]. Parking is a special place for vehicles to stop for safety [11]. It can be concluded that parking is a place to stop vehicles for a short or long period of time according to the goals and needs of motorists.

2.3 Parking Types

Parking According to its Placement. Parking placement is divided into two types and can be described as follows [4].

1. On-street parking. It is a parking lot that uses the shoulder of the road as a vehicle parking lot. The advantage is that it can park the vehicle easily;
2. Off-street parking. Is a parking facility at the location of the parking area with a special land use provided that has access to entrance and exit service doors as well as information on the number of vehicles that fill the parking space at a certain duration according to the time of ticket collection.

Parking According to its Status. According to its status, parking is divided into five types, it can be explained as follows [3][4][5]:

1. Public parking. It is a parking area managed by the local government;
2. Dedicated parking. Is a parking area managed by a third party;
3. Emergency parking. Is a public parking area that uses local government or private land for incidental purposes;
4. Park parking. It is a parking area managed by the local government;
5. Parking building. Is a parking area created and managed by the local government or private.

2.4 Parking Patterns

Parallel Parking Patterns. A parallel parking pattern is a pattern of sequential parking on the side of the road [4]. Generally, parallel parking facilities are applied in the city center and residential areas (see Fig. 2).

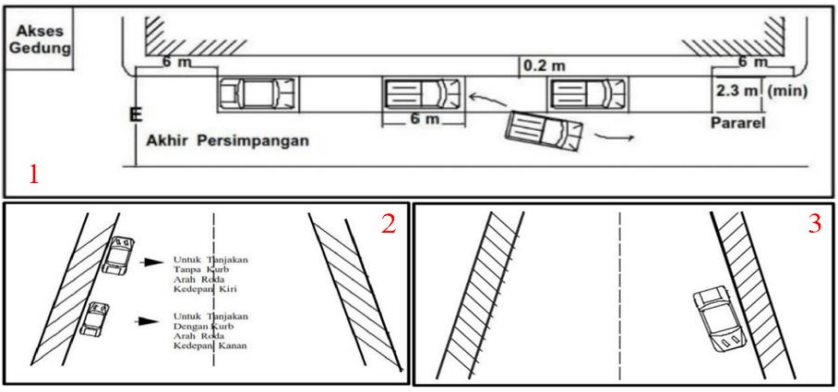


Fig. 2. Parking patterns of Flat (1), uphill (2), and downhill (3)

Angled Parking Patterns. The angled parking pattern has more capacity than the parallel parking pattern and also makes it easier for vehicle users to maneuver in and out of parking spaces [4] (see Fig. 3).

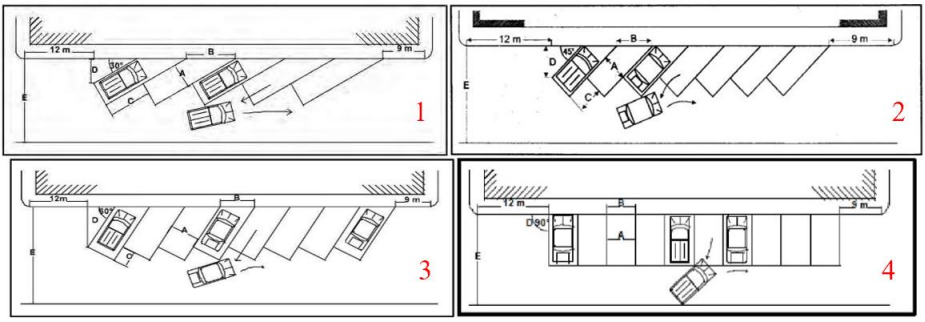


Fig. 3. Angled parking pattern with 30° angle (1), 45° angle (2), 60° angle (3), and 90° angle (4)

Information:

A = Width of parking space (m)
B = Width of feet of parking space (m)
C = Parking space length difference (m)
D = Effective parking space (m)
M = Maneuver room (m)
E = D + M

2.5 Parking Space Units

Determination of Parking Space Unit. In measuring the width of parking spaces, it is usually adjusted to the type of parking vehicle. The determination of parking space units (PSU) can be seen in Table 1.

Table 1. Determination of parking space unit (PSU) standards based on road type

Road Type	Min Speed (km/h)	Road Body Width (m)	Vehicle Parking Location	Vehicle Stop Location	Wide Pavement
Primary Artery	60	8,00	Not allowed	Not allowed	2 x 7 m 2 x 3 m
Secondary Artery	30	8,00	Limited	Limited	2 x 7 m 2 x 3 m
Primary Collector	40	7,00	Limited	Limited	2 x 6,5 m 2 x 2,5 m
Secondary Collector	20	7,00	Limited	Limited	2 x 6,5 m 2 x 2,5 m
Primary Collector	40	7,00	Limited	Limited	2 x 6,5 m 2 x 2,5 m
Secondary Collector	20	7,00	Limited	Limited	2 x 6,5 m 2 x 2,5 m
Primary Location	20	6,00			2 x 3 m
Secondary Location	10	5,00			2 x 2,5 m

Source: Peraturan Direktorat Jenderal Perhubungan Darat, 1996 [4]

The determination of parking space unit (PSU) measurement standards based on vehicle type can be seen in Table 2.

Table 2. Determination of parking space unit (PSU) standards based on vehicle type

No.	Vehicle Type	PSU (m^2)
1.	a. Passenger Cars (Group I)	2,30 x 5,00
	b. Passenger Cars (Group II)	2,50 x 5,00
	c. Passenger Cars (Group III)	3,00 x 5,00
2.	Bus / Truck	3,40 x 12,50
3.	Motorcycle	0,70 x 2,00

Source: Peraturan Direktorat Jenderal Perhubungan Darat, 1996 [4]

Parking Space Unit for Motorcycles. The following is the size of the parking space unit for motorcycles. (see Fig. 4).

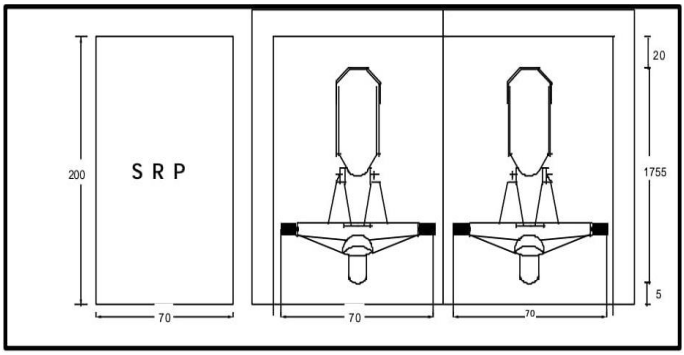


Fig. 4. Parking space units for motorcycles (cm)

2.6 Characteristics of Parking

Characteristics of parking are a basic assessment of parking services and parking problems that occur in the study area. Based on the results of parking characteristics, it can be known that parking conditions that occur in the study area can be explained as follows [6][7]:

1. Parking volume. Is the number of vehicles involved in the parking load (vehicles per specific period of time, usually one day). The parking volume is calculated by adding up the vehicles that use the parking area within a day;
2. Accumulated parking. Is the number of vehicles that are in the parking area at a certain time;
3. Parking duration. Is the length of time used by vehicle users in parking spaces. To obtain the calculation of duration, it is carried out by observing the time of entry and exit of the vehicle from the parking space;
4. Parking turnover. Is the number of vehicles that have utilized parking spaces at a given time;

5. Parking index. Is the percentage of the number of parking vehicles occupying the parking area equal to the number of parking spaces available in the parking area. The parking index value is obtained from the comparison between accumulation and parking capacity;
6. Parking space requirements. Is the number of vehicles that can be accommodated in the parking area [1].

3 Methodology

The parking research was carried out in the main campus area of the State Polytechnic of Sriwijaya. This research is a type of quantitative analysis research with descriptive graphics and analysis, namely by using primary data in the form of observational surveys and secondary data in the form of location maps. More detail in this research stage can be explained through the flow chart (see Fig. 5).

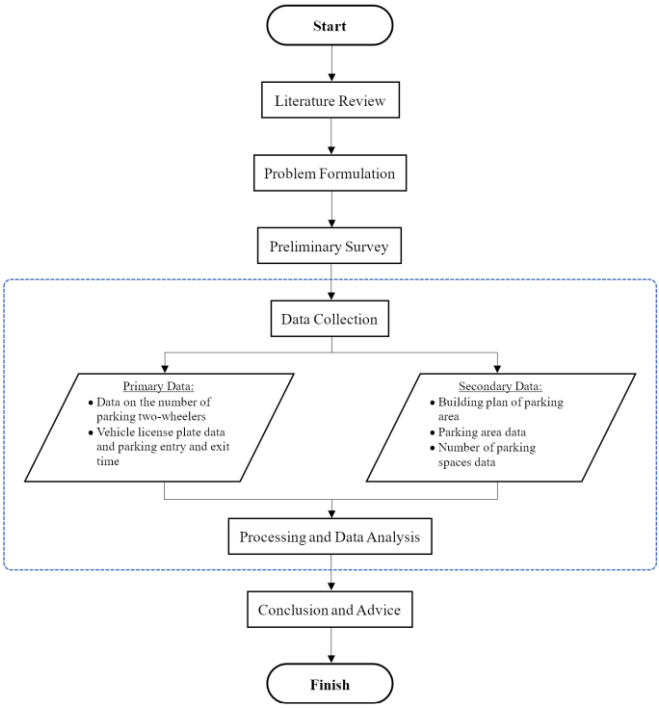


Fig. 5. Research data flow chart

3.1 Primary Data Collection

The primary data taken is in the form of two-wheeled vehicle parking data adjusted to the number of parking areas in the main campus environment, consisting of the security guard post parking area (P1), the first-floor parking building area (P4), the mechanical

engineering parking area (P5), the computer engineering parking area (P7), the chemical engineering laboratory parking area (P8), and the ceremonial field parking area (P10). More detail can be explained in the layout of the parking area (see Fig. 6).

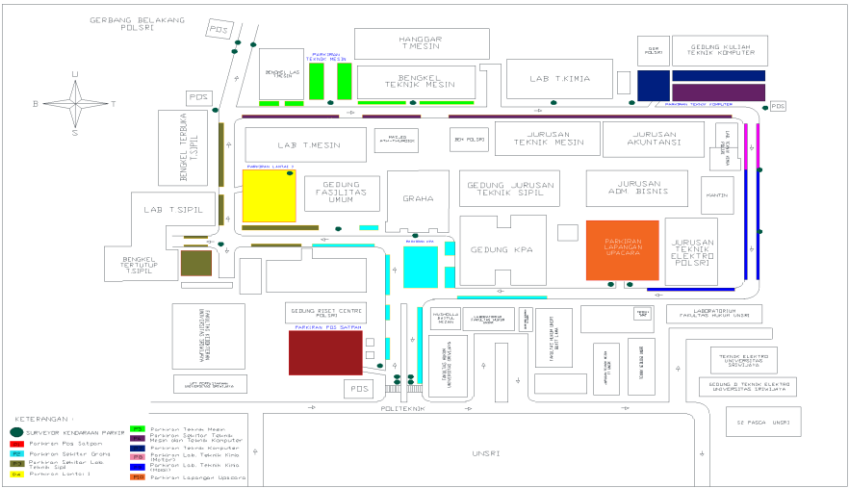


Fig. 6. Parking layout of the main campus of the State Polytechnic of Sriwijaya

The primary data collected in the study was in the form of recording vehicle police license plates at the time of entry and exit. Primary data survey observations are carried out for 5 (five) working days starting from Monday to Friday, with a survey time of 12 (twelve) hours starting at 06.00–18.00 local time.

3.2 Secondary Data Collection

Secondary data is taken in the form of parking area building plans, parking area data, and data on the number of parking space plots. The data is an indicator that helps analyze the need for parking evaluation at the main campus of the State Polytechnic of Sriwijaya. In addition, data on the number of parking space plots is used to evaluate parking dimensions based on the type of vehicle. The following secondary data in the form of parking area and number of parking space units can be seen in Table 3.

Table 3. Secondary data on parking capacity area & number of motorcycle parking space units

Vehicle Type	Parking Location	Static Capacity (PSU)	Static Capacity (m^2)
Motorcycle	Security post parking (P1)	179	250,60
	First-Floor parking building (P4)	435	609
	Mechanical engineering parking (P5)	135	189
	Computer engineering parking (P7)	209	292,60
	Chemical engineering lab parking (P8)	48	67,20
	Ceremonial field parking (P10)	1110	1554

Source: General Administration Section of the State Polytechnic of Sriwijaya, 2023

3.3 Data Analysis Methods

Data analysis is a calculation to process primary data obtained and then evaluate secondary data as an indicator so that validation of the stages of parking space characteristics is obtained. This research uses quantitative analysis methods, both descriptively and analytically, using parking characteristics calculation formulas. Here is the equation of parking characteristics that can be seen as follows:

$$Parking\ Volume = Ei + X \tag{1}$$

Information:
Ei = Entry (vehicles enter the parking area)
X = Vehicles that existed before the time of the survey

$$Parking\ Accumulation = Ei - Ex + X \tag{2}$$

Information:
Ei = Entry (vehicles enter the parking area)
Ex = Exit (vehicles exit the parking area)
X = Vehicles that existed before the time of the survey

$$Parking\ Duration = Ex\ time - En\ time \tag{3}$$

Information:
Ex time = When the vehicle exits the parking location
En time = When the vehicle enters the parking location

$$Parking\ Turnover\ Numbers = \frac{Parking\ Volume}{Parking\ Space\ Capacity} \tag{4}$$

Information:
Parking Volume = Total number of vehicles 1 day survey (veh/day)
Parking Space Capacity = Field observation data / PSU secondary data

$$Parking\ Index = \frac{Parking\ Accumulation}{Number\ of\ Parking\ Space\ Capacity} \times 100\% \tag{5}$$

Information:
PI Value < 100% (Parking requirements are below the number of parking spaces)
PI Value = 100% (Parking requirements are balanced with the number of parking spaces)
PI Value > 100% (Parking requirements are exceed the number of parking spaces)

$$Parking\ Area = PI \times Highest\ PA \times PSU\ size \tag{6}$$

Information:
PI = Parking index
Highest PA = Highest parking accumulation
PSU size = Parking space unit size by vehicle type [6]

4 Results and Discussion

4.1 Processing and Data Analysis

Based on the parking characteristics data analysis method, output data is obtained in the form of vehicle volume results in Table 4 and Table 5, the highest accumulation in Table 6, parking duration in Table 7, parking turnover value in Table 8, parking index in Table 9, and parking space requirements in Table 10.

Table 4. Maximum volume data (veh/h) by vehicle type of motorcycle

VehicleType	Parking Location	Maximum Volume (veh/h)				
		Monday	Tuesday	Wednesday	Thursday	Friday
Motorcycle	Security post parking (P1)	83	79	51	46	56
	First-floor parking building (P4)	269	265	262	253	314
	Mechanical engineering parking (P5)	75	79	66	61	72
	Computer engineering parking (P7)	148	140	154	127	151
	Chemical engineering lab parking (P8)	37	54	38	42	37
	Ceremonial field parking (P10)	349	316	312	286	284

Source: Primary Data, 2023

Table 5. Total volume data (veh/day) by vehicle type of motorcycle

Vehicle Type	Parking Location	Total Volume (veh/day)				
		Monday	Tuesday	Wednesday	Thursday	Friday
Motorcycle	Security post parking (P1)	301	290	240	218	275
	First-floor parking building (P4)	1244	1200	1193	1070	1103
	Mechanical engineering parking (P5)	396	423	379	375	387
	Computer engineering parking (P7)	650	593	665	540	664
	Chemical engineering lab parking (P8)	133	130	126	129	117
	Ceremonial field parking (P10)	2025	1916	1800	1711	1772

Source: Primary Data, 2023

Table 6. Highest parking accumulation data (veh/h) by vehicle type of motorcycle

Vehicle Type	Parking Location	Maximum Accumulation (veh/h)				
		Monday	Tuesday	Wednesday	Thursday	Friday
Motorcycle	Security post parking (P1)	168	201	160	135	189
	First-floor parking building (P4)	577	591	589	512	560
	Mechanical engineering parking (P5)	140	181	160	147	129
	Computer engineering parking (P7)	310	265	307	261	289
	Chemical engineering lab parking (P8)	88	81	82	79	57
	Ceremonial field parking (P10)	891	807	736	768	705

Source: Primary Data, 2023

Table 7. Highest parking duration data (veh/day) by vehicle type of motorcycle

Vehicle Type	Parking Location	Maximum Parking Duration (veh/day)				
		Monday	Tuesday	Wednesday	Thursday	Friday
Motorcycle	Security post parking (P1)	38	44	35	32	60
	First-floor parking building (P4)	341	380	359	290	338
	Mechanical engineering parking (P5)	88	65	76	84	87
	Computer engineering parking (P7)	117	101	106	95	113
	Chemical engineering lab parking (P8)	46	32	38	31	47
	Ceremonial field parking (P10)	430	428	425	411	423

Source: Primary Data, 2023

Table 8. Parking turnover rate data (veh/PSU/h) by vehicle type of motorcycle

Vehicle Type	Parking Location	Parking Turnover Rate (veh/PSU/h)				
		Monday	Tuesday	Wednesday	Thursday	Friday
Motorcycle	Security post parking (P1)	1,68	1,62	1,34	1,22	1,54
	First-floor parking building (P4)	2,86	2,76	2,74	2,46	2,54
	Mechanical engineering parking (P5)	2,93	3,13	2,81	2,78	2,87
	Computer engineering parking (P7)	2,04	1,86	3,18	1,69	2,08
	Chemical engineering lab parking (P8)	2,77	2,71	2,63	2,69	2,44
	Ceremonial field parking (P10)	1,82	1,73	1,62	1,54	1,60

Source: Primary Data, 2023

Table 9. Parking index data (%) by vehicle type of motorcycle

Vehicle Type	Parking Location	Parking Index (%)				
		Monday	Tuesday	Wednesday	Thursday	Friday
Motorcycle	Security post parking (P1)	93,85	112,29	89,38	75,41	105,58
	First-floor parking building (P4)	132,64	135,86	135,40	117,70	128,73
	Mechanical engineering parking (P5)	103,70	134,07	118,52	108,89	95,56
	Computer engineering parking (P7)	148,33	126,79	146,89	124,88	138,28
	Chemical engineering lab parking (P8)	183,33	168,75	170,83	164,58	118,75
	Ceremonial field parking (P10)	80,27	72,70	66,30	69,18	63,51

Source: Primary Data 2023

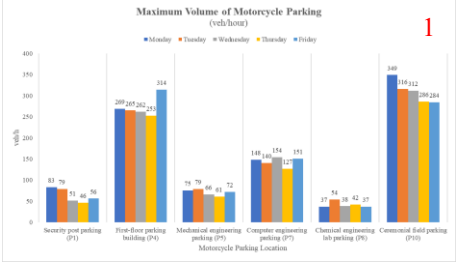
Table 10. Parking space requirements data (m^2) by vehicle type of motorcycle

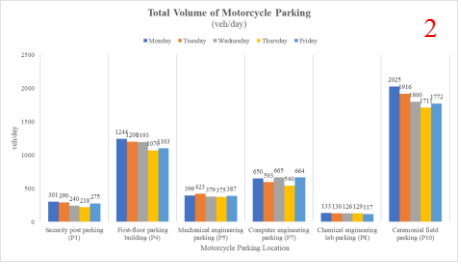
Vehicle Type	Parking Location	Parking Space Requirements (m^2)
Motorcycle	Security post parking (P1)	315,98
	First-floor parking building (P4)	1124,11
	Mechanical engineering parking (P5)	339,74
	Computer engineering parking (P7)	643,73
	Chemical engineering lab parking (P8)	223,30
	Ceremonial field parking (P10)	1001,20

Source: Primary Data, 2023

4.2 Parking Characteristics Analysis Graph

The following graph is based on the results of parking characteristics data analysis in the form of vehicle volume, highest accumulation, parking duration, parking turnover rate, and parking index (see Fig. 7), as well as parking space requirements data from primary and secondary data (see Fig. 8).





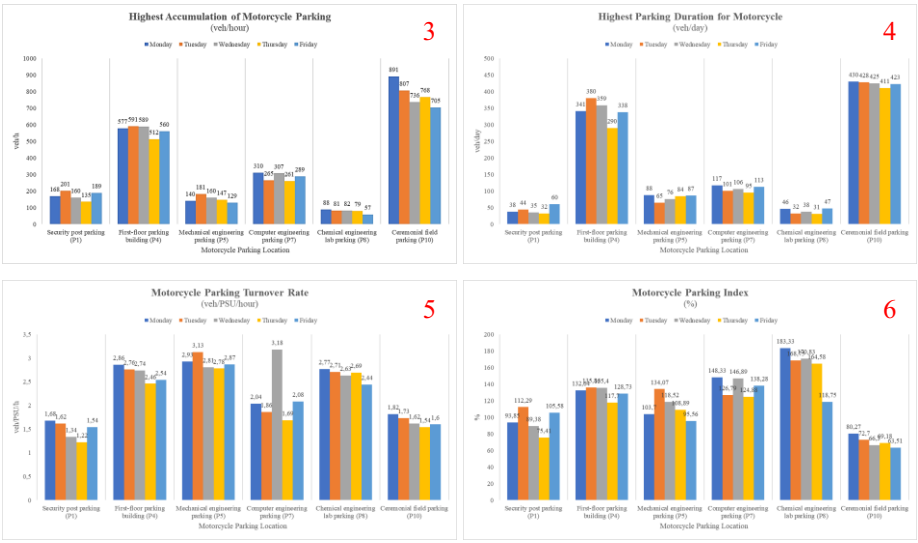


Fig. 7. Graph of data processing results for comparison of each parking location based on parking characteristics in the form of maximum volume veh/h (1), total volume veh/day (2), highest accumulation (3), parking duration (4), parking turnover value (5), and parking index (6)

The following is a graph of the results of data analysis of parking space requirements from parking characteristics data processing in the form of primary data processing and secondary data as a comparison to be used as an evaluation indicator of the comparison of parking space requirements at the main campus of the State Polytechnic of Sriwijaya (see Fig. 8).

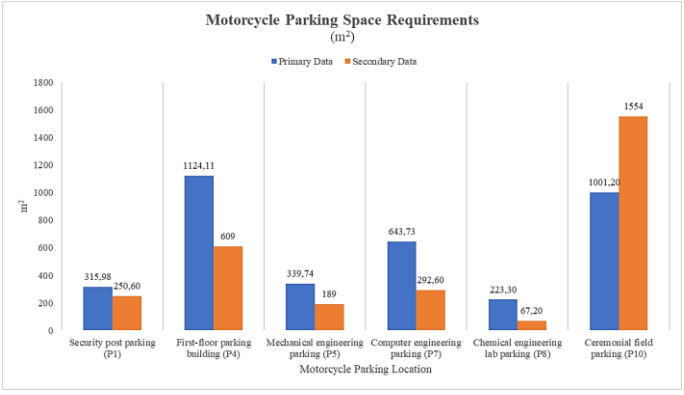


Fig. 8. A comparison graph of the evaluation of parking space needs data from the results of primary data processing and secondary data.

4.3 Evaluation Results of the Comparison of Primary Data and Secondary Data

The results of the data analysis for the comparison of primary data processing and secondary data can be seen in Table 11.

Table 11. Recapitulation of evaluation parking characteristics from primary data

Parking Location	Primary Data						
	Volume	Volume	Highest Accumulation	Highest Duration	Turnover Rate	Parking Index	Parking Space Requirements
	(veh/hour)	(veh/day)	(veh/hour)	(hour)	(veh/PSU/hour)	(%)	(m^2)
(1)	(2)	(3)	(4)	(5)	(6) = 3-9	(7) = 4-9 x 100%	(8) = 7 x 4 x PSU
(P1)	83 (07.00-08.00) (Monday)	301 (Monday)	201 (14.00-15.00) (Tuesday)	4 – 5 (60 veh) (Friday)	1,22 – 1,68	112,29	315,98
(P4)	314 (13.00-14.00) (Friday)	1244 (Monday)	591 (14.00-15.00) (Tuesday)	5 – 6 (380 veh) (Tuesday)	2,46 – 2,86	135,86	1124,11
(P5)	79 (06.00-07.00) (Tuesday)	423 (Tuesday)	181 (09.00-10.00) (Tuesday)	2 – 3 (88 veh) (Monday)	2,78 – 3,13	134,07	339,74
(P7)	154 (12.00-13.00) (Wednesday)	665 (Wednesday)	310 (12.00-13.00) (Monday)	2 – 3 (117 veh) (Monday)	1,69 – 3,18	148,33	643,73
(P8)	54 (07.00-08.00) (Tuesday)	133 (Monday)	88 (16.00-17.00) (Monday)	4 – 5 (47 veh) (Friday)	2,44 – 2,77	183,33	223,30
(P10)	349 (12.00-13.00) (Monday)	2025 (Monday)	891 (11.00-12.00) (Monday)	4 – 5 (430 veh) (Monday)	1,54 – 1,82	80,27	1001,20
Total	1033	4791	2262			132,36	3648,06

Source: Primary Data, 2023

Table 12. Recapitulation of the results of comparative evaluation and data analysis of parking characteristics from primary data processing and secondary data

Primary Data	Secondary Data		Evaluation Results
Parking Location	Static Capacity	Static Capacity	Parking Space Requirements
	(PSU)	(m^2)	(m^2)
(1)	(9)	(10)	(11) = 8 – 10
Security post parking (P1)	179	250,60	65,38 (47 PSU)
First-Floor parking building (P4)	435	609	515,11 (368 PSU)
Mechanical engineering parking (P5)	135	189	150,74 (108 PSU)
Computer engineering parking (P7)	209	292,60	351,13 (251 PSU)
Chemical engineering lab parking (P8)	48	67,20	156,10 (112 PSU)
Ceremonial field parking (P10)	1110	1554	-552,80 (-395 PSU)
Total	2116	2962,40	686 (490 PSU)

Source: Primary Data and Secondary Data, 2023

Information: (+) Need additional parking space units (PSU); (–) Parking space units (PSU) still sufficient

Based on the results of motorcycle parking characteristics data for the evaluation of the highest value was obtained from the lack of parking spaces at the location of the first-floor parking building (P4) with the parking space requirements of 515,11 m^2, or around 368 PSU motorcycles. From the results of data processing, it can also be concluded that

secondary data for the first-floor parking building (P4) information on the number of available parking spaces is only 609 m^2, or around 435 PSU motorcycles, so for motorcycle parking spaces requirements is greater than secondary data.

5 Conclusions

Based on the results of the evaluation, the comparison of primary and secondary data shows that:

1. The volume of motorcycles entering the parking area is greater than the available parking capacity, with a maximum volume of 314 veh/hour, a maximum parking accumulation of 891 veh/hour, a parking turnover rate of 3,13 veh/PSU/hour, and a parking index exceeding the maximum limit of 132,36% with a parking space requirement of 3648,06 m^2;
2. Parking requirements are greater than secondary data in the form of the number of available parking spaces, which is 2962,4 m^2, so an additional area of 686 m^2, or 490 PSU, is needed specifically for two-wheeled motorcycles;
3. The evaluation results can be used as a reference for the development of problem-solving solutions in the form of several alternative scenarios, the latest methods, and the addition of four-wheeled vehicle analysis to optimize and provide overall total parking stacking solutions in future research studies.

References

1. Agustin, T. H., Hakim, L., Wiranata, D. Y., Kurnia, A. Y., Jamilah, W., Agustien, M., Syafarina, P., Sari, N. M., Pirdiansyah.: Transportation Management. Indie Press, Bandung (2023).
2. Buchari. E., Susetyo D. A.: Parking Simulation Modeling and Parking Requirement Analysis Integrated Islamic School Bina Ilmi, Tanjung Rawa, Palembang. International Symposium of FSTPT, Islamic Universitas of Indonesia, October, Ch.7, pp.840-850 (2016).
3. Directorate General of Land Transportation.: Guidelines for Planning and Operation of Parking Facilities. Ministry of Transportation, Jakarta (1998).
4. Directorate General of Land Transportation.: Technical Guidelines for the Implementation of Parking Facilities. Ministry of Transportation, vol.1, no.1, p.41 (1996).
5. Government Regulation No.43.: Road Infrastructure and Traffic. President of the Republic of Indonesia. Jakarta (1993).
6. Hoobs, F.: Urban Transportation Planning. Gajah Mada Press, Yogyakarta (1995).
7. Miro, F.: Transportation Planning For Students, Planners and Practitioners. Erlangga, Jakarta (2005).
8. Oktaviani, S. N. M., Revian, B.: Analysis of Vehicle Parking Space Requirement. J. Teknol. Inf. Pendidik., vol.10, no.03, pp. 11–25 (2017).
9. Prasetyo, A. A.: Analysis of Vehicle Parking Performance at Sultan Hasanuddin International Airport After the Covid-19 Pandemic. Hasanudin University, Makassar (2023).
10. Susetyo, D. A.: Trip Generation Modeling and Parking Space Requirement Analysis at Integrated Islamic School Bina Ilmi, Tanjung Rawa, Palembang. Sriwijaya University (2016).
11. Tamim, O. Z.: Modelling and Transport Planning. Bandung Institute of Technology (2003).