PERFORMANCE ANALYSIS OF PARKING SPACE CAPACITY AT DR. SOEDONO GENERAL HOSPITAL OF MADIUN

Bagastha Pudji Yurinko Labina, Sri Wiwoho Mudjanarko, Rizal Bahaswan
Department of Civil Engineering Narotama University Surabaya INDONESIA
E-mail: sri.wiwoho@narotama.ac.id

ABSTRACT

Parking is an element of facilities that cannot be separated from the overall transportation system. The increase in the population of a city will cause an increase in the need to carry out various activities. Hospital is one of the public facilities with a fairly high level of activity. However, in reality, the parking lot at the dr. Soedono General Hospital in Madiun is often full and disrupts the surrounding traffic. Therefore, it is necessary to analyze the performance of parking capacity and space at the dr. Soedono General Hospital. The research was done by doing a literature study on parking behavior, a preliminary survey at the study site, collecting primary and secondary data, then proceed with analyzing data in the form of capacity and parking space performance. The results of this study show that the maximum parking volume is 217 motorbikes/day and 249 cars/day, the average parking duration for motorbikes is 4.92 hours and 3.63 hours for cars, the maximum parking accumulation for motorbikes is 121 vehicles/day, and 62 cars/day, the maximum parking index for motorbikes and cars is 4.31% and 4.64%, and the parking space requirement for motorcycles (SRP) is 100 SRP and cars 80 SRP.

Keywords: parking performance; parking space requirements; hospital; SRP; vehicle.

INTRODUCTION

Economic centers, trade, and industry, the increasing growth of a city demands the availability of public facilities, such as health facilities, office facilities, education, and other facilities. One of the public facilities that are visited by many people is the hospital, which belongs in the health sector. The provision of facilities in hospitals is very important. In line with the increasing need for health services, the demand for facilities that support these activities is also getting bigger. In order for the transportation system to be efficient, a busy place with activity and generating travel movements must provide adequate service facilities (Sholikhin and Mudjanarko, 2017). Parking facilities are locations that are determined as temporary stops for vehicles for a certain period of time (Zaimuddin, Mudjanarko, et al., 2019). A poor parking management seems to cause bigger problems, such as vehicle security vulnerabilities, inexpedient and hardship of obtaining parking locations, and more importantly it can cause traffic jams (Mudjanarko et al., 2020). The creation of parking space is well purposed and prioritized to ease of access. If a person cannot park his or her vehicle, he cannot carry out activities properly (Yulmida, Mudjanarko, et al., 2017).

With the increasing ownership of motorized vehicles, problems will occur if it is not accompanied by the provision of adequate parking facilities. As happened in RSUD dr. Soedono, Madiun. Based on the observations of parking lots at dr. Soedono General Hospital, Madiun, which has 22 plots for four-wheeled vehicles and 36 plots for two-wheeled vehicles, they are still unable to accommodate vehicles that will be parked, both four-wheeled vehicles and two-wheeled vehicles. So that many vehicles are parked in places that are not supposed to be parked and some even park on the road in front of the hospital which causes traffic jams around the hospital.

From the problems above, a reference can be taken about the existing parking at dr. Soedono General Hospital, Madiun, because it cannot be said to be a sufficient and adequate parking facility. One example is that there are still vehicle users who park their vehicles, not at the parking location provided. The results of this calculation are expected to assist further handling approach, to create a more orderly, safe, and comfortable environment so that alternative solutions that may be applied can be obtained.

Anggraini D, Syaiful S (2013) said that parking activities in one building will affect the type of vehicle used. Parking activities will support the activities of motorists to be able to carry out various activities at the destination.

Furthermore, Syaiful S, Yuliantino M (2017) explained that parking activities in one building will make parking lot users more secure and safe. The parking building provided must be complete with adequate parking facilities. This affects the smoothness of user activities in the building.

Good parking will guarantee users in making the choice to use a fast service or use a ticket/card. Parking service is now an important thing, considering that there are so many motorists who will be traveling so that a good parking service is needed. Parking in the designated area ensures the safety and comfort of users. Vehicle parking is now a necessity. Considering that the parking lot is now equipped with good and good facilities (Syaiful S et.al. 2020; Syaiful S. et.al, 2018; Syaiful S. 2012).

Formulations of the Problem

Based on the above background, the authors noticed several main problems related to parking performance and the need for parking spaces in dr. Soedono General Hospital, Madiun, namely:
a) How many vehicles are parked, both two-wheeled and four-wheeled, during rush hour at Dr. Soedono General Hospital, Madiun?
b) How is the parking performance (duration of parking, parking accumulation, parking turnover rate, parking volume, parking capacity, parking index, average parking duration, number of parking spaces required) at dr. Soedono General Hospital, Madiun?
c) What are the recommendations that can be given to the parking manager at dr. Soedono General Hospital, Madiun?

RESEARCH METHODS

According to the Parking Facility Planning Guidelines, the Directorate General of Land Transportation (1998) "parking" is a temporary immobile state of a vehicle. Also included in the definition of parking is "every vehicle that stops at certain places, whether stated with signs or not and not solely for accommodation of people or goods." PP No.43 of 1993 explains the definition of parking as a condition where the vehicle does not move for a certain period of time or is not temporary.
The data were analyzed with the parameters used to calculate parking characteristics (SRP), namely:
a) Parking Volume
    Parking volume is the number of vehicles that enter the parking lot at a certain time (Hobbs, 1995).
    $$Volume = E_i + X \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$
    Where:
    Ei = Number of incoming vehicles (vehicles)
    X = Vehicles that existed before the time of the survey (vehicles)
b) Parking Duration
    Parking duration is the duration of parking vehicles calculated based on the difference between the time of entering and leaving (Oppenlander, 1976).
    $$D = T_x - T_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$
    Where:
    TX = time recorded when the vehicle exits the parking location
    Ti = time recorded when the vehicle entered the parking location

c) Parking Capacity
    Parking capacity consists of 2 types, namely static capacity and dynamic capacity. Static capacity is the number of parking spaces available in a parking lot.
    Dynamic capacity is the ability of a parking lot to accommodate vehicles (McShane, 1990).
    $$P = \frac{K_S \times T}{D} \times F \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

Where:
Ks = Static Capacity (SRP)
T = Length of observation in the parking lot (hours)
D = Average parking duration during the observation period (hours)
F = reduction factor, the amount is between 0.85 to 0.95

d) Accumulation

Accumulation is the number of parking vehicles in a certain period. The unit of accumulation is the vehicle (Hobbs, 1995).

$$Accumulation = X + E_i - E_x \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(4)$$

Where:
X = Number of existing vehicles
Ei= Entry (Number of vehicles entering the parking location)
Ex= Entry (vehicles leaving the parking lot)

e) Parking Index

The parking index is a comparison between the accumulation of parked vehicles and the available parking capacity. This parking index is used to determine whether the number of parking plots available at the research site meets or not to accommodate parked vehicles (Hobbs, 1995).

$$IP = \frac{Accumulation \times 100\%}{parking\ plot\ available} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (5)$$

f) Parking Turnover

The rate of parking turnover will indicate the level of parking spaces usage obtained from the division between the number of vehicles parked during the observation time (Oppenlander, 1976).

$$PTO = \frac{Nt}{(S)x\ (Ts)} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(6)$$

Where:
PTO = Parking Turnover Rate (vehicles/plot/hour)
Nt = Number of Parking Vehicles (Vehicles)
S = Number of Parking Plots (Parking Plots)
TS = Length of Survey Period (hours)

g) Parking Space Needs

Analysis of Parking space needs deals with the number of places required to accommodate parking vehicles based on the facilities and functions of land. To find out parking needs in an area under study (Suprianto and Mudjanarko, 2015).

$$Z = \frac{YxD}{T} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (7)$$

Where:
Z = Parking Space Required
Y = Number of vehicles parked during the study period (Vehicles)
D = Average Parking Duration
T = Length of observation time (hours)

The research was observed in dr. Soedono General Hospital, Madiun, because in this location many hospital visitors park outside the hospital parking lot, thus disrupting traffic around the hospital and frequent traffic jams.
The survey on the vehicles entering and exiting dr. Soedono General Hospital, Madiun was observed for 6 days in 3 months. On weekdays and holidays or weekends, with the division as follows:
1. Wednesday, April 14, 2021 and Saturday, April 17, 2021
2. Tuesday, May 25, 2021 and Saturday, May 29, 2021
3. Wednesday, 02 June 2021 and Saturday, 05 June 2021

Data collection was carried out at 07.30 – 16.30, this was done following the polyclinic opening hours and patient visiting hours.

Table 1. Parking Survey Data at dr. Soedono General Hospital, Madiun on Wednesday 14 April 2021

No.	Parking Time	Flow of Vehicle			
		Entering		Exiting	
		Motorcycle	Car	Motorcycle	Car
1	07.30 - 08.30	52	78	2	18
2	08.30 - 09.30	19	25	14	27
3	9.30-10.30	20	29	9	30
4	10.30 - 11.30	12	21	9	19
5	11.30-12.30	17	17	12	19
6	12.30-13.30	6	11	11	13
7	13.30-14.30	19	26	6	24
8	14.30 - 15.30	11	9	8	14
9	15.30-16.30	8	9	107	52
	Total	164	225	178	216

Source: Data Analysis 2021

Table 2. Parking Survey Data at dr. Soedono Madiun on Saturday 17 April 2021

No.	Parking Time	Flow of Vehicle			
		Entring		Exiting	
		Motorcycle	Car	Motorcycle	Car
1	07.30 - 08.30	40	25	3	7
2	08.30 - 09.30	2	16	7	13
3	9.30-10.30	2	16	13	13
4	10.30 - 11.30	3	11	10	5
5	11.30-12.30	5	14	3	14
6	12.30-13.30	6	10	8	4
7	13.30-14.30	1	10	4	10
8	14.30 - 15.30	2	2	0	7
9	15.30-16.30	2	9	20	35
	Total	63	113	68	108

Source: Data Analysis 2021

Table 3. Parking Survey Data at dr. Soedono General Hospital, Madiun on Tuesday 25 May 2021

No.	Parking Time	Flow of Vehicle			
		Entering		Exiting	
		Motorcycle	Car	Motorcycle	Car
1	07.30 - 08.30	8	72	2	18
2	08.30 - 09.30	20	26	14	27
3	9.30-10.30	21	28	10	22
4	10.30 - 11.30	12	20	8	17

5	11.30-12.30	18	17	3	19
6	12.30-13.30	7	11	6	11
7	13.30-14.30	19	26	6	25
8	14.30 - 15.30	12	10	9	14
9	15.30-16.30	10	9	112	57
	Total	127	219	170	210

Source: Data Analysis 2021

Table 4. Parking Survey Data at dr. Soedono General Hospital, Madiun on Saturday 29 May 2021

| No. | Parking Time | Flow of Vehicle | | | |
| | | Entering | | Exiting | |
		Motorcycle	Car	Motorcycle	Car
1	07.30 - 08.30	50	16	2	7
2	08.30 - 09.30	3	16	14	13
3	9.30-10.30	5	16	9	9
4	10.30 - 11.30	3	11	9	6
5	11.30-12.30	5	14	4	14
6	12.30-13.30	2	10	9	3
7	13.30-14.30	3	10	1	9
8	14.30 - 15.30	5	2	2	4
9	15.30-16.30	1	9	26	33
	Total	77	104	76	98

Source: Data Analysis 2021

Table 5. Parking Survey Data at dr. Soedono Madiun on Wednesday, 02 June 2021

| No. | Parking Time | Flow of Vehicle | | | |
| | | Entering | | Exiting | |
		Motorcycle	Car	Motorcycle	Car
1	07.30 - 08.30	57	56	2	10
2	08.30 - 09.30	21	25	14	19
3	9.30-10.30	21	28	9	22
4	10.30 - 11.30	12	21	9	11
5	11.30-12.30	19	17	3	13
6	12.30-13.30	7	11	4	7
7	13.30-14.30	19	26	6	25
8	14.30 - 15.30	11	10	36	22
9	15.30-16.30	9	9	120	57
	Total	176	203	203	186

Source: Data Analysis 2021

Table 6. Parking Survey Data at dr. Soedono General Hospital, Madiun on Saturday, 05 June 2021

| No. | Parking Time | Flow of Vehicle | | | |
| | | Entering | | Exiting | |
		Motorcycle	Car	Motorcycle	Car

1	07.30 - 08.30	47	29	2	4
2	08.30 - 09.30	3	11	14	12
3	09.30-10.30	6	15	9	9
4	10.30 - 11.30	6	7	9	9
5	11.30-12.30	10	8	4	2
6	12.30-13.30	2	9	9	10
7	13.30-14.30	3	7	1	12
8	14.30 - 15.30	5	2	5	11
9	15.30-16.30	2	8	29	26
	Total	84	96	82	95

Source: Data Analysis 2021

RESULTS AND DISCUSSION

The parking characteristics are found in the existing parking space of the dr. Soedono General Hospital.

a) Parking Volume

Based on the results of field data collection, it was found that the volume of motorcycles was 217 vehicles/day and 249 vehicles/day for cars. The volume calculation shows that weekdays have the highest volume compared to holidays. This happened due to the schedule of the hospital's poly that operates from Monday to Friday.

b) Parking Duration

Table 7. The results of the analysis of the duration of parked motorized vehicles at dr. Soedono General Hospital, Madiun.

Day	Parking Vehicle	Parking Duration (minutes) (1)	Total Vehicle (2)	Parking Duration x Total Vehicle (3)	Average Duration (3)/$\sum$(2)	Average Duration (hours)
Wednesday, 02 June 2021	Motorcycle	540	182	53760	295.38	4.92
Saturday, 05 June 2021	Car	540	102	22200	217.65	3.63

Source: Data Analysis 2021

Table 7 above shows the average duration of parking for motorbikes and cars in more than 3 hours. This shows that the majority of hospital visitors have long-term needs.

c) Parking Capacity

Table 8. Static Capacity

No	Parking Vehicle	Static Capacity SRP
1	Motorcycle	36
2	Car	22

Source: Data Analysis 2021

Table 9. Results of Dynamic Parking Capacity Analysis at dr. Soedono General Hospital.

Day	Parking Vehicle	Static Capacity	Average Duration	Dynamic Capacity
		SRP	**Hour**	**SRP**
Saturday, May 28, 2021	Motorcycle	36	4.25	65
Saturday, May 28, 2021	Car	22	2.85	59

Source: Data Analysis 2021

Based on table 9 above, the dynamic capacity of motorcycle and car parking is 65 SRP and 59 SRP.

d) Accumulation

Based on the results of field data collection, the largest accumulation of vehicles entering the parking lot occurred on Wednesday, June 2, 2021, at 14.30 – 15.30 with 151 vehicles for motorcycles and 102 vehicles for cars.

e) Parking Index

Table 10. Result of Parking Index Analysis at dr. Soedono General Hospital.

Day	Parking Vehicle	Static Capacity	Max Accumulation	Parking Index
		SRP	**Vehicle**	**%**
Wednesday, 02 June 2021	Motorcycle	36	155	4.31
Wednesday, 02 June 2021	Car	22	102	4.64

Source: Data Analysis 2021

Based on the results of table 10 above, it is found that the highest parking index for motorbikes is 4.31% and cars are 4.64%. This is because the cars and motorcycles parking at dr. Soedono General Hospital exceeds the parking lot's normal capacity.

f) Parking Turnover

Table 11. Result of Parking Turnover Analysis at dr. Soedono General Hospital.

Day	Parking Vehicle	Parking Volume	Static Capacity	Turnover
		Vehicle	**SRP**	
Wednesday, 02 June 2021	Motorcycle	222	36	0.69
Wednesday, April 14, 2021	Car	249	22	1.26

Source: Data Analysis 2021

Based on table 11 above, the largest parking turnover rate for motorcycles is 0.69 times on Wednesday, 02 June 2021 and 1.26 times for cars on Wednesday, 14 April 2021. So it can be concluded that the turnover rate of car parking is greater than that of motorcycles.

g) Parking Space Needs

Table 12. Results of Analysis of Parking Space Requirements at dr. Soedono General Hospital.

Day	Parking Vehicle	Total	Length of observation time (hours)	Average Duration (hours)	Required SRP
		Y	**T**	**D**	**(Y x D)/ T**
Wednesday, 02 June 2021	Motorcycle	182	9	4.92	100
Wednesday, 02 June 2021	Car	205	9	3.50	80

Source: Data Analysis 2021

Based on the results of table 12 above, it is found that the need for parking spaces in Dr. Soedono General Hospital, Madiun, for motorcycles and cars is 100 SRP and 80 SRP.
Hence, the lack of parking space at dr. Soedono General Hospital, Madiun, for motorbikes is 100 – 36 = 64 SRP and cars of 80 – 22 = 58 SRP.

h) Recapitulation of Calculations

Parking characteristics were analyzed six times. The existing data was obtained from a field survey for six days, namely three working days and three days off. The calculation results for six days can be seen in the table 13 and table 14.

Table 13. Recapitulation of Calculation of Parking Space Needs Analysis for Six Days

No	Parameter		Wed, 14 April 2021		Sat, 17 April 2021		Tue, 25 Mei 2021	
			Motor-cycle	**Car**	**Motor-cycle**	**Car**	**Motor-cycle**	**Car**
1	Volume		217	249	97	131	189	240
2	Average Duration		4,74	3,11	4,13	3,03	4,77	3,16
3	Dynamic Capacity		58	54	67	56	58	53
4	Max. Accumulation		138	84	71	54	121	83
5	Average Accumulation		112,56	75,56	51,00	43,67	87,00	73,78
6	Parking Index	Static	3,83	3,82	1,97	2,45	3,36	3,77
		Dynamic	2,38	1,55	1,07	0,97	2,10	1,56
7	Parking Turn Over		0,67	1,26	0,30	0,66	0,58	1,21
8	Parking Space Needs		93	78	28	38	93	78

Table 14. Recapitulation of Calculation of Parking Space Needs Analysis for Six Days (continued)

No	Parameter		Sat, 28 Mei 2021		Wed, 02 Juni 2021		Sat, 05 Juni 2021	
			Motor-cycle	**Car**	**Motor-cycle**	**Car**	**Motor-cycle**	**Car**
1	Volume		106	120	222	228	111	114
2	Average Duration		4,25	2,85	4,92	3,50	4,46	3,63
3	Dynamic Capacity		65	59	56	48	62	46
4	Max. Accumulation		77	48	155	102	72	52
5	Average Accumulation		56,11	36,78	115,22	84,00	55,78	42,67
6	Parking Index	Static	2,14	2,18	4,31	4,64	2,00	2,36
		Dynamic	1,19	0,81	2,77	2,12	1,17	1,12
7	Parking Turn Over		0,33	0,61	0,69	1,15	0,34	0,58
8	Parking Space Needs		38	33	100	80	44	41

i) The Calculation for The Next Five Years

The calculation for the next 5 years is shown in table 15. Refer to the volume value, number of parking vehicles, dynamic capacity, and the largest accumulation in 2021. It can be calculated using the following formula:

$$F = P \text{ x } (1+ i\%)^n \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (8)$$

Where;

F   = Future Value

P   = Present Value
i   = Growth Rate (using the average value, $i_{motorcycle}$= 5,769% dan i_{car} = 8,788%)
n   = Number of Periods

For example, motorcycle volume on 2021 is 222 vehicles, so motorcycle volume on 2022 can be thought of as follows:

F   = P x $(1+ i\%)^n$
F   = 222 x $(1+ 5,769\%)^1$

F   = 235 vehicles

Table 15. Recapitulation of Calculation of Parking Space Needs Analysis for the Next Five Years

No	Parameter		2021		2022		2023	
----	-----------	--	Motor-cycle	Car	Motor-cycle	Car	Motor-cycle	Car
1	Volume		222	249	235	271	248	295
2	The number of vehicles		182	225	192	245	204	266
3	Average Duration		4,92	3,63	4,92	3,63	4,92	3,63
4	Static Capacity		36	22	36	22	36	22
5	Dynamic Capacity		67	59	71	64	75	70
6	Max. Accumulation		155	102	164	111	173	121
7	Average Accumulation		115	84	122	91	129	99
8	Parking Index	Static	4,31	4,64	4,55	5,04	4,82	5,49
		Dynamic	2,77	2,12	2,33	1,73	2,33	1,73
9	Parking Turn Over		0,69	1,26	0,72	1,37	0,77	1,49
10	Parking Space Needs		100	80	105	99	111	107

Table 16. Recapitulation of Calculation of Parking Space Needs Analysis for the Next Five Years (continued)

No	Parameter		2024		2025		2026	
----	-----------	--	Motor-cycle	Car	Motor-cycle	Car	Motor-cycle	Car
1	Volume		263	321	278	349	294	379
2	The number of vehicles		215	290	228	315	241	343
3	Average Duration		4,92	3,63	4,92	3,63	4,92	3,63
4	Static Capacity		36	22	36	22	36	22
5	Dynamic Capacity		79	76	83	83	88	90
6	Max. Accumulation		183	131	194	143	205	155
7	Average Accumulation		136	108	144	118	153	128
8	Parking Index	Static	5,09	5,97	5,39	6,49	5,70	7,06
		Dynamic	2,33	1,73	2,33	1,73	2,33	1,73
9	Parking Turn Over		0,81	1,62	0,86	1,76	0,91	1,92
10	Parking Space Needs		118	117	125	127	132	138

CONCLUSION

Based on the calculation of the data analysis, the following conclusions were obtained: Maximum parking volume dr. Soedono General Hospital occurred on weekdays, namely motorcycles as many as 217 vehicles/day and cars of 249 vehicles/day. The average duration of parked vehicles is more than 3 hours. The available parking capacity is 36 SRP for motorcycles and 22 SRP for cars, while the dynamic parking capacity is 65 SRP for motorcycles and 59 SRP for cars. The largest accumulation of vehicles entering the parking lot occurred on weekdays at 14.30 -15.30 WIB with 155 motorcycles and 102 cars. With the highest parking index for motorcycles at 4.31% and cars at 4.64%. Thus, the need for parking space in dr. Soedono General Hospital could not accommodate the vehicle for hospital visitors. And also based on the calculation of parking space requirements in the next 5 years it is not possible to add parking spaces in the current parking lot. New land is needed to build a parking building. Meanwhile, an adequate solution is found based on the results of the analysis. On 2021 additional parking space of 64 SRP for motorcycles and 58 SRP for cars is suggested to be added.

REFERENCES

Akbari, Dessy Ratnaningrum. 2017. *Evaluasi Kebutuhan Ruang Parkir pada Rumah Sakit Tipe B di Kota Surabaya*. Tugas Akhir D4 Tenik Sipil, Fakultas Vokasi, Institut Teknologi Sepuluh Nopember Surabaya. (Indonesian).

D Anggraini, S Syaiful. 2013. ANALISIS KONSEP PARKIR PADA PLAZA EKALOKASARI BOGOR. ASTONJADRO: CEAESJ 2 (2), 9-18. (Indonesian).

Direktorat Jendral Perhubungan Darat. 1996. *Pedoman Teknis Penyelenggaraan Fasilitas Parkir*. Keputusan Direktur Jendral Perhubungan Darat. Jakarta. (Indonesian).

Direktorat Jendral Perhubungan Darat. 1998. *Pedoman Perencanaan dan Pengoperasian Fasilitas Parkir. Direktorat Bina Sistem Lalu Lintas Angkutan Kota*. Jakarta. (Indonesian).

Hobbs, F. D, Terjemahan Suprapto dan Waldijono. 1995. *Perencanaan dan Teknik Lalu Lintas*. Edisi Kedua, Gadjah Mada University Press. Yogyakarta. (Indonesian).

McShane, William R. 1990. *Traffic Engineering, Prentice Hall Polytechnic Series in Transportation*. New Jersey.

Mudjanarko, S. W., Kamisutara, M., Purworusmiardi, T., Mucayan, A., Winardi, S., Bahaswan, R., & Wiwoho, F. P. 2020. Android-based information technology design for easy parking. In *Proceedings of the International Conference on Industrial Engineering and Operations Management* (Vol. 59, pp. 2301–2308). IEOM Society.

Oppenlander, J.C. and Box P.C. 1976. *Manual of Traffic Engineering Studies*. Fourt Edition. Institue of Transportation Engineering Washington DC.

Pemerintah Republik Indonesia. 1993. *Peraturan Pemerintah Nomor 43 Tahun 1993 tentang Prasarana dan Lalu Lintas Jalan*. Jakarta. (Indonesian).

Sholikhin, Riyadlus, Sri Wiwoho Mudjanaro. 2017. Analisis Karakteristik Parkir Di Satuan Ruang Parkir Pasar larangan Sidoarjo. *Teknika: Engineering and Sains Journal*, 1(2): 145-150. http://dx.doi.org/10.51804/tesj.v1i2.150.145-150. (Indonesian).

Suprianto, Joko, Sri Wiwoho Mudjanarko. 2015. Evaluasi Kinerja Parkir Di RSU Haji Surabaya. *e-Jurnal Spirit Pro Patria*, 1(2). E-ISSN 2443-1532. (Indonesian).

S Syaiful, Y Elvira. 2017. Case Study On Use Area Parking At New Market City Shopping Center Bogor. International Journal of Transportation And Infrastructure (IJTI) 1 (1), 34-40.

S Syaiful, M Yuliantino. 2017. The Study Of Land Parking Mall Bogor Indah Plaza. Global Research on Sustainable Transport (GROST 2017), 286-303.

S Syaiful, H Prayoga, J Akbardin. 2020. SUSTAINABLE ABOUT THE NEED OF PARKING SYSTEMS AT THE MALL RDS BOGOR. ARPN Journal of Engineering and Applied Sciences 15 (22), 2620-2626.

S Syaiful, R Rulhendri, A Syaifudin. 2018. Analisis Kapasitas Parkir Di Sekitar Stasiun Bogor. Media Teknik Sipil 16 (1), 52-59. (Indonesian).

S Syaiful. 2012. KAJIAN TENTANG AKTIVITAS PARKIR PADA JALAN DUA JALUR DENGAN PEMBATAS HUBUNGANNYA DENGAN KARAKTERISTIK JALAN (Studi Kasus Jalan Margonda Raya Kota Depok). ASTONJADRO: CEAESJ 1 (2), 28-34. (Indonesian).

Yulmida, Damarta Anugrah, Sri Wiwoho Mudjanarko, M. Ikhsan Setiawan, dan Arthur Daniel Limantara. 2017. Analisis Kinerja Parkir Sepanjang jalan Walikota Mustajab Surabaya. *UkaRst*, 1(1). E-ISSN 2581-0855. (Indonesian).

Zaimuddin, M. Alvie, Slamet Winardi, Sri Wiwoho Mudjanarko, Benediktus Anindito. 2019. Sistem booking Parkir Mall Dengan Identifikasi Plat Nomor Kendaraan Berbasis Android. *Jurnal Technology Acceptance Model*, 10(2): 93-99. E-ISSN 2579-4221. (Indonesian).