ALTERNATIVE PARKING NEED FOR THE CHANDRA SUPER STORE TANJUNG KARANG PARKING AREA

A. R. Indra Tjahjani[1]; Atika Dalima Vurry[2]
[1]Civil Engineering Study Program, Engineering Faculty Universitas Pancasila
Email: arindratjahjani@univpancasila.ac.id

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ABSTRACT

Bandar Lampung is the largest city in Lampung province and the third most populous city on Sumatra island. The population of this city is increasing every year. Since Bandar Lampung becomes a business center, it causes a transportation problem. One of which is parking in a public area like a mall. The purpose of this study was to find out and analyze the parking characteristics in Chandra Super Store Tanjung Karang and to analyze the capacity and parking spaces needs in Chandra Super Store Tanjung Karang. The method in this study uses secondary data consisting of data in and out of parking vehicles. From these data, an analysis is carried out to obtain the accumulation of parking, parking volume, parking duration, parking turnover rate, parking capacity, parking index, and parking requirements. The results of this study are maximum accumulation parking for cars is 592 vehicles, while motorcycles are 676 vehicles, with the average are 536 for cars and 580 for motorcycles. For maximum daily volume, the results are 1803 for cars and 1764 for motorcycles, with daily average are1429 for cars and 1495 for motorcycles. For the average duration of cars and motorcycles are 3,6 and 3,7 hours. The result for maximum car parking turnover is 4,145 with the average is 3,284. While for motorcycle is 3,285 with the average is 3. The average for parking index is 1,215 for cars and 1,131 for motorcycles. The maximum capacity of parking is 498 PSU while the needs are 572 PSU, So it can be concluded that the existing parking capacity is not able to meet the needs. It can be concluded that the existing parking capacity is not able to meet the needs. As an alternative to choosing the parking facility at Chandra Super Store, the Hydraulic Automatic Parking system.

Keywords: *Characteristics of parking, Parking requirements, Chandra Super Store, Tanjung Karang*

BACKGROUND

Bandar Lampung is the largest city in Lampung province and third most populous in Sumatra. It has a population of 1.068.982 with a density rate of 5.420 people / km^2 (BPS, 2015). Along with the increase in population, currently, the city of Bandar Lampung has become one of the centers of service, trade, and economy, and has led to an increase in the complexity of transportation problems. One of the problems is the availability of parking spaces in shopping centers. The largest shopping centers in Bandar Lampung are Chandra Super Store Tanjung Karang. Located in a very strategic spot, it makes Chandra the main shopping location for the people of Bandar Lampung. Apart from supermarkets and department stores, Chandra also has various facilities such as a food court, jewelry shop, hair salon, playground, electronics, and handphone center, even a bowling alley and billiards. There are also inns, namely Wisma Chandra, as well as public service facilities such as the One Roof One-Stop Administration System (SAMSAT), driving license services, and the Indonesian Red Cross. The many facilities available at Chandra Super Store make this shopping center always busy with visitors every day. This high number of visitors requires the management to provide supporting facilities for their convenience, one of which is parking facilities. The current parking lot available at Chandra Super Store is often unable to accommodate the number of visitors when entering entering the holiday season.
This study has not considered the impact of the Covid-19 pandemic

METHOD

This research was conducted in stages as shown in the following Research Flow Chart in Figure 1.

Previous Research Literature

F. Rachman (2011) analyzed the capacity of parking spaces and land use in providing parking space services, saying that the actual need for parking spaces has not been able to meet existing parking users. So, to overcome the problem, two options are suggested, namely adding parking space and the second, namely arranging the parking lot to be centered on a five-story parking building so as not to use too much land. F. Syarifuddin (2017) analyzes parking space requirements and determines parking patterns. R. Darma (2019) improves parking facilities in the form of dividing markers and also returns land parking which is used for trading by street vendors so that it is used according to its purpose. The calculation of space requirements is completed using this formula:

Accumulated parking (F. D Hobbs, 1995)

The number of vehicles that are parked within a certain time.

Accumulated Parking = X + Ei……(1)

Where :
Ei = entry (vehicles enter the parking location)
Ex = Exit (vehicle exit the parking location)
E = Number of pre-existing vehicles

Parking Volume

Parking volume is the number of vehicles that have used the parking space in a parking area in a certain time unit, usually calculated per day.
Volume = Ei + X……..(2)

where
Ei = Number of incoming (vehicle)
X = Vehicles that have been parked before the survey time (vehicle)

Parking Duration

Duration is the amount of time spent by a vehicle when it is parked.

Duration (D) = $T_{in} - T_{out}$……(3)

Where
T_{in} = Time when vehicle enters the parking lot
T_{out} = Time when vehicle exits the parking lot

There are 3 classifications of parking duration:
a. short time parking
b. middle time parking
c. long time parking

$$D = \frac{N_x \times X \times i}{N_t} \quad \text{……(4)}$$

Where:
D = Average parking time (hour / vehicle)
(N_x) = Number of vehicles parked during *x* time
(X) = Number of intervals
(i) = Duration of each interval (hours)
N_t = Total number of vehicles at the time of the survey

Parking Turnover (PTO)

Parking turnover is obtained from the volume of vehicles parked during the observation time divided by the number of parking spaces for a certain period.

$$PTO = \frac{\text{Parking Volume}}{\text{Parking Space Available}} \quad \text{…….....(5)}$$

Parking Capacity

Parking capacity is the maximum capacity of a parking space in a certain time.

$KP = \frac{S}{D}$……(6)

where:

KP = Parking capacity (vehicle/ hour)
S = Number of parking lots
D = Average parking time

Parking Index
The parking index is a comparison between the accumulated parking vehicles and the available parking capacity, expressed as the percentage of space occupied by parked vehicles.

$$IP = \frac{Accumulated\ parking}{Parking\ space\ available}\ x\ (100\ \%) \ldots\ldots\ldots\ldots\ldots\ldots(7)$$

As a benchmark, if:
IP > 1 means that the parking requirement exceeds the parking capacity / number of parking lots.
IP <1 means that the parking requirement is less than the parking capacity / number of parking lots.
IP = 1 means that the parking requirement is balanced between the parking capacity / number of parking lots.

Parking Needs
This existing parking needs uses the method of calculating the largest accumulation at the interval of observation time. Accumulated parking is the number of vehicles parked at a certain time interval, where the number of parked vehicles will never be the same in one place to another from time to time. Then a comparison is made with the existing parking capacity based on the parking space availability standard as seen in the table below:

Table 1. Availability of Parking Spaces based on Parking Space Unit (PSU)

Allocation	Parking Space Unit (PSU) for passenger cars	Parking space needs
Trading center		
•Shops	PSU/ 100m^2 effective floor area	3,5 -3,7
•Supermarkets	PSU/ 100m^2 effective floor area	3,5 -3,7
•Markets	PSU/ 100m^2 effective floor area	3,5 -3,7
Office Center		
•Non-public Service	PSU/ 100m^2 floor area	1,5 - 3,5
•Public Service	PSU/ 100m^2 floor area	
School	PSU/ students	0,7 - 1,0
Hotel	PSU/ rooms	0,2 - 1,0
Hospital	PSU/ beds	0,2 - 1,3
Cinema	PSU/ seats	0,1 - 0,4

Source: Directorate General of Land Transportation (1996)

2. Future Parking needs
The formula for projecting future year parking space requirements

$$X_n = X\ (1+a)^n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

where
X = parking needs condition
a = growth percentage
n = plan year

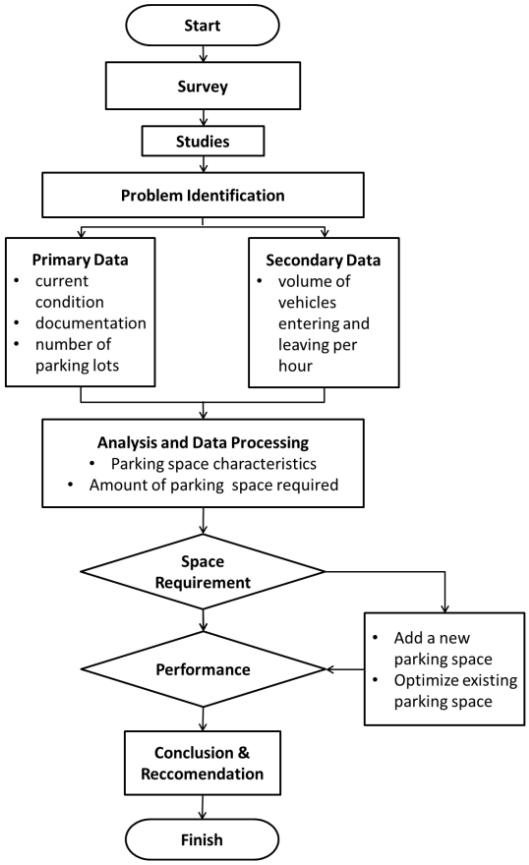

Figure 1. Research flow chart

RESULTS AND DISCUSSION

The data gathered is then processed t0 obtain

Table 2. Parking Accumulation

No.	Date	Maximum Parking Accumulation	Peak Hour
1	Mon, 2/03/ 2020	552	16.00 - 17.00
2	Tue, 3/03/2020	508	17.00 - 18.00
3	Wed, 4/03/2020	676	16.00 - 17.00
4	Thu, 5/03/2020	577	17.00 - 18.00
5	Fri, 6/03/ 2020	597	16.00 - 17.00
6	Wed, 7/03/2020	571	17.00 - 18.00
7	Sun, 2/032020	479	13.00 - 14.00
Highest accumulation		676	
Lowest accumulation		580	

Based on Table 2, the maximum parking accumulation is on Wednesday, March 4, 2020 at 16.00-17.00 WIB with a total of 676 motorbikes. However, the accumulated value used as the basis for calculating the other parking characteristics parameters is the average accumulated value of the seven samples, which is 580 vehicles.This value was used because the maximum accumulated value in one day is not accurate enough to represent the total accumulated value.

Parking Volume
From Table 3, it can be seen that the maximum car parking volume occurs on Saturday, March 7 2020 with 1.803 motorbikes, but when using the average value, the average volume of vehicles

parking every day is 1.429 cars starting from 07.00 to 23.00

Table 3. Maximum car daily parking volume

No.	Date	Review Hour	Car parking volume (vehicle / day)
1	Mon, 2/03/ 2020	07.00 - 23.00	1286
2	Tue, 3/03/2020	07.00 - 23.00	1155
3	Wed, 4/03/2020	07.00 - 23.00	1261
4	Thu, 5/03/2020	07.00 - 23.00	1417
5	Fri, 6/03/ 2020	07.00 - 23.00	1547
6	Wed, 7/03/2020	07.00 - 23.00	1803
7	Sun, 2/032020	07.00 - 23.00	1532
Highest Volume			1803
Average Volume			1429

Table 4 shows that the maximum parking volume occurred on Saturday 7 March 2020 as many as 1,764 motorbikes, but if using the average value of parking vehicle volume per day is 1,429 cars from 07.00 to 23.00.

Table 4. Maximum Motorcycle daily parking volume

No.	Date	Review Hour	Motorcycle parking volume (vehicle / day)
1	Mon, 2/03/ 2020	07.00 - 23.00	1354
2	Tue, 3/03/2020	07.00 - 23.00	1406
3	Wed, 4/03/2020	07.00 - 23.00	1536
4	Thu, 5/03/2020	07.00 - 23.00	1485
5	Fri, 6/03/ 2020	07.00 - 23.00	1578
6	Wed, 7/03/2020	07.00 - 23.00	1764
7	Sun, 2/032020	07.00 - 23.00	1344
Highest Volume			1764
Average Volume			1495

Parking Duration

Table 5 shows that the highest percentage of car parking time is in the duration of 2-3 hours, namely 24.85%. The average car park duration is 3.6 hours. Meanwhile, from Table 7 below, it can be seen that the highest percentage of motorcycle parking duration is in the 2-3 hour duration range, namely 22.31%. For the duration of the motorbike parking, the average obtained is 3.7 hours.

Table 5. Average daily car park duration

No.	Parking Duration (Hour)	middle value (x)	Number of vehicles	Percentage (%)	Cumulative Percentage (%)	fx
	(1)	(2)	(3)	(4)	(5)	(6)= (2)*(3)
1	0-1	0.5	104	7,30	7,30	52,07
2	1-2	1.5	287	20,12	27,42	430,50
3	2-3	2,5	354	24,85	52,27	886,07
4	3-4	3,5	263	18,42	70,69	919,50
5	4-5	4,5	182	12,78	83,47	820,29
6	5-6	5,5	134	9,41	92,88	737,79
7	>6	6	102	7,12	100,00	609,43
TOTAL			1426	100	-	4455.64

Table 6. Average daily car park duration

No	Parking Duration (Hour)	middle value (x)	Number of vehicles	Percentage (%)	Cumulative Percentage (%)	fx
	(1)	(2)	(3)	(4)	(5)	(6)= (2)*(3)
1	0-1	0.5	123	8.22	8.22	61.36
2	1-2	1.5	308	20.59	28.81	461.36
3	2-3	2.5	333	22.31	51.12	832.86
4	3-4	3.5	267	17.86	68.98	933.50
5	4-5	4.5	152	10.21	79.19	685.93
6	5-6	5.5	125	8.36	87.55	686.71
7	>6	6	186	12.45	100.00	1116.0
TOTAL			1493	100	-	4777.7

Existing Condition Parking Capacity

Operation of parking facilities at Chandra Super Store Tanjung Karang:

Type of activity = Trade Center

Effective floor area = 20,000 m^2

Parking Space (PSU=Parking Space Unit) Availability Standards = 3.5 - 7.5 (Table 1.)

The number of PSU in existing conditions can be seen in the table below:

Table 7. Existing parking capacity

Vehicle Type	Total PSU	Total Passenger Car PSU
Car PSU	435	435 PSU + 500/8 PSU = Total 498 PSU
Motorcycle PSU	500	

The existing parking availability value is (498 * 100 m^2) /20,000 m^2 = 2,49. When compared with the parking space availability standard issued by the Director General of Land Transportation, this value does not meet the requirements.

3,5 < 2,49 < 7,5 → does not meet the requirements.

Parking Turnover Rate

Table 8 shows that the highest car parking turnover rate is four times a day and the average ranges up to three times a day. This shows that the performance of the car park is quite busy

Table 8. Car Parking Turnover Rate (PTO)

No.	Date	Daily Capacity	Volume (Vehicle/day)	PTO
1	Mon, 2/03/ 2020	435	1286	2,95
2	Tue, 3/03/2020	435	1155	2,65
3	Wed, 4/03/2020	435	1261	2,89
4	Thu, 5/03/2020	435	1417	3,25
5	Fri, 6/03/ 2020	435	1547	3,55
6	Wed, 7/03/2020	435	1803	4,14
7	Sun, 2/032020	435	1532	3,52
Highest PTO				4,14
Average PTO				3,28
=				3

Table 9. Motorcycle Parking Turnover Rate (PTO)

No.	Date	Daily Capacity	Volume (Vehicle/day)	PTO
1	Mon, 2/03/ 2020	500	1354	2.70
2	Tue, 3/03/2020	500	1406	2.81
3	Wed, 4/03/2020	500	1536	3.07
4	Thu, 5/03/2020	500	1485	2.97
5	Fri, 6/03/ 2020	500	1578	3.15
6	Wed, 7/03/2020	500	1764	3.52
7	Sun, 2/032020	500	1344	2.68
Highest PTO				3.52
Average PTO				2.99
=				3

Table 9 above shows that the motorbike parking turnover rate is the highest and also the average is three times a day. This shows that the car park performance is quite high.

Parking Index

The following table is a parking index table for cars.

Table 10. Car Parking Index

No.	Date	Accumulation	No. of Parking Lots	Parking Index
(1)	(2)	(3)	(4)	(5) = (3)/(4)
1	Mon, 2/03/ 2020	439	435	1.009
2	Tue, 3/03/2020	501	435	1.152
3	Wed, 4/03/2020	566	435	1.301
4	Thu, 5/03/2020	550	435	1.264
5	Fri, 6/03/ 2020	527	435	1.211
6	Wed, 7/03/2020	592	435	1.361
7	Sun, 2/032020	524	435	1.205
Average		528.42	435	1.215

Based on Table 10, the average car parking index value is 1,215, whereas when viewed in detail, the largest parking index is on Saturday, March 7, 2020.

Table 11. Motorcycle Parking Index Value

No.	Date	Accumulation	No. of Parking Lots	Parking Index
(1)	(2)	(3)	(4)	(5) = (3)/(4)
1	Mon, 2/03/ 2020	552	500	1,104
2	Tue, 3/03/2020	508	500	1,016
3	Wed, 4/03/2020	676	500	1,352
4	Thu, 5/03/2020	577	500	1,154
5	Fri, 6/03/ 2020	597	500	1,194
6	Wed, 7/03/2020	571	500	1,142
7	Sun, 2/032020	479	500	0,958
average		565.71429	500	1,1314286

Based on Table 11, the average motorcycle parking index value is 1,1, while when viewed in detail, the largest parking index is on Wednesday, March 6 2020 WIB. So it can be concluded that both car parking and motorbike parking capacities are not able to meet the parking needs at peak hours, because the average parking index obtained is more than 1.

Existing Parking Needs

In this study, the need for existing parking spaces is calculated using the method of the largest difference between vehicle arrivals and departures using a cumulative graph of incoming and outgoing vehicles.For car parking, the sample used is the average value in each of the same time intervals. So that the overall need at peak hours (16.00 - 17.00) is 504 PSU cars while the available parking lot is 435 PSU cars.

Meanwhile, for motorbike parking, the overall need at peak time (at 16.00-17.00) is 528 PSU cars, while the available parking lots are 500 plots. So for the total comparison between parking capacity and demand at Chandra Super Store, it can be seen in the table below:

Table 12. Parking Capacity and Demand Comparison

Number of parking lots		Number of PSU Passenger Cars	
Capacity	PSU car	435	435 PSU+ 500/8
	PSU motorcycle	500	PSU = 498 PSU
Needs	PSU car	504	504 PSU + 528/8
	PSU motorcycle	528	PSU = 570 PSU

It can be seen that the difference between parking capacity and the demand is 72 PSU.

Projected Future Parking Needs

Based on data from the Cooperatives and Administration Section which states that in the last 5 years since 2018, visitor growth has been in the range of 2,86 – 3,29%, along with the growth of various types of tenants. So that the parking needs for the next 10 years can be seen in the table below:

Table 13. Projection of parking demand in the coming year

year	PSU Capacity	Parking Needs (PSU)	Difference between parking needs and capacity
2020	498	570	72
2021	498	588	90
2022	498	606	108
2023	498	624	127
2024	498	644	146
2025	498	663	166
2026	498	684	186
2027	498	705	207
2028	498	726	229
2029	498	749	251
2030	498	772	274

Based on Table 13, the need for parking space is always increasing every year, so there is a need for additional parking spaces to meet the user's needs.

Comparing the results of parking requirements and existing capacity, the existing conditions do not meet. 2020 in particular is still experiencing a shortage of 72 PSU. Then projecting the next 10 years, the existing conditions will also experience shortages. Each year the average demand for PSU increases by 20, so that at the end of the projection, 772 PSU are needed. the difference with the current capacity is 274 PSU.

RECOMMENDATION

Based on the results of the analysis and projections of parking conditions in the coming year, it can be concluded that the performance of parking spaces for the current conditions does not meet the existing parking needs.

This can be seen from the current conditions. improvements need to be made in the arrangement of parking spaces.

In order for this goal to be realized, several alternative solutions that can be carried out by the Chandra Super Store Tanjung Karang regarding the parking problems are:

increase the parking area

Based on the existing conditions in the parking lot, the available parking spaces do not meet the existing needs. For the next ten years, it is necessary to improve by taking into account the increase in the number of visitors and business expansion which is always increasing every year.

The basement can still be expanded by increasing the parking floor to 2-3 levels. If in the existing condition the area can accommodate 82 cars, then if it is made into 3 levels, the car park area can be increased by 246 cars.

Improve Parking Management

From the observations, it was concluded that there was a need for good management. One of which is the addition of parking attendants who manage parking because there are still many vehicles that are not properly parked.

More optimal supervision and regulation are expected to optimize the available parking space.

Parking restrictions

Parking restrictions can be carried out in various ways, some of which are by reducing the number of vehicles entering the parking area, increasing parking rates or by limiting parking time.

Implementation of Advanced Technology Parking

Solving parking problems can also be done with the help of technology. One of them is the use of Hydraulic Automatic Parking system. The driver simply enters the vehicle into one of the lifts. This kind of parking system is often called a puzzle system, because the way it works is assembling like a puzzle game. The driver simply enters the vehicle into one of the lifts. The position of the car must be right, it must not cross the yellow line on the plate where the car is rests. After the driver gets out of the car and exits the lift, the elevator doors will close. The vehicle number is entered into the data panel. In the elevator, the machine automatically searches for an empty parking space. After that, the steel rope moved to pull the car holder towards the empty shelf floor. The holder with the chain then moves to the right or left according to the location of the shelf. The car is also stored in the parking space. The process is quite fast, only 2-3 minutes. This parking technology makes it very easy for consumers to park their vehicles because it is not difficult to find an empty parking space, it only takes 2-3 minutes. Following are the advantages and disadvantages of these alternative solutions:

Table 14. Alternative Solutions

No	Alternatives	Advantages	Disadvantaged
1	increase parking area	• increase the number of parking lots • Increase the number of visitors • Can meet parking needs> 10 years	• The building structure must be strong • large investment funds for land acquisition and construction • The construction period will seriously disturb the existing parking conditions
2	Improved parking management	• Many choices of methods • sustainable impact • land for shopping areas can be the main focus in development	• Does not meet the sustainability aspect • Does not give a significant change • Parking attendants are needed for supervision throughout operations
3	Parking restrictions	• Many choices of methods • Give that impact • Mall area is the main focus in development	• lots of illegal parking • Decreased circulation of money
4	Use of Hydraulic Automatic Parking Parking Technology	• The land required is small • Can increase the number of parking lots • The design can last up to> 15 years • Provide more convenience for users	• Needs big investment. • During the construction period there must be a temporary additional area • Must make a new building • If there is a power failure, the parking system will also be disrupted

CONCLUSION

1. The parking characteristics at Chandra Super Store indicate that:
   a. The maximum accumulation of parking in the Chandra Super Store parking area for cars is 592 vehicles which occur on Saturday 7 March 2020 at 16.00 - 17.00 WIB and motorbikes for 676 vehicles which occur at 16.00 - 17.00 WIB. For the average parking accumulation, both of them are 536 units for cars and 580 units for motorbikes;
   b. The daily maximum parking volume in the Chandra Super store parking area occurs on Saturday, March 7, 2020 with details of 1803 cars and 1764 motorbikes. The daily volume averages 1429 for cars and 1495 for motorbikes.
   c. The average duration of parking vehicles is 3.6 hours for cars and 3.7 hours for motorbikes.
   d. The existing parking capacity is 498 PSU with details of 435 parking lots for cars and 500 parking lots for motorbikes. The existing parking availability value obtained is 2.49, which means that it still does not reach the standard set by the Directorate General of Land Transportation, which must be between 3.5 - 7.5;
   e. The maximum parking turnover rate for cars is 4.145 with an average of 3.284. Meanwhile, the maximum parking turnover rate for motorbikes is 3.285 with an average of 3;
   f. The average parking index for cars is 1.215 and for motorbikes is 1.131. This means that the parking requirements for motorbikes and cars exceeds the capacity / number of parking lots available because the index value is > 1.2. Current parking requirements obtained from the analysis are 570 PSU or with details of 504 for 4-wheeled vehicles and 528 for 2-wheeled vehicles.
2. The comparison between the available parking capacity and the current parking needs shows that the capacity cannot meet the parking needs
3. Based on some of the solutions described, it is concluded that the best solution is by combining additional parking lots with hydraulic automatic parking technology. This method is considered capable of meeting the parking needs at Chandra Super Store but still does not limit the number of visitors which are expected to continue to increase at any time. With the use of this technology, it does not require a large parking area, because it utilizes a vertical parking system arranged like a puzzle with an elevator, so it does not require additional vehicle lane access.

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