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Analysis and Evaluation of Parking Space Requirements for The Graha Pelni Building in Surabaya

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ABSTRACT

Parking is one part of the transportation system that is needed and also a common problem in big cities for office services, shopping centres, and residential buildings. Graha Pelni Building in Surabaya city is an office building owned by PT. Pelayaran Nasional Indonesia which is located on Jl. Pahlwan No. 112-114, Surabaya City. This building not only serves the purchase and operation of PT PELNI but also an office centre.
In an effort to handle the problem of the parking system in the Graha Pelni Building, a good planning is needed. Among other things, adequate parking space and the right form of parking pattern determination. The data that has been obtained will be processed into several analyses, including: Analysis of Parking Characteristics, Parking Accumulation, Parking Volume, Parking Duration, Parking Turnover, Parking Capacity, Parking Index, Parking Space Requirements, Additional Parking Area Requirements[2]. The results of the analysis of the calculation of characteristics at Graha Pelni Surabaya Building based on survey data: The maximum parking volume for motorbikes is 71 vehicles / hour at 08.00 - 09.00 and cars are 58 vehicles / hour at 13.00 - 14.00. Parking index for motorbike is 137% and car is 126% 5 m^2. According to BPS Surabaya City 2022 economic growth in Surabaya City is 6.51% in 2022.
Keywords: Parking, Parking Space Requirement, Parking System

1. Introduce

Parking is a necessary part of the transportation system. Therefore, a good parking arrangement scheme will be useful for the efficient utilization of parking spaces to avoid problems. Nowadays, parking is one of the most common problems in transportation systems in big cities and developing cities. This problem will become more important as the ownership of motorized vehicles, both two-wheeled and four-wheeled, begins to grow. Parking is needed in both public and private areas.
In large cities in Indonesia, many have begun to hand over parking issues to other parties or special parties who can control parking in office buildings, shopping centers, and residential buildings.

Graha Pelni Building in Surabaya city is an office building owned by PT. Pelayaran Nasional Indonesia (PELNI) which is located on Jl. Pahlawan No. 112-114, Krembangan, Surabaya City. Basically this building functions as a center for the sale and purchase of ship tickets run by PT. PELNI itself, but several rooms in this 8-story building are used for other office areas or rented out.
Other office areas or rented out. Considering that this building does not only serve the purchase and operation of PT. PELNI, it is necessary to provide services according to standards so that the interests of prospective passengers and several companies or office space tenants in the Graha Pelni Building can be fulfilled, one of which is the parking

system or parking lots available in the building area.

1.1 Research Background

In an effort to deal with the parking system problems that exist in the Graha Pelni Building, a good planning is needed. Among other things, adequate parking space and the right form of parking pattern determination, where the need for parking space (demand) and the required infrastructure (supply) must be balanced and in accordance with parking standards (Director General of Land Transportation 1996 parking guidebook) (Direktorat Jenderal Perhubungan Darat, 1996).

1.2 Formulation Problem

there are 4 points in the formulation of the problem, among others

1. Has Graha Pelni provided adequate parking space and infrastructure in accordance with standards and needs?
2. What are the layout, characteristics (parking volume, parking accumulation, parking duration, parking turnover, parking space provider, capacity, and parking index) and the number of parking space requirements (KRP) for two and four wheels in the existing building that is already operating in the Graha Pelni Surabaya Building?
3. What is the amount of parking space requirements (KRP) for two and four wheels in the Graha Pelni Building parking lot against the 1996 Director General of Land Transportation parking guidebook?
4. How to optimize the layout, gate system and technical circulation in and out of vehicles at Graha Pelni Building Surabaya?

1.3 Research Objective

The purpose of this study is to determine the parking demand at the research location, comparison with the guidebook, parking user growth, and for the public and students.

2. Research Method

2.1 Research overview and method design

The research to be carried out is how the existing parking conditions at the research location in terms of capacity and characteristics of existing parking in accordance with the theory presented and will be implemented in the field.

This research with one repeat of the research and carried out at the research site to collect parking data, including parking area in the existing building, parking space users, motobike and car.

This type of research is quantitative, samples that have been taken for one week or more if possible will be calculated in such a way according to existing formulas to get conclusions.

2.2 Technical

The sampling technique is to conduct a survey at the research location repeatedly for one week on an effective day of building operations. The survey was conducted by taking data on motobike and car.

2.2.1 Primary Data

Primary data to be obtained is a vehicle survey conducted on existing parking structures with data collection techniques also called a parking characteristic survey as follows:

2.2.1.1 Parking accumulation

Parking accumulation is calculated with the aim that the author knows the number of vehicles parked with a span of 30 minutes in the parking space area. The formula that will be used is as follows[4](Hobbs., 1997) :

$$\text{Accumulation} = Q_{in} - Q_{out} + Qs \quad (1)$$

2.2.1.2 Parking volume

Parking volume is calculated in order for the author to know the total number of vehicles using the parking lot during the survey time. Can be calculated with the formula below (Hobbs., 1997):

$$\text{Volume (V)} = X + Km \quad (2)$$

2.2.1.3 Parking duration

Parking duration is the time used by a vehicle in using a parking space expressed in units of vehicles/hour. With the formula[4](Hobbs., 1997):

$$D = T_{out} - T_{in} \quad (3)$$

2.2.1.4 Turnover

Parking turnover is a number that shows a comparison between parking volume and available parking capacity in a parking lot in a certain period. With the formula (Hobbs., 1997):

$$Turn\ Over = \frac{Volume\ parkir}{Kapasitas\ parkir} \quad (4)$$

2.2.1.5 Parking capacity

Parking capacity is the maximum number of vehicles that can be served by a parking lot during the service time. The formula used is as follows (Hobbs., 1997):

$$P = \frac{Ks\ x\ T}{D}\ x\ F \quad (5)$$

2.2.1.6 Parking index

Parking index is the ratio between parking accumulation and parking capacity. The value obtained from the parking index can show how much the capacity of a parking lot has been filled. The index value can be obtained using the following formula (Hobbs., 1997):

$$IP = \frac{Akumulasi\ Parkir}{Kapasitas\ Parkir} \quad (6)$$

2.2.1.7 Parking space requirement

Parking space requirements (KRP) is the number of spaces needed to accommodate the number of vehicles that require parking spaces based on the facilities and functions of a land management. (Dhea Ananda Runikha, 2021) parking space requirements can be calculated using the following formula (Hobbs., 1997):

KRP = F1 x F2 x Volume Parkir Harian (7)

2.2.1.8 Additional parking area

The parking lot area requirement serves to calculate the area needed if the existing parking spaces can no longer accommodate the parking space requirements. With the formula below (Runikha, 2021):

LPP=JPP x UPP (8)

2.2.1.9 Forecasting

Forecasting calculations serve to calculate the growth of parking users in the (annual) time frame to be addressed, so that parking providers can estimate whether they need to expand parking lots or change parking space management to meet the growth of parking users in the area. The formula used is as follows (Hobbs., 1997):

$$Pn = Po\ (1 + i\%)^n \quad (9)$$

2.2.2 Secondary Data

The secondary data that will be required are as follows:

- Parking lot area
- Parking lot plan
- Parking plot
- Related regulations
- Literature books related to research

3. Discussions and result

The data collection process at the research location was carried out for a month which was out of the initial plan which would only be done for a week. This research was conducted for a month due to the potential for parking user patronage at the time of data collection. The following is a summary of the highest parking data from the survey results that have been carried out as per table below:

Table 1 Parking survey data for Graha Pelni Surabaya building on Tuesday 17 May 2023

No	Time	Motobike		Car	
		In	Out	In	Out
1	08.00 - 09.00	71	20	53	1
2	09.00 - 10.00	60	12	15	4
3	10.00 - 11.00	65	27	10	20
4	11.00 - 12.00	16	53	8	53
5	12.00 - 13.00	53	48	11	28
6	13.00 - 14.00	37	40	58	7
7	14.00 - 15.00	22	74	15	42

No	Time	Motobike		Car	
		In	Out	In	Out
8	15.00 - 16.00	14	57	8	16
	Jumlah	338	331	178	171

The layout of the research site to be analyzed and evaluated which includes the building layout, parking plan, and parking plot to serve as a reference for analysis and evaluation so that at the end of this study the author can determine whether the research location needs expansion or not if the space or parking lot cannot meet the demand of parking users. The following is Figure 1 regarding the area of the parking building in the Graha Pelni Surabaya.

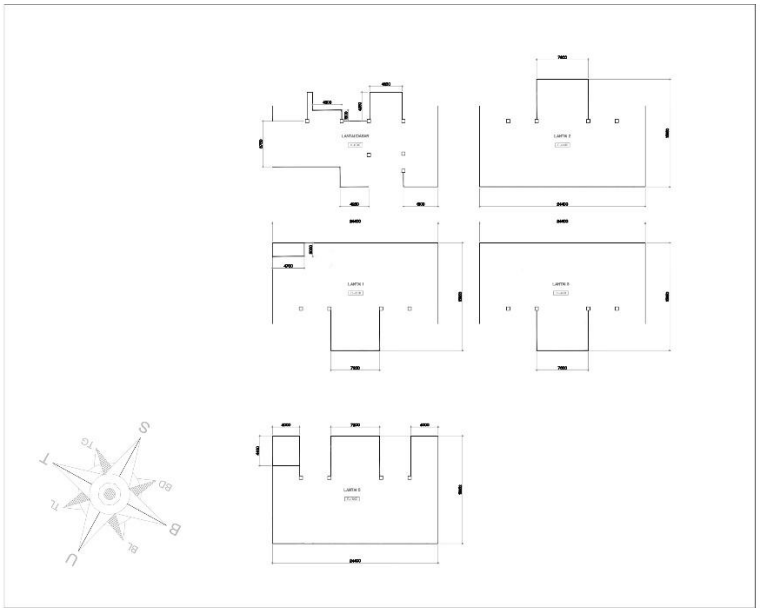

Figure 1 Parking Existing building plan

3.1 Parking and area data

Parking data collection is obtained by calculating the number of plots or parking units available in the existing building. In the existing building there are 5 floors of active parking spaces. The number of plots or parking units for motorcycles and cars is shown in Table 2 and Table 3 for area data as below:

Table 2 Details of the number plots or parking units at Graha Pelni Surabaya Building

Floor	Motobike (SRP)	Car (SRP)
Ground floor	-	50
1 floor	11	-
2 floor	14	-
3 floor	14	-
4 floor	11	50
Total	**50**	**100**

Table 3 Existing building Efective area

Floor	Effective width (m^2)	Function
Ground floor	227.37	Parking, canteen, co-operative
1 floor	303.23	Parking area
2 floor	322.04	Parking area
3 floor	312.63	Parking area
4 floor	339.64	Parking area
Total	1504.91	

3.2 Parking characteristic

3.2.1 Parking pattern

The results of observations in the field of car parking patterns at Graha Pelni Surabaya Building are two-sided patterns with an angle of 90 °. This parking pattern is used because the parking lot is large enough with one-way vehicle circulation (Sarifah, 2015). In contrast to the parking pattern used for two-wheeled vehicles, which uses a one-sided, two-sided, and island pattern with an angle of 90 ° and 45 ° for a two-sided pattern due to limited parking area. (Sarifah, 2015)

3.2.2 Parking volume

Parking volume is the number of vehicles that have used a parking space in a particular parking lot in a certain unit of time. The following summarizes the parking volume that has been obtained at the study location in Table 4 below:

Table 4 Parking volume

Time	Motobike		Car	
	In	Comulative	In	Comulative
08.00 - 09.00	71	71	53	53
09.00 - 10.00	60	131	15	68
10.00 - 11.00	65	196	10	78
11.00 - 12.00	16	212	8	86
12.00 - 13.00	53	265	11	97
13.00 - 14.00	37	302	58	155
14.00 - 15.00	22	324	15	170
15.00 - 16.00	14	338	8	178

After looking at the table above, it can be shown that the maximum volume is as follows:

- Motobike Vol Maks:71 Vehicles (2)
  Jam : 08.00 – 09.00
- Car Vol Maks: 58 Vehicles (2)
  Jam : 13.00 – 14.00

3.2.3 Parking duration

Parking duration is the time used by a vehicle in using the parking space from the time it enters the parking area until it leaves the parking area. Parking duration can be calculated with the following formula

$$\begin{aligned} D &= Tout - Tin \\ &= 09.00 - 08.00 \\ &= 60 \text{ menit} \end{aligned} \quad (3)$$

Details for the duration of motorcycle and car parking can be seen in table 4, and table 5 below:

Table 5 Motobike parking duration

length of parking (minute)	total vehicle	length of parking (minute	total vehicle
60	20	260	16
80	3	280	19
100	4	300	20
120	1	320	7
140	5	340	11
160	22	360	34
180	12	380	23
200	15	400	26
220	6	420	50
240	30	440	7

Table 6 Car parking duration

Length of parking (minute)	Total vehicle	Length of parking (minute	Total vehicle
60	1	260	12
80	2	280	9
100	3	300	5
120	6	320	5
140	10	340	8
160	21	360	2
180	13	380	10
200	5	400	25
220	8	420	1
240	25	440	0

After conducting a parking duration survey and obtaining the parking duration for each vehicle as an example of the calculation above, so that the duration of each vehicle can be grouped. motorbikes with a duration of 420 minutes, a total of 50 vehicles and cars for 420 minutes as many as 1 vehicle.

3.2.4 Parking accumulation

Parking accumulation is used to determine how many vehicles are in a parking area at a certain time. The following is an example of accumulation calculation as below :

- Motobike parking accumation

Akumlasi1 = Qin – Qout + Qs (1)
= 48 – 9 + 0
= 39 (time 08.00 – 09.00)
Akumulasi2 = Qin – Qout + Qs (1)
= 39 – 12 + 46
= 73 (time 09.00 – 10.00)

- Car parking accumulation

Akumulasi1= Qin – Qout + Qs (1)
= 6 – 2 + 0
= 4 (time 08.00 – 09.00)
Akumulasi2= Qin – Qout + Qs (1)

= 4 – 3 + 12
= 13 (time 09.00 – 10.00)

maximum accumulation of motorcycles 137 vehicles at 10:00 - 11:00 and maximum accumulation of cars 63 vehicles at 09:00 - 10:00

3.2.5 Parking capasity

Parking capacity can be seen in the **Table 2** above. In the table is called static capacity, for dynamic capacity please see below :

- Motobike :

$$P = \frac{Ks\ x\ T}{D}\ x\ F \qquad (5)$$

P = $\frac{100\ x\ 8}{292.39/60}\ x\ 0.85$
P = 139.54 → 140 Vehicles

- Car

P = $\frac{50\ x\ 8}{254.39/60}\ x\ 0.85$
P = 80.19 → 80 Kendaraan

3.2.6 Parking index

The parking index is the percentage of the accumulated number of vehicles at a given time interval divided by the static capacity. Here is an example of the calculation.

- Motobike

IndeksParkir= $\frac{Akumulasi\ Parkir}{Kapasitas\ Parkir}\ x\ 100\%$ (6)
= $\frac{137}{100}\ x\ 100\%$
= 137%

- Car

= $\frac{63}{50}\ x\ 100\%$

= 126%

3.2.7 Turnover

Parking turnover is obtained from the number of vehicles that have used the parking lot at certain times divided by the available parking spaces. Here is an example of the calculation

- Motobike

Turn Over = $\frac{Volume\ Parkir}{Kapasitas\ Parkir}$ (4)

= $\frac{338}{100}$ = 3,38

From the results of the above calculations, it can be concluded that during the observation time each SRP experienced a turnover of 3.38 times (motobike) and 3.56 times (car).

3.2.8 Parking space requirement

Parking space requirement is a unit of parking space where the land requires the number of parking spaces to carry out its function.

3.2.8.1 Actual data

- Motobike
  KRP= F1xF2xVolumeParkir Harian(7)
  = ($\frac{137}{338}\ x\ 100\%$) x 1,5 x 338
  = 206 SRP
- Car
  = ($\frac{63}{178}\ x\ 100\%$) x 1,5 x 178
  = 95 SRP

From the results of the above calculations, the results of the parking space requirements (KRP) are 206 SRP for motorcycles and 95 SRP for cars. When referring to the static capacity of Table 2 for the availability of motorcycle and car parking, it is still sufficient. KRP recapitulation can be seen in table 7 below :

Table 7 Existing building parking space requirement

Vehicles type	Vehicles volume	Acc max	F1	KRP (SRP)	Available KRP (Actual)	Enough/No
Motobike	338	137	40,53%	206	100	NO
Car	178	63	35,39%	95	50	NO

From the calculation of KRP above, the maximum KRP on busy days of passenger service that occurs in the existing building is 206 SRP for motorbikes and 95 SRP for cars, assuming 1 SRP car = 6 SRP motorbikes and in accordance with the effective area of the parking building according to Table 3 Effective Area Data of existing buildings of 1504.91 m^2, then it can be calculated the standard parking space in the Graha Pelni Surabaya Building, namely :

$$KRP = \frac{1504,91}{50+(\frac{1}{6}x206)} = 17,84 \rightarrow 18\ m^2/SRP \quad (7)$$

As per above calculation, it can be concluded that in 18 m^2 of effective area the building manager is required to provide 1 SRP.

3.2.8.2 Parking space requirement with parking standards (Director General of Land Transportation 1996 parking guidebook)

Table 8 Space requirement of Ditjen

Jumlah karyawan		1000	1250	1500	1750	2000	2500	3000	4000	5000
Kebutuhan (SRP)	Administrasi	235	236	237	238	239	240	242	246	249
	Pelayanan umum	288	289	290	291	291	293	295	298	302

Source : Director General of Land Transportation 1996 parking guidebook

Looking at the standard table of KRP requirements for office centers by the Director General of Land Transportation 1996 (Direktorat Jenderal Perhubungan Darat, 1996) as above, where the number of employees working in the Surabaya pelni graha building environment does not reach 1000 employees and this building is also the flow of prospective passengers and cars carrying cargo, it is enough to take the lowest data from the SRP table, namely 288 SRP. If calculated with the formula below, it will get the following data :

$$KRP = \frac{1504,91\ m2}{288} = 5,22\ m^2/SRP \quad (7)$$

From the two calculation methods above, it can be detailed as follows in the table 9 below

Table 9 Detailed calculation at Graha Pelni Surabaya Building

KRP	Actual data	Dirjen Perhub. Darat 1996
Total area (m^2)	1.504,91	100m^2/SRP
Needed(SRP)	130	288
KRP = m^2/SRP	18	28

From the calculation table above, it can be obtained that in 18 m^2 of effective area the building manager must provide 1 SRP, so this can help and be the basis if the manager wants to expand the parking area.

3.2.9 Additional parking area

This additional expansion calculation is used to meet the needs of parking spaces in 2023 now. Before doing the expansion calculation, we will first look for the number of excess vehicles in the maximum data results when conducting a survey at the research location. It is known in table 8 that the static capacity of motorcycles is 100 SRP and cars 50 SRP and it is assumed that 1 SRP car = 6 SRP motorcycle. In table 8 it is known that the total shortage of SRP needed is 63 SRP. The following is the calculation of the parking lot expansion below :

$$LPP = JPP\ x\ UPP \quad (8)$$

LPP = 63 x 2.30m x 5.00m
LPP = 724.5 m^2

3.2.10 Forecasting

Calculating parking demand in the next 5 years or in 2028 is assuming per day in 2028. The calculation of motorcycle parking space requirements in 5 years is assumed to use the economic growth ratio of Surabaya city obtained from BPS Surabaya city in 2022 of 6.51%. (BPS Kota Surabaya, 2023)

Figure 2 Growth of several Cities/Districts in East Java
Source : BPS Surabaya City, 2023

The following forecasting calculations are as follows

Pn = Po (1 + i%)n (9)
Pn = 130 (1 + 0,0651)^5
Pn = 178,19 -> 179 SRP

It can be concluded that the need for motorcycle parking at the Graha Pelni Surabaya Building in 2028 is 179 SRP, which is more than the existing needs, this can happen because the growth ratio of the number of vehicle owners per year is 6.51%. (BPS Kota Surabaya, 2023)

4. Conclusion and Suggestion

4.1 Conclusion

Based on the research results obtained in the survey and calculations in the Graha Pelni Surabaya parking area, the following conclusions can be drawn:

a. The need for parking space (KRP) provided by the management or manager of the Graha Pelni Surabaya Building based on the results of surveys and calculations is 206 SRP for motorbikes and 95 SRP for cars. While the effective area is 1,504.91 m^2.
b. The results of the analysis of parking space requirements (KRP) against the available parking space units (SRP) of 100 SRP for motorbikes and 50 SRP for cars with the assumption of 1 SRP car = 6 SRP motorbikes with a total of 66 SRP available while based on the Director General of Land Transportation in 1996 for office buildings intended for general administration of 288 SRP. The smallest number to meet the parking demand in the Graha Pelni Building parking area is 130 SRP with a parking expansion of 724.5 m^2.
c. The growth of parking demand with the destination time for the next 5 years is 179 SRP with a growth value of 6.51% according to BPS Surabaya City 2022.

4.2 Suggestion

Based on the above conclusions derived from the results of this study, there are several important things that will be used as suggestions for managers and the continuation of this research, as follows:

a. Graha Pelni Surabaya Building parking manager should immediately expand the parking area so that the demand for parking in the area is fulfilled considering that ship users are also still many enthusiasts, especially for eastern Indonesia.

b. Graha Pelni Surabaya Building parking manager provides parking facilities in accordance with the 1996 Director General of Land Transportation guidelines.
c. Regulation of the Director General of Transport. Darat 1996 needs to be adjusted again because the factual parking space requirements (KRP) in the field do not meet the standards.

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