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Evaluation of Traffic Performance due to Closing Access to Private Vehicles on Pintu Besar Selatan Street for Mass Transportation (Case Study: Pancoran Street, West Jakarta Administrative City)

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Abstract

To expand the implementation of a Low Emission Zone (LEZ) in the Kota Tua area by restricting vehicles passing on Pintu Besar Selatan Street to only Transjakarta buses and diverting private vehicles to Pancoran Street, which is a commercial area and there is parking on the road which hinders the smooth flow of traffic. This study aims to analyze the effect of traffic performance on Pancoran Street due to the diversion of private vehicles from Pintu Besar Selatan Street in the planning year and alternative solution and parking characteristics on Pancoran Street. This research focuses on the evaluation of road performance and analysis of parking characteristics using Indonesian Road Capacity Guidelines (PKJI 2023), PTV Vissim, and Parking Facility Planning and Operation Guidelines 1998. Based on the analysis in the alternative problem solving for the planning year 2029, the implementation of odd-even and off-street parking has an effect on traffic performance, which has improved significantly by reducing the level of service (LOS) value was originally D for Pancoran Street Lane I and Lane II to C in Lane I and B in Lane II, reducing the average delay from 21,03 seconds originally to 1,95 seconds and increasing the network speed from 15,89 km/hour originally to 34,33 km/hour. The results of the parking analysis show that the parking space requirement is 18 SRP at the 0^0-corner parking and 29 SRP at the 60^0-corner parking, which means that the land is still able to accommodate, furthermore the parking changes often hinder the smooth flow of traffic. The recommendation that can be given is that it is necessary to implement alternative solutions to improve city traffic immediately and it can reduce air quality problems.

1. Introduction

To reduce traffic congestion and air quality problems in the Kota Tua area of Jakarta, Provincial Transportation Agency DKI Jakarta has implemented traffic diversion around the Kota Tua area as a government effort to solve urban traffic problems (Tamin, 2008). The traffic diversion has been implemented since the implementation of the Low Emission Zone (LEZ) in the Kota Tua area (Isradi et al., 2022; Hartatik et al., 2020).

As a result of the traffic diversion, one of the roads leading to the Kota Tua area, namely Pintu Besar Selatan area as a connecting road to the Kota Tua area from central Jakarta, has experienced increased congestion (Muneera & Krishnamurthy, 2020). As an important road because of its proximity to tourist areas, offices, and commercial places, Pintu Besar Selatan Street experiences traffic congestion problems, especially during rush hours. Alternative solutions to problems at one location often create new problems that require the government to look to the future to consider the best alternatives (Morlok, 1985).

As a follow-up program to reduce congestion and air quality problems, the Provincial Transportation Agency DKI Jakarta has implemented traffic diversion for Pintu Besar Selatan Street by limiting the number of vehicles that can pass through the road (Rifai et al., 2020). Private vehicles heading to the Kota Tua area will be diverted via Pancoran Street, and only Transjakarta buses will be allowed to use Pintu Besar Selatan Street. The government plays an important role in setting the policy for the expansion of the LEZ (Rizki et al., 2022).

Pancoran Street is a commercial area with access to Glodok Market, Pancoran Chinatown Point Mall, shops and has on-street parking. The implementation of the policy of using Pancoran Street as the main road due to the diversion policy of Pintu Besar Selatan Street has resulted in increased traffic congestion and air pollution in the area (Samudra & Hertasning, 2024).

Therefore, it is necessary to evaluate the traffic performance of Pancoran Street in terms of the factors that affect the level of service on the road section as an effort to reduce the level of congestion and air quality problems in the area. Furthermore, with this research, it is hoped that it can increase the efficiency of traffic movement with a high level of accessibility.

2. Methodology

Pancoran Street is approximately 300 meters long and one-way. There is on-street parking on the south side of the street. The research site in this study is shown in Fig. 1 below.

Fig. 1 *Research location*

This research focused on Pancoran Street and the data collection was conducted on Wednesday, May 8, 2024, at hours representing morning rush hour from 06:00 to 09:00, afternoon rush hour from 11:00 to 13:00, and evening rush hour from 16:00 to 21:00, and 08:00 to 18:00 for parking data.

The required data collection includes primary data collection in the form of road section and roadside parking inventory survey, classified traffic volume survey, travel speed survey, side obstacle survey, and parking patrol survey (Putri & Tama, 2022). As for the secondary data collection, data on the research location map, study area conditions, and population data.

The data analysis technique of this research is focused on evaluating road traffic performance and parking characteristics using PTV Vissim software, the Indonesian Road Capacity Guidelines 2023, and the Directorate General of Land Transportation Parking Facilities Planning and Operation Guidelines 1998 conducted on Pancoran Street, West Jakarta Administrative City. The aspects analyzed in this study consist of road section performance, parking characteristics analysis and forecasting (Angelo et al., 2022; Isradi et al. 2021).

2.1 Research Variables

2.1.1 Road Section Performance

Urban traffic performance can be analyzed using the parameters of segment performance, intersection performance, and accident data at the location of the study area (Tamin, 2008; Azahra et al., 2023). Traffic performance measurement analysis based on the PKJI 2023. (Direktorat Jenderal Bina Marga, 2023). Traffic performance analysis requires:

a. Traffic Volume

Traffic volume is the number of vehicles that pass through a given point on a segment in a given unit of time, which can be expressed in veh/hour or pcu/hour (Tamin, 2008). The volume of vehicles in passenger car unit per hour (pcu/hour) to be calculated is the number of passenger car equivalent (pce) vehicles crossing the observation point or location and can be calculated using the equation (1).

$$Qpcu = (PCE_{SM} \times SM) + (PCE_{MP} \times MP) + (PCE_{KS} \times KS) \quad (1)$$

Description:
- $Qpcu$ = number of vehicles (pcu/hour)
- PCE_{SM} = passenger car equivalent for motorcycle
- SM = notation for motorcycle
- PCE_{MP} = passenger car equivalent for car
- MP = notation for car
- PCE_{KS} = passenger car equivalent for medium vehicle
- KS = notation for medium vehicle

b. Model Validation Using Chi-Square Hypothesis Test

The purpose of model validation is to test whether the model results obtained are significantly different from the survey results so that the model can be accepted. The Chi-Square Hypothesis Test is a hypothesis test used in this study to test whether two variables are aligned and independent in influencing the test statistics (Harinaldi, 2005). In this research, the variables used are the traffic volume from the survey and the traffic volume from the traffic model using PTV VISSIM.

The rejection area or critical limit of the chi-square table by determining the significance level with a confidence level of 95% or α = 5% can be seen the parameter price in the chi-square table (X^2), taking into account the number of observation conditions (k) and test decision rules, and it can be concluded that H0 is accepted if the X^2 value < the parameter price and H0 is rejected if X^2 > the parameter price.

c. Road Capacity

Capacity is calculated using adjustment factors that take into account road geometry and traffic under existing conditions (Direktorat Jenderal Bina Marga, 2023). Road capacity can generally be calculated using equation (2).

$$C = Co \times FC_{LJ} \times FC_{PA} \times FC_{HS} \times FC_{UK} \quad (2)$$

Description:
- C = capacity (pcu/hour)
- Co = base Capacity (pcu/hour)
- FC_{LJ} = lane width difference correction factor
- FC_{PA} = directional separation correction factor for undivided road type
- FC_{HS} = side obstacle class correction factor
- FC_{UK} = city size correction factor

d. Speed and Density

Speed is the average time it takes a passenger car to travel the analyzed road segment (Nama et al., 2016). And traffic density is the number of vehicles contained in a given unit of road length by comparing traffic volume with traffic speed, which can be expressed in veh/km or pcu/km (Tamin, 2008). To determine the density can be calculated using the equation (3).

$$K = \frac{Q}{V_{MP}} \quad (3)$$

Description:
- K = traffic density (veh/hour or pcu/hour)
- Q = number of vehicles (veh/hour or pcu/hour)
- V_{MP} = space mean speed(km/hour)

e. Degree of Saturation and Level of Service

The degree of saturation is a parameter used to determine the performance level of road sections (Direktorat Jenderal Bina Marga, 2023). To determine the degree of saturation, the following equation can be used (4).

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$$D_J = \frac{q}{C} \qquad (4)$$

Description:

D_J = degree of saturation

q = traffic Flow Volume (pcu/hour)

C = road segment capacity (pcu/hour)

Level of service (LOS) is a qualitative measure that describes the operational conditions of a traffic flow and the perception of these conditions by drivers and/or passengers (Khisty & Lall, 2005). Related to the characteristics of the level of service of road sections can be seen in Table 1.

Table 1 *Level of Service characteristics (Tenggara et al., 2021)*

(1)	(2)
Level of Service	Characteristics
A	Free flow with low traffic, average speed ≥ 80 km/hour, V/C Ratio 0 – 0,2 and low traffic density
B	Stable flow with moderate traffic, average travel speed up to ≥ 70 km/hour, V/C Ratio 0,21 – 0,45 and low traffic density
C	Stable flow with higher traffic, average speed down to ≥ 60 km/hour, V/C Ratio 0,46 – 0,75 and medium traffic density
D	Near Unstable flow with high traffic volume, average speed decreases to ≥ 50 km/hour, V/C Ratio 0,76 – 0,84 and moderate traffic density
E	Unstable flow with traffic near capacity, average travel speed Approximately 30 km/hour on interurban roads and 10 km/hour on urban roads, V/C Ratio 0,85 – 1, high traffic density due to internal barriers
F	Flow is stopped and queuing occurs, average travel speed < 30 km/hour, V/C Ratio more than 1 and very high traffic density and low volume

2.1.2 Parking Characteristics Analysis

Parking is part of the transportation system and a necessity (Isradi et al., 2020; Isradi et al., 2021). Therefore, a good parking arrangement is needed so that parking can be used efficiently and does not cause problems for other activities (Chen et al., 2021). And it can be seen that parking is divided into two, namely on-street parking and off-street parking (Direktorat Jenderal Perhubungan Darat, 1998).The analysis of parking data using:

a. Parking Accumulation

The number of cars parked at a given time is called parking accumulation (Munawar, 2004), which is obtained by the equation (5).

$$\text{Accumulation} = Ei - Ex + X \qquad (5)$$

Description:

Ei = number of incoming vehicles

Ex = number of outgoing vehicles

X = number of vehicles parked before observation

b. Parking Duration

Parking duration is the amount of time a vehicle is parked in a space (Munawar, 2004), which is obtained by the equation (6).

$$\text{Duration} = \frac{\sum_{i-n}^{n} di}{n} \qquad (6)$$

Description:

di = duration of the i-th vehicle (i from the i-th vehicle to the n-th vehicle)

n = number of vehicles

c. Parking Volume

Parking volume is the total number of vehicles performing parking activities at the location (Isradi & Vahira, 2021). which is obtained by the equation (7).

$$\text{Parking Volume} = \text{Ei} + \text{X} \tag{7}$$

d. Parking Index

The parking index is a description of the effectiveness of the use of parking spaces with space capacity. The parking index value can be calculated using equation (8).

$$\text{Parking Index} = \frac{Parking\ Accumulation\ x\ 100\%}{Parking\ Space\ Available\ (PSU)} \tag{8}$$

e. Parking Turnover Rate

Parking space utilization, which is the ratio of parking volume for a given period of time to the number of parking spaces or parking capacity. The parking turnover rate value can be calculated using equation (9).

$$\text{Parking Turnover Rate} = \frac{Parking\ Volume}{Parking\ Space\ Available\ (PSU)} \tag{9}$$

f. Number of Parking Spaces Required

Parking spaces are required in a location to accommodate the number of vehicles that will be parked in a given period of time. The number of parking spaces required value can be calculated using equation (10).

$$\text{Parking Space Requirements} = \frac{number\ of\ vehicles\ x\ average\ parking\ duration}{Survey\ Time\ Length} \tag{10}$$

2.1.3 Traffic Forecasting Condition Plan Year

Traffic forecasting in the target year is needed to analyze the traffic management that will be or has been implemented, with the aim of knowing whether a traffic performance solution that has been made can still be applied in the next few years (Isradi et al., 2024). The traffic forecast is carried out for the generation and attraction of each traffic zone in the target year using the growth rate method (compounding factor), which is obtained by the equation (11).

$$Pt = Po\ (i + 1)^{n} \tag{11}$$

Description:

Pt = the value of variable X in year n

Po = the value of the variable in the current year

I = average growth rate

N = time span of the analysis year

2.2 Alternative Solutions to Traffic Performance Problems

Alternative solutions to traffic performance problems that can improve the performance value studied with a traffic management and engineering approach. This refers to the proposals that will be applied according to the calculation results that can optimize the performance of the road section (Zheng & Liu, 2017; Jong & Bliemer, 2015).

3. Result and Discussion

3.1 Road Section Performance

Based on the results of the field survey, the Pancoran Street section is an area with land use characteristics in the form of commercial buildings such as offices and stores. The data is described based on the layout and geometric conditions of the road, traffic volume data, speed, degree of saturation, level of service and road network performance (Oh et al., 2002).

3.1.1. Layout and Road Geometric Data

The results of collecting data on the geometric conditions of the road sections produced the layout of Pancoran Street, presented in Fig. 2.

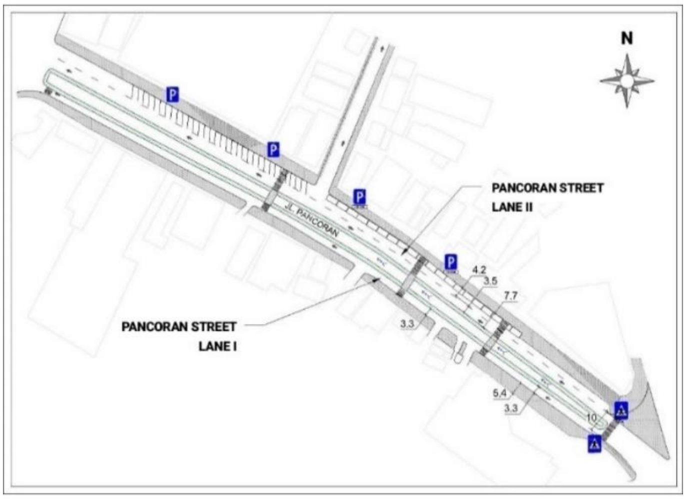

Fig. 2 *Pancoran street layout map*

The following road geometry data is shown in Table 2.

Table 2 *Road geometric data*

(1)	(2)
Description	Pancoran Street
Road Type	2/1 T (2 Lanes 1-way Devided)
Width of Road	3,5 m per lane
Shoulder Width	5,4 m
Median	6,7 m
Road Condition	Flat
Side Obstacle	High
Type of Pavement	Flexible Pavement

Based on the survey results at the research site, it was determined that Pancoran Street is a 2-lane, one-way street type separated by a median, and each lane is 3.5 m wide.

3.1.2. Existing Traffic Volume Conditions

To determine the characteristics of traffic, a traffic enumeration survey was conducted during peak hours and was carried out in two conditions, namely on weekdays and weekend and the observations were divided into 2 (two) lanes. The recapitulation of traffic volume can be seen in Table 3.

Table 3 *Traffic volume summary*

Wednesdey May 8, 2024 (Vehicles/Hour) Time 11.45-12.45				
(1)	(2)	(3)	(4)	(5)
Road Segment	SM	MP	KS	Total
Pancoran Street Lane I	1278	824	1	2103
Pancoran Street Lane II	978	929	1	1908

From the observation results, it can be seen that the highest peak hour on Pancoran Street occurred on Wednesday, May 8, 2024 at 11.45 to 12.45.

3.1.3. Traffic Volume Result of the VISSIM Transportation Model

The traffic volume output from the VISSIM software processing is in the form of hourly vehicle volumes, which are then manually distributed using the proportion of vehicles from the peak hour traffic census results to determine the value of the pcu/hour volume. The following is a look at the VISSIM application shown in Fig. 3.

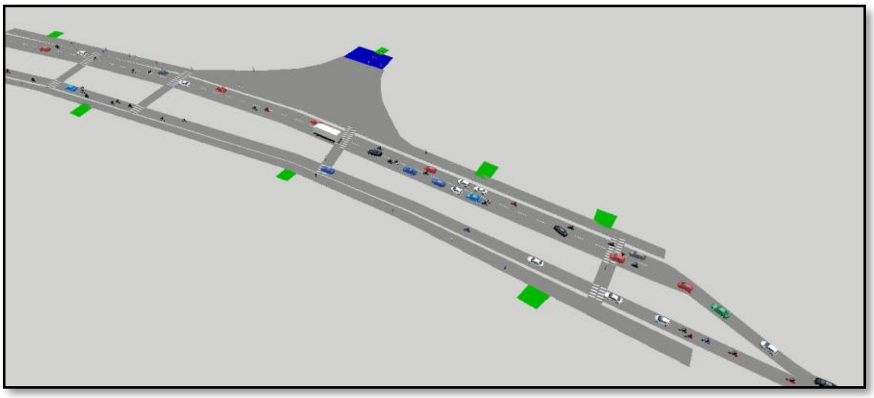

Fig. 3 *Software VISSIM on Pancoran Street*

The determination of volume (pcu/hour) can be calculated using equation (1).

Qpcu = (PCESM x SM) + (PCEMP x MP) + (PCEKS x KS)
= (0,25 x 1246) + (1 x 804) + (1,2 x 1)
= 311,5 + 804 + 1,2
= 1116,7 veh/hour

The summary of the vehicle volume calculation from the traffic model results is shown in Table 4.

Table 4 *Traffic volume summary (pcu/hour)*

(1)	(2)				(3)			
Road Segment	Volume Lalu Lintas (Vehicle)				Volume Lalu Lintas (Passenger Car Unit (pcu))			
	SM	MP	KS	Total (Veh/hour)	SM (PCE = 0,25)	MP (PCE = 1)	KS (PCE = 1,2)	Total (pcu/hour)
Pancoran Street Lane I	1246	804	1	2051	311,5	804	1,2	1116,7
Pancoran Street Lane II	945	897	1	1843	236,25	897	1,2	1134,45

Based on the results of the analysis in Table 4, the highest volume is found on Pancoran Road, Lane 2, which is 1134.45 pcu/hour.

3.1.4. Transport Model Validation Using Chi-Square Hypothesis Test

The purpose of model validation is to test whether the model results obtained are significantly different from the survey results so that the model can be accepted. The rejection region or critical limit of the X^2 table determines the significance level with a confidence level of 95% or $\alpha = 5\%$, there are 2 conditions (k) in the observation, which means k = 2, then, df : $v = k - 1 = 2 - 1 = 1$.

Looking at the X^2 distribution table, we can see that the value of X^2 (0.05; 1) = 3.84. The decision rules determine the test criteria, namely H_0: accept if $X^2 < 3.84$ and H_1: accept if $X^2 > 3.84$. The results of the road segment validation result are shown in Table 5.

Table 5 *Road segment validation results*

(1)	(2)		(3)	(4)	(5)
Road Segment	Volume (Veh/hour)		O-E	Chi-Square Test (X^2)	Sample
	Survey (O)	Model (E)		$X^2 = (O-E)/E$	
Pancoran Street Lane I	2103	2051	-52	1,31838	Ho accepted
Pancoran Street Lane II	1908	1843	-65	2,29246	Ho accepted
	TOTAL			**3,610839**	

From Table 5, H_0: is accepted because X^2 count <3.84, which has a value of 3.61, and the data from the model is accepted and can be used for further data analysis.

3.1.5. Road Capacity

The determination of capacity (C) can be calculated using equation (2):

$C = C_0 \times FC_{LJ} \times FC_{PA} \times FC_{HS} \times FC_{UK}$
$= 1700 \times 1 \times 1 \times 0{,}88 \times 1$
$= 1496$ pcu/hour

The calculation recapitulation is presented in Table 6.

Table 6 *Road capacity summary*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Road Segment	C_0 (pcu/hour)	FC_{LJ}	FC_{PA}	FC_{HS}	FC_{UK}	C (pcu/hour)
Pancoran Street Lane I	1700	1	1	0,88	1	1496
Pancoran Street Lane II	1700	1	1	0,88	1	1496

Based on the analysis in Table 6, it can be seen that Pancoran Lane I and Lane II have the same capacity of 1496 pcu/hour.

3.1.6. Speed and Density

The density of road segments can be calculated by dividing the traffic volume in passenger car units from the traffic census by the speed of the traffic model. The density determination can be calculated using equation (3).

$$K = \frac{Q}{Us} = \frac{1116{,}7\ pcu/hour}{26{,}34\ km/hour} = 42{,}4 \text{ pcu/km}$$

The calculation recapitulation is presented in Table 7.

Table 7 *Road density summary*

(1)	(2)	(3)	(4)
Road Segment	Volume (pcu/hour)	Speed (km/hour)	Density (pcu/km)
Pancoran Street Lane I	1116,70	26,34	42,40
Pancoran Street Lane II	1134,45	31,40	36,13

Based on the results of the analysis in Table 7, it can be seen that the highest density occurs on Pancoran Street Lane I with 42.4 pcu/km.

3.1.7. Degree of Saturation, Level of Services and Road Network Performance

The degree of saturation value can be calculated using equation (4).

$$D_J = \frac{q}{C} = \frac{1303{,}7\ pcu/hour}{1496\ pcu/hour} = 0{,}87$$

The calculation recapitulation is presented in Table 8.

Table 8 *Road performance summary*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Road Segment	Peak Hour Volume (pcu/hour)	Road Capacity (pcu/hour)	Degree of Saturation (D_J)	Level of Service (LOS)	Average Delay (second)	Road Network Speed (km/hour)
Pancoran Street Lane I	1116,70	1496	0,75	C	20,92	18,09
Pancoran Street Lane II	1134,45	1496	0,76	C		

From the analysis results in Table 8, both lanes have a level of servoce value of C, with an average performance delay value of 20,92 seconds, and the lowest network speed on weekdays is 18,09 km/hour.

3.2 Parking Characteristics Analysis

A static survey (inventory) and a dynamic survey (parking patrol) were conducted to determine the existing roadside parking conditions on the north side of Pancoran Street. The parking patrol survey was conducted over a period of 15 minutes for 10 hours, starting from 08.00 WIB to 18.00 WIB.

3.2.1. Parking Geometric Data

According to the survey results, two locations are allowed for roadside parking. From the picture of the parking layout, it can be seen that the north side of Pancoran Street is intended for four-wheeler parking only. The following parking geometry data is shown in Table 9.

Table 9 *Parking geometric data*

(1)	(2)	(3)	(4)	(5)
Parking Segment	Lenght (m)	Vehicles Type	Parking Type	Capacity Parking Space Unit (PSU)
Pancoran Street at corner 0°	100,3	Cars	On Street	20
Pancoran Street at corner 60°	107,7	Cars	On Street	31

The following layout of geometric conditions in the parking segment on Pancoran Street, shown in Fig. 4.

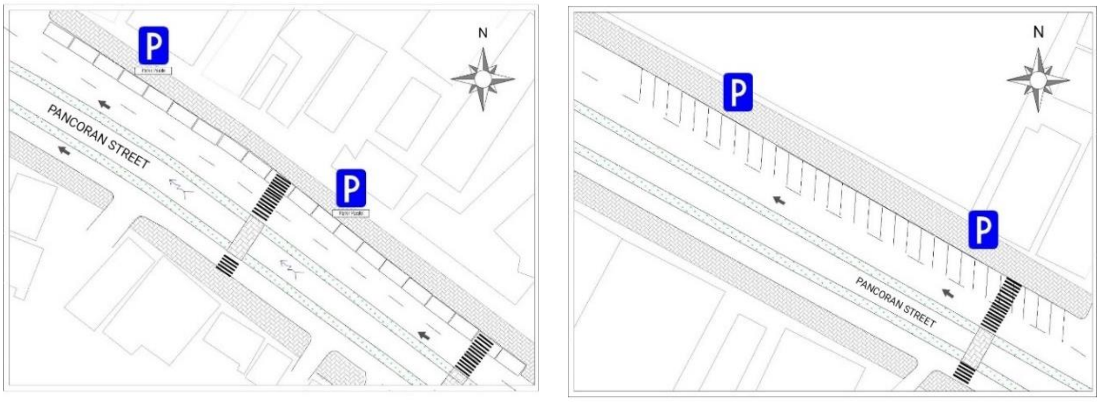

Fig. 4 *Layout of on-street parking with corner 0^0 (left) and corner 60^0 (right)*

Based on the survey results at the research site, there are two locations that are allowed for on-street parking with different parking angle positions, namely corner 0^0 and corner 60^0.

3.2.2. Parking Accumulation

Parking accumulation calculation observation time 08.00 to 18.00. Parking accumulation value can be calculated using equation (5).

Parking accumulation at corner 0^0 = Ei – Ex + X
= 4 – 0 + 16
= 20 vehicles

Parking accumulation at corner 60^0 = Ei – Ex + X
= 4 – 1 + 27
= 30 vehicles

From the results of the analysis, the highest parking accumulation on Pancoran Street, corner 0^0 at 12.00 to 12.15 which is 20 vehicles and corner 60^0 at 12.45 to 13.45 which is 30 vehicles.

3.2.3. Parking Duration

Parking duration value can be calculated using equation (6):

Parking duration at corner 0^0 $= \frac{\sum_{i-n}^{n} di}{n}$

$$= \frac{10845\ minutes/vehicles}{137\ vehicles}$$

= 79,16 minutes

Parking duration at corner 0^0 $= \frac{\sum_{i-n}^{n} di}{n}$

$= \frac{17160\ minutes/vehicles}{187\ vehicles}$

= 91,76 minutes

From the results of the analysis, it was found that the highest parking duration occurred at the 0^0-corner parking location with an average duration of 91,76 minutes.

3.2.4. Parking Volume

This volume is based on the duration of the survey, which is 10 hours. Parking Volume Calculation Observation time (08.00 to 18.00). Parking volume value can be calculated using equation (7).

Parking Volume at corner 0^0 = Ei + X
= 3 + 134
= 137 vehicles

Parking Volume at corner 60^0 = Ei + X
= 0 + 188
= 188 vehicles

From the results of the analysis, it was determined that the highest parking volume occurred at the 60^0 corner parking location with 188 vehicles.

3.2.5. Parking Index

Parking index value can be calculated using equation (8):

Parking Index $= \frac{Parking\ Accumulation\ x\ 100\%}{Parking\ Space\ Available}$

$= \frac{20\ x\ 100\%}{20}$

= 100%

The calculation recapitulation is presented in Table 10.

Table 10 *Summary of the parking index*

(1)	(2)	(3)	(4)
Parking Segment	Parking Accumulation (max)	Parking Space Unit (PSU)	Parking Index (%)
Pancoran Street at corner 0°	20	20	100,00
Pancoran Street at corner 60°	30	31	96,77

From the analysis results in Table 10, it was determined that the highest parking index occurred at the 0^0-corner parking location with 100 percent.

3.2.6. Parking Turnover Rate

The parking turnover rate value can be calculated using equation (9):

Parking turnover rate $= \frac{Parking\ Volume}{Parking\ Space\ Available\ (PSU)}$

$= \frac{137}{20}$

= 6,85

The calculation recapitulation is presented in Table 11.

Table 11 *Summary of the parking turnover rate*

(1)	(2)	(3)	(4)
Parking Segment	Volume (Veh/hour)	Parking Space Available (PSU)	Turnover Rate
Pancoran Street at corner 0°	137	20	6,85
Pancoran Street at corner 60°	188	31	6,06

From the analysis results in Table 11, it was determined that the highest parking turnover rate occurred at the 0^0-corner parking location with 6,85 times.

3.2.7. Number of Parking Spaces Required

The value of parking space requirements can be calculated using equation (10):

$$\text{Parking Space Requirements} = \frac{number\ of\ vehicles\ x\ average\ parking\ duration}{Survey\ Time\ Length}$$

$$= \frac{137\ x\ 1{,}32}{10}$$

$$= 18\ \text{PSU}$$

The calculation summary is shown in the following Table 12.

Table 12 *Summary of parking space requirements*

(1)	(2)	(3)	(4)	(5)
Parking Segment	Number of Vehicles (Veh)	Average Parking Duration (hour)	Survey Time Length (hour)	Parking Space Requirements (PSU)
Pancoran Street at corner 0°	137	1,3	10	18
Pancoran Street at corner 60°	188	1,5	10	29

From the analysis results in Table 12, it can be seen that the parking space requirement for the 0^0-corner parking location is 18 psu and the 60^0-corner parking location is 29 psu.

3.3 Forecasting Condition Plan year

The average vehicle growth in the DKI Jakarta area is 1.9% per year with a forecast plan for the next five years. The following calculation is used to find the vehicle growth rate on Pancoran Street in plan year 2029 using equation (11):

$$Pt = Po\ (i + 1)^n$$
$$= 2051\ (0{,}019 + 1)^5$$
$$= 2259\ \text{veh/hour}$$

The calculation recapitulation is presented in the following Table 13.

Table 13 *Comparison of the actual and planned growth of the traffic capacity*

(1)	(2)	(3)		(4)	
No	Parameters	Existing Condition		2029 Plan Year Condition	
		Pancoran Street Lanes I	Pancoran Street Lane II	Pancoran Street Lane I	Pancoran Street Lane II
1	Volume (Veh/hour)	1116,70	1134,45	1229,45	1249,45
2	Road Capacity (pcu/hour)	1496,00	1496,00	1496,00	1496,00
3	Degree of Saturation	0,75	0,76	0,82	0,84
4	Level of Services (LOS)	C	C	D	D
5	Average Delay (second)	20,92		21,03	
6	Road Network Speed (km/hour)	18,09		15,89	

The results of the analysis in Table 13 show that over the next five years, degree of saturation, level of service and average delay will increase, while network speed will decrease.

3.4 Alternative Solution to Traffic Performance Problems

Alternative conditions for the year 2029 on Pancoran Street are simulated in the form of odd-even application in both lanes and the relocation of parking to the outside of the road. With the application of odd-even, it is expected that the number of private vehicles crossing the road can be reduced by 50%, and additional road capacity in the form of additional lanes can be gained from the removal of on-street parking. The results of the traffic performance calculation comparing the Plan Year conditions with the scenario are shown in Table 14.

Table 14 *Comparison of traffic performance in the 2029 condition with the alternative solution*

(1)	(2)	(3)		(4)	
No	Parameters	2029 Plan Year Condition		Scenario	
		Pancoran Street Lanes I	Pancoran Street Lane II	Pancoran Street Lane I	Pancoran Street Lane II
1	Volume (Veh/hour)	1229,45	1249,45	813,45	816,95
2	Road Capacity (pcu/hour)	1496	1496	1496	2992
3	Degree of Saturation	0,82	0,84	0,54	0,27
4	Level of Services (LOS)	D	D	C	B
5	Average Delay (second)	21,03		1,95	
6	Road Network Speed (km/hour)	15,89		34,33	

Based on the results of the analysis in Table 14, it can be seen that Pancoran Street has improved traffic performance for both lanes after scenario, with the degree of saturation, level of service (LOS), and average delay decreasing and the network speed increasing.

By considering the projected demand for on-street parking in the 2029 plan year that will be shifted off-street so that alternative problem-solving planning can be optimally implemented. A summary of the calculation of off-street parking requirements is shown in the following Table 15.

Table 15 *Forecast of parking demand growth*

(1) Parking Segment	(2) Parking Space Requirement Year 2024 (PSU) (Po)	(3) Growth Rate (%) (i)	(4) Range of Plan Years (n)	(5) Parking Space Requirement Year 2029 (PSU) (Pt)	(6) Total
Pancoran Street at corner 0°	18	0,019	5	20	52
Pancoran Street at corner 60°	29	0,019	5	32	

Based on the results of the analysis in Table 15, it can be seen that the total demand for off-street parking spaces is 52 PSU.

4. Conclusion

From the results of the research conducted, the following can be concluded:

1. Based on the results of the traffic performance analysis on Pancoran Street Lane I and Lane II under existing conditions with a saturation value of 0,75 and 0,76, a level of service (LOS) of C for both lanes, an average delay of 20,92 seconds, and a road network speed of 1809 km/hour.
2. Based on the results of the parking analysis in Pancoran Street as follows:
   a. The parking index on Pancoran Street at 0^0- corner parking is100% and the parking turnover rate is 6,85 times.
   b. The demand for parking spaces on Pancoran Street in the current year is 18 SRP at Corner Parking 0^0 and 29 SRP at Corner Parking 60^0 and the number of available parking spaces is 20 SRP at Corner Parking 0^0 and 31 SRP at Corner Parking 60^0.
3. Based on the results of the analysis of the traffic performance of Pancoran Street in Plan Year 2029 by implementing alternative solutions in the form of odd-even implementation and off-street parking, it affects the traffic performance of Pancoran Street, which has improved significantly by reducing the level of service (LOS) value was originally D for Pancoran Street Lane I and Lane II to C in Lane I and B in Lane II, reducing the average delay from 21,03 seconds originally to 1,95 seconds and increasing the network speed from

15,89 km/hour originally to 34,33 km/hour and the total number of off-street parking spaces required is 52 PSU.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

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