Estimated Travel Time on the Kelapa Gading – Pulo Gebang Toll Road Using the MKJI Method and Speed Choice Analysis

Widodo Budi Dermawan, Arief Cahya Purnomo, Muhammad Isradi and Amar Mufhidin
Faculty of Engineering, Mercu Buana University Jakarta, Indonesia
wbdermawan@gmail.com , acahya10 @gmail.com,
isradi@mercubuana.ac.id, amarmufhidin@gmail.com

Joewono Prasetijo
Industry Center of Excellence for Railways (IcoE-REL), Universiti Tun Hussein Onn
Malaysia, 84600 Panchor, Johor, Malaysia
joewono@uhtm.edu.my

Abstract

The increase and development of the DKI Jakarta area have implications for the increasing needs of the population so that the need for travel and high mobility will also increase in the form of increased activities for the movement of people and goods in one area or city. The DKI Jakarta Provincial Government has made efforts to build 6 Inner City Toll Roads in the DKI Jakarta Region to reduce congestion polemics which will be carried out in stages, namely Section A of the Development of the 9.3 km Kelapa Gading - Pulo Gebang Inner City Toll Road. Based on the MKJI analysis, the travel time was 6 minutes, and with the speed choice analysis, it was found that the travel time was around 7 minutes. Based on the evaluation of the performance analysis of the toll road section, the capacity of 6,624 pcu/hour was obtained with the level of service in category B for the Pulo Gebang direction and the level of service in category A for the Kelapa Gading direction with traffic flow calculations at peak-peak hours in the afternoon. From the results of the analysis, it was found that post-operational toll roads can reduce congestion on the existing road, namely Jalan Boulevard Barat Raya, Kelapa Gading with a 61% shift in vehicle volume so that the level of service changes from category C to category B.

Keywords
Travel Time Value, Road Capacity, Speed Choice and Toll Road.

1. Introduction
Jakarta is the center of the capital city which has a very high level of congestion. The congestion polemic in Jakarta is caused by the increasing vehicle population growth without any increase in road growth (Isradi et al. 2020). Congestion is the situation or condition of congestion or last stop cross which is caused by a lot of vehicles that exceed the capacity of the road (Prasetijo et al. 2011). Traffic jam problems seem to have already become a characteristic of big cities in developing countries, including Indonesia (Manganta et al. 2019). With the high mobility of travel needs, it will have an impact on the growth of motorized vehicles, by 4.4% in the period 2016-2020 (BPS Kota Bekasi 2021). Meanwhile, the growth of road length in the DKI Jakarta area only reaches 0.01% per year (Hadiwardoyo 2018), resulting in an increase in the vehicle population that is not commensurate with the growth of road construction, which causes the polemic issue of congestion in the DKI Jakarta area until 2021. The low level of public awareness in complying with traffic rules causes traffic conflicts and congestion (Prasetijo and Ahmad 2012).

The increase and development of the DKI Jakarta area have implications for the increasing needs of the population so that the need for travel and high mobility will also increase in the form of increased activities for the movement of people and goods in one area or city (Isradi et al. 2021). The DKI Jakarta Provincial Government, in collaboration with PT Jakarta Toll Development, took the initiative in the construction and operation of infrastructure in the form

of expressways in DKI Jakarta, namely 6 Sections of Inner City Toll Roads in the DKI Jakarta Region, namely Section A Development of the Kelapa Gading - Pulo Gebang Inner City Toll Road, along 9.3 km as a form of implementation of one of the additions to the road network. The purpose of the construction of 6 Inner City Toll Roads in the DKI Jakarta Region is to increase the level of service and provision of transportation services and be affordable by the community (Rifai et al. 2021). Success development is very influenced by the role of transportation as a center of life, economy, social culture, security, and politics (Isradi et al. 2020) and (Setiawan et al. 2021). The development of highway infrastructure or toll roads in a country can be used as a benchmark to determine the extent of the economic progress of a country, both macro and micro (Rifai 2015). This study aims to determine the value of travel time, a description of the condition of the segment, and the impact of congestion after the operation of the Inner City Toll Road in the DKI Jakarta Region Section A Kelapa Gading – Pulo Gebang.

2. Research Methods
2.1. Research Location
a. The place chosen in this study is the Kelapa Gading - Pulo Gebang Inner City Toll Road segment. This location is a Project of the Construction of 6 Inner City Toll Roads in the DKI Jakarta area see Figure 1, namely Section A Development of the Kelapa Gading – Pulo Gebang Inner Toll Road along 9,287 km with the type of freeway, namely 3 lanes 2 divided directions (MW 6/2D)
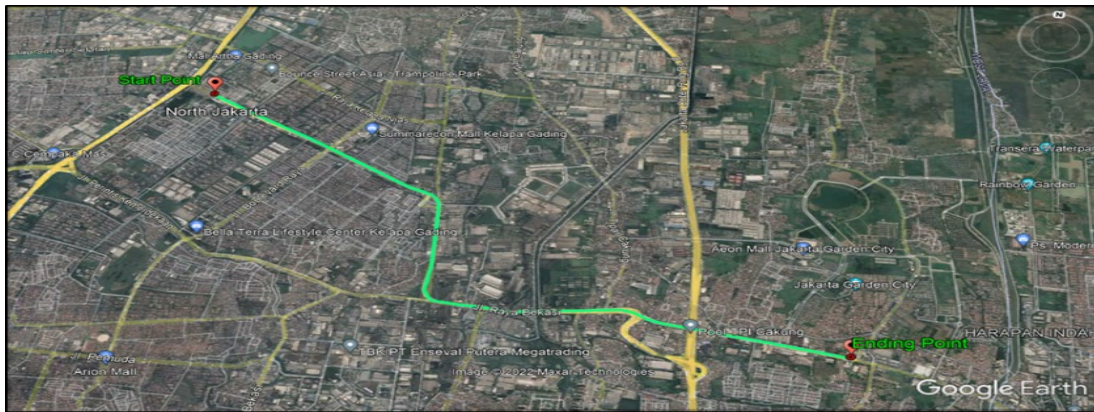

Figure 1. Map Freeway Location

b. The existing research site selected in this research is Jl. Boulevard Barat Raya 0.493 km long. The specified existing road see Figure 2 is a road point for which road widening has not been carried out so that it becomes the part that intersects with the ramp of the freeway segment.
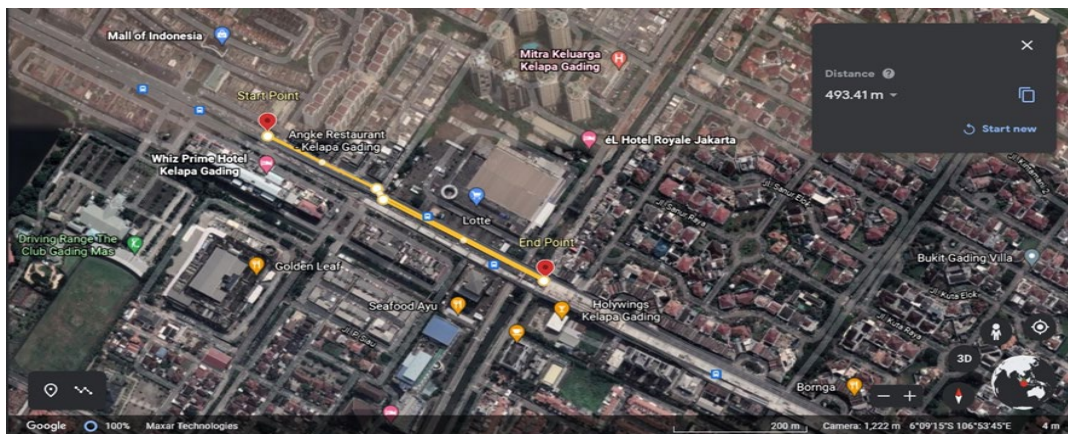

Figure 2. Map Existing Road Location

2.2.   Data Collection

Data collection is carried out after the preparation stage and is the first step in the process of implementing the evaluation and planning because at this stage a problem can be determined and various alternative sets to determine the solution to the problem to be taken (Dermawan et al. 2020). The data taken are primary data and secondary data which includes for this study, among others: vehicle volume, vehicle speed, road geometric, vehicle criteria, vehicle traffic data (Hartatik et al. 2020).

2.3.   Number of Samples

Determination of the number of observation samples on the Kelapa Gading – Pulo Gebang toll road section was carried out before the main survey. This was done on Tuesday, December 7, 2021, by calculating the number of vehicle population at the observation point from secondary data for toll road exit gates. The calculated vehicles include light vehicles, medium-heavy vehicles, and large trucks. After determining the number of vehicle populations, the number of samples in each interval (Prasetijo et al. 2020).

2.4.   Speed Survey Design

The local speed survey is a survey aimed at measuring the speed and travel time of passing vehicles at the observation point by using a speed measuring instrument (*Speed Gun*) and a time-measuring instrument (*Stopwatch*), in determining the local speed (Isradi et al. 2020). First, determine the location of the survey which is determined by dividing the segment by 3 (three) *links* see in Figure 3.
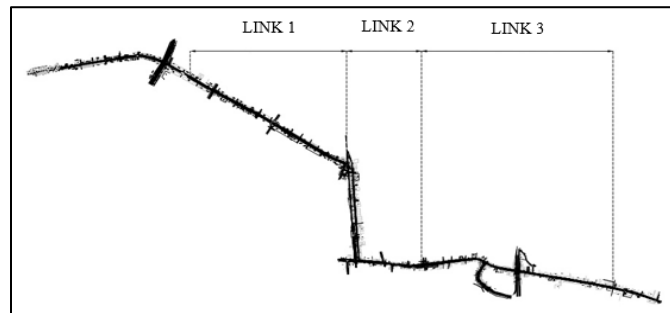

Figure 3. Local Speed Location Map

2.5.   Travel Time Analysis

In determining the travel time, calculations were made based on the 1997 MKJI and the speed choice analysis method (Bina Marga 1997). Travel time estimation methods can be estimated by direct surveys in the field and can also be obtained from travel time modeling (Brilon and Wu 2001). The speed choice analysis method uses an instantaneous model estimation based on spot speed data which has been processed into 2 (two) forms of variable speed, namely: time average speed (TMS) and space average speed (SMS) (Bina Marga 2009).

2.6.   Analysis After Toll Road Operates

In the post-operational analysis, the toll road operates by calculating the volume of traffic flow based on the afternoon rush hour, it is estimated that the volume of the existing road can be reduced by the volume of the toll road for the Kelapa Gading – Pulo Gebang direction so that the transition value of the volume of vehicles for each road segment is obtained, and evaluation of road performance which aims to determine the impact of congestion due to the construction of the toll road (Prasetijo et al. 2021).

2.7.   Speed Choice Analysis Method

Speed Choice Analysis method is a method or method to determine the value of vehicle travel time in calculating travel time (Bina Marga 1997). The analysis of the value of travel time with this speed calculation is based on the technicality of driving a vehicle at a certain speed to minimize the total cost of the trip. The speed choice analysis method after getting the local speed, then calculating the estimated trip using the instantaneous model with the following calculation formula:

$$t(i,k) = \frac{2\,l_{i,}}{v\,(i_a,k) + v\,(i_b,k)}$$

Where:

li	= *Link* length (km)
v, (ia, k)	= Speed upstream of *link* i at time k (km/h)
v, (ib, k)	= Speed downstream of *link* i at time k (km/h)
t(i,k)	= Travel time

3. Results and Analysis

3.1. Vehicle Traffic Volume

The volume of vehicle traffic on the toll road see Figure 4, the highest recapitulation was obtained on Tuesday for the direction of Kelapa Gading - Pulo Gebang so that the traffic data recapitulation was chosen in this study.
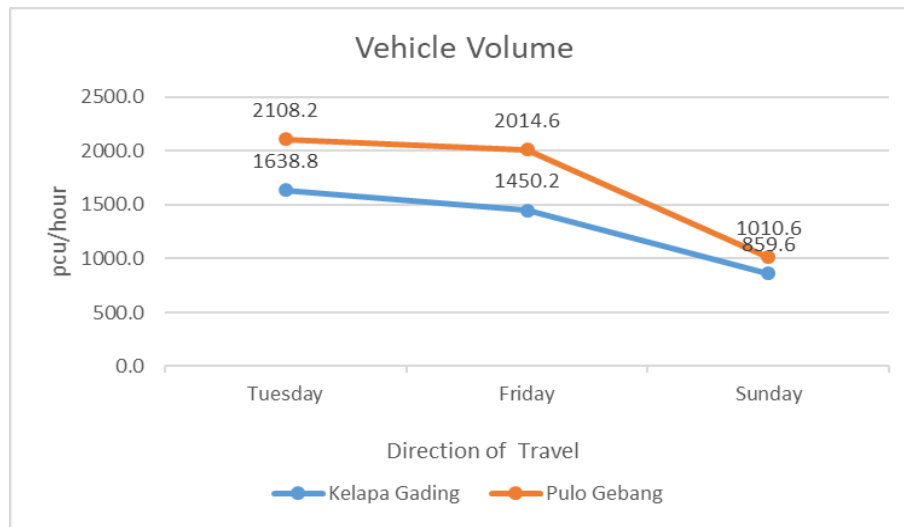

Figure 4. Vehicle Volume Data

Surveyor retrieval of vehicle traffic volume data based on traffic data at rush hour at the exit gate of the Kelapa Gading – Pulo Gebang toll road. Estimated traffic rush hour around 06:00-08:00, 11:00-13:00, 17:00-19:00. Secondary data collection of traffic during peak hours on toll roads for 3 days, namely on 7 December, 10 December, 12 December 2021 see Table 1.

Table 1. Pulo Gebang Direction Traffic Data Recapitulation

No.	Day	Light Vehicle	Medium Heavy Vehicle	Big Truck	Volume
		pcu/hour	pcu/hour	pcu/hour	pcu/hour
1	Tuesday	2077	25.2	6	2108.2
2	Friday	1973	33.6	8	2014.6
3	Sunday	980	12.6	18	1010.6
Total		5030	71.4	32	5133.4
Average		1676.7	23.8	10.7	1711.1

3.2. Number of Vehicle Samples

From the calculation of secondary data in the direction of Pulo Gebang, it is found that the number of vehicles passing at intervals of 2 hours during the afternoon rush hour conditions on December 7 see Table 2, 2021, namely LV = 1,519 pcu/hour, MHV = 12.6 pcu/hour, LT = 2 pcu/hour, and the total vehicle becomes 1,533.6 s m p/hour.

Tabel 2. Vehicle Population Calculation

Period	Time Interval	Light Vehicle (LV)	Medium Heavy Vehicle (MHV)	Big Truck (BT)	Total
		pcu/hour	pcu/hour	pcu/hour	pcu/hour
Afternoon Rush Hour	17:00 - 19:00	1519	12.6	2	1533.6
Proportion		99%	1%	0%	100.00%

So that the proportion of vehicles is LV = 99%, MHV = 1%, and LT = 0%. Then determine the minimum number of vehicle samples at each interval using the krejcie table. Based on the krejcie table, the number of vehicle samples that can be taken for observation is 310 vehicles. For sample calculations every 5 minutes for 2 (two) hours is 310/24 = 12.92 vehicles, then rounded up to 13 vehicles at every 5-minute interval.

3.3. Toll Road Section Performance

The toll road section in the city of Kelapa Gading - Pulo Gebang is a toll road that has a type of 6 lanes 2 divided directions (MW 6/2D) with a segment length of 9,287 km, for the calculation of vehicle volume using the total number of vehicles on Tuesday during peak hours. busy afternoon in each direction at 17:00 – 19:00.

3.3.1. Road Capacity

The calculation for road capacity is based on the manual (Bina Marga 1997a). According to the MKJI manual, the capacity of a road is the sum of the maximum traffic flows that can be maintained under a certain condition. The unit is pcu/hour.

$$C = Co \times FCw \times FCsp$$

Where have known the factors that relate to finding road capacity:
a. The type of road is 6 lanes 2 directions divided (MW 6/2D) Co = 2300 pcu/hour/lane so Co = 6900 pcu/hour total of 3 lanes
b. Adjustment factor due to traffic lane width, FCw = 0.960
c. Adjustment factor due to direction separation (divided freeway), FCsp = 1.0

The result is that the road capacity is C = (6900 x 0.960 x 1.0) so that the result is C = 6.624 pcu/hour.

3.3.2. Free Flow Speed

$$FV = FVo + FVw$$

Where it is known that the factors related to finding the free-flow velocity are:
a. The type of road is 6 lanes 2 divided directions (MW 6/2D) so that the basic free-flow speed with light vehicles (LV), FVo = LV (91 km/hour)
b. The adjustment factor due to the width of the traffic lane with the width of the flat lane (3.25 m) is the result, FVw = -1

The result of the basic free flow velocity is FV = 91 + (-1) so that the result is FV = 90 km/hour.

3.3.3. Other Vehicle Base Free Flow Speed

$$FV (MH, LB, LT) = FV (MHV, LB, LT)o + (FVw \times FV(MHV,LB,LT)o/Fvo$$

Where it is known that the factors related to finding the free flow velocity are:
a.   The road type is 6 lanes 2 divided directions (MW 6/2D) so that the basic free flow speed of other vehicles
b.   FVo = MHV (71 km/h), LB (93 km/h), LT (66 km/h)
c.   The adjustment factor due to the width of the traffic lane with a flat lane width (3.25 m) results in FVw = -1

The results obtained for the other basic free-flow speed of vehicles are:
a.   FV MHV   = 71 + (-1 x 71)/91 so the result is FV = 70.21 km/hour.
b.   FV LB   = 93 + (-1 x 93)/91 so the result is FV = 91.97 km/hour.
c.   FV LT   = 66 + (-1 x 66)/91 so the result is FV = 65.27 km/hour.

3.3.4. Degree of Saturation

$$DS = Q/C$$

The degree of saturation is obtained from the calculation of traffic flow divided by capacity. Where it is known that the traffic flow Q = 1533 pcu/hour in the direction of Pulo Gebang and Q = 292 pcu/hour in the direction of Kelapa Gading and the capacity of C = 6624 pcu/hour to obtain:
DS   = 1533/6624   = 0.231 for Pulo Gebang direction, and
DS   = 292/6624   = 0.044 for Kelapa Gading direction

3.3.5. Speed
Actual speed calculation obtained based on DS = Q/C. The obtained DS = 0.231 for the direction of Pulo Gebang and 0.044 for the direction of Kelapa Gading.
a.   Light Vehicle (LV) of 83.52 km/hour
b.   Medium Heavy Vehicle (MHV) of 65.16 km/hour
c.   Large Bus (LB) of 85.36 km//hour
d.   Large Truck (LT) of 60.58 km/hour

3.3.6. Travel time
Calculation of travel time according to the sample from the main survey, namely light vehicles (LV), Calculation of travel time based on MKJI, namely:

$$TT = L/V$$

The results obtained from the direction of Kelapa Gading to Pulo Gebang:
TT   = (9,287)/(83,52) x 60 = 6.7 minutes and

From Pulo Gebang to Kelapa Gading:
TT   = (9,287)/(88,80) x 60 = 6.3 minutes

3.3.7. Road Service Level
The level of service (Level of Service/LOS) states the level of traffic quality on the current road section. The level of service (Level Of Service/LOS) is based on the degree of saturation (DS) = 0.231 from the Kelapa Gading direction and (DS) = 0.044 from the Pulo Gebang direction. So that the Level Of Service is based on the standard LOS value according to MKJI:

a.   The direction of Kelapa Gading to Pulo Gebang with DS = 0.231 obtained the category "LOS B" The flow is stable, but the operating speed is starting to be limited by traffic conditions, the driver has enough freedom to choose the speed "

b.   The direction of Pulo Gebang towards Kelapa Gading with DS = 0.044 obtained the category "LOS A" with the characteristics of free flow conditions at high speed, the driver can choose the desired speed without

obstacles "

3.4. Travel Time Analysis

Travel time analysis using the speed choice analysis method is based on calculations with primary data from local speed (*spot speed*), so that from spot speed data, travel time can be calculated based on segment length or the number of links observed (Høyer 2000).

3.4.1 Time Average Speed Analysis (Ū TMS)

The calculation of the average vehicle time means speed (TMS) is the total speed at the time interval divided by the number of samples studied. To be able to analyze the average speed of time as follows:

$$\text{TMS} = \frac{\sum Speed}{total\ sample}$$

Examples of calculating *time mean speed* can be seen in Table 4.

Tabel 4. Calculation Example TMS

No.	Time Interval	Transportation type	TMS Upstream Link 1	TMS Upstream Link 2	TMS Upstream Link 3	TMS Downstream Link 3
1	17:00 - 17:05	LV	70.69	66.54	74.31	68
2	17:05 - 17:10	LV	78.46	78.38	75.62	64.77
3	17:10 - 17:15	LV	76.62	78.92	72.15	66.85
4	17:15 - 17:20	LV	77.85	78.31	74.92	65.15
5	17:20 - 17:25	LV	77.54	77.54	76.77	63

3.4.2 Space Average Speed Analysis (Ū SMS)

The average space speed is carried out for all *links* on the researched road segment. The calculation of the average *peace mean speed* (SMS) of vehicles is as follows:

$$\text{SMS} = \frac{1}{\frac{1}{n}\sum\frac{1}{U}}$$

Examples of calculating *peace mean speed* can be seen in Table 5.

Tabel 5. Example Calculation Table SMS

No.	Time Interval	Transportation type	SMS Upstream Link 1	SMS Upstream Link 2	SMS Upstream Link 3	SMS Downstream Link 3
1	17:00 - 17:05	LV	69.83	65.6	73.09	67.45
2	17:05 - 17:10	LV	77.5	76.67	74.07	63.67
3	17:10 - 17:15	LV	75.68	78.29	71.5	66.22
4	17:15 - 17:20	LV	76.88	76.47	73.45	63.97
5	17:20 - 17:25	LV	76.28	76.47	75.84	62.23

3.4.3 Travel Time Analysis with Instantaneous Model

Estimated travel time for vehicles on the Kelapa Gading - Pulo Gebang toll road segment on observations using the instantaneous model method based on spot speed *data* that has been processed into 2 (two) forms of variable speed, namely:

© IEOM Society International

1. Average speed time (TMS)
2. Space average speed (SMS)

The calculation of the estimated travel time of the vehicle is based on the calculation of the average time speed ($\bar{U}$ TMS) in the first 5-minute interval at 17:00 – 17:05 WIB as follows:
1. *Upstream Link 1*   = 70.69 km/hour
2. *Upstream Link 2*   = 66.54 km/hour
3. *Upstream Link 3*   = 74.31 km/hour
4. *Downstream Link 3* = 68.00 km/hour

The travel time of each *link* is calculated as the *link length* divided by the local average speed on the upstream and downstream *links* as follows:

$$t\,(\,i,k\,) = \frac{2\,l_{i,}}{v\,(i_a,k) + v\,(i_b,k)}$$

1. Travel time on *link* 1 = ((2 x 3)/(70.69+66.54)) x 60 = 2.62 minutes
2. Travel time on *link* 2 = ((2 x 3)/(66.54+74.31)) x 60 = 2.56 minutes
3. Travel time on *link* 3 = ((2 x 3)/(74.31+68.00)) x 60 = 2.53 minutes

Based on the calculation of the estimated travel time with variable speed, the average time to cross the road which is observed in the first 5-minute interval at 17:00 – 19:00 WIB from the *upstream link point* 1 to *downstream link* 3 is 2.62 + 2 .56 + 2.53 = 7.7 1 minute

The calculation of the estimated travel time of the vehicle is based on the calculation of the space average speed ($\bar{U}$ SMS) in the first 5 minutes interval at 17:00 – 17:05 WIB as follows:
1. *Upstream Link 1*   = 69.83 km/hour
2. *Upstream Link 2*   = 65.60 km/hour
3. *Upstream Link 3*   = 73.09 km/hour
4. *Downstream Link 3* = 67.45 km/hour

The travel time of each *link* is calculated as the *link length* divided by the local average speed on the upstream and downstream *links* as follows:
1. Travel time on *link* 1 = ((2 x 3)/(69.83+65.60)) x 60 = 2.66 minutes
2. Travel time on *link* 2 = ((2 x 3)/(65.60+73.09)) x 60 = 2.60 minutes
3. Travel time on *link* 3 = ((2 x 3)/(73.09+67.45)) x 60 = 2.5 6 minutes

Based on the results of the calculation of the estimated travel time with the variable speed of the average space to cross the road which is observed in the first 5 minutes interval at 17:00 – 19:00 WIB from the *upstream link point* 1 to *downstream link* 3 is 2.65 + 2 .58 + 2.56 = 7.82 minutes.

3.5. Traffic Impact Analysis After Toll Road Operations
3.5.1 Existing Road Vehicle Volume
The volume of vehicles on the existing road on Tuesday, 7 December 2021, at the peak hour in the afternoon, can be seen in Table 6, as follows:

Table 6. Recapitulation of Traffic Data for Kelapa Gading Mall

Period	Time Interval	Motorcycle (MC)	Light Vehicle (LV)	Heavy Vehicle (HV)	Volume
		pcu/hour	pcu/hour	pcu/hour	pcu/hour

Afternoon Rush Hour	17:00 - 18:00	219	1215	16	1450
	18:00 - 19:00	171	935	23	1129
Total		390	2150	37	2579
Average		195	1075	19	1289

The highest traffic flow was found in the direction of the Kelapa Gading mall on Tuesday, December 7, 2021, so the calculation was carried out based on the traffic flow at the peak of the afternoon in the direction of the Kelapa Gading Mall. In table 6, it can be seen that the average traffic volume towards Mall Kelapa Gading during the afternoon rush hour is MC = 195 pcu/hour, LV = 1075 pcu/hour, HV = 19 pcu/hour. So the total flow during the afternoon rush hour towards Mall Kelapa Gading Q = 1289 pcu/hour.

3.5.2 Road Capacity

The calculation for road capacity is based on the 1997 MKJI manual. According to the MKJI manual, the capacity of a road is the sum of the maximum traffic flows that can be maintained under certain conditions. The unit is pcu/hour. The formula for calculating road capacity is as follows:

$$C = Co \times FCw \times FCsp \times FCsf \times FCcs$$

Where have known the factors that relate to finding road capacity:
a. The type of road is 4 lanes 2 directions divided (MW 4/2D) Co = 1650 pcu/hour/lane so Co = 3300 pcu/hour total of 2 lanes
b . Adjustment factor due to traffic lane width , FCw = 0.92
c . Adjustment factor due to direction separation (divided urban roads) , FCsp = 1.0
d . Adjustment factor of side resistance with kereb, FCsf = 0.86
e . City size adjustment factor FCcs = 0.86
The result is that the road capacity is C = (3300 x 0.92 x 1.0 x 0.86 x 1.0) so that the result is C = 2.610 pcu/hour.

3.5.3 Degree of Saturation

The calculation of the degree of saturation based on the 1997 MKJI is as follows:

$$DS = Q/C$$

The degree of saturation is obtained from the calculation of traffic flow divided by capacity. Where it is known that the traffic flow Q = 1289 pcu/hour and the capacity C = 2610 pcu/hour so we get: DS = 1274/2610 = 0.49 for the direction of Kelapa Gading Mall

3.5.4 Road Service Level

The level of service (Level of Service / LOS) states the level of traffic quality on the current road section. The level of service (Level Of Service / LOS) is based on the degree of saturation (DS) = 0.49. So that the Level of Service is based on the standard LOS value according to MKJI: The direction of Kelapa Gading Mall with DS = 0.49 got the "LOS C" category with stable current characteristics, but the speed and motion of the vehicle are controlled, the driver is limited in choosing the speed "

3.5.5 Performance Analysis After Toll Road Operations

Estimated traffic volume based on the afternoon rush hour on Tuesday 7 December 2021, it is estimated that the volume of existing roads that can be reduced by the volume of the toll road for the Kelapa Gading – Pulo Gebang direction can be seen in Table 9 as follows:

Table 9. Percentage of Volume Change of Existing Road Vehicles

PERIOD	TIME INTERVAL	Traffic Flow			
		Pre Operation	Toll road	Post Operation	Percentage redirected (%)
		vehicle/hour	vehicle/hour	vehicle/hour	vehicle/hour
Afternoon Rush Hour	17:00 - 18:00	2103	818	1285	61.10%
	18:00 - 19:00	1639	710	929	56.68%
Total		3742	1528	2214	59.17%
Average		1871	764	1107	59.17%

After calculating the degree of saturation with the volume that has been changed according to the reduction in the volume of vehicles entering the toll road, the results can be seen in Table 10 and Table 11 as follows:

Table 10. Recapitulation of Vehicle Traffic Data in the direction of Kelapa Gading Mall after Toll Operations

PERIOD	TIME INTERVAL	MOTORCYCLE	LIGHT VEHICLE	HEAVY VEHICLE	VOLUME
		vehicle/hour	vehicle/hour	vehicle/hour	vehicle/hour
Afternoon Rush Hour	17:00 - 18:00	876	401	8	1285
	18:00 - 19:00	685	230	14	929
Total		1561	631	21	2214
Average		781	316	11	1107

Table 11. Recapitulation of Traffic Data for Middle School in the direction of Mall Kelapa Gading after Toll Operations

PERIOD	TIME INTERVAL	MOTORCYCLE	LIGHT VEHICLE	HEAVY VEHICLE	VOLUME
		pcu/hour	pcu/hour	pcu/hour	pcu/hour
Afternoon Rush Hour	17:00 - 18:00	219	401	8	628
	18:00 - 19:00	171	230	17	418
Total		390	631	25	1046
Average		195	316	13	523

The results of the analysis in table Q = 523 pcu/hour after access to the toll road section. So that road users who aim to Bekasi City can directly access the toll road without having to pass through the Kelapa Gading urban road. The results obtained degrees of saturation of:

DS = $\frac{523}{2610}$= 0.20 So the *Level Of Service* based on the standard LOS value according to MKJI: Mall Kelapa Gading direction with DS = 0.20 the category "LOS B" is obtained with stable flow characteristics, but the operating speed is starting to be limited by traffic conditions, the driver has enough freedom to choose the speed "

3.6. Road Performance Estimation

$$Pn = Po + (1 + i)^n$$

Where:
Po = Total volume of the original vehicle
i = growth rate (rate of interest)
n = Amount of time (in years)
Pn = Total volume of vehicles at the end of year n

The calculation of the estimated 5-year projected road performance uses a traffic growth rate that can be projected until 2035, namely (i) = 4.8% (KemenPUPR 2017). Estimated road performance estimates can be seen in Table 12.

Table 12. 5-Year Projected Traffic Flow Estimate

Segment	Direction	Capacity	Traffic Flow	Degree of Saturation	LOS
		pcu/hour	pcu/hour		
Freeway	Kelapa Gading - Pulo Gebang	6,624	1.533	0.23	**B**
Urban Street	Kelapa Gading - Pulo Gebang	2,610	1.049	0.40	**B**

4. Conclusion

1. Based on the results of this study, the travel time on the toll road towards Kelapa Gading using the MKJI method was 6.7 minutes and the direction of Pulo Gebang was 6.3 minutes, while using speed choice analysis it was 7.17 minutes based on the average speed of time. and 7.25 minutes based on space average velocity.
2. The capacity of inner-city toll roads based on the analysis results is obtained at 6,624 pcu/hour, with a vehicle volume of 1528 vehicles/hour based on the afternoon peak rush hour on December 7, 2021, and the level of service on toll roads is located in the LOS B category.
3. The impact after the operation of the Kelapa Gading - Pulo Gebang inner-city toll road section can reduce congestion on the existing road, namely Jalan Boulevard Barat Raya Kelapa Gading with a transition percentage of 61% to reduce traffic volume on existing roads and road service levels on existing roads. from category C to category B.

References

Bina Marga, *Manual Kapasitas Jalan Indonesia,* Kementrian Pekerjaan Umum dan Perumahan Rakyat, Jakarta,1997.
Bina Marga, *Standar Geometri Jalan Bebas Hambatan Untuk Jalan Tol*, Departemen Pekerjaan Umum Direktorat Jenderal Bina Marga*,* Jakarta, 2009.
BPS Kota Bekasi, *Badan Pusat Kota Bekasi*, Pemerentah Kota Bekasi, Bekasi, 2021
Brilon, W., and Ning W., Capacity at Unsignalized Ivtersections Derived by Conflict Tehnique, *Transportation Research Board*, vol. 1776, no. 1, pp. 82-90, 2001.
Dermawan, W. B., Isradi,M., and Pawaztris,P., Analysis Of Accident Prone Areas Along Jenderal Ahmad Yani Road In Bekasi, *Journal of Applied Science, Engineering, Technology, and Education,* vol. 1, no. 2, pp. 124–30, 2020.
Hadiwardoyo, S. P., *Jalan Dan Model Pengembangan Infrastruktur Transportasi*, Kuadran, Bandung, 2018.
Hartatik, N., Prasetijo, J., and Isradi, M., Characteristics of Traffic Accidents in Jalan Tol Surabaya-Porong, Jawa Timur, *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 1, no. 4, pp. 9-15, 2020.
Høyer, K. G., *Sustainable Mobility -the Concept and Its Implications*, Roskilde University, Denmark, 2020
Isradi, M., Dwiatmoko, H., Setiawan,M. I., and Supriyatno, D., Analysis of Capacity, Speed, and Degree of Saturation of Intersections and Roads, *Journal of Applied Science, Engineering, Technology, and Education,* vol. 2, no. 2,

pp. 150–64, 2020.

Isradi, M., Prasetijo, J., Hartatik, N., and Arifin, Z., Analysis of Urban Road Damage Assessment Using Surface Distress Index (SDI), Pavement Condition Index (PCI), and International Roughness Index (IRI) Methods, *RIGEO • Review of International Geographical Education*, vol. 11, no. 2, pp. 699–715, 2021

Isradi, M., Zaenal, A., and Sudrajat, A., Analysis of the Damage of Rigid Pavement Road by Using Pavement Condition Index (PCI), *Journal of Applied Science, Engineering, Technology, and Education,* vol. 1, no. 2, pp. 193–202, 2020.

Manganta, M., Halim, H., Angka, A., and Saing, Z., Traffic Accident Rate in Makassar City, *International Journal of Scientific & Technology Research, IJSTR,* vol. 8, no. 4, pp. 150–54, 2020.

Prasetijo, J., and Ahmad, H., Capacity Analysis of Unsignalized Intersection Under Mixed Traffic Conditions, *Procedia - Social and Behavioral Sciences,* vol. 43, no. 2, pp. 135–47, 2021.

Prasetijo, J., Mehdi, H. P., and Ghadiri, S. M. R, Capacity of Unsignalized Intersections under Mixed Traffic Conditions, *Procedia - Social and Behavioral Sciences 6ᵗʰ International Symposium on Highway Capacity and Quality of Service Stockholm,* pp. 676-685, Sweden June 28 – July 1, 2011.

Prasetijo, J., Zhang, G., Isradi, M., Zainal, Z. F., Musa, W. Z., and Setiawan, M. I., Accident Prediction Based on Integrated Design Consistency with the Lower Number of Vehicles/Traffic Volumes (Due to Health Disaster/COVID-19), *IJEBD (International Journal Of Entrepreneurship And Business Development),* vol. 3, no. 3, pp. 287–95, 2020.

Prasetijo, J., Zhang, G., Jawi, Z. M., Mahyeddin, M. E., Zaenal, Z. F., Isradi, M., and Muthukrisnan, N., Crash Model Based on Integrated Design Consistency with Low Traffic Volumes (Due to Health Disaster (COVID-19)/Movement Control Order), *Innovative Infrastructure Solutions,* vol. 6, no. 1, pp. 22-27, 2021.

Rifai, A. I., Implementasi Data Mining Untuk Mendukung Sistem Manajemen Perkerasan Jalan Di Indonesia, *Jurnal HPJI,* vol. 1, no. 2, pp. 93–104, 2015.

Rifai, A. I., Lista., Isradi, M., and Mufhidin, A., How Did the COVID-19 Pandemic Impact Passenger Choice toward Public Transport ? The Case of Jakarta , Indonesia, *Design Engineering,* vol.2 , no. 8, pp. 16–24, 2021.

Setiawan, M. I., Nasihien, R, D., Razi, M. A. M., Utomo, W. M., Isradi, M., and Sukoco, A, Bali Economic , Mobility , Transportation and Hotels to The End of 2021 Tren, *IJEBD (International Journal Of Entrepreneurship And Business Development),* vol. 4, no. 5, pp. 82–86, 2021.

Biography

Widodo Budi Dermawan , born on 2 July 1970. Parahyangan Catholic University 1994, Fuel Filling System at Soekarno Hatta Airport, MSCE, 1996 University of Wisconsin at Madison. Track-based multi-class dynamic traffic assignment model, road safety interest research, accident prediction model, intelligent transportation systems, teaching at UMB; Transportation Engineering, Geometric design.

Arief Cahya Purnomo, born in Cirebon, 15 November 1997. He will achieve a Bachelor's degree in Civil Engineering at Mercu Buana University in 2022.

Muhammad Isradi., born in Kandangan on 18 August 1972. He is the secretary of the Civil Engineering department at Mercu Buana University. He earned a degree in Civil Engineering from Universitas Muhammadiyah Malang in 1998 with the thesis entitled "One Way Flat Plate Planning at Queen Plaza Madison. Hey then obtained a Master's degree in Civil Engineering, Transportation Concentration from Brawijaya University in 2001 with a thesis entitled "Family Movement Awakening Model in Sawojajar Housing Area, Malang". He also teaches several subjects such as Pavement Planning, Geometric Road Planning, Transportation Planning, and Environmental Engineering.

Amar Mufhidin., born in Majalengka, 16 June 1991. He is a lecturer in several study programs: pavement planning, road geometric planning, and transportation planning. He gained a degree in Civil Engineering from Universitas Pendidikan Indonesia and a Masters in Civil Engineering with a concentration in the field of transportation from Institut Teknologi Bandung. He has a pavement expertise certificate from Indonesia's Construction Services Regulatory Agency. He is also still active in road planning projects in Indonesia.

Dr.-Ing. Joewono Prasetjo., born in Pontianak, 18 October 1969. He graduated with an Engineer degree in Civil Engineering at Tanjungpura University, Pontianak, Indonesia in 1993. He then obtained a Master of Science degree

in Road and Transportation Engineering from the Delft University of Technology, the Netherlands in 1996. He obtained his Doctor Ingenieur degree from Ruhr-Universität Bochum, Germany in 1996. Now, he is Head of the Department of Railway Transportation Engineering Technology, Faculty of Engineering technology, Tun Hussein Onn University Malaysia.