# Feasibility Analysis for Kunciran – Cengkareng Toll Road from Economic and Financial Aspects

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ABSTRACT

The development of existing infrastructure influences the region's economic growth. A concrete example that has become a priority for the government to develop the economy is toll road infrastructure, one of the problem solutions of transportation, logistics distribution, and the mobility of goods and services. Toll roads can also be a solution to the congestion problem as the volume of vehicles grows each year. Thus, Kunciran – Cengkareng Toll Road was built to be a solution to economic issues and congestion in the study area environment. For the planning of Kunciran – Cengkareng Toll Road to be efficient and feasible for investment, it is necessary to analyze the feasibility of Kunciran – Cengkareng Toll Road from an economic and financial perspective. The data used to analyze the feasibility of Kunciran – Cengkareng Toll Road were geometry data and existing road traffic data. The data were obtained from the Tangerang City Transportation Agency and the Google Earth assistance program. In addition, toll road plan geometry data was obtained from PT. Jasamarga Kunciran Cengkareng. The data was used to analyze road performance before and after the existence of the toll road and analyze Vehicle Operating Cost (VOC) savings and time value. In addition, to analyze trip assignments to determine the percentage of the trip that move from the existing road to the toll road and analyze the feasibility of Kunciran – Cengkareng Toll Road from an economic and financial aspect. This study used the Smock, Davidson, and diversion curve methods to analyze trip assignments, but in the end, the results from the Davidson and Smock methods were used. This study used Benefit Cost Ratio (BCR) and Net Present Value (NPV) parameters to analyze the feasibility of the economic aspect. While from the financial aspect, this study used the Benefit Cost Ratio (BCR), Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP) parameters. The results of the economic feasibility analysis due to existing urban roads, it was obtained a BCR value of 1.391 (BCR>1) and an NPV of IDR 2.465.996.456.295 (NPV> 0), while a result of existing toll roads obtained a BCR value of 1.285 (BCR> 1) and an NPV of IDR 1. 763.186.348.857 (NPV>0). Therefore, it can be concluded that Kunciran – Cengkareng Toll Road was economically and financially feasible.

## INTRODUCTION

The development of a city and region is determined by four main aspects, namely economic, socio-cultural, physical, and environmental aspects [1]. Infrastructure is an example of the influence of concrete economic aspects in a region and is directly proportional to the good and bad of the region's economic growth. An example of infrastructure development is also a government priority in producing freeway infrastructure, namely toll roads. Toll roads are one of the infrastructure solutions for transportation flexibility.

Kunciran – Cengkareng Toll Road has a strategic function, namely connecting transportation in Greater Jakarta (*Jabodetabek*) and helping to balance traffic density as the volume of vehicles grows, especially traffic density towards Soekarno - Hatta International Airport. Nowadays, access to the airport can only use the existing urban road in Tangerang City and the only airport toll road, namely Prof. Sedyatmo Airport Toll Road, where the existing road is relatively congested due to the increasing vehicle volume. Kunciran – Cengkareng Toll Road is also one of the projects included in the Jakarta Outer Ring Road II (JORR II) Toll Road series, in which the toll road connects Tanjung Priok Port which is very influential in helping logistics distribution.

To see the differences in existing conditions (before the toll road) and after the toll road was built, it is necessary to conduct a study, including determining the percentage of vehicle movement from the existing road

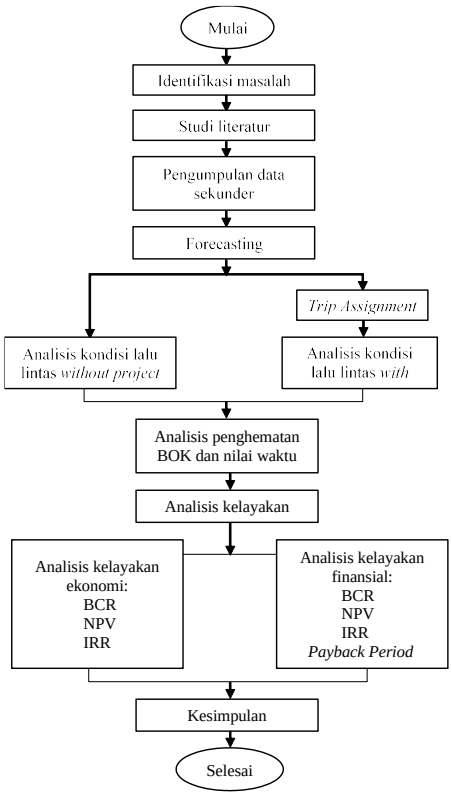


Figure 1. Feasibility Analysis Flowchart

Operating Costs (VOC) and time value are obtained with the existence of Kunciran – Cengkareng Toll Road. Therefore, the feasibility of Kunciran – Cengkareng toll road will be known in terms of economic and financial analysis.

## METHODOLOGY

Secara garis besar, tahapan kegiatan yang dilakukan Boardly, the stages of activities carried out to analyze the feasibility of Kunciran – Cengkareng Toll Road from the economic and financial aspects began with identifying the problems and was followed by collecting secondary data. Furthermore, it continued with analyzing road performance without projects, trip assignments, road performance with projects, and calculating VOC savings and time value. The last was to analyze the feasibility of economic and financial aspects with predetermined parameters. These stages are contained in the flow chart in Figure 1.

## DATA ANALYSIS AND RESULTS

### *A. Road Geometry Data Analysis*

Road geometry data used was geometry data. The existing urban roads in Tangerang City, namely M.H. Thamrin Street, Jendral Sudirman Street, Daan Mogot Street, DR. Sitanala Street, Marshal Suryadarma Street, and South Perimeter Street. As well as the existing toll roads, namely Jakarta - Tangerang Toll Road, the Jakarta Outer Ring Road, and Prof. Sedyatmo Airport Toll Road. Then, the geometric data of Kunciran – Cengkareng Toll Road as a planned toll road. The existing urban road geometry data was obtained from the Tangerang City

Table 1. The capacity of Existing Roads and Kunciran – Cengkareng Toll Road

| Road Section | $C_0$ (lvu/hour/lane) | $FC_{LW}$ | $FC_{DS}$ | $FC_O$ | $FC_{CS}$ | C (lvu/hour) Per lane |
|---|---|---|---|---|---|---|
| M.H Thamrin | 3.300 | 0.92 | 1 | 0.94 | 1 | 11.367 |
| Jendral Sudirman | 2.475 | 1 | 1 | 0.94 | 1 | 6.950 |
| Daan Mogot | 2.475 | 1 | 1 | 0.95 | 1 | 7.069 |
| DR. Sitanala | 2.900 | 0.87 | 1 | 0.82 | 1 | 4.138 |
| Marsekal Suryadarma | 2.900 | 1 | 1 | 0.89 | 1 | 5.162 |
| Perimeter | 2.400 | 0.87 | 1 | 0.94 | 1 | 4.743 |
| Jakarta – Tangerang Toll | 2.300 | 1 | - | - | - | 9.200 |
| Jakarta Outer Ring Road | 2.300 | 0.96 | - | - | - | 6.624 |
| Prof. Sedyatmo Toll | 2.300 | 0.96 | - | - | - | 6.624 |
| Kunciran – Cengkareng Toll | 2.300 | 1.012 | - | - | - | 6.982 |

to the toll road. Furthermore, , large savings in Vehicle Transportation Agency and the Google Earth assistance program. In contrast, the data for the Kunciran – Cengkareng Toll Road plan were obtained from PT. Jasamarga Kunciran Cengkareng. Geometry data for existing urban roads and Kunciran – Cengkareng Toll Road can be seen as follows:

1. M.H. Thamrin Street
   a. Road length : 3.1 km
   b. Road type : 8/2T
   c. Side resistance class : High
   d. Road width : 18 m
   e. Lane width : 3 m
   f. Roadside width : 1 m
2. Jendral Sudirman
   a. Road length : 3.7 km
   b. Road type : 6/2T
   c. Side resistance class : Moderate
   d. Road width : 21 m
   e. Lane width : 3.5 m
   f. Roadside width : 0.5 m
3. Daan Mogot Street
   a. Road length : 7.5 km
   b. Road type : 6/2T
   c. Side resistance class : Low
   d. Road width : 14 m
   e. Lane width : 3.5 m
   f. Roadside width : 1 m
4. DR. Sitanala Street
   a. Road length : 0.9 km
   b. Road type : 2/2TT
   c. Side resistance class : High
   d. Road width : 6 m
   e. Lane width : 3 m
   f. Roadside width : 0.5 m
5. Marsekal Suryadarma Street
   a. Road length : 5.8 k
   b. Road type : 2/2TT

Table 2. Degree of Saturation of Kunciran – Cengkareng Road in 2021

| Road Section | Direction | Q (lvu/hour) | C (lvu/hour) | Ds |
|---|---|---|---|---|
| M.H. Thamrin | Cengkareng | 6.470 | 11.367 | 0.57 |
| | Kunciran | 7.421 | | 0.66 |
| Jendral Sudirman | Cengkareng | 3.105 | 6.950 | 0.45 |
| | Kunciran | 3.068 | | 0.45 |
| Daan Mogot | Cengkareng | 3.483 | 7.069 | 0.50 |
| | Kunciran | 3.512 | | 0.50 |
| DR. Sitanala | Cengkareng | 2.374 | 4.138 | 0.58 |
| | Kunciran | 1.445 | | 0.35 |
| Marsekal Suryadarma | Cengkareng | 2.366 | 5.162 | 0.46 |
| | Kunciran | 1.445 | | 0.28 |
| South Perimeter | Cengkareng | 1.768 | 4.743 | 0.38 |
| | Kunciran | 1.294 | | 0.28 |
| Jakarta – Tangerang Toll | Cengkareng | 6.668 | 9.200 | 0.73 |
| | Kunciran | 7.053 | | 0.77 |
| Jakarta Outer Ring Road | Cengkareng | 4.713 | 6.624 | 0.72 |
| | Kunciran | 3.683 | | 0.56 |
| Prof Sedyatmo Airport Toll | Cengkareng | 4.596 | 6.624 | 0.70 |
| | Kunciran | 4.786 | | 0.73 |

Table 3. Free Flow Speed of Vehicles on Existing Roads and Kunciran – Cengkareng Toll Road

| Road Section | Free Flow Speed (km/hour) | | | |
|---|---|---|---|---|
| | SM | KR | KB | |
| M.H. Thamrin | 41.54 | 53.81 | 45.31 | |
| Jendral Sudirman | 45.70 | 58.07 | 49.50 | |
| Daan Mogot | 48.00 | 61.00 | 52.00 | |
| DR. Sitanala | 30.34 | 33.62 | 30.34 | |
| Marsekal Suryadarma | 36.00 | 39.60 | 36.00 | |
| South Perimeter | 37.00 | 41.00 | 37.00 | |
| | KR | KS | BB | TB |
| Jakarta – Tangerang Toll | 91.00 | 71.00 | 93.00 | 66.00 |
| Jakarta Outer Ring Road | 90.00 | 70.00 | 92.00 | 65.00 |
| Prof. Sedyarmo Airport Toll | 90.00 | 70.00 | 92.00 | 65.00 |
| Kunciran – Cengkareng Toll | 91.80 | 71.62 | 93.82 | 66.58 |

c. Side resistance class : Moderate
d. Road width : 7 m
e. Lane width : 3.5 m
f. Roadside width : 0.5 m

6. South Perimeter Street
a. Road length : 9.7 km
b. Road type : 2/2TT
c. Side resistance class : Very Low
d. Road width : 6 m
e. Lane width : 3 m
f. Roadside width : 0.5

7. Jakarta – Tangerang Toll Road
a. Road length : 7 km
b. Road type : 8/2T
c. Road width : 19.5 m
d. Lane width : 3.5 m
e. Roadside width : 2 meters

8. *Jakarta Outer Ring Road*
a. Road length : 7.5 km
b. Road type : 6/2T
c. Road width : 19.5 m
d. Lane width : 3.25 m
e. Roadside width : 2 m

9. Prof. Sedyatmo Airport Toll Road
a. Road length : 8.5 km
b. Road type : 6/2T
c. Road width : 19.5 m
d. Lane width : 3.25 m
e. Roadside width : 2 m

10. Kunciran – Cengkareng Toll Road
a. Road length : 14.19 km
b. Plan speed : 100 km/hour
c. Total project costs : I5.009.664.000
d. Lane width : 3.60 meters
e. Roadside width : 3.00 meters
f. Inside side width : 1.5 meters

*B. Traffic Data Analysis*

The traffic data used was secondary data obtained from the Tangerang City Transportation Agency in the form of real traffic counting data for vehicles crossing Urban Roads in Tangerang City. These roads were M.H. Thamrin Street, Jendral Sudirman Street, Daan Mogot Street, DR. Sitanala Street, Marshal Suryadarma Street, and South Perimeter Street from both directions were recorded every 15 minutes for 12 hours. In addition, there

Table 4. Trip Assignment Results Using Smock Method

| Origin | Destination | Direction | Not Moving | Moving |
|---|---|---|---|---|
| Jakarta – Tangerang Toll | Kunciran – Cengkareng Section I Toll Road | Cengkareng | 50.00% | 50.00% |
| | | Kunciran | 50.00% | 50.00% |
| Jakarta – Tangerang Toll, Jakarta Outer Ring Road | Kunciran – Cengkareng Section II Toll Road | Cengkareng | 50.00% | 50.00% |
| | | Kunciran | 50.00% | 50.00% |
| Jakarta Outer Ring Road | Kunciran – Cengkareng Section III Toll Road | Cengkareng | 50.00% | 50.00% |
| | | Kunciran | 40.00% | 60.00% |
| Prof. Sedyatmo Airport Toll | Kunciran – Cengkareng Section IV Toll Road | Cengkareng | 50.00% | 50.00% |
| | | Kunciran | 50.00% | 50.00% |

Table 5. Trip Assignment Results Using Davidson Method

| Origin | Destination | Direction | Not Moving | Moving |
|---|---|---|---|---|
| M.H. Thamrin | Kunciran – Cengkareng Section I Toll Road | Cengkareng | 29.10% | 70.90% |
| | | Kunciran | 38.66% | 61.34% |
| Jendral Sudirman | Kunciran – Cengkareng Section II Toll Road | Cengkareng | 29.23% | 70.77% |
| | | Kunciran | 25.37% | 74.63% |
| Daan Mogot, DR. Sitanala | Kunciran – Cengkareng Section III Toll Road | Cengkareng | 50.48% | 49.52% |
| | | Kunciran | 54.58% | 45.42% |
| Marsekal Suryadarma, South Perimeter | Kunciran – Cengkareng Section IV Toll Road | Cengkareng | 39.21% | 60.79% |
| | | Kunciran | 33.85% | 66.15% |

Table 6. Degree of Saturation of Existing Roads and Kunciran – Cengkareng Toll Road in 2021

| Road Section | Direction | Q (lvu/hour) | C (lvu/hour) | Ds |
|---|---|---|---|---|
| M.H. Thamrin | Cengkareng | 6.470 | 11.367 | 0.29 |
| | Kunciran | 7.421 | | 0.41 |
| Jendral Sudirman | Cengkareng | 3.105 | 6.950 | 0.22 |
| | Kunciran | 3.068 | | 0.20 |
| Daan Mogot | Cengkareng | 3.483 | 7.069 | 0.40 |
| | Kunciran | 3.512 | | 0.41 |
| DR. Sitanala | Cengkareng | 2.374 | 4.138 | 0.39 |
| | Kunciran | 1.445 | | 0.25 |
| Marsekal Suryadarma | Cengkareng | 2.366 | 5.162 | 0.28 |
| | Kunciran | 1.445 | | 0.16 |
| South Perimeter | Cengkareng | 1.768 | 4.743 | 0.26 |
| | Kunciran | 1.294 | | 0.15 |
| Jakarta – Tangerang Toll | Cengkareng | 6.668 | 9.200 | 0.37 |
| | Kunciran | 7.053 | | 0.39 |
| Jakarta Outer Ring Road | Cengkareng | 4.713 | 6.624 | 0.36 |
| | Kunciran | 3.683 | | 0.25 |
| Prof Sedyatmo Airport Toll | Cengkareng | 4.596 | 6.624 | 0.35 |
| | Kunciran | 4.786 | | 0.37 |
| Kunciran – Cengkareng Section I Toll | Cengkareng | 3.275 / 2.223 | 6.982 | 0.47 / 0.32 |
| | Kunciran | 2.828 / 2.351 | | 0.41 / 0.34 |
| Kunciran – Cengkareng Section II Toll | Cengkareng | 1.577 / 1.897 | 6.982 | 0.23 / 0.28 |
| | Kunciran | 1.728 / 1.789 | | 0.25 / 0.26 |
| Kunciran – Cengkareng Section III Toll | Cengkareng | 1.458 / 1.571 | 6.982 | 0.21 / 0.23 |
| | Kunciran | 1.046 / 1.473 | | 0.15 / 0.22 |
| Kunciran – Cengkareng Section IV Toll | Cengkareng | 1.535 / 2.298 | 6.982 | 0.22 / 0.33 |
| | Kunciran | 1.210 / 2.393 | | 0.18 / 0.35 |

were also existing toll roads, namely Jakarta - Tangerang Toll Road, Jakarta Outer Ring Road, and Prof. Sedyatmo Airport Toll Road, with the same real traffic counting data. From these data, it could be searched for traffic flow during peak hours. Traffic flow during peak hours was converted into light vehicle units by multiplying with LVE (Light Vehicle Equivalence) value and used to analyze road performance.

### *C. GRDP Data Analysis and Total Population*

Traffic growth in subsequent years was calculated using the population growth rate, GRDP at constant prices, and GRDP per capita of Tangerang City as its growth rate factor.

Population growth was assumed to be equivalent to the growth of public transport vehicles and buses. GRDP, according to the business field on the basis of constant prices, was assumed to be equivalent to the growth of freight vehicles and trucks. In contrast, GRDP per capita at constant prices was assumed to be equivalent to the growth of passenger vehicles.

### *D. Road Performance Analysis without Projects*

The road performance analyzed was road section capacity, degree of saturation, free flow speed, travel speed, and travel time.

Road section capacity is the maximum flow that can be maintained per unit hour that passes through a road segment under existing conditions [2]. Roads capacity under review was assumed to be constant, and there was no change in geometry during the plan age. Equation (1) is a formula for calculating road capacity on Tangerang City Urban Road and Kunciran – Cengkareng Toll Road.

$$C = C_0 * FC_{LW} * FC_{DS} * FC_O * FC_{CS} \quad (1)$$

Where:

C = Road capacity (lvu/hour)
$C_0$ = Basic capacity (lvu/hour)
$FC_{LW}$ = Adjustment factor due to traffic lane width
$FC_{DS}$ = Adjustment factor due to directional separator
$FC_O$ = Adjustment factor due to obstacles
$FC_{CS}$ = Adjustment factor due to city size

Table 7. Revenue from Kunciran - Cengkareng Toll Road in 2021

| Toll Road | Toll Tarrif Revenue |
|---|---|
| Section 1 (Due to Existing Urban) | IDR66.527.297.231 |
| Section 2 (Due to Existing Urban) | IDR60.012.740.736 |
| Section 3 (Due to Existing Urban) | IDR87.208.835.665 |
| Section 4 (Due to Existing Urban) | IDR29.538.331.357 |
| Section 1 (Due to Existing Toll) | IDR47.103.175.680 |
| Section 2 (Due to Existing Toll) | IDR66.114.761.812 |
| Section 3 (Due to Existing Toll) | IDR103.429.574.182 |
| Section 4 (Due to Existing Toll) | IDR49.777.342.150 |

Calculation results of the capacity of the existing road and Kunciran – Cengkareng Toll Road are in Table 1.

After knowing the capacity, the degree of road section saturation can be calculated. The degree of saturation will indicate whether the road has a capacity problem or not.

Equation (2) is the formula for calculating the Degree of Saturation (DS).

$$Ds = {}^{Q}/_{C} \quad (2)$$

Where:
Ds = Degree of Saturation
Q = Traffic Flow (lvu/hour)
C = Road capacity (lvu/hour)

The results of the degree of saturation calculation of the existing road prior to Kunciran – Cengkareng Toll Road are in Table 2.

In addition to the degree of saturation, it also required analysis of the free flow velocity in conditions before the project (without project). Free flow speed is the vehicle speed that is unaffected by the presence of other vehicles [2]. Equation (3) is a formula for calculating the free flow speed of LV (Light Vehicle) on Urban Roads.

$$V_B = (V_{BD} + V_{BL}) * FV_{BHS} * FV_{BUK} \quad (3)$$

Where:
$V_B$ = LV free flow speed of field conditions (km/h)
$V_{BD}$ = LV basic free flow speed (km/h)
$FV_{BL}$ = Adjustment factor due to road width (km/hour)
$FV_{BHS}$ = Speed adjustment factor for side obstacle conditions
$FV_{BUK}$ = Speed adjustment factor for city size

To calculate the free flow speed of LV-type vehicles on Kunciran – Cengkareng Toll Road, equation (4) is used.

$$V_B = V_{BD} + V_{BL}. \quad (4)$$

Where:
$V_B$ = LV free flow speed of field conditions (km/h)
$V_{BD}$ = Basic free flow speed of LV on observed road and alignment (km/h)
$V_{BL}$ = Adjustment factor due to road width (km/h)

For other types of vehicles besides LV, the free flow speed on Kunciran – Cengkareng Toll Road is calculated using equation (5).

$$V_{B,KS} = V_{BD,KS} + V_{BL} * {}^{V_{BD,KS}}/_{V_{BD}} \quad (5)$$

Where:
$V_{BD}$ = LV basic free flow speed (km/h)
$V_{BD, KS}$ =Basic free flow speed MV (Medium Vehicle) (km/h)
$V_{B, KS}$ =Basic free flow speed MV (Medium Vehicle) (km/h)

Calculation results of the free flow speed for each class of vehicles on the existing road and Kunciran – Cengkareng Toll Road are in Table 3.

After obtaining the free flow speed for each class of vehicles on all road sections, the vehicle travel speed could be analyzed using the relationship graph between free flow speed and degree of saturation (DS) contained in the Indonesian Road Capacity Guidelines (IRCG) 2014. Then, the travel speed of each vehicle class can be calculated with equation (6).

$$T_T = {}^{L}/_{V_T} \quad (6)$$

Where:
$T_T$ = Travel time (hour)
L = Road length (km)
$V_T$ = Vehicle travel speed (km/h)

*E. Trip Assignment Analysis*

Trip assignment analysis was carried out to determine the vehicle movement percentage from the existing road to Kunciran - Cengkareng Toll Road when the toll road was already in operation, namely in 2021.

Davidson This study calculated trip assignments using the Smock, Davidson, and diversion curve methods. However, the Davidson method was chosen for the trip assignment of existing urban roads to planned toll roads and Smock for the trip assignment of existing toll roads to planned toll roads due to consideration of the most suitable results. Trip assignment calculation step using the Smock and Davidson Method can be seen as follows:

a. *Smock Method*
   1. Determine the maximum vehicle volume in lvu/hour units.
   2. Determine the length of the existing road and Kunciran – Cengkareng Toll Road.
   3. Determine the average speed of the free flow of vehicles on the existing road and Kunciran – Cengkareng Toll Road.
   4. Determine the capacity of the existing road section and Kunciran – Cengkareng Toll Road.
   5. Determine the amount of travel time in minutes.

For existing travel time, travel time was calculated by dividing the road length by the average travel speed and converting it into minutes. Meanwhile, the travel time on Kunciran – Cengkareng Toll Road was calculated in the same way, but there was an addition due to the toll fee by dividing the amount of the toll fee for each class of vehicle by the amount of time value. Furthermore, it was averaged.

6. Determine the incremental volume, by dividing the maximum vehicle volume (without motorbikes) divided by the number of iterations.
7. Comparing the amount of travel time for each iteration between the existing road and Kunciran – Cengkareng Toll Road.

The results of trip assignment using Smock Method can be seen in Table 4.

b. *Davidson Method*

1. Determine the maximum vehicle volume in lvu/hour units.
2. Determine the incremental volume, by dividing the maximum vehicle volume (without motorbikes) divided by the number of iterations.
3. Determine the capacity of the existing road section and Kunciran – Cengkareng Toll Road.
4. Determine the length of the existing road and Kunciran – Cengkareng Toll Road.
5. Determine the coefficient a for the existing road and Kunciran – Cengkareng Toll Road.
6. Determine the average free flow speed of vehicles on the existing road and Kunciran – Cengkareng Toll Road.
7. Determine the amount of travel time in minutes.
8. Determine the amount of t0 (1/speed in mile/minute) for the 0th iteration.
9. Enter the volume of motorbikes on the existing road in the first iteration
10. Comparing the amount of travel time for each iteration between the existing road and Kunciran – Cengkareng Toll Road.
11. The results of trip assignment using Davidson Method can be seen in Table 5.

*F. Road Performance Analysis with Project*

From the trip assignment results, it can be calculated the number of vehicles that remain on the existing road and move to Kunciran – Cengkareng Toll Road.

The percentages in Table 4 and Table 5 were used to obtain the number of vehicles that remain on the existing road or move to the toll road for each section. Besides, the degree of saturation (Ds) of the existing road and Kunciran – Cengkareng Toll Road, travel speed, and vehicle travel time in with project conditions could be calculated.

The degree of saturation (Ds) on the existing road and Kunciran – Cengkareng Toll Road in 2021 is shown in Table 6.

*G. Road Performance Analysis with Project*

Vehicle operating costs are the total costs required to operate a vehicle under certain traffic and road conditions for one type of vehicle per kilometer of distance traveled, in units of rupiah per kilometer [3]. In this study, the BOK calculation used the Jasa Marga method.

The following is an assumption on the types and prices of vehicle components for each class used in the study.

a. Class I (passenger car, microbus, and big bus)
   a) Vehicle type : Grand new Avanza type 1/3G M/T
      1). Vehicle price : IDR 218.000.000
      2). Fluel : IDR 7.650/liter (Pertalite)
      3). Engine oil : IDR 88.000/liter (TOP1 HP Plus)
      4). Tire type : Bridgestone
      5). Tire price : Rp 616.165
      6). Maintenance cost : IDR 15.000/hour
   b) Vehicle type : Izuzu ELF NLR 55B
      1). Vehicle price : IDR 453.700.000
      2). Fluel : IDR 9.300/liter (biodiesel)
      3). Engine oil : IDR 50.000/liter (cartago)
      4). Tire type : Bridgestone
      5). Tire price : IDR 975.000
      6). Maintenance cost : IDR 15.000/hour
   c) Vehicle type : Hino bus A215
      1). Vehicle price : IDR 654.750.000
      2). Fluel : IDR 9.300/liter (biodiesel)
      3). Engine oil : IDR 50.000/liter (cartago)
      4). Tire type : Bridgestone
      5). Tire price : IDR 2.250.000
      6). Maintenance cost : IDR 15.000/hour
b. Class II (2-axle truck)
   Vehicle type : Hino dutro 130HD
   1). Vehicle price : IDR 268.900.000
   2). Fluel : IDR 9.300/liter (biodiesel)
   3). Engine oil : IDR 50.000/liter (cartago)
   4). Tire type : Bridgestone
   5). Tire price : IDR 1.375.000
   6). Maintenance cost : IDR 15.000/hour
c. Class III (3-axle truck)
   Vehicle type : Hino FL235JW
   1). Vehicle price : IDR 702.000.000
   2). Fluel : IDR 9.300/liter (biodiesel)
   3). Engine oil : IDR 50.000 (cartago)
   4). Tire type : Bridgestone
   5). Tire price : IDR 2.925.000
   6). Maintenance cost : IDR 15.000/hour
d. Class IV (4-axle truck)
   Vehicle type : Hino SG 285J ABS
   1). Vehicle price : Rp 715.000.000
   2). Fuel : IDR 9.300/liter (biodiesel)
   3). Engine oil : IDR 50.000/liter (cartago)
   4). Tire type : Bridgestone
   5). Tire price : IDR 2.925.000
   6). Maintenance cost : IDR 15.000/hour
e. Class V (5-axle truck)
   Vehicle type : Hino FM 265 T/H
   1). Vehicle price : IDR 917.000.000
   2). Fuel : IDR 9.300/liter (biodiesel)
   3). Engine oil : IDR 50.000/liter (cartago)
   4). Tire type : Bridgestone
   5). Tire price : IDR 5.868.000
   6). Maintenance cost : IDR 15.000/hour

VOC per year can be calculated by VOC for each class of vehicles in one year multiplied by the road length and the volume of each class of vehicles in one year. VOC per year for each class of vehicle when added up will get the total VOC in a year.

*H. Time Value Analysis*

Time value is the amount of money prepared by a person to spend (or save) to save one unit of travel time [4]. This study analyzed the time value using the Jasa Marga Method as contained in equation (7).

$$Time\ Value = Max\{(K * Basic\ time\ value); Minimum\ time\ value\} \quad (7)$$

With this equation, the time value results in this study in 2019 can be seen as follows:

a. Class I = IDR 36.854,79/hour/vehicle
b. Class IIa = IDR 55.595,45/hour/vehicle
c. Class IIb = IDR 41.295,79/hour/vehicle

Time value increased every year due to inflation. Therefore, to determine the time value in 2021 and the following years, equation (8) was used with an inflation rate of 2.73% obtained from the average inflation in the last three years from the official website of Bank Indonesia (www.bi.go.id).

$$P_n = P_o(1+i)^n \quad (8)$$

Where:

a) $P_n$= $n^{th}$ year time value data sought (year 2021)
b) $P_0$= Known year time value data (2019)
c) i = growth rate factor = inflation rate
d) n = ($n^{th}$ year) – (Known year)

To calculate the time value each year, it can be calculated by the travel time (hour) multiplied by the time value (IDR/vehicle/hour) and the volume of vehicles per year.

*I. Economic Feasibility Analysis*

The economic aspect is an investment review from the government or the community perspective, which will benefit later [5]. The parameters used in this study analysis included Net Present Value (NPV) and Benefit Cost Ratio (BCR).

The benefit values in the economic aspect are the sum of the VOC savings and the time value savings each year. Meanwhile, the costs used are investment costs and toll road operational and maintenance costs.

1. VOC Savings

VOC *without project* = VOC of all existing road sections in the condition *without project*.
VOC *with project* = VOC of existing road *with project* + VOC of Kunciran – Cengkareng Toll Road
VOC Savings = VOC *without project* – VOC *with project*
In 2021, it was obtained VOC savings of IDR 103.473.477.469 due to existing urban roads and IDR 436.161.585.708 due to existing toll roads.

2. Time Value Savings

Time Value Savings = Time value$_{without\ project}$ – Time value$_{with\ project}$
In 2021, it was obtained time value savings of IDR 119.261.792.339 due to existing urban roads and IDR 167.597.186.662 due to existing toll roads.

3. Economic Feasibility

Economic feasibility calculation is given in the form of *cash flow* during the Toll Road concession period (35 years). The amount of investment and maintenance costs are as follows:

a) Investment costs = IDR5.009.665.000.000
b) Maintenance costs = IDR36.851.000.000
c) Expansion costs = IDR945.013.000.000
d) Interest rate = 5.10%

Then, carried out the calculation and it was obtained as follows:

1). Due to Existing Urban Roads
a) Benefit = IDR 8.870.398.153.915
b) Cost = IDR 6.314.401.697.620

Thus, BCR dan NPV values are obtained as follows:

a) BCR = $\frac{\text{IDR8.870.398.153.915}}{\text{IDR6.314.401.697.620}}$
= 1.391 (BCR >1)
b) NPV = IDR8.870.398.153.915 – IDR6.314.401.697.620
= IDR2.465.996.456.295 (NPV >0)

2). Due to Existing Toll Roads
a) Benefit = IDR 7.952.219.738.499
b) Cost = IDR 6.189.033.389.642

Thus, BCR and NPV values are obtained as follows:

a) BCR = $\frac{\text{IDR7.952.219.738.499}}{\text{IDR6.189.033.389.642}}$
= 1.285 (BCR >1)
b) NPV = IDR7.952.219.738.499 – IDR6.189.033.389.642
= IDR1.763.186.348.857 (NPV >0)

Therefore, it could be concluded that Kunciran - Cengkareng Toll Road was feasible from economic aspects.

*J. Financial Feasibility Analysis*

Financial feasibility analysis is the basis for determining the financial resources required for a certain expected level of activity and profit. Financial analysis aims to find estimates in terms of cash flow funding so it can be seen whether the business is feasible or not [5].

Financial feasibility parameters used in this study were *Benefit Cost Ratio* (BCR), *Net Present Value* (NPV), *Payback Period*, and *Internal Rate of Return* (IRR).

Cost aspects in this feasibility analysis included investment costs and maintenance costs. Meanwhile, the benefit aspect is the income derived from the payment of toll tariff and 1.5% advertising of the toll tariff revenue.

1. Tol Tarif Revenue

Kunciran – Cengkareng Toll Road with a road length of 14.19 km is planned to operate in mid-2021 with an initial tariff per vehicle km determined by PT. Jasamarga Kunciran Cengkareng. It can be seen as follows:

a. Class I = IDR 1.550/km/vehicle
b. Class II = IDR 2.325/km/vehicle
c. Class III = IDR 2.325/km/vehicle
d. Class IV = IDR 3.100/km/vehicle
e. Class V = IDR 3.100/km/vehicle

From the toll tariff per kilometer, the toll rate for Kunciran – Cengkareng Toll Road in each section can be calculated by multiplying the toll rate per kilometer by the toll road length. Then, it was continued by multiplying the toll revenue per vehicle by the volume per year to obtain revenue per year.

PT. Jasamarga Kunciran Cengkareng assumed that the toll rate increased every two years with 7% inflation. Table 7 shows toll tariff revenue in 2021.

2. Financial Feasibility

Financial feasibility calculation is given in the form of cash flow during the Toll Road concession period (35 years). The amount of investment and maintenance costs are as follows:

a) Investment costs = IDR5.009.665.000.000
b) Maintenance costs = IDR36.851.000.000

c) Expansion costs = IDR945.013.000.000
d) Interest rate = 5.10%

Then, carried out the calculation and it was obtained as follows:

Due o Existing Urban Roads
a) Benefit = Rp23.146.591.001.269
b) Cost = Rp6.314.401.697.620

Thus, BCR, NPV, IRR, and *Payback Period* are obtained as follows:

a) BCR = $\frac{\text{IDR23.146.591.001.269}}{\text{IDR6.314.401.697.620}}$
= 3.666 (BCR >1)
b) NPV = IDR23.146.591.001.269 – IDR6.314.401.697.620
= IDR16.832.189.303.649 (NPV >0)
c) IRR = 12.9801% (IRR > Interest rate)
d) PP = 17$^{th}$ year (Before the concession period ends)

Therefore, it could be concluded that Kunciran – Cengkareng Toll Road was feasible from financial aspects.

Due to Existing Toll Roads
a) Benefit = IDR24.814.222.669.690
b) Cost = IDR6.189.033.389.642

Thus, BCR, NPV, IRR, and *Payback Period* are obtained as follows:

a) BCR = $\frac{\text{IDR24.814.222.669.690}}{\text{IDR6.189.033.389.642}}$
= 4.009 (BCR >1)

b) NPV = $\frac{\text{IDR24.814.222.669.690}}{\text{IDR6.189.033.389.642}}$
= IDR18.625.189.280.048 (NPV >0)
c) IRR = 13.6539% (IRR > Interest rate)
d) PP = 15$^{th}$ year (Before the concession period ends)

## CONCLUSIONS AND SUGGESTIONS

### *A. Conclusions*

1. Based on an analysis of traffic volume calculations in conditions *without project*, the degree of saturation (Ds) was obtained on the existing road in 2021 before the Kunciran – Cengkareng Toll Road construction in the first year. It can be seen as follows:
   a. M.H. Thamrin Street
      a) Cengkareng Direction = 0.57
      b) KunciranDirection = 0.66
   b. Jendral Sudirman Street
      a) Cengkareng Direction = 0.45
      b) Kunciran Direction = 0.45
   c. Daan Mogot Street
      a) Cengkareng Direction = 0.50
      b) Kunciran Direction = 0.50
   d. DR. Sitanala Street
      a) Cengkareng Direction = 0.58
      b) Kunciran Direction = 0.35
   e. Marsekal Suryadarma Street
      a) Cengkareng Direction = 0.46
      b) Kunciran Direction = 0.28
   f. South Perimeter Street
      a) Cengkareng Direction = 0.38
      b) KunciranDirection = 0.28
   g. Jakarta – Tangerang Toll Road
      a) Cengkareng Direction = 0.73
      b) Kunciran Direction = 0.77
   h. Jakarta Outer Ring Road
      a) Cengkareng Direction = 0.72
      b) Kunciran Direction = 0.56
   i. Prof. Sedyatmo Airport Toll Road
      a) Cengkareng Direction = 0.70
      b) Kunciran Direction = 0.73
2. Based on the analysis of traffic volume calculations in conditions with project, the degree of saturation (Ds) was obtained on the existing road and Kunciran - Cengkareng Toll Road after the Kunciran - Cengkareng Toll Road construction in the first year. It can be seen as follows:
   a. M.H. Thamrin Street
      a) Cengkareng Direction = 0.29
      b) Kunciran Direction = 0.41
   b. Jendral Sudirman Street
      a) Cengkareng Direction = 0.22
      b) Kunciran Direction = 0.20
   c. Daan Mogot Street
      a) Cengkareng Direction = 0.40
      b) Kunciran Direction = 0.41
   d. DR. Sitanala Street
      a) Cengkareng Direction = 0.39
      b) Kunciran Direction = 0.25
   e. Marsekal Suryadarma Street
      a) Cengkareng Direction = 0.28
      b) Kunciran Direction = 0.16
   f. South Perimeter Street
      a) Cengkareng Direction = 0.26
      b) Kunciran Direction = 0.15
   g. Tol Jakarta – Tangerang Street
      a) Cengkareng Direction = 0.37
      b) Kunciran Direction = 0.39
   h. Jakarta Outer Ring Road
      a) Cengkareng Direction = 0.36
      b) Kunciran Direction = 0.25
   i. Prof. Sedyatmo Airport Toll Road
      a) Cengkareng Direction = 0.35
      b) Kunciran Direction = 0.37

   1). Due to Existing Urban Roads
   a. Kunciran – Cengkareng Seksi I Toll Road
      a) Cengkareng Direction = 0.47
      b) Kunciran Direction = 0.41
   j. Kunciran – Cengkareng Seksi II Toll Road
      a) Cengkareng Direction = 0.23
      b) Kunciran Direction = 0.25
   k. Kunciran – Cengkareng Seksi III Toll Road
      a) Cengkareng Direction = 0.21
      b) Kunciran Direction = 0.15
   l. Kunciran – Cengkareng Seksi IV Toll Road
      a) Cengkareng Direction = 0.22
      b) Kunciran Direction = 0.18

   2). Due to Existing Toll Roads
   m. Kunciran – Cengkareng Seksi I Toll Road
      a) Cengkareng Direction = 0.32
      b) Kunciran Direction = 0.24
   n. Kunciran – Cengkareng Seksi II Toll Road

a) Cengkareng Direction = 0.28
b) Kunciran Direction = 0.26

o. Kunciran – Cengkareng Seksi III Toll Road
a) Cengkareng Direction = 0.23
b) Kunciran Direction = 0.22

p. Kunciran – Cengkareng Seksi IV Toll Road
a) Cengkareng Direction = 0.33
b) Kunciran Direction = 0.35

3. Based on the results of the trip assignment analysis and calculation using the Smock and Davidson method, the vehicles moving from the existing road to Kunciran – Cengkareng Toll Road are as follows:

1). *Davidson Method*

a. M.H Thamrin Street to Kunciran – Cengkareng Section I Toll Road
a) Cengkareng Direction = 70.90%
b) Kunciran Direction = 61.34%

b. Jendral Sudirman Street to Kunciran – Cengkareng Section II Toll Road
a) Cengkareng Direction = 70.77%
b) Kunciran Direction = 74.63%

c. Daan Mogot Street and DR. Sitanala Street to Kunciran – Cengkareng Section III Toll Road
a) Cengkareng Direction = 49.52%
b) Kunciran Direction = 45.42%

d. Marsekal Suryadarma Street and South Perimeter Street to Kunciran – Cengkareng Section IV Toll Road
a) Cengkareng Direction = 60.79%
b) Kunciran Direction = 66.15%

2). *Smock Method*

a. Jakarta – Tangerang Toll Road to Kunciran – Cengkareng Section I Toll Road
a) Cengkareng Direction = 50%
b) Kunciran Direction = 50%

b. Jakarta – Tangerang Toll Road to Kunciran – Cengkareng Section II Toll Road
a) Cengkareng Direction = 50%
b) Kunciran Direction = 50%

c. Jakarta Outer Ring Road to Kunciran – Cengkareng Section III Toll Road
a) Cengkareng Direction = 50%
b) Kunciran Direction = 60%

d. Prof. Sedyatmo Airport Toll Road to Kunciran – Cengkareng Section IV Toll Road
a) Cengkareng Direction = 50%
b) Kunciran Direction = 50%

4. Based on the calculation results of Vehicle Operating Costs (VOC) in the conditions without project and with project, the total savings in the first year obtained IDR 103.473.477.469. At the end of the plan age, namely 2055, VOC savings reached IDR 472.051.315.455 due to existing urban roads. Whereas due to the existing toll roads, the total savings in the first year was IDR 436,16,585,708, and at the end of the planned age of VOC savings were – IDR1.785.528.870.830.

5. Based on the results of the time value calculations in conditions *without project* and *with project*, total savings in the first year of 2021 was IDR 119.261.792.339. At the end of the plan year, namely 2055, the time value savings reached IDR 750.849.031.078 due to existing urban roads. Whereas due to the existing toll roads, the total savings in the first year was IDR 167.597.186.662, and at the end of the plan age, the time value savings reached IDR 535.798.471.089.

6. Based on the calculation and feasibility analysis results from the economic aspect, the results are obtained as follows:

a. Due to Existing Urban Roads
*a) Present worth benefit* =IDR8.870.398.153.915
b) *Present worth cost* =IDR6.314.401.697.620

Thus, the results are obtained:
a) BCR = 1.391 > 1 (Feasible)
b) NPV = IDR2.465.996.456.295 > 0 (Feasible)

b. Due to Existing Toll Roads
*a) Present worth benefit* = IDR7.952.219.738.499
b) *Present worth cost* = IDR6.314.401.697.620

Thus, the results are obtained:
a) BCR = 1.285 > 1 (Feasible)
b) NPV = IDR6.189.033.389.642>0 (Feasible)

Based on the feasibility analysis results, it can be concluded that Kunciran – Cengkareng Toll Road construction was economically feasible.

7. Based on the calculation and feasibility analysis results from the financial aspect, the results are obtained as follows:

a. Due to Existing Urban Roads
a) *Present worth benefit* =IDR23.146.591.001.269
b) *Present worth cost* =IDR6.314.401.697.620

Thus, the results are obtained:
a) BCR = 3.666 > 1 (Feasible)
b) NPV = IDR16.832.189.303.649 > 0 (Feasible)
c) IRR = 12.9801% > Interest Rate (Feasible)
d) PP = 17$^{th}$ year (Before the concession period ends)

b. Due to Existing Urban Roads
a) *Present worth benefit*=IDR24.814.222.669.690
b) *Present worth cost* =IDR6.189.033.389.642

Thus, the results are obtained:
a) BCR = 4.009 > 1 (Feasible)
b) NPV = IDR18.625.189.280.048 > 0 (Feasible)
c) IRR = 13.6539% > Interest Rate (Feasible)
d) PP = 15$^{th}$ year (Before the concession period ends)

Based on the feasibility analysis results, it can be concluded Kunciran – Cengkareng Toll Road construction was financially feasible.

*B. Suggestions*

The analysis results in this final project showed that Kunciran – Cengkareng Toll Road was feasible from economic and financial perspectives. Therefore, this project is expected to be completed soon to overcome the existing problems

REFERENCES

[1] D. Sri A W, S. Sulistyono, and D. Nurtanto, "Jurnal Rekayasa Sipil Dan Lingkungan Feeder Route Planning of Public Transportation in Jember," 2017.
[2] Daftar and Dirjen Bina Marga, "Pedoman Kapasitas Jalan Indonesia (PKJI)," 2014.
[3] Departemen Pekerjaan Umum, "Pra Studi Kelayakan Proyek Jalan dan Jembatan." Jakarta, 2005.
[4] O. Z. Tamin, *Perencanaan dan Pemodelan Transportasi*. Penerbit ITB EDISI KEDUA EDISI KEDUA, 2000.
[5] Kementrian Pekerjaan Umum dan Perumahan Rakyat, "Modul 5 Kelayakan Finansial," 2017

NOTES:

Figure 1. Feasibility Analysis Flowchart

- *Mulai* : Start
- *Identifikasi masalah* : Problems Identification
- *Studi literature* : Literature study
- *Pengumpulan data sekunder* : Secondary data collection
- *Forecasting* : Forecasting
- *Trip Assignment* : Trip Assignment
- *Analisis kondisi lalu lintas without project*: Analysis of traffic conditions *without project*
- *Analisis kondisi lalu lintas with project*: Analysis of traffic conditions *with project*
- *Analisis penghematan BOK dan nilai waktu*: Analysis of VOC savings and time values
- *Analisis kelayakan* : Feasibility analysis
- *Analisis kelayakan ekonomi BCR, NPV, IRR* : Economic feasibility analysis: BCR, NPV, IRR
- *Analisis kelayakan finansial: BCR, NPV, IRR, Paypack Period* : Financial feasibility analysis: BCR, NPV, IRR, Payback Period
- *Kesimpulan* : Conclusions
- *Selesai* : End