The Analysis of Economic and Traffic Feasibility of Flyover Ganefo Mranggen Demak Construction

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ABSTRACT

Traffic jam is a common problem for the Demak Society. One of the causes of the traffic jam occured in Demak Regency is the road section that cannot accommodate the vehicle volume. Every day, the vehicle volume keeps increasing, but it is not followed by road facility improvement. One of the areas that is prone to traffic congestion in Demak Regency is the crossroad between the road and railroad of Ganefo Mranggen, which located on Karangawen road. It connects Semarang Regency and Demak Regency. In general, traffic jam on this road occurs during rush hours, such as when the workers start going to work and back home from their workplace. Considering the phenomenon, it is necessary for Demak government to build an infrastructure that can solve the traffic congestion problem. Flyover construction can be a way to manage traffic congestion in the congestion center. By constructing this flyover on Karangawen road, it will save travel time for road users when passing the flyover compared to the existing road. Therefore, a Study of the Economic and Traffic Feasibility of Flyover Ganefo Mranggen Demak Construction was carried out. This feasibility study compared the user cost with the vehicle volume, and the degree of saturation (DS) before and after the flyover was constructed. In addition, the study of economic feasibility was reviewed from BCR (Benefit Cost Ratio) and NPV (Nett Profit Value) from this Flyover Ganefo Mranggen construction. The method used to analyze the Vehicle Operating Cost (VOC) was the Jasa Marga method. The data was collected using the survey traffic counting method. The result of this study obtained the feasibility calculation of Flyover Ganefo Mranggen construction was Benefit Cost Ratio (BCR) =1,12 Net Present Value (NPV)=IDR 38.330.261.991.14. According to the result, it can be concluded that the Flyover Ganefo Mranggen Demak construction is stated feasible economically.

INTRODUCTION

A highway is a land transportation infrastructure that plays a significant role in transportation sector, especially for the continuity of goods and services distribution. It is essential to accommodate the pace of economic growth following the increasing need for transportation facilities. The high population in an area will affect the economy in that area, such as Mranggen District. It is the center of the road between Demak and Semarang regency, especially on Karangawen road. This road is usually passed by heavy vehicles such as buses, large trucks, cars, and two-wheeler vehicles.

Demak Regency is one of the regencies in Center Java Province, with its capital city of Semarang. This regency is bordered by the Java Sea to the west, Jepara Regency to the North, Kudus Regency to the East, Grobokan Regency to the Southeast, and Semarang City and Semarang Regency to the West. The area of the Demak Regency is 897, 43 km2, and the population of 1.151.796 people [1]. It consists of 14 districts, one of which is the Mranggen District. It has high access to trade, namely a modern market called Ganefo Market.

Ganefo market is located on Karangawen Mranggen Demak Road. The high activity of the community in the morning on the South route of Demak Regency, which is a connecting road for Semarang Regencies and Demak Regencies, and a railroad crossing on the road creates the potential for traffic jams. The police officers from the Mranggen Police are on standby to make arrangements in order to anticipate the traffic jams.

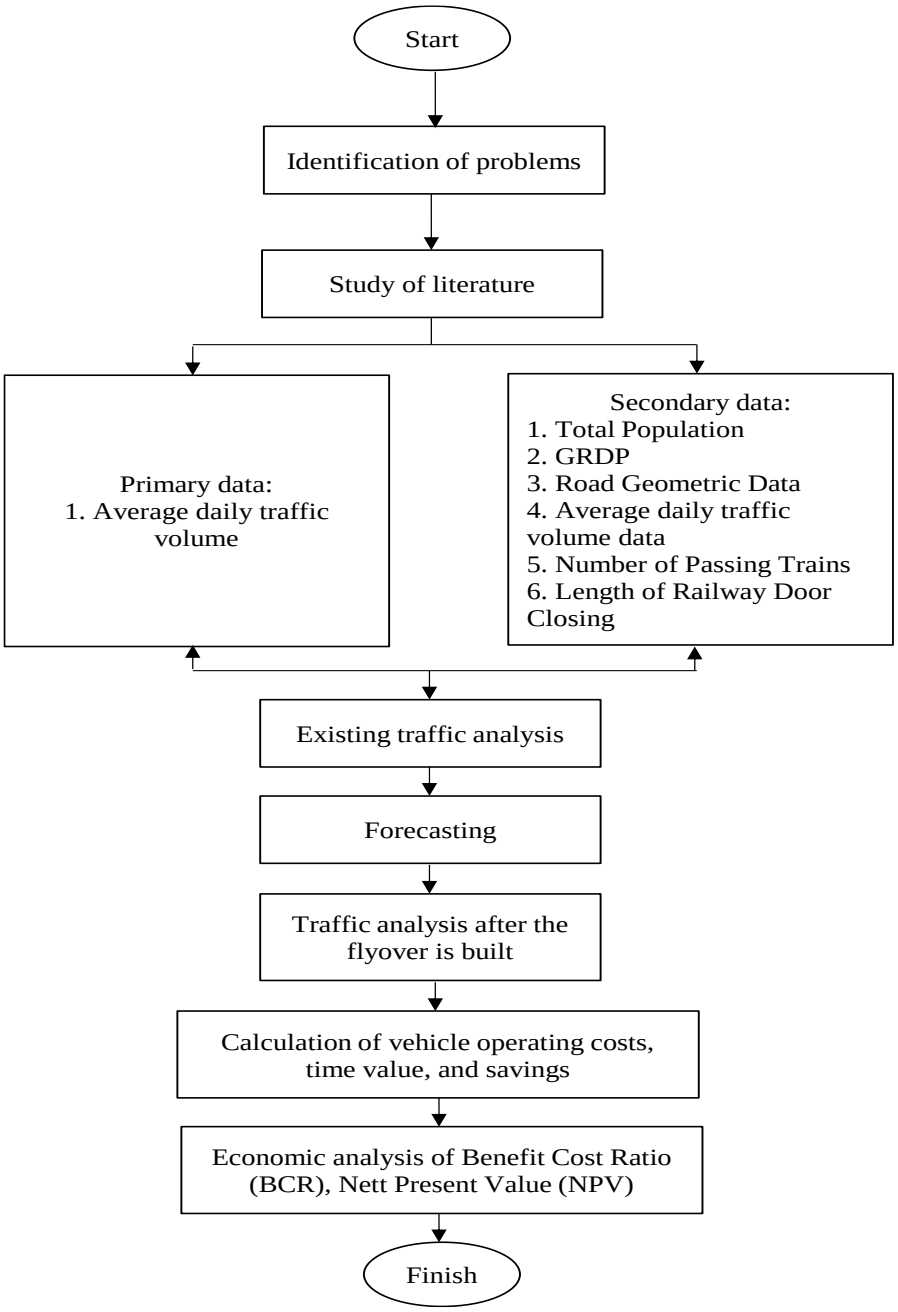

Figure 1. Calculation Flowchart.

One of the causes of the traffic jams in that place is the high buying and selling activity of the people at the Ganefo spill market. In addition, the mobilization of the train every 10 minutes makes the road even more congested. The officers of Mranggen police station often stand in the middle of the road like a guardrail to prevent crowds or traffic congestion so that traffic flows smoothly.

Traffic jams often occur on this road due to the very high volume of vehicles. From an economic aspect, the traffic congestion experienced by vehicles is a cost that must be paid by vehicle users due to the traffic jam. On the one hand, from the traffic aspect, vehicle users will take a longer time to arrive at their destination due to the traffic jam on Karangawen Road. Both things cause the condition on Semarang - Demak road section requires serious handling. The government has tried to handle this problem by constructing a flyover. It is expected that the flyover can provide many benefits to road users and it can save their costs and travel time. Before the physical construction was conducted, it is necessary to know the feasibility of the flyover. Therefore, the study of the economic and traffic feasibility of the Flyover Ganefo Mranggen Demak construction was carried out. The analysis aimed to find out the traffic characteristics before and after the construction of the flyover on the Karangawen road section. In addition, it aimed to determine the difference in time and saving costs before and after the construction of the Flyover on the Karangawen road section.

METHODOLOGY

A. Problems Identification

The problem raised in the analysis of the Economic and Traffic Feasibility of the Flyover Ganefo Mranggen Demak construction was the existence of the level crossing. Thus, the alternative to solve this problem was

Table 1 Existing Road traffic volume

Movement Direction	M	Class 1	Class 2	Class 3	Class 4	Class 5
Semarang - Purwodadi	46.610	5.602	1.429	94	2	101
Purwodadi - Semarang	40.822	7.430	1.154	8	3	27

Table 2. Road Vehicle Survey Data.

Movement Direction	M	Class 1	Class 2	Class 3
Purwodadi - Semarang (Straight)	1.954	697	186	151
Purwodadi - Semarang (Turn)	286	82	19	15
Semarang - Purwodadi (Straight)	2.047	745	219	221
Semarang - Purwodadi (Turn)	357	98	27	8

Table 3. Traffic Volume Equivalence Results.

Direction Movement	Total (scr/day)	Total (scr/hour)
Purwodadi - Semarang (straight)	27.462	3.021
Purwodadi - Semarang (turn)	3.826	421
Semarang - Purwodadi (straight)	25.374	2.802
Semarang - Purwodadi (turn)	4.113	452

Table 4. Growth Rate of Gross Regional Domestic Product (GRDP) at 2016 Constant Prices According to Demak Regency, 2016-2020.

Areas	2016	2017	2018	2019	2020
Demak Regency	4,46%	5,27%	4,29%	5,93%	5,04%

Table 5. Analysis of the Volume of Existing Road Vehicle

Movement Direction	M	Class 1	Class 2	Class 3	Class 4	Class 5
Semarang - Purwodadi (Straight)	7.420.20	1.938.02	501.8	78.025	1.661	83.835
Semarang - Purwodadi (Turn)	1.086.06	242.749	51.25	7.751	165	8.328
Purwodadi - Semarang (Straight)	6.343.60	2.541.28	379.6	7.045	2.642	23.777
Purwodadi - Semarang (Turn)	1.106.36	346.803	46.74	256	96	861

Table 6. Capacity of Existing Road

Traffic Direction	C_0	FC_{LJ}	FC_{PA}	FC_{HS}	Capacity (C) (scr/hour)
Semarang - Purwodadi (Straight)	3.100	1	1	0,94	2.914
Semarang - Purwodadi (Turn)	3.100	1	1	0,94	2.914
Purwodadi - Semarang (Straight)	3.100	1	1	0,94	2.914
Purwodadi - Semarang (Turn)	3.100	1	1	0,94	2.914

feasibility consideration of the flyover construction, whether it is more effective or not to be constructed. The problem discussed in this study referred to the limitation of problems that had been discussed previously. Therefore, this analysis could be completed within the time planned.

B. Literature Review

This stage looked for the references as the supporting data to conduct the Analysis of the Economic and Traffic Feasibility of Flyover Ganefo Mranggen Demak. The based theory used referred to the textbook, information from the internet, journals, and other sources related to the analysis of flyover feasibility.

C. Traffic Intesity Analysis

The data used in this study were primary and secondary data. Primary data consisted of the data on vehicle volume, train closing frequency, speed survey, train closing time, and queues. Secondary data was data obtained from existing research and sources. In this study, there were 7 secondary data, including vehicle volume data, data for VOC components, BI inflation data, vehicle volume data, GRDP data, road geometry data, and development and maintenance cost data.

D. Analisis

The followings are the discussion carried out to analyze the feasibility of this flyover:

1. Finding out the traffic conditions surrounding before the construction of the flyover.
2. Calculating the Vehicle Operating Cost (VOC) saving after the construction of the flyover.
3. Finding out the feasibility analysis of the construction of the flyover at the railroad crossing after the flyover.

1) Existing Traffic Analysis

This traffic performance was analyzed from 2019 to the year planned. It assumed there was no flyover that had been constructed, so this was the actual condition on Karangen, Ganefo Mranggen road section. The analysis included vehicle growth, average daily traffic volume (ADT), degree of saturation calculation, and free flow speed.

2) Flyover Traffic Analysis

The traffic performance analysis on the flyover was carried out the same way as the flyover in the existing conditions by considering that the operation of the new flyover will run in the specified year. The planned life of the flyover itself is 30 years.

3) Light Vehicle Equivalence (LVE)

In light vehicle equivalence, LVE value was required to convert medium heavy vehicles (MHV), motorcycles (M), and large buses (LB) into the light vehicle (LV).

4) Capacity

The capacity was used to determine the capacity of an existing road or flyover every hour. The capacity calculation used the Indonesian Road Capacity Guidelines (IRCG). The capacity could be determined by analyzing it using the following formula below.

$$C = C_0 \times FC_W \times C_{SP} \times FC_{SF} \text{ (smp/hour)}$$

5) Degree of Saturation

The degree of saturation is a flow ratio to capacity. It was used as the main factor in determining the

Table 7. Capacity of Flyover Road

Traffic Direction	C_0	FC_{LJ}	FC_{PA}	FC_{HS}	Capacity (C) (scr/hour)
Semarang - Purwodadi (Straight)	3.800	0,96	1	0,99	3.611,52
Semarang - Purwodadi (Turn)	1.900	0,92	-	0,93	1.625,64
Purwodadi - Semarang (Straight)	3.800	0,96	1	0,99	3.611,52
Purwodadi - Semarang (Turn)	1.900	0,92	-	0,93	1.625,64

Table 8. Calculation of Degree of Saturation of Exisitng Road

Traffic Direction	Flow (Q)	Capacity (C)	DS (Q/C)
Semarang - Purwodadi (Straight)	3.021	2.914	1,0366
Semarang - Purwodadi (Turn)	421	2.914	0,1444
Purwodadi - Semarang (Straight)	2.802	2.914	0,9616
Purwodadi - Semarang (Turn)	452	2.914	0,1553

Table 9. Calculation of Degree of Saturation of Flyover Road

Traffic Direction	Arus (Q)	Capacity (C)	DS (Q/C)
Semarang - Purwodadi (Straight)	3.021	3.611,5	0,8364
Semarang - Purwodadi (Turn)	421	1.625,6	0,2588
Purwodadi - Semarang (Straight)	2.802	3.461	0,8096
Purwodadi - Semarang (Turn)	452	1.625,6	0,2783

Table 10. Free Flow Speed of Existing Road

Traffic Direction	$V_{B,KBM}$ (km/hour)				
	M	LV	MHV	LB	TB
Semarang – Purwodadi(Straight)	49,005	60,588	53,46	61,47	49
Semarang - Purwodadi(Turn)	49,005	60,588	53,46	61,47	49
Purwodadi - Semarang(Straight)	49,005	60,588	53,46	61,47	49
Purwodadi - Semarang(Turn)	49,005	60,588	53,46	61,47	49

performance level of road sections. The degree of saturation value indicated whether the road section is able to accommodate capacity or not if it is not connected with the existing traffic volume. The value of the degree of saturation can be calculated using the following formula below.

$$DS = Q/C$$

6) Free-flow Speed

The free flow speed is the speed at which all vehicles were assumed to be undisturbed by other vehicles. In the other words, it was a condition where all vehicles travel without traffic congestion. The calculation of this free flow speed was required to calculate the travel speed obtained from a road being reviewed. The road being studied had the same road section size at every point. The equation for determining free flow speed used the formula as follows..

$$FV = (FV_0+FVw) \times FFV_{SF} \times FFV_{RC}$$

7) Travel Speed

Travel speed is the actual speed of the vehicles. The amount of which was determined based on the function of DS and Fv that had been determined. The benchmark of road segment performance was travel speed because it is easy to understand and measure. It was also an significantt input to road user costs in economic analysis.

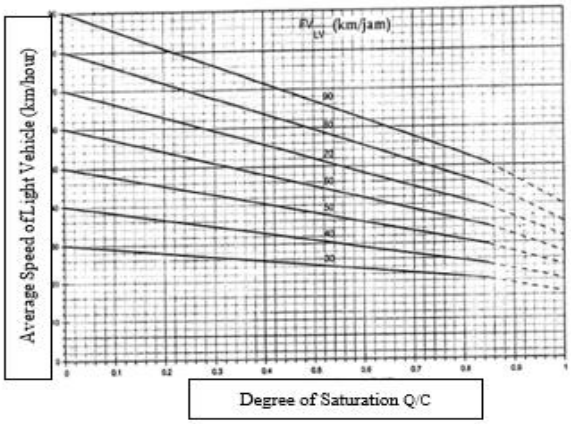

Figure 2. Speed Graph

Table 11. Free Flow Speed of Flyover Road.

Traffic Direction	$V_{B,KBM}$ (km/hour)				
	M	LV	MHV	LB	TB
Semarang – Purwodadi(Straight)	58,8	72,52	60,43	64,15	51,13
Semarang - Purwodadi(Turn)	49,005	60,588	53,46	61,47	49,00
Purwodadi - Semarang(Straight)	58,8	72,52	60,43	64,15	51,13
Purwodadi - Semarang(Turn)	49,005	60,588	53,46	61,47	49,00

Table 12. Vehicle Speed of Existing Road

Traffic Direction	Travel Speed (km/hour)				
	SM	KR	KBM	BB	TB
Semarang - Purwodadi (Straight)	29,5	35,3	31,7	35,7	29,5
Semarang - Purwodadi (Turn)	45,0	56,0	50,0	57,0	46,0
Purwodadi - Semarang (Straight)	29,5	35,3	31,7	35,7	34,5
Purwodadi - Semarang (Turn)	56,0	35,3	31,7	35,7	29,5

Travel speed can be defined as the space mean speed of the vehicle along the road segment.

8) Travel Time (TT)

Travel time (TT) (hour, minute, second) was required by a vehicle to travel a particular road length. It included all delay times and stationary times. The travel time could be known from Vt in traveling the road segments analyzed along L. The relationship between TT, L, and Vt as the formula no (4).

$$V = L/TT$$

9) Vehicle Operating Cost (VOC)

Vehicle Operating Cost is the cost spent to operate a vehicle. The method that would be used to calculate the vehicle operating costs in this study was the Jasa Marga Method, and for motorcycles, it used the ND LEA method [1]. In Jasa Marga's formula, operational cost components are divided into 7 categories. It consisted of fuel consumption, lubricating oil consumption, tire consumption, maintenance, depreciation, interest on capital, and insurance.

10) Delay

The shock Wave method is a part of the study regarding the traffic phenomenon, which are the characteristics of the shock wave to the flow of traffic. "The Effect of Railroad Crossing Closing on the

Table 13. Vehicle Speed of Flyover Road

Traffic Direction	Travel Speed (km/hour)				
	SM	KR	KBM	BB	TB
Semarang - Purwodadi (Straight)	35,0	42,0	36,0	38,0	31,0
Semarang - Purwodadi (Turn)	43,0	53,0	47,0	54,0	43,0
Purwodadi - Semarang (Straight)	36,0	33,0	38,0	42,0	35,0
Purwodadi - Semarang (Turn)	43,0	54,0	48,0	55,0	44,0

Table 14. Vehicle Costs of Existing Road

Traffic Direction	Travel Costs(IDR)	Delay Cost (IDR)	Total Cost (IDR)
Semarang - Purwodadi (Straight)	21.454.002	1.093.951.018	1.115.405.020
Purwodadi - Semarang (Straight)	16.432.745	582.031.240	868.463.985

Table 15. Vehicle Operation Cost of Existing Road

Traffic Direction	Total of GOL (IDR)	Usercost (IDR)	Total of VOC (IDR)
Semarang - Purwodadi (Straight)	7.385.615.471	1.115.405.020	8.501.020.492
Semarang - Purwodadi (Turn)	383.891.656	-	383.891.656
Purwodadi - Semarang (Straight)	7.200.833.830	868.463.984	8.069.297.815
Purwodadi - Semarang (Turn)	473.364.870	-	473.364.870

Table 16. Vehicle Operational Cost of Flyover Road

Traffic Direction	Total GOL (IDR)	Usercost (IDR)	Total VOC (IDR)
Semarang - Purwodadi (Straight)	7.098.472.535	-	7.098.472.535
Semarang - Purwodadi (Turn)	384.921.700	-	384.921.700
Purwodadi - Semarang (Straight)	6.835.383.76	-	6.835.383.736
Purwodadi - Semarang (Turn)	418.770.415	-	418.770.415

Table 17. Motorcycle Vehicle Operating Cost of Existing Road.

Traffic Direction	M/Class I	Addition Factor	Total M VOC (IDR)
Semarang - Purwodadi (Straight)	382,864	0,383	1.598.805.869
Semarang - Purwodadi (Turn)	447,407	0,447	`100.898.185
Purwodadi - Semarang (Straight)	249,623	0,25	1.366.840.312
Purwodadi - Semarang (Turn)	3,19	1,006	375.765.352

Table 18. Motorcycle Vehicle Operating Cost of Flyover Road.

Traffic Direction	M/Class I	Addition Factor	Total M VOC (IDR)
Semarang - Purwodadi (Straight)	382,864	0,383	1.508.087.603
Semarang - Purwodadi (Turn)	447,407	0,447	`101.857.281
Purwodadi - Semarang (Straight)	249,623	0,250	1.289.284.065
Purwodadi - Semarang (Turn)	3,190	1,006	325.510.916

Determination of Queue Length of Intersection Arms Using Shock Wave Analysis" [2]. A shock wave is defined as the movement of a traffic flow change. In free-flow conditions, the vehicles will move at a certain speed. If the flow is hindered (disturbance), the flow will be reduced that can pass through the obstacle location.

11) Time Value

The time value was calculated using the Jasa Marga formula. It was reviewed from the studies of the existing time value study.

12) Economic Feasibility Study

An economic feasibility study is an evaluation stage of a project from an agency that will determine whether the project will continue or not. This project would be carried out if the planning had been made. The results of this feasibility analysis were an analysis of whether feasible or not a project to be carried out and a recommendation on how the project to be implemented. The parameter used to analyze the feasibility were BCR (Benefit Cost Ratio) and NPV (Net Present Value).

E. Flow Chart

Schematically, the flow of activiries to be carried out in this study is shown in Figure 1.

RESULTS AND DISCUSSIONS

A. General

This analysis will explain the collected data and the calculation analysis. The calculation in this study will be used to determine the feasibility of the flyover Ganefo Mranggen, Demak construction. The traffic volume on the road was obtained from the Department of Highways and also did traffic counting.

From collecting the data, then it obtained the capacity, degree of saturation, and delay required in traffic performance evaluation. The data collected, then will be used in vehicle operating cost (VOC) calculation.

B. Data Collection

1) The Number of Population

According to the Central Bureau of Statistics 2016, the Demak Population was 1.129.402 people. This population data will later be used in calculations to determine the size of the city.

2) Traffic Data

The traffic volume obtained from Department of Bina Marga dan Cipta Karya [3] . Daily traffic volume on existing road is shown in Table 1.

On flyover Ganefo Mranggen Demak planned, there will be two roads. It consisted of the upper road which will pass through the flyover and the lower road, which will only be used to turn left or U-turn before a railroad crossing. It was necessary to find out the traffic volume that turn left or U-turn before the railroad crossing first in order to find the planned flyover traffic volume that will pass below. It is because the railroad crossing will be completely closed to vehicles. Therefore, the lower flyover road is only used for turning left or U-turning. The following is the location of the survey points at the Ganefo Mranggen Demak crossing to find the proportion of straight or turning traffic volume. Based on the survey results above, the proportion of vehicles and per road section can be seen in Table 2.

Table 19. Vehicle Operating Cost of Existing Road plus Motorcycles

Traffic Direction	Total GOL (IDR)	Usercost (IDR)	Total VOC (IDR)
Semarang - Purwodadi (Straight)	8.984.421.340	1.115.405.020	10.099.826.361
Semarang - Purwodadi (Turn)	484.789.842	-	484.789.842
Purwodadi - Semarang (Straight)	8.567.674.142	868.463.985	9.436.138.127
Purwodadi - Semarang (Turn)	474.166.684	-	474.166.684

In the next calculation, unit equalization is carried out to become Light Vehicle Units (LVU) per hour. To change must be multiplied by the light vehicle equivalence factor (EKR) of out-of-town and urban roads and then multiplied by the K Factor to find vehicles per hour. The results of the recapitulation of vehicle volume equivalence on all roads are shown in Table 3.

C. Traffic Forecasting

The percentage growth of Gross Regional Domestic Product (GRDP) was used to forecast the vehicle volume that will increase in the following years. The percentage was based on expenses that showed added value of goods and services. It was calculated using the applicable prices in one year as the basis. In general, it is useful to find out the economic growth from year to year. This data will be used as a reference to forecast the growth level of vehicles on the existing roads that affect Flyover Ganefo Mranggen Demak. The following are the GRDP data used in Table 4.

The average GRDP growth from 2016 - 2020 was taken from the data above amounting to 5.00%. It was used as the basis to analyze the growth rate of vehicles on all road sections in the study location. This percentage is used for 30 years during the project concession period for all vehicle types.

D. Traffic Analysis Without Project

1) Vehicle Volume Analysis

Vehicle Volume Analysis is a condition of the traffic volume that occurs from the forecasting result on the existing road section for the next 30 years without project on Flyover Ganefo Mranggen Demak. After obtaining an analysis of the traffic volume per segment (scr/hour), it can be predicted that the volume of vehicles will occur by multiplying it by a factor. In addition, it must be multiplied by 365 days to get the traffic volume per year. The following is an analysis of the volume of existing road vehicles in 2020, which can be seen in Table 5.

2) Road Capacity Calculation

Road capacity calculation was carried out to determine the capacity of an existing road or flyover being reviewed. This calculation used the Indonesian Road Capacity Guidelines (IRGC). The calculation results for each existing road capacity can be seen in Table 6 and the flyover road in Table 7.

3) Degree of Saturation Calculation

The degree of saturation calculation is the calculation used to determine the characteristics of an intersection or road section that was being reviewed. The followings are the results of DS calculation in 2020 that can be seen in Table 8 for the existing road and Table 9 for the flyover road.

Table 20. Vehicle Operating Cost of Flyover Road plus Motor

Traffic Direction	Total GOL (IDR)	Usercost (IDR)	Total VOC (IDR)
Semarang - Purwodadi (Straight)	8.606.560.138	-	8.606.560.138
Semarang - Purwodadi (Turn)	486.508.981	-	486.508.981
Purwodadi - Semarang (Straight)	8.124.667.802	-	8.124.667.802
Purwodadi - Semarang (Turn)	744.281.331	-	744.281.331

E. Free-flow Speed Analysis

The free-flow speed can be defined as a speed when the flow level is zero. In other words, it can be defined as where there is no obstacle from other motorized vehicles on the road. The free-flow speed analysis was based on the geometric condition of each road section. The formula used was IRGC out-of-town road.

1) Free-flow Speed Calculation of the Existing Road.

The following is the free flow speed for each type of vehicle on the existing road.

2) Flyover Free Flow Speed Calculation

The following is the free flow speed for each type of vehicle on the flyover.

FEASIBILITY ANALYSIS

In planning the Flyover Ganefo Mranggen Demak construction, it is necessary to conduct the feasibility analysis from an economic aspect to determine whether the construction of a project is feasible or not to be conducted.

A. The Calculation Analysis of User Cost Existing and Flyover

The Fylover Ganefo Mranggen Demak is stated as feasible economically if *Benefit Cost Ratio* is>1 and *Net Present Value is* >0. The Vehicle Operating Cost and Time Value calculation will be obtained from both parameters. However, this feasibility economic analysis required two methods which were the Oglesby and Hicks methods [4] on the railroad crossing. In addition, it used *the Jasa Marga* method to calculate VOC flyover. Then, on the calculation for existing VOC used *the Jasa Marga* method added with the VOC of Oglesby & Hicks [4] calculation methods. The VOC flyover only used *the Jasa Marga* method.

1) Speed.

Vehicle Operating Cost (VOC) and the calculation of existing User Cost were based on the speed of a vehicle that crossed the road. The degree of saturation (DS) and free-flow speed obtained from the previous calculation were required to calculate the vehicle speed. This speed was based on IRCG 2014, which in out-of-town areas, all vehicles were average the same. The things required to calculate the VOC of Jasa Marga and Oglesby & Hicks [4] can be seen in Figure 1.

2) VOC Calculation of the Clarkson H. Oglesby & R.Gary Hick Methods.

As the explanation above, the VOC calculation of existing used Oglesby & Hicks [4] methods. It required a nomogram that will be plotted. The result obtained from the nomogram was the calculation factor for the running and stationary costs of a vehicle crossing a railroad crossing. It is because there is a time on the railroad crossing when the vehicle will not move during the closing of the cross gate train. It will move again after the cross gate train is open. It causes additional running and stationary costs for each vehicle that crossed the crossing.

a) Vehicle Running Cost

Some costs will be incurred by each road user when the vehicle will run from a crossing.

b) Vehicle Stationary Cost

According to the Oglesby & Hicks methods [4], there will be additional costs spent due to the stationary by each vehicle in the additional calculation of stationary cost when the vehicle stops at a crossing. The results of running and stationary cost calculations can be seen in Table 14.

3) VOC Calculation of the Jasa Marga Method

In this jasa marga method, the sum between moving and stationary costs is influenced by several components which can later affect vehicle operating costs (VOC). The followings are the price of each vehicle component.

Class I (Passanger Car)
- Vehicle Type : Honda Mobilio.
- Vehicle Prices : IDR 231,100,000.
- Fuel : IDR 6,450/liter (Pertalite).
- Lubricant Oil : IDR 50,000/liter.
- Tire Prices : IDR 470,000/item (IRC).
- Maintenance Costs : IDR 20,000/hour.

Class II (2 Axle Truck)
- Vehicle Types : Hino dutro 110 HD.
- Vehicle Prices : IDR 294,700,000.
- Fuel : IDR 9,400/liter (Solar).
- Lubricant Oil : IDR 30,000/liter.
- Tire Prices : IDR 1,170,000.
- Maintenance Costs : IDR 20,000/hour.

Class III (3 Axle Truck)
- Vehicle Types : Truk Mitsubishi FM 517 HL
- Vehicle Prices : IDR 646,000,000
- Fuel : IDR 9,400/liter (Solar).
- Lubricant Oil : IDR 30,000/liter.
- Tire Prices : IDR 1,840,000/item.
- Maintenance Costs : IDR 20,000/hour.

Class IV (4 Axle Truck)
- Vehicle Types : Hino SG 260 J.
- Vehicle Prices : IDR 680,000,000.
- Fuel : IDR 9,400/liter (Solar).
- Lubricant Oil : IDR 30,000/liter.
- Tire Prices : IDR 2,750,000/item.
- Maintenance Costs : IDR 20,000/hour.

Class V (5 Axle Truck)
- Vehicle Types : Hino FM 320 PL.
- Vehicle Prices : IDR 876,000,000.
- Fuel : IDR 9,400/liter (Solar).
- Lubricant Oil : IDR 30,000/liter.
- Tire Prices : IDR 6,650,000/item.
- Maintenance Costs : IDR 20,000/hour

The results of the Jasa Marga VOC calculation example were then added to the VOC from the Oglesby & Hicks method. [4]. After the calculation of the existing VOC was carried out, then it carried out the calculation of the flyover VOC. However, the calculation of the flyover VOC did not use the existing calculation method. It only used the Jasa Marga method. The calculation results of the existing and flyover VOC in 2020 can be seen in Table 15 and Table 16.

4) Ndlea Method

Due to the Jasa Marga method did not discuss VOC of motorcylces, then it was used as an additional cost for Class 1 with the ND LEA method [3]. The followings are the calculation results of 2020 in each direction reviewed. It can be seen in the Table 17 for existing roads and table 18 for flyover road.

After adding the VOC of Motorcycle, the existing and flyover VOC in 2020 can be seen in Table 19 and Table 20.

5) VOC Saving Calculation

Saving cost of Vehicle Operating Cost is a comparison between VOC value on existing and flyover condition. The VOC saving in 2020 was obtained from:

VOC Saving =Tot. Existing VOC-Tot. Flyover VOC

Saving VOC =IDR 10.099.826.361-IDR 8.606.560.138

=IDR 1.493.266.223 / year

6) Queue and Delay Calculation

When the railroad crossing is closed, queues occur because there are vehicles not serviced for a certain period during the cross-gate train was closed. The delay calculation for closed cross-gate conditions resulted in a delay value due to the current being blocked by the crossing closure. In Shock Wave Analysis, the average delay that occurred is influenced by the closing time, queue release time, and recovery time.

The vehicle volume during the peak hours, namely from 07.00 – 08.00 was used because the vehicle volume on the Ganefo Mranggen railroad crossing was the daily data. Thus, it used the vehicle volume data on one road section and converted it to traffic volume data at the Ganefo Mranggen train crossing. The train was assumed to be fixed every year in terms of the number and timing of closing. However, the traffic volume was assumed to change every year by means of forecasting using GRDP in the Demak Regency.

According to the calculation results above, 3 trains passed the railroad crossing during the peak hours. The calculation results obtained a delay of 157.408 seconds or 2.623 minutes. In addition to calculating during peak hours, it counted the most train that passed in one hour. It was from 20.00-21.00 because 5 trains passed the railroad crossing. The calculation results obtained a delay of 139,67 seconds or 2,32 minutes. Based on the calculation, it can be concluded that there is a difference of 1 minute for a delay between the peak hours and the most train passing the railroad.

Therefore, the length of delay used was the average of peak hours and the most passing trains. The result is

148.52 seconds or 2.47 minutes. It can be seen in the travel time calculation in 2020 on each road in Table 21 and Table 22.

7) Time Value Analysis

The time value analysis used was from PT. Jasa Marga's (1990-1996) method with the following base time value. Time value is the number of costs spent by each road user to save their travel time. Jasa Marga method was used to analyze the time value by considering the increase of time value every year. For this reason, it used inflation of 3.04% for the existing road. It was the same as the flyover road, but in this case, it was multiplied by the travel time of the flyover road. The overall results of existing and flyover roads in 2020 can be seen in Table 23 for existing roads and Table 24 for flyover roads.

From the Table 23 and Table 24, the results of Saving of Time Value in 2020 can be calculated in the following way:

Saving of Time Value = Total Existing Time Value - Total Flyover Time Value

Saving of Time Value = IDR 8.391.383.619–IDR 3.228.935.793

=IDR 5.162.447.825 / year

B. Flyover Development Costs Analysis

The investment costs for the Ganefo Mranggen Flyover were obtained from the analysis and calculations results with unit prices. It was sourced from the 2017 unit and component prices (UCP). The construction costs for the Ganefo Mranggen Demak Flyover are IDR 120,125,842,674.

C. Land Acquisition Cost

Total land acquisition was obtained from the Department of Bina Marga and Cipta Karya Java Province. The result of the land acquisition cost of IDR 85,065,960,000 was then added to the flyover construction cost. After that, it carried out an economic feasibility analysis.

D. Economic Feasibility Analysis

1) Analysis of the Benefit Cost Ratio (BCR) Value

The Economic feasibility analysis of Flyover Ganefo Mranggen Demak can be seen from the BCR Value. The BCR value analysis was carried out by comparing the cost spent for flyover construction. It included maintenance costs with the amount of saving in it. The saving was obtained from VOC and time value saving. Based on the calculation, it obtained:

Total of Present Worth Cost =IDR 328.870.870.105
Total of Present Worth Benefit =IDR 367.201.132.096

Benefit cost ratio (BCR) =Benefit/Cost

Benefit cost ratio (BCR) = (IDR 328.870.870.105)/ (IDR 367.201.132.096)

=1,12 >1 (Feasible)

The result obtained was BCR value =1,12>1. Based on the requirement, the BCR value is >1. Therefore, the flyover construction was stated as feasible economically.

2) Analysis of Net Present Value (NPV)

The same as BCR analysis, NPV analysis was also used to review the economic feasibility. If the BCR was obtained from the comparison between Present Worth Benefit and Present Worth Cost, the NPV was obtained from the difference between Benefit and Cost. The result of calculation is as follows.

Total of Present Worth Cost =IDR 328.870.870.104
Total of Present Worth Benefit =IDR 367.201.132.096

Net Present Value (NPV) =*Benefit–Cost*

Net Present Value (NPV) =IDR 328.870.870.104-IDR 367.201.132.096

=IDR 38.330.261.991>0 (Layak)

Based on the calculation, it obtained the NPV =IDR 38.330.261.991>0. Based on the requirement, the NPV >0. Therefore, the flyover construction was stated as feasible economically.

CONCLUSIONS AND SUGGESTIONS

a) The results of vehicle volume analysis obtained the value of degree of saturation from the existing road (Without Project) in 2020 from Semarang to Purwodadi is 1, 36. The degree of saturation from Purwodadi to Semarang is 1, 02. The condition of degree of saturation (DS) was 0.59 from Semarang to Purwodadi during the existing road or the flyover project was constructed. The degree of saturation was 0.44 from Purwodadi to Semarang. On the road section, there was a decrease of the degree of saturation. It caused the project was considered to solve the traffic congestion problem at the intersection of Ganefo Mranggen Demak.

b) The calculation of VOC will result in the comparison between the VOC before the flyover construction and VOC after the construction of the flyover. The cost saving obtained was based on the difference between existing and flyover VOC in 2020 of IDR 1.493.266.223. Time value savings obtained in 2020 are IDR 5,162,447,825.

c) An economic feasibility analysis was carried out by calculating the Benefit Cost Ratio value (BCR) and Net Present Value (NPV). The calculation results obtained the BCR value was 1, 12 (BCR>1), and NPV was IDR 38.330.261.991 (NPV>0). Therefore, the flyover construction of the Aloha Roundabout flyover can be stated as feasible economically.

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