Analysis of Land Transport Comparison with Water Transport for Coal Transportation

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***Abstract*—Coal is one of the most abundant energy resources in Indonesia. At present, coal in Indonesia is not only an export commodity producing foreign exchange, but also began to be used as a source of energy to replace oil and natural gas. Coal demand is still high for export and domestic needs, coal production in one area of the Province of South Kalimantan will be increased from 8,000,000 tons / year to 10,000,000 tons / year.Increasing the amount of production requires appropriate transportation so that production can be achieved. The calculation of the comparison of coal transportation starts from the transport capacity, the capacity of the freight transportation based on the graph of the travel schedule,Land transportation used is a 30 ton capacity truck and the water transport used is a 180 feet barge with a capacity of 1,000 tons. Based on the results from the analysis, land transportation production is 8,466.120 tons. The amount of production cannot be increased because the capacity of the cargo has been maximal and the number of queues of vehicles is tide. Based on the results of calculations, the best transportation for coal transportation is water transportation.**

Keywords*—*Coal; Transport Capacity; Comparison Transportation; Coal Transportation.

I. INTRODUCTION

Coal is one of the most abundant energy resources in Indonesia. At present, coal in Indonesia is not only an export commodity producing foreign exchange, but also began to be used as a source of energy to replace oil and natural gas. Increasing demand for coal in the country is expected to increase coal production in the coming years. Kalimantan Island is the largest coal producer in Indonesia as seen from the amount of its reserves which reaches ± 16,627 million tons, while the amount of coal reserves in Sumatra Island is ± 13,284 million tons. On Borneo Island there are 4 coal-producing provinces, namely: Central Kalimantan, South Kalimantan, East Kalimantan, and North Kalimantan. South Kalimantan Province is the second largest producer after East Kalimantan (Lakin Minerba, 2017). Coal transportation in this area uses water transportation and land transportation. The water transportation used is a 180 feet drag barge with a capacity of 1,000 tons and transported by river as far as 29 km. The land transportation used is a truck with a capacity of 30 tons. The river used as a transportation route is the normalization of the dead river called Sungai Muning. Coal is transported from the starting point at the Upper Terminal and transported to the Lower Terminal. Coal production in this region will be increased to meet domestic coal demand and export needs. Coal production will be increased from 8,000,000 tons / year to 10,000,000 tons / year. From this increase in production will be carried out the calculation of the transport capacity used, namely land transportation with water transport, to be carried out in comparison so that it can be known which transportation is more efficient to increase coal production in the region.

II. METHODOLOGY

A. *Thought Flow Chart*

Analysis of coal transport capacity is carried out by comparing the transport capacity used, then from the comparison it is chosen to be coal transport in the Muning River[1].In conducting this research, the author uses a flow of thought that will be explained through the flow chart Figure 1:

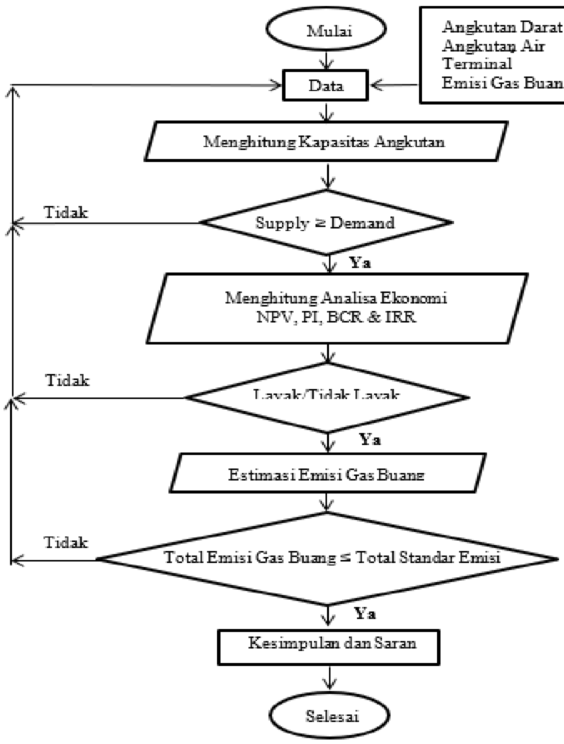


Figure 1. Flow Chart

To calculate the travel time of coal transportation using the following formula:

T = ... ………………………………………………........… (1)

Where

t = travel time (hour)

s = distance traveled (km)

v = speed (km / h)

From the above calculation then proceed to calculate the total trip per day (nh), where the formula used is as follows:

$n_h = \frac{\text{Time Work / Day}}{\text{Time Total (tw)}}$..(2)

For the calculation of payload capacity per day, the calculation must meet equation (2), the transport capacity used (Wo) and the total trip per day (nh) must be the same as the requirement (W).

W = Wo x nh .... (3)

Whereas to determine coal transport capacity for one year using the following formula:

Wx = Wtotal x n .... (4)

Where :

Wx = total 1 year load (tons)

Total = total load per day (tons)

n = effective work time of 1 year

After knowing the total load per year then the division between the total production last year with the total load per year, the formula used is as follows :

$Na = \frac{W_{tahun}}{W_x}$……………………..….................................(5)

Where :

Na = Number of trucks used

Wtahun = Total production last year

Wx = Total payload a year

B. Methodology of NPV, PI, and IRR

1. Net Present Value (NPV)

Net Present Value (NPV) can be interpreted as the present value of the revenue stream generated by investment. Mathematically, the NPV calculation can be formulated as follows:

NPV = TPV - Investment ....(6)

Where:

- NPV = net profit based on the amount of Present Value (PV)
- PVP = the total amount of cash flow after multiplying (x) the interest rate
- Investment = total amount of initial business investment

The assessment criteria with the NPV method are if the NPV (+) means that the investment is received, while if the NPV (-) means that the investment is rejected.

2. Payback Period (PP)

Payback Period (PP) is the period or number of years needed to return the value of the investment that has been issued.

Following is the formula used to calculate PP.

$PP = \frac{\text{Investasi}}{\text{Nilai rata-rata } \textit{cas flow}}$…………….......................….(7)

3. Profitability Index (PI)

This method calculates the comparison between net cash receipts in the coming year and the current investment value. If the Profitability Index (PI) is> 1, the project is said to be profitable. Whereas if the <1 project is not profitable.

$PI = \frac{\text{PV (A)}}{\text{Investasi}}$……….............…….....………..…….(8)

Dimana

PI = Profitability Index

PV (A) = total Present Value of Cash Flow

Investasi = investasi

4. IRR (Internal Rate Of Return)

Internal Rate of Return (IRR) is the maximum interest rate that a business can pay for the resources used because the business again requires funds to finance operations and investments[8]. If the IRR is equal to r% (discount rate), the business does not get profit or loss, and if the IRR <r% (discount rate) of the business is not feasible to run. A viable business is run if the IRR> r%. The discount rate (r%) has been determined by the company. Systematically, IRR calculations can be formulated as follows:

$IRR = i1 + \frac{NPV}{PV(B) - PV(C)}(i2 - i1)$…..............….............(9)

Where:

IRR = internal rate of return

i1 = 1st interest rate

i2 = the second interest rate

NPV = NPV value

PV (B) = Total present value discount rate 1

PC (C) = Total present value discount rate 2

C. Waste Emission Estimation

Calculation of estimated emissions is calculated based on the European methodology standard (MEET), where this calculation has been applied by Trozzi. Trozzi in his research used daily engine fuel consumption and emissions were calculated by considering factors such as engine power and type of fuel used. [9]

Exhaust emissions generated from land transportation are derived from truck engines, while exhaust emissions generated by water transport come from tugboat engines. To find out the data used in calculating exhaust emissions, and standard calculations, and the results after the calculation can be seen in Figure 3.3.

To find the exhaust gas emissions each stage can be used as follows:

Ei (upstream): t x k x d .... (10)

Ei (downstream): t x k x d .... (11)

Ei (trip): t x k x d .... (12)

Where :

T = time

K = fuel consumption

D = engine power

Whereas to find the total emissions from pollutants are as follows:

$E_{i\,(Total)} = E_{i\,(hulu)} + E_{i\,(hilir)} + E_{i\,(perjalanan)}$ ……..................(13)

III. DATA

A. *Shipping Rute*

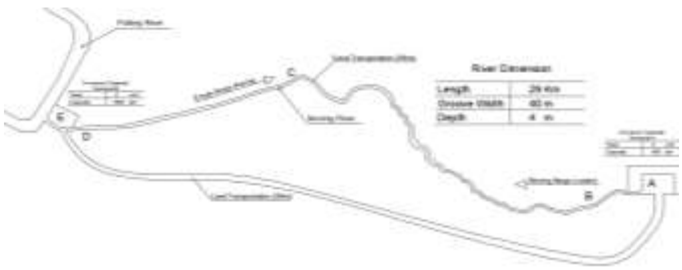
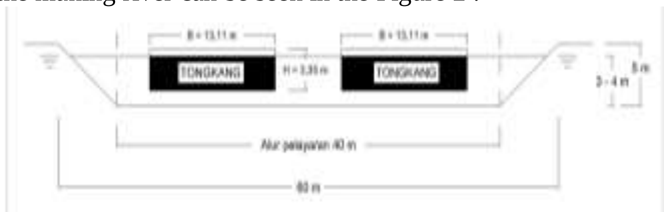


Figure 2. Shipping Rute

The muning river is used as a coal transportation route for water transport that connects from the upstream terminal to the downstream terminal which is 29 km away. The dimensions of the muning river can be seen in the Figure 2 .



Source : Research Data

Figure 3. Muning River Dimension

B. *Tidle Data*

Tides in these waters occur 2 times for 1 day. The influence of tides in these waters is not too large because of its distance from the sea. The following are the tidal data based on the Bathimetry and Hydro-Oceanography Survey that has been carried out. The survey was carried out using a palm (tidal sign) with a height of 3 m and then recorded a change in water height for 15 days.

TABLE I. DATA FOR TIDAL RIVER MUNING

Jam / Tgl	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17-Dec-13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source : Survey Bathimetri dan Hidro-Oceanogarfi

The table above is the tide data of the Muning River. The tide will be used to calculate the size of the tug boat.

- Coal Transportation
  Land Transportation

In transporting coal, use 2 modes of transportation, namely on land using trucks and canals using drag barges. The following data is used:

TABLE II. SPECIFICATION

Merk	Hino
Type	FM 260 JD New
Model	*Dump*truk
Max Power	260 PS (266 HP)
SFOC	178 gr/kwh
Rpm	2500 rpm
Capacity	30 Ton
Dimension P x L x T	8645 x 2490 x 2770 m

Source : www.hino.co.id

- Water Transportation

  Water transport that will be used to transport coal is drag barges and tugboats. Tugboat is used to towing barges.

TABLE III. SPECIFICATION TUG AND BARGE

No	Name	Dimension (M)			Speed (Knot)
		LOA	B	d	
1.	Tug Boat	15,50	4,80	2,30	8
2.	Barge	52,67	13,11	3,35	8

Source : Reseearch Data

The main engine specification data used are as follows:

TABLE IV. MAIN ENGINE SPECIFICATION

Merk	DOOSAN INFRACORE
Type	L 126 TIH
Number Series	EDIKM210685
Power	360 PS (265 Kw)
Rpm	2000 rpm
SFOC	117 g/kwh
Fuel	Solar

Source : Research Data

The auxiliary engine specification data used is as follows:

TABLE V. AUXILIARY ENGINE SPECIFICATION

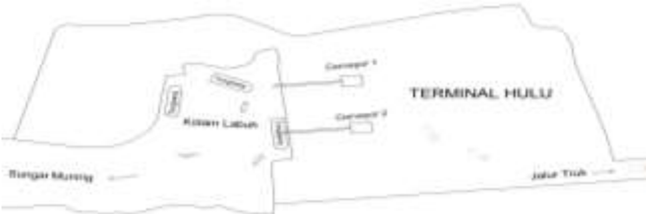
Merk	WEICHAI
Type	D226B-3C1
Power	35 Kw
Rpm	1800 rpm
SFOC	198 g/kwh
Fuel	Solar

Source : https://www.weichai.com

- Loading and unloading data

  This coal terminal will be used as a place to load and unload coal that is transported through the river channel. In this study the upstream terminal is at the starting point of the coal loaded, while the downstream terminal for the coal loading site.

- Upper Terminal Data



Source : Analysis

Figure 4. Layout Upper Terminal

Data Upper Teminal is :

- Depth = 5m
- Total conveyor = 2unit
- Capacity conveyor = 1.500 t/hour
- Length of Port = 186m
- Breadth of Port = 114m
- Time Operational = 24hours
- Area = 11.000m^2

- Downstream Terminal Data

Downstream Terminal Data are as follows:

- Depth = 5 m
- Conveyor number = 3 units
- Conveyor capacity = 900 t / hour
- Operating time = 24 hours
- Area area = 45,000 m2

The location of the Downstream Terminal is at the end of the Muning River, the cargo that has been transported in this place will then be transported by a larger barge via the Putting River line with the width of the river reaching 240 m.

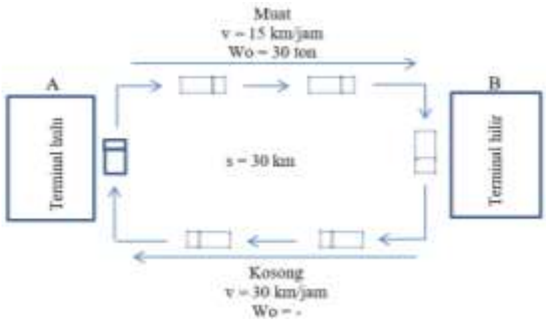
Source : Analysis Data

Figure 5. Layout Downstream Terminal

IV. RESULTS AND DISCUSSIONS

A. *Land Transport Capacity*

The land transportation used for coal transportation is a truck with a dump truck type with WO load capacity = 30 tons. Truck travel when loading is from A-B, while truck trips when empty are from B-A. The concept and calculation of trucks when loading up to empty trucks are as follows:



Source : Analysis Data

Figure 6. Land Transportation Concept

Below is a table of distance and speed of time taken for land transportation:

TABLE VI. DISTANCE, SPEED AND TRAVEL TIME OF LAND TRANSPORTATION

No	Condition	Distance (Km)	Speed (Km/Hour)	Time (Jam)
1.	Load	30	15	2
2.	Empty	30	30	1
Total				3

Source : Analysis Data

The table explains the length of travel time when the barge is fully loaded and the barge is empty when returning to the loading place.

- Total Time 1 trip (t_W)
  Time = 3 hours= 180 minutes
  Time Loading = 15minutes
  Time Unloading = 5 minutes
  Total time(t_W) = 180 + 15 + 5= 200minutes
  = 3,33 hours
- Total trip per day(n_h)
  Time Work Per Day= 24 jam
  $n_h = \frac{\text{Time Work Per Day}}{tw}$
  $n_h = \frac{24 \text{ jam}}{3{,}33 \text{ jam}} = 7{,}20$ trip
- Total Cargo per Day(W_{total})
  W_{total}= Wox n_h= 30 ton x 7,20 trip= 216 ton
- Effective Time per Year (n)
  1 Year= 365 Days
  Holiday in 1 year = 30Days
  n = 365 – 30
  = 335 Days
- Total loading in 1 year(Wx)
  Wx = W_{total} x n
  = 216 x 335
  = 72.360 ton
- Total Production Last Year (W_{tahun})
  W_{tahun} = 8.000.000 ton
- Total Of Using Truck (Na)
  Na $= \frac{W_{tahun}}{W_x}$

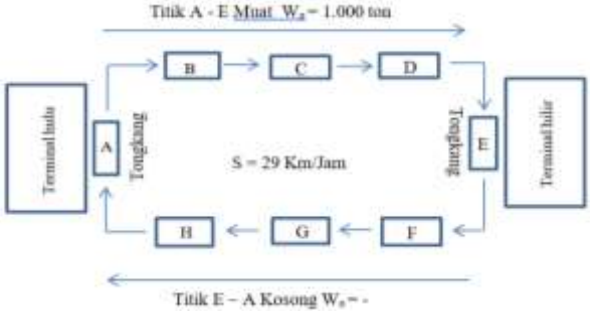
$= \frac{8.000.000 \text{ ton}}{72.360 \text{ ton}}$

= 110,56 = 111 truk

From the above calculation, it is known that the truck used is 111 units, and the number of truck transportation reserves is 9 units.

B. Water Transport Capacity

Water transportation used for coal transportation is a drag barge. The drag barge used is a 568 GT 180 feet barge with a WO loading capacity = 1,000 tons. The barge trip when loading is from A-E, while from E-A the barge travels when it is empty. The concept of coal transportation using barges can be seen in the Figure 7.



Source : Analysis Data

Figure 7. River Transportation Concept

Coal transportation from loading to empty has different speeds, the details are as follows:

- Water transport when loading

  The A - E point is the condition when the barge is loaded with Wo = 1,000 tons. The distance and calculation of travel time when loading is found in the table VII.

TABLE VII. DISTANCE, SPEED AND TRAVEL TIME OF WATER TRANSPORTATION

No	Point	Distance	Speed	Speed	Time
		(Km)	(Knot)	(Km/Hour)	(Hour)
1.	A - B	2	2	3,70	0,54
2.	B - C	16	4	7,41	2,16
3.	C - D	10	5	9,26	1,08
4.	D - E	1	2	3,70	0,27
Total					4,05

Source : Analysis Data

The data above is the speed traveled on each stage, so that the time taken in one trip will be known. The data above is data from land or truck transportation

- Water transport when empty

  Whereas at point E - A conditions when barges are empty. The distance and speed of the barges and the calculation of the travel time of the barges when empty are found in the table VIII.

TABLE VIII. DISTANCE, SPEED AND TRAVEL TIME OF WATER TRANSPORT WHEN EMPTY

No	Point	Distance	Speed	Speed	Time
		(Km)	(Knot)	(Km/Hour)	(Hour)
1.	E - D	1	2	3,70	0,27
2.	D - C	10	6	11,11	0,90
3.	C - B	16	4	7,41	2,16
4.	B - A	2	2	3,70	0,54
Total					3,87

Source : Analysis Data

The data above is the speed traveled on each stage, so that the time taken in one trip will be known. The data above is data from Tug and Barges.

- Calculation total time 1 trip (t_W)
  conveyor loading Capacity = 1.500 tph
  conveyor unloading Capacity = 900 tph
  conveyor Efficiency = 90 %
  Loading Time = 0,74 Hour = 44,44 Minutes
  Unloading Time = 1,23 Hour = 74,07 Minutes
- Total Time Barge(t_w)
  t_w = Total Time Loading + total Empty Time + Time Loading + Time Unloading
  = 4,05 + 3,87 + 0,74 + 1,23
  = 9,89 Hour
  Time Work Per Day = 24 Hours
- Total trip per Day(n_h)
  $n_h = \frac{\text{Time Work Per Day}}{t_w}$
  $= \frac{24}{9,89}$
  = 2,43 trip
- Loading Barge Capacity (Wo)
  Wo = 1.000 ton
- Total Loading per Day (W_{total})
  $W_{total} = W_o \times n_h$
  = 1.000 x 2,43
  = 2.425,55 ton
- Total Loading per Year(Wx)
  $W_x = W_{total} \times n$
  = 2.425,55 x 335
  = 812.558,26 ton
- Total Production Last Year(W_{tahun})
  W_{tahun}= 8.000.000 ton
- Total Barge Using (Na)
  $Na = \frac{W_{tahun}}{W_x}$
  $= \frac{8.000.000 \text{ ton}}{812.558,26 \text{ ton}}$
  = 9,85 = 10 Barges

From the above calculation, it is known that the barge transportation used is 10 units, and the number of reserves is 1 unit.Based on the Bathimetry and Hydro-Oceanography Survey that has been carried out, the change in water level at high tide reaches 4.09 m, while the change in water at low tide

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is 3.45 m. The water-laden height is then added to the trim by stern condition and clearance with seabed.

TABLE IX. ADDITION OF BARGE HIGHT

No	Kondisi	Tinggi
1.	*Trim by stern*	0,4 m
2.	*Clearance with seabed*	0,5 m
Jumlah		0,9 m

Source : Analysis Data

The height of 230 feet barge water is 2.77 m after adding 0.9 m to 3.67 m, the lowest river depth is 3.45 m. the river depth is less than 0.22 m so that the depth of the river can be traversed by 230 feet. Dredging the river channel into a solution so that the 230 feet barge can be used optimally in these waters.

- Economic Analysis of Water Transport

  The costs used for calculating the feasibility of investment in water transport consist of the investment costs of transportation and terminals, operational costs, and operational costs of travel.

  Cash flow estimation calculations (Cash Flow), Payback Period (PP), Net Present Value (NPV), Profitabilty Index (PI), and Internal Rate of Return (IRR).
- Estimated Cash Flow

TABLE X. ESTIMATED CASH FLOW OF WATER TRANSPORT FOR 5 YEARS

Information	Calculation Cash Flow per Years (Rp.)				
	2017	2018	2019	2020	2021
Income	1.520.000	1.530.000	1.800.000	2.090.000	2.400.000
Operating Cost	105.069	110.322	115.838	121.630	127.712
Depreciation	70.083	66.579	63.250	60.088	57.083
Pre – Tax Income	1.344.848	1.353.098	1.620.911	1.908.282	2.215.205
Tax 30%	403.454	405.930	486.273	572.485	664.561
After Tax Revenue	941.393	947.169	1.134.638	1.335.797	1.550.643
Depreciation	70.083	66.579	63.250	60.088	57.083
CashFlow	1.011.477	1.013.748	1.197.888	1.395.885	1.607.727
Total	6.226.725				

Source : Analysis Data

a. Ivestation Analysis with *Payback Period* (PP) metode :

Investation	= 2.106.530
Cash Flow 2017	= 1.011.477
	= 1.095.053
Cash Flow 2018	= 1.013.748
	= 81.305
	$= \frac{81.305}{1.012.612} \times 12 = 0{,}9$
PP	= 2,09 Years

The time period for returning the investment value is 2.09 years.

b. Investation Analysis with*Net Present Value* (NPV) metode :

TABLE XI. NPV WATER TRANSPORT CALCULATION

No	Year	*Cash Flow*	*DF* 10%	*PV of Cash*
1.	2013	1.011.477	0,909	919.432
2.	2014	1.013.748	0,826	837.356
3.	2015	1.197.888	0,751	899.614
4.	2016	1.395.885	0,683	953.390
5.	2017	1.607.727	0,621	998.398
PV (A)				4.608.190
Investation				2.106.530
NVP				2.501.660

Source : Analysis Data

c. Investment analysis using Profitabilty Index (PI) method

The Profitability Index method is a method that calculates the comparison between the present value of net cash receipts in the future (proceeds) and the present value of investment (outlays). If PI is greater 1, then the investment project is worth it. If the PI is smaller 1, then the investment project is not feasible.

$$PI = \frac{4.608.190}{2.106.530}$$
$$= 2{,}19$$
$$= 2{,}19 > 1$$

Based on the results of the calculation above, a positive result or 2.19> of 1 can be obtained, thus investment in coal transportation using water transport is feasible.

d. Investment Analysis with Internal Rate of Return (IRR) Method

TABLE XII. ESTIMATED WATER TRANSPORT NPV WITH AN INTEREST RATE OF 10% AND 16%

No.	Year	*Cash Flow*	DF 10%	*Present Value*Investation	DF 16%	*Present Value Cash Flow*
1	2013	1.011.477	0,909	919.432	0,862	792.551
2	2014	1.013.748	0,826	837.356	0,743	622.155
3	2015	1.197.888	0,751	899.614	0,641	576.653
4	2016	1.395.885	0,683	953.390	0,552	526.271
5	2017	1.607.727	0,621	998.398	0,476	475.238
PV (B)				4.608.190	PV(C)	2.992.867
Investation				2.106.530		2.106.530
				2.501.660		886.337

Source : Analysis Data

IRR $= Rr + \left(\frac{NVP}{PV(B)-PV(C)}\right) x(Rt-Rr)$

Where :

Rr = 10%

Rt = 16%

NVP = 2.501.660

PV (B) = 4.608.190

PV (C) = 2.992.867

Interest Rate = 6,57%

So,

IRR $= 10\% + \left(\frac{2.501.660}{4.608.190-2.992.867}\right) x\ (16\% - 10\%)$

IRR = 19 %

Because the IRR is 19% greater than the interest rate, the project is feasible to run. Based on the calculation of the IRR Analysis above, the transportation of coal using water transport is feasible to use because the IRR is greater than the interest rate that has been set at 6.57% per year.

V. CONCLUSION

Based on the calculation of the cash flow projection, and from the aspect of investment analysis with the Payback Period (PP) method, Net Present Value (NPV), Profability Index (PI), and Internal Rate of Return (IRR) the results of analysis of coal transportation using land and water transport worth running. A summary of the results of the calculation of economic feasibility can be seen in the table XIII.

TABLE XIII. SUMMARY OF THE RESULT OF PP, NPV, PI AND IRR

No	Type	PP (Month)	NPV (Rp)	PI	IRR
1.	Land Transportation	3,27	797.723.385.164	1,22	13%
2.	River Transportation	2,09	2.501.660.211.614	2,19	19%

Source : Analysis Data

From the results of the economic feasibility of coal transportation using water transport the results are more feasible than land transportation. This makes water transportation chosen to be used as coal transportation to increase planned production.

The following suggestions can be given as a consideration for objects of observation in making decisions and subsequent research.

1. Water transport facilities for loading and unloading so that they can be repaired or replaced to speed up the time when loading and unloading.
2. Dredging the river channel so that the depth of the river increases, with increasing depth will not be an obstacle for a larger barge.
3. For further research, a study on the use of Self Propeller Barge for coal transportation in the Muning River can be carried out. This use aims to make coal transportation more practical because the engine barges have their own propulsion machines so that they do not require barges during the transport process.

For further research can be done Placement of empty barges at the coal terminal to optimize the performance of the tugboat.

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