THE FEASIBILITY STUDY OF ROAD IMPROVEMENT GEOTEXTILE USING DISCOUNTED CASH FLOW METHOD

A CASE STUDY OF PT BERAU COAL

FINAL PROJECT

In partial fulfilment of the requirements
for the master's degree
from Institut Teknologi Bandung

By:

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INSTITUT TEKNOLOGI BANDUNG

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ABSTRACT

THE FEASIBILITY STUDY OF ROAD IMPROVEMENT GEOTEXTILE USING DISCOUNTED CASH FLOW METHOD (A CASE STUDY OF PT BERAU COAL)

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PT Berau Coal is one of the largest coal company in Indonesia which engaged in the energy sector for coal commodities and contributes to global energy supply. Lati Mine Operation is one of the open pit mining operational owned by PT Berau Coal. This area has overburden removal production annual target 134,556,000 BCM and coal getting 8,631,000 MT in year 2022. In the first semester of 2022, actual overburden removal was achieved in 94% under the year to date plan. Based on pareto loss production analysis, the biggest lost contributor of overburden removal was came from hauler productivity parameter. The root cause of hauler productivity problem is material used for road surfacing which has implication to road condition. Road surfacing material was came from redisturb material that cause low bearing capacity on subgrade layer and impacted to road damage on the surface. One of improvement can be done to increase productivity and reduce cost maintenance is investment of geotextile implementation to mine road reinforcement. Therefore, project investment need to be evaluated through a comprehensive financial analysis to get financial feasibility of this project. This research will use capital budgeting analysis to evaluate the financial feasibility, including sensitivity analysis and risk analysis.

The baseline of feasibility analysis regarding improvement project shows good result with Net Present Value (NPV) worth IDR 2.128.571.460,46 Internal Rate Return (IRR) of 41,09%, 1,43 of Profitability Index (PI) , and 1,22 years of payback period (PBP). Based on Monte Carlo Simulation, the probability to get IRR below base scenario (< 41,09%) is 13,7%, or in the other words, there is probability 13,7% that the IRR project will generate value below base scenario target calculation in this project. In conclusion, mine road improvement using geotextile is feasible and potentially give optimum impact on increase productivity and cost efficiency regarding to mine road maintenance. For the future research, geotextile improvement financially and technically could be implemented to all mine road PT Berau Coal, in order to that, further studies regarding to material properties in every mine road segments and durability of geotextile itself need to be done.

Keywords : geotextile , cost efficiency , capital budgeting , risk analysis

=:

ABSTRAK

STUDI KELAYAKAN TENTANG PERBAIKAN JALAN GEOTEKSTIL MENGGUNAKAN METODE DISCOUNTED CASH FLOW (STUDI KASUS PT BERAU COAL)

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PT Berau Coal merupakan salah satu perusahaan batu bara terbesar di Indonesia yang bergerak di bidang energi untuk komoditas batu bara dan berkontribusi dalam penyediaan energi dunia. Lati Mine Operation merupakan salah satu operasi penambangan terbuka yang dimiliki oleh PT Berau Coal. Area ini memiliki target tahunan produksi pengupasan lapisan penutup sebesar 134.556.000 BCM dan produksi batubara sebanyak 8.631.000 MT pada tahun 2022. Pada semester pertama tahun 2022, pencapaian pengupasan lapisan penutup tercapai hanya sebesar 94% di bawah target yang direncanakan. Berdasarkan analisis ketidaktercapaian produksi, penyumbang kegagalan terbesar pada pemindahan batuan penutup berasal dari parameter produktivitas unit angkut. Akar penyebab masalah produktivitas unit angkut adalah material yang digunakan untuk permukaan jalan yang berimplikasi pada kondisi jalan. Material perkerasan jalan berasal dari material redisturb yang menyebabkan rendahnya daya dukung lapisan tanah dasar dan berdampak pada kerusakan jalan di permukaan. Salah satu perbaikan yang dapat dilakukan untuk meningkatkan produktivitas dan menekan biaya pemeliharaan adalah investasi penerapan geotekstil untuk perkuatan jalan tambang. Oleh karena itu, investasi proyek perlu dievaluasi melalui analisis finansial yang komprehensif untuk mendapatkan kelayakan finansial dari proyek ini. Penelitian ini akan menggunakan analisis capital budgeting untuk mengevaluasi kelayakan keuangan, termasuk analisis sensitivitas dan analisis risiko.

Baseline analisis kelayakan mengenai proyek perbaikan menunjukkan hasil yang baik dengan Net Present Value (NPV) senilai Rp 2.128.571.460,46 Internal Rate Return (IRR) sebesar 41,09%, Profitability Index (PI) 1,43, Payback Period (PBP) 1,22 tahun. Berdasarkan Simulasi Monte Carlo, probabilitas untuk mendapatkan IRR di bawah skenario dasar (< 41,09%) adalah 13,7%, atau dengan kata lain terdapat probabilitas 13,7% bahwa IRR proyek akan menghasilkan nilai di bawah skenario dasar perhitungan target dalam proyek ini. Kesimpulannya, perbaikan jalan tambang dengan menggunakan geotekstil adalah layak dan berpotensi memberikan dampak optimal pada peningkatan produktivitas dan efisiensi biaya pemeliharaan jalan tambang. Untuk penelitian selanjutnya, proyek geotekstil secara finansial dan teknis dapat diterapkan pada semua jalan tambang di PT Berau Coal, untuk itu perlu dilakukan studi lebih lanjut mengenai sifat material di setiap ruas jalan tambang dan durabilitas geotekstil itu sendiri

Kata kunci: geotekstil , efisiensi biaya , capital budgeting , analisis risiko

VALIDATION PAGE

THE FEASIBILITY STUDY OF ROAD IMPROVEMENT GEOTEXTILE USING DISCOUNTED CASH FLOW METHOD (A CASE STUDY OF PT BERAU COAL)

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Approved

Bandung, December 2022

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This thesis is dedicated to mother, big family , my beloved future wife, and PT Berau Coal who always support me on this program

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Gratitude to Almighty God's presence for His inclusion and mercy so this final project can be completed. Final project entitled “The Feasibility Study of Road Improvement Geotextile using Discounted Cash Flow Method” prepared to complete the Master of Business Administration (MBA) program in the School of Business and Management Institut Teknologi Bandung (SBM ITB). This program gave me mind-opening knowledge that could hopefully being the benefit for my career future. In arranging this final project, the author truly get lots challenges and obstructions but with help of many individuals, those obstructions could passed, because of that, the author would like to express the sincere appreciation for :

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Hopefully, this final project can provide maximum benefits for both science and business practice. This final project is certainly not perfect, criticism and suggestions for improvement are very welcome.

Bandung, December 2022

Yosua Posma Tambunan

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1.1 Background

Coal is essential resource for tackling the challenges facing the modern world, specifically the rapid increase in energy consumption. Coal accounts for around 35% of the world's electricity supply and the most abundant source of electricity worldwide compared with oil and gas . It is fundamental in powering homes and industries, providing energy for transport and producing steel, concrete, and cement production. For now, coal is still cheaper and more accessible than other fossil fuels and its reserves are distributed much more equally around the planet.

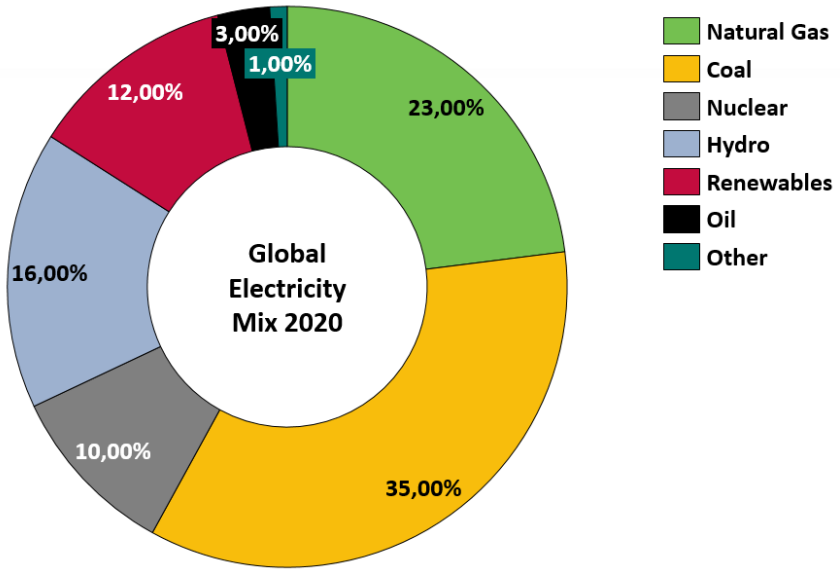


Figure I.1 Global Electricity Generation in 2020

In Indonesia itself, total coal production has reached 607 million ton in 2021, where it was exported 52% and the rest 48% was consumed to support domestic needs. Indonesia is one of top global coal exporters, in 2021, total coal exports reached 317 million ton and fills the portion of demand world's top coal consumer, China and India. China and India were also the world's two most populous nations. These figures equate to approximately 54% of world's coal consumption while India accounted for 11%. Then the following world biggest coal consumers are United States of America, Japan, and Russia, and European countries. Global coal consumption since 1978 has been steadily increasing until 2020. Due to strategic position

to the China and India, Indonesia's position is closer to them. In addition, Indonesia coal quality are medium rank or thermal coal which is very suitable for their coal power plant needs. Because of this significant contribution for nation, coal as national energy source and income, it is important to improve the efficiency of operational in coal mining industry.

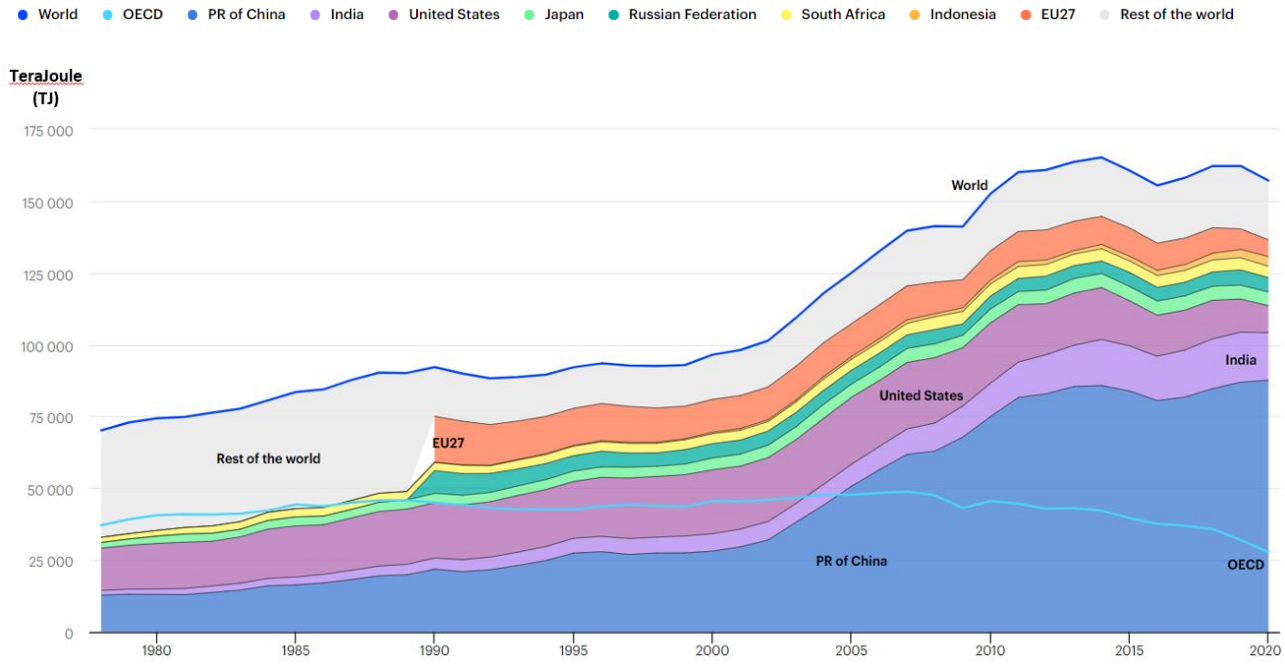


Figure I.2 Word Coal Consumption, 1978 - 2020

1.2 Company Profile

PT Berau Coal is one of the largest coal mining company in Indonesia which established in 1983, operates in Berau Regency, East Borneo Province. PT Berau Coal applies an open pit mining method with total production 28,182,186 metric ton of coal in 2021. PT Berau Coal owns a 118,400 Hectare of mining concession area and it was based on letter from the Ministry of Energy and Mineral Resources (ESDM) and valid until 2025 with possibility to extend in 2 x 10 years. This concession area covering five mining sites, namely Lati Mine Operation, Binungan Mine Operation, Sambarata Mine Operation, Parapatan Mine Operation, and Gurimbang Mine Operation. And each mining site has its supply chain including mining pits, hauling toads, coal processing plant, and jetty coal.

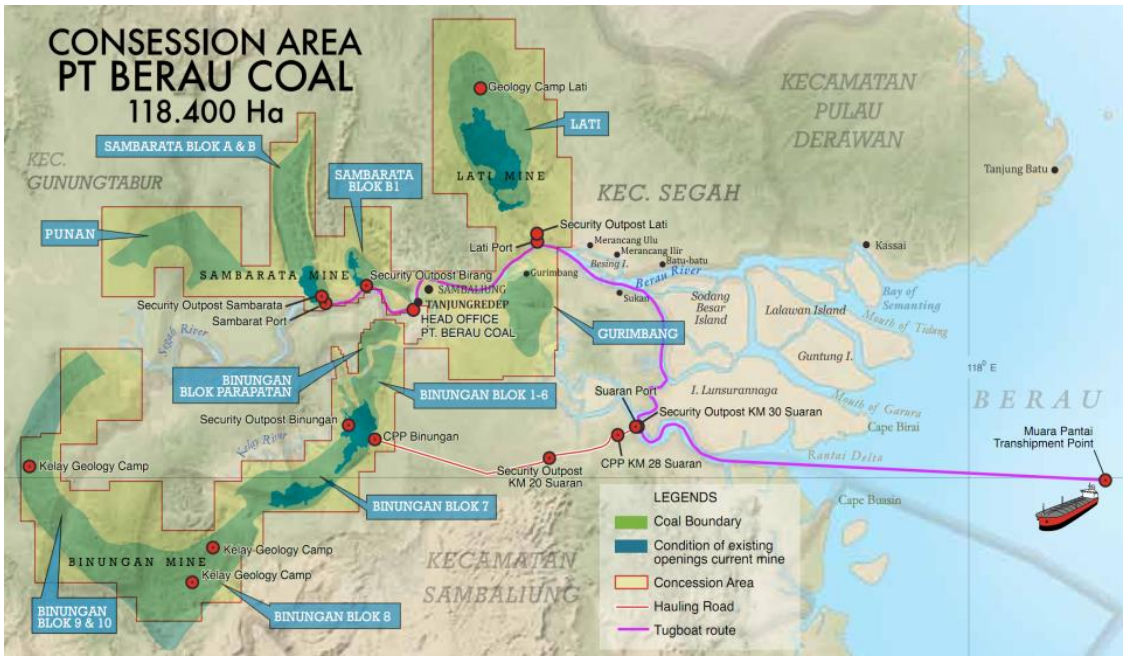


Figure I.3 Concession Area of Berau Coal (Berau Coal Energy, 2020)

Since 1992, PT Berau Coal has shown its significant production growth until 2021. It was in line with the growth of world coal consumption. In 1992, coal production was only 7,853 MT but in 2021 the actual coal production has reached 28,182,816 MT.

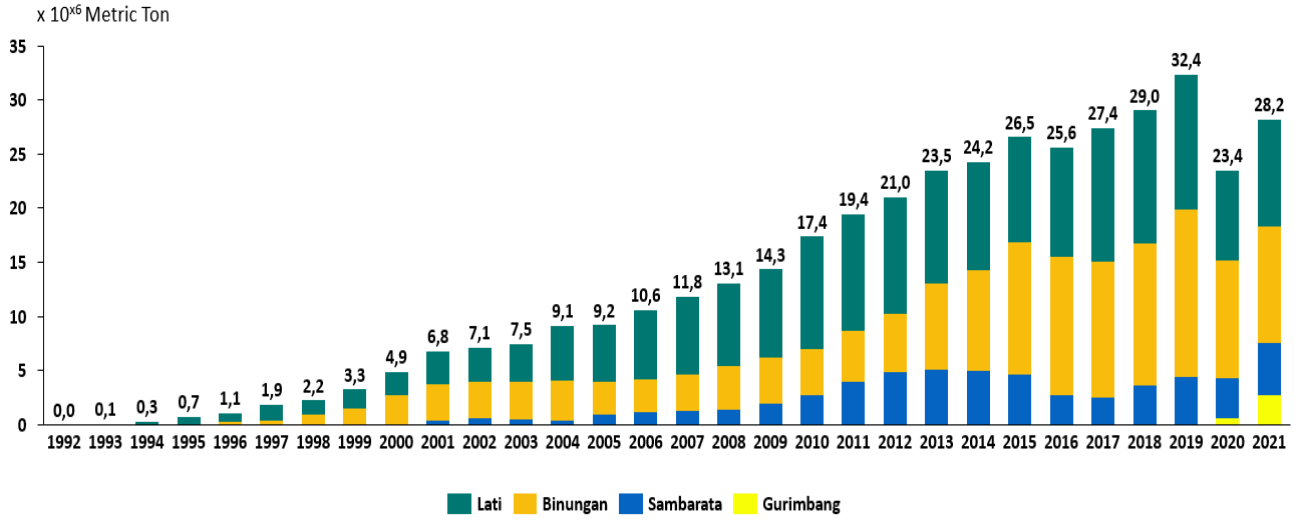


Figure I.4 Historical of actual coal production in 1992 until 2021

PT Berau Coal produces five coal main brands, namely Eboni, Mahoni, Mahoni B, Agathis, and Sungkai. PT Berau Coal has sub-bituminous quality with low ash and sulfur content. The calorific value is between 4,900 to 5,500 Kcal / kg (GAR).

Parameter	Kcal / kg	Eboni	Mahoni	Mahoni B	Agathis	Sungkai
Calorific Value (ARB)	Kcal / kg	5,700	5,500	5,300	5,100	5,000
Calorific Value (ADB)	%	6,100	5,900	5,750	5,600	5,500
Total Moisture (ARB)	%	18	20	22.5	25	26
Inherent Moisture (ADB)	%	12	14	16	17	18
Ash Content (ADB)	%	5	5	5	5	5
Total Sulphur (ADB)	%	1.8	0.9	0.9	0.9	0.1*

*Sulfur levels for sungkai products at special conditions according to customer request, can still be increased to 1.4 – 1.85 % ADB.
Source (Berau Coal, 2020)

Figure I.5 Coal Quality of each brand in PT Berau Coal

Coal transportation from mining area uses river channel by barge to the transhipment point which located in Muara Pantai. PT Berau Coal has transhipment facilities with gear and gearless vessel. And PT Berau Coal has 7 gearless vessel for loading tools.

Gearless Vessel	Loading Capacity (MT / day)
Bulk Borneo FTS	32,000
FTS Bulk Celebes	30,000
Bulk Java FTS	28,000
Bulk Sumatra FTS	30,000
FC Chloe	30,000
FC Blitz	20,000
FOTP Derawan	28,000

Figure I.6 7 unit Gearless Vessel in Transhipment Point

Core business process in mining operation has several main activities as explained below :

1. Geological mapping and exploration

2. Geological drilling

3. Land acquisition

4. Land clearing

5. Soil Removal

6. Drilling & Blasting

7. Overburden Removal (Excavating, Hauling & Dumping at Disposal Area)

8. Coal Getting

9. Coal Hauling

10. Coal Processing (Crushing, Stockpiling, Blending)

11. Coal Barging

12. Coal Transport from port to transhipment point

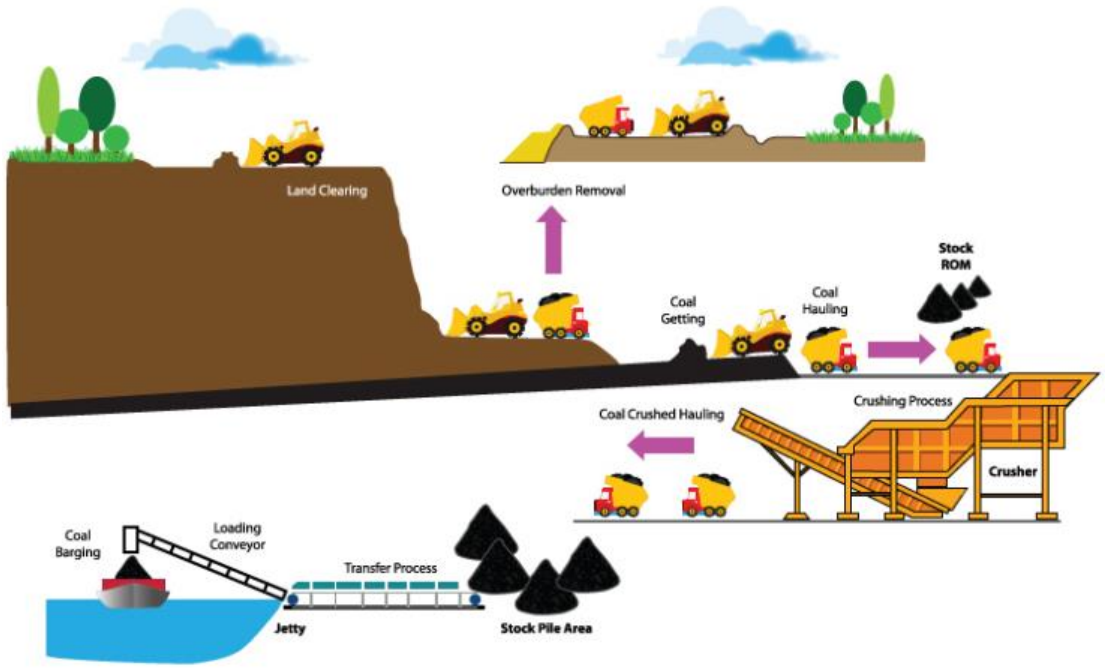


Figure I.7 Coal Mining Flow Process

1.2.1 Company Vision and Mission

Vision : Enabling a brighter future through becoming an exponential energy transformer

Mission : Our business is to manage natural resources became a source of energy with the operational standards that prioritizes environmental sustainability and social welfare

1.2.2 Corporate Values

Innovative : being exponentially driven has allow us to become innovative, future-driven, and proactive

Progressive : being exponentially transformative, we are able to lead professionally within a progressive synergy

Trust : we are trustworthy, customer focus, and compliance tp ensure the delivery of the exponential benefit

1.3 Business Issue

PT Berau Coal is one of big five coal mining company in Indonesia which has concession area at Kabupaten Berau, East Borneo. It applies open pit mine method or usually called surface mining. The stages of mining activity run by PT Berau Coal consist of land clearing, top soil removal, drilling and blasting, overburden removal, coal getting, and coal hauling. One of the success parameter in mining operation is marked by achieving production target, both overburden removal and coal getting production. If the overburden removal production is not achieve target, then coal extraction cannot be carried out optimally.

PT Berau Coal has four big active sites which operates in different area, those are Lati Mine Operation, Binungan Mine Operation, Sambarata Mine Operation, and Gurimbang Mine Operation. This research issue came from Lati Mine Operation which has overburden removal production annual target 134,556,000 BCM and coal getting 8,361,000 MT in year 2022. In the 1st Semester of 2022, actual overburden removal production target were not achieved. Overburden removal was achieved in 94% under the year to date plan. The biggest lost contributor was came from productivity parameter. One of crusial activity in mining flow process to support productivity is overburden removal hauling activity that carry overburden material from front to disposal by hauler. The productivity driver of hauler itself is speed (km/hour). Actual hauler productivity and speed in 1st Semester in 2022 was under target.

The root cause of hauler productivity problem is material used for road surfacing which has implication to mine road condition. Mine road for hauling activity is essential component in determining the achievement of overburden and coal production. Based on the geographical location of Lati Mine Operation, the majority of forming materials consists of many redisturb and swamp materials causing disruption in existing mining process. Road surfacing material was came from redisturb material that cause low bearing capacity on subgrade layer and impacted to road damage on the surface. Besides having an impact on productivity, this also affects the physical availability (PA) condition of the hauler, where many haulers breakdown due to cracks and spring fractures, impacted to higher cost maintenance and fuel consumption as well.

Alternative solution to increase speed and productivity is by using a layer of geotextile material for road subgrade reinforcement, then layering is carried out again using blasting hard material. For this project, it will be implemented on 2 road segments, Gunung Tabur and Channel Dump access. With this method, it can this will be able to strengthen road conditions, avoid damage and road repair with frequent frequency. And it will produce the increasing of productivity and hauler speed. It can also help reduce reduce cost maintenance and fuel efficiency. In the end, production target will potentially achieved and get higher profitability.

Mine operation permit from Republic Indonesia government through Minister of Energy and Mineral Resources (ESDM) will expire on December 2025 so this investment need to be analyzed through a comprehensive financial analysis to get financial feasibility of this project.

1.4 Research Question

The problem identification process of this research is approached by answering following questions :

- What are the project impacts on operational which will affect cost saving ?
- Is the road improvement project financially feasible (NPV, IRR, Payback Period, Profitability Index) ?
- What are the variables which will sensitively affect the project and how to assess the risk ?

1.5. Research Objective

To find out the financial benefit which could be obtained by PT Berau Coal in Road Improvement Project :

1. Analyze the financial feasibility of the project.
2. Analyze the financial parameters with capital budgeting method (NPV, IRR, Payback Period, and Profitability Index).
3. Analyze the risk of the project using sensitivity analysis and Monte Carlo Analysis.

1.6 Research Scope and Limitation

The limitations of this research are :

1. Capital expenditure information is based on manufacturer's quotation of geotextile material provider and actual data from PT Berau Coal
2. All primary datas are obtained from PT Berau Coal
3. This research focus on incremental variables analysis which make cost saving between initial and improvement scheme
4. Financial analysis using capital budgeting including NPV, IRR, Payback Period, and PI with monte carlo method and sensitivity analysis
5. This research was made based on the Decree of the Minister of Energy and Mineral Resources No. 1827.K / 30 / MEM / 2018 concerning Guidelines for the Implementation of Good Mining Engineering Rules, namely on the Implementation of Mining and Processing Safety and / or Mineral and Coal Refining in Appendix II to the Mining Technical Management Guidelines; 6. Mining; b. The Surface Mine; 2) Implementation; part xix Mining Road.

1.7 Writing Structure

- **Chapter II**

This chapter will explain in detail about problem exploration, literature review, and conceptual framework. The problem exploration defines the context of business issue, exploration and clarification of root cause problem. The literature review chapter covers the flow of thought and scientific development in the topic of study. Essentially, the research results of a researcher is not a new discovery that stands alone but something that is related to the results of previous researches. And conceptual framework defines the relevant objectives for the research process and maps out how they come together to draw coherent conclusions.

- **Chapter III**

This chapter will explain in detail about research methodology to ensure valid and reliable resuts that address the research aims and objectives. What data to collect and how to collect

it, how to analyse it. In other words, the methodology chapter is to justify the design choices, by showing that the chosen methods and techniques are the best fit for the research aims and objectives, and will provide valid and reliable results.

- **Chapter IV**

This chapter will explain in detail about data analysis of existing problem and find business solution alternatives to improve road condition which implicated to hauler speed and increasing of productivity.

- **Chapter V**

This last chapter is the culmination of this study and explain about conclusion and recommendation that answer the research question.

Chapter II Literature Review

2.1 Problem Exploration

The coal mining business is currently faced with various challenges, such as policy export restrictions, increasing added value product, and volatile coal price. In order to be able to compete in industry, coal mining companies are required to increase productivity and efficiency as well as continues improvement in business process. Higher productivity could boost production volume and make cost efficiency, in the end it leads to higher profitability. As one of coal concession holders, PT Berau Coal has annual production target which has to be achieved. Production target of Overburden Removal and Coal Getting are divided into four major big sites, those are Lati Mine Operation, Binungan Mine Operation, Sambarata Mine Operation, and Gurimbang Mine Operation.. In order to achieve production target, there are several production parameters which has to be hit and evaluated continuously. Those parameters are productivity, physical availability (PA), use of availability (UA), and unit quantity.

- **Productivity**

Productivity is about production levels over a defined period of time (e.g tonnes of coal or bcm of overburden removal per annum) and may consider factors such as the quality of material produced. The amount of production from loader (loading equipment) and hauler (hauling equipment) are obtained by multiplying bucket capacity of loader, number of trips per hour, and correction factor, the correction factor consist of the bucket fill factor and work efficiency. So the formula of productivity is :

$$Qm = \left(\frac{60}{Ctm}\right) \times Cb \times Ff \times Sf \times E$$

Qm : Loader Productivity (bcm/hour)

Ctm : Loader cycle time (minute)

Cb : Bucket capacity of loader (bcm)

Ff : Bucket fill factor (%)

Sf : Swelling factor

E : Work efficiency (%)

- **Physical Availibility (PA)**

Physical readiness is a record of the physical condition of the equipment being used. It relates with unit breakdown time and maintenance or repair duration. PA can be expressed by the formula :

$$PA = \frac{W + S}{W + R + S} \times 100\%$$

PA : Physical availibility (%)

W : Working hour (hour)

R : Breakdown time (hour)

S : Stand by time (hour)

- **Use of Availibility (UA)**

Use of availability shows the percentage of time used by a unit to operate when the unit is ready and can be used. From UA, we could know whether the unit operates efficiently or not. UA can be expressed by the formula :

$$UA = \frac{W}{W + S} \times 100\%$$

UA : Use of availibility (%)

W : Working hour (hour)

S : Stand by time (hour)

In this research, project will be executed in Lati Mine Operation as the biggest site in PT Berau Coal . Lati Mine Operation has overburden removal production annual target 134,556,000 BCM (Bank Cubic Meter) and coal getting 8,361,000 MT (Metric Ton) in year 2022. In the 1st Semester of 2022, actual overburden removal was achieved in 94% under the year to date plan. Based on production parameter analysis, the biggest lost contributor of overburden removal was came from productivity parameter. And the productivity issue came from the key productivity driver, hauler speed (km/hour), it was under the target in the 1st Semester of 2022.

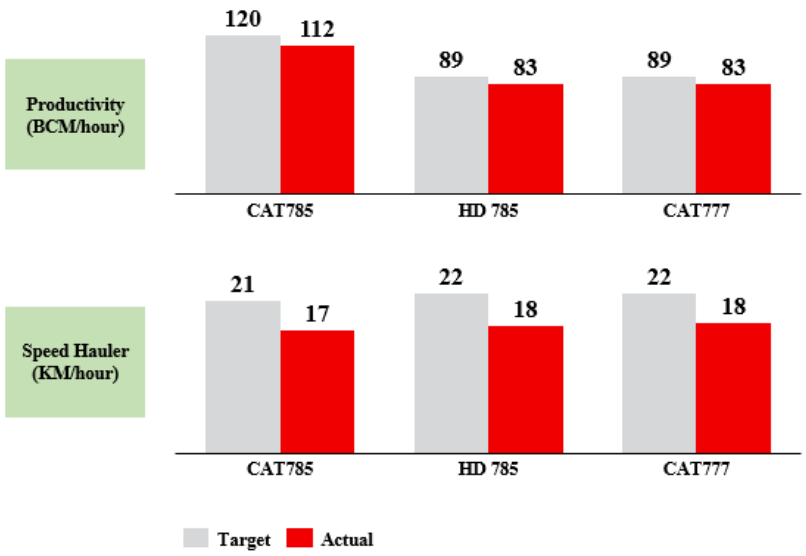


Figure II 1 Plan vs Actual Productivity and Speed Hauler in 1st Semester 2022

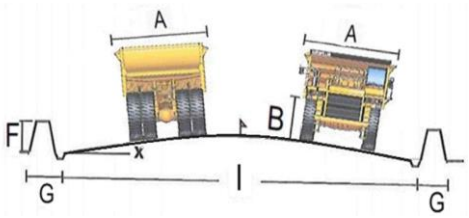
The root cause of hauler productivity problem is material used for road surfacing which has implication to road condition. Based on the geographical location of Lati Mine Operation, the majority of forming materials consists of many redisturb (material from ex-disposal) and swamp materials causing disruption in existing mining process. Road surfacing material was came from redisturb material that has loose behavior type of material (non-solid material). It cause low bearing capacity on subgrade layer and impacted to road damage on the surface. Besides having an impact on productivity, this also affects the physical availability (PA) condition of the hauler, where many haulers breakdown due to cracks and spring fractures. Bad mine road condition affects to higher road cost maintenance and fuel consumption, the utilization frequency of unit support, such as dozer,motor grader, and small loader for

maintenance was very high to keep the mine road at good condition and comply with mine road standard procedure in PT Berau Coal.

2.2 Literature Review

2.2.1 Mining Haul Road

Open pit mining in coal mine activities are related to material removal (waste and coal) excavation work, loading, hauling, and stockpiling. Key performance indicator which can be used to determine the level of success in coal mining industry is the amount of production target that can be achieved. One of parameter that affect the achievement of production is productivity. And one of the important factor to achieve high productivity is the condition of mine haul road which has implication to the speed of hauler in hauling activity. In overburden hauling activity, mine haul road is the essential parameter to support unit hauler activity. Good mine haul road is determined by two factors, source material which built the mine road and body road geometry. If material formed and road geometry have a good standard, this will certainly make a big contribution for cycle time and hauler speed and impacted to higher productivity for hauling activity. Standard body road geometry in Lati Mine Operation has comply with Standard Operational Procedure stated in P-CHD-02 Mine Road Management. This is the basic parameter that is used as a reference for each type of hauler unit that crosses the mine road. This is a mine road standard that has taken into account safety and technical aspects.



NO	PARAMETER		UNIT	TYPE TRUCK													
				CAT 793	CAT789	CAT785	CAT777	CAT773	CAT730	HD1500	HD785	HD465	EH1700	TR100	TR60	A40	K360
A	UNIT WIDTH	W	m	7.6	7.7	6.6	6.1	5.1	7.5	6.6	5.7	4.7	6.1	5.9	5	3.4	2.5
B	TIRE HEIGHT	H	m	3.4	3.59	3.06	2.72	2.19	3.3	2.9	2.7	2.1	2.5	2.6	2.1	2.1	1.2
C	NETT MINE ROAD WIDTH	3.5XW	m	27	27	23	21	18	26	23	20	16	21	21	18	12	9
D	BEND ROAD WIDTH	4XW	m	30	31	27	24	20	30	26	23	19	24	24	20	14	10
E	CROSSFALL	X	%	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4
F	BUNDWALL HEIGHT	0.75XH	m	2.6	2.7	2.3	2	1.6	2.5	2.2	2	1.6	1.9	2	1.6	1.6	0.9
G	BUNDWALL WIDTH	(2XF)+1	m	6	6	6	5	4	6	5	5	4	5	5	4	4	3
H	DIRT WIDTH	2X0.5	m	1	1	1	1	1	1	1	1	1	1	1	1	1	1
I	TOTAL NETT MINE ROAD WIDTH	C+G+H	m	34	34	30	27	23	33	29	26	21	27	27	23	17	13
J	TOTAL BEND ROAD WIDTH	D+G+H	m	38	38	33	30	26	37	33	29	24	30	30	25	19	14

Figure II 2 Standard Body Road Geometry in Lati Mine Operation

In this research, will concern in material source that forms mine haul road and affect productivity in hauling activity.

2.2.2 Soil Material

Soil is the thinnest layer of the earth crust which is located at the outermost and the result of weathering or erosion of anorganic rocks mixed with organic matter. Mineral are the main element in soil and formed from anorganic solid. In the process of its formation, the soil goes through a natural process that last a very long time, besides that the type of soil that is between one place and another are different. The difference could be caused by the type of rock, sunlight, original contour, and organism that live on the soil. Hardiyanto (2006) explained that in civil engineering perspective, soil is a collection of minerals, organic matters, and relatively loose deposits, which is located above the bedrock (base material). Formation of soil can be a physical or chemical process. Soil formation process physically changing rock into smaller particles, occurs due to the influence of erosion, wind, water, ice, humans, or the destruction of soil particles because changes in temperature or weather. The particles may be spherical, jagged, and in between. If the result of weathering is still present in place, then this soil called residual soil, but if soil transport to another place, is called transported soil.

2.2.3 Soil Material Classification

Prior to planning for infrastructure development, mine road hauling, highway transport, buildings, etc, first thing that has to do is soil material condition assessment for finding out whether the structure being built is able to be supported by the material itself or not. Soil material assessment is also carried out to find out whether the materials are in accordance with determined classification. If it is not in accordance with the classification, some efforts have to be done such as strengthening or reinforcement so that the soil material is able to support the structure above it. The purpose of soil material classification system is to provide the information of material characteristic and physical properties of the soil.

One of soil material classification system that common to be used is USCS (*Unified Soil Classification System*). This classification was proposed by Cassagrande in 1942 which was later revised by The Corps of ENgeneers and The US Bureau of Reclamation in 1952. This system classifies soil into two categories, namely coarse soil provided that less than 50% of the soil passes through sieve No.200 and fine ground provided that more than 50% of the soil

passess through sieve No.200. Some of the following symbols are often used in the classification of the USCS method :

1. Type of soil

G : *gravel*

S : *sand*

M : *silt*

C : *clay*

2. Type of gradation

W : *well graded*

P : *poorly graded*

3. Plasticity consistency

H : *high plasticity*

L : *low plasticity*

The table of USCS (*Unified Soil Classification System*) can be seen on the table below :

Table II 1 Table of USCS (*Unified Soil Classification System*)

Main Division			Classification Symbol	Description
Coarse grained soil 50% or more stuck in the filter no 200 (0.075 mm)	Gravel 50% or more than the coarse fraction pass on the sieve no.4 (4.75 mm)	Clean gravel (little or no	GW	Fine-graded gravel and gravel-sand mixtures, containing little or no fines
			GP	Bad-graded gravel and gravel-sand mixtures, containing little or no fines
		Gravel contains a lot	GM	Silty gravel, gravel-sand-clay mixture
			GC	Loamy gravel, clay sand gravel mixture
	Sand more than 50% the coarse fraction pass on the sieve no .4 (4.75 mm)	Clean gravel (little or no	SW	Fine graded sands, gravelly sands, little or no fines
			SP	Bad graded sands, gravelly sands, little or no fines
		Gravel contains a lot	SM	Silty sand, mixed silt sand
			SC	Loamy sand, loamy sand mixture
fine grained soil 50% or more stuck in the filter no 200 (0.075 mm)	Silts and clays liquid limit of 50% or less		ML	Inorganic silts and very fine sands, rock powders or silty or loamy fine sands
			CL	Inorganic silts of low to moderate plasticity, gravelly clays, sandy loams, silty clays
			OL	Organic clays and organic silty clays with low plasticity
	Silts and clays liquid limit of > 50%		MH	Inorganic clay or fine sand, elastic silt
			CH	Inorganic clay with high plasticity
			OH	Organic clays with moderate to high plasticity
Soil with high organic content			P_1	Cleat and other soils with a high organic content
Source : Hardiyatmo (2010)				

In this research, the major issue came from source material for mine haul road construction in Lati Mine Operation is clay which has high plasticity and it can cause the expansion of volume if the water content increases. In general, higher plasticity could cause the level of strength worse. Moreover, based on the geographical location of Lati Mine Operation, the majority of forming materials consists of many redisturb (ex-disposal which has loose characteristic) and swamp materials causing disruption in existing mining process. Base material was came from redisturb material which has low CBR (CBR <3%) that cause low bearing capacity on subgrade layer and impacted to road damage on the surface.

CBR Test is stands for California Bearing Ratio Test, is performed in construction materials laboratories to evaluate the strength of soil subgrades and base course materials. One of the strength of road construction is determined by the quality of the original soil bearing capacity as a subgrade. The way to determine the bearing capacity of the road subgrade is the CBR (California Bearing Ratio) test. The CBR value is used as the basis for planning the next road embankment pavement, depending on the desired road class. The higher the CBR value, the better the subgrade condition. If the original soil has a low bearing capacity (dry density, CBR), the road construction will quickly experience damage. The damage is cracks , undulations , and road settlement due to super heavy unit such as hauler and loader keep on going through the mine haul road.

In mining haul road construction, the low CBR and low bearing capacity of the material is a complicated problem. The alternative way to overcome this problem is to find another source hard material which has good bearing capacity and high CBR and then used as base material , but this condition is complicated considering the majority source material in Lati is from redisturb and swamp as base material which formed by clay with character high plasticity material. Moreover, there will be added cost which tends to be higher. Therefore, we need another alternative method which better in terms of technical and cost to prevent mine haul road damages for getting higher productivity, higher hauler speed, and cost efficiency (maintenance frequency and fuel consumption). Nowadays, along with technology advances, it has been found a synthetic layer which has high resistance to weathering processes and it is layered above the subgrade material. This synthetic layer, called geotextile, will prevent good

embankment material and poor base material mixed so that increasing level of bearing capacity.

2.2.4 Geotextile for mine haul road reinforcement

In general, geotextiles are widely used for various jobs related with the soil material, because geotextiles can provide stability to the embankment located in original redisturb and swampy material condition (soft material) which have low bearing capacity. The utilization of geotextile is a modern way of strengthening soft material. The use of geotextile as reinforcement is commonly applied to road projects highways, slope areas, and retaining wall construction.

Geotextile is a type of geosynthetic or artificial product of polymeric material that serves to improve soil performance and the shape is like carpet or cloth. The function of geotextile as a layer separator (separation), filter layer (filtration), water distributor (drainage), soil reinforcement (reinforcement), and moisture barrier or armor when covered by bitumen.

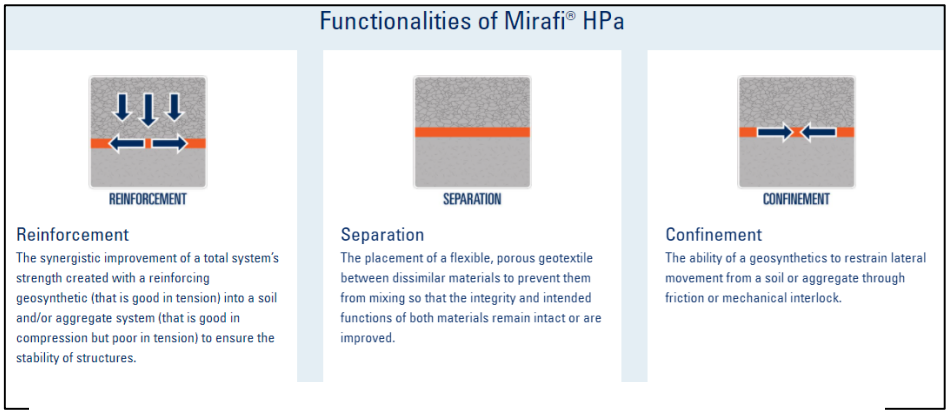


Figure II 3 The functionalities of Mirafi HPa

Generally, geotextiles are made of polymeric materials polyester (PET) or polypropylene (PP). According to J.P Girioud, geotextile are distinguished into two types based on the method used to combine filaments or ribbons into a sheet structure, woven geotextile and non-woven geotextile.

- **Woven Geotextile**

Woven geotextile is one type of geotextile produced by adopting techniques such as ordinary clothing textile weaving. This type of geotextile woven, usually bidirectional up and down

made of fiber or fiber polymer yarn made from polypropylene or polyester. Woven geotextile provides maximum tensile strength at minimal resistance weight. This matter provides a great economic advantage to get the level expected structural safety. Woven geotextile is permeable and has a higher tensile strength when compared to non-woven geotextile. Some of the advantages of woven geotextile are :

1. The shape is regular and woven so that it has a large tensile strength compared to non-woven geotextile, it is veru suitable as a reinforcement.

2. Permeable to water so it can be used as a filter layer.

- **Non-woven Geotextile**

Non-woven geotextile is a type of geotextile made of polypropylene and polyester material. The shape of the non-woven geotextile is not woven geotextile is not woven fabrics such as rugs. This type of geotextile are designed to provide optimum performance per unit weight. Excellent mechanical and hydraulic resistance make non-woven geotextile the right choice for lining separator and filter because it has high puncture resistance to ensure the material is not damaged during execution. There are several advantages of non-woven geotextile :

1. Has a fairly large permeability, so it is suitable to be applied on subgrade which contains a lot of plant residues.

2. has better hydraulic properties so that it can be as a filter layer that only dissolves water without carrying soil particles.

3. The resistance to sharp object is better than woven geotextile.

Research conducted by Ichsan (2016) is a Numerical Analysis of the Use of Ge-Cell 10-40 from geotextile material on road foundation layer. The result obtained after conducting the research is that the pattern of settlement is decrease in the presence of geotextile reinforcement. It can increase the bearing capacity along with the increasing of coated surface area.

2.2.5 Impact Geotextile for increasing hauler speed and mine road maintenance efficiency

Based on actual research which had conducted by Ahmad Zohiri (2020) in Pit Inul Lignit PT Kaltim Prima Coal (PT KPC), Sangatta, East Borneo, application of geotextile in mine road could increase the hauler speed (on its research using CAT785 Caterpillar) and reduce the frequency of use of surfacing material for mine road maintenance. Before geotextile application, actual hauler speed in Pit Inul Lignit always under target. Besides of geotextile function as mine road reinforcement, it is able separate the material above and below geotextile. The use of geotextile could prevent mixing material on the mine haul road and overburden from Pit Inul Lignit which will be utilized on the surface. Therefore, the application of geotextile can reduce rolling resistance from initial value 8% become 3% and impacted to increase 39,59% of hauler speed. In addition, the use of geotextile could reduce the number of maintenance frequency up to 87,5%. Before the application of geotextile, maintenance frequency using backfilling method was 24 times per day, however, after the improvement was executed, the frequency was reduce become 3 times per day. This improvement gave impact to increase productivity of hauler and cost maintenance efficiency for real.

2.3 Conceptual Framework

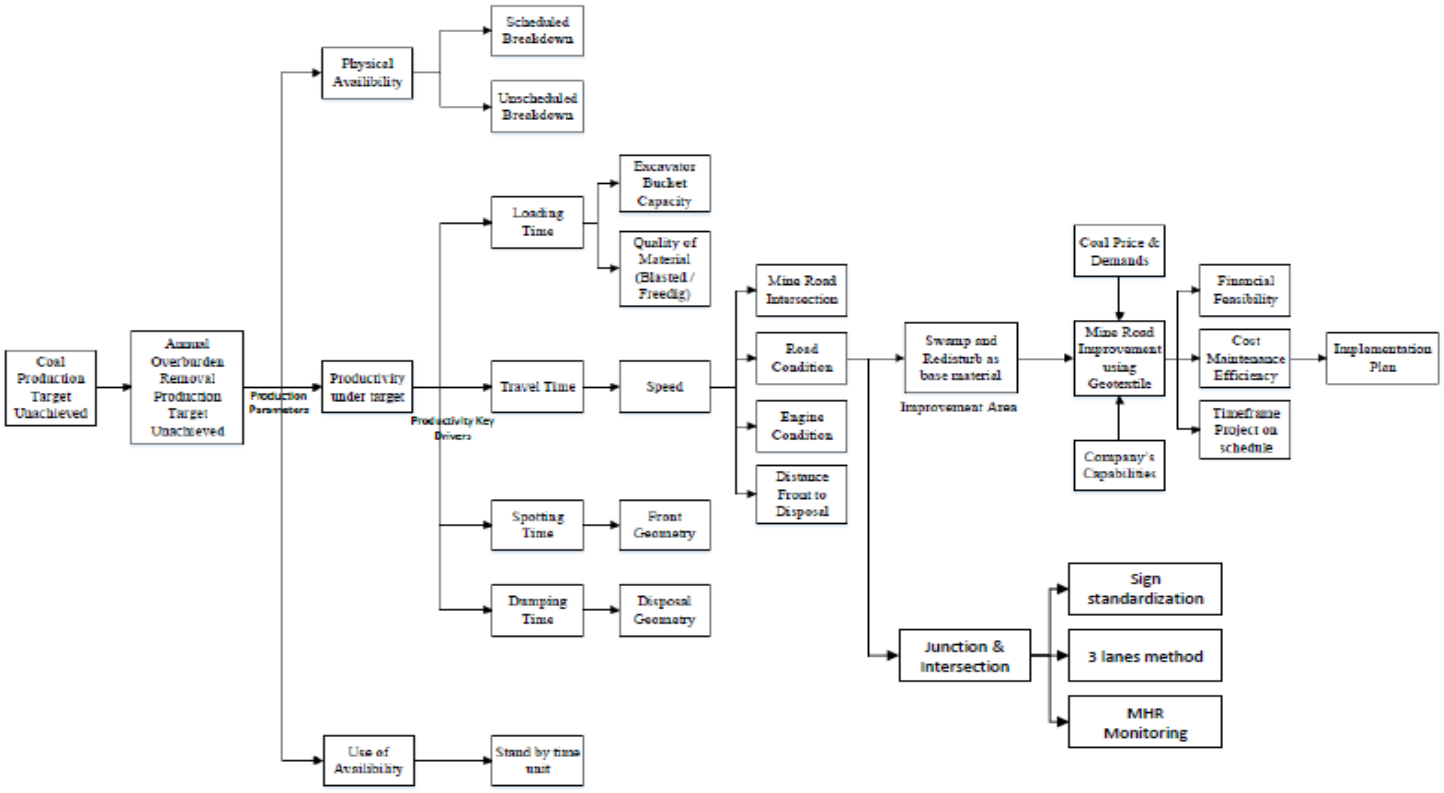


Figure II 4 Conceptual Framework

The conceptual framework above (Figure II.4) is a conceptual model on how the theory or logical sense of the relationship identified as necessary problem. It could be the answer of the business issue by following several steps in this flow chart to find the solution of this project. The issue comes from annual target of coal production which will be exposed and hit if overburden removal could achieve the annual target. As the business issue explained before, in the 1st Semester of 2022 (January – June 2022) , the achievement of overburden removal production was 94% under from year to date target. Production parameters consist of three variables which are physical availability, use of availability, and productivity. The biggest loss contributor was came from productivity hauler. Productivity is driven by several parameters, which are loading time, spotting time, dumping time, and travel time. Loading time is influenced by excavator bucket capacity and quality of material blasted or freedig, spotting time influenced by front geometry, dumping time influenced by disposal geometry, and travel time influenced by speed. Hauler speed is depend on the number of mine road intersection,

engine performance, distance from front to disposal, and mine road condition. Because of majority material forming in Lati Mine Operation is swamp and redisturv which have low bearing capacity, base material for mine road construction is not good enough to withstand with unit hauler that pass. One of improvement that can be a solution is geotextile application as mine road reinforcement. The author will conduct the research starting from preliminary design until the result of the project. The author will use two methods in this study, quantitative and qualitative to analyzing and calculating capital budgeting on Road Geotextile project. Both primary and secondary data will be needed, primary data will be collected from monthly records performance production from site Lati Mine Operation PT Berau Coal while secondary data will use books and literatures related to the unit productivity, overburden removal hauling, and mine road reinforcement using geotextile.

This new improvement need to be analyzed through a comprehensive financial analysis to get financial feasibility of this project. This research will use discounted cash flow (DCF) to assess and decide whether this investment project will be executed or not. If this project feasible, it will be initiated on Januari 2023 and take 6 months for construction period, so it will be ready for use in July 2023.

And for the final impact of this project, it can this will be able to strengthen road conditions, avoid damage and road repair with frequent frequency. And it will produce the increasing of productivity and hauler speed. It can also help reduce cost maintenance and fuel efficiency. In the end, production target will potentially achieved.

Chapter III Research Methodology

3.1 Data Collection

3.1.1 Primary data from PT Berau Coal

In this research, all primary datas will be collected directly from PT Berau Coal. All datas will be explained in detail as follow :

- The production profile of Lati Mine Operation from 2023 until 2025 generated by Mine Plan Department of PT Berau Coal consist of overburden removal, coal exposed, coal getting, mining strip ratio, contract strip ratio, overburden removal distance, and coal getting distance.
- Gain or loss actual production in the 1st Semester 2022 (January – June 2022) which shows waterfall analysis chart of production parameters (physical availibility, use of availibility, productivity, and quantity)
- All data parameters will be obtained from 5 fleets which are planned to access 2 segments of mine haul road using geotextile. Each fleet consist of excavator paired by hauler. Those units are described in the table below.

Table III 1 Table of list unit which access 2 segments of mine haul road using geotextile

Unit	Unit Type	Brand	Quantity
Excavator	EX3600	Hitachi	1 unit
	EX2500	Hitachi	2 unit
	PC2000	Komatsu	2 unit
Hauler	CAT785	Caterpillar	5 unit
	HD785	Komatsu	10 unit
	CAT777	Caterpillar	10 unit

- All utilized unit support for doing maintenance are PC400 Komatsu, Dozer 155 Komatsu, and Motor Grader type 24 M Caterpillar.
- Productivity data (bcm/hour) was taken from average actual historical data from January – June 2022 and productivity target or expected productivity after the project is implemented.

- Maintenance duration (hours) was taken from average actual historical data from January – June 2022 and expected maintenance duration target which will be reduced after the project is implemented.
- Fuel consumption (liter/hour) was taken from average actual historical data from January – June 2022 and expected fuel consumption target which will be reduced after the project is implemented.
- Effective working hour of 5 fleets which are planned to access 2 segments of mine haul road using geotextile was taken from average actual historical data from January – June 2022.
- Fuel price assumption using brent oil price in Indonesian Coal Index-3 (ICI-3) based and then converted to site price factor.
- Data type material in Lati Mine Operation from 2023 until 2025 generated by Mine Plan Department which consist of redisturb and swamp material.

3.1.2 Data Geotextile

In this project, we will use woven geotextile type Mirafi HP280a. Geotextile Mirafi HPa integrated subgrade stabilization geotextiles are multi-function combination products created from super high-tenacity polypropylene yarns formed into an innovative woven structure to prove all the relevant functions for roads and other load support platforms constructed on soft subgrades. The super high tenacity polypropylene yarns allow mobilization of tensile resistance for reinforcement benefits at low working strains of 2%. The innovative woven structure results in a product that has high water flow for rapid dissipation of excess pore pressure induced as the wheel load passes while serving as a separator to prevent the intermixing of soft subgrade soil and the structural aggregate layer, thereby preventing the deterioration of the aggregate layer over time. The innovative woven structure also results in a product that has superior interaction coefficient to provide confinement to the lateral spreading of aggregate at the interface of the geotextile and the structural aggregate layer.

Table III 2 The Properties of Geotextile Mirafi HPa

Properties of Geotextile Mirafi Hpa Subgrade Stabilization Geotextile				
Property	**Test Standard**	**Unit**		**HP280a**
Mechanical				
Tensile modulus @2% strain	ISO 10319	MD	kN/m	400
Tensile modulus @2% strain	ISO 10319	CD	kN/m	700
Wide width tensile strength	ISO 10319	MD	kN/m	40
Wide width tensile strength	ISO 10319	CD	kN/m	40
Elongation at break	ISO 10319	MD	%	12
Elongation at break	ISO 10319	CD	%	10
CBR puncture strength	ISO 12236		kN	4
UV resistance (at 500 hours)	ASTM D4355		% retained	90
Hydraulic				
Pore size, O_{90}	ISO 12956		mm	0,35
Water permeability, O_{50}	ISO 111058		$l/m^2/min$	2.250
Roll width			m	4,5
Roll length			m	100

3.1.3 General assumption for financial feasibility study

The basic assumptions to develop financial analysis of this project are detailed as per below :

- The revenue projection, OPEX (Operating Expenditure), forecasting coal price and fuel price, market size projection, royalty, and other parameters are assumed to be the same for 2 schemes in overburden hauling activity (without geotextile and applied geotextile)
- The source of capital is 100% from equity
- Tax rate is 45% based on Republic of Indonesia government's regulation (PKP2B)
- The depreciation using straight line method

- The construction of geotextile mine road in 2 road segment, Gunung Tabur and Channel Dump mine road, will be assumed start in January 2023 and estimated ready for use on July 2023, so the construction of this project will take 6 months working time. Therefore, in the same year, applied geotextile will begin to increase the productivity and make cost efficiency for operational in Lati Mine Operation PT Berau Coal
- The project will be operated for three years period (until the end of PKP2B contract)
- The WACC is the discount rate of the investment used in capital budgeting analysis and has been determined by the calculation. The WACC is decided to be feasible if the result of internal rate of return (IRR) is above the WACC.

3.2 Research Methodology

The final project uses primary and secondary data. Primary data is obtained from PT Berau Coal and direct observations during the project trial process. Secondary data was collected from books, journals (literature review) , articles, and websites. Both primary and secondary data consist of quantitative and qualitative information. Primary and secondary data are used as the input of financial analysis to produce financial projection and financial feasibility.

3.2.1 Project Valuation Technique

The fundamental aspect that permits the realization of a project is its value. By the term value we intend not only the mere rupiah-money value, but also strategic value, such as knowledge on a certain subject, or position on a certain market. There are many different methods developed by financial analyst for determine the value of project. Project Valuation Technique divided into 2 major methods which are Discounted Cash Flow (DCF) and Real Option (ROA) Valuation Method. On this research, we will use and concern to Discounted Cash Flow because is more familiar for decision maker to assess this project investment. This project assumed has simple coal business (low uncertainty), simple complexity of investment, simple complexity of method,and will use WACC to take account time value of money.

- **Discounted Cash Flow**

The Discounted Cash Flow method involves the use of only one set of variables, making it a deterministic method. The project Net Present Value is the summation of the Present Values of all the cash inflows and cash outflows from the development and production phases of a project. The formula of present value :

$$PV = \frac{FV}{(1+r)^n}$$

Where :

PV : Present Value

FV : Future value

n : Periods from initial investment

R : Interest Rate

Project NPV : PV of cash flows in production phase – PV of investment costs

If the project Net Present Value based on the Discounted Cash Flow analysis is greater than zero, the project is considered financially attractive. In other words, if the total Present Value of expected free cash flows (the project payoff) is greater than the total Present Value of the investment costs, the project is deemed worthy of investment.

- **Capital Expenditure (CAPEX)**

Capital Expenditure are funds used by a company to acquire, upgrade, and maintain physical assets such as property, infrastructure, buildings, technology, or equipment. CAPEX is made by companies to increase the scope of their operations or add some future economic benefit to the operation.

- **Capital Budgeting**

Capital Budgeting is the process of evaluating and selecting long term investment that are consistent with the firm's goal of maximizing owner's wealth (Gitman & Zutter, 2010). The

process of capital budgeting consists of proposal generation, review and analysis, decision making, implementation, and follow up. The decision criteria at the capital budgeting techniques consist of Net Present Value (NPV), Internal Rate Return (IRR), Payback Period, and Profitability Index (PI).

- **Net Present Value (NPV)**

Net present value is the present value of the cash flows at the required rate of return of the project compared with the initial investment. In practical terms, it's a method of calculating return on investment, or ROI, for a project or expenditure. This is the sum of the present value of cash flows (positive and negative) for each year associated with investment, discounted so that it's expressed in today's dollars. If the NPV is negative, the project is not a good one to be executed. It will ultimately drain cash from the business. However, if it's positive, the project should be accepted. The larger the positive number, the greater the benefit we get.

The following formula is used calculate the net present value :

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t}$$

where:

R_t = Net cash inflow-outflows during a single period t

i = Discount rate or return that could be earned in alternative investments

t = Number of timer periods

- ✓ If the NPV is less than $0, project rejected
- ✓ If the NPV is greater than $0, project accepted

- **Internal Rate of Return (IRR)**

Internal Rate of Return (IRR) is the discount rate that equates the NPV of an investment opportunity with $0 (because the present value of cash inflows equals the initial investment). The following formula as follow :

$$0 = CF_0 + \frac{CF_1}{(1+IRR)} + \frac{CF_2}{(1+IRR)^2} + \frac{CF_3}{(1+IRR)^3} + \ldots + \frac{CF_n}{(1+IRR)^n}$$

Or

$$0 = NPV = \sum_{n=0}^{N} \frac{CF_n}{(1+IRR)^n}$$

Where:
CF_0 = Initial Investment / Outlay
$CF_1, CF_2, CF_3 \ldots CF_n$ = Cash flows
n = Each Period
N = Holding Period
NPV = Net Present Value
IRR = Internal Rate of Return

The decision criteria related with internal rate of return (IRR) on the accept – reject approach are as follow :

- ✓ If the IRR is less than the cost of capital, reject the project.
- ✓ If the IRR is greater than the cost of capital, accept the project.

- ➢ **Payback Period (PBP)**

Payback period is the amount of time required for a firm to recover its initial investment in a project , as calculated from cash inflows (Gitman and Zutter, 2012). Payback period is factored in to make accept-reject decision based on the following criteria :

- ✓ If the PBP is shorter than the maximum acceptable payback period, then accept the project
- ✓ If the PBP is longer than the maximum acceptable payback period, then decline the project (Gitman, 2009)

- **Profitability Index (PI)**

Profitability index is a variation of the NPV rule. The PI is calculated by divide the present value of cash inflows to the initial cash outflow. The decision rule of profitability index is to invest in the project when PI is greater than 1.

- **Weighted – Average Cost of Capital**

The limitation in the availability of either equity or loan as the source of project financing, forces the company to configure certain portion of both financing source in fulfilling project's capital needs. The required return of the source of funds either from loans or equity is commonly referred as cost of capital. Since both sources of funds have different required return, the portion of each in funding the project is used to represent the overall cost of capital, which is later referred as weighted-average cost of capital (WACC). The formula used to calculate the WACC is as follow :

$$WACC = (wi \times ri) + (ws \times rs)$$

Where :

WACC : weighted-average cost of capital

wi : Proportion of long-term debt in capital structure

ri : Cost of long-term debt

ws : Proportion of equity in capital structure

rs : Cost of equity

- **Sensitivity Analysis**

Sensitivity Analysis is the study how the uncertainty the ouotput of a model (numerical or otherwise) can be apportioned to different sources of uncertainty in the model input (Saltelli, Tarantola, Capolongo, & Ratto, 2004). This analysis is carried out to determine the effect of changes in project parameters on system performance in the project in order to generating profits. The value of key parameter on the project return, including coal price, oil price, cost of capital, and operating expenses. The purpose of sensitivity analysis is to investigate the impact of changes in project variables on the base case. The variability of the project is evaluated based on a comparison of its Internal Rate of Return (IRR) to the financial or economic opportunity cost of capital. Alternatively, the project is considered to be viable when the Net Present Value (NPV) is positive, using a selected discount rate. Sensitivity analysis, therefore, focuses on analyzing the effects of changes in key variables on the projects IRR or

NPV, the two most widely used measure of project worth. In this study, a tornado chart is used to determine which variable are most important in sensitivity analysis, it illustrates the swing between maximum and minimum forecast value for each variable.

- **Simulation Analysis**

Major investment projects must meet certain conditions, including criteria related to the size of the risk. The risk is a problem (situation, event, etc.) , which as not yet appeared, but may occur in the future, in which case, obtaining the results previously set is threatened or enhanced. In the first case, the risk poses a threat, and in the second, the risk represents an opportunity. Risk represents the uncertainty in achieving the desired results and should be regarded as a combination of probability and impact. This present research comes to propose a risk estimation method using Monte Carlo Simulation to be applied in standardized way on investment project.

Monte Carlo analysis is essentially a statistical analysis that calculates the response of a circuit when device model parameters are randomly varied between specified tolerance limits according to a specified statistical distribution. Monte Carlo analysis provides statistical data predicting the effect of randomly varying model parameters or component values (variance) within specified tolerance limits. The generated values follow a statistically defined distribution. The circuit analysis is repeated a number of specified times with each values. Monte Carlo run generating a new set of randomly derived component or model parameter values. The greater the number of runs, the greater the chances that every component value within its tolerance range will be used for simulation. On Monte Carlo analysis, a random value is selected for each task and the model is calculated based on random value. The result of the model is recorded then the process will be repeated. This simulation calculates thousand times, each time using different randomly-selected values.

Monte Carlo method is relatively easy to perform and provides important information regarding the risk of investment projects. After identification, analysis and evaluation of qualitative and quantitative economic and financial risk of investment projects, there may be different methods and approaches for managing and responding to risks.

3.3 Research Design

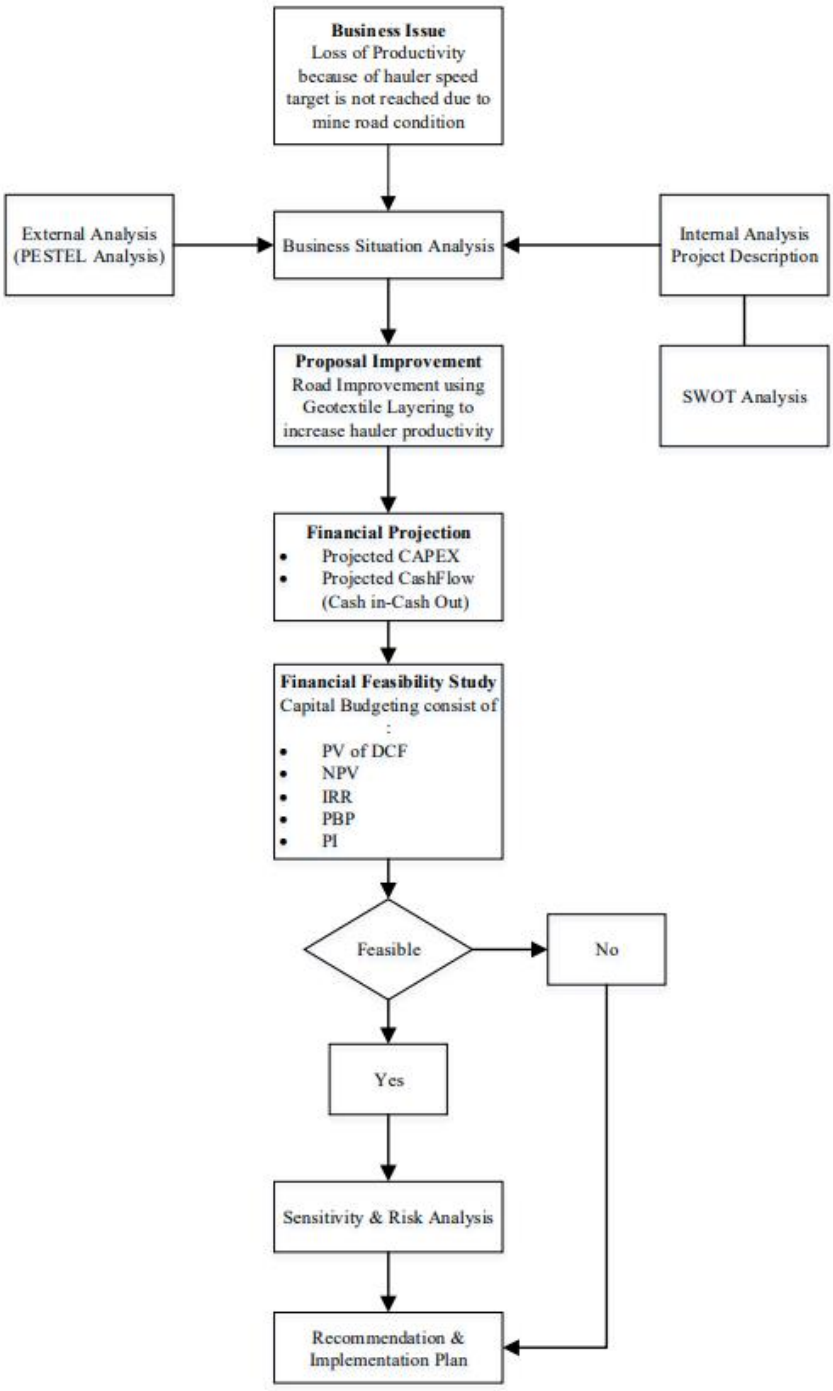


Figure III 1 Flow Chart of Research Design

PT Berau Coal, especially site Lati Mine Operation, is aiming to increase hauler productivity by improve hauler speed to initial target (22 kph). In 1st Quarter of 2022, production parameter

which is productivity is one of the biggest loss contributor for loss production. The root cause of hauler productivity problem is material used for road surfacing which has implication to road condition. Based on the geographical location of Lati Mine Operation, the majority of forming materials consists of many redisturb and swamp materials causing disruption in existing mining process. To solve this issue, the improvement to increase speed and productivity is by using a layer of geotextile material for road subgrade reinforcement, then layering is carried out again using blasting hard material.

The business situation analysis consist of internal and external analysis. Internal analysis gives the knowledge to leverage company's strength, expertise, and opportunities related to project financial performance. External analysis or also called environmental analysis, will explain and assess the current and forecasted change which could affect this business operation and financial performance.

Business situation analysis will be used to create project's financial projection. Project's financial projection consists of CAPEX, project cash in, and project cash out. The results of the analysis are used as a basis for providing recommendations and implementation strategies for management to be able to increase hauler speed by applying geotextile layering on road improvement.

Chapter IV Findings : Business Solution

4.1 Analysis

4.1.1 Problem Analysis

Lati Mine Operation as the biggest site in PT Berau Coal has overburden removal production annual target 134,556,000 BCM and coal getting 8,361,000 MT in year 2022. In the 1st Semester of 2022, actual overburden removal was achieved in 94% under the year to date plan. Based on pareto loss production analysis, the biggest lost contributor of Overburden Removal was came from productivity parameter.

Table IV 1 Plan vs Actual Overburden Removal in 1st Semester Production

Description		Unit	Jan	Feb	Mar	Apr	May	Jun	Total Volume	Achievement
Overburden Removal	Plan	bcm	8.809.000	8.956.000	9.673.000	9.439.000	11.163.000	13.736.000	61.776.000	94%
	Actual	bcm	9.158.871	8.718.515	8.764.783	10.371.149	8.819.772	12.085.581	57.918.671	

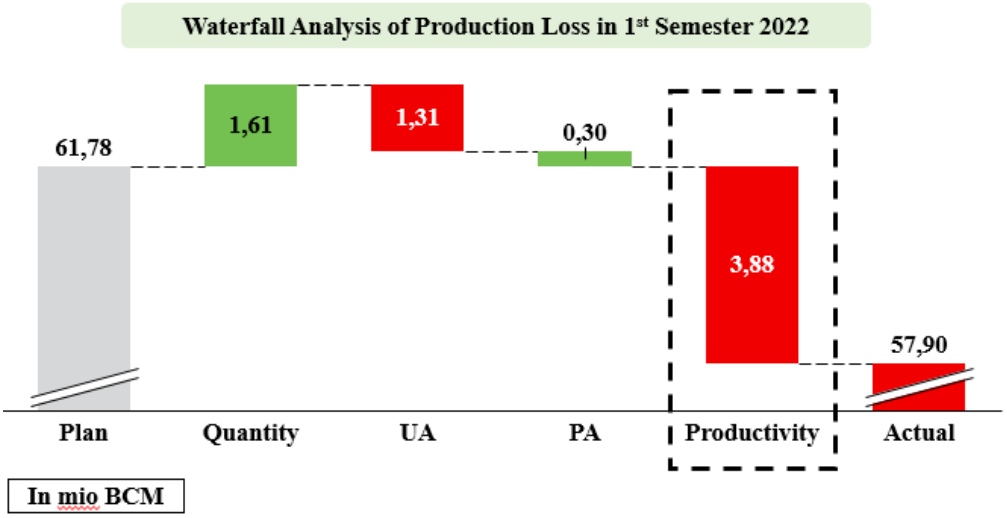


Figure IV 1 Waterfall Analysis of Production Loss in 1st Semester 2022

One of crusial activity in mining flow process to support productivity is overburden removal hauling activity that carry OB material from front to disposal by hauler. The productivity driver of hauler itself is speed (km/hour). Actual hauler productivity and speed in 1st Semester in 2022 was under target.

Table IV 2 Target vs Actual Productivity and Speed Hauler in 1st Semester of 2022

Productivity (bcm/hour)		CAT785	HD 785	CAT777
	Target	120	89	89
	Actual	112	83	83

Speed (km/hour)		CAT785	HD 785	CAT777
	Target	21	22	22
	Actual	17	18	18

The root cause of hauler productivity problem is material used for road surfacing which has implication to road condition. Based on the geographical location of Lati Mine Operation, the majority of forming materials consists of many redisturb and swamp materials causing disruption in existing mining process. Redisturb area is re-mining ex-disposal that has previously been mined and reclaimed while swamp is wetlands that are always in moisture condition naturally. In Lati Mine Operation, the total of redisturb and swamp material are classified as a lot. Redisturb area is 30% of total waste material volume while swamp is 24%. This condition make the operational challenging especially for road condition due to the source material for mine haul base road. The table below shows the detail redisturb and swamp material volume from 2023 until 2025.

Table IV 3 Profile of redisturb and swamp material in 2023 until 2025

Material Type	Unit	2023	2024	2025	Total Volume	% of Total Volume Waste Material
Redisturb	bcm	30.714.666	28.831.515	23.065.212	82.611.393	30%
Swamp	bcm	24.143.859	22.858.054	18.286.443	65.288.356	24%
Total Waste Material	bcm	110.926.000	95.931.000	70.528.000	277.385.000	

Road surfacing material was came from redisturb material that cause low bearing capacity on subgrade layer and impacted to road damage on the surface. Besides having an impact on productivity, this also affects the physical availability (PA) condition of the hauler, where many haulers breakdown due to cracks and spring fractures. Bad mine road condition affects to higher road cost maintenance and fuel consumption, the utilization frequency of unit support, such as dozer,motor grader, and small loader for maintenance was very high to keep

the mine road at good condition and comply with mine road standard procedure in PT Berau Coal.

To solve this issue, the improvement to increase the productivity and cost maintenance efficiency is by using a layer of geotextile material for road subgrade reinforcement, then layering is carried out again using blasting hard material. For pilot project, it will be implemented on two road segments, Gunung Tabur and Channel Dump access. This method will be able to strengthen road conditions, avoid damage and reduce significantly road maintenance frequency. And it will produce the increasing of productivity and hauler speed. It can also help reduce cost road maintenance, fuel consumption efficiency, and increase the physical availability (PA) of hauler. In the end, production target will potentially achieved and generate higher profitability.

This new improvement need to be analyzed through a comprehensive financial analysis to get financial feasibility of this project. This research will use discounted cash flow (DCF) to assess and decide whether this investment project will be executed or not.

4.1.2 External Analysis : PESTLE Analysis

A PESTEL analysis is a strategic framework commonly used to evaluate the business environment in which a firm operates. PESTLE itself stands for Political, Economic, Social, and Technological, Legal, and Environmental factors as well. This is a tool that commonly used for analyzing key drivers that affecting an organization. External analysis carried out to determine the opportunities and threats that occur both from the macro-environment, industry, and competitors . The following PESTLE analysis for PT Berau Coal :

- **Political**

Indonesia's policies have a significant effect on the development of the coal industry due to the dynamic nature of demand and supply, it emphasize about focusing to fulfill domestic needs and increase the added value of mining products, as well as optimize the principles of mining conservation through various strategies. These strategies include complying Domestic Market Obligation (DMO is an obligation for producers to sell a portion of their domestic production at a predetermined price (not market price) and Domestic non-DMO (D non DMO)

patterns, in which government restricts the export of strategic mining products in order to ensure he sustainability of raw material supplies.

In an attempt to obtain security and independence, the Ministry of Energy and Mineral Resources has requested coal producers to reserve a certain amount of their production for domestic consumption. In addition, the government uses export taxes imposed by the Directorate-General of Customs and Excise of the Ministry of Finance to reduce coal exports.

This has implications for coal production which in 2022 targeted 693 million tons, (i.e., less than the year before (2021) at 625 million tons). However, the addition of national coal production still under government control, so that domestic utilization could increase proportionately. The allocation of domestic coal utilization in 2022 reached 25 percent, or approximately 166 million tons. Companies with better compliance to government regulation earn better bureaucracy benefit compared to others who comply less.

At the end of December 2021, the Indonesian government released a number of policies about exporting coal. These policies came in the form of letters from the Ministry of Energy and Mineral Resources' Directorate General of Mineral and Coal ("DGMC"), among other things ("MEMR"). The world's largest producer, consumer, and importer of coal, China's decision to abandon it will have a significant impact on how effectively the rest of the world combats climate change. China has pledged to become carbon neutral by the year 2060 and to reduce its use of coal beginning in 2026. In 2015, nearly 200 countries signed the Paris Agreement, making a promise to deal with the climate crisis and work to improve climate mitigation, adaptation, and climate finance. To reach the goals of the Paris Agreement, we need to quickly cut back on fossil fuel use. Coal is still the primary source of electricity in some nations. However, since numerous governments are working to remove carbon dioxide from the energy system, coal use will significantly decrease over time. Indonesia and other nations that produce and use coal must be prepared for this. The value chain and long-term coal production will be impacted by the declining coal demand.

- **Economic**

The selling price of coal mining industry is influenced by macroeconomics factors such as international coal market outlook, Indonesia’s Gross Domestic product (GDP), oil and gas

price, foreign currency, and growth of renewable energy sources. While most macroeconomics indicators trying to growing up for economics in Q1-2022, there did occur the threat of the Omicron wave that peak in mid-February 2022. Fortunately, this wave did not translate to a significant number of people requiring medical treatment, hence there was no need for the government to scale up existing social and business restrictions significantly. Obviously, in the 1st Quarter 2022, Indonesia economic growth expanded 5.01 percent year-on-year (y/y). In short, what supported Indonesia economic growth were particularly the following factors :

1. Indonesia's export performance was very strong due to high commodity prices especially coal industry
2. Household consumption continued to recover in Indonesia as the Covid-19 threat decline.
3. Investment continued to recover in Indonesia because there will no need for tighter social and business restrictions in the foreseeable future

And we all knew since the end of February 2022, global coal prices soared in the aftermath of the Russian invasion of Ukraine. ICE Newcastle coal for March 2022 delivery reached US$274.50 per ton. The coal price still continue to increase because of the cut in gas supplies from Russia to Europe, we know that 45% gas needs in Europe was delivered from Gazprom, the largest natural gas company in the world owned by Russian government. This international situation has an big influence on competitive selling price, it is undeniable that government and national coal mining company gain large profits from this market condition.

- **Social**

In coal mining industry business activities, job opportunities are open for mine-round society and increasing levels of public welfare and wealth. Based on Law No. 4 of 2009 on Mineral and Coal Mining, coal producers have to comply with labor regulation related to locals which have to get opportunity to be employed during the mine project lifetime. In this condition, local society could support the project.

- **Technological**

Coal producers have to consider the environmental impacts from gas emissions due to coal usage as well as the unavoidable utilization of coal to fulfill rising enegy needs. The implementation of technology to reduce pollutants from coal usage need to be developed, namely Clean Coal Technologies (CCT). This technology can be classified based on the level of energy production processes in its implementation, which encompasses technology for pre-combustion, combustion, post-combustion, and coal conversion. This technology has to be implemented in order to reduce emissions from steam power plants and improve the amount of heat recovered or increasing heat generation efficiency.

- **Legal**

Regulation for mining sector is strongly encouraged by Indonesia government which cover various aspect such as environmental, social economic, and others. Based on Peraturan Menteri ESDM Indonesia Nomor 26 Tahun 2018, every coal producers have to do their operation by following Good Mining Practice (GMP) as the guideline and mining technical is one part of it.

- **Enviromental**

Enviromental aspect is one of important thing which has to be considered before commencing any mining business or activity. Mining Business Permit and Special Mining Business Permit applicants must conduct study on the large important ramifications of a business or mining activity, which is then priven through an Enviromental Impact Assessment document. In operating a business or mining activity, Mining Business Permit and Special Mining Business Permit holders must undertake reclamation and post-mining activities, which are conducted throughout the entire mining business cycle, in order to organize, restore, and rehabilitate the quality of the environment and the ecosystem so that these can continue to function. After a portion or the entirety of a mining business is carried out, holders of Mining Business Permits or Special Mining Business Permits must conduct post-mining activities which are planned, systematic and continuous, in order to restore environmental functions and social functions according to local conditions throughout the entire mining area.

Table IV 4 PESTEL Analysis

Component	Assessment	Impact
Political Factors	Government Policies has big influence in coal mining industry in Indonesia or other countries related to demand and supply control	High
Economic	Coal price is extremely influenced by market condition and very volatile. In 2022, coal projection price is still high.	High
Social	Regarding to relationship between community and sociocultural issue, coal business maintains good relationship, so it will not really has an impact to surrounding	Low
Technological	Coal Mining Industry is most likely use conventional method with modest technological improvement. Threat is only came from other product such as natural gas.	Medium
Environment	Coal mining industry must undertake reclamation and post-mining activities, which are conducted throughout the entire mining business cycle. in order to organize, restore, and rehabilitate the quality of the environment and the ecosystem so that these can continue to function	High
Legal	Changes in regulations in a country will directly affect the condition of the coal industry from a technical, non-technical and operational perspective.	High

4.1.3 Internal Analysis

- **Competitive Advantage**

An internal analysis is the process of an organization examining its internal components to assess its resources, assets, characteristics, competencies, capabilities, and competitive advantages. This helps management during the decision-making, strategy formulation, and execution processes by identifying the organization's strengths and weaknesses. And internal scanning for PT Berau Coal can be seen as Table IV.5 below

Table IV 5 Competitive Advantages of PT Berau Coal

Resources	Rare	Valuable	Costly to Imitate	Non-substitutable
Natural Resources				
Mining Location	Yes, mostly in remote area	Yes	No	No
Coal Quality	Yes, each site has certain quality	Yes	No	No
Coal Reserve	Yes	Yes	Yes	No
Additional Resources				
Safety, Health, Environtment to be prioritized	Yes, relative	Yes	No	Yes
Infrastructure	Yes, relative	Yes	No	No
Mining Contractor	No	Yes	Yes	No
Operation Management	Yes, relative	Yes	Yes	No
Combine Resources				
Supporting Infras for quality & reserve	Yes	Yes	Yes	Yes
SHE Mining Contractor	Yes	Yes	Yes	Yes
Location, quality & backup with operation management	Yes	Yes	Yes, for large mining operation	Yes

- **Internal Resources Analysis**

This section will discuss the detailed Internal Resources Analysis of Lati Mine Operation PT Berau Coal. The data was obtained from interviews with the mine manager and mine engineer.

Resources are divided into tangible and intangible assets that focus on increasing hauler productivity that has implication on increasing overburden removal production :

A.Tangible Asset

A.1 Area Improvement

The data collected from Mine Engineer will be explained in this section. The area of improvement is the development area in south. The project focuses on two mine road segments are located in Gunung Tabur Road elevation +40 and Channel Dump road segment. The design geometry of Gunung Tabur Road elevation +40 has length 735 meter with width 40 meter while Channel Dump Road segment has length 778 meter with width 40 meter.

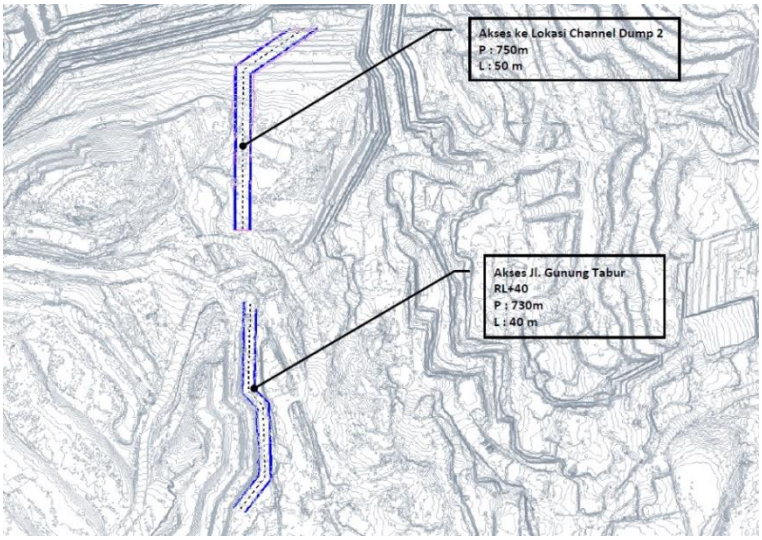


Figure IV 2 Area Mine Road Project Improvement

A.2 Unit Population

Unit in mining operations are broken down into various categories, including OB Removal, Coal Getting, and Support Activities. Each of these categories makes use of a different set of units. On the other hand, all units with a concentration on maintenance processes on mine haul road are appended to the table that may be found below :

Table IV 6 Unit Support Population

No	Type	Unit	Population
1	Bulldozer	Dozer 375	25
		Dozer 155	27
		Dozer 85 E SS	9
2	Motor Grader	Grader825	15
		CAT24M	10
3	Wheel Dozer	WD600	5
4	General Excavator	PC200	15
		PC400	15
5	General Hauler	A40F	5

A.3 Financial Resources

The discussion in this financial overview is based on information obtained from the Consolidated Financial Statements of PT Berau Coal Energy Tbk and its Subsidiaries as of December 31, 2021 and 2020, which have been audited by Public Accounting Firm Mirawati Sensi Idris. The ability of the company to generate profits from its operations is revealed by profitability ratios, which are financial indicators. The following describes the company's profitability ratios for the last 2 years.

Table IV 7 PT Berau Coal Profitability Ratio

2021	2020	Description
7.4	(15.0)	Income (Loss) to Sales Ratio
11.2	(15.8)	Income (Loss) to Total Assets
(80.8)	47.4**	Income (Loss) to Total Capital Deficiency*

B. Intangible Asset

1. Contractors: PT Berau Coal's overburden removal and coal hauling operations are in majority conducted by contractor. Such step is taken so that PT Berau Coal can focus on planning and supervision activities, in addition to optimizing the capital expenditures. Cooperation with contractors is built intensively in order to ensure compliance with the Health, Safety, and Environment Standards set by PT Berau Coal.

2. Engineer: The employees in various competency related to the sustainibility aspects according to needs. The employee divided into two types non-technical skills and

technical skills. The employee position majority in supervisor and superintendent position, which is the technical and non-technical skill is good. In operation the total employee in Lati Mine Operation more than 30 people.

3. Coal Brands: The type of coal produced by the Lati Mine Operation has a calorific value of 4,700 kcal/ kg to 5,300 kcal/kg (on a “gross as received” basis). The coal is marketed under three names, namely Mahoni, Mahoni-B, and Agathis and it has already world-wide known.

- **Value Chain Analysis**

The value chain obtained from the company annual report 2021, and interview with Mine Manager and Market Research of PT Berau Coal as follows.

Figure IV 3 Value Chain in PT Berau Coal

These are the primary activity in the value chain PT Berau Coal that create the customer value.

a. Operation: The amount of coal produced by Lati Mine Operation PT Berau Coal on December 31, 2021 was 9,8 million tons, a 20.1 percent increase over the 8.2 million tons produced in 2020. The majority of PT Berau Coal's overburden removal and coal mining are performed by mine contractor. Land clearing is the first step in the mining process, followed by topsoil removal, drilling and blasting for overburden removal, excavation, and coal transport. PT Berau Coal also engages in post-mining activities such as backfilling, final disposal contouring, and eventual reforestation of pits. To ensure compliance with the

applicable rules and to maintain health and safety standards, each mining activity process adheres to the standards and procedures.

b. Distribution: Strategic locations are one of the advantages of PT Berau Coal's company, allowing it to reduce its transportation costs. At each mining operation, coal is transported by barge along the river that connects the barge port at the mine site to the open sea, where transhipment facilities are prepared to load coal onto the buyer's vessels. PT Berau Coal always complies with and implements the International Ship and Port Security (ISPS) code in its coal shipping operations. The purpose of this measure is to ensure that the annual shipping goals are met, with a focus on timely delivery and demurrage expenses, without sacrificing health, workplace safety, or the environment.

Figure IV 4 Distribution in Lati Mine Operation PT Berau Coal

c. Sales and Marketing: In response to the dynamism of the contemporary business environment, the company has devised a variety of marketing techniques to achieve its 2021 objectives. PT Berau Coal persists in its efforts to expand its marketing reach among domestic and international potential clients. PT Berau Coal's coal product sales constantly prioritize meeting the needs of the domestic power generation industry, while also seeking new market share prospects. To achieve this objective, PT Berau Coal has implemented numerous strategies as follows.

- Maximizing coal shipments related to the existing contracts.
- Participating in coal procurement held by domestic power plants, both for electricity (PLN) and non-electricity.

4.1.4 SWOT Analysis

A SWOT analysis is a planning process that helps to overcome challenges and determine what new leads to pursue. This analysis focuses on the four elements of the acronym, Strength, Weaknesses, Opportunities, and Threats, allowing companies to identify the forces influencing a strategy, action or initiative. SWOT analysis combines external factors and internal factors of the business. Strength (S) and Weaknesses (W) refer to internal factors, which are the resources and experience readily available to the company. External factors consist of Opportunities (O) and Threats (T) and these conditions are occur outside the company that affect the process of this project. External factors can provide benefits or losses depends on the situation and implication for a whole business process. The SWOT Analysis of PT Berau Coal and this project as follows as Figure IV.2

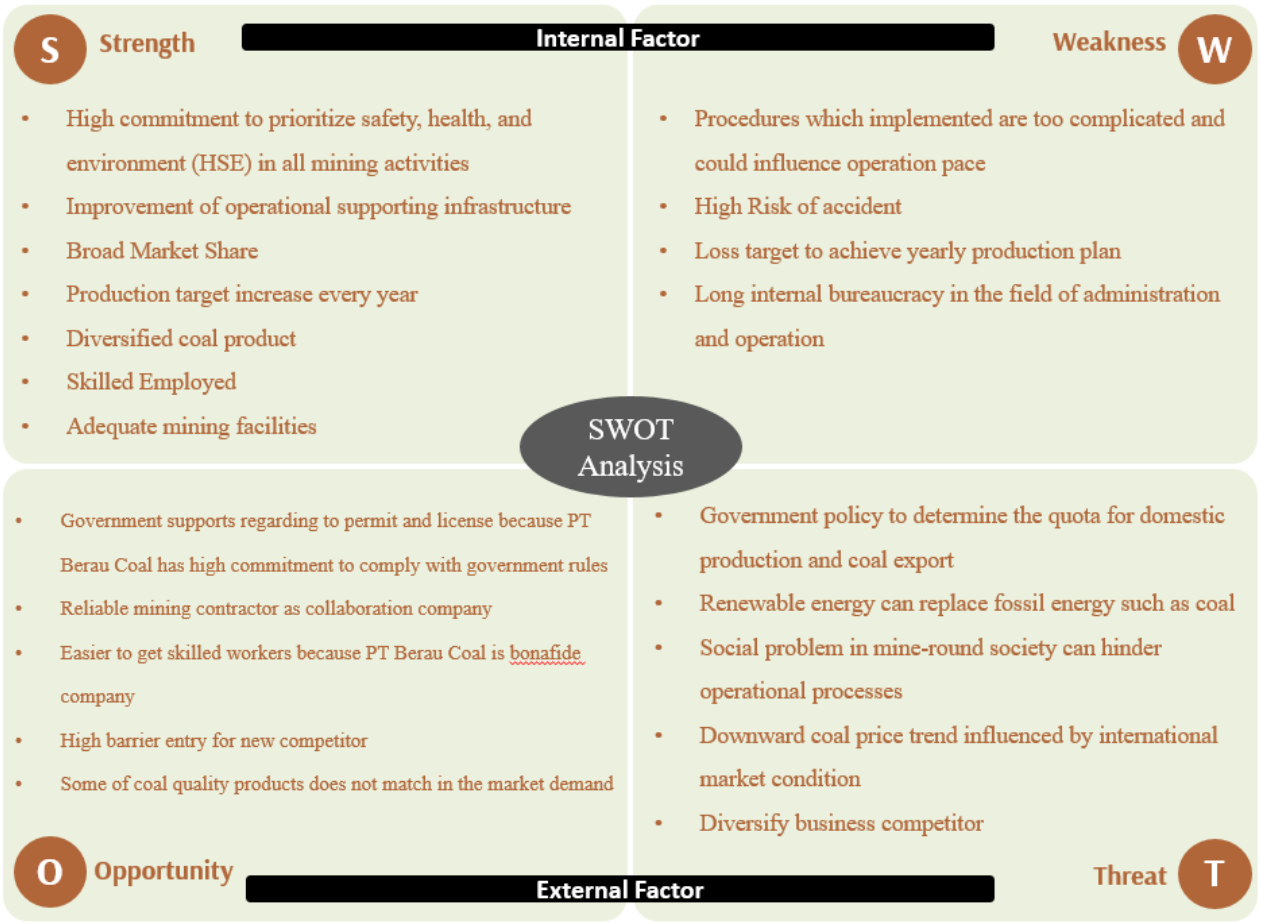


Figure IV 5 SWOT Analysis of PT Berau Coal

4.2 Solution and Proposed Implementation Plan

4.2.1 Production Target

Based on calculation from Mine Plan Department of PT Berau Coal, life of mine (LoM) of Lati Mine Operation (LMO) from 2023 until 2025 has total volume overburden removal 278.385.000 BCM (Bank Cubic Meter) and coal getting 20.487.000 MT (Metric Ton). Stripping ratio (SR) or ratio between volume of overburden removal and coal getting is 13,59 BCM/MT

Table IV 8 Production Profile LoM Lati Mine Operation 2023-2025

Mine	Description	Unit	2023	2024	2025	Total
Lati Mine Operation	Overburden Removal (OB)	bcm	111.926.000	95.931.000	70.528.000	278.385.000
	Coal Exposed	ton	7.974.000	7.150.000	5.363.000	20.487.000
	Coal Getting	ton	7.974.000	7.138.000	5.375.000	20.487.000
	Mining Strip Ratio	bcm/ton	14,04	13,42	13,15	13,59
	Contract Strip Ratio	bcm/ton	14,04	13,44	13,12	13,59
	OB Distance	meter	2.600	2.800	2.500	2.644
	Coal Distance	meter	17.000	17.000	17.500	17.131

Data productivity is taken from 5 fleets which are planned to access 2 segments of roads using geotextile. The fleets consist of 3 excavator or loader type and 3 hauler type, those excavators are EX3600, EX2500, and PC2000 while haulers are CAT785, HD785 Komatsu, and CAT777. The purpose of geotextile reinforcement is increasing the productivity, decrease cost maintenance, and cost fuel efficiency. The average actual productivity and fuel consumption for each unit were taken from historical data January – June 2022 and presented as follows.

Table IV 9 Actual and target productivity for each unit

Unit		Quantity	Actual Productivity bcm/hour	Target Productivity bcm/hour	Effective working hour hour/day
Loader	EX3600	1	933	1150	15
	EX2500	2	538	585	15
	PC2000	2	466	500	15
Hauler	CAT785	5	112	120	15
	HD785 Komatsu	10	83	89	15
	CAT777	10	83	89	15

Table IV 10 Actual fuel consumption per unit

Unit		Fuel Consumption Actual Liter/hour
Loader	EX3600	264
	EX2500	174
	PC2000	126
Hauler	CAT785	102
	HD785 Komatsu	62
	CAT777	67
Support Maintenance	D155 Komatsu	45
	PC 400	40
	CAT 24M	46

Actual productivity is taken from past 6 months in January until June 2022 when geotextile has not been executed, but target productivity is expected achievement after the geotextile is implemented. For mine haul road maintenance, there are several unit support which dedicated to keep the mine haul road at good condition to support operational. These unit support are PC 400, Dozer 155 Komatsu, and Motor Grader CAT 24M. Every single unit support has each rent cost that calculated by working hour. Rent cost unit in Lati Mine Operation using Bukit Makmur Mandiri Utama (BUMA) unit rate as mine contractor. The rent cost is presented below.

Table IV 11 Average Monthly Maintenance Duration of unit support

Unit		Actual Maintenance Duration (in average) hours/month	Target Maintenance Duration hours/month
Support Maintenance	D155 Komatsu PC 400 CAT 24M	93	50

Table IV 12 Rent Cost unit support maintenance

Unit		Rent Cost IDR / hour
Support Maintenance	D155 Komatsu	980.000
	PC 400	560.000
	CAT 24M	1.300.000

4.2.2 Improvement Project

This project is located in PT Berau Coal site Lati Mine Operation Pit PQRT. Based on business issue that concern to improve hauler speed and impacted to higher hauler productivity, this project will do mine road improvement to reinforce mine road base using geotextile Mirafi HP280a method to mine road subgrade reinforcement. The project focuses on two mine road segments are located in Gunung Tabur Road elevation +40 and Channel Dump road segment. The design geometry of Gunung Tabur Road elevation +40 has length 735 meter with width 40 meter while Channel Dump Road segment has length 778 meter with width 40 meter. There are drone view from those two mine road segments area which will be implemented as road improvement using geotextile project :

Figure IV 6 Channel Dump Road Segment

Figure IV 7 Gunung Tabur Road Segment

On top of the geotextile Mirafi HP280a needs to be layered with material surfacing from blasted material with thickness 1,3 meter. The road section consist of blasted material on top surface, followed by geotextile Mirafi HP280a, subgrade material, and for the bottom layer is redisturb material.

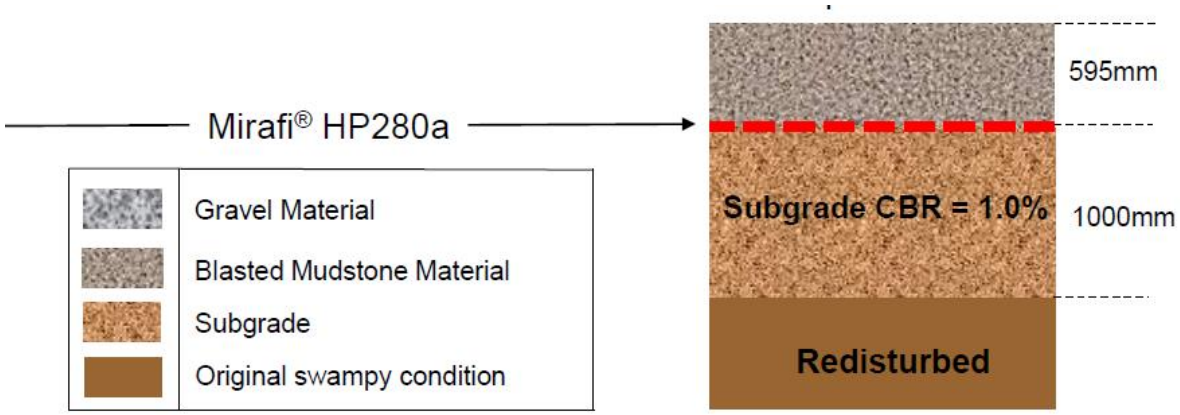


Figure IV 8 Road Section of Geotextile Mirafi HP280a

After this road section is applied, then compaction is extremely needed per 30 cm using compactor with total passing 10-15 per layer. Compaction activity is needed to get CBR test result 60% for top surface (blasted material) and 20% for subgrade layer. CBR Test is stands for California Bearing Ratio Test, is performed in construction materials laboratories to evaluate the strength of soil subgrades and base course materials. One of the strength of road construction is determined by the quality of the original soil bearing capacity as a subgrade. The way to determine the bearing capacity of the road subgrade is the CBR (California Bearing Ratio) test. The CBR value is used as the basis for planning the next road embankment pavement, depending on the desired road class. The higher the CBR value, the better the subgrade condition. If the original soil has a low bearing capacity (dry density, CBR), the road construction will quickly experience damage.

4.2.3 Capital Expenditure (CAPEX) for this project

The capital expenditure for road improvement using geotextile layer in 2023 is assumed to be the same with the CAPEX which created in 2022 but adjusted by the inflation rate. The CAPEX of this project is shown by the table below :

Table IV 13 The CAPEX of road improvement using geotextile layer

NO.	Description	Volume		Unit Price (IDR)	Total Price (IDR)	Remarks
		Qty	Unit			
A	**Preparation**					
	1 Mobilisasi + Demobilisasi A2B	1,00	Ls	40.950.000,00	40.950.000,00	1 fleet
				Sub Total A	**40.950.000,00**	
B	**Earthworks**					
	1 Compacting of soil thickness 100 cm	121.750,40	M^3	10.241,29	1.246.881.662,66	Thickness 100 cm
	2 Fuel Truck 5 KL	3,0	Month	18.000.000,00	54.000.000,00	
	3 Water Truck 5 KL	3,0	Month	33.500.000,00	100.500.000,00	
	4 Bund wall (Both of side of road)	4.989,6	M^3	38.701,47	193.104.868,32	
	5 Earth drain (Both of side of road)	4.989,6	M^3	8.855,27	44.184.268,80	
	6 Rental LV untuk support pengawasan Project	3,0	Month	18.000.000,00	54.000.000,00	
				Sub Total B	**1.692.670.799,78**	
C	**Geotextile**					
	1 Geotextile Mirafi HP280a	60.480,00	M^2	42.000,00	2.540.160.000,00	L=100 m, W=4,5m
	2 Instalasi Geotextile	60.480,00	M^2	5.000,00	302.400.000,00	
	3 Mobilisasi Geotextile	1,00	Ls	300.000.000,00	300.000.000,00	1 roll = 200 kg (135 roll)
				Sub Total C	**3.142.560.000,00**	
D	**Culvert supply**					
	1 Steel Pipe Spiral Welded Dia. 918 mm, 6 meter	30,00	Pcs	35.000.000,00	1.050.000.000,00	
	2 Instalasi steel pipe	120,00	M	512.650,00	61.518.000,00	
				Sub Total D	**1.111.518.000,00**	
				Total	**5.987.698.799,78**	
				Countigencies	598.769.879,98	
				Sales tax 2,5% PKP2B G1	149.692.469,99	
				Grand Total	6.736.161.149,75	
				Rounded Grand Total	**6.736.161.100,00**	

Initial investment needed in 2022 is IDR 6.736.161.100 and with the average inflation rate 2,21% , the projected CAPEX investment in 2023 is IDR 6.884.917.990,96.

4.2.4 Depreciation

Depreciation for mining operation refers to the natural wear and tear that occurs to a building and its assets over time. Mining companies can use either the rime cost or diminishing value method to work out the decline in value for all equipment and structures. Under the prime cost method, the deduction for each year is calculated as a percentage of the cost. In this project, the salvage value of road improvement using geotextile is assumed 0 at the end of the mining permit. The lifetime of this infrastructure is 30 months with straight line method , the depreciation is determined at 3,33% per month. The depreciation simulation is shown as follow.

Table IV 14 Depreciation

Month	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Depreciation	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726
Cummulative	229.748.726	459.497.451	689.246.177	918.994.902	1.148.743.628	1.378.492.353

Month	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24
Depreciation	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726
Cummulative	1.608.241.079	1.837.989.805	2.067.738.530	2.297.487.256	2.527.235.981	2.756.984.707	2.986.733.432	3.216.482.158	3.446.230.884	3.675.979.609	3.905.728.335	4.135.477.060

Month	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Depreciation	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726	229.748.726
Cummulative	4.365.225.786	4.594.974.511	4.824.723.237	5.054.471.963	5.284.220.688	5.513.969.414	5.743.718.139	5.973.466.865	6.203.215.590	6.432.964.316	6.662.713.042	6.892.461.767

4.2.5 Cost of Equity

The cost of equity is the return that a company requires to decide if an investment meets capital return requirements. It often use as a capital budgeting threshold for the required rate of return. In general, company funds its project from two aways, debt and equity. In this project, PT Berau Coal fully financed with own equity. Some assumptions used in the cost of equity calculation are explained as follow.

$Ke = Rf + \beta\ (Rm - Rf)$

$Ke = 3{,}43\% + 1{,}174\ (9{,}06\% - 3{,}43\%)$

$Ke = 10{,}04\%$

Where :

The following formula is used to calculate the Risk free Rate (R*f) :*

$$R_{fr} = \frac{(1 + R_{fn})}{(1 + I_e)} - 1$$

R*fn* : Indonesia Government Bond Yield 10 Years (average from Jan 2012 – Dec 2021)

I*e :* Historical Inflation Rate of Indonesia

$$Rf = \frac{(1 + 7{,}21\%)}{(1 + 3{,}65\%)} - 1$$

$$Rf = 3{,}43\%$$

Beta of Security (β) : using companies beta 1,174 (Due to BCE delisting since 16 November 2017, trend assumed equal to ADRO as of June 2022)

Market Rate of Return (R*m*) : based on historical monthly market return last 10 years (Dec 2011 – Dec 2021) which about 9,06%

4.2.6 Weighted Average Cost of Capital (WACC)

Weighted average cost of capital (WACC) is a discount rate widely used in corporate finance. It is used to discount the project's cash flow ignoring financing charge such as interest and dividend payments. However, the correct calculation of the WACC rests on correct valuation of the tax shields. The value of tax shields depends on the debt policy of the company. Because PT Berau Coal fully financed by own equity, the calculation will be described below.

$$\text{WACC} = \left(\frac{E}{E+D}\right) \text{ x } Ke + \left(\frac{D}{E+D}\right) x\ Kd\ x\ (1-T)$$

$$\text{WACC} = \left(\frac{100\%}{100\%+0}\right) \text{ x } 10{,}04\% + \left(\frac{0}{100\%+0}\right) x\ 0\%\ x\ (1-45\%)$$

WACC =10,04%

Where :

Equity Composition (E) : PT Berau Coal uses its own capital to financing this project, so it is 100%

Debt Composition (D) : 0%

Corporate Tax Rate (T) : 45% (Tax for PKP2B 1st generation)

Long Term Debt Interest Rate : 10%

Cost of Debt (K*d*) : 0% due to PT Berau Coal uses own capital to financing this project

4.2.5 Cost Efficiency Projection

The efficiency cost of this project comes from 3 variables, those are :

1. The reduce of maintenance duration (rent cost for unit support maintenance)

2. Fuel saving from the reduce of maintenance duration

3. Fuel saving from the increasing of hauler productivity

The cost efficiency in this project is mainly incremental those 3 variables between rent cost of maintenance duration, fuel usage for maintenance, and fuel usage hauler when geotextile implemented and if the project is not applied. This incremental variable will be expressed on financial model from January 2023 until December 2025.

- **Incremental rent cost of maintenance duration**

Maintenance duration after geotextile applied expected to be reduced by 46% from historical actual maintenance duration. Therefore, it will be more efficient and reduce cost maintenance as this project executed.

Table IV 15 The Financial Model of Incremental Cost Maintenance

Parameter	Unit Support for Maintenance		UoM	2023											
				Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Rent Cost	Dozer 155 Komatsu		IDR/hour	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000
	PC 400 Komatsu		IDR/hour	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000
	Grader CAT 24M		IDR/hour	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000
Quantity	Dozer 155 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	PC 400 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	Grader CAT 24M		Unit	1	1	1	1	1	1	1	1	1	1	1	1
IDR-US Rate	Reference rate		IDR/USD	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500
	Actual Rate		IDR/USD	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369
Average Maintenance Working Hour	Dozer 155 Komatsu	Before	hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	PC 400 Komatsu		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Grader CAT 24M		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Dozer 155 Komatsu	Geotextile Applied	hour/month	-	-	-	-	-	-	50	50	50	50	50	50
	PC 400 Komatsu		hour/month	-	-	-	-	-	-	50	50	50	50	50	50
	Grader CAT 24M		hour/month	-	-	-	-	-	-	50	50	50	50	50	50
Incremental Cost Maintenance			IDR/month	-	-	-	-	-	-	129.976.877	129.976.871	129.976.868	129.976.867	129.976.867	129.976.867

Parameter	Unit Support for Maintenance		UoM	2024											
				Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24
Rent Cost	Dozer 155 Komatsu		IDR/hour	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000
	PC 400 Komatsu		IDR/hour	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000
	Grader CAT 24M		IDR/hour	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000
Quantity	Dozer 155 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	PC 400 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	Grader CAT 24M		Unit	1	1	1	1	1	1	1	1	1	1	1	1
IDR-US Rate	Reference rate		IDR/USD	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500
	Actual Rate		IDR/USD	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369
Average Maintenance Working Hour	Dozer 155 Komatsu	Before	hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	PC 400 Komatsu		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Grader CAT 24M		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Dozer 155 Komatsu	Geotextile Applied	hour/month	50	50	50	50	50	50	50	50	50	50	50	50
	PC 400 Komatsu		hour/month	50	50	50	50	50	50	50	50	50	50	50	50
	Grader CAT 24M		hour/month	50	50	50	50	50	50	50	50	50	50	50	50
Incremental Cost Maintenance			IDR/month	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867

Parameter	Unit Support for Maintenance		UoM	2025											
				Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Rent Cost	Dozer 155 Komatsu		IDR/hour	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000	980.000
	PC 400 Komatsu		IDR/hour	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000	560.000
	Grader CAT 24M		IDR/hour	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000	1.300.000
Quantity	Dozer 155 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	PC 400 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	Grader CAT 24M		Unit	1	1	1	1	1	1	1	1	1	1	1	1
IDR-US Rate	Reference rate		IDR/USD	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500	13.500
	Actual Rate		IDR/USD	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369	14.369
Average Maintenance Working Hour	Dozer 155 Komatsu	Before	hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	PC 400 Komatsu		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Grader CAT 24M		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Dozer 155 Komatsu	Geotextile Applied	hour/month	50	50	50	50	50	50	50	50	50	50	50	50
	PC 400 Komatsu		hour/month	50	50	50	50	50	50	50	50	50	50	50	50
	Grader CAT 24M		hour/month	50	50	50	50	50	50	50	50	50	50	50	50
Incremental Cost Maintenance			IDR/month	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867	129.976.867

- **Incremental fuel saving from the reduce maintenance duration**

The reduce of maintenance duration has impact to fuel cost efficiency. Therefore, there will be incremental of fuel usage between before and after this project be implemented. The incremental will be presented by financial model as follows.

Table IV 16 The financial model of incremental fuel saving from maintenance duration

Parameter	Unit Support for Maintenance		UoM	2023											
				Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Average Actual Fuel Consumption	Dozer 155 Komatsu		IDR/hour	45	45	45	45	45	45	45	45	45	45	45	45
	PC 400 Komatsu		IDR/hour	40	40	40	40	40	40	40	40	40	40	40	40
	Grader CAT 24M		IDR/hour	46	46	46	46	46	46	46	46	46	46	46	46
Quantity	Dozer 155 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	PC 400 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	Grader CAT 24M		Unit	1	1	1	1	1	1	1	1	1	1	1	1
Average Maintenance Working Hour	Dozer 155 Komatsu	Before	hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	PC 400 Komatsu		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Grader CAT 24M		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Dozer 155 Komatsu	Geotextile Applied	hour/month	-	-	-	50	50	50	50	50	50	50	50	50
	PC 400 Komatsu		hour/month	-	-	-	50	50	50	50	50	50	50	50	50
	Grader CAT 24M		hour/month	-	-	-	50	50	50	50	50	50	50	50	50
Fuel Usage	Dozer 155 Komatsu	Before	L/month	4.185	4.185	4.185	4185	4185	4185	4185	4185	4185	4185	4185	4185
	PC 400 Komatsu		L/month	3.720	3.720	3.720	3720	3720	3720	3720	3720	3720	3720	3720	3720
	Grader CAT 24M		L/month	4.278	4.278	4.278	4278	4278	4278	4278	4278	4278	4278	4278	4278
	Dozer 155 Komatsu	Geotextile Applied	L/month	-	-	-	-	-	-	2250	2250	2250	2250	2250	2250
	PC 400 Komatsu		L/month	-	-	-	-	-	-	2000	2000	2000	2000	2000	2000
	Grader CAT 24M		L/month	-	-	-	-	-	-	2300	2300	2300	2300	2300	2300
Incremental Fuel Usage due to Maintenance			L/month	-	-	-	-	-	-	5.633	5.633	5.633	5.633	5.633	5.633
Fuel Price	Brent Crude Oil		USD/L	-	-	-	-	-	-	68	68	68	68	68	68
	Site Oil Price		IDR/L	-	-	-	-	-	-	8.508	8.508	8.508	8.508	8.508	8.508
Cost Saving from Incremental Fuel Usage			IDR/month	-	-	-	-	-	-	47.926.220	47.926.218	47.926.217	47.926.217	47.926.217	47.926.216

Parameter	Unit Support for Maintenance		UoM	2024											
				Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24
Average Actual Fuel Consumption	Dozer 155 Komatsu		IDR/hour	45	45	45	45	45	45	45	45	45	45	45	45
	PC 400 Komatsu		IDR/hour	40	40	40	40	40	40	40	40	40	40	40	40
	Grader CAT 24M		IDR/hour	46	46	46	46	46	46	46	46	46	46	46	46
Quantity	Dozer 155 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	PC 400 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	Grader CAT 24M		Unit	1	1	1	1	1	1	1	1	1	1	1	1
Average Maintenance Working Hour	Dozer 155 Komatsu	Before	hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	PC 400 Komatsu		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Grader CAT 24M		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Dozer 155 Komatsu	Geotextile Applied	hour/month	50	50	50	50	50	50	50	50	50	50	50	50
	PC 400 Komatsu		hour/month	50	50	50	50	50	50	50	50	50	50	50	50
	Grader CAT 24M		hour/month	50	50	50	50	50	50	50	50	50	50	50	50
Fuel Usage	Dozer 155 Komatsu	Before	L/month	4.185	4.185	4.185	4185	4185	4185	4185	4185	4185	4185	4185	4185
	PC 400 Komatsu		L/month	3.720	3.720	3.720	3720	3720	3720	3720	3720	3720	3720	3720	3720
	Grader CAT 24M		L/month	4.278	4.278	4.278	4278	4278	4278	4278	4278	4278	4278	4278	4278
	Dozer 155 Komatsu	Geotextile Applied	L/month	2.250	2.250	2.250	2250	2250	2250	2250	2250	2250	2250	2250	2250
	PC 400 Komatsu		L/month	2.000	2.000	2.000	2000	2000	2000	2000	2000	2000	2000	2000	2000
	Grader CAT 24M		L/month	2.300	2.300	2.300	2300	2300	2300	2300	2300	2300	2300	2300	2300
Incremental Fuel Usage due to Maintenance			L/month	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633
Fuel Price	Brent Crude Oil		USD/L	68	68	68	68	68	68	68	68	68	68	68	68
	Site Oil Price		IDR/L	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508
Cost Saving from Incremental Fuel Usage			IDR/month	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216

Parameter	Unit Support for Maintenance		UoM	2025											
				Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Average Actual Fuel Consumption	Dozer 155 Komatsu		IDR/hour	45	45	45	45	45	45	45	45	45	45	45	45
	PC 400 Komatsu		IDR/hour	40	40	40	40	40	40	40	40	40	40	40	40
	Grader CAT 24M		IDR/hour	46	46	46	46	46	46	46	46	46	46	46	46
Quantity	Dozer 155 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	PC 400 Komatsu		Unit	1	1	1	1	1	1	1	1	1	1	1	1
	Grader CAT 24M		Unit	1	1	1	1	1	1	1	1	1	1	1	1
Average Maintenance Working Hour	Dozer 155 Komatsu	Before	hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	PC 400 Komatsu		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Grader CAT 24M		hour/month	93	93	93	93	93	93	93	93	93	93	93	93
	Dozer 155 Komatsu	Geotextile Applied	hour/month	50	50	50	50	50	50	50	50	50	50	50	50
	PC 400 Komatsu		hour/month	50	50	50	50	50	50	50	50	50	50	50	50
	Grader CAT 24M		hour/month	50	50	50	50	50	50	50	50	50	50	50	50
Fuel Usage	Dozer 155 Komatsu	Before	L/month	4.185	4.185	4.185	4185	4185	4185	4185	4185	4185	4185	4185	4185
	PC 400 Komatsu		L/month	3.720	3.720	3.720	3720	3720	3720	3720	3720	3720	3720	3720	3720
	Grader CAT 24M		L/month	4.278	4.278	4.278	4278	4278	4278	4278	4278	4278	4278	4278	4278
	Dozer 155 Komatsu	Geotextile Applied	L/month	2.250	2.250	2.250	2250	2250	2250	2250	2250	2250	2250	2250	2250
	PC 400 Komatsu		L/month	2.000	2.000	2.000	2000	2000	2000	2000	2000	2000	2000	2000	2000
	Grader CAT 24M		L/month	2.300	2.300	2.300	2300	2300	2300	2300	2300	2300	2300	2300	2300
Incremental Fuel Usage due to Maintenance			L/month	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633
Fuel Price	Brent Crude Oil		USD/L	68	68	68	68	68	68	68	68	68	68	68	68
	Site Oil Price		IDR/L	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508
Cost Saving from Incremental Fuel Usage			IDR/month	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216	47.926.216

- **Incremental of productivity which impact to cost fuel saving**

Application of road improvement geotextile has purpose to increase hauler speed and productivity simultaneously. The increasing of productivity leads to gain production and fuel cost saving from unit which involved. The incremental of productivity and implication to fuel efficiency will be explained in financial model as follows.

Table IV 17 The financial model of incremental productivity which impact to fuel saving

Parameter	Unit		UoM	2023											
				Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Quantity	CAT785		Unit	5	5	5	5	5	5	5	5	5	5	5	5
	HD785 Komatsu		Unit	10	10	10	10	10	10	10	10	10	10	10	10
	CAT777		Unit	10	10	10	10	10	10	10	10	10	10	10	10
Avg Actual Effective Working Hour all unit	All Unit		hour/month	15	15	15	15	15	15	15	15	15	15	15	15
Days in a month			days/month	31	28	31	30	31	30	31	31	30	31	30	31
Productivity	CAT785	Before	BCM/hour	112	112	112	112	112	112	112	112	112	112	112	112
	HD785 Komatsu		BCM/hour	83	83	83	83	83	83	83	83	83	83	83	83
	CAT777		BCM/hour	83	83	83	83	83	83	83	83	83	83	83	83
	CAT785	Geotextile Applied	BCM/hour	-	-	-	-	-	-	120	120	120	120	120	120
	HD785 Komatsu		BCM/hour	-	-	-	-	-	-	89	89	89	89	89	89
	CAT777		BCM/hour	-	-	-	-	-	-	89	89	89	89	89	89
Total Gain Production from Incremental Productivity			BCM/hour	-	-	-	-	-	-	74.400	74.400	72.000	74.400	72.000	74.400
Fuel Ratio Benchmark			L/bcm	-	-	-	-	-	-	0,43	0,43	0,43	0,43	0,43	0,43
Distance Benchmark			KM	-	-	-	-	-	-	2,30	2,30	2,30	2,30	2,30	2,30
Average Distance Actual 1st Sem 2022			KM	-	-	-	-	-	-	2,07	2,07	2,07	2,07	2,07	2,07
Variation of Fuel Ratio			L/bcm.km	-	-	-	-	-	-	0,22	0,22	0,22	0,22	0,22	0,22
Fuel Usage from Gain Productivity			L/month	-	-	-	-	-	-	28.227	28.227	27.317	28.227	27.317	28.227
Fuel Price	Brent Crude Oil		USD/L	-	-	-	-	-	-	68	68	68	68	68	68
	Site Oil Price		IDR/L	-	-	-	-	-	-	8.508	8.508	8.508	8.508	8.508	8.508
Cost Saving Fuel from Incremental Productivity			IDR/month	-	-	-	-	-	-	240.161.667	240.161.656	232.414.501	240.161.649	232.414.499	240.161.648

Parameter	Unit		UoM	2024											
				Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24
Quantity	CAT785		Unit	5	5	5	5	5	5	5	5	5	5	5	5
	HD785 Komatsu		Unit	10	10	10	10	10	10	10	10	10	10	10	10
	CAT777		Unit	10	10	10	10	10	10	10	10	10	10	10	10
Avg Actual Effective Working Hour all unit	All Unit		hour/month	15	15	15	15	15	15	15	15	15	15	15	15
Days in a month			days/month	31	29	31	30	31	30	31	31	30	31	30	31
Productivity	CAT785	Before	BCM/hour	112	112	112	112	112	112	112	112	112	112	112	112
	HD785 Komatsu		BCM/hour	83	83	83	83	83	83	83	83	83	83	83	83
	CAT777		BCM/hour	83	83	83	83	83	83	83	83	83	83	83	83
	CAT785	Geotextile Applied	BCM/hour	120	120	120	120	120	120	120	120	120	120	120	120
	HD785 Komatsu		BCM/hour	89	89	89	89	89	89	89	89	89	89	89	89
	CAT777		BCM/hour	89	89	89	89	89	89	89	89	89	89	89	89
Total Gain Production from Incremental Productivity			BCM/hour	74.400	69.600	74.400	72.000	74.400	72.000	74.400	74.400	72.000	74.400	72.000	74.400
Fuel Ratio Benchmark			L/bcm	0,43	0,43	0,43	0,43	0,43	0,43	0,43	0,43	0,43	0,43	0,43	0,43
Distance Benchmark			KM	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Average Distance Actual 1st Sem 2022			KM	2,17	2,17	2,17	2,17	2,17	2,17	2,17	2,17	2,17	2,17	2,17	2,17
Variation of Fuel Ratio			L/bcm.km	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22
Fuel Usage from Gain Productivity			L/month	29.921	27.991	29.921	28.956	29.921	28.956	29.921	29.921	28.956	29.921	28.956	29.921
Fuel Price	Brent Crude Oil		USD/L	68	68	68	68	68	68	68	68	68	68	68	68
	Site Oil Price		IDR/L	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508
Cost Saving Fuel from Incremental Productivity			IDR/month	254.575.145	238.150.942	254.575.145	246.363.044	254.575.145	246.363.044	254.575.145	254.575.145	246.363.044	254.575.145	246.363.044	254.575.145

Parameter	Unit		UoM	2025											
				Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Quantity	CAT785		Unit	5	5	5	5	5	5	5	5	5	5	5	5
	HD785 Komatsu		Unit	10	10	10	10	10	10	10	10	10	10	10	10
	CAT777		Unit	10	10	10	10	10	10	10	10	10	10	10	10
Avg Actual Effective Working Hour all unit	All Unit		hour/month	15	15	15	15	15	15	15	15	15	15	15	15
Days in a month			days/month	31	28	31	30	31	30	31	31	30	31	30	31
Productivity	CAT785	Before	BCM/hour	112	112	112	112	112	112	112	112	112	112	112	112
	HD785 Komatsu		BCM/hour	83	83	83	83	83	83	83	83	83	83	83	83
	CAT777		BCM/hour	83	83	83	83	83	83	83	83	83	83	83	83
	CAT785	Geotextile Applied	BCM/hour	120	120	120	120	120	120	120	120	120	120	120	120
	HD785 Komatsu		BCM/hour	89	89	89	89	89	89	89	89	89	89	89	89
	CAT777		BCM/hour	89	89	89	89	89	89	89	89	89	89	89	89
Total Gain Production from Incremental Productivity			BCM/hour	74.400	67.200	74.400	72.000	74.400	72.000	74.400	74.400	72.000	74.400	72.000	74.400
Fuel Ratio Benchmark			L/bcm	0,43	0,43	0,43	0,43	0,43	0,43	0,43	0,43	0,43	0,43	0,43	0,43
Distance Benchmark			KM	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30	2,30
Average Distance Actual 1st Sem 2022			KM	2,28	2,28	2,28	2,28	2,28	2,28	2,28	2,28	2,28	2,28	2,28	2,28
Variation of Fuel Ratio			L/bcm.km	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22
Fuel Usage from Gain Productivity			L/month	31.700	28.632	31.700	30.678	31.700	30.678	31.700	31.700	30.678	31.700	30.678	31.700
Fuel Price	Brent Crude Oil		USD/L	68	68	68	68	68	68	68	68	68	68	68	68
	Site Oil Price		IDR/L	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508	8.508
Cost Saving Fuel from Incremental Productivity			IDR/month	269.709.317	243.608.415	269.709.317	261.009.016	269.709.317	261.009.016	269.709.317	269.709.317	261.009.016	269.709.317	261.009.016	269.709.317

4.2.6 Financial Feasibility Analysis

One of valuation method used in this financial feasibility analysis is Discounted Cash Flow (DCF). The DCF method values the company on basis of the net present value (NPV) of its future free cash flows which are discounted by an appropriate discount rate. The formula for determining the NPV of numerous future cash flows is shown below. It can be found in various sources, e.g in "Financial Management – Theory and Practice" (Brigham & Gapenski, 1997, p. 254).

$$NPV = \sum_{t=0}^{n} \frac{FCF_t}{(1+r)^t}$$

Where :

n = life of the asset

FCF_t = free cash flow in period t

r = discount rate reflecting the riskiness of estimated cash flows

The free cash flow is the amount of "cash not required for operations or reinvestment" (Brealey, Myers, & Allen, 2006, p. 998). Since the DCF method is a valuation technique that is based on predictions, a scenario analysis is usually conducted to examine the effects of changes in the underlying assumption. Such a scenario analysis is usually based on three scenarios, namely "base case" or "management scenario" that uses the management's estimations for the relevant metrics, a "best case" which uses very optimistic assumptions and a "worse case" that calculates the company's value if it performs badly.

The process of valuing a company with the DCF method contains different stages. In the first stage scenarios are developed to predict future free cash flows (FCF) for the next five to ten years. Afterwards, an appropriate discount rate, the *weighted average cost of capital* (WACC) has to be determined to discount all future FCFs to calculate their NPVs.

$$Value\ of\ firm\ = \sum_{t=1}^{t=\infty} \frac{FCFF_t}{(1+WACC)^t}$$

Where :

$FCFF_t$ = free cash flow to firm in year t

WACC = weighted average cost of capital

FCFF is measured by using the following formula :

FCFF = EBIT (1 – Tax rate) + Depreciation – Capital Expenditure – Δ Working capital

For this project, the FCFF calculation are explained as follows.

Table IV 18 Free Cash Flow to Firm

Stream	Year	2023	2024	2025
		0	1	2
Revenue	Incremental Cost Maintenance	779,861,217	1,559,722,400	1,559,722,399
	Incremental Fuel Saving from Maintenance	287,557,305	575,114,597	575,114,597
	Incremental Fuel Saving from Gain Productivity	1,425,475,621	3,005,629,134	3,175,609,700
	Total Revenue	2,492,894,143	5,140,466,131	5,310,446,697
Operating Cost	Fuel Filter	29,963,490	59,926,980	59,926,980
	Total Operating Cost	(29,963,490)	(59,926,980)	(59,926,980)
Profit & Loss	EBITDA	2,462,930,653	5,080,539,151	5,250,519,717
	(-) Depreciation	(2,756,984,707)	(6,616,763,296)	(4,411,175,531)
	Taxable Income	(294,054,054)	(1,536,224,146)	839,344,186
	Tax Expense	132,324,324	691,300,866	(377,704,884)
	Net Income	(161,729,730)	(844,923,280)	461,639,302
Cash Flow	(+) Depreciation	2,756,984,707	6,616,763,296	4,411,175,531
	CF Operation	2,595,254,977	5,771,840,016	4,872,814,833
	CF Investment (CAPEX)	(6,892,461,767)		
	Net Cash Flow (EAT)	(4,297,206,790)	5,771,840,016	4,872,814,833
	Cummulative Cash Flow	(4,297,206,790)	1,474,633,226	6,347,448,059
Depreciation Schedule	Beginning remaining asset value	6,892,461,767	11,027,938,827	4,411,175,531
	CAPEX	6,892,461,767		
	Depreciation	(2,756,984,707)	(6,616,763,296)	(4,411,175,531)
	End remaining asset value	11,027,938,827	4,411,175,531	-
	% Depreciation	20%	60%	100%

After that, we are going to calculate discounted cash flow by using WACC as consideration, and to evaluate the feasibility of the project, we will use five criterias, three of them includes NPV (Net Present Value), IRR (Internal Rate Return), and Profitability Index (PI). And two of them include Non-Discounted Cash Flow (Non-DCF), those are Payback Period (PBP) and Discounted Payback Period (DPBP). Based on the results obtained, it is known that the calculation results are as follows:

Table IV 19 Discounted Cash Flow Calculation

Stream	2023	2024	2025
	0	1	2
Free Cash Flow to the firm			
Cash Outflow	(6,892,461,767.07)	(59,926,980.00)	(59,926,980.00)
Cash Inflow	1,991,413,337.42	4,067,899,489.91	4,161,388,801.16
Total Cashflow	(4,901,048,429.66)	4,007,972,509.91	4,101,461,821.16
Accumulated Cash Flow	(4,901,048,429.66)	(893,075,919.74)	3,208,385,901.42
Cash Flow (in Billion)	(4.90)	(0.89)	3.21
WACC	**10.04%**		
PV of Cash Flow	(4,901,048,429.66)	3,642,342,487.81	3,387,277,402.30
Accumulated PV of Cash Flow	(4,901,048,429.66)	(1,258,705,941.84)	2,128,571,460.46

Table IV 20 Financial feasibility analysis for road improvement geotextile project

Criteria	Result
Payback Period	1.22
Discounted Payback Period	1.37
Net Present Value	IDR 2,128,571,460.46
Profitability Index	1.43
IRR	41.09%

Based on the positive value of NPV of IDR 2.128.571.460,46 coupled with the IRR of 41,09% which is greater than WACC of 10,04 % , the profitability index 1,43, payback period of 1,22 years, and discounted payback period is 1,37 years, it can be concluded that the project is feasible to run in terms of financial aspects.

4.2.7 Sensitivity Analysis

In this research, sensitivity analysis is conducted to identify how significant certain variables influence the financial feasibility parameters of the project. The changes in value of NPV is used to determine the impact of changes in particular variables within the project. There are two types of variables are defined in this research namely :

- *Uncontrollable variable* : This include fuel price and the assumption used in this research is based on the 2012 – 2021 historical Brent Crude Oil and converted into site oil price
- . However, the uncertainty in price is still present.
- *Controllable variable* : This includes all parameters in Figure IV.6 below, except uncontrollable variable mentioned previously. These variables are considered controllable since changing the value is possible to be conducted by the company upon operational and renegotiation with related parties.

The scenarios are divided into two groups, which are downside scenario, and upside scenario which are adjusted in value by 20% lower and higher respectively. The sensitivity analysis is only conducted for PT Berau Coal's financial projection whom this research aims to

deliver recommendation to. The changes in the value of NPV is presented in tornado chart as shown in.

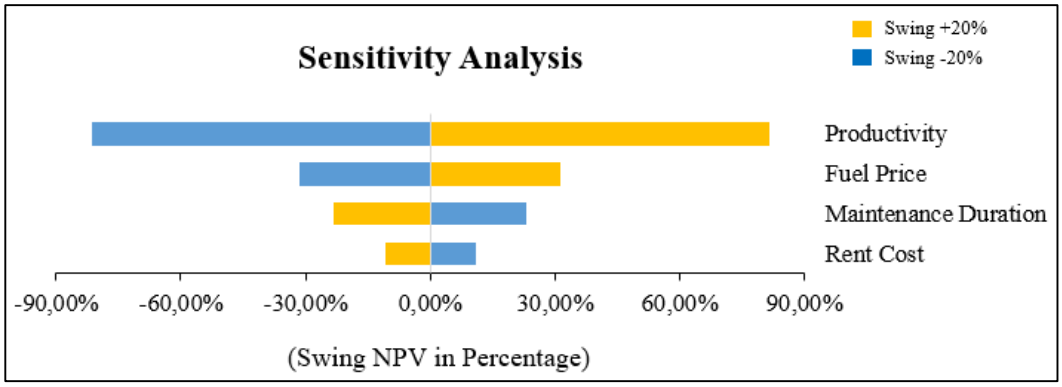


Figure IV 9 Swing NPV Tornado Chart

The simulation of upside and downside scenarios exhibited that productivity, fuel price, and maintenance duration are the biggest three compared to other variables, this can be seen from fairly wide range. While the others variables changes in the basic value do not generate significant results in the NPV range. In mining operation perspective, the decrease of productivity will actually make the total production target unachieved and inefficiency cost from fuel consumption, this condition will be the same if maintenance duration in mine haul road increase, it will impacted to higher cost of maintenance and fuel consumption. And for the other variables, it is important that PT Berau Coal to conduct the negotiation at the best rate possible to reduce operational cost, therefore, produce higher cash flow and profitability.

4.2.8 Scenario Analysis

Scenario analysis is a process of examining and evaluating possible events or scenarios that could take place in the future and predicting the various feasible results or possible outcomes. This analysis is an development of sensitivity analysis and important tool in decision making. Sensitivity analysis is more focus on single value of variable and its impact of NPV value, however, in scenario analysis, possibilities are includes to be evaluated so that it will generate three basic scenarios, base case (most likely or expected), worst case (pessimistic) , and best case scenario (optimistic). The range can be determined by substracting the pessimistic-outcome NPV from the optimistic-outcome NPV (Gitman & Zutter, 2015). In

this research, there are 4 variables in cash flow which will be used to determine outcome-NPV in three scenarios :

1 Productivity hauler

2 Maintenance duration

3 Fuel price

4 Rent cost for unit support maintenance

For worst and best scenario are obtained from data min and max of productivity hauler, maintenance duration, and rent cost historical 6 months primary data from January until June 2022 while fuel price is obtained from historical Brent oil price in January 2012 until December 2021 then converted into oil site price.

Table IV 21 Scenario Analysis

Variables		Unit	Scenario		
			Worst Case	Base Case	Best Case
Productivity	CAT785	bcm/hour	112	120	123
	HD785 Komatsu		83	89	92
	CAT777		83	89	92
Rent Cost	Dozer 155 Komatsu	IDR/hour	1,100,000	980,000	690,000
	PC 400 Komatsu		880,000	560,000	300,000
	Grader CAT 24M		1,450,000	1,300,000	750,000
Fuel Price	IDR/Liter		3,078	8,508	10,052
Maintenance Duration	hour/month		80	50	43
Net Present Value (NPV)	**IDR**		**309,117,674**	**2,128,571,460**	**3,185,247,386**

Based on three scenarios calculation, the best scenario of this project would generate positive NPV almost 1,4 times more profitable than base case scenario, with amount IDR 3.185.247.386, while the worst case still generate positive NPV amount IDR 309.117.674 means that at worst condition, the project would generate revenue to PT Berau Coal in the form of cost efficiency through mine haul road improvement using geotextile.

4.2.9 Monte Carlo Analysis

In this research, Monte Carlo Simulation provides statistical data predicting the effect of randomly varying model parameters or component values (variance) within specified tolerance limits. On this simulation, a random value is selected for each task and the model is

calculated based on random value. The result of the model is recorded then the process will be repeated. This simulation calculates thousand times, each time using different randomly-selected values. Variables which selected to be used in this simulation are productivity, fuel price, and maintenance duration, because all these variables are the most sensitive when analyzed using sensitivity analysis. The simulation output includes statistics for each variable such as max, min, mean, median, standard deviation, kurtosis, skewness, and probability to generate IRR as base scenario (41,09%) . The statistic data of each variable presented in the table below.

Table IV 22 The statistic data of each variable

Variables		Unit	Standar Deviation	Mean	Median	Kurtosis	Skewness	Max	Min
Productivity	CAT785	bcm/hour	2,59	115	115	(1,21)	0,17	123	112
	HD785 Komatsu		2,10	87	87	(1,10)	(0,19)	92	83
	CAT777		2,29	88	88	(1,22)	0,01	92	83
Fuel Price	IDR/Liter		2.096	7.608	6.401	(0,92)	0,39	10.052	3.078
Maintenance Duration	hour/month		14,06	66	65	(1,19)	(1,19)	80	43

When the simulation is complete, a number of results from the model are obtained, each number based on randomized input number. In this study, the Monte Carlo Simulation is presented in histogram chart shown below.

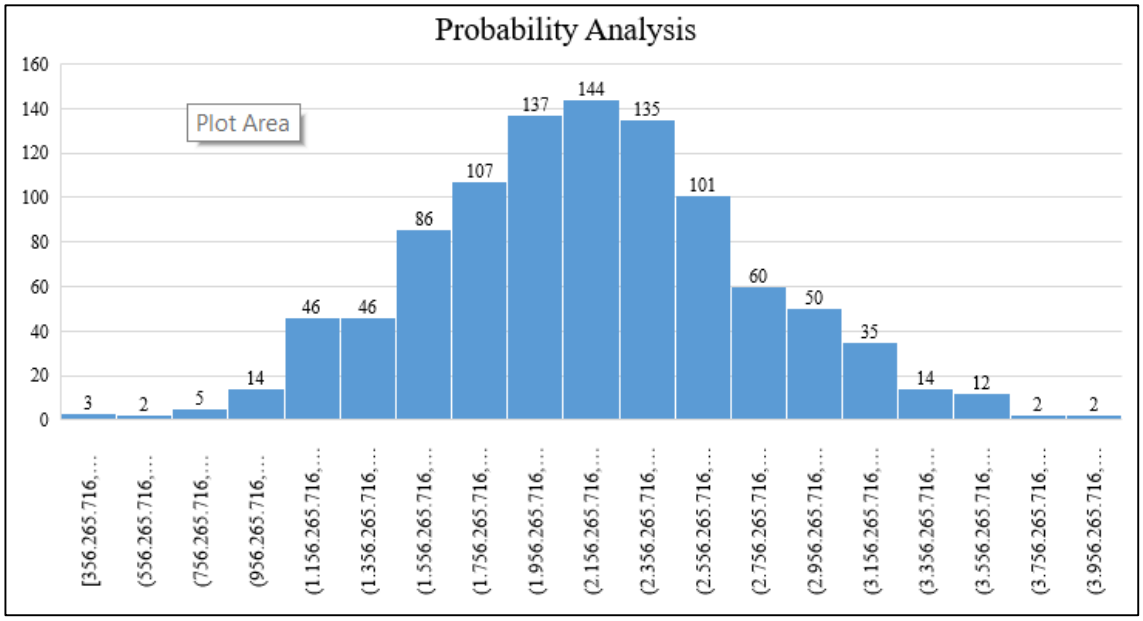


Figure IV 10 Monte Carlo Analysis

Table IV 23 Monte Carlo Simulation Result

Descriptive Statistic	
Mean	42.3%
Median	42.4%
Standard Deviation	8.9%
Kurtosis	6.4%
Skewness	4.0%
Minimum	15.4%
Maximum	75.7%
Probability to get IRR below base scenario	13.7%

As we can see on the table above, the mean or average of IRR across the simulation is 42,3% with maximum value of 75,7% and minimum value of IRR is 15,4%. The mean or average IRR is the value from this cost efficiency project with amount 41,09% in present value and this value raises within the standard deviation. The best possibility of this project could generate IRR up to 75,7%, and the worst possibility could generate IRR of 15,4% to PT Berau Coal if all variables which take effect for cash flow do not meet or under expectation. The probability to get IRR below base scenario (< 41,09%) is 13,7%, or in the other words, there is probability 13,7% that the IRR project will generate value below base scenario target calculation in this project.

4.2.10 Risk Management

In this research, there is possibility that the IRR could generate less than base scenario (< 41,09%). To mitigate the possibility of project's feasibility underperformance, author propose the risk mitigation to be carried out. Lark (2015) explained that risk management consist of three processes, which are identification, analysis, and evaluation or mitigation. The proposed risk management of the project explained in the Table IV.24

Table IV 24 Risk Management

No	Identification	Analysis		Evaluation (Mitigation)
		Cause	Impact	
1.	Hauler Productivity	Unit Low Power and the number of	Loss of Production	Quick Response Trouble

		junction at mine haul road		shooting, coordination between plant and equipment team. For junction, team has to make junction standardization and 3 lanes median to break the traffic.
2.	Unexpectedly higher operating cost	Lack of control in budget management and missing cost component while planning phase	Reducing Net Income	To includes contract clauses mentioning that the increases in operational expenditure are covered by both parties according to scope of works. To create a tight project budgeting
3.	Delay in Project Execution	Delay in making project decision,	Decreasing the value of the project due to time	To increase the awareness of top management in making decision by

		delay in delivery material, construction delay	value of money correction	providing calculated options. To perform periodic project monitoring by qualified personnel in project management from certain background expertise (technical, legal, financial).

Chapter V Conclusion and Recommendation

5.1 Conclusion

This research issue came from Lati Mine Operation which has overburden removal production annual target 134,556,000 BCM and coal getting 8,361,000 MT in year 2022. In the 1st Semester of 2022, actual overburden removal target were not achieved. Overburden removal was achieved in 94% under the year to date plan. The biggest lost contributor was came from productivity parameter. The root cause of hauler productivity problem is material used for road surfacing which has implication to mine road condition. The majority of forming materials consists of many redisturb and swamp materials that cause low bearing capacity on subgrade layer and impacted to road damage on the surface. To answer this issue, business situation analysis was undertaken at the beginning by analyzing the internal and external factors may affect the operational performance in the future, and the idea of mine road improvement by geotextile implementation is the alternative way to increase productivity and make the cost efficiency for getting higher profitability.

Based on financial analysis projection, the mine road improvement using geotextile is feasible to implement. PT Berau Coal covers 100% of initial investment cost with amount IDR 6.892.461.767,07 at 10,04% of WACC. This improvement is projected to give IDR 2.128.571.460,46 in 3 years of project lifetime from July 2023 until December 2025. The NPV of the project is highly affected by four factors which are hauler productivity, maintenance duration, rent cost of unit support for maintenance, and fuel price. The Internal Rate Return (IRR) of this project is expected to be 41,09% with Payback Period (PBP) 1,22 year. The probability to get IRR below base scenario (< 41,09%) is 13,7%, or in the other words, there is probability 13,7% that the IRR project will generate value below base scenario target calculation in this project.

The project's financial projection is mostly sensitive to the productivity, fuel price, and maintenance duration. In term of productivity and fuel price, the higher the value, the higher the cost efficiency which generated from this project, but it is different with maintenance duration, the higher of maintenance duration time, it will increase the operational cost and impacted to decrease the cost efficiency, even the worst, it will make loss of operational. To mitigate the possibility of project's feasibility underperformance, author propose the risk

mitigation to be carried out. The risk mitigation consist of hauler productivity, unexpectedly higher operating cost, and delay in project execution.

5.2 Implication

Road Improvement with geotextile implementation could give positive impact for PT Berau Coal in increasing productivity hauler, reduce cost maintenance for mine haul road, and fuel consumption saving, cost efficiency from this project will increase company's profitability. Higher productivity hauler can reduce loss of gap overburden removal production between target and actual, if overburden removal achieved, in the end, it will make the acceleration of coal expose. In addition, PT Bukit Makmur Mandiri Utama (PT BUMA) as a mine contractor at Lati Mine Operation could get benefit from total volume overburden removal production which had set as target , cost maintenance , fuel efficiency , and higher utilization for their unit support in other area in Lati Mine Operation.

5.3 Recommendation

This section will be explaining the strategy recommendation and implementation plan to ensure the mine road improvement using geotextile can be completed successfully.

In conducting the financial feasibility analysis, several parameters are still assumption. Despite of the theoretical approaches used in this research to obtain the most representative number, actual project execution will be more dynamic. Consequently, it is recommended to do the regular strict monitoring to avoid excessive budget using which could reduce the cost efficiency that will be generated. The delay of project implementation will also definitely affect the NPV generated by this project. But, considering the current situation and current coal prices in the global market, it is advisable for PT Berau Coal to implement this project immediately because this project will generate NPV worth IDR 2.128.571.460,46 with Internal Rate Return worth 41,09%.

In general, the stages of implementation of the mine road improvement using geotextile in Lati Mine Operation based on proposed strategy as follow (Figure V.1) :

1. Creating CAPEX Proposal and proposed it to top management of PT Berau Coal. This proposal includes the project background, cost, benefit, and project timeframe.

2. After the approval, next step is tender process and making contract agreement to issuing purchase orders to selected supplier.

3. The next stage is completing all administrative steps needed and go to road construction process, preparing working area, mobilization and demobilization of unit and equipment, until culvert installation for drainage system.

4. After that, go through the geotextile application, this stage will be dedicated dozer/grader support unit for material overlay and layering material for road surfacing and dedicated supervisor for the fabrication process and DCP test.

5. Final stage is join inspection and commissioning process to ensure all things are comply and ready to be used.

6. Periodically evaluation through weekly hauling road maintenance meeting to monitoring and control the hauler productivity, speed, maintenance duration, and fuel consumption.

Activities	2023																												2024	2025	Responsibe
	Jan-23					Feb-23				Mar-23					Apr-23				May-23					Jun-23				Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23			
	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23	W24	W25	W26	W27								
Proposal																																			
Create CAPEX Proposal																																			Mining Operation & Project
Proposal Approval by BOD																																			General Management Office
Project Tender																																			
Tender																																			Contractor Management
Vendor Appointment																																			Contractor Management
Contract Agreement																																			Contractor Management
Vendor Preparation & Administration																																			Contractor Management & Permit
Geotextile Delivery																																			Logistic & Mining Operation
Project Preparation																																			
Unit Mobilization & Demobilization																																			Mining Operation
Road Construction (Grade, Earth Drain, Cross Fall)																																			Mining Operation
Culvert Installation																																			Mining Operation
Geotextile Installation																																			
DCP road base test																																			Mining Operation
Sewing & positioning geotextile																																			Mining Operation
Fill geotextile Layer 1																																			Mining Operation
DCP Layer 1 Test																																			Mining Operation
Fill geotextile Layer 2																																			Mining Operation
DCP Layer 2 Test																																			Mining Operation
Final Inspection & Commisioning																																			Mining Operation , Safety , Commisioning
Project Evaluation																																			Mining Operation

Figure V 1 Project Implementation Plan

5.4 Limitations and Future Research

Due to the nature of the research questions and the limited literature of this project, this research was based on financial feasibility and only limited in PT Berau Coal. Eventhough this improvement could be implemented in other area inside or outside PT Berau Coal, there is possibility that road mine using geotextile project's parameters technically and financially are not identified and calculated in this research. Because of mining industries are continuously develop and exposed to technology advancement, there are possible efficient alternative projects to maintain mine haul road condition regarding to increase productivity hauler and other sophisticated investment analysis tools.

The limitations of this research point towards topics to be addressed in the future. For future research of this project can lead to further analysis of financial feasibility and operation management. The following are a few areas for future research:

a) Based on this research, geotextile implementation is only limited in Lati Mine Operation and applied in two road segments with total length 1,5 km. For the future research, geotextile improvement is financially and technically feasible to be implemented in all mine haul road PT Berau Coal to increase productivity hauler and make cost efficiency. However, due to in all mine haul road segments have different material properties, more data drill and laboratory testing regarding to material properties have to be done. Material properties is needed to know type of geotextile which suitable for the condition of road forming material so it could give optimum benefit for operational.

b) Unit hauler which operating and accessing the road geotextile improvement has different weight and vessel capacity, material properties as well, therefore, it will impact to durability of geotextile. For the future research, need to be done further studies to determine specific lifetime duration of geotextile.

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Appendices

Month - Year	Inflation (%)
Sep-22	6,0%
Aug-22	4,7%
Jul-22	4,9%
Jun-22	4,4%
May-22	3.5 %
Apr-22	3.4 %
Mar-22	2.6 %
Feb-22	2.1 %
Jan-22	2.2 %
Dec-21	1,9%
Nov-21	1,8%
Oct-21	1,7%
Sep-21	1,6%
Aug-21	1,6%
Jul-21	1,5%
Jun-21	1,3%
May-21	1,7%
Apr-21	1,4%
Mar-21	1,4%
Feb-21	1,4%
Jan-21	1,6%
Dec-20	1,7%
Nov-20	1,6%
Oct-20	1,4%
Sep-20	1,4%
Aug-20	1,3%
Jul-20	1,5%
Jun-20	2,0%
May-20	2,2%
Apr-20	2,7%
Mar-20	3,0%
Feb-20	3,0%
Jan-20	2,7%
Dec-19	2,7%
Nov-19	3,0%
Oct-19	3,1%
Sep-19	3,4%
Aug-19	3,5%
Jul-19	3,3%
Jun-19	3,3%
May-19	3,3%
Apr-19	2,8%
Mar-19	2,5%
Feb-19	2,6%
Jan-19	2,8%

Appendices 1 Indonesian Inflation Rate

(Source : www.bi.go.id)

Month - Year	Exchange Rate (USD-IDR)
Jan-19	13.973
Feb-19	14.069
Mar-19	14.243
Apr-19	14.257
May-19	14.269
Jun-19	14.126
Jul-19	14.022
Aug-19	14.198
Sep-19	14.195
Oct-19	14.043
Nov-19	14.108
Dec-19	13.866
Jan-20	13.655
Feb-20	14.318
Mar-20	16.310
Apr-20	14.882
May-20	14.610
Jun-20	14.265
Jul-20	14.600
Aug-20	14.563
Sep-20	14.880
Oct-20	14.625
Nov-20	14.120
Dec-20	14.050
Jan-21	14.030
Feb-21	14.235
Mar-21	14.525
Apr-21	14.445
May-21	14.280
Jun-21	14.500
Jul-21	14.463
Aug-21	14.268
Sep-21	14.313
Oct-21	14.168
Nov-21	14.332
Dec-21	14.242
Jan-22	14.345
Feb-22	14.350
Mar-22	14.348
Apr-22	14.375
May-22	14.615
Jun-22	14.600

Appendices 2 Exchange Rate USD to IDR

(Source : www.bi.go.id)

Appendices 3 Geotextile and its Implementation in another industry

(Source : https://www.tencategeo.asia/id)