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Determining of Mine Planning Alternative Pit South Pasopati at PT Borneo Indobara

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ABSTRACT
PT Borneo Indobara plans to develop the South Pasopati Pit, a 6200 kcal/kg coal mining project that has a higher selling price than other pits. However, the remote location and lack of connection to active mining operations require large infrastructure investments and limited production forest area licenses. This study aims to analyze the economic feasibility of the South Pasopati Pit project by evaluating various alternative waste dump scenarios. The method used is Net Present Value - Discounted Cash Flow (NPV-DCF) based economic analysis complemented by decision tree analysis and sensitivity analysis using tornado charts to measure the resilience of the selected alternative to price changes. The results showed that the 6th alternative, which is waste disposal only in the South Pasopati (PSS) area, is the most profitable option with an expected value of $30,675k. The alternative of disposal in North Pasopati (PSU) yielded $25,718k, while that in West Kusan Girimulya (KGW) only reached $12,412k. This study confirms that the selection of waste disposal sites has a significant effect on project profitability. Therefore, PT Borneo Indobara needs to comprehensively consider economic and regulatory aspects to maximize investment value and reduce the risk of uncertainty in the development of the South Pasopati Pit.

Keywords: Mine Planning, Valuation, NPV, DCF, Decision Tree Analysis.

INTRODUCTION

Indonesia plays an important role in the global coal mining industry. Energy and Mineral Ministry data 2020 states that Indonesia has the sixth largest coal reserves in the world, with a total of 37,606 million tonnes (KESDM, 2020). Coal remains a fossil energy source that is still in demand globally. According IEA data on Figure I.1, coal consumption in the world has increased over the past 20 years. Although there was a decline in coal consumption during 2019 – 2020 due to the Covid 19 pandemic and most of other countries transitioning to cleaner energy sources, global coal consumption began to rise again in 2021 and reaching more than 8 billion tons in 2022, in line with the coal price increasing. This indicates that coal continues to be a favoured energy source worldwide.

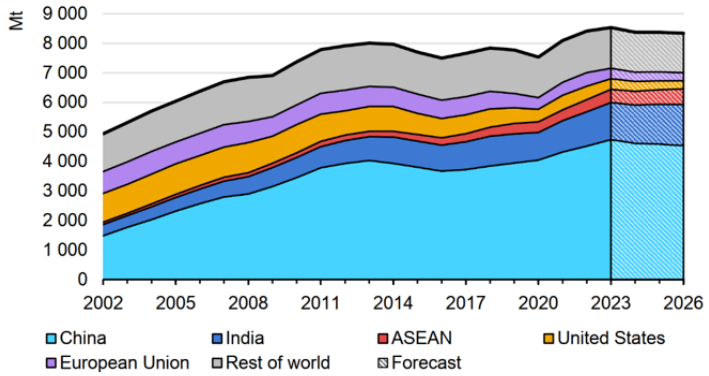

Figure 1. Global Coal Consumption

Source: International Energy Agency – Coal 2023

Statista data recorded that in 2023, about 775 million metric tons of steam coal were produced in Indonesia. Figure I.2 shows that Indonesia exported 462.2 million metric tons of coal in 2022, and this increased by about 50 million metric tons in 2023, reaching 518 million tons.

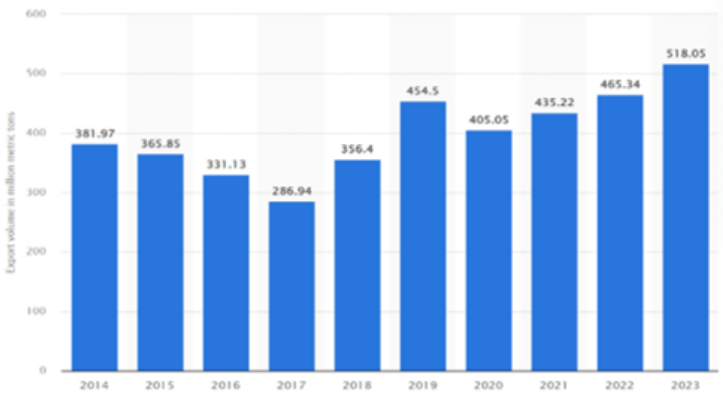

Figure 2. Export Coal Tonnage from Indonesia

Source: https://www.iea.org

This increasing is in line with Indonesia's Coal Production and Reserve Sustainability Plan on the figure I.3, as well as its commitment, Indonesia plans to produce around 600 million tons per year until 2040, with an estimated remaining reserve of 24.75 billion tons by 2040.

Those are seen as an opportunity and boosts confidence for companies as well as coal mining concession holders to continue producing and selling coal, allowing them to remain competitive in the global coal mining industry.

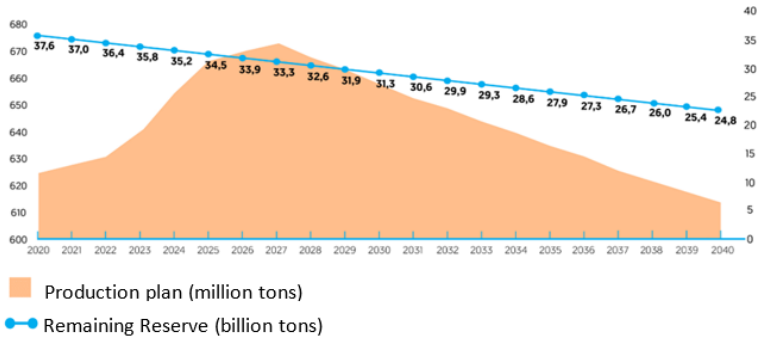

Figure 3. Indonesia Coal Production Plan and Reserve Sustainability

Source: www.esdm.go.id – KESDM, 2020

To support the Indonesia coal production plan, PT. Borneo Indobara plans to increase their coal production target to 54 mio Tonnes in the future as shown in the Figure 4.

Coal Production Schedule	Unit	Mining Period												Total
		Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	
West Block															
Girimulya barat	kt		359	359	283										1,001
Pasopati	kt	**221**	**573**	**563**	**563**	**161**									**2,081**
Batulaki	kt	94	1,351	884	853	852	852	852	852	852	861	336	49		8,689
Sub Total West Block	kt	315	2,283	1,806	1,699	1,013	852	852	852	852	861	336	49		11,771
East Block															
Kusan & Girimulya	kt	15,706	48,894	49,371	50,178	50,863	51,197	52,457	53,148	53,148	53,139	53,664	53,951	31,139	616,855
North Sebamban	kt	423	2,000	2,000	1,155	1,155	981								7,715
South Sebamban	kt		823	823	969	969	969	690							5,244
Sub Total East Block	kt	16,130	51,717	52,194	52,302	52,987	53,147	53,147	53,148	53,148	53,139	53,664	53,951	31,139	629,814
Total BIB	**kt**	**16,445**	**54,000**	**54,000**	**54,001**	**54,000**	**54,000**	**54,000**	**54,000**	**54,000**	**54,000**	**54,000**	**54,000**	**31,139**	**641,584**

Figure 4. Production Target Life of Mine PT. BIB

Source: PT. BIB, 2023

Based on the Feasibility Study report, PT. BIB is going to open the new Pit South Pasopati. Mine planning strategy alternatives are needed and to be the keys to competing in the market and to result the optimal profits for the company. Commonly, company uses the NPV-DCF calculation method to analyse the economic value and profitability of mining plan alternatives. The results of this NPV-DCF calculation will usually be used by company as a basis for making decision about which mining alternative give the most profitable value. But calculations using the current standard NPV-DCF rules cannot flexibly to anticipate the uncertainty that will be faced in the pit South Pasopati case. Therefore, decision tree analysis can be used as one of scenario planning method to complete the economic calculation of NPV-DCF. Through the decision node model, decision tree analysis is an explicit, quantitative, and systematic approach to decision making under uncertainty condition (Lee, Joynt, Anthony, Keitz, Mc Ginn, Wyer, 2009).

PT. Borneo Indobara (PT. BIB) has held a Coal Mining Concession Work Agreement (PKP2B) since August 15th, 1994. This license is classified as Generation II and covers a concession area of 24,100 Ha located in the districts of Satui, Angsana, Kusan Hulu, Sungai Loban, Tanah Bumbu

Regency, South Kalimantan Province. The PKP2B license grants PT. BIB right to operate until August 15th, 2036. PKP2B PT. BIB is divided into 2 production blocks:

a. East block, consist of 3 sub-blocks: Kusan Girimulya, North Sebamban, and South Sebamban.
b. West block, consist of 3 sub blocks yaitu Pasopati, Batulaki, dan Girimulya Barat.

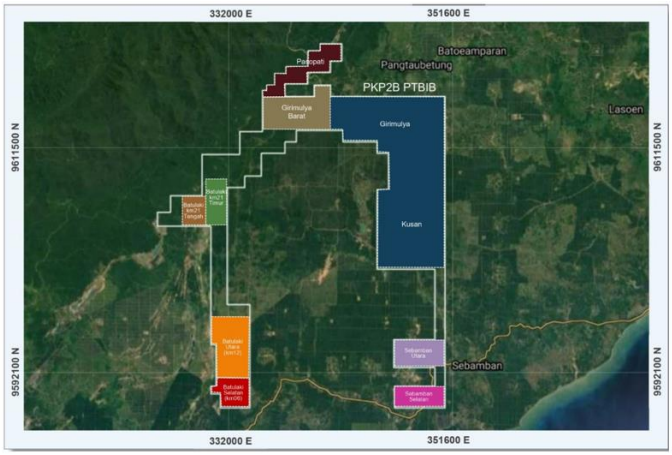

Figure 5. PKP2B PT. Borneo Indobara and Production Block

Source: PT. BIB, 2023

PT. BIB began its commercial production in 2005 with an initial production capacity of 168.000 metric tons. With the discovery of significant additional reserves from continued exploration activities, PT. BIB has revised its feasibility study several times to increase the production level. Over a span of 10 Years, PT BIB experienced significant annual production growth, reaching 42.1 million tons in 2023. The actual coal production PT. BIB can be seen on the Figure 5.

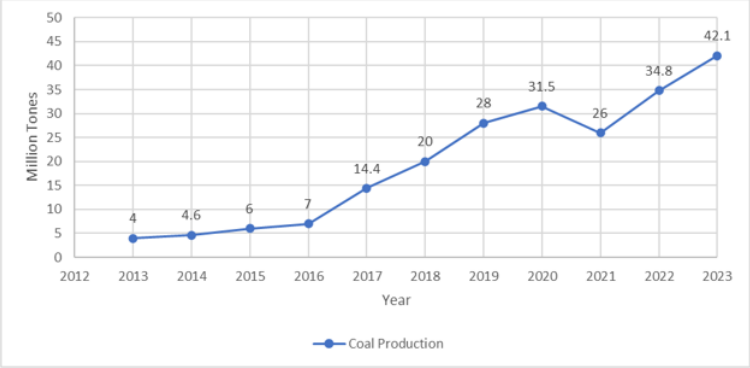

Figure 6. PT. BIB Coal Production 2013-2023

Source: PT. BIB, 2023

PT. BIB has developed an organizational structure as shown in Figure 6 in regard to support the coal production increase activities towards 54 million tons. The company as whole is led by the President Director, assisted by several directors who oversee the corporate functions and operational functions. The operational function organization is led by Head of Mining Technical (KTT), who is responsible to the COO.

PT. Borneo Indobara plans to increase their coal production target to 54 mio Tonnes in the future. To support the target, PT. BIB is going to open the new pit, Pit South Pasopati at 2026. Pit South Pasopati has coal reserve around 2.08 million Tonnes. Even though pit South Pasopati only has small number of coal reserve, but this pit provides the highest calorific value coal product around 6200 Kcal/kg, which the sell price is almost twice compared to the other Pit at PT. BIB mining area as mentioned in the Table 1.

Table 1. PT. BIB Calorific Value Coal Product

Block - Pit	CV-gar (kcal/kg)
Kusan Girimulya	4,034
Pasopati	6,222
Batulaki Utara	4,300
Batulaki Selatan	4,277

Source: PT. BIB, 2023

Uncertainty world coal price condition in the future push PT. BIB management to sell the coal immediately to get a good price. The current coal price is shown on the table 2.

Table 2. ICI Coal Price Index

Indonesia Coal Price Index	CV-GAR (kcal/kg)	Coal Price($)
ICI 1	6,500	$127.72
ICI 2	5,800	$92.87
ICI 3	5,000	$72.24
ICI 4	4,200	$51.18
ICI 5	3,400	$31.78

Source: https://www.jwcindonesia.com – accessed at January 8th 2025

Currently to mine the pit South Pasopati will face some challenges. Refer to Figure 4, pit South Pasopati is located in the northernmost area of PT. BIB's concession, and its location is very far from the current mining area. Beside the location is in the remote area, PT. BIB will face several challenges such as:

a. The limitedness of PPKH (Pinjam Pakai Kawasan Hutan) permit area. This condition led to insufficiency waste dump capacity at Pit South Pasopati. Mining activities can't be conducted if there is insufficiency waste dump area.
b. As a new pit, South Pasopati lacks a coal hauling road that connects it to the existing coal hauling road to the port. Without this road, the coal cannot be transported and sold.
c. The ex-illegal mining void is found there. This leads to uncertainty and decreasing of coal reserve calculation there.
d. Possibility of villager's rejection who live near pit South Pasopati due to logistic activities PT. BIB.

The stakeholders who are needed to be involved are PT. BIB management, License division, External division, Project Expansion division, Coal Logistic & Road Maintenance division, contractors (mining and hauling), villagers, and local/village government. Figure 7 shows the rich picture of those business issues and related stakeholders.

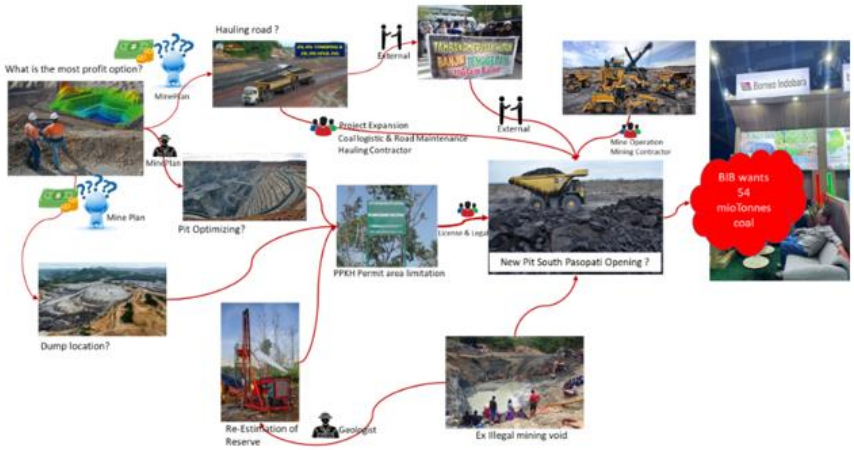

Figure 7. The Rich Picture
Source: Author, 2025

The rich picture on the Figure 7 illustrates the complexity of the business issue in opening pit South Pasopati. However, this research will focus on discussing the business issues related to the limitations of the PPKH permit. This issue is a major concern for the management of PT. BIB because it could significantly impact to the various of mining operational planning scenario and the cost structure required.

In this case, PT. BIB management need some options of strategic mine planning scenario include economic calculation to help them to decide which the best solution should be taken prior to mine Pit South Pasopati.

RESEARCH METHOD

Research design is the framework of research method and technique which chosen by author to conduct a study. In this case, author will use quantitative method because the research will give the recommendation what should be done or what the best option to be taken by PT. Borneo Indobara's management to mine pit South Pasopati using mathematical modelling or financial calculation comparison. The research design is shown on the Figure III.1.

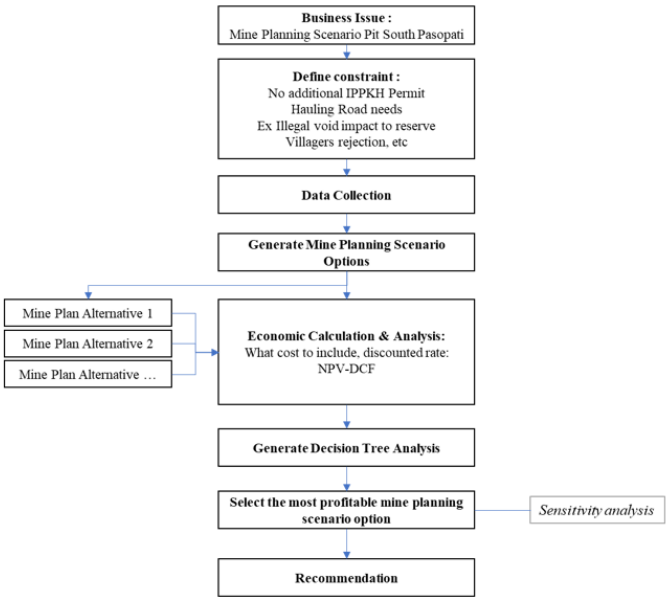

Figure 8. Research Design Flowchart

Source: Author, 2025

This research originates from business issues related to the mine planning scenario of Pit South Pasopati, which is set to begin in 2026. The mining scenarios to be developed aim to accommodate key constraint, including the limited area of PPKH (Pinjam Pakai Kawasan Hutan) permit, the availability of coal hauling roads to the port, the presence of ex-illegal mining voids which affects the calculation for remaining coal reserves, and community concerns. Supporting data needed for the process of creating alternative mining plans to address the main constraint of Pit South Pasopati will then be collected by the author.

In creating the mining plan options for Pit South Pasopati, the author will use mine planning design and scheduler software that used in the company. Through that software, author can create the mine sequence and its alternative until life of mine. The resulting mining alternatives will be processed to the economic calculation and analysis. At this stage, necessary cost and other parameter will be identified and included in calculations using the net present value method. Furthermore, the author will complement the net present value calculation with decision tree analysis. The decision tree analysis results will provide a comparison of the economic value of the

alternative mining plans, allowing a recommendation of the mining plan that offers the most profitable value for company.

Data Collection Method

In collecting data, the author used both primary and secondary data. Primary data was acquired through interviews or discussion with several management members of PT. BIB regarding constraint and key concerns related to mining activities at pit the South Pasopati in the future. The author also received questions from PT. BIB management during that management meeting. The main concerns of those discussion and questions mostly about PPKH concern and its impact to what mine plan alternative can be generated by author. The list of questions that came out from PT. BIB's management is shown on the Table III.1.

Table 3. List of Management Questions

No	Questions	The source of question
1	What is the estimated reserve of the South Pasopati pit considering the conditions caused by illegal mining?	Mine Development Contract Manager
2	Is the area covered by the company's current PPKH permit sufficient to accommodate the volume of waste to be relocated and the mining facilities supports?	Mine Development Contract Manager
3	What is the additional PPKH permit area required to accommodate the life of mine pit South Pasopati?	Legal & License Manager
4	If the current PPKH permit cannot meet the waste dump requirements, what are the alternatives area that can be used as waste dump with economic hauling distances and what supporting facilities needed? How feasible is void PSU can be utilized for waste dump?	Mine Head PT. BIB
5	What are the alternative dump plans if operations are conducted only within the existing PPKH permit area around pit South Pasopati? What is the optimal reserve tonnage that can be obtained?	Mine Development Contract Manager
6	What alternative mining strategies can be implemented to minimize the extent of Pasopati block void for mine closure needed?	Mine Head PT, BIB
7	How many kilometres of alternative coal hauling road need to be constructed to connect to the existing haul road and port?	Project Expansion Manager

8	Are there any mining activities that will directly intersect with the activities of the surrounding community?	External Manager
9	How much the estimated mining cost for each mining alternative?	Finance & Accounting Division Head
10	What is the most profitable mining plan alternatives can be taken?	Director

Source: PT.BIB, 2024

The notes of meeting were documented in company's minutes of meeting. Additionally, during the primary data collection process, to answer those questions, the author conducted design creation, measurements, and trial calculations of the mining design using the company's mine planning software namely Minescape for mine design and SPRY for mine scheduling.

Secondary data, on the other hand, was acquired from internal company documents. In this case, author coordinated with related department in the company to support in providing data. Supporting report related to the cost history of previous projects undertaken by the company, publicly available journal, article, website and published news. To ensure the confidentially of company data, the author made several modifications or grouping number to the figures, particularly those related to project cost information, and did not include the detail of data in the research report. After all of data have been compiled, the next step continues to mine economic calculation for each of mine plan alternative and generate decision tree analysis to obtain the result and comparation. The data collection method process is shown in the Figure 9.

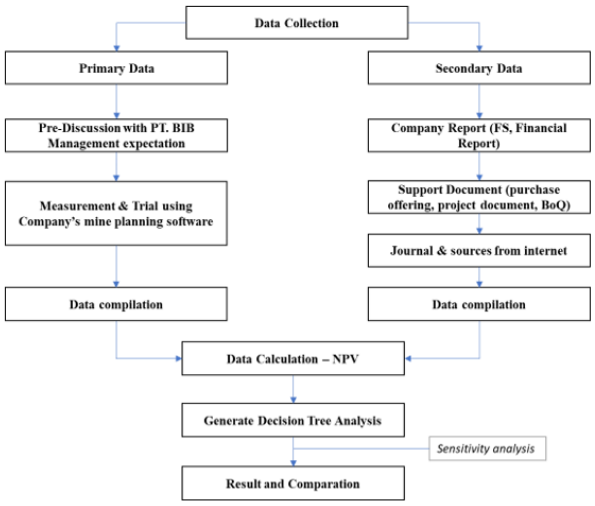

Figure 9. Data Collection Method

Source: Author, 2025

Data Analysis Method

The author prepared assumption data to be used in creating mining design and scenarios, utilizing raw quantitative data obtained through both primary and secondary data collection. In the process of preparing these mining assumptions, the author processed the design and data to produce several alternative mining plans.

The mining cost assumption data obtained was the processed and incorporated into Net Present Value (NPV) – Discounted Cash Flow (DCF) calculation using Excel application for each alternative. Subsequently, the NPV-DCF calculation were supplemented with an analysis using decision tree analysis to compare the alternatives. This approach helps to identify which mining plan would be the most profitable for the company. Then sensitivity analysis is conducted to the most profitable alternative to explore how robust the alternative toward the price changes. The process of data analysis method is shown on the Figure 10.

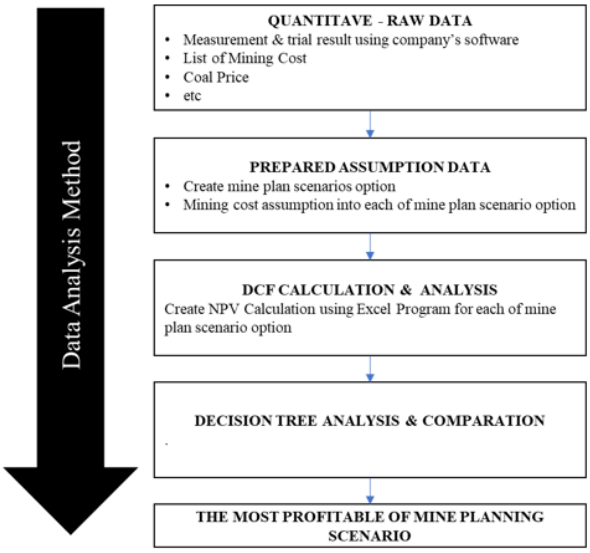

Figure 10. Data Analysis Method

Source: Author, 2025

RESULT AND DISCUSSION

PT. BIB is the coal mining company that implement surface mining – open pit method in their operational. The disturbed area is increased as the increasing of coal production every year. Most of the area of PKP2B PT. BIB include pit South Pasopati are in the forest area, so PPKH permit from the government is required before starting the mining process. Company has responsible to propose PPKH permit to the government as Regulation of The Minister of Environment and Forestry Republic of Indonesia No 7 of year 2021. Refer to the PT.BIB's feasibility report 2023, PT. BIB hold 10.942 Ha PPKH permit totally in 2023.

In preparing to mine Pit South Pasopati, obtaining the PPKH permit is the priority focus of PT Borneo Indobara's management. The availability of PPKH permit will give significantly impacts to the main company's mining strategic plan related to the mine design, operations and location of mining support facilities as well as its influence on the costs that the company will incur later. According to the mining planning strategy in the Feasibility Study report, PT. Borneo Indobara (BIB) require additional PPKH to cover waste dump area needs at South Pasopati. Obtaining this additional PPKH permits is not easy, this really depends on the availability of PPKH permit quotas as regulated in Minister of the Environment Regulation No. P.27-2018/ Menlhk/Setjen/Kum.1/7/2018. With this condition, PT. BIB will face the uncertainty of obtaining additional PPKH permits according to the size of the work area required. PT. BIB's management considers it is necessary to create some alternative mine planning related to the concern of waste dump area location to accommodate the limitation of PPKH permit issues. This is important to manage ambiguity and mobilize action in the under-uncertainty condition in the future.

Beside South Pasopati (PSS) area, one of location alternative is dumping at void pit North Pasopati area (PSU), which has mined out in 2021 (Figure 11). This void is located on the northern of pit South Pasopati and is considered as a potential alternative waste dump location. Beside fulfilling waste dump capacity needs, PT. BIB's management considers it is important to reduce the void left area in the Pasopati block for mine closure benefit and reduce void cost. Currently, North Pasopati has 60 Ha Void area left. According to Indonesia Government Regulation No 36 of 2024, the use of forest area land is categorized into three types L1, L2, and L3. The disturb area such as void, fall under the L3 category, which is designated for permanently damaged forest areas that cannot be optimally reclaimed. For this category, company must pay PNBP per year at rate of 7 times the basic tariff to the government, multiplied by the cumulative remaining void area per year. The PNBP costs will impact to the mining cost increasing.

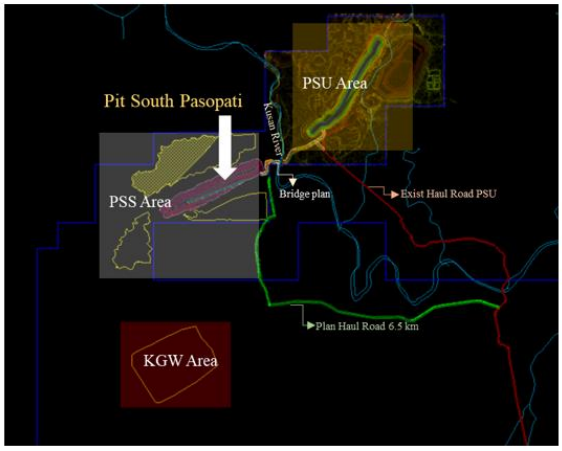

Figure 11. Waste Dump Pit South Alternative

Source: Author, 2025

In addition to the void of pit North Pasopati, optimizing the existing of disturbed area can help reduce PNBP per year costs rather than to open new land clearing for waste dump. Under the regulation, forest area uses for dumping sites is categorized as L2, for which company must pay PNBP per year at 4 times the basic tariff, multiplied by the cumulative disturbed area for dumps each year. The larger of disturb area categorized as L1, L2, or L3, the greater the annual PNBP costs paid by the company to the government. PNBP cost will be included into mining cost calculation.

However, utilizing the disturbed area at pit Pasopati North as a waste dump location is not without challenges. Refer to Figure 11, there is Kusan River, wide and fast-flowing, separates the pit South Pasopati and North Pasopati. A suspension bridge is needed for dump truck access to transport waste material from pit Pasopati South to the Pasopati North area. Constructing such a bridge would incur very high costs. Nevertheless, this bridge can be utilized for coal hauling truck and it can reduce new coal hauling road construction cost. The bridge will connect to the existing coal hauling road at North Pasopati that can be accessed to the port. Beside the bridge, waste overhaul distance also giving high impact in the mining cost calculation. PT. BIB will pay the excess of waste haul distance when the distance over than 1 km. In this case, author will use mine scheduling SPRY software to measure the annual waste haul distance. Then this number will be included to the mining cost calculation.

Beside pit North Pasopati (PSU) area, other alternative waste dump location is at Western of pit Girimulya (KGW). The location is shown in the Figure 11, it is quite far from pit South Pasopati and is in an area where already has PPKH permit. This alternative will disturb new area, which will increase the PNBP cost and mining support facilities cost. Besides that, as the location of western of pit Girimulya is quite far from pit South Pasopati, the haul distance cost will also getting higher than other option.

Therefore, an economic valuation of using the existing disturbed North Pasopati area and Western of pit Girimulya as an alternative dumping site are necessary to see how profitable these options.

Business Solution

As the mentioned analysis on the section 11, author generate several steps for business solution. The detail of the business solution description as follows.

Pit South Pasopati Mine Plan Alternative

Refer to the analysis in the previous section and to answer the management's question in the Chapter 3, the author provides 7 (seven) pit South Pasopati mine plan alternatives which based on the three main waste dump location. The locations of waste dump are in the PSS and PSU, PSS and KGW, and PSS only.

There are four mine plan alternatives when the scenario dump to PSS and PSU, one mine plan alternative dump to PSS and KGW, and two mine plan alternative dump to PSS only. The picture of Pit South Pasopati (PSS) mine plan alternative is shown on the Figure 12

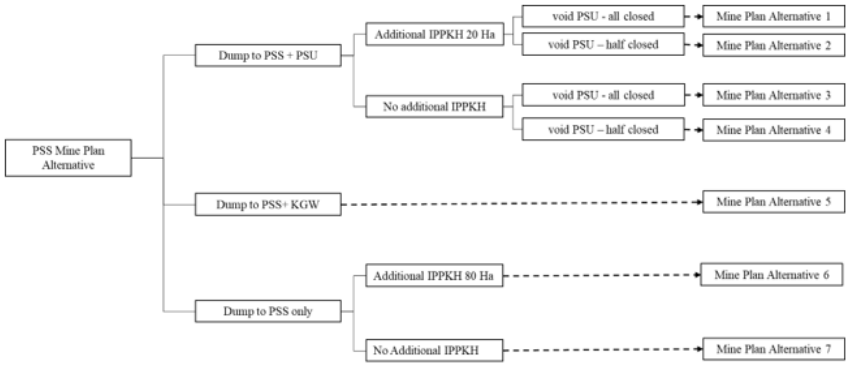

Figure 12. Mine Plan Alternatives of Pit South Pasopati

Source: Author, 2025

The seven alternatives of PSS Mine Plan are:

a. Alternative 1, it is assumed that BIB will obtain 20 Ha additional PPKH permit in the pit South Pasopati. The waste dump area is planned in the PSS and PSU area. Mine scheduling results over haul distance higher than alternative 1. Some additional mining cost such as bridge construction and pumping void Pit North are needed in this scenario. Then void PSU will be fully closed and there is only 1 void left in the Pasopati block namely pit South Pasopati.
b. Alternative 2, it is assumed that BIB will obtain 20 Ha additional PPKH permit in the pit South Pasopati. The waste dump area is similar with alternative 2, but in this plan, void PSU is not fully closed. There will be two voids left in the Pasopati block.
c. Alternative 3, it is assumed that BIB can't obtain the additional PPKH permit at all and utilized all of the void North Pasopati area as waste dump location. Additional mining cost such as bridge construction and pumping void pit North are needed in this scenario. But there is coal hauling road construction,
d. Alternative 4, it is assumed that BIB can't obtain the additional PPKH permit at all and utilized only half of the void North Pasopati area as waste dump location.
e. Alternative 5, it is assumed that BIB can't obtain the additional PPKH permit at all and utilizing the existing PPKH permit area at western of pit Girimulya as waste dump.
f. Alternative 6, it is assumed that BIB will obtain 80 Ha additional PPKH permit in the pit South Pasopati area (PSS) for waste dump needs, enabling mining activities and other supporting operation to be carried out in the pit Pasopati South (PSS).
g. Alternative 7, it is assumed that BIB can't obtain the additional PPKH permit at all and utilizing the existing PPKH permit area at pit South Pasopati. This scenario results in a reduction of reserve.

From those assumptions, the author has made the production plan for each of alternative. For mine plan scheduling simulation PT. BIB use SPRY Scheduling Software as Appendices 1. The scheduling simulation resulted yearly production of waste volume, coal quantity, and overhaul

distance pit South Pasopati (PSS) which is shown on the Appendices 2. The author has summarized the production plan including the key concerns, impact and action plan need to be taken for each alternative that will be used in the economic calculation in the Table 13.

Key Concern	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Will BIB obtain additional IPPKH for Waste Dump ?	Yes (20 Ha)	Yes (20 Ha)	No	No	No	Yes (80 Ha)	No
Where is the alternative waste dump location ?	PSS & PSU	PSS & PSU	PSS & PSU	PSS & PSU	PSS + KGW	PSS	PSS
What is the estimated total reserve of PSS ?							
Waste (ktbcm)	27,898	27,898	27,743	27,743	29,880	28,608	22,171
Coal (kton)	2,042	2,042	2,042	2,042	2,042	2,042	1,717
SR (bcm/t)	13.66	13.66	13.59	13.59	14.64	14.01	12.92
Over haul distance (km)	2.13	1.96	2.36	2.16	3.02	1.42	1.50
What action plan need to be taken?							
Bridge Construction from pit PSS to PSU	Yes	Yes	Yes	Yes	No	No	No
Haul Road ROM to Port Construction (km)	1.2	1.2	1.2	1.2	6.5	6.5	6.5
Water Pumping Volume (m3)	1,494,995	1,079,268	1,494,995	1,079,268	386,390	386,390	386,390
Water door of settling pond quantity? (unit)	3	3	3	3	4	3	3
How wide is the void left at Pasopati Block?							
North Pasopati (PSU) Void - (Hectares)	0	42	0	32	60	60	60
South Pasopati (PSS) Void - Hectares	59	59	59	59	59	59	39
Total Void at Pasopati Block Left(Hectares)	59	101	59	91	119	119	99
How wide the disturbed area at category L1, L2, L3	Appendices 3	Appendices 3	Appendices 3	Appendices 3	Appendices 3	Appendices 3	Appendices 3
Is there any activities intersect with villager activities ?	No	No	No	No	Yes	Yes	Yes

Figure 13. Key Concern of Pit PSS Mine Plan Alternative

Source: Author, 2025

Revenue and Cost Factor Assumption

The cost and revenue factors used in the calculation are as follows:

a. All costs and revenue are in US Dollars. Financial model will be calculated until 2036 based on the feasibility study report.
b. Coal sales price –ICI 2 is used at $90.5/ton. It is based on the LOM coal price average that determined in the PT. BIB's feasibility report.
c. Royalty which company pay to government is 13.5% of revenue.
d. Operating expenditure costs are consisted of:
    a) Overburden cost
    b) Over haul distance cost if the haul distance more than 1 km
    c) Coal getting cost
    d) ROM management cost
    e) Coal hauling ROM to port cost
    f) Coal hauling road maintenance cost
    g) Coal handling at Port (crushing, handling, barging, transhipment)
    h) Other cost such as rehabilitation, environmental management, CSR, salary, camp, medical, and land
    i) Administration and overhead cost
    j) Extra void pumping cost
    k) PNBP cost

According to Indonesia Government Regulation No 36 of 2024, the use of forest area land is categorized into three types L1, L2, and L3. The PNBP is paid to the Government based on the each of categories. The cost calculation as follows:

L1 Category: 1 x $ 293.75 x Cumulative disturb area / year

L2 Category: 4 x $ 293.75 x Cumulative disturb area / year

L3 Category: 7 x $ 293.75 x Cumulative disturb area / year

The cumulative disturb area / year is shown on the Appendices 3.

e. Depreciation

The depreciation in this research focused on depreciation in development CAPEX and paid for 10 years. The period length of depreciation is determined by company.

f. APEX (Capital Expenditure)

In this research, CAPEX are consist of:

a) Bridge to PSU construction cost
b) Coal hauling road construction cost
c) Water door of Settling Pond cost

g. Payable tax has been determined by the company at 22%

h. WACC is used to determine the investment discount rate and has been determined by the company at 10%

NPV-DCF Calculation

From those cost and revenue factors assumptions, the author establish the financial analysis using NPV-DCF method at excel application for each alternative. As shown in the Table 14, the difference of 7 alternatives mostly come from the OPEX cost and CAPEX. Refer to the Appendices 4, alternative 5 result the highest total OPEX due to the overburden removal activities. It is caused by this alternative has the highest waste removal volume, over haul distance and also the widest disturbed land than another alternative. Furthermore, even though the PNBP cost of alternative 1, 2, 3, 4 are lower than alternative 6 and 7, the OPEX of these alternatives is still higher due to higher over haul distance cost.

Description	Alternative						
	1	2	3	4	5	6	7
Revenue	$ 184,771	$ 184,771	$ 184,771	$ 184,771	$ 184,771	$ 184,771	$ 155,352
Royalti	$ 24,944	$ 24,944	$ 24,944	$ 24,944	$ 24,944	$ 24,944	$ 20,972
Net Revenue	**$ 159,827**	**$ 159,827**	**$ 159,827**	**$ 159,827**	**$ 159,827**	**$ 159,827**	**$ 134,379**
Total OPEX	**$ 110,032**	**$ 107,521**	**$ 112,634**	**$ 109,906**	**$ 132,376**	**$ 101,920**	**$ 82,253**
Depreciation	**$ 3,548**	**$ 3,548**	**$ 3,548**	**$ 3,548**	**$ 632**	**$ 614**	**$ 614**
Total CAPEX	**$ 3,548**	**$ 3,548**	**$ 3,548**	**$ 3,548**	**$ 632**	**$ 614**	**$ 614**
Profit Before Tax	$ 46,247	$ 48,758	$ 43,645	$ 46,373	$ 26,818	$ 57,293	$ 51,513
Payable Tax	$ 11,854	$ 12,296	$ 11,248	$ 11,717	$ 8,638	$ 13,541	$ 12,030
Profit After Tax	$ 34,393	$ 36,462	$ 32,398	$ 34,655	$ 18,180	$ 43,752	$ 39,483
Cummulative Discounted Cash Flow	**$ 24,877**	**$ 26,684**	**$ 23,291**	**$ 25,241**	**$ 12,412**	**$ 33,661**	**$ 29,204**

Table 14. NPV-DCF Calculation Summary

Source: Author, 2025

Then, at alternative 1, 2, 3, 4 shows that the total CAPEX reach k$ 3,548, higher than the other three alternative. It becomes higher due to bridge construction factor at those alternatives. Even the total length of coal hauling road construction in the alternative 6, and 7 are 5 times than alternative 1 – 4, the cost of CAPEX is still be the lowest than others. In the end of NPV calculation, the alternative 6 shows the highest number of cumulative discounted cash flow than others which is amount k$33,661.

Decision Tree Analysis

As systematic approach to decision making under uncertainty condition, the financial analysis NPV-DCF of Pit South Pasopati will be completed with the decision tree analysis.

Prior to create the decision tree analysis, it needs to calculate the NPV of operating expenditure (OPEX), tax and net revenue. The result is shown on the Table 15 and will be inserted into the decision tree analysis.

		Unit	Alternative						
			1	2	3	4	5	6	7
		k$	3,548	3,548	3,548	3,548	632	614	614
CAPEX	Water door at Settling Pond	k$	56	56	56	56	75	56	56
	Haul Road	k$	105	105	105	105	557	557	557
	Bridge	k$	3,386	3,386	3,386	3,386	-	-	-
NPV Calculation	OPEX	k$	87,585	85,418	89,644	87,303	105,509	80,344	62,996
	Tax	k$	8,773	9,133	8,300	8,691	6,230	10,165	8,746
	Net Revenue	k$	124,783	124,783	124,783	124,783	124,783	124,783	101,559

Fugure 15. CAPEX and NPV Calculation at DTA Analysis

In the staging of each alternative which has the outcome of additional IPPKH, the probability is 0.33. This probability number is calculated from the realisation of obtained PPKH permit area along 2022 – 2024 toward the plan.

The decision tree analysis result that the option to dump at PSS only (South Pasopati) show the most profitable option with the value of project is $ 30,675. Alternative 6 giving the best profitable number compared to other. But in the uncertainty condition of limited IPPKH quota availability, management BIB can choose the alternative 7 when additional IPPKH 80 Ha as alternative 6 can't be obtain at Y2026. This alternative can be the best solution for management compared to the alternative of dumping at PSU or KGW.

Sensitivity Analysis

After getting the most profitable alternative, the last step is conducting sensitivity analysis. The analysis is given to the alternative 6 as the most profitable alternative. The factors that are taken into consideration as follow:

a. Coal price
b. OPEX cost

c. CAPEX cost.

In this research, the author uses tornado chart for the sensitivity analysis. The analysis of the 3 factors above to NPV with changes of parameter in swing -20% and +20%. The author inserted the swing number in each of cost factors to get the changes of NPV score and formulated it to create the tornado chart. The tornado chart result can be seen in the Figure 16.

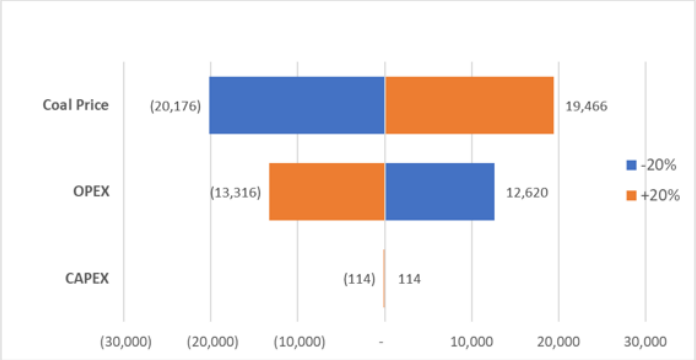

Figure 16. Sensitivity Analysis – Tornado Chart

Based on the tornado chart result in the Figure 16, it is concluded that coal price is the most significant influence in the changing of NPV number. When the coal price is swing to -20%, the NPV of cashflow can be reduced around k$ 20,176. Other factor such as CAPEX, the swing doesn't give significant result for NPV.

Implementation Plan

This section describes the steps as well as the timeframe of the implementation process, as follow:

a. Mine plan provides the best alternatives of mine planning pit South Pasopati
b. Economic evaluation and analysis of profitable value : done, on section IV.2.4
c. The decision to choose the most profitable alternative at dump to PSS only.
d. PT. BIB's top management conduct internal meeting to discuss about PPKH permit proposal.
e. PT. BIB will prepare action plan related to the pre-mining activities especially for coal haul road and water door construction.
f. PT. BIB will conduct meeting with mining contractor to discuss about detail all constraint, preparation to achieve the target volume, manpower, equipment, legal issues, and others.

The detail of proposed implementation plan that aligns with the alternative mining plan - dump to PSS only is shown on the Figure 17.

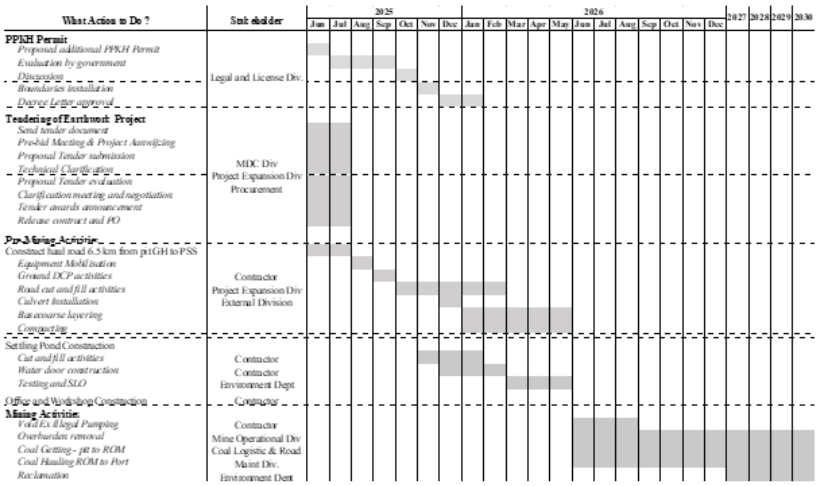

Table 17. Workplan of Pit South Pasopati

CONCLUSION

Based on the research objectives outlined in Chapter 1, this study identifies seven mine planning scenarios to address waste dump area and PPKH permit issues, categorized into three main waste dump locations: four alternatives involving dumping to PSU and PSS, one alternative for dumping to KGW and PSS, and two alternatives for dumping to PSS only. The evaluation using NPV calculations and decision tree analysis reveals that the most profitable option is alternative 6, with an estimated profit of k$ 33,661. However, if the PPKH permit cannot be obtained as planned, alternative 7, which involves dumping to PSS only, emerges as the next best option, providing a profit of k$ 30,675. This research contributes to mine planning optimization by offering a structured decision-making approach for waste dump management, enabling companies like PT. BIB to maximize profitability while addressing regulatory constraints. Future research can expand on this study by integrating environmental and operational risk assessments, incorporating dynamic market conditions, and exploring advanced optimization models for sustainable and cost-effective mine planning strategies..

REFERENCES

Balasubramanian, A. (2017). Coal Mining Methods. Mysore : Centre for Advanced Studies in Earth Science.

Borneo Indobara, (2023), Laporan Akhir Studi Kelayakan Tambang Batubara PT. Borneo Indobara.

Budiarto, A. (2022). Proposed Strategic Mine Planning and Economic Valuation of Pit C2H Sambarata PT. Berau Coal. Institut Teknologi Bandung.

Davis, Graham A, Newman, Alexandra M. (2008). Modern Strategic Mine Planning. Colorado School of Mines.

Eschenback, T. G. (1992). Spider Plots Versus Tornado Diagrams for Sensitivity Analysis.

Interfaces, 22, 40–46

Fauconnier, C.J, Kersten, R.W.O. (1982). Increased Underground Extraction of Coal : The South African Institute of Mining and Metallurgy Monograph Series No.4. South African : The South African Institute of Mining and Metallurgy.

Haq, N. (2018). Modelling Valuation, Risk, Decision in Mining Projects. Indonesia: FIRA Publishing.

Kamiński, B., Jakubczyk, M., Szufel, P. (2017). A Framework for Sensitivity Analysis of Decision Trees. Central European Journal of Operations Research. 26 (1): 135–159. Doi:10.1007/s10100-017-0479-6. PMC 5767274. PMID 29375266.

Khan, M.Y. (1999). Theory & Problems in Financial Management. Boston : McGraw Hill Higher Education.

Kear, R.M. (2006). Strategical and Tactical Mine Planning Components. Santiago: The Journal of the South African Institute of Mining and Metallurgy.

KESDM, (2020). Peluang Investasi Batubara Indonesia. Retrieved from Kementrian Energi dan Sumber Daya Mineral : www.esdm.go.id

Kotze, A.P.L., Van Der Westhuizen J.A, & Pienaar, W.C. (1986). The Planning of Open-Pit and Strip Mines. Ed. Deetlefs, J.P. Johannesburg, SAIMM. South Africa: Iscor.

Lee, A., Joynt, G.M., H, Anthony, Keitz, S., McGinn, T., Wyer, C.P. (2009). Making Sense of Decision Analysis Using a Decision Tree. New York City: Society of General Internal Medicine.

Mangkusubroto, K. (2011). Pengambilan Keputusan. Bandung : ITB Press

Reyck, B.D., Degraeve, Z., Vandenborre. (2006). Project Options Valuation with Net Present Value and Decision Tree Analysis. Europian Journal of Operational Research: www.elsevier.com

Rudeno, V. (2012). The Mining Valuation Handbook: Mining and Energy Valuation for Investors and Management. Australia : Jhon Wiley & Sons Australia, Ltd.

Schissler, AP. (2004). Coal Mining, Design and Methods of. Pennsylvania United States: Encyclopaedia of Energy.

Saltelli, A., Tarantola, S., Campolongo, F., Ratto, M. (2004). Sensitivity Analysis in Practice. Aguide to Assessing Scientific Models. Vol. 1. doi:10.1002/0470870958. ISBN 978-0-470-87093-8.

Trigeorgis, L. (1996). Real Options: Managerial Flexibility and Strategy in Resource Allocation. Cambridge Massachusetts : The MIT Press.

Von Winterfeldt, D., Edwards, W. (1986). Decision Trees – Decision Analysis and Behavioural Research. Cambridge University Press. Pp. 63–89. ISBN 0-521-27304-8.

Whittle, D. (2005). Strategic Mine Planning. Australia: Monash University

Zizlavsky, O. (2014). Net Present Value Approach : Method for Economic Assessment of Innovation Projects. Elsevier Ltd

Reference of Indonesia Regulation:

Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.27/Menlhk/Setjen/Kum .1/7/2018 concerning Guidelines for Borrowing and Using Forest Areas.

Republic of Indonesia Government Regulation Number 36 of 2024 concerning Types and Rates of Non-Tax State Revenue (PNBP) that Apply to the Ministry of Environment and Forestry

Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 7 of 2021 concerning Forestry Planning, Changes in the Designation and Function of Forest Areas, and Use of Forest Areas.

Reference from website :

Coal 2023, Analysis and Forecast to 2026, data is obtained from website : https://www.iea.org. Downloaded on August 23rd, 2024.

ICI Coal Price Index, data is obtained from website: https://www.jwcindonesia.com. Accessed at January 8th, 2025