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Investment Project Analysis in the Crusher Replacement Plan

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ABSTRACT:
The global coal market experienced three turbulent years, with a sharp decline in demand during the Covid-19 pandemic, followed by a rebound in demand post-Covid and after Russia's invasion of Ukraine. In 2022, global coal demand reached an all-time high of 8,415 million metric tons, driven by growth in China and India, and continued to rise slightly by 1.4% to 8,536 Mt in 2023. The downward trend in coal prices poses challenges for mining companies, including PT Berau Coal Site Binungan Mine Operation (BMO). This study aims to address the frequent breakdowns of the CR12 crusher at BMO, which result in increased maintenance costs, production downtime, and reduced overall efficiency. Using Total Cost of Ownership (TCO) calculations and the Discounted Cash Flow (DCF) method, the Net Present Value (NPV) of several secondary crusher brands—Joy (existing), MMD, and Shumar—were compared. Results show that Joy has an NPV of -$5,822,030, MMD has an NPV of -$4,527,456, and Shumar has an NPV of -$2,559,450. The negative NPV indicates total costs, where a smaller NPV is preferable. Incremental calculations show that MMD has an NPV of $1,294,575, and Shumar has an NPV of $3,262,581. Based on this analysis, Shumar was selected as the replacement for the CR12 crusher due to its low NPV and cost efficiency.
Keywords: Secondary Crusher, TCO, DCF, NPV.

INTRODUCTION

An essential energy resource, coal is a mined product used as feedstock for cement, fertilizer, and power plant sectors. Its many benefits over alternative energy sources make it a key commodity (Jermain, Pilcher, Ren, & Berardi, 2024). In 2022, coal demand reached a record high of 8 415 Mt, a 4% increase, driven by growth in countries like China and India. High gas prices and weaker nuclear and hydropower production also contributed to the growth (Gyamfi, Adedoyin, Bein, Bekun, & Agozie, 2021). China, the world's largest coal consumer, saw a 4.6% increase in overall coal demand, accounting for over half of global coal demand. India, the second-largest coal consumer, saw a 9% increase (Ahmad & Zhang, 2020). However, global coal

demand is expected to decrease by 1.4% in 2023, reaching a new all-time high of 8 536 Mt. China, India, and ASEAN countries are expected to consume three-quarters of global demand. A trend of declining global coal demand is expected to emerge until 2026, with China remaining the decisive player, as shown in Figure 1 below (International Energy Agency (IEA), 2023).

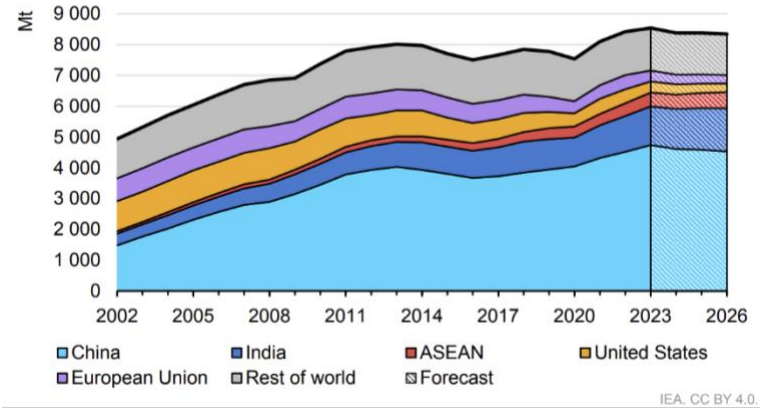


Figure 1. Global coal consumption, 2002-2026

Responding to the increasing global coal demand and the condition of the domestic coal industry based on data from the Ministry of Energy and Mineral Resources (Mohanty & Sarkar, n.d.), coal production in Indonesia from 2020 to 2023 shows a positive trend, increasing from year to year, peaking in 2023 at 771 billion tons (up 12% from the previous year), and exports reaching 407 million tons (up 19% from the previous year), as shown in Figure 2.

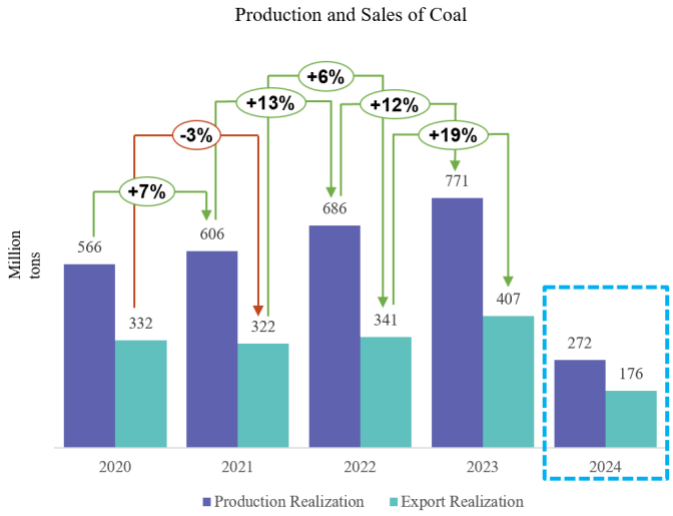


Figure 2. Indonesia Coal Production and Sales (Mohanty & Sarkar, n.d.)

According to Figure 2, Indonesian coal exports in April 2024 (as shown in Figure 3) increased by 2.2 percentage points from the previous year, with 44.54 million metric tons exported, up

from 46.1 million metric tons in March. Indonesia exported about 176 million metric tons of coal in January–April, rising from 168.5 million metric tons during the same period last year (Argusmedia.com, 2024).

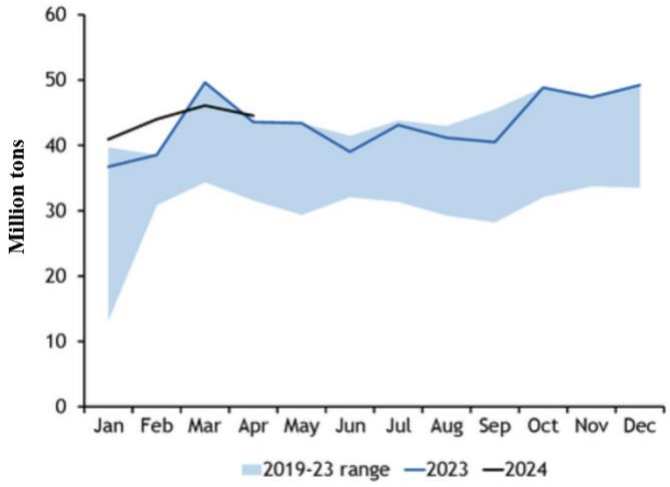


Figure 3. Indonesian coal exports (Argusmedia.com, 2024)

April's year-on-year increase in exports was mainly supported by increased demand from India (as shown in Figure 4), the world's second-largest coal importer, as companies there made massive purchases to add stocks for the summer. Exports to India rose 8.5% from year to year and 4.8% from month to month to 11.03 million tons. This export is supported by strong demand from utilities in the presence of increased coal-fired power plants (Rentier, Lelieveldt, & Kramer, 2019). Indonesian exports also increased to meet increased demand from Southeast Asia, with deliveries to Vietnam more than doubled to 2.86 million tons. Deliveries to RRT account for almost 35% of Indonesia's exports, which is 15.57 million tons. Indonesian production could face pressure from heavy rainfall in the Kalimantan region and production cuts. (Argusmedia.com, 2024).

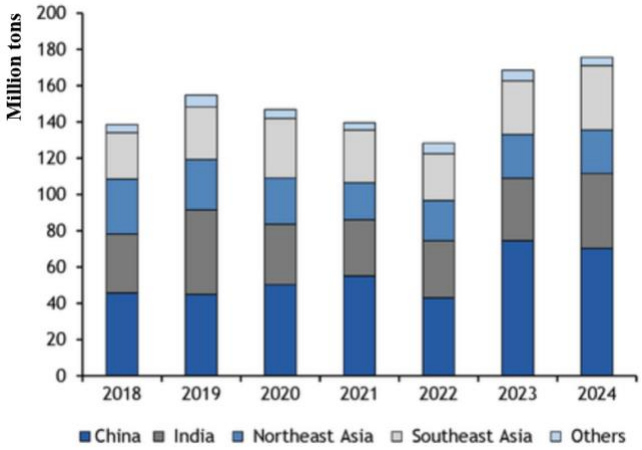


Figure 4. Indonesia Jan-Apr coal exports by destination (Argusmedia.com, 2024)

Although coal demand at the beginning of the year was high, it was inversely proportional to the selling price. As can be seen in figure I-5 below, coal prices continue to decline, with the April 2024 HBA at 135 USD/ton (Wollff, 2023a).

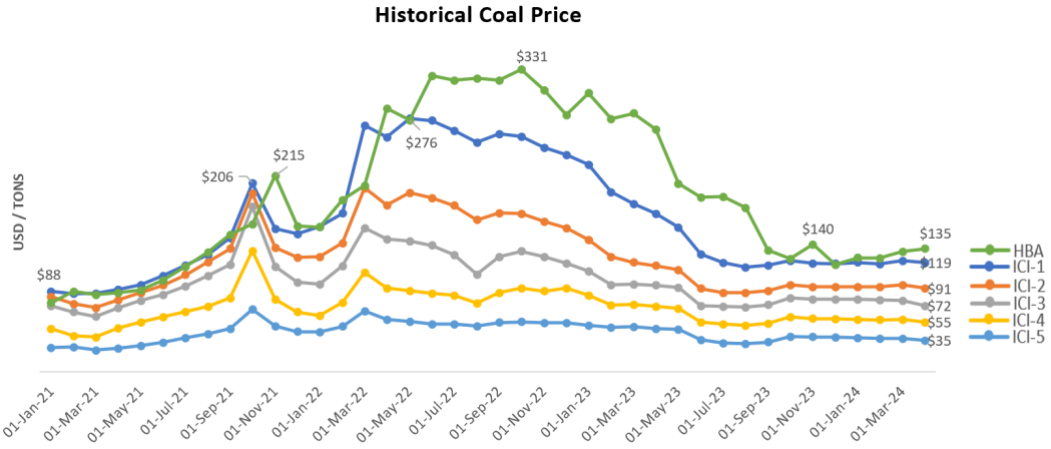


Figure 5. Historical Coal Price (Wollff, 2023a)

The dynamic changes and high uncertainty in the coal industry are challenging for mining companies, especially their OPEX (Strazzabosco, Gruenhagen, & Cox, 2022). Coal mining operating costs include fuel and energy costs, labor costs, equipment and machinery costs, and overhead costs. Coal demand and market prices also affect costs. Therefore, balancing these factors is critical to the success of coal mining operations (Asr, Kakaie, Ataei, & Tavakoli Mohammadi, 2019).

This thesis focuses on the coal crushing process at PT Berau Coal's Binungan Mine Operation (BMO) site, one of five sites within their concession (Wollff, 2023b). Site BMO has four coal processing plants (CPP) consisting of CR03, CR04, CR11, and CR12, as shown in Figure I-8.

The function of these crushers is to reduce mined coal from a large size of 600 mm (raw coal) to a final product of 50 mm (fine coal).

Figure 6. Layout of the Crushing Plant at the BMO Site

The main focus of the author is on Crusher CR12. As shown in Figure I-9, coal is dumped into the hopper and then moved and simultaneously crushed by the feeder breaker to reduce the raw coal size from 600 mm to 100 mm. The crushed coal then travels on a CV40 conveyor belt to the secondary crusher (SC12) for further processing to 50 mm. Finally, the processed coal is received by conveyor CV41 for further stacking in the stockpile.

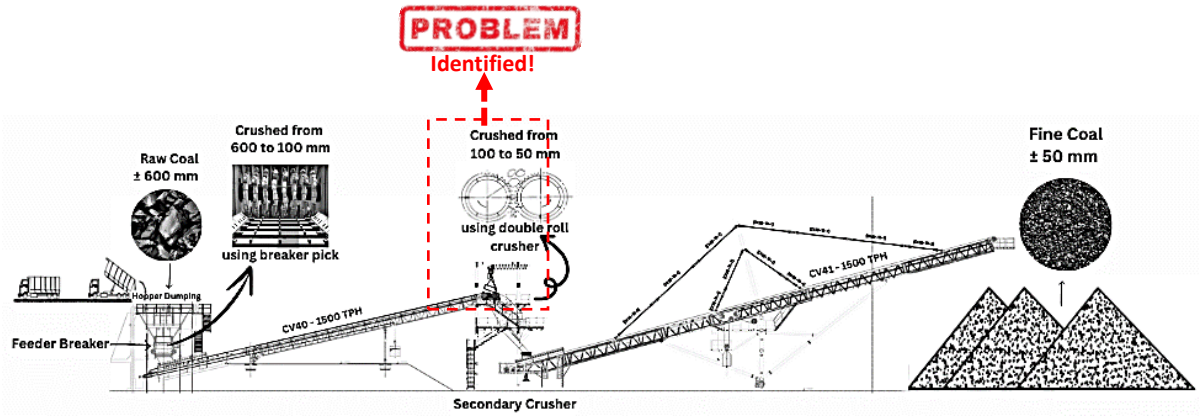


Figure 7. Coal Processing Flow

The plant's current secondary crusher, model Joy MVT II, has a very high breakdown rate, including gear damage, burnt bearings, loose segments, and broken shafts (Sinisalo, 2021). Figure I-10 below shows the total breakdown data for the past five years.

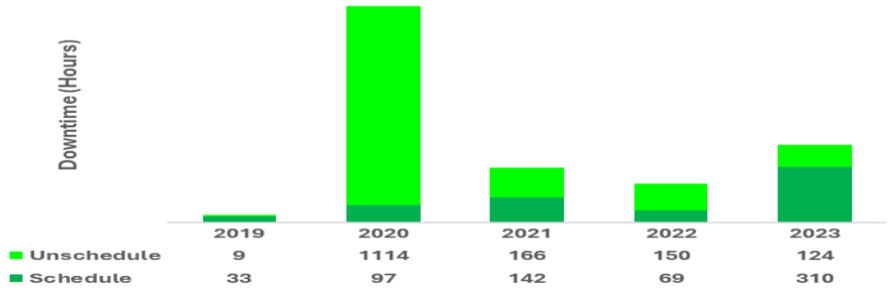


Figure 8. Downtime data for secondary crusher SC12

Due to the significant amount of downtime, several critical issues arose.

1. Increased Maintenance Costs: Repairing these breakdowns was expensive, leading to a large increase in the overall maintenance budget (OPEX).
2. Production Downtime: The long repair time associated with the SC12 failure resulted in significant production losses, which directly affected revenue generation and also caused demurrage on coal shipments.
3. Reduced Overall Efficiency: Frequent breakdowns disrupted the smooth running of the shredding process, hindering overall plant efficiency and productivity.

The coal mining industry operates in a dynamic environment with many uncertainties. Effective and efficient operations are essential in this context to remain competitive (Nwaila et al., 2022). For PT Berau Coal, addressing frequent failures in SC12 is critical, as reliable equipment is indispensable for uninterrupted production and timely coal delivery. In coal production operations, costs incurred include energy consumption and maintenance costs. Downtime caused by repairing or replacing parts in the crusher affects productivity. If the cost and downtime are high, the process is inefficient. With this issue, a proposal was made to replace the secondary crusher with other brand options, such as Shumar and MMD.

RESEARCH METHODS

The research design is illustrated in the flow chart presented in Figure 9. This study assesses the financial feasibility of investing in a secondary crusher replacement plan. The main focus of the study was to improve profitability through reduced maintenance and operational costs. A comprehensive analysis of the business situation was conducted to achieve this goal, including a cost evaluation of the existing units. Data collection was done using internal company information. The company's internal data calculated the Total Cost of Ownership (TCO). With the results from AHP and TCO, a financial analysis was conducted to project the Net Present Value (NPV).

Finally, a business solution was formulated based on all the analyses, and an implementation plan was developed to replace the secondary crusher.

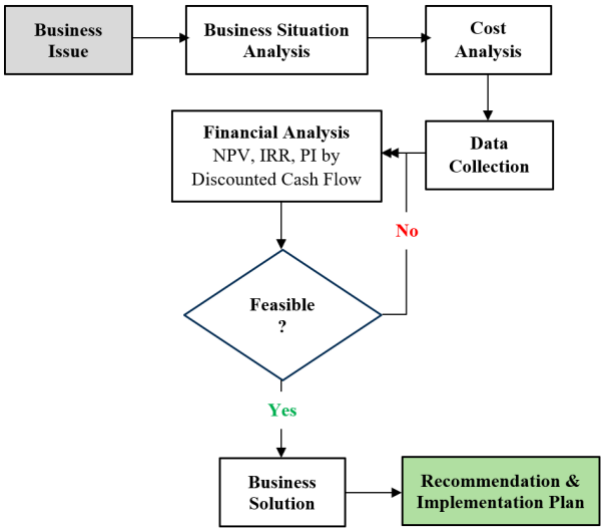


Figure 9. Research Flowchart

RESULTS AND DISCUSSION

Cost Analysis

A thorough examination of the data from the past five years reveals that Site BMO has incurred significantly higher maintenance costs, accounting for 59% of the total, compared to other sites such as LMO and SMO (see Figure 10) (Martin, Gilbert, & Gusy, 2020). Furthermore, the CR12 unit has shown a notable increase in maintenance costs, with a staggering 47% of the total costs attributed to it (see Figure 11). Upon closer inspection, it becomes apparent that the SC12 unit within CR12 is the primary contributor to these high maintenance costs, accounting for a substantial 42% (see Figure 12).

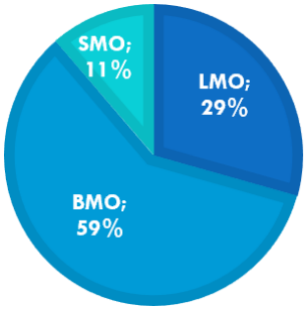


Figure 10. Maintenance Cost 2019-2023

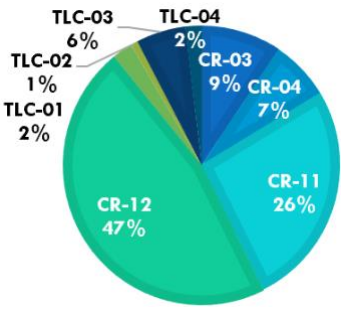


Figure 11. BMO Maintenance Cost 2019-

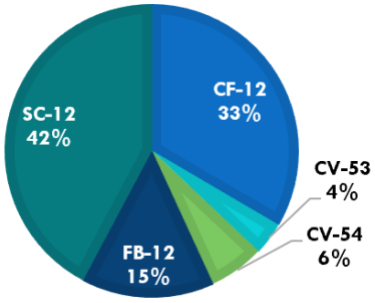
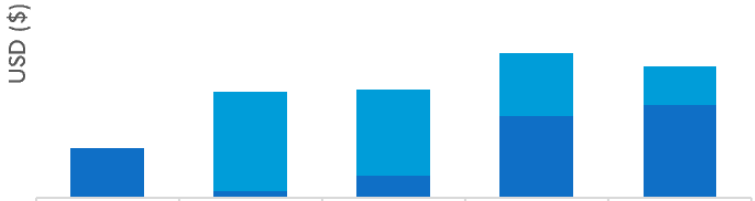


Figure 12. CR12 Maintenance Cost 2019-

Figure 13 provides a detailed breakdown of the maintenance costs incurred by Joy's secondary crusher over the past five years.



	2019	2020	2021	2022	2023
Total	$129.347	$275.296	$280.596	$377.558	$341.255
Sparepart	$-	$258.346	$222.783	$166.269	$100.026
Consumable	$129.347	$16.950	$57.813	$211.289	$241.229

Figure 13. SC12 Maintenance Cost 2019-2023

Detailed maintenance costs are divided into two categories: spare parts and consumables (Zhang, Huang, & Yuan, 2021). Spare parts include drive and driven shafts, gearboxes and motors, bearings, drum rolls, and plate adapters (Kershaw, 2023). Consumables include oil, grease, and segments. The crusher began operating in 2019, with a smooth initial performance. However, from 2020 to 2023, the crusher's maintenance costs increased significantly.

In 2020 and 2021, the crusher required replacements of gearboxes and motors, resulting in substantial spare part costs. This led to a large expense for spare parts during those years.

In 2022 and 2023, the crusher underwent two replacements of double roll crusher (including segment), resulting in high consumable costs. This further contributed to the overall maintenance costs during those years.

Capital Expenditure (CAPEX)

This secondary crusher replacement plan has three options: continue using the existing unit (Joy) or replace it with other brands, specifically Shumar and MMD (Stout, 2017). If options two and three are chosen, there will be an investment cost or CAPEX, as detailed in the following calculations:

Table 1. Capital Expenditure

CAPEX	Unit	Alt 1: Joy	Alt 2: Shumar	Alt 3: MMD
Purchase Crusher	$/Unit	$ -	$ 551.672	$ 439.973
Mobilisation and Custom Clearance	$/Unit	$ -	$ 124.556	$ 103.583
Installation	$/AU	$ -	$ 4.696	$ 4.696
Total	***USD***	**$ -**	**$ 680.924**	**$ 548.252**

Weighted Average Cost of Capital

PT Berau Coal finances all of its operations and investments through equity without using debt. Thus, in calculating the weighted average cost of capital (WACC), the proportion of debt is

recorded as 0%, which indicates that the company's entire cost of capital comes from equity (Olson & Pagano, 2023). To calculate the cost of equity using the capital asset pricing model (CAPM) method, the data used in the CAPM calculation is as follows:

Table 2. Data for Cost of Equity Calculation

Parameter	Reference	Time Range	Value
Risk free rate	Yield Sun from IBPA 8 Years Government Bond	As 7 Mar24	6,62%
	Default spread from Damodaran	As 1Jan24	2,04%
Beta	Industry average from Damodaran	As 5 Jan24	0,96
Equity risk premium	ERPs by country from Damodaran	As 1 Jan24	7%

Source: (Hartwell & Malinowska, 2019)

Using Formula, the calculation is as follows:

$$k_e = R_f + \beta(R_m - R_f)$$

$$R_f = Yield\ SUN - Default\ Spread = 6{,}6209\% - 2{,}04\% = 4{,}55\%$$

$$k_e = 4{,}55\% + 0{,}96(7\%)$$

$$k_e = 11{,}64\%$$

So, the WACC value used in this project is 11.64%.

This WACC value will subsequently be used as the discount rate to calculate the Net Present Value (NPV)

Total Cost of Ownership

In this study, the Total Cost of Ownership (TCO) will be calculated for three brands of secondary crushers: Joy (the existing unit), Shumar, and MMD. The primary objective of this analysis is to determine the total lifetime cost of these units, which will subsequently be evaluated using Net Present Value (NPV) calculations (Abdelhady, 2021).

Table 3. TCO of Joy Crusher

Alt 1 - Exsisting Crusher (JOY MVT II)

All costs are in $ (USD)

Item	Description	Value	2024	2025	2026	2027	2028	2029	2030	2031	2032
1	**OPEX**										
	Labor Cost		(4.989)	(18.235)	(18.928)	(19.647)	(20.394)	(21.169)	(21.973)	(22.808)	(23.675)
	Maintenance Cost		(85.360)	(638.632)	(662.900)	(688.090)	(714.238)	(741.379)	(769.551)	(798.794)	(829.148)
	Energy Consumption		(40.468)	(84.012)	(87.204)	(90.518)	(93.957)	(97.528)	(101.234)	(105.081)	(109.074)
2	**(-) Depreciation**		0	0	0						
3	**Total Cost Before Tax (TC**		(130.817)	(740.879)	(769.032)	(798.255)	(828.589)	(860.075)	(892.758)	(926.683)	(961.897)
4	**Tax shield**	45%	(58.868)	(333.395)	(169.187)	(175.616)	(182.290)	(189.217)	(196.407)	(203.870)	(211.617)
5	**Total Cost After Tax (TCA**		(189.685)	(1.074.274)	(938.219)	(973.871)	(1.010.879)	(1.049.292)	(1.089.165)	(1.130.553)	(1.173.514)
6	**CAPEX**		0								
7	**(+) Depreciation**		0	0	0						
8	**Cash Flow**		(189.685)	(1.074.274)	(938.219)	(973.871)	(1.010.879)	(1.049.292)	(1.089.165)	(1.130.553)	(1.173.514)
9	**WACC**	11,64%									
10	**PV**		(189.685)	(962.302)	(752.830)	(699.988)	(650.855)	(605.171)	(562.693)	(523.197)	(486.473)
11	**Accumulated Cash Flow**		(189.685)	(1.151.987)	(1.904.817)	(2.604.805)	(3.255.660)	(3.860.831)	(4.423.525)	(4.946.722)	(5.433.195)
12	**NPV**		(5.056.576)								

The calculation of the total cost of using the joy crusher for the next 8 years, shown by the NPV value of—$5.056.576, means that the costs will be $5.056.576.

Table 4. TCO of Shumar Crusher

Alt 2 - Replace with Shumar

All costs are in $ (USD)

Item	Description	Value	2024	2025	2026	2027	2028	2029	2030	2031	2032
1	**OPEX**										
	Labor Cost		(3.109)	(12.733)	(13.216)	(13.719)	(14.240)	(14.781)	(15.343)	(15.926)	(16.531)
	Maintenance Cost		(450)	(35.612)	(36.965)	(38.370)	(39.828)	(41.341)	(42.912)	(44.543)	(46.236)
	Energy Consumption		(14.838)	(100.750)	(104.578)	(108.552)	(112.677)	(116.959)	(121.404)	(126.017)	(130.806)
2	**Depreciation**		-	(85.115)	(85.115)	(85.115)	(85.115)	(85.115)	(85.115)	(85.115)	(85.115)
3	**Total Cost Before Tax (TCBT)**		(18.397)	(234.210)	(239.875)	(245.756)	(251.861)	(258.197)	(264.774)	(271.601)	(278.687)
4	**Tax shield**		(8.279)	(105.394)	(52.773)	(54.066)	(55.409)	(56.803)	(58.250)	(59.752)	(61.311)
5	**Total Cost After Tax (TCAT)**		(26.676)	(339.604)	(292.648)	(299.823)	(307.270)	(315.000)	(323.024)	(331.353)	(339.999)
6	**CAPEX**		(680.924)								
7	**Depreciation**		0	85.115	85.115	85.115	85.115	85.115	85.115	85.115	85.115
8	**Cash Flow**		(707.600)	(254.489)	(207.532)	(214.707)	(222.154)	(229.885)	(237.909)	(246.238)	(254.883)
9	**WACC**	11,64%									
10	**PV**		(707.600)	(227.963)	(166.525)	(154.325)	(143.034)	(132.584)	(122.910)	(113.954)	(105.660)
11	**Accumulated Cash Flow**		(707.600)	(935.563)	(1.102.088)	(1.256.412)	(1.399.447)	(1.532.031)	(1.654.941)	(1.768.895)	(1.874.556)
12	**NPV**		**(2.386.770)**								

The calculation of the total cost of using the Shumar crusher for the next 8 years, shown by the NPV value of—$2.386.770, means that the costs that will be incurred are $2.386.770.

Table 5. TCO of MMD Crusher

Alt 3 - Replace with MMD

All costs are in $ (USD)

Item	Description	Value	2024	2025	2026	2027	2028	2029	2030	2031	2032
1	**OPEX**										
	Labor Cost		(3.109)	(18.256)	(18.950)	(19.670)	(20.417)	(21.193)	(21.998)	(22.834)	(23.702)
	Maintenance Cost		(7.194)	(336.917)	(349.720)	(363.009)	(376.804)	(391.122)	(405.985)	(421.412)	(437.426)
	Energy Consumption		(35.612)	(85.468)	(88.716)	(92.087)	(95.586)	(99.219)	(102.989)	(106.902)	(110.965)
2	**Depreciation**			(68.532)	(68.532)	(68.532)	(68.532)	(68.532)	(68.532)	(68.532)	(68.532)
3	**Total Cost Before Tax (TCBT)**		(45.915)	(509.173)	(525.917)	(543.298)	(561.339)	(580.065)	(599.504)	(619.681)	(640.624)
4	**Tax shield**	45%	(20.662)	(229.128)	(115.702)	(119.525)	(123.494)	(127.614)	(131.891)	(136.330)	(140.937)
5	**Total Cost After Tax (TCAT)**		(66.576)	(738.300)	(641.619)	(662.823)	(684.833)	(707.680)	(731.394)	(756.010)	(781.562)
6	**CAPEX**		(548.252)								
7	**Depreciation**			68.532	68.532	68.532	68.532	68.532	68.532	68.532	68.532
8	**Cash Flow**		(614.829)	(669.769)	(573.087)	(594.291)	(616.302)	(639.148)	(662.863)	(687.479)	(713.030)
9	**WACC**	11,64%									
10	**PV**		(614.829)	(599.958)	(459.847)	(427.158)	(396.806)	(368.624)	(342.454)	(318.151)	(295.582)
11	**Accumulated Cash Flow**		(614.829)	(1.214.787)	(1.674.634)	(2.101.792)	(2.498.598)	(2.867.222)	(3.209.675)	(3.527.827)	(3.823.409)
12	**NPV**		**(4.039.722)**								

The calculation of the total cost of using the MMD crusher for the next 8 years, shown by the NPV value of -$4.039.722, means that the costs that will be incurred are $ 4.039722. From the calculation of the Total Cost of Ownership (TCO) of the three crusher brands, the highest cost is Joy, with a total of $5.056.576, followed by MMD, with a total cost of $4.039722, and the cheapest is Shumar, with a total cost of $2.386.770.

Furthermore, an incremental calculation is carried out to determine the revenue of each crusher. In this analysis, the cost of each crusher brand is reduced by the cost of the Joy brand (existing unit). For example, the cost of Shumar is reduced by the cost of Joy, and the cost of MMD is also reduced by the cost of Joy (Kautish, Siddiqui, Siddiqui, Sharma, & Alshibani, 2023).

Table 6. Incremental Shumar - Joy

Incremental Joy-Shumar

All costs are in $ (USD)

Item	Description	Value	2024	2025	2026	2027	2028	2029	2030	2031	2032
1	**Cash Flow**		(517.915)	819.785	730.687	759.164	788.724	819.407	851.256	884.316	918.631
2	**Accumulated Cash Flow**		(517.915)	301.871	1.032.557	1.791.722	2.580.446	3.399.853	4.251.109	5.135.425	6.054.056
3	**WACC**	11,64%									
4	**PV of Cash Flow**		(517.915)	734.339	586.305	545.663	507.821	472.587	439.783	409.243	380.813
5	**Accumulated PV of Cash Flow**		(517.915)	216.424	802.729	1.348.393	1.856.214	2.328.800	2.768.583	3.177.827	3.558.640
5	**NPV**		**2.669.807**								

From the results of these calculations, the profit of using a Shumar crusher instead of a Joy crusher is represented by an NPV value of $ 2.669.807

Table 7. Incremental MMD - Joy

Incremental Joy-MMD

All costs are in $ (USD)

Item	Description	Value	2024	2025	2026	2027	2028	2029	2030	2031	2032
1	Cash Flow		425.144	(404.505)	(365.132)	(379.580)	(394.577)	(410.144)	(426.302)	(443.075)	(460.484)
2	Accumulated Cash Flow		425.144	20.638	(344.494)	(724.074)	(1.118.651)	(1.528.795)	(1.955.097)	(2.398.172)	(2.858.656)
3	WACC	11,64%									
4	PV of Cash Flow		425.144	18.487	(276.423)	(520.441)	(720.244)	(881.720)	(1.010.058)	(1.109.825)	(1.185.039)
5	Accumulated PV of Cash Flow		425.144	443.631	167.208	(353.234)	(1.073.478)	(1.955.199)	(2.965.257)	(4.075.082)	(5.260.121)
5	NPV		(1.951.433)								

The results of these calculations show that the profit of using an MMD crusher instead of a Joy crusher is represented by an NPV value of—$1.951.433.

Business Solution

Based on the Total Cost of Ownership (TCO) and discounted cash flow calculations using Weighted Average Cost of Capital (WACC) (Wang et al., 2024), the crusher brand with the highest Net Present Value (NPV) is Shumar. Thus, the implementation plan for the procurement of the Shumar crusher will be scheduled in the second week of September 2024 and is expected to be completed by the end of June 2025; the stages are as follows

CONCLUSION

Based on the analysis and calculations related to the crusher replacement plan at the Binungan site, the Shumar brand is recommended for purchase due to its lower total expenditure and higher Net Present Value (NPV) of $3,262,581 compared to the existing unit (Joy) and MMD. This analysis considers factors such as operational costs, maintenance expenses, technical features, and after-sales support. Adopting Shumar is expected to enhance operational efficiency and reduce long-term costs, positively impacting overall profitability. The next step should be to evaluate Shumar's reliability and after-sales support further to ensure that this decision yields maximum benefits.

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