COSTING: Journal of Economic, Business and Accounting
Volume 8 Nomor 4, Tahun 2025
e-ISSN : 2597-5234

FEASIBILITY STUDY OF CNC MACHINE INVESTMENT TO OPTIMIZE MAIN WORKSHOP OPERATIONS AT PT BUKIT ASAM TBK

STUDI KELAYAKAN INVESTASI MESIN CNC UNTUK MENGOPTIMALKAN OPERASIONAL BENGKEL UTAMA DI PT BUKIT ASAM TBK

Rizki Satriawan[1], Oktofa Yudha Sudrajad[2]
Program Studi Magister Adminstrasi Bisnis, Institut Teknologi Bandung[1,2]
rizki_satriawan@sbm-itb.ac.id, oktofa@sbm-itb.ac.id

ABSTRACT

PT Bukit Asam Tbk (PTBA), a company operating in the coal mining industry, is currently facing challenges in improving operational efficiency, especially in the maintenance and repair activities at the Coal Handling Facility (CHF). The increasing demand for components and spare parts reveals the shortcomings of conventional machinery in terms of precision, productivity, and cost-effectiveness. In response, PTBA is exploring the possibility of investing in Computer Numerical Control (CNC) machines to enhance output and lower long-term operational costs. This study investigates the feasibility of such an investment using capital budgeting techniques, including Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PBP), and Profitability Index (PI). To further examine potential uncertainties, a risk assessment was carried out through sensitivity analysis and Monte Carlo simulation. The findings show that the investment is financially sound, generating an NPV of IDR 5.26 billion, an IRR of 18%, and a payback period of 6 years and 4 months, with a 93.7% likelihood of achieving a positive return. With proper execution—such as optimizing production processes, maximizing machine utilization, and providing adequate workforce training—the CNC machine investment is anticipated to significantly improve operational performance, reduce dependency on third-party suppliers, and support PTBA's long-term strategic goals.

Keywords : *Investment Feasibility, CNC Machines, Operational Efficiency, Capital Budgeting, Risk Analysis*

ABSTRAK

PT Bukit Asam Tbk (PTBA), sebuah perusahaan di sektor pertambangan batubara, tengah menghadapi tantangan dalam meningkatkan efisiensi operasional, khususnya pada aktivitas pemeliharaan dan perbaikan peralatan di Coal Handling Facility (CHF). Peningkatan permintaan terhadap komponen dan suku cadang menunjukkan keterbatasan mesin-mesin konvensional dalam aspek presisi, efektivitas, dan biaya operasional. Untuk menjawab permasalahan tersebut, PTBA mempertimbangkan investasi pada mesin Computer Numerical Control (CNC) sebagai upaya untuk meningkatkan produktivitas sekaligus menekan pengeluaran jangka panjang. Studi ini bertujuan untuk menganalisis kelayakan investasi mesin CNC dengan menggunakan metode penganggaran modal seperti Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PBP), dan Profitability Index (PI). Selain itu, dilakukan pula analisis risiko melalui pendekatan analisis sensitivitas dan simulasi Monte Carlo guna mengukur pengaruh ketidakpastian terhadap hasil investasi. Hasil evaluasi menunjukkan bahwa investasi ini layak secara finansial, dengan NPV sebesar Rp 5,26 miliar, IRR mencapai 18%, dan periode pengembalian modal selama 6 tahun 4 bulan, serta peluang sebesar 93,7% untuk memperoleh pengembalian positif. Dengan penerapan yang tepat—meliputi optimalisasi proses produksi, peningkatan efektivitas penggunaan mesin, dan pengembangan kompetensi tenaga kerja—investasi mesin CNC diharapkan mampu meningkatkan efisiensi operasional, mengurangi ketergantungan terhadap vendor luar, serta mendukung keberlangsungan usaha PTBA dalam jangka panjang.

Kata Kunci : Kelayakan Investasi, Mesin CNC, Efisiensi Operasional, Penganggaran Modal, Analisis Risiko

INTRODUCTION

Over time, many mining companies in Indonesia have continued to use conventional machines in their machining operations. Although these machines fulfill similar functions, they often fall short in precision, time

efficiency, and automation capabilities. In today's increasingly competitive and technology-oriented environment, the long-term sustainability of a company's operations hinges on its ability to adopt advanced technologies.

As the industrial era progresses rapidly, the mining industry is also undergoing technological advancements to meet growing demands for higher efficiency, productivity, and competitiveness. One widely adopted innovation in the sector is the use of Computer Numerical Control (CNC) machines, commonly utilized for manufacturing and repairing components of heavy machinery.

CNC technology offers several advantages, including the ability to produce highly precise parts, minimize human error, and operate automatically via computer programs. These capabilities contribute to lowering operational costs, enhancing product quality, and reducing equipment downtime, making CNC machines a strategic solution to improve accuracy and efficiency in the production of mining machinery components.

However, transitioning from conventional to CNC machines requires considerable investment in terms of capital, supporting infrastructure, and workforce development. As such, before committing to this technological shift, mining companies must conduct a thorough feasibility study. This includes evaluating costs and benefits, identifying potential risks, assessing organizational readiness, and analyzing the long-term impacts on productivity and profitability.

The purpose of this study is to assess the viability of moving from conventional machinery to CNC technology in the mining sector, taking into consideration factors like operational efficiency, economic feasibility, and readiness in terms of technology and human resources. The findings aim to guide mining companies in making well-informed strategic decisions regarding CNC adoption.

In a landscape shaped by rapid technological progress and growing market expectations, companies that embrace modern technology will gain a competitive edge. Therefore, CNC adoption could be a key factor in enhancing the competitiveness of Indonesia's mining industry.

To meet its 2025 target of producing 50 million tonnes of coal—rising to 60 million tonnes in 2026—PT Bukit Asam (PTBA) has initiated the construction of new coal handling facilities to expand transportation capacity along the Tanjung Enim–Keramasan railway. These developments include three new coal handling units: two Train Loading Stations (TLS) each with a 3,000-tonne-per-hour capacity and integrated rail loops; two conveyor systems stretching 13 km and 17 km, each with a 3,000-tonne-per-hour capacity; and three dump hoppers capable of receiving 60-tonne and 100-tonne dump trucks.

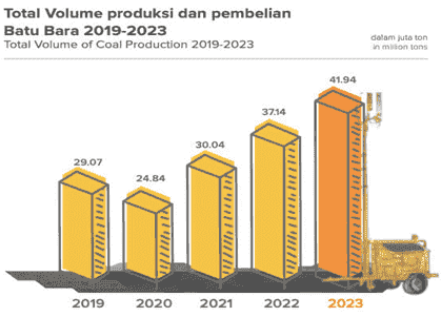

Figure 1. Coal Production of PT Bukit Asam Tbk

(Source: Website of PT Bukit Asam Tbk : https://www.ptba.co.id/bisnis-kami/batubara#alur-kerja, Accessed March, 2025)

Apart from enhancing coal handling facilities, PTBA also faces the challenge of maintaining the reliability

of its existing infrastructure. Therefore, the company expects its maintenance division to ensure the consistent performance of all coal handling systems. To achieve this, the maintenance team must explore various strategies and tools that can effectively support the reliability of coal handling equipment.

Figure 2. Total Closing work order of Main workshop
(Source : Internal data main workshop)

Figure 3. Total Closing work order of machine shop
(Source : Internal data main workshop)

The main workshop within the engineering and manufacturing unit, which operates under the maintenance division, is tasked with the repair, maintenance, modification, production, and management of components used in coal handling facilities. As production demands grow, the workshop faces the challenge of enhancing operational efficiency while maintaining product quality. To address this, the engineering and manufacturing workshop is planning to invest in advanced machinery, including CNC lathes, milling machines, laser cutters, and welding equipment. These new machines are intended to replace conventional equipment, with the goal of boosting both productivity and work efficiency in the workshop.

LITERATUR REVIEW

Building on insights from the reviewed literature, the following section presents an empirical analysis aimed at evaluating the feasibility and strategic impact of CNC machine investment at PT Bukit Asam. This analysis applies both qualitative and quantitative methods, including SWOT analysis, VRIO framework, capital budgeting techniques, and risk assessment through simulations.

Definition and Fundamental Concepts of Investment

Investment generally refers to the allocation of capital with the expectation of generating future returns. Several definitions by experts include:

1. Bodie, Kane, and Marcus (2014) describe investment as the forgoing of present consumption to achieve greater value in the future.
2. Sharpe (2011) defines investment as the process of placing funds into assets with the goal of earning capital gains or income.

In the context of CNC machine procurement, investment encompasses not only financial resources but also the commitment of human capital and time for adopting technology aimed at enhancing the productivity of workshop operations.

To assess the viability of an investment project, various analytical methods are commonly used. This study utilizes several of those methods to evaluate the proposed investment.

Capital Budgeting Analysis

1. **Capital Expenditure (CAPEX):** As explained by Damodaran (2010) in *Corporate Finance: Theory and Practice*, capital expenditure refers

to strategic investments undertaken by a company to support future growth. These include spending on acquiring, upgrading, or enhancing fixed assets such as land, buildings, machinery, and equipment.

2. **Operating Expenditure (OPEX):** According to Charles T. Horngren et al. (2012) in *Cost Accounting: A Managerial Emphasis*, operating expenses are the costs incurred to maintain day-to-day business operations. These expenses do not contribute to the acquisition or enhancement of company assets.
3. **Weighted Average Cost of Capital (WACC):** WACC represents the average rate of return that a company must provide to its investors—both equity and debt holders—based on their proportion in the capital structure. It serves as a benchmark for evaluating investment opportunities.
4. **Depreciation:** This is the methodical allocation of a fixed asset's cost over its expected useful lifespan, reflecting the gradual reduction in its value due to usage and time.
5. **Net Present Value (NPV):** As noted by Brealey, Myers, and Allen (2017), NPV is a comprehensive investment evaluation method that incorporates the time value of money to determine the present value of a project's future cash flows relative to its initial cost.
6. **Internal Rate of Return (IRR):** IRR is the rate at which the present value of expected cash inflows equals the original investment amount, effectively measuring the project's profitability.
7. **Payback Period (PP):** As outlined by Atrill & McLaney (2018), the payback period is a straightforward metric that determines how long it will take for a project to recoup its initial investment from its net cash inflows.
8. **Discounted Cash Flow (DCF):** DCF is a valuation technique used to estimate the present value of future cash flows generated by a company, project, or investment. These future cash flows are discounted using a rate that typically reflects the cost of capital or the expected rate of return, as explained by Damodaran (2012).

Risk Analysis Methods

To account for the uncertainties typically present in investment forecasts, this study employs various risk assessment techniques, including sensitivity analysis, scenario analysis, and Monte Carlo simulation. These methods help evaluate how changes in key variables may influence the viability of the CNC machine investment.

1. **Scenario Analysis** involves developing and examining multiple potential future conditions that could occur throughout the project's duration, helping to understand the impact of different environmental or operational situations.
2. **Simulation Analysis** expands upon scenario analysis by offering a more in-depth, probabilistic evaluation. This method considers a wider range of variable uncertainties and their interrelationships, providing a more complete overview of possible investment outcomes.

Conceptual Framework

This study's conceptual framework outlines the interconnection among the core concepts underpinning the research. It begins with the identification of the primary business problem, followed by an evaluation of both internal and external business environments. Based on this, financial

projections are prepared using income statements, balance sheets, and cash flow analyses. The financial viability of the investment is then evaluated through capital budgeting techniques and risk assessment. Finally, the study presents its conclusions and strategic recommendations. The framework is illustrated below.

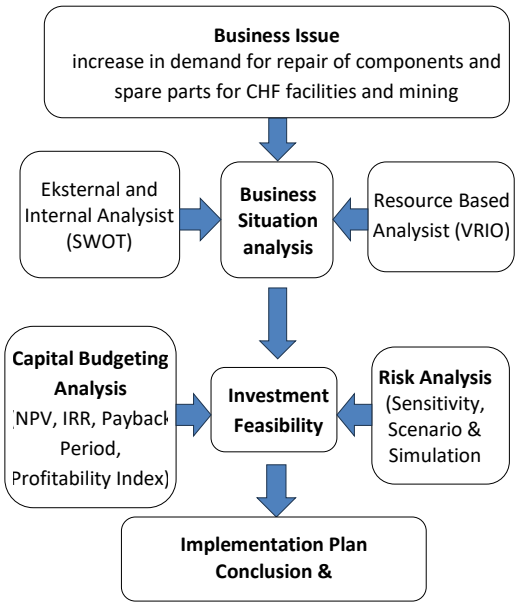

Figure 4. Conceptual Framework
(Source : Author Analysis)

RESEARCH METHODOLOGY

This study aims to assess the feasibility of investing in CNC machines for the main workshop at PT Bukit Asam. A quantitative method is used, drawing on internal data from the engineering and manufacturing unit, which includes historical cost information and key operational performance metrics from the past five years.

Research Design

The research design outlines the structure for planning and carrying out the study. It defines the methodology to be applied and organizes the steps needed to meet the research objectives. By providing a systematic and structured approach, the research design ensures that the study is both valid and reliable. An illustration of the research design is shown in the figure below.

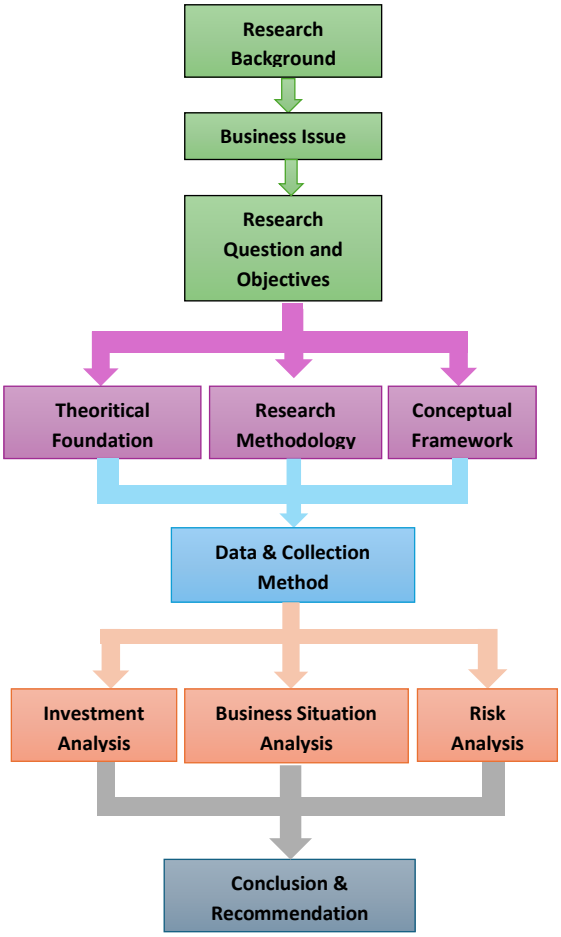

Figure 5. Research Design
(Source : Author Analysis)

Data Collection Method

This study adopts a quantitative approach, utilizing both primary and secondary data sources. Primary data was gathered through direct interviews and internal communications conducted by the researcher with engineers and machine planners at the main workshop. Secondary data was obtained from historical internal records of the main workshop and external sources, such as authorized distributors. All data has been adjusted to reflect the company's current conditions. The details of the data used in the study are as follows:

1. **Capital Expenditure (Capex) Data**:
   Includes the cost of a CNC turning machine, installation, and applicable taxes, sourced directly from vendors or authorized distributors.
2. **Operating Expenditure (Opex) Data**:
   Comprises several components, including the cost of purchasing repaired or damaged spare parts (from distributors, vendors, and market references); electricity costs based on PLN's per-kWh tariff; annual work order volumes from the Main Workshop Planning and Scheduling Unit; preventive maintenance data from the Planning and Engineering Division; wage data based on contractor salaries in the main workshop; material costs obtained from internal procurement records; and depreciation rates sourced from the company's business unit.
3. **General and Financial Data**:
   Encompasses macroeconomic variables such as the inflation rate (sourced from the Bank of Indonesia) and the risk-free rate (based on the yield to maturity of 1-year FR government bonds as of December 2024). It also includes financial assumptions like beta values and equity risk premiums from Damodaran's Emerging Markets data for the Engineering & Construction sector. Additionally, the study considers the Cost of Equity and WACC, calculated from relevant assumptions; internal financial ratios; cash flow data from company records; and investment evaluation metrics—NPV, IRR, PBP, and PI—derived from the projected cash flows.

Data Analysis Method

In this investment project, the author applies several analytical techniques. To assess the current business environment, a Resource-Based View (RBV) approach using the VRIO framework is employed, along with SWOT analysis to examine both internal and external factors. Given that this study focuses on investment evaluation, the main method utilized is capital budgeting, complemented by risk analysis to determine the project's feasibility.

Resource-Based View with VRIO Framework

The Resource-Based View (RBV) is a strategic model that emphasizes the importance of a firm's internal resources in achieving and sustaining competitive advantage. This theory was introduced by Birger Wernerfelt in his 1984 article titled *"A Resource-Based View of the Firm"*, published in the *Strategic Management Journal*.

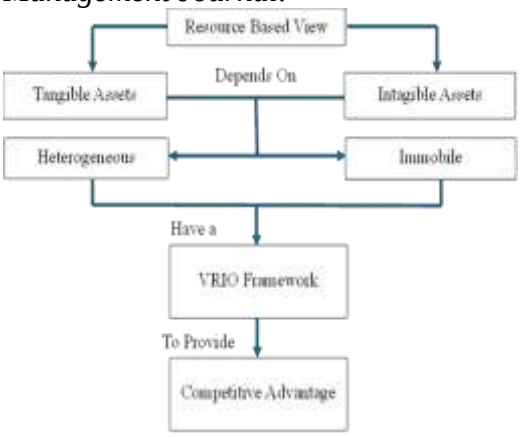

Figure 6. Resource-based view with VRIO Framework

(Source : Author Analysis)

The VRIO framework, developed by Jay Barney in his 1991 article *"Firm Resources and Sustained Competitive Advantage"*, outlines that for a company to achieve and maintain a sustainable competitive advantage, its resources must meet four key criteria:

Is a resource or capability …					
Valuable?	Rare?	Costly to imitate?	Exploited by organisation?	Competitive implications	Economic performance
No	–	–	No	Competitive disadvantage	Below normal
Yes	No	–	▲	Competitive parity	Normal
Yes	Yes	No		Temporary competitive advantage	Above normal
Yes	Yes	Yes		Sustained competitive advantage	Above normal
			▼ Yes		

Figure 7. VRIO Framework
(Source : Barney (2002))

Meeting all four criteria in the VRIO framework enables a company to build a sustainable competitive advantage over the long term. However, if only some of the criteria are satisfied, the advantage gained will likely be short-lived or temporary.

SWOT Analysis

The SWOT analysis identifies the strengths, weaknesses, opportunities, and threats relevant to a project, situation, or organization. It supports strategic planning by helping understand both internal capabilities and external challenges that may influence performance. Below is a SWOT analysis of the engineering and manufacturing unit.

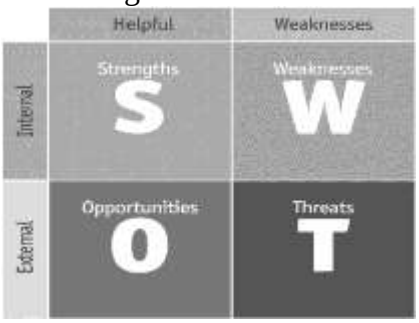

Figure 8. SWOT analysis
(Source : Author analysis)

Capital Budgeting Analysis

Capital budgeting analysis is essential to assess the financial feasibility of an investment project. This process involves the following steps:

1. Assessing Project Viability: The feasibility of the investment is evaluated by analyzing and calculating relevant financial data. This includes reviewing key financial indicators to understand the potential returns and risks involved. The analysis incorporates several capital budgeting techniques:
   - Net Present Value (NPV) assesses expected cash inflows and outflows.
   - Internal Rate of Return (IRR) identifies the discount rate at which the NPV becomes zero.
   - Payback Period calculates how long it will take to recover the initial investment from net cash flows.
   - Profitability Index (PI) measures the ratio of the present value the difference between the present value of
   - of inflows to the initial investment, indicating the project's overall profitability.
2. Risk Evaluation: To understand potential uncertainties, risk assessment is conducted through sensitivity and scenario analyses, evaluating how changes in each variable affect the investment outcome. Additionally, a simulation analysis (such as Monte Carlo) is used to determine the likelihood of achieving a favorable result by factoring in variations in critical variables such as costs, revenue, and discount rates.

RESULT AND DISCUSSION

Business Situation Analysis

1. External and Internal Analysis: SWOT

Table 1. SWOT analysis

Strength
1. Modern technology 2. Strong management support for investment in new technology. 3. Suitable infrastructure to support the operation of the CNC machines. 4. Increased Production Capacity and product quality
Weakness
1. Initial investment for CNC machines is high. 2. CNC machines require regular maintenance and repair costs may be high if not managed properly 3. Lack of experience in managing new technology among staff. 4. Dependence on certain suppliers for machine parts. 5. Adaptation time
Opportunity
1. Demand for manufacturing and repairing precision mining and heavy equipment components is increasing every year that can be produced with CNC machines. 2. Market expansion 3. Product Innovation 4. Strategic Partnerships by establishing partnerships with other companies or educational institutions for research and development and training.
Threat
1. Raw material price fluctuation. 2. risk of machine failure and breakdown. 3. volatile coal price 4. faster and cheaper technological developments in the future.

(Source : Author Analysis)

2. Internal Analysis: VRIO Method

This analysis aims to evaluate the resources and capabilities of the work unit in supporting the proposed investment project. By applying the VRIO framework, it can be determined whether the investment has the potential to deliver a long-term competitive advantage for the organization.

Tangible Resources:

1. Infrastructure Facilities: The Engineering and Manufacturing Unit possesses infrastructure that supports efficient operations and maintenance activities.
2. Tools and Equipment: A variety of essential tools and machinery are available to ensure the smooth execution of maintenance and support tasks.
3. Technology Systems: The unit implements integrated operational management software and standardized procedures to enhance coordination and efficiency across departments.

4. Financial Resources: Availability of innovation investment funds allocated by the company.

Intangible Resources:

1. Human Resources: The unit is composed of six integrated departments staffed with skilled and capable personnel.
2. Customer Relationships: The unit serves internal clients whose order volumes increase consistently each year.
3. Reputation: Recognized as a reliable internal partner, the unit maintains a strong reputation for environmental safety, quality, and efficiency—receiving fewer than three major complaints annually.
4. Experience: With over 50 years of operational experience, the unit completes an average of 500 maintenance and repair tasks annually

Table 2. VRIO analysis of main workshop work unit

Resource	Valuable	Rare	Imitability	Organization	Competitive
Tools and Equipment	Y	Y	N	N	Temporary competitive advantage
Operational system technology	Y	Y	N	N	Temporary competitive advantage
Infrasctructure facilities	Y	Y	N	N	Temporary competitive advantage
Customer relationship & Network	Y	Y	Y	Y	Sustain competitive advantage
Human Resource : Competent and excellent service	Y	Y	Y	Y	Sustain competitive advantage
Human Resource :Innovation in product design & customization	Y	Y	Y	Y	Sustain competitive advantage
Finance: Company Innovation investment funds	Y	Y	Y	Y	Sustain competitive advantage
Experience	Y	Y	Y	Y	Sustain competitive advantage
Reputation	Y	Y	Y	Y	Sustain competitive advantage

(Source : Author Analysis)

Based on the findings from both the external and internal analyses using the SWOT method, along with a more detailed internal assessment through the VRIO framework, it can be concluded that investing in CNC machines within the engineering and manufacturing unit is a viable decision. The SWOT analysis highlights core strengths such as the use of modern technology and a skilled workforce, alongside strong market opportunities for high-precision products.

Meanwhile, the VRIO analysis reveals that CNC machines offer substantial added value, are technologically rare, difficult for competitors to replicate, and are supported by an organization ready to fully utilize their potential. Considering all these aspects, the investment is expected to enhance the unit's operational efficiency and strengthen its competitive edge.

Capital Budgeting Analysis
Project Assumption

1. Capital Expenditure

Table 3. Capex of purchasing cnc turning machine

Specification	Details
Machine Model	Mazak Integrex i500-2500U
Max Swing Diameter	700 mm
Max Machining Diameter	700 mm
Max Machining Length	2,984 mm
Bar Work Capacity	77 mm
X, Y, Z Axis Travel	845/420/2600 mm
X, Y, Z Axis Travel Angle	130°, 210°
Chuck Size	12 inches
Spindle Speed (Main Spindle)	4,000 rpm
Milling Spindle Speed	12,000 rpm (optional: 4000 rpm)
Tool Holder Type	HSK-A63
Max Tool Diameter	90 mm
Max Tool Length	500 mm
Max Tool Weight	12 kg
Main Spindle Motor Power	30/22 kW
Milling Spindle Motor Power	30/22 kW
Machine Footprint	6980 × 3400 mm
Machine Weight	23,500 kg
Unit Price	16,390,000,000
VAT (10%)	1,802,000,000
Grand Total	18,192,000,000

(Source : Vendor quotation document)

2. Operating Expenses (Opex).

Operating costs for this project include salaries for two employees, industrial electricity costs of Rp1,035 per kwh as well as machinery maintenance costs of 5% of the initial value of the machinery.

Table 4. Operating expenses

No.	Component	Details	Cost /year in Rp
1	Employee Salaries	2 employees, each earning Rp 6 million/month and fix bonus of 2 months salaries.	168,000,000
2	Electricity Costs	Industrial rate of Rp1,035/kWh, cnc machine using max 48 kw for 8 hour/working day with 22 working day per moth	104,924.000
3	Maintenance Cost	200 liters coolant spindle oil 20 liters engine oil 20 liters hydraulic oil 60 liters assumption of maintenance replacement cost per year = 5% of machine price.	958,600,000

(Source : Author Analysis)

3. Inflation rate.

Based on bank indonesia web data for the last 5 years, it is found that the average inflation rate is around 2.76%. for more details, the movement of inflation in Indonesia is described in the graph below.

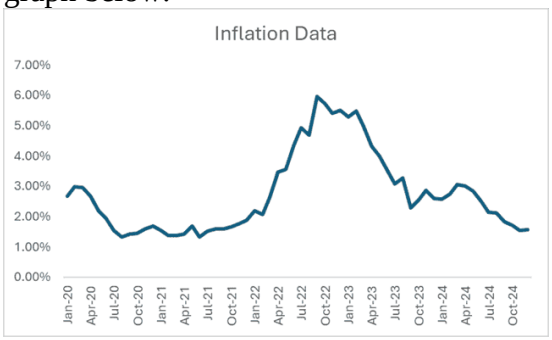

Figure 9. Indonesian inflation chart in the last 5 years

(Source : Bank Indonesia website)

4. Depreciation.

Using the straight-line method, depreciation is calculated based on the length of operation which is around 10 years with a depreciation rate of 10% per year or 0.83% per month. the table below explains the depreciation rate of cnc machines during 10 years of use.

Table 5. Depreciation

Year	In thousand rupiahs			
	Opening book of Value	Depre expenses	Accumulated depreciation	Closing book of value
0	18,192,000	-	-	18,192,000
1	18,192,000	1,819,200	1,819,200	16,372,800
2	16,372,800	1,819,200	3,638,400	14,553,600
3	14,553,600	1,819,200	5,457,600	12,734,400
4	12,734,400	1,819,200	7,276,800	10,915,200
5	10,915,200	1,819,200	9,096,000	9,096,000

6	9,096,000	1,819,200	10,915,200	7,276,800
7	7,276,800	1,819,200	12,734,400	5,457,600
8	5,457,600	1,819,200	14,553,600	3,638,400
9	3,638,400	1,819,200	16,372,800	1,819,200
10	1,819,200	1,819,200	18,192,000	-

(Source : Author analysis)

5. List of CNC machine work orders.

Some work orders that were previously done on conventional machines will later be done on cnc machines.

Table 6. List of work order in cnc turning machine

Work description	Material cost (thousand Rp)	Order quantity	Product quantity	Labour cost (Thousand Rp)
Year of 2023				
Flange	250,408	7	12	142,065
Bush	8,814,637	65	493	1,426,320
Shaft	3,245,699	84	487	1,930,005
Pin	691,392	51	255	517,230
Ring	1,090,851	33	117	917,280
total	14,092,987	240	1,364	4,932,900
Year of 2022				
Flange	470,970	8	24	142,380
Bush	2,825,722	65	1,361	2,781,450
Shaft	4,054,855	94	305	3,316,635
Pin	4,102,625	49	895	1,075,410
Ring	880,763	33	183	1,133,370
total	12,334,936	249	2,768	8,449,245
Year of 2021				
Flange	1,901,246	21	43	519,435
Bush	12,292,046	50	712	404,105
Shaft	2,504,076	95	297	712,490
Pin	1,253,569	46	708	499,430
Ring	3,089,179	29	74	635,945
total	21,040,116	241	1,834	2,771,405
Year of 2020				
Flange	84,296	19	50	92,295
Bush	1,193,020	40	288	254,480
Shaft	1,846,454	62	79	326,580
Pin	503,131	37	797	181,935
Ring	1,392,468	28	67	307,155
total	5,019,370	186	1,281	1,162,445
Total	52,487,408	916	7,247	17,315,995
Average	13,121,852	229	1,812	4,328,999

(Source : Internal main workshop data.)

6. Weighted average cost of capital (WACC)

WACC is calculated based solely on equity financing sourced entirely from the company's project funds, without undertaking debt or external financing. thus reflecting a fully equity-based capital structure, which affects the overall cost of capital and investment decisions.

To calculate the cost of equity value using the formula:

$$Cost\ of\ equity\ (Re) = rf + \beta$$

By comparing the historical data of JKSE and PTBA shares for 5 years. beta value is obtained based on the slope of the linear regression as follows.

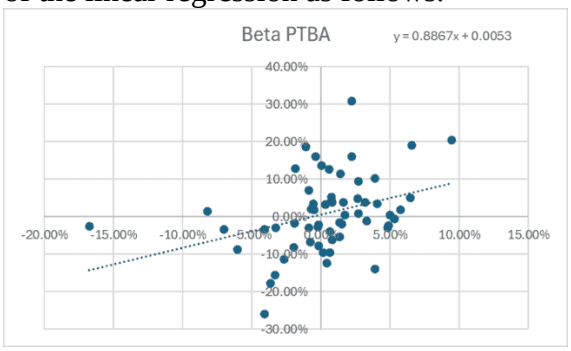

Figure 10. Beta Levered PTBA
(Source: Author calculation)

Table 7. WACC calculation

Parameters	Values	Source
Risk Free rate (rf)	6,89%	PHEI corporate bond yield of 5 year Feb 2025
Equity risk premium (erp)	6,44%	Country default spread Damodaran 4 july 2024
Beta (β)	0,88	calculated

(Source : Author calculation)

with a 100% equity financing structure, the calculated WACC is 12.56%. This implies that the CNC machine investment must achieve a return exceeding 12.56% to be considered financially viable and profitable for the company.

Financial Projection

1. Income Projection

Revenue in this context is defined as the difference between the operating cost incurred using conventional machines and the projected operating cost after the implementation of CNC machines, reflecting the significant cost savings that can be achieved.

Revenue = cost of using old machines

Average of operating cost from 2020-2023 are Rp 3,580,561,250.00.

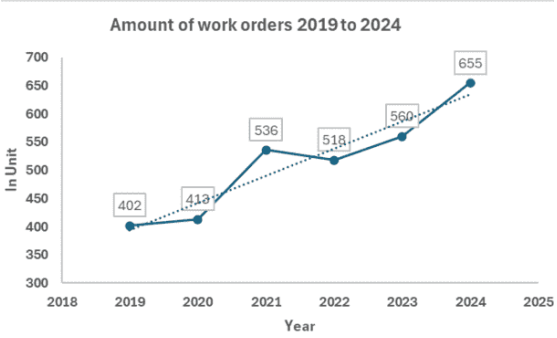

Figure 11. amount of Work orders in 5 years before

(Source: Author analysis)

The graph of work orders from 2019 to 2024 shows a general upward trend, increasing from 402 to 655 units, with an average annual growth of 10%, despite a slight decline in 2022. Therefore, operating costs using conventional machines from 2026 to 2035 are projected to grow at the same annual rate.

Table 8. WACC calculation

Year	In thousand rupiah		
	Operating cost before	increase order	Cost projection
2026	4328999	-	4328999
2027	4,328,999	10%	4,761,899
2028	4,761,899	10%	5,238,088
2029	5,238,088	10%	5,761,897
2030	5,761,897	10%	6,338,087
2031	6,338,087	10%	6,971,896
2032	6,971,896	10%	7,669,085
2033	7,669,085	10%	8,435,994
2034	8,435,994	10%	9,279,593
2035	9,279,593	10%	10,207,553

(Source: Author calculation)

2. Total operating expenses and depreciation

Table 9. Total operating expenses and depreciation

Year	In thousand rupiah	
	Depre	Total Opr. Cost
2026	1,819,200	3,050,724
2027	1,819,200	3,084,714
2028	1,819,200	3,119,642
2029	1,819,200	3,155,534
2030	1,819,200	3,192,417
2031	1,819,200	3,230,318
2032	1,819,200	3,269,265
2033	1,819,200	3,309,287
2034	1,819,200	3,350,413
2035	1,819,200	3,392,675

(Source: Author calculation)

Total operating expenses and depreciation for the CNC turning machine over the ten-year period from 2026 to 2035 amount to Rp 32,154,990,000. This figure is derived from the summation of annual operating costs, which include energy costs, salary expenses, maintenance costs, and depreciation.

Calculation incorporates an average annual inflation rate of 2.76%, affecting all cost components except depreciation, which remains constant at Rp 1,819,200,000 per year. The projected cost trend indicates a steady increase in total operating expenses over the investment period, highlighting the financial commitment required for the long-term operation of the CNC machine.

3. Operating profit

Operating profit is calculated based on the formula :

$$Opr.profit = Cost\ saving$$

$$Opr.profit = \text{Cost before} - \text{Cost cnc}$$

$$Opr\ profit\ margin = \frac{Opr\ profit}{\text{Cost opr before}}$$

use the formula above to calculate operating profit in the table below :

Table 10. Total operating profit

Year	In thousand Rupiah			Operating saving margin
	Operating cost before	Operating expenses	Operating saving	
2026	4,328,999	3,050,724	1,278,275	29.53%
2027	4,761,899	3,084,714	1,677,185	35.22%
2028	5,238,088	3,119,642	2,118,446	40.44%
2029	5,761,897	3,155,534	2,606,363	45.23%
2030	6,338,087	3,192,417	3,145,670	49.63%

2031	6,971,896	3,230,318	3,741,578	53.67%
2032	7,669,085	3,269,265	4,399,820	57.37%
2033	8,435,994	3,309,287	5,126,707	60.77%
2034	9,279,593	3,350,413	5,929,180	63.89%
2035	10,207,553	3,392,675	6,814,878	66.76%

(Source: Author calculation)

In 2026, the initial year of implementation, the cost savings amount to Rp 1,278,274,750, representing an operating profit margin of 29.53%. As the years progress, the cost savings increase substantially, reaching Rp 6,814,877,993.90 in 2035, with an operating profit margin of 66.76%.

4. Net Profit

Net profit, also known as net income or net earnings, represents the amount remaining after all expenses, including taxes and interest, have been deducted from total revenue"(Gitman and Zutter,2015). net profit is calculated based on the formula

$$Net\ Profit\ = Operating\ profit - Tax$$

while net profit margin is calculated using the formula:

$$Net\ Operating\ profit = \frac{Net\ profit}{Revenue}$$

Based on the calculation using the methodology above, the net profit is shown in the table below:

Table 11. Total operating profit

Year	In thousand Rupiah			net profit margin
	Operating profit (saving)	Tax	Net profit (saving)	
2026	1,278,275	281,220	997,054	23.03%
2027	1,677,185	368,981	1,308,204	27.47%
2028	2,118,446	466,058	1,652,388	31.55%
2029	2,606,363	573,400	2,032,963	35.28%
2030	3,145,670	692,047	2,453,622	38.71%
2031	3,741,578	823,147	2,918,431	41.86%
2032	4,399,820	967,960	3,431,860	44.75%
2033	5,126,707	1,127,876	3,998,832	47.40%
2034	5,929,180	1,304,420	4,624,761	49.84%
2035	6,814,878	1,499,273	5,315,605	52.08%

(Source: Author calculation)

The net profit analysis demonstrates that the implementation of CNC machines yields increasing financial benefits over a ten-year period, with net profit rising from Rp 997,054,305 in 2026 to Rp 5,315,604,835.25 in 2035. The net profit margin similarly improves from 23.03% to 52.08%. This consistent upward trend indicates that, despite tax obligations, CNC technology significantly enhances operational efficiency, leading to sustainable cost savings and strengthening the company's long-term financial performance. Consequently, the investment is validated as both financially feasible and profitable over time.

Financial Analysis

1. Cash Flow

The cash flow analysis based on net savings highlights the financial viability of the CNC machine investment by evaluating the annual operating cash flow and free cash flow over the ten-year period from 2026 to 2035.

Table 12. Cash flow from net saving

Year	In thousand rupiah				
	Net Profit	Depre	Opr. cash flow	net fixed asset investment	free cash flow
2026	997,054	1,819,200	2,816,254	18,192,000	(15,375,746)
2027	1,308,204	1,819,200	3,127,404	-	3,127,404
2028	1,652,388	1,819,200	3,471,588	-	3,471,588
2029	2,032,963	1,819,200	3,852,163	-	3,852,163
2030	2,453,622	1,819,200	4,272,822	-	4,272,822
2031	2,918,431	1,819,200	4,737,631	-	4,737,631
2032	3,431,860	1,819,200	5,251,060	-	5,251,060
2033	3,998,832	1,819,200	5,818,032	-	5,818,032
2034	4,624,761	1,819,200	6,443,961	-	6,443,961
2035	5,315,605	1,819,200	7,134,805	-	7,134,805

(Source: Author calculation)

In the first year (2026), the investment in net fixed assets amounts to Rp 18,192,000,000, resulting in a negative free cash flow (FCF) of Rp (15,375,745,695). This negative FCF is expected, as it reflects the substantial initial capital expenditure required for acquiring the CNC machine. However, from 2027 onward, the free cash flow turns positive, beginning at Rp

3,127,403,959 and steadily increasing each year, reaching Rp 7,134,804,835 by 2035. This continuous growth in FCF signifies that the investment is progressively generating surplus cash, which can be utilized for reinvestment, debt servicing, or shareholder returns.

The increasing trend in operating cash flow, from Rp 2,816,254,305 in 2026 to Rp 7,134,804,835 in 2035, underscores the efficiency of CNC technology in reducing operating expenses and enhancing overall financial performance. The absence of additional net fixed asset investments beyond the initial year further strengthens the investment's attractiveness, as all future cash flows contribute directly to the company's financial reserves.

2. Capital Budgeting analysis.

To determine the feasibility of the CNC machine investment, the projected cash flows over the investment period are discounted using the Weighted Average Cost of Capital (WACC). Table IV-21 presents the detailed computation of the present value of cash flows over the 10-year period.

Table 13. Present value cash flow

Year to	In Million rupiah		WACC	In Milion rupiah	
	Cash Flow	Accum-ulated Cash Flow		PV of Cash Flow	Accumulated PV of Cash Flow
0	(18,192)	(18,192)	1.000	(18,192)	(18,192)
1	2,816	(15,376)	1.1256	-	(15,690)
2	3,127	(12,248)	1.2670	-	(13,222)
3	3,472	(8,777)	1.4261	-	(10,787)
4	3,852	(4,925)	1.6052	-	(8,388)
5	4,273	(652)	1.8068	-	(6,023)
6	4,738	4,086	2.0338	-	(3,693)
7	5,251	9,337	2.2892	-	(1,399)
8	5,818	15,155	2.5768	-	858
9	6,444	21,599	2.9004	-	3,080
10	7,135	28,734	3.2647	-	5,266

(Source: Author calculation)

Based on the results of the present value cash flow calculation table, the NPV, IRR, PBP, PI values are as follows:

Table 14. Capital budgeting analysis

Parameters	Criteria	Value	Decision
NPV	> 0	Rp 5,265,658,554	Acceptable
IRR	> WACC (12.56%)	18%	Acceptable
PBP	< 10 years	6 year and 4 months	Acceptable
PI	> 1	1.29	Acceptable

(Source : Author analysis)

The investment's Net Present Value (NPV) is Rp 5,265,658,554.00, indicating financial viability, as the present value of projected cash flows discounted at a Weighted Average Cost of Capital (WACC) of 12.56% exceeds the initial capital outlay. The Internal Rate of Return (IRR) stands at 18%, surpassing the WACC and confirming the project's capacity to generate returns above the company's cost of capital. The Payback Period (PP) is 6 years and 4 months, which falls well within the acceptable limit of 10 years, suggesting timely recovery of the investment. Furthermore, the Profitability Index (PI) of 1.29 signifies that the project is expected to create Rp 1.29 in value for every rupiah invested. Collectively, these indicators affirm the economic feasibility and profitability of the CNC machine investment.

Buy or lease

Under the CNC machine purchase option, the company must allocate an initial investment of Rp 18.2 billion. Despite the substantial upfront cost, ownership of the machine provides a long-term asset for the company. Additionally, annual maintenance costs, estimated at approximately 5% of the purchase price, must be accounted for. Conversely, the rental option offers greater flexibility, requiring a monthly payment of Rp 583 million, amounting to approximately Rp 7 billion annually. This leasing arrangement eliminates the need for a significant initial investment, replacing it with a predictable fixed annual cost. A comparative analysis of

the buy and lease options is presented in the table below.

Table 15. buy vs lease comparison

Finance		
Parameter	**Buy (Purchase)**	**Lease (Rental)**
Initial Investment	Rp18,200,000,000 (including tax)	Rp 0
Monthly Cost	Rp0	Rp 583,000,000
Annual Cost	-	Rp 7,000,000,000
Depreciation	10 % of initial investment / year	-
Maintenance Costs	5 % of initial investment / year	included in contract
Insurance Premium	2% of initial investment/ year	Include in contract
Down Payment	-	30%
Tax	22%	-
Salvage Value	0	-
Interest Rate (BNI)	8.67%	8.67%
After tax cost of debt	6.76% per years	6.76% per years

(Source : Author Analysis)

Table 16. Lease alternative

Year	In million rupiah			
	Lease Payment	**Option to Purchase**	**Tax Shield**	**Total Cash Outflows**
0	-	-	-	-
1	7,000	-	1,540	5,460
2	7,000	-	1,540	5,460
3	7,000	-	1,540	5,460
4	7,000	-	1,540	5,460
5	7,000	-	1,540	5,460
6	7,000	-	1,540	5,460
7	7,000	-	1,540	5,460
8	7,000	-	1,540	5,460
9	7,000	-	1,540	5,460
10	7,000	-	1,540	5,460

(Source : Author calculation)

Table 17. Buy with debt alternative

Year	In million Rupiah				
	Beginning Balance	**Total Payment**	**Interest Payment**	**Princpal Payment**	**Ending Balance**
1	12,734	1,956	1,104	851	11,883
2	11,883	1,956	1,030	925	10,958
3	10,958	1,956	950	1,006	9,952
4	9,952	1,956	863	1,093	8,859
5	8,859	1,956	768	1,187	7,672
6	7,672	1,956	665	1,290	6,382
7	6,382	1,956	553	1,402	4,979
8	4,979	1,956	432	1,524	3,455
9	3,455	1,956	300	1,656	1,800
10	1,800	1,956	156	1,800	-

Year	In million Rupiah				
	Maint. & Insurance Cost	**Depre. Expense**	**Interest Payment**	**Total**	**Tax shields**
1	1,273	3,638	1,104	6,016	1,324
2	1,273	2,911	1,030	5,214	1,147
3	1,273	2,329	950	4,552	1,001
4	1,273	1,863	863	3,999	880
5	1,273	1,490	768	3,532	777
6	1,273	1,192	665	3,131	689
7	1,273	954	553	2,781	612
8	1,273	763	432	2,468	543
9	1,273	610	300	2,183	480
10	1,273	488	156	1,918	422

Year	In Million Rupiah				
	Down Payment	**Loan Payment**	**Maintenance & Insurance Cost**	**Tax**	**Total Cash Outflows**
0	5,458	-	-	-	5,458
1	-	1,956	1,273	1,324	1,905
2	-	1,956	1,273	1,147	2,082
3	-	1,956	1,273	1,001	2,228
4	-	1,956	1,273	880	2,349
5	-	1,956	1,273	777	2,452
6	-	1,956	1,273	689	2,540
7	-	1,956	1,273	612	2,617
8	-	1,956	1,273	543	2,686
9	-	1,956	1,273	480	2,749
10	-	1,956	1,273	422	2,807

(Source : Author Calculation)

Table 18. PV Buy vs Lease in 10 years

Year	In Rupiah			
	Lease Cash Ouflows	**PV of Lease Cash Outflows**	**Buy Cash Ouflows**	**PV of Buy Cash Outflows**
0	-	-	5,458	5,458
1	5,460	5,114	1,905	1,785
2	5,460	4,790	2,082	1,826
3	5,460	4,487	2,228	1,830
4	5,460	4,203	2,349	1,808
5	5,460	3,936	2,452	1,768
6	5,460	3,687	2,540	1,715
7	5,460	3,453	2,617	1,655
8	5,460	3,235	2,686	1,591
9	5,460	3,030	2,749	1,525
10	5,460	2,838	2,807	1,459
PV Lease Alternative		38,773	**PV Buy Alternative**	22,422

(Source : Author Analysis)

Figure 12. PV of cash outflows lease vs buy in 10 years
(Source: Author calculation)

Table 19. Buy vs Lease other factor

Factor	Buy	Lease
Ownership	Yes	No
Flexibility	Hard to upgrade	Easy to upgrade
Financial Impact	Report as a capital expenditure	Report as an operational expenditure
Impact on Cash Flow	High initial investment but lower long-term costs	Predictable expenses but higher total cost over time
Long-Term Cost Efficiency	Lower cost if machine is used for > 5 years	More expensive if leased long-term (>5 years)

(Source : Author Analysis)

Risk Analysis

1. Sensitivity Analysis

Sensitivity analysis is conducted to evaluate the impact of changes in key variables on the Net Present Value (NPV) of the project. Using this approach, it is possible to identify which factors have the greatest influence on investment returns and how much fluctuation is likely to occur under different scenarios. Table IV-23 presents the results of the sensitivity analysis by looking at changes in input values against the NPV output, while the Tornado Chart illustrates the level of sensitivity of each variable visually.

Variable	In Million Rp Input value		
	Low	**Base**	**High**
Cost operating	3,463	4,329	5,195
WACC (%)	15.07%	12.56%	10.05%
Work order (%)	8.00%	10%	12.00%
Maintenance cost	1,150	959	767
Income Tax (%)	18%	22%	26%
Salary Cost	202	168	134
Inflation rate (%)	3.31%	2.76%	2.21%
Energy cost	126	105	84

Table 20. Sensitivity analysis

Variable	In Million Rp Input value			Swing	%
	Low	Base	High		
Cost operating	(156)	5,266	10,687	10,843	43.62%
WACC	2,683	5,266	8,347	5,665	22.79%
Work order	3,239	5,266	7,495	4,255	17.12%
Maintenance cost	4,353	5,266	6,178	1,825	7.34%
Income Tax	4,509	5,266	6,022	1,513	6.09%
Salary Cost	5,106	5,266	5,426	320	1.29%
Inflation rate	5,146	5,266	5,382	237	0.95%
Energy cost	5,166	5,266	5,365	200	0.80%
	Total				100%

(Source: Author calculation)

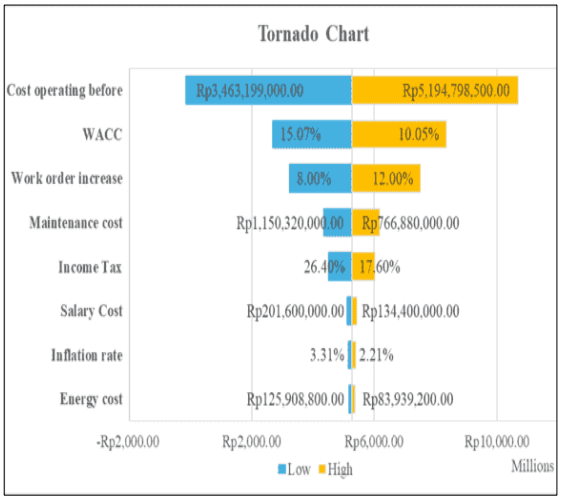

Figure 13. Tornado Chart
(Source: Author calculation)

The implementation of CNC machines is projected to improve financial performance significantly, with net profit increasing from Rp 997 million in 2026 to Rp 5.3 billion in 2035 and the net profit margin rising from 23.03% to 52.08%. Capital budgeting analysis confirms the project's feasibility, with a positive NPV of Rp

5.27 billion, an IRR of 18% exceeding the 12.56% WACC, a Payback Period of 6 years and 4 months, and a Profitability Index of 1.29. These results indicate strong profitability and financial viability over the investment horizon.

The procurement analysis shows that purchasing requires a large initial investment but secures long-term asset ownership, while leasing offers greater flexibility with lower upfront costs. Sensitivity analysis identifies operating costs before investment, WACC, and work order increases as the key factors influencing project value. Effective management of these variables is essential to optimize returns and ensure the project's long-term success.

2. Simulation Analysis

Monte Carlo simulation is a powerful technique used to evaluate the uncertainty and risk associated with financial projections. By running multiple iterations based on probabilistic variations in key input parameters, it provides a comprehensive understanding of potential outcomes.

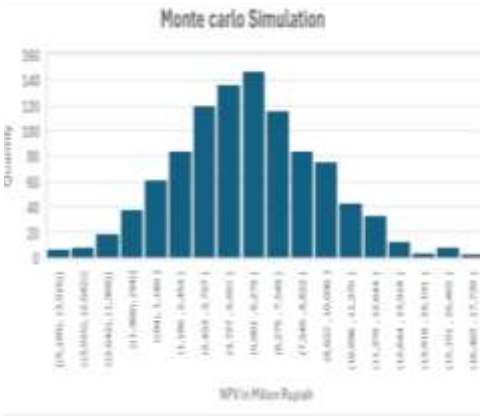

Figure 14. Probability NPV distribution in histogram
(Source: Author calculation)

Table 21. Sensitivity analysis

Probability > 0	93.70%
Probability < 0	6.30%
Max (In million Rp)	Rp19,998.85
Min (In million Rp)	-Rp 5,053.06
Average (In million Rp)	Rp 5,398.66
Standar Deviation (SD) (In million (Rp)	3838
Median (In million (Rp)	5224
Kurtosis	0.06
Skewness	0.22
Prob NPV > Average	48%

(Source: Author calculation)

The Monte Carlo simulation results indicate a 93.70% probability of achieving a positive NPV, suggesting a strong likelihood of financial viability, while the risk of financial loss remains low at 6.30%. The simulated NPV values range from -Rp 5,053.06 million to Rp 19,998.85 million, with an average of Rp 5,398.66 million and a standard deviation of Rp 3,838 million, reflecting moderate variability. These findings emphasize the importance of implementing effective risk mitigation strategies to manage potential fluctuations in project outcomes.

The NPV distribution, visualized through a histogram, appears approximately normal, with most results concentrated between Rp 1,447 million and Rp 7,247 million. The slight positive skewness (0.22) and near-normal kurtosis (0.06) further suggest that positive financial outcomes are more probable than negative ones. Moreover, with a 48% probability of achieving an NPV above the average, the simulation reinforces the investment’s favorable risk-return profile.

Business Solution

The investment in CNC machines at PT Bukit Asam's Main Workshop is a strategic initiative to enhance production efficiency, reduce operational costs, and improve internal

manufacturing capabilities. By adopting CNC technology, the company can increase production speed and precision while minimizing reliance on external suppliers. Successful implementation, however, requires a well-planned strategy to ensure optimal machine utilization and long-term value creation.

1. The company needs to ensure that this investment is made with an optimal funding structure. if the company wants to make a direct machine purchase with full equity it is more profitable than renting, especially in the next 5 years.
2. In the previous NPV calculation analysis, all the work that will be done by the cnc machine is the work of conventional machines. even though there are still many expensive spare parts that are precision done by external vendors due to the inability of conventional machines. by using CNC machines, companies can produce these parts themselves at a much lower cost than vendour costs. thus increasing higher efficiency than previous calculations.
3. This investment must be accompanied by a production optimization strategy to achieve efficiency. Automation of the manufacturing process with CNC allows PT Bukit Asam to increase precision, reduce processing time, and minimize product reject rates. To avoid technical problems that can disrupt production, the company needs to implement a preventive maintenance schedule.
4. Investment in CNC machines also requires an effective HR management strategy so that the workforce has skills that match operational needs. Therefore, PT Bukit Asam should conduct training and certification for CNC operators, covering technical skills such as G-Code programming, basic maintenance, as well as troubleshooting. This training can be conducted internally or through cooperation with professional training institutions to ensure higher competency standards.
5. Based on the results of the sensitivity analysis, it is found that Cost operating before is the highest variable that affects the NPV value. The operating costs before reflecting the production costs with conventional machines are quite high. If this value fluctuates, the impact on cost efficiency after investment becomes significant.

Implementation Plan and Justification

To ensure the successful implementation of CNC machine investment at main workshop, a structured plan with clear stages is required. The following implementation plan is organized into several phases:

Table 22. Implementation planning

Project	:	Investment project of CNC lathe in main workshop			2025			indicator
Phase	ID	Activity	Related parties	Days	Jan	Feb	Mar	
1		Planning and Analysis		90				
	1	setting investment goals and objectives	ws planning section	10				Investment approval from management
	2	review of work demand requirements and machine specifications	ws engineering section	15				Machine specifications and selected vendor
	3	Develop investment estimates and financial analysis	finance & investment div.	30				Finalization of budget and funding
	4	Identify vendors or suppliers	procurement division	15				
	5	internal management approval and develop funding strategy.	top management	20				

Project:		Investment project of CNC lathe in main workshop			2025								indicator
Phase	ID	Activity	Related parties	Days	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
2		Procurement and Installation		225									
	1	Contract negotiation with vendors	vendor	30									Machines properly installed
	2	facility readiness for machine installation	procurement team	30									No technical problems in installation
	3	Delivery and installation of CNC machines	Project team	150									Machine successfully passed the initial test phase
	4	Initial test run and calibration of the machine	ws engineering section	15									

Project:		Investment project of CNC lathe in main workshop			2025		2026	indicator
Phase	ID	Activity	Related parties	Days	Nov	Dec	Jan	
3		Operational Training and Integration		45				
	1	CNC operator training for basic operation and maintenance.	ws planning section	10				All operators have completed training and are certified
	2	Integrate the CNC machine into the main production process.	machining section	10				CNC machines are operating at optimum capacity
	3	Production trials	QC section	15				Trial production shows results
	4	implementation of monitoring system and maintenance schedule.	Project team	10				that comply with quality standards
	5	Finalize and operation	vendor					

Project:		Investment project of CNC lathe in			2026					indicator
Phase	ID	Activity	Related parties	Days	Jan	Feb	Mar	Apr	May	
4		Evaluation and Optimization		150						
	1	Monitoring production performance and efficiency of CNC machines	ws planning section	90						Increased production efficiency and reduced operational costs
	2	Identify technical or operational constraints	QC section	30						No major obstacles in CNC machine operation
	3	Evaluate the impact of investment on cost efficiency and productivity.		30						achievement of ROI targets within the planned timeframe

(Source: Author analysis)

CONCLUSION AND RECOMMENDATIONS

Conclusion

PT Bukit Asam Tbk (PTBA), a company operating in the coal mining industry, continues to experience annual production growth. To maintain operational continuity and ensure the efficiency of maintenance activities at its Coal Handling Facility (CHF), PTBA relies on its engineering and manufacturing unit for the repair and production of equipment components. However, increasing demands for part repairs and the need for greater precision have exposed the limitations of the current conventional machinery, especially in terms of accuracy, speed, and cost-efficiency.

To address these challenges, this research evaluates the viability of investing in CNC (Computer Numerical Control) machines as a means to enhance the productivity and efficiency of PTBA's main workshop. The study employs capital budgeting techniques—including Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PBP), and Profitability Index (PI)—as well as risk evaluation methods such as sensitivity analysis, scenario planning, and Monte Carlo simulations.

The analysis indicates that the investment is financially sound, with an NPV of IDR 5.26 billion, an IRR of 18%, and a payback period of 6 years and 4 months. Monte Carlo simulations further reveal a 93.7% probability of achieving a positive NPV, suggesting a strong likelihood of financial benefit. The sensitivity analysis identifies the most critical variables affecting NPV: initial operating costs, WACC, the rate of work order growth, and CNC machine maintenance costs.

From an operational standpoint, CNC machine implementation is expected to enhance product accuracy, reduce repair turnaround times, and minimize equipment downtime at the CHF. This also enables PTBA to lessen its reliance on external suppliers, contributing to lower long-term costs. On the workforce side, the adoption of CNC technology will require dedicated training programs to equip personnel with the necessary technical skills.

In summary, investing in CNC machinery at PTBA's main workshop represents a strategic initiative that not only delivers economic returns but also advances operational capabilities and strengthens the company's position in the competitive mining sector.

Recommendations

In light of the research findings, several strategic recommendations have been outlined for PT Bukit Asam to support the successful implementation of CNC machine investments. Firstly, the company should seek to optimize its funding strategy by utilizing cost-effective financial resources, including tax benefits, low-interest loans, or leasing programs with competitive conditions. Should PTBA opt for internal funding, it is crucial to ensure that the expected return surpasses the company's cost of equity. Secondly, advancing towards an automated production system through the integration of CAD/CAM technology and IoT-based maintenance practices can significantly enhance operational efficiency and reduce unexpected equipment failures. Thirdly, investment in human resource development is essential, requiring structured training and certification programs for CNC operators, along with mentorship between experienced and junior staff. Lastly, expanding internal production to include previously outsourced components can help minimize external costs and optimize the utilization of CNC machines, thereby reinforcing the company's operational capacity and long-term competitiveness.

REFERENCE

Baker, H. K., & English, P. (2011). *Capital budgeting valuation: Financial analysis for today's investment project* (1st ed.). Wiley.

Bank Indonesia. (2023). *Pertumbuhan ekonomi 2023*. Retrieved from https://bi.go.id

Cardeal, N., & Antonio, N. (2012). Valuable, rare, inimitable resources and organization (VRIO) resources or valuable, rare, inimitable resources (VRI) capabilities: What leads to competitive advantage? *South African Journal of Business Management*.

Damodaran, A. (2002). *Investment valuation* (2nd ed.).

Damodaran, A. (2012). *Investment valuation: Tools and techniques for determining the value of any assets* (3rd ed.).

Damodaran, A. (2015). *Applied corporate finance* (3rd ed.).

Gjosevska, B., & Karanovic, G. (2012). Analysis of risk and uncertainty using Monte Carlo simulation and its influence on project realization. *The International Conference on Economics and Administration*, 8–9.

GÜREL, E. (2017). SWOT analysis: A theoretical review. *Journal of International Social Research, 10*(51), 994–1006. http://dx.doi.org/10.17719/jisr.2017.1832

Hayes, A. (2019). Earnings before interest, taxes, depreciation, and amortization.

Istiqomah, & Andriyanto, I. (2017). Analisis SWOT dalam pengembangan bisnis (studi pada sentra jenang di desa wisata Kaliputu Kudus). *Jurnal Bisnis dan Manajemen Islam, 2*, 363–368.

John Wiley & Son, Gitman, & Zutter. (2012). *Principles of managerial*

finance (13th ed.). United States of America: Prentice Hall.

McGaghie, W. C., Bordage, G., & Shea, J. A. (2001). Problem statement, conceptual framework, and research question. *Academic Medicine, 76*(9), 923–924.

Michelon, P., Lunkes, R. J., & Bornia, A. C. (2020). Capital budgeting: A systematic review of the literature. http://dx.doi.org/10.1590/0103-6513.20190020

Percoco, M., & Borgonovo, E. (2012). A note on the sensitivity analysis of the internal rate of return. *International Journal of Production Economics, 135*(1), 526–529. https://doi.org/10.1016/j.ijpe.2011.09.002

Plaza, M., & Zebala, W. (2019). A decision model for investment analysis in CNC centers and CAM technology. *Computers & Industrial Engineering, 131*, 565–577. https://doi.org/10.1016/j.cie.2019.03.028

Salar, H., & Salar, O. (2014). Determining pros and cons of franchising by using SWOT analysis. *Procedia - Social and Behavioral Sciences, 150*, 515–519. https://doi.org/10.1016/j.sbspro.2014.01.1385