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Investment Feasibility Analysis Using Discounted Cash Flow Valuation Method (Case Study: Gold Mine in Pit A PT XYZ)

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ABSTRACT
Investment in the mining sector carries a high risk, so a comprehensive financial evaluation is required to ensure project feasibility. This study assesses the financial feasibility of gold mining investment in Pit A, PT XYZ, for the period 2025 to 2036. The purpose of this study is to evaluate the feasibility of the project through the analysis of key financial indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PBP) using the Discounted Cash Flow (DCF) method. The DCF method was chosen due to its ability to project future cash flows and incorporate them into a comprehensive assessment of the potential benefits and risks of the project. In addition, sensitivity analysis was conducted to see the effect of changes in important variables such as revenue, cost of goods sold (COGS), and capital expenditure (capex) on the financial results of the project. The results show that the project is financially viable, with a positive NPV of US$404.16 million, an IRR of 52.10%, and a PBP of 3.32 years, all of which indicate a strong return on investment. Further sensitivity analysis shows that the project remains robust under various scenarios of changes in key variables. This study contributes to the investment evaluation literature in the mining sector by offering a more integrated approach to addressing investment uncertainty and risk through the combined use of the DCF method and sensitivity analysis.

Keywords: Gold Mining Investment, Financial Feasibility, Discounted Cash Flow, Sensitivity Analysis, Risk Assesment.

INTRODUCTION

Investment in the gold mining sector offers significant profit opportunities but also exposes investors to high risks (Aminuddin & Burhanuddin, 2023). Market uncertainty, gold price volatility, and high operating costs are some factors that need to be carefully considered in evaluating the feasibility of gold mining investments (Hisam, 2024). The global gold market has shown substantial fluctuations, driven by economic conditions, geopolitical tensions, and changes in demand from central banks (Chiang, 2022). According to the World Gold Council, the

past decade has witnessed a steady increase in gold prices, peaking during periods of financial instability, which positions gold as a preferred asset for risk-averse investors.

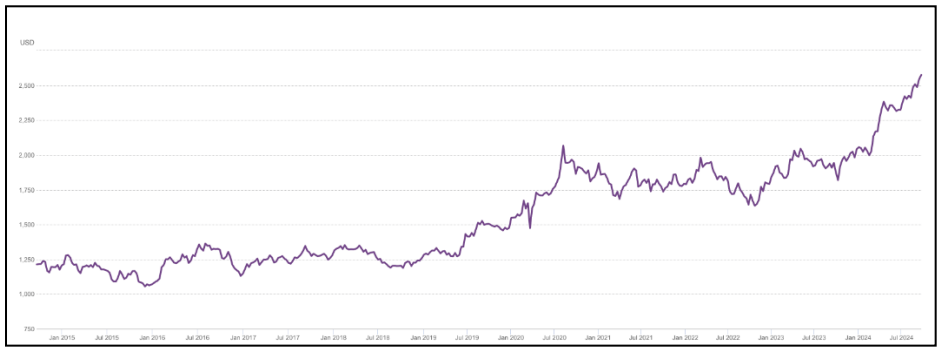

Figure 1. Global Gold Prices in the Last 10 Years

Source: FastMarkets, ICE Benchmark Administration, Thomson Reuters, World Gold Council

The figure above shows the global gold price trend over the past 10 years, which illustrates the significant fluctuations and changes in the gold market price. The upward trend seen in recent years highlights the increased market demand and interest in gold as a safe-haven asset, especially during periods of economic uncertainty. Trends such as these are critical for assessing investment viability, particularly in the gold mining sector where price volatility directly impacts revenue projections and overall investment returns.

In Indonesia, the gold mining sector remains a vital contributor to the economy. The country holds substantial gold reserves, and companies like PT XYZ have been key players in leveraging these resources. However, the high operational costs, coupled with regulatory challenges and the volatile nature of gold prices, create a complex landscape for investment decisions (Riswanto et al., 2024). A robust investment analysis approach is essential to ensure that ventures such as gold mining can deliver sustainable returns while mitigating associated risks (Oktoyoki et al., 2024).

Previous studies have provided a foundation for understanding the financial analysis of mining investments. (Brealey et al., 2018) highlighted the effectiveness of the Discounted Cash Flow (DCF) method in evaluating the potential benefits and risks of investments through future cash flow projections. Their research emphasized that the DCF method allows investors to assess whether the present value of expected future cash flows exceeds the initial capital investment, providing a straightforward measure of investment feasibility (Schumacher & Klönne, 2018).

However, some scholars have criticized the traditional use of DCF analysis due to its inherent limitations in dealing with market uncertainties. (Shivute, 2019) pointed out that DCF analysis often lacks a sensitivity analysis component, which can lead to an underestimation of the impact of changes in critical variables like gold prices, operating costs, and capital expenditures on investment outcomes. This shortcoming suggests that while DCF is valuable for assessing baseline financial feasibility, it may not fully capture the risks associated with fluctuating market conditions.

(Jenkins & Harberger, 2018) advanced this discourse by advocating for the inclusion of sensitivity analysis in investment evaluations. They argued that sensitivity analysis enables a more nuanced understanding of how variations in key assumptions—such as revenue growth or shifts in market demand—affect investment viability. Their work demonstrated that combining DCF with sensitivity analysis provides a more comprehensive risk assessment, allowing decision-makers to make more informed strategic choices (Pike & Neale, 2006).

Given the volatile nature of the global gold market and the significant capital involved in mining projects, there is an urgent need to refine investment evaluation methods to better accommodate market uncertainties (Ali & Rafique, 2024). The global economic environment has become increasingly unpredictable, with factors such as inflation rates, currency fluctuations, and geopolitical tensions directly influencing gold prices (Reivan-Ortiz et al., 2023). For companies like PT XYZ, accurately forecasting investment outcomes amidst these uncertainties is critical for maintaining financial stability and competitive advantage.

The novelty of this research lies in its application of a combined DCF and sensitivity analysis approach tailored to the unique dynamics of gold mining investments. By focusing on the case study of Pit A, PT XYZ, this study not only examines the financial viability of a specific project but also provides insights into how changes in critical variables, such as gold price fluctuations and operational costs, can impact overall investment outcomes.

This study aims to evaluate the financial feasibility of gold mining investment in Pit A, PT XYZ, for the period 2025 to 2036 using the Discounted Cash Flow (DCF) method. The objective is to determine whether the project meets financial viability criteria through metrics such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PBP), and to assess the impact of varying market conditions using sensitivity analysis.

The findings of this study are expected to guide the management of PT XYZ in making informed investment decisions by providing insights into potential risks and returns. Specifically, the sensitivity analysis will help management understand how different scenarios, such as a decrease in gold prices or an increase in operating costs, could impact the overall profitability of the investment. This understanding will enable PT XYZ to develop risk mitigation strategies and enhance decision-making processes.

RESEARCH METHOD

This study employs a systematic financial analysis approach to evaluate the feasibility of investing in the gold mining project at Pit A, PT XYZ. The research process begins with identifying the business issue, namely determining whether the gold mining project is financially viable. The research outlines several crucial stages to address this question, from business situational analysis and data collection to an in-depth financial analysis. The first stage is the Business Situational Analysis, which involves assessing the current business conditions, including market analysis, the operational environment, and the opportunities and challenges PT XYZ faces in executing this gold mining project. This analysis aims to provide a comprehensive overview of

the relevant business context and highlight external and internal factors that may influence the investment outcome.

After conducting the situational analysis, the next step is Data Collection. Critical data are gathered during this stage, including gold price projections, operational costs (COGS), capital expenditure (capex), and estimated production data (Mandagi, 2019). These collected data form the basis for projecting future cash flows, which will be used in the financial analysis. Additionally, an appropriate discount rate is determined to reflect the project's risk, ensuring a more accurate valuation.

The subsequent stage is the Financial Analysis, which serves as the core of this research methodology. In this phase, a valuation analysis using the Discounted Cash Flow (DCF) method is conducted. The projected cash flows gathered earlier are discounted using the chosen discount rate to calculate the Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PBP) of this gold mining project. NPV determines whether the present value of future cash flows exceeds the initial investment costs, while IRR measures the expected rate of return. PBP is calculated to determine the time required to recover the initial investment.

Additionally, a Sensitivity Analysis is performed to assess how changes in key variables such as revenue, operational costs, and capex can affect the valuation results (Arnold & Yildiz, 2015). This analysis is crucial in identifying which variables are most sensitive to changes, providing better guidance for management in anticipating potential risks.The financial analysis results are then compiled in the Valuation Result, which presents a summary of the NPV, IRR, and PBP for this gold mining project. These results form the basis for formulating a recommendation for the management of PT XYZ on whether the project is feasible and should be pursued and what strategies should be implemented to maximize profits and mitigate risks.

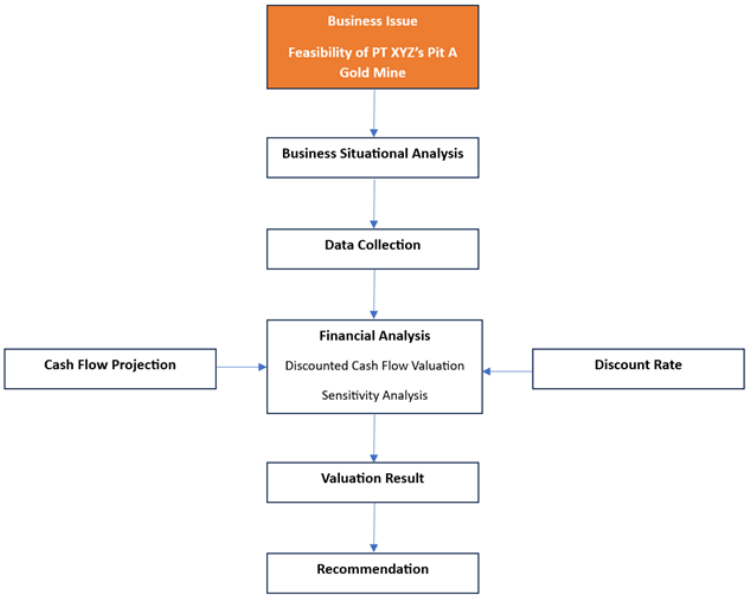

Figure 2. Research Design

RESULT AND DISCUSSION

Production Scenario

PT XYZ itself will carry out mining. Generally, the mining stages in Pit A of PT XYZ Pit follow the diagram shown in Figure 3. In the PT XYZ open pit mining method, activities carried out include land clearing, stripping topsoil, drilling, blasting, moving and hauling overburden to the waste dump location, extracting ore using an excavator, and loading and hauling ore using a dump truck to the processing area owned by PT JKL.

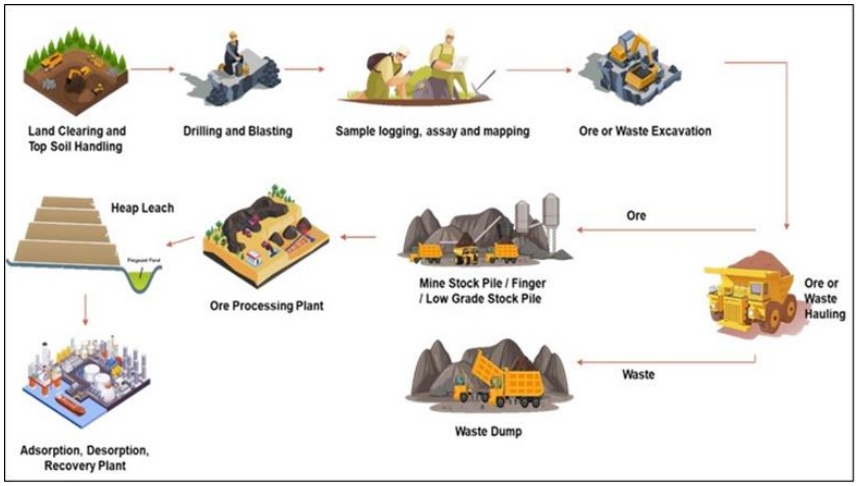

Figure 3. PT XYZ Pit Mining Method Flow Diagram

The final product of PT XYZ mining activities is Dore bullion, a mixture of gold and silver. The ore produced by PT XYZ from mining activities is sent to PT JKL. PT JKL will process the ore using a processing services scheme. The product is produced from ore processing activities through a cyanidation process using the heap-leached method. The output of the PT JKL processing process is Dore bullion. Next, the Dore bullion will be sent by PT XYZ to the Precious Metals Processing and Refining Business Unit belonging to PT ANTM. Dore bullion products will later be refined to produce gold and silver metal that can be traded. This Dore bullion product will be purified through several processes, namely the electrolysis process in nitric acid media, which is washed, melted, and granulated into small granules ready to be marketed or exported.

Dore bullion with a high gold content will be melted directly in the Induction Furnace and carried out by a chlorination process. The output of this process is a gold anode, which will be processed via electro-refining to produce pure gold with a content of 99.99%. Next, it will be molded into gold bars or pure gold granules.

Table 1 below shows the projected number of gold and silver products that PT XYZ will produce.

Table 1. Gold Production Scenario

Parameter	Unit	Total
Production Period	Year	12
Ore Mined	Ton	72,206,256
Waste Mined	Ton	49,347,514
Ore Hauling Distance	m	6,218
Waste Hauling Distance	m	6,267
Ore Stacked	Ton	72,206,256
Ore Grade	g/t	1.77
Au Grade	g/t	1.28
Au Contained	ounces	1,784,090
Ag Contained	ounces	2,981,310
Recoverable Gold	ounces	1,329,701
Recoverable Silver	ounces	1,180,605
Gold Sold	ounces	1,327,707
Gold Sold	ounces	1,121,575

Capital Expenditure

The purpose of estimating capital costs is to provide investment components that PT XYZ needs to meet for mining activities. Furthermore, with this input, the feasibility of the investment issued can be estimated in terms of quantity.

Capital costs are needed for exploration activities, infrastructure development, purchase of mining equipment, common service, contingency and corporate costs, and sustaining capital. Details of capital costs can be seen in the table below.

Table 2. Details of PT XYZ Capital Costs

Component	Unit	Total
Exploration	US$	45,072,756
Infrastructure	US$	12,821,603
Mining Equipment	US$	51,803,709
Advanced Exploration	US$	18,116,500
Common Service	US$	1,833,723
Contingency and Corporate Cost	US$	4,176,272
Sustaining Capital	US$	5,695,715

Revenue

Revenue from this project is obtained from 2025-2036, which comes from the production and sale of gold and silver, and the selling price assumption used is based on market analysis. Life of Mine revenues are estimated at US$ 2,801 million. Details of product quantity, selling price, and revenue level obtained by PT XYZ can be seen in the figure below.

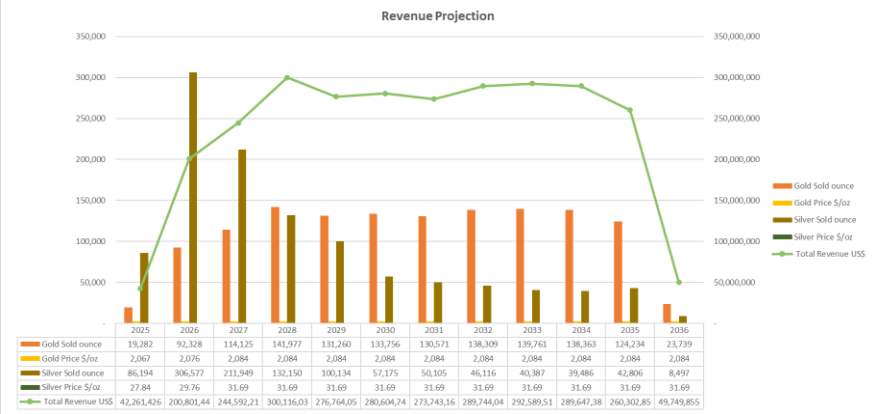

Figure 4. Mining Revenue Projection of PT XYZ

Weighted Average Cost of Capital (WACC)

The entire capital cost will be financed with a debt-to-equity composition of 100% loans. The debt is a shareholder loan/intercompany loan. WACC is assumed to use the figure of 8.88% as the basis for calculating discounted cash flows, with the calculation details explained in the table below.

Table 3. WACC Calculation

Basis for Calculating WACC		
Cost of Equity:		Source
Indonesia Government Bond 12Y (as of 20 Sep 2024)	6.55	https://www.phei.co.id/en-us/Data/Fair-Prices-and-Yield
Indonesia Default Spread	2.07	Damodaran (as of 5 Jan 2024)
a. Risk-free rate	4.48	
b. Beta	0.87	Damodaran (as of Jan 2024)
c. Equity market return	7.38	Damodaran (as of 5 Jan 2024)
Cost of equity	10.90	
Cost of Debt:		
Debt cost (pre-tax)	11.39	actual interest rate of the company's affiliated debt
Tax rate	22	
Debt cost (post-tax)	8.88	
Weighted Average Cost of Capital	8.88	Debt to total capitalization 100% Equity to total capitalization 0%

Discounted Cash Flow (DCF) Valuation

The feasibility of a project is assessed using three criteria: Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PBP). The results are shown in the table below.

Table 4. Mine Valuation Result

Parameter	Unit	Result
Net Present Value (NPV)	US$	404,163,890
Internal Rate of Return (IRR)	%	52.10%
Payback Period (PBP)	Year	3.32

From the results above, the NPV was obtained at US$ 404.16 million. A positive NPV value indicates that the project is feasible to work on. This project is also feasible, considering the IRR value of 52.1% is above the WACC, which was previously assumed to be 8.88%. This value reflects the rate of return on capital costs incurred at the project's beginning through profits generated from operating activities. The mining project investment will reach PBP for 3.32 years after the start of production in 2025.

Sensitivity Analysis

In calculating investment analysis and the feasibility of a project, the investment uncertainty factor is a problem that influences the level of confidence in the calculation results. Therefore, uncertainty factors must be quantified to see the extent to which uncertainty factors influence investment analysis calculations and project feasibility.

The calculation of this investment uncertainty can be done by looking at the level of profitability, in this case, NPV, if the parameters in the DCF analysis calculation change (Alfianur et al., 2018). Each parameter will be compared to determine which parameter has the most significant effect on changes in profitability levels. This can be seen from which parameters provide the most considerable change interval in profitability.

In carrying out a sensitivity analysis to determine the effect of changes on the level of profitability, the parameters that are taken into consideration include:

a. Project Revenue
b. Cost of Goods Sold (COGS)
c. Capital Costs

The sensitivity analysis of the two factors above to NPV with changes in parameter values from -20% to +20% can be seen in the table and figure below.

Table 5. Sensitivity Analysis of PT XYZ Mining Projects

Changes (to the base case)	NPV (Million US$)		
	Revenue	COGS	Capex
-20%	164.32	515.58	420.80
-10%	284.24	459.87	412.48
0%	404.16	404.16	404.16
10%	524.09	348.46	395.84
20%	643.91	292.75	387.53
-33.4%	0	589.74	431.91
71.4%	1,256.37	0	344.78
483.5%	6,169.46	-2,830.40	0

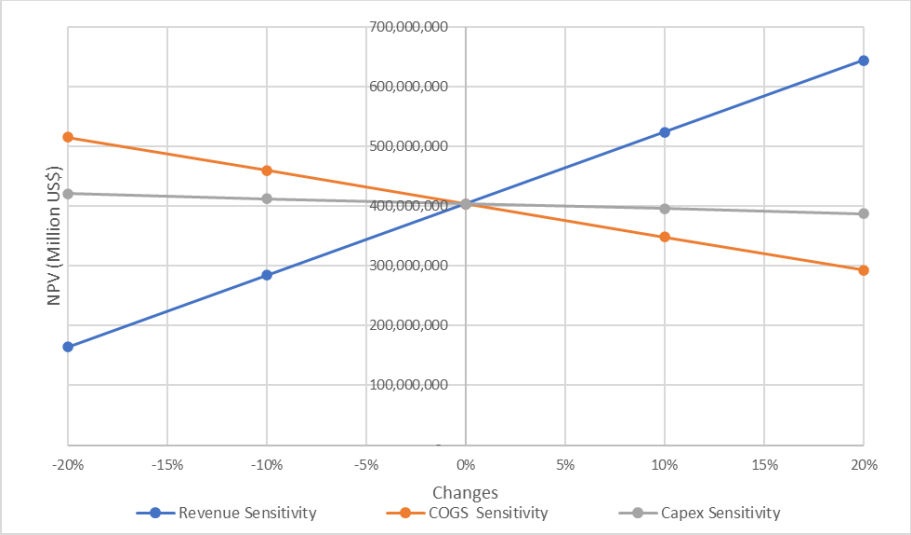

Figure 5. Effect of Changes in Parameters on NPV

Sensitivity analysis of the NPV of each cash flow forming parameter shows the following:

1. A 20% increase in revenue impacts increasing NPV by 59%, while a 20% decrease in revenue impacts decreasing NPV by 59%. A 33.4% decrease in revenue from the base case will cause NPV to be equal to 0;
2. A 20% increase in COGS results in a 28% decrease in NPV, while a 20% decrease in COGS results in a 28% increase in NPV. A 71.4% increase in COGS from the base case will cause the NPV to be equal to 0;
3. A 20% increase in capital costs results in a 4% decrease in NPV, while a 20% decrease in capital costs results in a 4% increase in NPV. A 483.5% increase in capital costs from the base case will cause the NPV to be equal to 0.

CONCLUSION

The conclusion of this study shows that the results of the economic feasibility analysis of the PT XYZ gold and silver mining project confirmed its strong financial potential, with a positive NPV of US$ 404.16 million, an IRR of 52.10%, and a payback period of 3.32 years, signifying strong profitability. Sensitivity analysis highlighted that revenue and cost of goods sold (COGS) were the most influential variables, with even small fluctuations significantly affecting project viability. Capital expenditure also plays a key role, although its impact is relatively less pronounced. These findings emphasize the importance of carefully managing costs and optimizing revenue streams, especially in volatile market conditions. For companies in the mining sector, this analysis underscores the value of proactive financial management, which enables better risk mitigation and improved decision-making. Future research could build on this approach by exploring more dynamic scenarios, such as commodity price shocks or regulatory changes, to refine investment

strategies. The methodology applied here serves as a useful framework for similar projects, guiding investors in making informed and data-driven decisions in the mining industry.

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