Multitek Indonesia: Jurnal Ilmiah

Volume: 19 No. 2 Desember 2025, Hal. 193-199
ISSN: 1907-6223 (print)
ISSN: 2579-3497 (Online)
http://journal.umpo.ac.id/index.php/multitek
https://doi.org/ 10.24269/mtkind.v19i2.12726

INVESTMENT FEASIBILITY OF A SAND AND GRAVEL QUARRY USING THE BENEFIT COST RATIO METHOD A CASE STUDY OF PT. ARKATAMA MINING, JAYAWIJAYA REGENCY, INDONESIA

Obed Patiung[1*], Mapuay Menasye Theo Afasedanya[1]
[1] Mining Engineering Department, Amamapare Polytechnic
Jl. C. Heatubun Kwamki Baru, Timika Central Papua
Email : obedpatiung85@gmail.com, mapuayafase87@gmail.com
*Alamat Korespondensi: obedpatiung85@gmail.com

Dikimkan: 26 November 2025. Direvisi: 9 Desember 2025. Diterima: 18 Desember 2025.

Abstract

The Wouma District in Jayawijaya Regency has significant potential for sirtu (sand and gravel) deposits, particularly along the Uwe River. PT. Arkatama Mining is one of the mining companies utilizing these resources for construction and mining activities. However, the economic feasibility and actual reserve quantity of sirtu have not been thoroughly studied. This research aims to analyze the economic feasibility of sirtu mining using the Benefit Cost Ratio (BCR) method. Data collection involved field measurements, interviews, and company document analysis. Results show that the mining area covers 4,320 m² with a sirtu resource volume of 38,880 m³. The BCR value obtained is 2.6, indicating that the project is economically feasible and profitable. The study recommends environmental monitoring and operational efficiency improvements to ensure sustainable mining practices.

Keywords: *Benefit Cost Ratio, Mining Feasibility, Sirtu, Economic Analysis, Investment*

INTRODUCTION

This study investigates the economic viability of establishing and operating a sand and gravel (sirtu) quarry in the Jayawijaya Regency, Indonesia, by applying the Benefit-Cost Ratio method. This approach allows for a comprehensive assessment of the project's financial attractiveness, taking into account both the expected monetary benefits and the associated costs over its operational lifespan [1]. The primary objective is to determine if the projected benefits outweigh the costs, thereby justifying the investment for PT. Arkatama Mining. A thorough financial analysis, including considerations of Net Present Value, Internal Rate of Return, and Payback Period, will further delineate the project's profitability and capital recovery timeline [2]. Such an analysis is crucial for nascent mining sectors, like those in Cambodia, where a scarcity of geological data necessitates robust financial modeling to guide investment decisions [3]. Moreover, evaluating the financial feasibility of such ventures is paramount in ensuring sustainable resource extraction and regional economic development [4]. This research aims to bridge this gap by providing a detailed financial feasibility study that combines the Benefit-Cost Ratio with other robust financial metrics to offer a holistic perspective on the project's investment potential [5]. This comprehensive approach is essential for mitigating investment risks and optimizing resource allocation in the context of fluctuating market demands and operational complexities inherent in the mining industry [6] [7]. The use of discounted cash flow methods, such as

Net Present Value, is critical in evaluating long-term mining projects by accounting for the time value of money, which is particularly relevant given the extended operational horizons of quarrying activities [8]. This methodology enables a more accurate appraisal of investment opportunities in resource-intensive industries, where initial capital outlay is substantial and returns accrue over an extended period [9]. Furthermore, integrating a cost-benefit analysis within this framework allows for a direct comparison of economic feasibility, ensuring that proposed benefits demonstrably exceed aggregated costs over the project's lifecycle [10]. The Net Present Value method, a frequently employed financial analysis technique, is particularly useful for assessing investment feasibility by comparing the present value of future cash inflows against the initial investment [11] [12]. This method, alongside the Internal Rate of Return and Payback Period, provides a robust framework for capital budgeting decisions in the mining sector [13]. Additionally, the payback period offers insight into the time required for an investment to generate cash flows sufficient to recover its initial cost, which is crucial for assessing liquidity and risk [11]. Moreover, these financial metrics collectively inform strategic decision-making, ensuring that investments in natural resource exploitation align with both economic objectives and long-term sustainability goals, especially in regions with significant resource endowments [14]. Such comprehensive analyses are particularly vital for attracting investors to the solid minerals sector, as demonstrated by studies evaluating large-scale dimension stone production [15]. Previous scholarly works have extensively explored financial management principles in private firms, highlighting cash flow as a critical determinant of financial health and value generation for stakeholders [16]. However, conventional discounted cash flow methods often overlook managerial flexibility in adapting to market fluctuations, prompting the exploration of alternative valuation approaches like real options to enhance investment decisions in mining projects [17]. While much of the literature focuses on financial planning and control, the ultimate aim of financial management—cash management—often receives less attention, despite its critical role in achieving profitability, liquidity, and efficiency [16]. This gap in traditional financial evaluation can lead to suboptimal decisions, particularly in sectors like mining where future uncertainties are high and opportunities for adaptive management are significant [18]. This has led some researchers to advocate for the use of real options analysis, which can more sophisticatedly allocate investment risk by considering the value of managerial flexibility in uncertain environments [19] [17]. Despite this, capital budgeting still heavily relies on methods like Net Present Value, Internal Rate of Return, Modified Internal Rate of Return, Discounted Benefit-Cost Rate, and Discounted Pay-Back Time, especially for assessing the magnitude and long-term implications of investments [20].

RESEARCH METHOD

Research Location

The Benefit-Cost Ratio method, employed in this study, offers a robust framework for evaluating the economic efficiency of projects by comparing the present value of total benefits to the present value of total costs, providing a clear indicator of investment desirability. This quantitative approach enables decision-makers to ascertain whether a project yields a positive return on investment, thereby contributing to informed capital allocation strategies [21]. This method is particularly valuable in resource-intensive sectors such as mining, where significant upfront investments necessitate rigorous financial scrutiny to ensure long-term sustainability and profitability [22] [23]. Moreover, the accurate prediction of cash flows is paramount for project managers to identify potential issues and mitigate project failures, making cash flow management an indispensable component of successful project implementation [24]. Furthermore, this method provides a standardized metric for comparing diverse projects, allowing for objective prioritization of investments based on their economic viability and potential for wealth creation. The discounted cash flow method is widely adopted for assessing project feasibility by summing all discounted expected cash flows over a determined period, thereby providing a comprehensive valuation [25].

This study was conducted at the mining site of PT. Arkatama Mining in Wesakin Village, Wouma District, Jayawijaya Regency. The research employed a quantitative approach utilizing both primary and secondary data.

Primary data collection included:

 ISSN : 1907-6223

- Field measurements using GPS (Garmin 78s) and roll meter to determine mining area coordinates and dimensions
- Direct observation of mining operations and equipment
- Interviews with company management and operational staff
- Time-motion studies using stopwatch to determine equipment cycle times

Secondary data was obtained from:

- Company documents including investment records and operational reports
- Literature studies from relevant journals and technical references
- Government regulations and mining standards

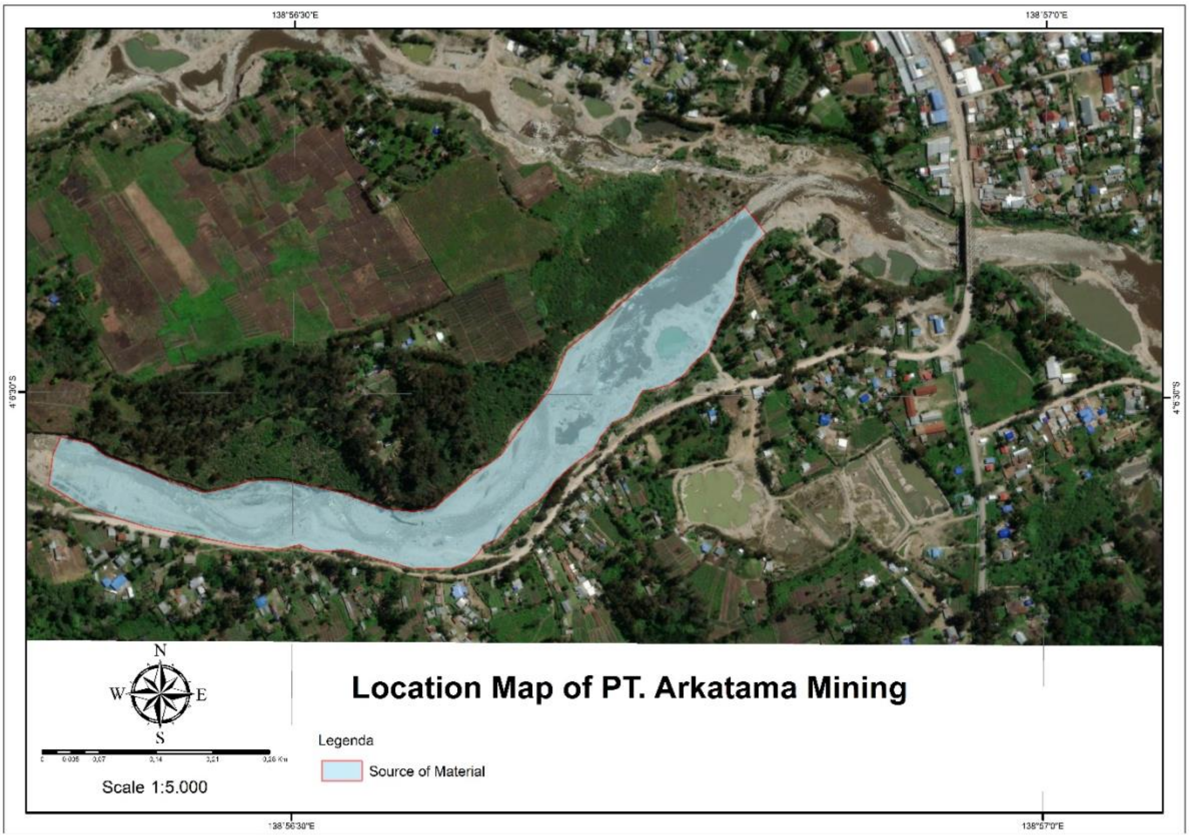

Figure 1 : Research Location

Data Analysis Method

The sirtu resource volume was calculated using the geometric method with the formula:

$$V = P \times L \times T \quad (1)$$

Where:
V= Volume (m³)
P = Length of mining area (m)
L = Width of mining area (m)
T = Thickness/depth of deposit (m)

Benefit Cost Ratio Analysis

The BCR was calculated using the formula:

$$BCR = \frac{Total\ benefit}{Total\ cost} \quad (2)$$

Where:
Total Benefit = Resource volume × selling price per m³
Total Cost = Investment cost + Operational cost
The criteria for economic feasibility were:

- BCR > 1 : Project is economically feasible

- BCR < 1 : Project is not economically feasible
- BCR = 1 : Break-even point

RESULTS AND DISCUSSION

Sirtu Resource Characteristics

The mining area of PT. Arkatama Mining covers 4,320 m² (0.432 hectares) with the following dimensions:

- Length: 108 meters
- Width: 40 meters
- Depth: 9 meters

Using the geometric calculation method:

$$V = 108 \times 40 \times 9$$
$$= 38.880 \text{ m}^3$$

The sirtu deposit consists of mixed sand and gravel materials derived from sedimentary rock formations in the area. The deposit characteristics indicate alluvial origin from the Uwe River sedimentation process.

Production Analysis and Mine Life

Based on field observations, the company operates with the following schedule:

- Working hours: 07.00 - 17.00 WIT = 10 hours
- Effective working time: 9 hours
- Delay time: 3,3 hours

Equipment efficiency calculation:

$$\text{Efficiency} = \frac{working\ hours - delay\ time}{effective\ working\ time} x\ 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots.. (3)$$
$$= \frac{10-3,3}{9}\ x\ 100\%$$
$$= 74,4\%$$

Production calculation for backhoe Sumitomo SH 210-6:

- Bucket capacity (H) : 1.10 m³
- Swell factor (I) : 0.67 %
- Cycle time (CT) : 0.38 minutes
- Efficiency Calculation (E) : 74.4%

$$P = \frac{E\ x\ I\ x\ H}{CT}\ x\ 60\ minutes/hours \quad \ldots\ldots\ldots\ldots\ldots\ldots(4)$$
$$= \frac{0,74\ x\ 0,67\ x\ 1,10}{0,38}\ x\ 60\ minutes/hours$$
$$= 86,5\ m^3/hours$$

Annual production calculation:

- Daily production: 86,5 m³/hour × 6 hours = 519 m³/day
- Monthly production: 519 m³/day × 21 days = 10,899 m³/month
- Annual production: 10,899 m³/month × 11 months = 119,889 m³/year

Mine Life

Based on field data, namely reserves and production targets, the life of a mine can be determined by :

$$\text{Mine life} = \frac{Resources}{Production\ targets} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$
$$= \frac{38.880}{119.997,3}$$
$$= 0,32 \text{ years}$$

The calculated mine life is approximately 4 months based on current production rates and available resources.

Investment Costs
The company's investment in mining equipment includes:

- 4 units of Backhoe Sumitomo SH 210-6: Rp 2.700.000.000
- 6 units of Dump Truck Hino Dutro 130HD: Rp 1.632.000,000
- Total Investment: Rp 4.332.000,000

Operational Costs
Detailed operational costs per year:

- Backhoe operational cost: Rp 33.869.505
- Dump truck operational cost: Rp 5.411.333
- Depreciation cost: Rp 63.133.333
- Employee salaries: Rp 28.800.000
- Total Operational Cost: Rp 131.214.171

Revenue Analysis

- Sirtu resource: 38.880 m^3
- Selling price: Rp 300.000/m^3
- Total Revenue: Rp 11.664.000,000

Benefit Cost Ratio Calculation
Based on company data, the sources of sandstone (sirtu) are as follows:

a. Benefit calculation
   - Sand and rocks recourses = 38.880 m^3
   - Selling price of material = Rp. 1.500.000
   - Hino dutro 130 HD Dump truck capacity (5 m^3)
     = Rp. 1.500.000/ 5
     = Rp. 300.000 m^3

   Benefit Value = total reserves x retail price ………………….. (6)
   = 38.880 m^3 x Rp. 300.000/m^3
   = Rp. 11.664.000.000

b. Cost Calculation
   - Sand and rocks recourses = 38.880 m^3
   - Annual production = Rp. 119.997 m^3/years
   - Operating cost = Rp. 131.214.171

   $$\text{Total Production Cost} = \frac{total\ resources}{production\ target}\ x\ operating\ cost \ \ldots\ldots (7)$$
   $$= \frac{38.880}{119.997}\ x\ 131.214.171$$
   = Rp. 42.514.454,37

c. Benefit Cost Ratio
   - Cost = Total production cost + investment cost ………. (8)
     = Rp. 42.514.454,37 + Rp. 4.332.000.000
     = Rp. 4.373.514.454

- Benefit Cost Ratio $= \frac{value\ of\ benefit}{cost\ of\ value}$ …………………… (9)

$= \frac{Rp.11.664.000.000}{Rp.4.374.514.454}$

= 2.6 (BCR > 1 : Project is economically feasible)

CONCLUSION

The comprehensive comparison of this study's findings with relevant literature validates the economic feasibility conclusion while highlighting important strategic considerations. The BCR of 2.6 positions the PT. Arkatama Mining sirtu quarry favorably within the range of successful small-scale mining operations in Indonesia and similar contexts. The operational efficiency of 74.4% demonstrates competitive equipment utilization, and the cost structure is consistent with industry norms. However, the 4-month mine life emerges as a critical constraint that requires strategic attention. While the high BCR ensures short-term profitability and capital recovery, sustainable business development will require resource base expansion through systematic exploration and permit acquisition in the Uwe River area. The study would be strengthened by incorporating additional financial metrics (NPV, IRR, payback period), conducting sensitivity analysis for key parameters, explicitly accounting for environmental costs, and developing a comprehensive resource expansion strategy. These enhancements would provide a more robust foundation for investment decision-making and long-term business planning. Overall, the research demonstrates that sirtu mining in the Jayawijaya Regency can be economically viable when supported by appropriate equipment, efficient operations, and sound financial analysis. The findings contribute valuable data to the limited literature on small-scale aggregate mining in Papua and provide a methodological framework that can be applied to similar operations in the region.

REFERENCE

[1] H. A. Rani, R. S. Bonenehu, and M. H. Mubarak, "Financial feasibility study of batching plant investment on Sigli -Banda Aceh highway construction project," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 821, no. 1, p. 012012, Apr. 2020, doi: 10.1088/1757-899X/821/1/012012.

[2] R. E. Nugroho and A. J. Raharja, "Financial Analysis and Fast Tracking of Sponge Ferro Alloy Smelter Construction Project at PT Sebuku Iron Lateritic Ores in Sebuku Island, South Kalimantan," *Saudi J. Eng. Technol.*, vol. 7, no. 6, pp. 335–342, Jul. 2022, doi: 10.36348/sjet.2022.v07i06.009.

[3] S. Kem and S. Pumjan, "A Pre-Feasibility Study of Limestone Quarry Development for Cement Industry in Cambodia," *Adv. Mater. Res.*, vol. 931–932, pp. 1696–1700, May 2014, doi: 10.4028/www.scientific.net/AMR.931-932.1696.

[4] B. Prayogi and V. Lubis, "FEASIBILITY ANALYSIS FOR HOSPITAL DEVELOPMENT USING COST-BENEFIT APPROACH: A CASE STUDY IN LEGOK DISTRICT, TANGERANG REGENCY," *SEEIJ (Social Econ. Ecol. Int. Journal)*, vol. 9, no. 1, pp. 18–26, Mar. 2025, doi: 10.21512/seeij.v9i1.12918.

[5] T. Trijayanto and D. F. Hakam, "Economic Viability and Flexibility of the South Pasopati Coal Project, Indonesia: A Real Options Approach Under Market Volatility and Carbon Pricing," *J. Risk Financ. Manag.*, vol. 18, no. 5, p. 225, Apr. 2025, doi: 10.3390/jrfm18050225.

[6] V. P. B. C. Heslouin, L. Pourcheresse, and N. Perry, "Feasibility Study of Cement Plant Production Facility Upgrade Project to Support Export Business," *Int. J. Bus. Technol. Manag.*, Jun. 2024, doi: 10.55057/ijbtm.2024.6.2.46.

[7] Jhony and O. Fuk Jin, "Feasibility study of development of coal transport support infrastructure with conveyor system in coal mining industry," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1007, no. 1, p. 012142, Dec. 2020, doi: 10.1088/1757-899X/1007/1/012142.

[8] A. I. Subroto and T. Faturohman, "Investment Valuation of Long-Term Coal Mining Project at Pit J Using

Discounted Cash Flow Method," *Asian J. Eng. Soc. Heal.*, vol. 3, no. 8, pp. 1760–1782, Aug. 2024, doi: 10.46799/ajesh.v3i8.388.
[9] E. Sutrisno and E. P. Anas, "The Application of Discounted Cash Flow and Real Option Analysis Methods for Coal Mining Projects with Abandonment and Expansion Options: A Case Study of Pt X in East Kalimantan, Indonesia," in *Proceedings of the 3rd Asia-Pacific Research in Social Sciences and Humanities Universitas Indonesia Conference (APRISH 2018)*, Paris, France: Atlantis Press, 2019. doi: 10.2991/aprish-18.2019.38.
[10] E. Benetto, K. Gericke, and M. Guiton, Eds., *Designing Sustainable Technologies, Products and Policies*. Cham: Springer International Publishing, 2018. doi: 10.1007/978-3-319-66981-6.
[11] M. I. Nashiruddin, P. A. Fadhila, N. M. Adriansyah, I. Ginting, M. A. Nugraha, and P. Rahmawati, "Business Sensitivity Options of Carrier Aggregation Strategies: A Simulation Model for 4G Deployment in Emerging Countries," *TEM J.*, pp. 2088–2100, Nov. 2023, doi: 10.18421/TEM124-20.
[12] M. A. Muttaqin, "Evaluasi Kebijakan Perbandingan Pengadaan Pegawai Non Aparatur Sipil Negara antara Mekanisme Swakelola dan Mekanisme Outsourcing di Puslatbang PKASN Lembaga Administrasi Negara," *J. Wacana Kinerja Kaji. Prakt. Kinerja dan Adm. Pelayanan Publik*, vol. 27, no. 2, p. 225, Nov. 2024, doi: 10.31845/jwk.v27i2.1033.
[13] S. F. Juma and M. W. Munala, "International Journal of Current Science Research and Review," *Int. J. Curr. Sci. Res. Rev.*, 2020.
[14] J. Sun and M. Qamruzzaman, "Technological innovation, trade openness, natural resources, clean energy on environmental sustainably: a competitive assessment between CO2 emission, ecological footprint, load capacity factor and inverted load capacity factor in BRICS+T," *Front. Environ. Sci.*, vol. 12, Feb. 2025, doi: 10.3389/fenvs.2024.1520562.
[15] R. . Adebimpe, B. . Arogundade, and O. Adeoti, "Engineering economy studies on the production of dimension stone from marble in Nigeria," *Technovation*, vol. 22, no. 4, pp. 259–265, Apr. 2002, doi: 10.1016/S0166-4972(00)00090-0.
[16] S. Udoh, "REVIEW OF FINANCIAL MANAGEMENT IN PRIVATE FIRMS: UNLOCKING THE CASH MANAGEMENT MODEL," *Int. J. Entrep. Knowl.*, vol. 10, no. 2, pp. 95–106, Dec. 2022, doi: 10.37335/ijek.v10i2.172.
[17] N. Foo, H. Bloch, and R. Salim, "The optimisation rule for investment in mining projects," *Resour. Policy*, vol. 55, pp. 123–132, Mar. 2018, doi: 10.1016/j.resourpol.2017.11.005.
[18] A. Chandra and P. R. Hartley, "Sequential investment decisions for mining projects using compound multiple volatility real options approach," *Resour. Policy*, vol. 97, p. 105241, Oct. 2024, doi: 10.1016/j.resourpol.2024.105241.
[19] R. Zdravlje, *REAL OPTIONS ANALYSIS OF MINING PROJECTS*. 2011.
[20] R. Sardaro, F. Bozzo, F. Petrillo, and V. Fucilli, "Measuring the financial sustainability of vine landraces for better conservation programmes of Mediterranean agro-biodiversity," *Land use policy*, vol. 68, pp. 160–167, Nov. 2017, doi: 10.1016/j.landusepol.2017.07.045.
[21] K. C. FITZGERALD and F. MARIMUTHU, "Enhancing Financial Decision-Making: Real Options Complementing the Net Present Value Technique in the Financial Services Sector," *Int. J. Environ. Sustain. Soc. Sci.*, vol. 5, no. 5, pp. 1395–1407, Sep. 2024, doi: 10.38142/ijesss.v5i5.1125.
[22] B. Bergougui and S. Meziane, "Assessing the Impact of Green Energy Transition, Technological Innovation, and Natural Resources on Load Capacity Factor in Algeria: Evidence from Dynamic Autoregressive Distributed Lag Simulations and Machine Learning Validation," *Sustainability*, vol. 17, no. 5, p. 1815, Feb. 2025, doi: 10.3390/su17051815.
[23] C. Liu, G. Dai, and H. Tu, "Study of a triple bottom line perspective to reach a sustainable development model for critical minerals using financial development," *Resour. Policy*, vol. 90, p. 104790, Mar. 2024, doi: 10.1016/j.resourpol.2024.104790.
[24] S. A. Banihashemi and M. Khalilzadeh, "A Robust Bi-objective Optimization Model for Resource Levelling Project Scheduling Problem with Discounted Cash Flows," *KSCE J. Civ. Eng.*, vol. 26, no. 6, pp. 2539–2554, Jun. 2022, doi: 10.1007/s12205-022-0679-z.
[25] N. Araya, A. Kraslawski, and L. A. Cisternas, "Towards mine tailings valorization: Recovery of critical materials from Chilean mine tailings," *J. Clean. Prod.*, vol. 263, p. 121555, Aug. 2020, doi: 10.1016/j.jclepro.2020.121555.