Economic feasibility analysis of cattle farming ecotourism on former coal mining land

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Abstract. This study aims to examine the economic feasibility of developing cattle farming ecotourism on former coal mining land in Tanjung Enim, South Sumatra. The methods used quantitative financial evaluation, which consists of Net Present Value (NPV), Internal Rate of Return (IRR), Benefit–Cost Ratio (BCR), and Payback Period (PP), were applied to assess the viability of integrating agricultural tourism with post-mining land reclamation. The analysis encompassed comprehensive investment components, including infrastructure development, cattle procurement, operational costs, maintenance expenses, and considering revenue streams from tourism activities and cattle sales. The results showed strong economic viability with favorable financial indicators, confirming the project's feasibility. Furthermore, the model enhances the distribution of the State-Owned Enterprises Partnership Program (PKBL), potentially increasing fund allocation in Muara Enim Regency by 877.36%. The findings indicate that cattle farming ecotourism not only generates direct economic benefits but also contributes to environmental rehabilitation through land reclamation and sustainable land use practices. This integrated approach offers a sustainable solution for utilizing post-mining areas, combining economic objectives with ecological conservation and community development. The study provides valuable insights for mining companies, policymakers, and local communities in transforming post-mining landscapes into productive economic zones while addressing socioeconomic challenges through innovative ecotourism models.

1 Introduction

Coal mining has long played a central role in Indonesia's economic growth and industrialization; however, it has also generated significant environmental challenges, including soil degradation, deforestation, and the formation of acid mine drainage. Addressing these impacts requires a comprehensive land reclamation approach that restores ecological balance while promoting regional socioeconomic development simultaneously. A holistic reclamation concept has therefore been recognized as a key

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factor in mitigating environmental problems in coal mining regions and ensuring sustainable land use transitions [1].

Recent perspectives on sustainable mining emphasize the importance of integrating reclamation efforts with the global Sustainable Development Goals (SDGs) framework, thereby transforming post-mining areas from degraded landscapes into productive assets that contribute to long-term sustainability. Mining companies are encouraged to align reclamation with social inclusion, economic diversification, and environmental resilience. This shift reflects the evolving understanding of sustainability in the mining sector, where restoration is no longer limited to biophysical recovery but extends to social and economic revitalization [2]. The utilization of reclaimed land for agriculture and tourism has emerged as one of the most promising strategies to achieve these multidimensional objectives. Ecotourism-based reclamation combines environmental restoration with community-based development, enabling the recovery of ecological function while generating employment and income. Several studies in Indonesia demonstrate that integrating tourism activities into post-mining land management can strengthen local economies, attract investment, and foster public awareness of environmental stewardship [3][4].

Agricultural activities, such as cattle grazing and feed cultivation, can further enhance the effectiveness of reclamation. Research indicates that post-mining reclamation improves soil physical and chemical properties, including increased organic matter, better soil structure, and enhanced nutrient availability, which support sustainable vegetation growth and livestock production [5]. The integration of livestock-based agriculture with tourism not only creates new economic value but also provides educational and recreational benefits that can attract visitors while maintaining ecological integrity.

Public–private partnerships (PPPs) have been identified as effective mechanisms for implementing sustainable mining tourism projects that promote SDG targets at the local level. Collaborative frameworks between government agencies, private companies, and local communities have proven essential to ensure that reclaimed land continues to generate economic benefits while maintaining social equity and environmental standards [6]. In Indonesia, PT. Bukit Asam Tbk (PTBA) has implemented such partnerships through its Partnership and Community Development Program (PKBL), which links corporate social responsibility to sustainable post-mining land use and community empowerment initiatives [7].

The present study focuses on the case of Tanjung Enim in Muara Enim Regency, South Sumatra, one of Indonesia's largest coal mining regions operated by PTBA. Decades of surface and underground mining have extensively altered the topography and hydrology of the region. Current reclamation programs include recontouring, revegetation, and drainage management to restore the landscape's stability and ecological function [8]. With a humid tropical climate and adequate hydrological resources, the reclaimed land in Tanjung Enim offers favorable conditions for developing cattle farming integrated with ecotourism. The significance of the study aligns with international best practices in integrated mine closure, as promoted by the International Council on Mining and Metals (ICMM), which emphasize that post-mining planning should enable productive and socially beneficial land uses rather than site abandonment [13].

Although significant progress has been made in post-mining reclamation practices, most studies still focus primarily on ecological performance and technical rehabilitation, with limited attention paid to the economic feasibility of integrated reclamation models. Few studies have quantitatively assessed the financial viability of combining livestock farming and ecotourism using standard investment indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), Benefit–Cost Ratio (BCR), and Payback Period (PP). The lack of empirical evidence on the financial dimension of reclamation projects limits the scalability of these sustainable models [9].

To address this gap, the present research analyzes the economic feasibility of developing a cattle-farming ecotourism project on reclaimed coal-mining land in Tanjung Enim, South Sumatra. The study aims to determine the financial viability of the proposed project, evaluate its potential contribution to PT Bukit Asam's Partnership and Community Development Program (PKBL), and provide policy-relevant insights for sustainable post-mining land management in Indonesia. The results are expected to contribute to the broader discourse on sustainable mining transitions by demonstrating how integrated reclamation initiatives can simultaneously promote economic revitalization, environmental recovery, and community development.

2 Material and methods

This study adopted a quantitative financial analysis approach to evaluate the economic feasibility of developing a cattle-farming ecotourism model on reclaimed coal-mining land in Tanjung Enim, South Sumatra. The methodology integrates financial assessment with sustainability principles to ensure that the proposed model supports environmental rehabilitation, social inclusion, and economic growth. Figure 1 shows the study area map.

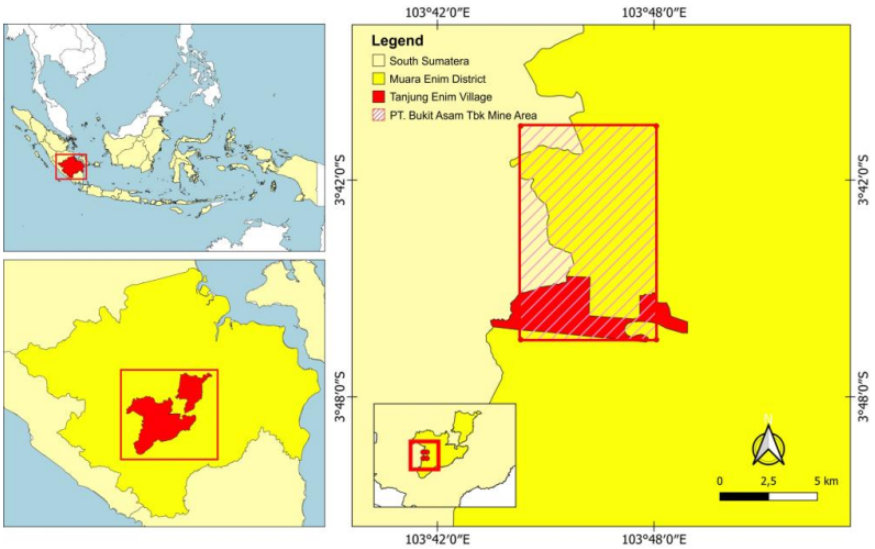

Fig. 1 Map of the study area in PT. Bukit Asam Tbk., Tanjung Enim Mine Area, South Sumatra, Indonesia.

2.1 Study location

The research was conducted in the Tanjung Enim mining complex, Muara Enim Regency, South Sumatra, managed by PT Bukit Asam Tbk (PTBA). The site has undergone extensive surface mining, followed by progressive reclamation through land contouring, re-vegetation, and drainage improvement. The East Air Laya reclaimed field was selected for its stable terrain, adequate hydrological management, and accessibility to surrounding communities, making it suitable for integrated agricultural and tourism activities [8]. The region has a humid tropical climate with annual rainfall exceeding 2,800 mm and average temperatures of 27–32 °C, favourable for forage cultivation, livestock production, and year-round tourism.

2.2 Data collection

Both primary and secondary data were collected. Primary data came from field surveys, interviews with 15 PTBA reclamation officers and 20 community partners, and direct observation of reclaimed sites. The participants were chosen for their involving reclamation and community development programs of the company. Secondary data were derived from corporate sustainability reports, feasibility studies, government regulations, and local livestock market data [7].
Investment and cost elements included four major components:

1. Infrastructure development: barns, feed storage, utilities, access roads, and tourist facilities;
2. Livestock procurement: purchase of Limousin and Bali cattle;
3. Operational expenses: feed production, labor, veterinary services, and maintenance;
4. Revenue streams: livestock sales, entrance tickets, and ecotourism services.

2.3 Financial evaluation

Economic feasibility was determined using four standard indicators: Net Present Value (NPV), Internal Rate of Return (IRR), Benefit–Cost Ratio (BCR), Payback Period (PP) and Sensitivity Analysis . NPV measures the difference between discounted project benefits and costs, indicating overall profitability. IRR represents the discount rate that equalizes the present value of benefits and costs, reflecting the project's expected return relative to capital investment. BCR expresses the ratio between total discounted benefits and costs; values above 1 denote economic viability. PP identifies the period required to recover the initial investment through net cash inflows. The project analysis was based on a 15-year operational period and a 10 % discount rate, consistent with Indonesian government standards for evaluating community-based and sustainable investment projects [14].

2.4 Sensitivity analysis

A sensitivity analysis was conducted to assess the project's resilience under economic uncertainty. Key parameters such as operational costs and revenue projections were varied to simulate different market condition. Scenarios were designed to test revenue reductions (–10 % and –30 %) and cost increases (+20 % and +40 %). The resulting changes in financial indicators were analyzed to determine how shifts in benefit–cost structures could affect project feasibility and investment risk.

2.5 Analytical framework

The study applied an integrated analytical framework that combined financial appraisal with sustainability considerations. Quantitative results were interpreted alongside environmental and social indicators to ensure alignment with reclamation objectives and local development goals. This approach reflects emerging best practices in embedding the Sustainable Development Goals (SDGs) into post-mining land-use planning and policy [13].

3 Results and discussions

3.1 Financial feasibility analysis

The financial analysis evaluated the feasibility of developing a cattle-farming ecotourism project on reclaimed coal mining land in Tanjung Enim, South Sumatra, over a 15-year operational period. The results indicate strong economic viability and profitability, as summarized in Table 1.

Table 1. Summary of Investment, Operational, and Benefit Values [14]

Category	Description	Present Value (Rp)
Investment Cost	Initial construction and facility development	34,467,000,000
Operational & Routine Maintenance	Annual costs (increasing 5 % per year, 15 years PV)	537,554,786,824
Periodic Maintenance	Every five years (5 % increase per cycle)	3,041,170,825
Total Cost (PV)		540,595,957,649
Total Benefit (PV)	Livestock sales, ticket sales, facility rental	704,215,127,395
Net Present Value (NPV)		129,152,169,746
Internal Rate of Return (IRR)		35.56 %
Benefit–Cost Ratio (BCR)		1.22
Payback Period (PP)		3.51 years

A positive NPV of Rp 129.15 billion and an IRR of 35.56%, exceeding the 10% discount rate, confirm that the project is financially feasible [14]. The BCR of 1.22 and a short payback period of 3.51 years indicate high capital efficiency and profitability [14]. These

finding s demonstrate that integrating livestock production and ecotourism can significantly enhance the economic utility of reclaimed mining areas while maintaining long-term sustainability [14].

3.2 Cost and benefit composition

The project requires an initial investment of Rp 34.47 billion for barn construction, feed storage, and tourism facilities [22]. Operational and maintenance costs total Rp 537.55 billion (PV) [14], while periodic maintenance adds Rp 3.04 billion (PV) [14]. The total present value of benefits comprising livestock sales (Rp 624.52 billion) [14], ticket sales (Rp 75.26 billion) [14], and facility rentals (Rp 4.44 billion) [14] amounts to Rp 704.22 [14] billion, exceeding the total PV of costs. This surplus confirms strong profitability and supports the application of ecotourism-based reclamation as a sustainable post-mining economic model [14].

3.3 Sensitivity analysis

A sensitivity analysis was performed to assess project resilience under varying revenue and cost conditions. This analysis examined how NPV would respond to decreases in benefits and increases in costs. The summary is provided in Table 2.

Table 2. Sensitivity Analysis of NPV under Different Scenarios

Scenario	PV Income (Rp)	PV Cost (Rp)	NPV (Rp)	Feasibility
Base Case	704,215,127,395	540,595,957,649	129,152,169,746	Feasible
Benefit ↓ 10%	698,050,632,180	575,062,957,649	122,987,674,531	Feasible
Benefit ↓ 20%	450,909,744,939	575,062,957,649	–7,432,358,227	Not Feasible
Cost ↑ 20%	704,215,127,395	650,078,254,459	54,136,872,936	Feasible
Cost ↑ 40%	704,215,127,395	757,658,475,391	–53,443,347,996	Not Feasible

The results reveal that the project remains feasible under moderate adverse conditions (benefit decline ≤10% or cost increase ≤20%), maintaining a positive NPV. However, at a 20% benefit reduction or 40% cost increase, the NPV becomes negative, rendering the project infeasible. This shows that financial performance is sensitive to revenue fluctuations, but remains stable within a realistic operating range. Similar patterns are noted in previous investment sensitivity studies for agritourism and post-mining enterprises.

3.4 Socioeconomic and environmental implications

Beyond financial performance, the project contributes to community empowerment through PT Bukit Asam's Partnership and Community Development Program (PKBL). The model is projected to increase PKBL fund distribution by 877.36%, generating new employment, micro-enterprise opportunities, and long-term community income [12].

Environmentally, the integration of cattle farming and ecotourism improves soil fertility and vegetation cover, supporting the reclamation process. The approach aligns with the Sustainable Development Goals (SDGs)—specifically SDG 8 (Decent Work and

Economic Growth), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land)—through sustainable land use, economic diversification, and community participation [14].

Overall, the findings confirm that the cattle-farming ecotourism project in Tanjung Enim is financially viable, socially beneficial, and environmentally sustainable. Its strong NPV, high IRR, and short payback period demonstrate sound investment performance, while the PKBL integration enhances community resilience. The sensitivity results emphasize the importance of maintaining cost efficiency and revenue diversification to ensure project stability under fluctuating economic conditions. This integrated approach offers a replicable model for sustainable post-mining land management, supporting the transition from extractive industries toward regenerative, community-based economies.

4 Conclusion

The economic analysis confirmed that the cattle-farming ecotourism project on reclaimed coal-mining land in Tanjung Enim is financially feasible, with an NPV of Rp 129.15 billion, an IRR of 35.56 %, a BCR of 1.22 [14], and a payback period of 3.51 years. Sensitivity tests showed the project remains viable under moderate cost and revenue fluctuations. Beyond financial gains, the model supports social and environmental sustainability through increased PKBL fund distribution (877.36 %) and improved land reclamation outcomes. Overall, cattle-farming ecotourism offers a sustainable, replicable approach for transforming post-mining areas into productive, community-based economic zones aligned with the Sustainable Development Goals.

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