

CONTRIBUTION OF WASTE MANAGEMENT RESULTS TO REVENUE AT THE BANYUMAS LANDFILL

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Abstract. The Banyumas landfill is a modern waste management facility that implements the zero waste to landfill concept with its main product being RDF (Refuse Derived Fuel). This study aims to analyze the contribution of RDF to the operational revenue of the Banyumas landfill. The method used is quantitative descriptive, utilizing primary data through questionnaires and interviews, as well as secondary data from reports and related literature. The variables observed include operational costs, production volume, selling price, and total revenue. The results show that the revenue from RDF sales of IDR 25,412,500,000 per month is able to cover operational costs of IDR 1,747,621,177 for variable costs, resulting in a contribution margin of IDR 23,664,878,823 with a contribution margin ratio of 93.12%. This finding confirms that RDF has a significant contribution in supporting fixed costs and generating profits, while strengthening the operational sustainability of the Banyumas landfill.

Keywords: RDF, contribution, operating costs, contribution margin, Banyumas landfill

1. Introduction

Population growth and human dynamics have a direct impact on the increase in waste generation [1]. Poor management of large volumes of waste risks reducing environmental quality and affecting public health. Central Java, as one of the provinces with a large population, faces a high volume of waste, largely driven by consumption patterns dominated by plastic packaging. Based on Law Number 18 of 2008, specific waste management requires non-normative handling methods tailored to the characteristics and volume of the waste. Therefore, a deep understanding of management strategies is necessary to ensure that implementation is not uniform across all types of specific waste. The challenge of waste management in Central Java is reflected in Banyumas Regency, which ranks 11th in terms of waste volume with daily generation reaching 192,793 m³. With an estimated population of 1,737,385 in 2025, Banyumas is among the top four most populous regions in the province. However, the current waste transportation rate of 22.72% remains below the provincial average of 26.94%, indicating a gap in management capacity. To address this, the Banyumas Landfill in Wlahar Wetan was established as a modern facility with a "zero waste to landfill" concept. The implementation of sustainable waste management at Banyumas Landfill involves sorting waste into organic, inorganic, and residual categories. This approach is closely linked to the principle of a circular economy, where waste is transformed into value-added products. The success of such sustainable initiatives is often determined by community-based empowerment and the development of eco-friendly innovations. Previous studies have shown that community empowerment through waste processing, such as the production of liquid organic fertilizer and botanical pesticides, significantly improves local resource management [2]. Furthermore, the

community's role in managing specific waste streams, such as used cooking oil, highlights the importance of institutionalizing green communities to support environmental quality [3]. In the context of Banyumas Landfill, innovations include the production of paving blocks and Refuse Derived Fuel (RDF) as a coal substitute. This strategy aligns with the broader trend of developing eco-friendly products from waste materials, such as utilizing corn cob waste for sustainable packaging [4] or designing eco-friendly dish soap to reduce chemical footprints [5]. The economic viability of these natural and waste-based innovations, much like the financial analysis of natural-based mouthwash tablets, is a critical determinant of long-term business sustainability [6]. The objective of this research is to clearly identify the operational cost structure at Banyumas Landfill, calculate the revenue from RDF sales, and analyze the extent to which RDF contributes to supporting operational revenue. This analysis is expected to provide a comprehensive picture of RDF's contribution to sustainable and economically viable waste management in Banyumas Regency.

Population growth and human dynamics have a direct impact on the increase in waste generation. Poor management of large volumes of waste risks reducing environmental quality and affecting public health. Central Java is one of the provinces with a large population, so the amount of waste produced is also relatively high [7]. The high level of waste generation is inseparable from people's consumption patterns, particularly the continued dominance of plastic packaging. Waste containing hazardous substances, waste containing hazardous waste, disaster waste, construction debris, waste that cannot be processed using technology, and waste that is produced irregularly are considered specific types of waste, based on Article 2 paragraph (4) of Law Number 18 of 2008 concerning Waste Management. This government regulation governs the generation of specific waste, namely waste that needs to be handled in a certain way due to its characteristics, volume, frequency of occurrence, or other factors that require sequential, non-normative handling methods that are only suitable for certain circumstances [8]. Therefore, a deep understanding of each type of specific waste is necessary, as are strategies for its management. As a result, its implementation cannot be applied consistently and uniformly to all types of specific waste.

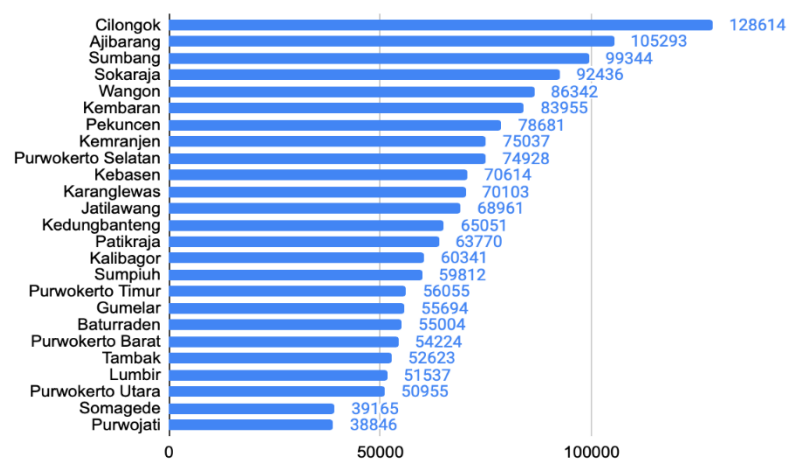


Figure 1. Distribution of Population by District in Banyumas Regency in 2025

Source: Secondary Data, BPS-Statistics of Banyumas Regency (2025)

Banyumas Regency ranks 11th among 35 regencies/cities in Central Java in terms of waste volume, with daily waste generation reaching 192,793 m³. Of this amount, only about 22.72% of waste is successfully transported per day, which is still below the provincial average of 26.94%. In 2025, the population of Banyumas Regency is estimated to reach 1,737,385, placing it among the top four regencies/cities with the largest populations in Central Java [9]. This condition shows that waste management capacity in Banyumas still faces limitations. With a

large population and high waste generation, the existence of final treatment facilities is very important. In Banyumas Regency, this role is carried out by the Banyumas Landfill, which is the main location for the collection and management of waste from various areas.

The Banyumas Landfill is a modern waste management facility located in Wlahar Wetan Village, Banyumas Regency, Central Java. This landfill has a processing capacity of up to 75 tons per day and implements a zero waste to landfill concept with the aim of minimizing the volume of waste that ends up in landfills [10]. The waste that comes in is sorted into organic, inorganic, and residual categories. Innovations developed at Banyumas Landfill include the use of residuals and plastic waste for the industrial-scale production of paving blocks and roof tiles as alternative building materials. Through a circular economy and waste-to-energy approach, RDF (Refuse Derived Fuel) has become the main product produced by the Banyumas Landfill. RDF is marketed as an alternative fuel to replace coal, thereby providing economic added value. Therefore, it is important to analyze the extent to which RDF contributes to the operational revenue of the BLE landfill as part of sustainable waste management efforts in Banyumas Regency. Based on this background, this study aims to identify the operational cost structure at the Banyumas Landfill, calculate the revenue from RDF sales, and analyze the extent to which RDF contributes to supporting operational revenue. This analysis is expected to provide a clearer picture of the contribution of RDF to sustainable waste management in Banyumas Regency.

2. Methods

This study employs a quantitative descriptive design to evaluate the economic contribution of Refuse Derived Fuel (RDF). The research was conducted at the Banyumas Landfill, Banyumas, Central Java. The materials used in this study include primary data collected through structured questionnaires and in-depth interviews with Banyumas Landfill management. Instruments used for data collection were validated interview guides and observation sheets. Secondary data were gathered from the 2024-2025 financial reports of the Banyumas Environmental Agency and relevant literature to support the cost-revenue analysis. The variables observed included operational costs, RDF production volume, selling price, and total revenue. The analysis was conducted descriptively by calculating the proportion of RDF revenue contribution to the total operational costs of the Banyumas Landfill.

This research protocol involves three stages:

- (1) identification of the operational cost structure (labor, electricity, maintenance, and chemicals),
- (2) quantification of RDF production volume and current selling price, and
- (3) calculation of total operational income.

The observed variables focus on the efficiency of waste-to-energy transformation. This protocol follows the principles of sustainable business modeling as previously applied in eco-friendly product design [11] and financial feasibility analysis of nature-based innovations [12]. Data were analyzed using descriptive statistics to determine the proportion of RDF revenue relative to total operating costs.

$$\text{Contribution (\%)} = \frac{\text{Total RDF Revenue}}{\text{Total Operational Costs}} \times 100\%$$

3. Results And Discussion

The Banyumas landfill serves as a waste treatment center with a capacity of up to 75 tons per day. The management system implemented is not only oriented towards waste management, but also towards reuse through a circular economy approach. Among the various innovations, RDF (Refuse Derived Fuel) is the main product produced and marketed to industry as an

alternative fuel. This product is also a source of financial income for the Banyumas landfill, making it relevant to analyze its contribution to operational costs.

Indirect costs have different meanings depending on the context of their use, where there are two perspectives in understanding costs [13]. In a broad sense, costs are understood as the sacrifice of economic resources expressed in monetary terms, both actual and potential, to achieve a specific goal. Meanwhile, in a narrow sense, costs are seen as part of the cost of goods sold that must be sacrificed in order to earn income.

Costs are classified into several types, namely fixed costs and variable costs. Fixed costs are costs that remain constant and do not change even if there are variations in volume or activity levels. Meanwhile, variable costs are costs whose total amount changes in line with changes in activity levels [14]. Fixed and variable costs at the Banyumas Landfill are presented in the table below.

Table 1. Cost Structure of the Banyumas Landfill

Item	Value (Rp)
Montly/annual rental	Owned by Local Government
Machine	
- Wastewater Treatment Equipment (WWTP/IP/ Machine)	195.000.000 (1)
- Steam Equipment / Steam Generator	1.654.000 (1)
- Conveyor	34.875.000 (2)
- Bag Opener Machine	99.750.000 (3)
- Compressor	8.180.145 (3)
- Grass Cutter (Handheld Brush Cutter)	5.700.000 (1)
- Pyrolysis Machine	150.000.000 (2)
- RDF Chopper/Shredder Machine	565.000.000 (1)
- Plastic Recycling Machine	169.400.000 (1)
- Compost Screening Machine	32.000.000 (5)
- Waste Crusher / Organic Waste Shredder	66.500.000 (4)
- Hydraulic Press Machine	59.527.500 (1)
- Wheel Loader + Attachment	358.500.000 (1)
- Shredder Machine	319.750.000 (1)
- Centrifugal Separator (Gibrig Sentris)	99.300.000 (1)
- Belt Conveyor	62.250.000 (2)
- Blower Machine	39.850.000 (3)
- Conveyor Feeder	20.663.000 (5)
- Screw Conveyor	138.750.000 (7)
- Plastic Crusher	20.700.000 (2)
- Magnetic Separator	74.300.000 (2)
TOTAL	4.401.986.935
Annual maintenance costs	208.165.000
Average salary/honorarium per employee	4.000.000
Other fixed costs (basic electricity, internet, administration, employee honorarium)	3.781.070.928
TOTAL FIXED COSTS	Rp8.395.222.863
Transportation/month	48.531.626
Vehicle fuel/month	29.100.000
Electricity and water costs/month	39.446.811
Supporting materials/month	1.387.692.740

Average daily wage/person	PHL = 2.150.000/mount = 71.666,67/day ; Daily = 75.000/day
Total wages/month	242.850.000
Contingency costs	-
TOTAL VARIABLE COSTS	Rp1.747.621.177
TOTAL COSTS	Rp10.142.844.040

Source: Processed secondary data (2025)

The high fixed costs, which account for 82% of total operating costs at the Banyumas Landfill, suggest that the facility operates under a capital-intensive model. This finding implies that the economic viability of the Banyumas Landfill is highly dependent on consistent waste input volumes to reach the break-even point. The use of modern machinery, such as the RDF Chopper and Pyrolysis Machine, which dominate the cost structure, demonstrates a commitment to environmentally friendly technology. This aligns with the principle that technology investment is a key prerequisite for waste-based product innovation to achieve market competitiveness [14]. Compared to conventional landfill systems, which are low-cost but environmentally harmful, the Banyumas Landfill model shifts the cost burden toward equipment investment to create long-term economic value.

The finding of high variable costs for supporting materials, amounting to IDR 1.38 billion per month, indicates that Waste-Derived Fuel (RDF) production is a viable industrial activity. This comprehensively answers the research question regarding the economic feasibility of the waste-to-energy concept. Integrating high operational costs with RDF yields creates a circular economy ecosystem. This strategy aligns with research by [15], which emphasizes that utilizing waste (such as corncoobs or waste residue) is not only an environmental solution but also a sustainable packaging and energy solution. Furthermore, the financial sustainability aspects analyzed here are similar to the feasibility study of natural mouthwash products, where pricing and market analysis are key to covering substantial operational costs with product revenue [16]. Compared to the community-based waste management model analyzed by [17] in their study of used cooking oil, the Banyumas landfill has significantly higher cost complexity but broader impact scope. Previous research has shown that community awareness is key, while this study adds that a robust technological infrastructure is necessary for waste processing on a regional scale.

Community empowerment within the BLE landfill ecosystem, through the absorption of labor with a total monthly wage of IDR 242.8 million, demonstrates that this project also functions as a socio-economic instrument. This reinforces the findings of [18] that technical programs (such as organic fertilizer and RDF production) must be accompanied by structured human resource management to ensure sustainable publication and implementation in the field.

The problem of waste transportation efficiency of only 22.72% in Banyumas can be addressed by optimizing revenue from RDF. If RDF revenue can significantly support operational costs, transportation capacity can be increased without unduly burdening the regional budget. This is in accordance with an environmentally friendly business model that prioritizes variable cost efficiency to achieve sustainable profitability [19].

Table 2. Revenue of Banyumas Landfill

Product	Volume (Ton/Month)	Average selling price (Rp/Ton)	Total Revenue (Rp)
RDF	50.825	500.000	25.412.500.000

From the table above, the fixed costs are Rp8.395.222.863,00 while the variable costs are Rp1.747.621.177.00, resulting in total operational costs at the BLE landfill of Rp10.142.844.040,00. Meanwhile, the revenue from products produced by the BLE landfill reaches 50.825 tons/month with a selling price of Rp500.000/ton, resulting in monthly revenue of Rp25.412.500.000.00. This amount of revenue shows that RDF is able to cover all operational costs and even generate a surplus. This condition indicates that the RDF products produced play a strategic role in supporting the financial sustainability of TPA BLE's operations. From the table above, it is also possible to calculate the contribution margin, which can be used to determine whether their sales are sufficient to cover fixed costs and achieve a profit [20]. The contribution margin can be calculated using the following formula:

$$\text{Contribution Margin} = \text{Total Revenue} - \text{Total Variable Costs}$$

The RDF product produced by the BLE landfill generates a margin contribution of IDR 23,664,878,823.00. This result is obtained from calculating sales revenue minus total variable costs. Furthermore, from the cost structure, it is also possible to calculate the contribution margin ratio, which represents the amount of sales revenue that remains after deducting variable costs, so that it can be used to cover fixed costs and generate profits [21]. This ratio is an important analytical tool in assessing the effectiveness and profitability of a product or service. In general, the contribution margin can be calculated using the following formula:

$$\text{Contribution Margin Ratio} = \frac{\text{Contribution Margin}}{\text{Total Revenue}} \times 100\%$$

$$\text{Contribution Margin Ratio} = \frac{\text{Rp23.664.878.823,00}}{\text{Rp25.412.500.000,00}} \times 100\%$$

$$\text{Contribution Margin Ratio} = 93,12\% \text{ or } 93,12$$

The contribution margin of Rp23.664.878.823,00 reflects the amount of revenue remaining after all variable costs are deducted from total sales. This value serves as the main source for covering fixed costs and generating profits. Meanwhile, the contribution margin ratio of 93,12% indicates that every rupiah of sales contributes 93,12% to the financing of fixed costs while also contributing to profit.

Based on the analysis results, it can be concluded that RDF (Refuse Derived Fuel) plays a significant role in supporting the operational sustainability of the Banyumas BLE landfill. The operational cost structure, which is largely supported by variable costs, can be covered by revenue from RDF sales, even generating a surplus that reflects the potential for financial independence. The contribution margin and contribution margin ratio also confirm that RDF sales can make a positive contribution to financing fixed costs and achieving profits. Thus, RDF not only serves as a technical solution in waste residue management, but also as an economic instrument that strengthens the position of the BLE landfill in realizing sustainable waste management in Banyumas Regency.

4. Conclusion

The results of the study show that the revenue from RDF sales at the Banyumas landfill, with an average of Rp25.412.500.000,00 per month, is able to cover monthly operational costs of Rp10.142.844.040,00 and even generate a surplus, so that RDF plays a strategic role in supporting sustainable waste management. However, the questionnaire results indicate several challenges that need to be addressed, including limited processing facilities and machinery, a relatively small RDF market, and unstable product quality. Therefore, efforts are needed to strengthen the RDF program through the addition and maintenance of machinery, expansion of the marketing network, and improvement of quality standards so that RDF can be optimized as a source of revenue and a sustainable solution for waste management in Banyumas Regency.

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