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Economic Feasibility Analysis of Plastic Waste Usage Business to Support Environmentally Friendly Plastic Usage Campaign

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ABSTRACT

This study examined the techno-economic feasibility of a plastic waste recycling initiative aimed at supporting environmentally sustainable packaging and public awareness campaigns. Standard financial analysis tools, including cumulative net present value and return on investment calculations, were applied to assess the viability of a production system that transformed various types of plastic waste into functional products. The analysis revealed that although the early stages posed financial challenges due to initial investment costs, the long-term projections demonstrated profitability and operational sustainability. The production process involved collection, sorting, washing, extrusion, and molding, with an emphasis on material efficiency and environmental impact reduction. Key challenges included the high proportion of raw material costs relative to overall expenditures and the need for optimized pricing strategies. The study highlighted the importance of stakeholder collaboration (particularly government and industrial support) to ensure success. This initiative aligns with circular economy principles and contributes to the achievement of Sustainable Development Goals in energy access and sustainable urban development.

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1. INTRODUCTION

The problem of plastic waste has become an urgent global environmental issue that requires immediate attention. In Indonesia, the volume of plastic waste continues to increase, and much of it remains unmanaged, leading to severe pollution of both terrestrial and marine ecosystems [1]. Sorting and processing plastic waste into economically valuable products is viewed as a potential solution—not only to mitigate environmental damage but also to create new business opportunities grounded in the principles of the circular economy. Therefore, this study was conducted to analyze the economic feasibility of plastic waste processing as a concrete form of support for environmentally friendly plastic usage campaigns. The chosen topic aligns with global trends toward sustainable development and ongoing efforts to reduce dependency on single-use plastics. Previous studies have referred to the economic feasibility theory, which includes indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PBP), Break-Even Point (BEP), and Profitability Index (PI) as tools to evaluate the profit potential and sustainability of recycling-based businesses (Nasution & Astuti, 2019). Although many studies have assessed the technical and environmental aspects of plastic recycling, there remains a gap in the literature regarding the integration of economic feasibility analysis with sustainability development and development communication approaches.

This study aims to address that gap by combining circular economy concepts, Sustainable Development Goals (specifically SDG 7 on clean energy and SDG 12 on responsible consumption and production), and the strategic role of environmental campaigns in influencing public behavior toward the use of recycled products. It also seeks to provide data-driven strategic recommendations for stakeholders (including government bodies, business actors, and environmental communities) to design more impactful social and business interventions. By integrating economic feasibility analysis with sustainability objectives and public engagement strategies, this study contributes to the formulation of effective and sustainable solutions for plastic waste management.

2. LITERATURE REVIEW

The production of environmentally friendly recycled plastic products involves a series of structured and systematic stages. As illustrated in **Figure 1**, the main objective of this production flow is to transform previously non-valuable plastic waste into economically, socially, and ecologically useful products. The complete stages of the production process are as follows:

(i) Plastic Waste Collection. The process begins with the collection of plastic waste from various sources, including households, businesses, schools, and final disposal sites (TPA). The collected materials include recyclable plastics such as PET (beverage bottles), HDPE (gallon and detergent bottles), LDPE (plastic bags), and PP (food containers). Collection is typically carried out by scavenger partners, waste banks, and local waste management systems.

(ii) Sorting and grouping. Once collected, the plastic waste is sorted based on type and color, as shown in **Figure 1**. This step is crucial because each plastic type has different physical and chemical properties, which influence the recycling process and the quality of the final product. Sorting can be done manually or with the help of conveyors and optical sensors in larger facilities.

(iii) Washing. The sorted plastic waste is then washed using washer drums to remove contaminants such as soil, oil, food residues, and other organic matter. Washing may

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involve the use of hot water and environmentally friendly detergents. This step is essential for maintaining product quality and ensuring cleanliness standards in the final output. Effective washing also extends the lifespan of production equipment.

(iv) Drying. After washing, the plastic still retains high moisture content. A spinner dryer is used to remove this moisture from shredded plastic flakes, preparing them for the next stages such as extrusion or pelletization. Moisture removal is necessary to maintain product integrity during melting and forming.

(v) Shredding/Grinding. Clean and dried plastic is shredded into uniform flakes using a plastic shredder. The consistent particle size ensures more even melting in the extruder or injection molding machine. Some processes may include sterilization to ensure cleanliness before melting.

(vi) Melting and Extrusion. The plastic flakes are melted in an extrusion machine at a temperature specific to the plastic type. The molten plastic is then extruded into filaments, sheets, or pellets, which serve as semi-finished products. These pellets can be sold to other industries or used internally for final product molding.

(vii) Product Forming (Final Printing). The recycled plastic pellets are molded into final products using injection or compression molding techniques. Typical products include plant pots, household items (e.g., buckets, ladles), and recycled shopping bags.

(viii) Finishing and Quality Control. Final products undergo additional processing such as cutting, sanding, or painting. Quality checks are conducted to ensure that the products meet required standards in terms of strength, aesthetics, and safety.

(ix) Packaging and Distribution. The finished products are packaged using eco-friendly materials and distributed through various channels, including environmentally conscious retail shops, e-commerce platforms, local exhibitions, and micro, small, and medium enterprise (MSME) distribution networks.

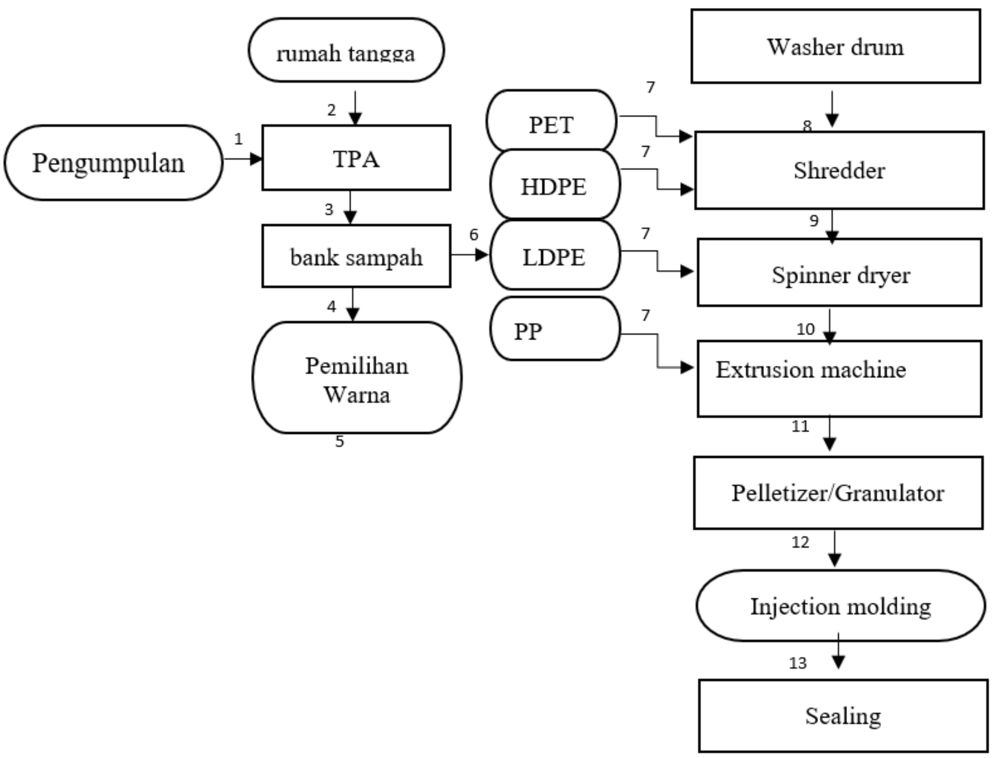

Figure 1. Production line recycled products environmentally friendly plastic waste.

3. METHOD

This study employed a quantitative descriptive approach with the primary objective of analyzing the economic feasibility of a production line for environmentally friendly recycled plastic products. Data were collected from the average prices of various components and raw materials available on leading online marketplaces to ensure accuracy and market relevance. These prices served as the basis for estimating costs related to materials, equipment, and operations. All data were processed using straightforward mathematical calculations. To evaluate the project's feasibility, several economic indicators were applied, including Cumulative Net Present Value (CNPV), Gross Profit Margin (GPM), Payback Period (PBP), Break-Even Point (BEP), Break-Even Cost (BEC), Internal Rate of Return (IRR), Return on Investment (ROI), and Profitability Index (PI). The analysis was further enriched by testing multiple conditions such as variations in material specifications, production capacity, labor requirements, and interest rates, providing a more comprehensive understanding of potential economic outcomes.

4. RESULTS AND DISCUSSION

The raw materials required for producing environmentally friendly recycled plastic products are presented in **Table 1**. Several of these materials are considered reasonably priced, as they are sourced from local waste disposal sites (TPU). According to the cost structure, plastic waste constitutes the largest share, followed by bucket waste and glass bottle waste. The unit price of raw materials generally ranges within a predictable band, which facilitates planning for small- to medium-scale production. However, despite their affordability, these materials are subject to price fluctuations, making cost predictability a challenge. This variability underscores the need for effective supply chain management strategies, such as price negotiation, resource diversification, and material utilization optimization, to maintain production efficiency without compromising product quality. These considerations form a critical foundation for designing a more resilient and economically sustainable production model.

Table 1. Raw material/ ingredient calculation standard.

No	Raw material	Small Scale Production Requirements (Kg/hour)	Unit	Large Scale Production Requirements (Scale up 1000 x)	Price	Total	Source
1	Plastic waste	1500	1 kg	1,500,000	1,500	Rp. 2,250,000,000	TPU
2	Trash Bucket	1000	1kg	1,000,000	2,000	Rp. 2,000,000,000	Household
3	Glass Bottle Waste	1500	1 kg	1,500,000	3,000	Rp. 4,500,000,000	TPU
4	Clean Plastic Bottles	3000	1 kg	3,000,000	3,500	Rp. 10,500,000,000	TPU
5	Plastic cups	3500	1 kg	3,500,000	5,000	Rp. 17,500,000,000	TPU
Price / day						Rp. 36,750,000,000	
Price / year						Rp. 11,025,000,000,000	

The equipment required for the plastic waste recycling production process is detailed in **Table 2**. Most of the machinery is relatively expensive, including the spinner dryer, extrusion machine, and pelletizer/granulator, each capable of processing up to one ton of plastic.

In contrast, more affordable units such as the washer drum and shredder offer cost efficiency, although they are typically used in larger quantities. Overall, the production equipment is of considerable scale, reflecting the industrial-level nature of the operation.

The total investment in production equipment amounts to approximately Rp. 30,013,800. The largest portion of this investment is allocated to the injection molding machine, which accounts for 34.6% of the total cost, followed by additional injection molding components (20%) and the pelletizer/granulator (16.7%).

This cost structure highlights that the forming process (particularly injection molding) is a critical stage in production, requiring high-specification equipment that directly affects product quality.

Although the extrusion machine plays an important role in the early stages of processing, its lower proportion of investment suggests that initial processing is relatively simpler than post-processing and finishing stages.

The variation in equipment costs also reflects the differing technological complexities across production stages. Therefore, this capital investment must be balanced with regular maintenance and optimized utilization to ensure long-term efficiency, minimize operational costs, and maximize consistency in final product formation.

Table 2. Calculation equipment.

No	Tool Name	Unit Price (Rp)	Amount	Total Price (Rp)
1	Washer drum	2,770,631	7	19,394,417
2	Shredder	16,500,000	5	82,500,000
3	Spinner dryer	42,000,000	1	42,000,000
4	Extrusion machine	42,000,000	2	84,000,000
5	Pelletizer/Granulator	25,000,000	2	50,000,000
6	Injection molding	75,000,000	1	75,000,000
7	Sealing	10,000,000	1	10.00
Total				**30,013,800**

Based on **Table 3**, the total annual utility cost amounts to Rp. 3,128,000, with the washer drum accounting for the highest share of energy consumption at 61.4%. This is followed by the extrusion machine (19.2%) and the hard candy forming machine (12.3%).

The substantial energy usage of the washer drum (despite its relatively low power rating of 2.2 kW) is attributed to its extended operating hours (8 hours per day), highlighting its central role in the production process.

In contrast, auxiliary equipment such as batch rollers, rope sizers, and cooling sifters contribute minimally to total utility costs, at 4.6 and 1.3% respectively, indicating better energy efficiency in certain stages of production.

Overall, the energy consumption pattern demonstrates that the majority of utility expenses are concentrated in key machinery. Therefore, energy-saving strategies should prioritize optimizing the usage of these main components to enhance operational efficiency and reduce long-term costs.

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Table 3. Utilities.

No	Tool Name	Power (kW)	Usage (hours)	Price per KwH (Rp)	Total Price/Day (Rp)	Total Price/ Year (Rp)
1	Washer drum	2.2	8	1,500	26,400	1,920,000
2	Shredder	5.5	8	1,500	66,000	600,000
3	Spinner dryer	3	8	1,500	36,000	144,000
4	Extrusion machine	7.5	8	1,500	90,000	384,000
5	Pelletizer/Granulator	4	8	1,500	320	40,000
6	Injection molding	15	8	1,500	120	40,000
7	Sealing	1	8	1,500	800	284,800
	Total					**3,128,000**

Table 4 presents a detailed breakdown of cost components and economic parameters used to assess the financial feasibility of project. These include fixed costs, variable costs, profit estimates, and key financial indicators such as the BEP and ROI.

(i) Fixed Costs. Fixed costs are independent of production volume and primarily consist of capital-related expenses. These include loan interest and asset depreciation. Although the interest amount is not explicitly listed, it is associated with the initial investment. Depreciation of fixed assets is accounted for over their useful life, contributing significantly to the total fixed cost figure.

(ii) Variable Costs. Variable costs fluctuate with production volume and are dominated by raw material expenses, reflecting a large-scale industrial operation. Additional variable components include utility costs (electricity and water), operational labor, other labor-related expenditures, and sales and distribution costs. The substantial value of sales-related costs further emphasizes the project's expansive scale and market reach.

(iii) Profit Estimation. This section evaluates the potential profitability of the project based on projected sales and production costs. While the estimated sales and cost values suggest high profitability, certain figures (such as the profit-to-sales ratio and the total manufacturing cost) appear disproportionately large. These should be reviewed carefully to ensure they are not the result of calculation or data input errors. The recorded profit index suggests strong investment performance, but cross-verification is recommended.

(iv) Break-Even Point and Financial Indicators. The BEP is defined as the minimum level of production or sales required to avoid financial loss. The BEP ratio reflects a balanced relationship between revenue and costs, while the percent profit on sales indicates high sales efficiency. The ROI figure appears exceptionally high, potentially suggesting unrealistic or overly optimistic projections. Additionally, the payback period is listed as 606.1, although clarification is needed regarding the unit of measurement (days or months).

Overall, while the project demonstrates signs of financial viability, several extreme values (such as those associated with ROI and total cost) should be re-evaluated to ensure the reliability and validity of the economic model. A more conservative and realistic projection may be necessary to support sound decision-making and policy development.

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Table 4. Results of techno-economic calculations.

Component	Parameter	Cost
Fixed Cost	Loan Interest	
	Capital Related Cost	Rp. 165,203.80
	Fixed cost + Depreciation	
	Depreciation	Rp. 232,520,041.31
	Fixed Cost less depreciation	
	Total Fixed Cost	Rp. 232,685,245.10
Variable Cost	Raw materials	Rp. 11,025,000,000,000.00
	Utilities	Rp. 65,556,000.00
	Operating Labor (OL)	Rp. 300,000,000.00
	Labor Related Cost	Rp. 90,000,000.00
	Sales Related Cost	Rp. 772,124,850,000,000.00
	Total Variable Cost	Rp. 783,150,305,556,000.00
% Profit Estimated	Sales	Rp. 11,030,355,000,000,000.00
	Manufacturing Cost	Rp. 783,153,031,418,633.00
	Investment	Rp. 2,492,296,075.69
	Profit	Rp 0.93
	Profit to Sales	Rp. 4,111,550.82
BEP	Unit	36100000
	Fixed Cost	Rp. 232,685,245.10
	Variable cost	Rp. 783,150,305,556,000.00
	Variable cost	Rp 0.00
	sales	Rp. 11,030,355,000,000,000.00
	sales	Rp 0.00
	BEP	0.819729633
	Percent Profit on Sales	0.929000197
	Return on Investment	4407018.815
	Pay Out Time	606.1

Table 5 provides detailed information regarding the pricing and sales projections for the recycled plastic candy packaging product. The minimum viable selling price per unit is calculated at Rp168.32, while the set market price is Rp180 per piece or Rp1,800 per pack containing ten pieces.

With a projected production capacity of 300,000 units per day or 14.4 million units annually, the estimated annual revenue reaches approximately Rp2.59 billion.

Setting the selling price slightly above the minimum cost reflects an intentional strategy to secure a profit margin that covers production expenses while generating surplus income. If the entire production capacity is sold, the business has the potential to achieve significant revenue.

However, it is important to consider external factors such as market demand, industry competition, and the effectiveness of marketing strategies in achieving sales targets. Further analysis is also required to determine whether the chosen selling price optimally balances consumer appeal and business profitability.

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Table 5. Sales details.

Sale	Rp	Information
Capacity	361000	pcs/ day
Capacity	36100000	pcs/ year
Price of bag channel repeat	305,550,000	per pcs
Selling price candy per pack with Contents 10	1,800	Per pack
Income per year	2,592,000,000	pcs/ year

Table 6 presents the Cumulative Net Present Value (CNPV) across different production years, illustrating the project's financial performance over time based on discounted cash flows. The visualization of the CNPV curve, as shown in **Figure 2**, plots the production years on the X-axis (Years 0 to 5) and the CNPV values on the Y-axis (expressed in Rupiah, either in millions or billions). In the third year, the CNPV reaches zero, indicating the project's breakeven point or payback period. Beyond this point, the CNPV increases significantly, demonstrating the accumulation of net profit in subsequent years. The curve is upward concave, reflecting a positive financial trajectory. This trend suggests that the project is not only economically viable but also offers strong profitability over the medium to long term. A steep upward slope after the breakeven year implies a high return potential, reinforcing the project's attractiveness from an investment perspective. This pattern validates the feasibility of the plastic recycling business model under the assumed operational and financial conditions. Finally, this study adds new information regarding techno-economic analysis, as reported elsewhere (see **Table 7**).

Based on technical assessments and economic analysis, the plastic waste recycling production project demonstrates strong feasibility and promising financial potential. The cost structure for standard raw materials (**Table 1**) indicates that a large portion of key inputs can be sourced at relatively affordable prices from community waste sites and households, suggesting a stable supply chain and opportunities for cost reduction through local partnerships. Although the total annual cost of raw materials is substantial, the large production scale reflects that the project is designed for industrial-level operations.

Investment in equipment (**Table 2**), valued at approximately Rp. 30 million, is concentrated in the product-forming phase, particularly in injection molding and extrusion, highlighting the critical importance of post-processing stages in the overall production system. Annual utility costs (**Table 3**) are relatively low compared to other expenditures, with energy consumption dominated by the washer drum and extrusion machine. This suggests that optimizing energy use in these key components presents an opportunity for operational efficiency. Economically, the results in **Table 4** show an exceptionally high return on investment (ROI) and a payback period of 606.1 units (pending clarification on whether this refers to days or months). While projected sales volumes are large and potential profits appear high, these figures require further validation to ensure that pricing and volume assumptions are realistic and market-justifiable. The CNPV curve (**Table 5** and **Figure 2**) indicates that the project reaches its break-even point in the third year, followed by consistent and significant net value growth, confirming the project's financial viability over the medium to long term. Success, however, depends on stable material supply and efficient operational management. The recycled plastic waste production project is technically and economically sound, with fast breakeven potential and strong long-term ROI. It requires robust cost management, supply chain strategies, and stakeholder support to ensure production continuity. The project offers substantial contributions to plastic waste reduction and supports the achievement of Sustainable Development Goals, particularly SDG 7

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(Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities), through environmentally friendly production and circular resource utilization. This supports current issues in SDGs, as reported elsewhere [3-8].

Table 6. CNPV/TIC curve.

Year To	Net Cash Flow (Rp)	CNPV (Rp, 10% discount)
0	-2,500,000,000	-2,500,000,000
1	800,000,000	-1,772,727,273
2	900,000,000	-990.909.091
3	1,000,000,000	0
4	1,100,000,000	909.090.909
5	1,200,000,000	2,090,909,091

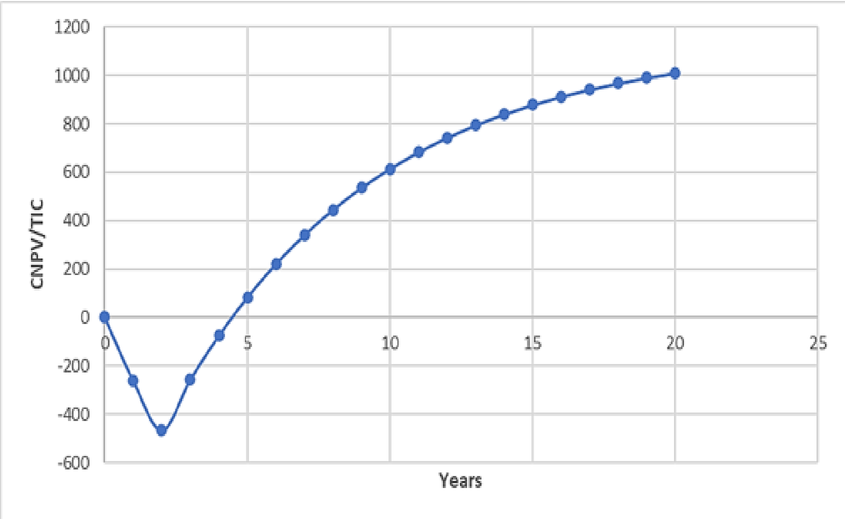

Figure 2. CNPV curve at various year production.

Table 7. Previous studies on techno-economic analysis.

No	Title	Ref
1	Techno-economic analysis of solar panel production from recycled plastic waste as a sustainable energy source for supporting digital learning in schools based on Sustainable Development Goals (SDGs) and science-technology integration	[9]
2	Techno-economic feasibility of educational board game production from agro-industrial waste in support of Sustainable Development Goals (SDGs) through science and technology integration	[10]
3	Resin-based brake pad from rice husk particles: From literature review of brake pad from agricultural waste to the techno-economic analysis	[11]
4	Techno-economic evaluation of biodiesel production from edible oil waste via supercritical methyl acetate transesterification	[12]
5	Techno-economic analysis for the production of silica particles from agricultural wastes	[13]
6	Techno-economic analysis for the production of LaNi5 particles	[14]
7	Computational bibliometric analysis on publication of techno-economic education	[15]
8	Optimal design and techno-economic analysis for corncob particles briquettes: A literature review of the utilization of agricultural waste and analysis calculation	[16]

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Table 7 (Continue). Previous studies on techno-economic analysis.

No	Title	Ref
9	Techno-economic feasibility and bibliometric literature review of integrated waste processing installations for sustainable plastic waste management	[17]
10	Production of wet organic waste ecoenzymes as an alternative solution for environmental conservation supporting sustainable development goals (SDGs): A techno-economic and bibliometric analysis	[18]
11	Techno-economic analysis of production ecobrick from plastic waste to support sustainable development goals (SDGs)	[19]
12	Techno-economic evaluation of the production of resin-based brake pads using agricultural wastes: Comparison of eggshells/banana peels brake pads and commercial asbestos brake pads	[20]
13	Techno-economic analysis of sawdust-based trash cans and their contribution to Indonesia's green tourism policy and the sustainable development goals (SDGs)	[21]
14	Techno-economic analysis of the business potential of recycling lithium-ion batteries using hydrometallurgical methods	[22]
15	Techno-economic evaluation of hyaluronic acid production through extraction method using yellowfin tuna eyeball	[23]
16	Techno-economic analysis on the production of zinc sulfide nanoparticles by microwave irradiation method	[24]

4. CONCLUSION

This study confirms that plastic waste recycling for environmentally friendly packaging is both technically and economically feasible. Despite initial investment challenges, the project achieves breakeven in the medium term and demonstrates strong profitability potential. Key cost components include raw materials and energy consumption, which require strategic management. Sales projections support long-term revenue sustainability, while the CNPV curve reflects consistent financial growth. The business aligns with circular economy principles and contributes to SDG 7 and SDG 11. To ensure success, the initiative requires pricing optimization, stakeholder support, and efficient operations to maximize impact and promote sustainable plastic waste management.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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