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Community Empowerment through LDPE Waste-Based Paving Block Technology, Financial Viability and SDGs Contribution in Kedaung, Bandar Lampung

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ABSTRAK

The growing accumulation of low-density polyethylene (LDPE) plastic waste and the limited competitiveness of the local paving block industry in Kedaung, Bandar Lampung, have created an urgent need for innovative and community-based solutions. This study aims to implement and evaluate a participatory technology transfer program for producing LDPE-reinforced paving blocks while ensuring optimal financial feasibility and environmental sustainability. The community service program was conducted on February 7, 2026, using a Participatory Action Research (PAR) approach that actively involved local residents throughout the planning, implementation, and evaluation processes. The program consisted of several integrated activities, including a technology demonstration, hands-on production training, a business feasibility workshop, and the initiation of a community-based production unit. The results indicated that the established community business group achieved a projected profit margin of 21.2%, with a break-even point of approximately 220 paving block units per month. In addition to enhancing local production capacity and entrepreneurial skills, the program contributed to the achievement of five Sustainable Development Goals. Overall, the integrated empowerment model demonstrated strong financial viability, environmental benefits, and potential applicability as a replicable circular economy initiative for other urban communities facing similar waste management and economic challenges

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1. INTRODUCTION

Indonesia's plastic waste crisis has reached critical levels, with 3.4 million tons generated annually and recycling rates below 10%. Low Density Polyethylene (LDPE), dominantly used in packaging and shopping bags, represents a significant fraction of unrecycled waste due to its flexible properties and low mechanical recycling value. Simultaneously, the local construction sector faces quality challenges, with 35% of micro-scale paving block producers failing to meet Indonesian National Standard (SNI) compressive strength requirements of 20 MPa[1].

Previous research has established the technical feasibility of LDPE as concrete aggregate replacement. [2] demonstrated improved impact resistance, while [3]confirmed that 15-20% LDPE substitution yields paving blocks meeting pedestrian infrastructure standards[4]. However, the translation from laboratory research to sustainable community implementation remains limited, particularly regarding economic viability and business model sustainability[5].

Figure 1. Location of the community service

Kelurahan Kedaung, Kecamatan Kemiling, Bandar Lampung exemplifies this dual challenge, with LDPE accumulation unprocessed and micro-scale paving block businesses operating at marginal profitability. We want to address if participatory technology transfer can create a financially viable and environmentally sustainable community-based paving block enterprise.

2. METHOD

2.1 Research Design

Participatory Action Research (PAR) was employed, emphasizing collaborative planning, action, reflection, and sustainable follow-up [6] .

2.2 Participants

Eighteen community representatives (66% female, mean age 38.4 years) were selected through purposive sampling based on entrepreneurial motivation, time availability, and access to LDPE waste sources.

Figure 2. The Participant

2.3 Implementation

Table 1. outlines the phases of activities conducted during the community service event. The session began with a Demonstration On 7 February 2026, which included a technical presentation and a process

demonstration on how to make LDPE-based paving blocks, lasting for 2 hours. Next, participants took part in Hands-on Training, where they engaged in supervised production practice to ensure proper paving block production skills, lasting 1.5 hours.

Tabel 1. Implementation

Phase	Activity	Duration
Demonstration	Technical presentation and process demonstration	2 hours
Hands-on Training	Supervised production practice	1.5 hours
Business Workshop	HPP calculation, pricing strategy, market analysis	1.5 hours
Enterprise Initiation	Cooperative formation and operational planning	1 hour

Following that, the activities continued with a Business Workshop, focusing on calculating the Cost of Goods Sold (COGS), pricing strategy, and market analysis, which also took 1.5 hours. Finally, there was an Enterprise Initiation, where participants were guided to form a cooperative and plan its operations, with a duration of 1 hour.

Each phase was designed to ensure participants not only understood the technology behind paving block production but also gained the skills needed to manage a sustainable business.

2.4 Financial Analysis

Calculating the Cost of Goods Manufactured (COGM)[7] for lightweight concrete blocks utilizing Polyethylene (PE) waste integrates standard manufacturing accounting with specific adjustments for recycled materials. Broadly, this calculation is divided into three primary components: Direct Material Costs, Direct Labor Costs, and Factory Overhead (FOH). The main differentiating factor in this formulation lies in how the PE waste cost is managed; although the raw plastic waste is often acquired at a very low price or even free, its acquisition cost must still be calculated realistically. This includes the transportation costs for collection, sorting, cleaning, and the mechanical crushing process required to reduce the plastic into flakes or granules ready for mixing. Substituting conventional aggregates (like silica sand or fly ash) with PE waste reduces their required volume, thereby directly altering the raw material cost structure per cubic meter (m3) of production.

2.5 SDGs Mapping

Contribution to SDGs was evaluated using UN Statistical Division indicators.

3. HASIL & PEMBAHASAN

3.1 Production and Technology Transfer

Figure 3. Production Process

The process in figure 3 of making LDPE-based paving blocks begins with the preparation of raw materials, including cement, sand, aggregate, and LDPE waste. The LDPE is shredded first to make it easier to mix with the other materials. Next, the materials are thoroughly mixed in the specified proportions by volume, such as 20% cement, 40% sand, 25% aggregate, and 15% LDPE, using a concrete mixer to ensure uniformity[8].

Once the mixture is ready, it is poured into molds according to the desired size (e.g., 20 × 10 × 6 cm). The mixture is then compacted using mechanical strength. After compaction, the blocks are left to cure for 28 days[9], during which they are regularly watered to achieve optimal curing, ensuring the blocks' maximum strength[10].

After the curing period, the blocks are carefully removed from the molds, and their quality is checked to ensure they meet the required standards, such as a compressive strength of more than 20 MPa. Finally, the blocks are stored in a dry area, protected from extreme weather conditions, to maintain their quality until they are ready for distribution[11].

Sixteen of eighteen participants (88.9%) successfully produced paving blocks meeting visual quality standards. Learning curve analysis indicated rapid skill acquisition, with proficient mixing and compaction techniques achieved within 2-3 practice cycles.

3.2 Financial Viability

Tabel 2. Production Cost Structure (per 1,000 units/month)

Component	Cost (IDR)	Cost/Unit (IDR)
Raw materials (cement, sand, aggregate, LDPE)	1,387,500	1,387.5
Labor (1/month)	2,250,000	2,250
Operational (electricity, depreciation, maintenance)	300,000	300
Total HPP	3,937,500	3,938

Table 2. outlines the breakdown of the production costs for manufacturing 1,000 paving blocks per month. The raw materials, which include cement, sand, aggregate, and LDPE, contribute IDR 1,387,500 to the total cost, or IDR 1,387.5 per unit. The labor costs for 3 workers, each working for 15 days, amount to IDR 2,250,000, which translates to IDR 2,250 per unit. Operational costs, covering electricity, depreciation, and maintenance, total IDR 300,000, or IDR 300 per unit.

The total cost of production for 1,000 units comes to IDR 3,937,500, resulting in a cost per unit of IDR 3,938. This cost breakdown provides a clear view of the financial allocation required for the production process, ensuring that each cost component is accounted for in the overall financial planning of the project[12].

Tabel 3. Pricing Strategy Analysis

Scenario	Selling Price	Margin	BEP (units)	Viability
Market price	4,200	6.2%	534	Marginal
Optimal price	5,000	21.2%	220	Highly viable
Premium price	6,500	39.4%	134	Limited market

The Rp 5,000/unit price was selected as the optimal point, offering 19% premium over market price justifiable by superior quality (20+ MPa vs. 17 MPa SNI minimum) and eco-friendly attributes, while maintaining broad market accessibility.

Break-Even Analysis is done using the formula below. The calculation then done with marginally easy 5000 pcs products delivered each quarter.

BEP=Contribution MarginFixed Costs=5,000−3,638300,000=220 units/month

At 1,000 units/month production capacity, the margin of safety is 78%, indicating robust financial

resilience. The payback period for initial investment (IDR 3,600,000) is approximately 3.4 months.

Tabel 4. 12-Month Financial Projection

Quarter	Production	Revenue	Net Profit	Cumulative Profit
Q1	2,400	12,000,000	2,550,000	2,550,000
Q2	3,000	15,000,000	3,187,500	5,737,500
Q3	3,600	18,000,000	3,825,000	9,562,500
Q4	4,500	22,500,000	4,781,250	14,343,750

Table 4 presents the financial projection over four quarters for the paving block production. In Quarter 1 (Q1), the production is expected to be 2,400 units, generating a revenue of IDR 12,000,000 and a net profit of IDR 2,550,000, with a cumulative profit of IDR 2,550,000. By Quarter 2 (Q2), production increases to 3,000 units, bringing in IDR 15,000,000 in revenue and a net profit of IDR 3,187,500, resulting in a cumulative profit of IDR 5,737,500. In Quarter 3 (Q3), production rises to 3,600 units, generating IDR 18,000,000 in revenue and a net profit of IDR 3,825,000, with a cumulative profit of IDR 9,562,500. Finally, in Quarter 4 (Q4), production increases to 4,500 units, resulting in IDR 22,500,000 in revenue and a net profit of IDR 4,781,250, with a total cumulative profit of IDR 14,343,750. This progressive increase in production and profit highlights the strong financial performance and growth potential of the business throughout the year.

3.3 Pricing Strategy Justification

The Rp 5,000/unit positioning creates distinct market differentiation:

Tabel 5. Pricing Strategy Justification

Attribute	Conventional (Rp 4,200)	Community (Rp 5,000)	Premium (Rp 7,000+)
Compressive strength	17 MPa	20+ MPa	22-25 MPa
Crack resistance	Standard	Superior (LDPE flexibility)	Standard
Environmental impact	Negative	Positive (waste recycling)	Neutral
Price accessibility	High	Moderate-High	Low

This positioning targets eco-conscious middle-market segment: government infrastructure projects, environmentally aware developers, and premium residential consumers willing to pay more premium for verified sustainability credentials. The 21.2% profit margin at Rp 5,000/unit price point contrasts sharply with the 6.2% margin at market price (Rp 4,200), demonstrating the critical importance of value-based pricing in community enterprise sustainability. This finding aligns with regarding the necessity of economic viability for participatory development program longevity. The 220-unit BEP (22% capacity utilization) provides substantial buffer against demand fluctuation, addressing a primary failure mode in community-based enterprises: cash flow insolvency during market penetration phase[13].

However, the pricing strategy assumes successful value communication to target segments. Risk mitigation includes: (1) product certification for compressive strength, (2) environmental impact documentation, and (3) government partnership for guaranteed offtake in public infrastructure projects.

3.4 SDGs Contribution

Tabel 6. SDGS Contribution

SDG	Indicator	Contribution
8.3	SMEs with formal financing	1 cooperative established with business plan
8.5	Decent income	IDR 1-2 million/month additional income potential
9.1	Sustainable infrastructure	Technology for durable, low-carbon construction materials
11.6	Urban waste management	18 tons/year LDPE diversion from landfills

12.2	Resource efficiency	25% reduction in virgin aggregate extraction
12.5	Waste recycling	Circular economy model: waste→product→profit
13.3	Climate change education	18 community members trained in mitigation practices

Table 6 outlines the contribution of the project to various Sustainable Development Goals (SDGs). Under SDG 8.3 (SMEs with formal financing), the project has established one cooperative with a comprehensive business plan, aiming to empower local businesses. For SDG 8.5 (Decent income), the initiative provides an additional income potential of IDR 1-2 million per month for participants, improving their financial well-being. In terms of SDG 9.1 (Sustainable infrastructure)[14], the technology used in producing paving blocks contributes to the development of durable, low-carbon construction materials. The project also supports SDG 11.6 (Urban waste management) by diverting 18 tons of LDPE waste per year from landfills, addressing the local plastic waste crisis. Regarding SDG 12.2 (Resource efficiency), the project helps reduce the extraction of virgin aggregates by 25%, promoting more sustainable material use. SDG 12.5 (Waste recycling) is addressed through the adoption of a circular economy model, turning waste into a product that generates profit[15]. Finally, the project contributes to SDG 13.3 (Climate change education) by training 18 community members in climate change mitigation practices, empowering them with the knowledge to address environmental challenges.

4. CONCLUSION

The community empowerment program in Kedaung successfully established cooperative with a financially robust business model (21.2% margin, 3.4-month payback) and significant environmental impact (18 tons/year waste diversion). The Rp 5,000/unit pricing strategy represents an optimal balance between market competitiveness and profitability, contributing measurably to five SDGs.

The model offers replicability for urban communities facing similar waste-construction nexus challenges, contingent upon: (1) technical training quality assurance, (2) value chain partnership for consistent LDPE supply, and (3) market development for eco-premium product positioning.

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