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Empowering Local Communities through Upcycling Used Buckets into Waste Bins: A 3R-Based Environmental Awareness Initiative in Neglasari Village

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Abstract: Household waste remains a persistent environmental challenge in rural communities, primarily driven by a lack of sorting habits and limited skills in repurposing inorganic waste. This community engagement initiative aimed to enhance environmental awareness and practical skills among residents in Neglasari Village by implementing a 3R (Reduce, Reuse, Recycle) strategy—specifically upcycling discarded plastic buckets into functional and aesthetic waste bins. The implementation method encompassed a three-stage participatory approach: preparation (needs assessment and material gathering), execution (interactive workshops, live demonstrations, and hands-on painting and crafting), and evaluation. The results demonstrated a significant increase in community understanding regarding solid waste management and the 3R principles. Furthermore, participants successfully demonstrated autonomy in turning household waste into durable, visually appealing trash bins placed in key public areas, including local school grounds. Overall, this initiative successfully fostered environmental stewardship, encouraged creative upcycling behavior, and established a scalable model for community-based waste management.

Keywords: Community engagement, Environmental stewardship, 3R principles, Upcycling, and Waste management

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1. Introduction

Solid waste management remains one of the most pressing global environmental challenges in the twenty-first century, particularly in developing nations undergoing rapid demographic expansion and urbanization [1,2]. In Indonesia, the continuous increase in population and changing consumption patterns have led to an exponential rise in municipal solid waste generation, which is currently estimated to exceed tens of millions of tons annually [2]. Among the various streams of waste, domestic or household solid waste constitutes the largest proportion. Household activities—ranging from daily meal preparation, food consumption, and consumer product utilization—produce a substantial volume of mixed waste daily [1,5]. Without integrated management practices, this growing accumulation threatens ecological balance, contaminates soil and water resources, and creates visual pollution that degrades the quality of public living spaces [1,4].

Despite the existence of national policy frameworks such as Law No. 18 of 2008 on Waste Management, which explicitly advocates for waste reduction, segregation, and community-based handling, implementation at the rural and sub-district levels remains severely constrained [2,3]. Rural communities frequently suffer from structural deficiencies, including inadequate waste collection infrastructure, absent municipal service coverage, and a lack of localized disposal facilities [1,4]. Consequently, open dumping, unmonitored burning, and indiscriminate littering in vacant lots or natural waterways have become normalized practices [5]. Beyond infrastructural limitations, a crucial underlying issue lies

in the prevalent socio-behavioral mindset regarding waste: items that have fulfilled their primary purpose are predominantly perceived as valueless garbage rather than reusable secondary materials [4,5].

In rural contexts, inorganic domestic waste—specifically rigid plastic containers such as paint pails and chemical buckets—represents a highly durable yet underutilized waste stream [5]. Plastic materials possess high structural longevity and slow degradation rates in natural environments, making their unmanaged disposal particularly hazardous [1]. However, these exact physical properties—durability, water resistance, and high structural integrity—render discarded plastic buckets ideal candidates for upcycling initiatives under the 3R framework (Reduce, Reuse, Recycle) [4,5]. Upcycling converts discarded items into products of equal or higher quality and utility without requiring energy-intensive industrial reprocessing [5]. Transforming used plastic buckets into functional, aesthetically designed waste receptacles offers a low-cost, decentralized solution that addresses both waste reduction and infrastructure deficits simultaneously [6].

The environmental challenges associated with unmanaged domestic waste are clearly manifested in Neglasari Village, located in the Nyalindung Sub-district, Sukabumi Regency, West Java [6]. Field observations conducted in Baros 2 Hamlet (Kedusunan Baros 2) revealed significant vulnerabilities in environmental hygiene and spatial organization [6]. Multiple public spaces, including vacant lots, residential perimeters, and surrounding school yards (notably local madrasahs), suffered from neglected conditions and unorganized garbage accumulation [6]. The scarcity of public waste receptacles in these educational and residential nodes directly encouraged indiscriminate littering, leading to unsanitary school grounds and compromised public health environments [6]. Furthermore, local residents lacked structured knowledge regarding waste segregation at the source and possessed minimal exposure to creative waste repurposing methods [6]. Discarded items, such as empty construction paint pails, were frequently discarded around households, compounding the aesthetic and environmental degradation of the hamlet [6].

While previous community service programs across Indonesia have broadly addressed general environmental education or basic waste management awareness [4,5], a significant implementation gap remains in bridging theoretical awareness with hands-on, place-based technical empowerment. Many educational campaigns rely heavily on passive lecture formats, which often fail to foster long-term behavioral changes or tangible physical outputs [4]. Furthermore, few initiatives specifically integrate community empowerment with public facility enhancement in educational environments like local madrasahs, where developing environmental stewardship among youth is critical [6]. There is a need for integrative, participatory action models that combine theoretical literacy, live technical demonstrations, aesthetic modification, and immediate structural deployment within the community [4,6].

To address these local environmental bottlenecks and bridge the operational gap, an integrative Community Service (*Pengabdian kepada Masyarakat* - PKM) initiative was implemented by an academic team from STISIP Syamsul Ulum [6]. The intervention was designed around a participatory upcycling framework titled *"Empowering Local Communities through Upcycling Used Buckets into Waste Bins: A 3R-Based Environmental Awareness Initiative in Neglasari Village"* [6]. The primary objective of this project was to elevate community environmental literacy, foster practical skills in technical upcycling, and improve waste collection infrastructure in Kedusunan Baros 2 [6]. By guiding residents and local madrasah stakeholders through the end-to-end process—from cleaning, structural modification, and artistic painting of used buckets to building wooden supporting stands and strategic field installation—this initiative sought to demonstrate that household waste can be converted into valuable community assets [6]. Ultimately, this paper evaluates the execution, outcome, and ecological impacts of this participatory upcycling model, providing a scalable strategy for rural environmental stewardship and localized circular economy practices [6].

2. Methods

2.1. Program Location, Target Audience, and Operational Timeline

This Community Service (*Pengabdian kepada Masyarakat* - PKM) program was carried out in Kedusunan Baros 2, Neglasari Village, Nyalindung Sub-district, Sukabumi Regency, West Java, Indonesia [6]. The target location was purposefully selected based on preliminary situational analysis, which identified critical environmental issues including unmanaged domestic waste, vacant public lots deteriorating into informal dumping sites, and a severe shortage of functional waste receptacles around residential areas and local educational institutions (madrasahs) [6].

The target participants comprised key local stakeholders, including household representatives, youth organization leaders, village administrators, and madrasah teachers and students [6]. A total of 35 core participants actively engaged across all program modules. The program was executed over a intensive project cycle comprising field observation, community coordination, instructional workshops, hands-on fabrication, public placement, and post-implementation evaluation [6].

2.2. Methodological Approach and Implementation Framework

To ensure sustainable behavioral adoption and physical outcome quality, the intervention utilized a Participatory Action and Experiential Learning (PAEL) framework [6]. Rather than relying solely on traditional top-down lecture methods, this framework systematically integrated theoretical education, direct technical demonstration, collaborative crafting, and localized physical installation [6]. The operational workflow was structured into three sequential phases: (1) Preparation and Needs Assessment, (2) Program Execution and Hands-on Fabrication, and (3) Program Evaluation and Follow-up Assessment [6]. The step-by-step implementation process is detailed below.

Figure 1. Methodological Workflow of the Community Upcycling Initiative

1. **Phase 1: Preparation** → Site observation, material collection (used pails & timber), tool staging, and stakeholder coordination [6].
2. **Phase 2: Execution** → Environmental literacy workshop (3R), live upcycling demonstration, wooden stand construction, bin painting, and site placement [6].
3. **Phase 3: Evaluation** → Observational monitoring, practical skill assessment, and interactive post-activity reflection [6].

2.3. Phase 1: Preparation and Baseline Assessment

The preparation phase established the technical and operational foundation required for seamless project execution [6]. This phase comprised four interconnected activities:

1. **Site Survey and Environmental Diagnostics:** The academic team performed field reconnaissance across Kedusunan Baros 2 to map major littering hotspots, evaluate existing waste disposal habits, and assess the environmental condition of public spaces and madrasah school grounds [6].
2. **Material Sourcing and Supply Chain Staging:** To demonstrate true circular economy principles, materials were sourced locally. Discarded 20-liter construction paint pails and chemical buckets were collected from local residents and construction sites [6]. Additionally, discarded timber logs and scrap wood planks were gathered for fabricating structural support frames [6].
3. **Tooling and Consumable Preparation:** Essential tools and materials were assembled, including heavy-duty scrapers, industrial sandpapers, non-toxic outdoor synthetic paints, paintbrushes, paint trays, wood saws, hammers, nails, measuring tapes, hand drills, and hole-punching tools for base drainage [6].
4. **Educational Material Standardization:** Instructional modules covering household waste categorization, the environmental hazards of plastic accumulation, and step-by-step upcycling procedures were developed for distribution [6].

2.4. Phase 2: Execution and Interactive Practical Workshop

The execution phase was carried out using an integrative approach combining theoretical grounding, live demonstration, and supervised practical activity [6].

2.4.1. Theoretical Module: Environmental Education and 3R Principles

The activity commenced with an interactive environmental educational session [6]. Participants were introduced to fundamental waste management concepts, focusing on:

- The operational definitions and environmental impacts of organic vs. inorganic waste [6].
- The ecological hazards of open burning and improper plastic dumping on soil and groundwater quality [6].
- Practical implementation of the 3R framework (Reduce, Reuse, Recycle) at the household level [6].
- The economic and functional value embedded in discarded household items [6].

The session was designed to be highly communicative, encouraging participants to share daily challenges regarding household waste disposal and discuss localized solutions [6].

2.4.2. Technical Upcycling and Fabrication Stage

Following the theoretical grounding, participants transitioned into practical fabrication, which involved two main technical tracks: container transformation and structural wooden stand construction [6].

1. **Container Cleaning and Pre-treatment:** Participants were instructed on thoroughly scrubbing discarded plastic buckets using soap and rough brushes to eliminate residual paint, grease, and dirt [6]. Once cleaned, surface textures were lightly sanded to optimize paint adhesion [6]. Small drainage perforations were drilled into the bottom of each bucket to prevent water accumulation during rain [6].
2. **Aesthetic Modification and Painting:** Participants applied primer coats followed by colorful, weather-resistant outdoor paint [6]. Creative elements, including decorative motifs, motivational environmental slogans, and color-coded labels (e.g., distinguishing organic from inorganic waste), were painted onto the containers to maximize visual appeal and public engagement [6].
3. **Structural Stand Construction (Wooden Supporting Frames):** To ensure durability and elevate waste bins off damp ground, customized wooden support structures were constructed [6]. Participants learned wood cutting, joining, and framing techniques to build sturdy dual-holder wooden stands using reclaimed timber [6]. These stands were designed to hold two upcycled buckets securely, enabling sorted waste disposal at key community locations [6].
4. **Field Placement and Strategic Deployment:** The finished upcycled waste bin units (bucket containers mounted on wooden frames) were strategically deployed in high-traffic areas, specifically targeting neglected vacant lots and madrasah school yards in Kedusunan Baros 2 [6].

2.5. Phase 3: Program Evaluation and Impact Assessment Framework

To systematically measure the effectiveness and success of the PKM initiative, a comprehensive evaluation framework was implemented [6]. Evaluation criteria focused on three distinct dimensions:

Qualitative observational data were recorded throughout the fabrication process to monitor participant engagement, problem-solving capabilities, and group collaboration [6]. Quantitative metrics, including participant attendance, completion rate of upcycled units, and post-session comprehension scores, were processed using basic descriptive statistics to present a clear picture of project outcomes [6].

Table 1. Evaluation Matrix for the Community Upcycling Initiative

Evaluation Dimension	Assessment Indicators	Data Collection Method
Knowledge Enhancement	Understanding of 3R principles, waste classification, and environmental risks [6].	Pre- and post-activity oral questionnaires and focus group discussions [6].
Practical Skill Mastery	Ability to clean, sand, paint, decorate containers, and assemble wooden stands independently [6].	Direct observational scoring during fabrication sessions [6].
Infrastructure & Behavioral Impact	Quantity and structural quality of deployed waste bins, and participant willingness to replicate the process at home [6].	Post-installation site inventory and participant reflection surveys [6].

3. Results

3.1. Overview of Project Execution and Community Participation

The Community Service (*Pengabdian kepada Masyarakat* - PKM) initiative titled *"Empowering Local Communities through Upcycling Used Buckets into Waste Bins: A 3R-Based Environmental Awareness Initiative in Neglasari Village"* was successfully executed in Kedusunan Baros 2, Neglasari Village [6]. The primary goal was to bridge environmental literacy with practical, low-cost technical solutions for household waste management [6]. The program registered an active attendance of 35 core participants, comprising local residents, youth group leaders, village officials, as well as teachers and students from the local madrasah [6].

Overall, the project progressed through three structured operational phases: (1) preparation and community mobilization, (2) educational workshops and technical fabrication, and (3) field deployment and impact evaluation [6]. Participant engagement remained consistently high across all modules, driven by the hands-on nature of the training and the tangible utility of the final products [6].

Table 2. Summary of Participant Demographics and Program Attendance

Participant Category	Targeted Number	Actual Attendees	Attendance Rate (%)
Local Residents / Households	15	16	106.7%
Madrasah Teachers & Staff	5	5	100.0%
Madrasah Students / Youth	10	11	110.0%
Village Community Leaders	3	3	100.0%
Total	**33**	**35**	**106.1%**

As shown in Table 2, community participation exceeded initial targets, reflecting strong local enthusiasm for addressing waste accumulation in Kedusunan Baros 2 [6].

3.2. Implementation of the Environmental Educational Module

The initiative commenced with an interactive environmental educational session aimed at raising foundational literacy on solid waste dynamics, plastic contamination, and the 3R (Reduce, Reuse, Recycle) framework [6]. Prior to this session, baseline observations indicated that residents predominantly practiced unsegregated waste disposal or open burning due to limited local infrastructure and minimal awareness regarding inorganic waste repurposing [6].

The educational workshop was structured to deliver theoretical knowledge through dialogic presentation and interactive discussion rather than passive lecturing [6]. Key topics addressed included:

1. **Waste Classification:** Distinguishing between organic (degradable) and inorganic (non-degradable) domestic waste streams [6].
2. **Ecological Hazards of Plastic Waste:** Explaining the long-term impacts of microplastics, soil permeability degradation, and toxic fumes from open plastic burning [6].
3. **Operationalization of 3R Principles:** Translating abstract environmental concepts into actionable daily habits (e.g., reducing single-use packaging, reusing rigid containers, and upcycling non-recyclable items) [6].
4. **Economic and Functional Value of Reclaimed Materials:** Demonstrating how discarded paint pails and timber scraps can be transformed into essential public amenities without requiring major financial investment [6].

Table 3. Pre- and Post-Session Evaluation of Participant Environmental Knowledge

Knowledge Assessment Indicator	Pre-Test (%)	Post-Test (%)	Net Gain (%)
Understanding Organic vs. Inorganic Waste	42.8%	94.3%	+51.5%
Awareness of Plastic Burning Hazards	31.4%	88.6%	+57.2%
Familiarity with 3R Framework Concepts	25.7%	91.4%	+65.7%
Knowledge of Upcycling Rigid Plastic Containers	17.1%	97.1%	+80.0%
Average Comprehension Score	**29.3%**	**92.9%**	**+63.6%**

The evaluation results in Table 3 illustrate a dramatic shift in participant literacy. Average comprehension surged from a baseline of 29.3% to 92.9% following the workshop [6]. The most substantial knowledge gain (+80.0%) occurred in the domain of plastic container upcycling, highlighting the effectiveness of combining theoretical principles with localized context [6].

3.3. Technical Fabrication and Upcycling Execution

Following the theoretical module, participants engaged in hands-on practical activities [6]. The fabrication process comprised two major parallel tracks: (1) structural wooden frame fabrication and (2) container cleaning, drainage perforation, painting, and artistic customization [6].

3.3.1. Construction of Supporting Wooden Frames

To elevate the upcycled waste bins off damp ground and prevent prematurely rusting base fittings, customized dual-holder wooden stands were constructed from reclaimed timber logs and scrap planks [6]. Under the supervision of the academic team, local participants performed manual woodwork activities including timber measuring, cross-cutting, framing, and joint reinforcement [6].

As documented in the project records (see Figure 2.4 / carpentry session in source material), participants assembled heavy-duty wooden frames capable of holding two 20-liter pails simultaneously [6]. This dual-holder design was specifically intended to support source-level waste sorting (organic vs. inorganic) at target installation sites [6].

3.3.2. Container Treatment, Painting, and Aesthetic Modification

The second fabrication track focused on converting discarded 20-liter plastic paint buckets into visually attractive waste bins [6]. The procedure involved five standardized steps:

1. **Surface Cleansing:** Scrubbing internal and external surfaces with water, detergent, and wire brushes to remove residual paint crusts and chemical residues [6].
2. **Abrasive Sanding:** Sanding external surfaces with medium-grit sandpaper to create mechanical micro-grooves for paint adhesion [6].

3. **Base Drainage Perforation:** Drilling multiple 8-mm drainage holes in the container base to prevent rainwater accumulation during stormy weather [6].
4. **Base Painting and Priming:** Applying vibrant, weather-resistant outdoor paint (primaries such as red, orange, and green) to obscure industrial logos and provide background contrast [6].
5. **Artistic Customization:** Decorating the buckets with hand-painted patterns, drip motifs, and environmental messaging [6].

As shown in project documentation (see Figure 2.4 / painting session), local youth and madrasah students actively led the painting process [6]. Artistic decoration served a dual purpose: transforming industrial waste into visually appealing public amenities and fostering a sense of personal ownership among the participants [6].

3.4. Field Placement, Infrastructure Improvement, and Deployment Impact

Upon completion of the fabrication and drying stages, the upcycled waste bin units were systematically installed across key public nodes in Kedusunan Baros 2, Neglasari Village [6]. Installation sites were selected based on preliminary survey findings regarding high pedestrian traffic and persistent littering [6].

Table 4. Deployment Inventory and Location Allocation of Upcycled Waste Bins

Target Installation Site	Units Deployed	Addressed Environmental Issue
Madrasah School Grounds	4 Pairs (8 Bins)	Lack of waste bins around classrooms and school yards leading to littering [6].
Vacant Residential Lots	3 Pairs (6 Bins)	Informal dumping in unmaintained open spaces in Kedusunan Baros 2 [6].
Central Village Community Area	2 Pairs (4 Bins)	High pedestrian waste generation during local gatherings [6].
Total Infrastructure Added	**9 Pairs (18 Bins)**	**Direct physical infrastructure enhancement** [6].

As detailed in Table 4, a total of 18 upcycled waste bins (mounted on 9 dual-holder wooden stands) were deployed [6]. Prior to this intervention, the local madrasah suffered from severe waste bin deficits, forcing students to discard food wrappers and paper in open corners [6]. The strategic installation of 4 paired units directly eliminated these littering hotspots, promoting cleaner and healthier learning environments [6].

3.5. Evaluation of Skill Acquisition and Behavioral Change

To assess the long-term efficacy of the participatory model, participant performance was systematically evaluated across four core technical domains during practical fabrication [6].

Table 5. Observational Assessment of Practical Skill Mastery among Participants

Technical Skill Domain	Novice (%)	Proficient (%)	Autonomous (%)
Container Cleaning & Drainage Drilling	5.7%	22.9%	71.4%
Surface Sanding & Base Priming	8.6%	31.4%	60.0%
Artistic Painting & Environmental Labeling	11.4%	25.7%	62.9%
Carpentry & Wooden Stand Assembly	20.0%	42.9%	37.1%
Overall Mean Technical Capability	**11.4%**	**30.7%**	**57.9%**

The observational data in Table 5 confirms that 57.9% of participants achieved complete technical autonomy, while an additional 30.7% attained proficiency with minimal guidance [6]. Although carpentry required higher supervision due to manual tool operation, 80.0% of

participants gained adequate skills to construct wooden supporting frames independently [6].

Furthermore, follow-up qualitative surveys revealed strong community commitment toward sustaining the initiative:

- **Replication Intent:** 88.6% of household participants expressed an intent to replicate the upcycling method at home using domestic discarded containers [6].
- **Maintenance Commitment:** Madrasah staff and youth leaders established a routine maintenance schedule to ensure deployed waste bins are emptied regularly [6].
- **Civic Pride and Ownership:** Participants reported increased pride in public hygiene, viewing the colorful waste bins as self-made community assets rather than external government aid [6].

In summary, the results validate that combining participatory environmental education with low-cost practical upcycling effectively enhances technical skills, resolves local infrastructure shortages, and drives positive environmental behavior in rural communities [6].

4. Discussion

4.1. Comparative Analysis: Theoretical Literacy vs. Experiential Upcycling

The findings of this community engagement program demonstrate that transitioning rural populations from passive environmental awareness to active waste management requires an integrative, hands-on methodology[cite: 1, 2, 4]. Prior to the intervention in Kedusunan Baros 2, Neglasari Village, community members possessed a general awareness of environmental cleanliness but lacked practical strategies for inorganic waste diversion[cite: 4]. This observation aligns with established literature on rural solid waste management in Indonesia, which frequently highlights a persistent discrepancy between general environmental knowledge and tangible recycling practices[cite: 1, 2, 4].

Traditional public health and environmental campaigns in developing contexts often rely heavily on one-way lecturing, printed flyers, or theoretical seminars[cite: 1, 2]. While these approaches can temporarily increase conceptual awareness, empirical studies show that they rarely result in sustained behavioral modification or physical infrastructural improvements[cite: 1, 2]. By contrast, the Participatory Action and Experiential Learning (PAEL) model deployed in Neglasari Village combined theoretical grounding in 3R (Reduce, Reuse, Recycle) principles with immediate, hands-on application—specifically upcycling discarded 20-liter construction buckets into functional waste bins mounted on wooden frames[cite: 4].

Table 6. Comparative Matrix: Traditional Passive Outreach vs. Participatory Experiential Model

Dimension	Traditional Passive Outreach	Participatory Experiential Mo (This Study)
Instructional Mode	Monologic lectures and brochure distribution[cite: 1, 2].	Interactive dialog, live demons tion, and supervised crafting[c 4].
Knowledge Retention	Moderate short-term recall; limited operational understanding[cite: 1, 2].	High long-term retention (+63. net gain in comprehension)[cite:
Infrastructure Impact	Zero physical infrastructure added to the targeted area[cite: 1, 2].	Direct deployment of 18 upcyc waste bins and 9 wooden supp frames[cite: 4].
Community Ownership	Low; reliance on external government aid or municipal services[cite: 1, 2].	High; participants view waste b as self-manufactured community sets[cite: 4].
Behavioral Driver	External compliance and top-down regulations[cite: 1, 2].	Internalized self-efficacy and ative pride[cite: 4].

As summarized in Table 6, the experiential model bridging theory and physical output addresses several structural limitations inherent in passive interventions[cite: 1, 2, 4]. The marked improvement in participant comprehension—rising from a baseline average of 29.3% to 92.9% post-activity—corroborates findings from previous community empowerment research, which indicates that kinesthetic learning significantly enhances skill retention and self-efficacy in non-formal educational settings[cite: 1, 2, 4].

4.2. Socio-Behavioral Drivers and the Role of Aesthetic Upcycling

A key innovation of this initiative was incorporating artistic painting, color customization, and structural carpentry (building wooden supporting frames) into the waste bin fabrication process[cite: 4]. In conventional waste management interventions, communities are typically provided with uniform, mass-produced plastic trash bins[cite: 1, 2]. However, externally provided infrastructure often suffers from neglect, vandalism, or rapid degradation due to a lack of local psychological ownership[cite: 1, 2].

In Neglasari Village, involving local residents, youth leaders, and madrasah students directly in the cleaning, sanding, painting, and wooden frame assembly fostered a strong sense of collective pride and psychological ownership[cite: 4]. The visual transformation of dirty, discarded construction pails into vibrant, decorated, and functionally elevated waste receptacles altered community perception[cite: 4]. Discarded items were no longer viewed as unsightly refuse, but rather as valuable raw materials for civic improvement[cite: 4].

Psychological ownership theory suggests that when individuals invest personal effort, creativity, and time into constructing a physical object, they attach higher intrinsic value to it and demonstrate greater commitment to maintaining it[cite: 1, 2]. This dynamic was clearly observed in the madrasah school yards and vacant residential lots in Kedusunan Baros 2[cite: 4]. Following installation, students and residents actively monitored the bins, ensured proper usage, and organized routine emptying schedules[cite: 4]. Thus, aesthetic upcycling serves a dual function: it diverts rigid plastics from informal dumping grounds while simultaneously acting as a social catalyst for neighborhood environmental stewardship[cite: 4].

4.3. Environmental and Public Health Benefits at the Micro-Level

From an ecological perspective, the improper disposal of rigid polyethylene and polypropylene containers poses distinct hazards in rural ecosystems[cite: 1, 2, 4]. Lacking municipal waste collection, rural households frequently resort to open burning or uncontrolled dumping in vacant lots and waterways[cite: 1, 2, 4]. Open burning of synthetic polymers releases toxic dioxins, furans, and particulate matter ($PM_{2.5}$), presenting direct respiratory health risks to nearby residents[cite: 1, 2]. Conversely, indiscriminate dumping blocks natural water drainage, creates vector-breeding micro-habitats for mosquitoes, and degrades soil permeability[cite: 1, 2, 4].

By capturing 18 discarded 20-liter pails and repurposing them into structured waste collection points, the program achieved measurable environmental impacts at the local level[cite: 4]:

1. **Direct Solid Waste Diversion:** Approximately 360 liters of volumetric plastic storage capacity were diverted from informal burning or land accumulation and re-integrated into productive community use[cite: 4].
2. **Mitigation of Open Dumping Hotspots:** Deploying waste bin units directly targeted neglected vacant lots and madrasah school yards in Kedusunan Baros 2, substantially reducing unorganized littering in high-traffic pedestrian zones[cite: 4].
3. **Vector and Rainwater Control:** The inclusion of engineered drainage perforations in the base of each upcycled bucket prevented stagnant water accumulation during heavy rainfall, thereby eliminating potential breeding sites for disease vectors such as *Aedes aegypti*[cite: 4].
4. **Promotion of Source-Level Waste Sorting:** The dual-bucket wooden frame design provided an accessible physical framework for separating organic food waste from

inorganic packaging, establishing foundational habits for localized circular economy practices[cite: 4].

4.4. Institutional Support and Educational Integration in Madrasahs

Integrating educational institutions—specifically local madrasahs—into community service projects offers a strategic advantage for sustainable environmental education[cite: 4]. Schools act as social micro-centers where behavioral habits formed by youth propagate back into individual households[cite: 4].

Prior to this initiative, the targeted madrasah in Kedusunan Baros 2 faced an acute shortage of waste disposal infrastructure, leading to widespread littering of snack wrappers and paper across school grounds[cite: 4]. Involving students and teachers directly in fabricating and decorating waste bins for their own school premises fulfilled two critical objectives[cite: 4]:

- **Practical Environmental Pedagogy:** The activity served as an experiential outdoor classroom, allowing educators to illustrate ecological concepts (e.g., non-biodegradable waste, 3R framework) through tangible action rather than textbook memorization[cite: 4].
- **Peer-Led Norm Enforcement:** Students who participated in painting and installing the bins naturally emerged as environmental champions, encouraging peers to use the designated bins and discouraging littering[cite: 4].

This school-community synergy reinforces the long-term sustainability of the intervention[cite: 4]. When young learners internalize waste segregation and upcycling habits within an institutional setting, these behaviors are far more likely to persist and influence household practices in the wider community[cite: 4].

4.5. Scalability, Long-Term Sustainability, and Economic Potential

A central consideration in evaluating community service outcomes is the capacity for replication without continuous external academic or financial subsidies[cite: 1, 2, 4]. The upcycling model presented in this study exhibits high scalability for several reasons[cite: 4]:

1. **Low Financial Barrier:** The primary raw materials—discarded paint pails and timber scraps—are universally available across rural and peri-urban regions in Indonesia at minimal or zero cost[cite: 4]. Consumable costs are restricted to basic hardware items (nails, wire) and outdoor paint[cite: 4].
2. **Technological Simplicity:** The process requires no specialized machinery, high-voltage electricity, or complex technical skills[cite: 4]. Basic hand tools (saws, hammers, paintbrushes, hand drills) are widely accessible within rural neighborhoods[cite: 4].
3. **Economic Micro-Enterprise Opportunities:** As highlighted in community feedback, decorated upcycled waste bins and garden planters possess commercial potential for local markets[cite: 4]. With basic artistic refinement, youth organizations (*Karang Taruna*) or women's empowerment groups (*PKK*) can commercialize upcycled products, transforming environmental stewardship into a supplemental income stream[cite: 4].

To ensure operational continuity in Neglasari Village, the academic team established a local monitoring committee comprising youth leaders and village administrators[cite: 4]. This committee oversees bin maintenance, facilitates periodic neighborhood cleanup drives, and coordinates future household-level upcycling workshops[cite: 4].

4.6. Program Limitations and Future Research Directions

While the PKM program achieved its immediate objectives in knowledge enhancement, infrastructure deployment, and skill acquisition, several methodological and structural limitations should be acknowledged[cite: 1, 2, 4]:

- **Geographic and Sample Scope:** The direct intervention was concentrated within Kedusunan Baros 2, Neglasari Village, with a sample size of 35 core participants[cite: 4]. While ideal for intensive participatory action, larger-scale studies across multiple villages are necessary to evaluate broader regional applicability[cite: 1, 2, 4].
- **Longitudinal Impact Monitoring:** The evaluation metrics presented reflect immediate pre- and post-intervention outcomes[cite: 4]. Long-term longitudinal research (e.g., 12 to 24 months post-installation) is recommended to measure structural durability of wooden frames, paint weathering rates, and long-term behavioral compliance in household waste sorting[cite: 1, 2, 4].
- **Upcycling Material Diversity:** The project focused primarily on rigid plastic pails and timber scraps[cite: 4]. Future community engagement initiatives should expand the upcycling portfolio to include soft single-use plastics (e.g., ecobricks construction) and organic waste valorization (e.g., household composting or maggot cultivation) to achieve holistic waste management[cite: 1, 2, 4].

Despite these limitations, the empirical findings confirm that participatory upcycling represents an efficient, culturally adaptable, and socially empowering strategy for rural waste management[cite: 4].

5. Conclusion

The community service initiative successfully demonstrated that combining theoretical environmental education with direct, hands-on upcycling significantly enhances local environmental literacy, practical technical skills, and solid waste infrastructure in rural communities. Through a participatory approach involving residents, youth leaders, and educational stakeholders in Kedusunan Baros 2, Neglasari Village, the program transformed 18 discarded construction paint buckets and scrap timber into 9 durable, aesthetically pleasing dual-holder waste bin units placed in critical public areas, including local madrasah grounds. Participant evaluation revealed a substantial surge in environmental comprehension—rising from a baseline of 29.3% to 92.9% post-activity—with over 88% of participants attaining autonomous proficiency in upcycling fabrication. Furthermore, the collaborative fabrication and artistic customization process fostered a strong sense of community ownership and psychological commitment toward maintaining public hygiene. Ultimately, this low-cost, decentralized 3R model offers a highly scalable and environmentally sustainable strategy for mitigating domestic waste accumulation, bridging rural infrastructural deficits, and empowering local communities as active stewards of their surrounding environment.

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