

Optimization of Inorganic Waste Recycling into Plant Pots Using the 4R Approach to Support the Adiwiyata Unggulan School Program

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Keywords:

Ecobrick

4R principle

Adiwiyata Unggulan

Received: October 2025

Accepted: November 2025

Published: February 2026

Abstract

Inorganic waste, particularly plastic generated from school canteens and learning activities, remains a significant environmental challenge due to its non-biodegradability, which contributes to soil, water, and air pollution. Addressing this issue, this community service program aimed to enhance students' environmental awareness and practical skills in managing plastic waste by producing ecobricks, which were repurposed as eco-friendly plant pots to improve the school's aesthetic and ecological quality. Mercu Buana University implemented the program in collaboration with the Rawakalong Village Government to support SMKN 1 Gunung Sindur in achieving Exemplary Adiwiyata School status. The initiative combined participatory training sessions, hands-on Fs, and continuous mentoring, emphasizing the application of the 4R principles in the school environment. The results indicated a marked increase in students' engagement, knowledge, and skills in waste management, along with a measurable reduction in plastic waste volume. Ecobricks were successfully integrated into school greening activities, serving as both functional plant pots and tangible educational tools that reinforced sustainable behaviors. The program also contributed to the fulfillment of Key Performance Indicators (KPI) 3 and 7 and promoted experiential, community-based learning aligned with the Merdeka Belajar–Kampus Merdeka initiative. This study demonstrates that ecobrick-based interventions can transform environmental challenges into educational opportunities, fostering sustainable practices and participatory learning among students. Moreover, the program highlights the potential to scale ecobrick initiatives across broader school and community contexts, supporting environmental stewardship and institutional commitment to sustainability. These findings provide practical and theoretical insights into integrating hands-on waste management strategies into school-based ecological education programs.



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PENDAHULUAN

The issue of inorganic waste, particularly plastic, remains a critical challenge at both global and national levels. Plastic is difficult to decompose naturally, leading to potential soil, water, and air pollution. In schools, single-use plastics from canteens and learning activities are a primary source of waste, which may reduce the quality of the school ecosystem as a healthy learning environment (Rahayu *et al.*, 2024; Wahyuni & Hapsari, 2021).

An innovative approach to address this problem is the utilization of plastic waste to produce ecobricks. Used plastic bottles are filled with inorganic waste until compacted, forming blocks that can be reused as plant pots or decorative materials. The

How to cite: Yuliani, E, S, Y., Hermadewita., Hermiyeti., Ur'Rahmi, U. (2026). Optimization of Inorganic Waste Recycling into Plant Pots Using the 4R Approach to Support the Adiwiyata Unggulan School Program. *PengabdianMu: Jurnal Ilmiah Pengabdian kepada Masyarakat*, 11(2), 675-682 . <https://doi.org/10.33084/pengabdianmu.v11i2.11082>

use of ecobricks not only reduces waste volume but also contributes to a greener, more aesthetically pleasing, and comfortable school environment. This activity actively engages students, fostering environmental awareness, cleanliness habits, and practical skills aligned with experiential learning principles (Salamah *et al.*, 2024; Akbar *et al.*, 2023; Ardiansari *et al.*, 2024; Nursanti *et al.*, 2024).

The application of ecobricks follows the 4R principles (Reduce, Reuse, Recycle, and Rework), encouraging reduced plastic consumption, material reuse, recycling, and the creation of environmentally friendly innovations. These principles support the vision of the Adiwiyata School program, which emphasizes building an environmentally conscious school culture through curriculum integration, student participation, and sustainable environmental management (Wardani & Khotimah, 2021; Manurung *et al.*, 2025). The success of this program requires multi-stakeholder collaboration. Through the Domestic Collaboration Community Service Program (PkM-KDN), Mercu Buana University, in partnership with the Rawakalong Village Government, assists SMKN 1 Gunung Sindur in training students to produce ecobricks and guiding the school toward achieving the Adiwiyata Excellent School designation (Salamah *et al.*, 2024). This initiative enhances student and community participation, creates a greener and more aesthetically pleasing school environment, and provides sustainable educational experiences.

This activity is also aligned with the Higher Education Main Performance Indicators (IKU) and the Merdeka Belajar Kampus Merdeka (MBKM) program. Mercu Buana University's students and lecturers engage in off-campus activities (IKU 3) and strengthen collaboration with external partners (IKU 7), providing contextual learning opportunities while delivering tangible benefits to the school environment (Rahayu *et al.*, 2024; Wahyuni & Hapsari, 2021). Although ecobricks have been widely applied at the elementary and junior high school levels, research at the vocational high school (SMK) level remains limited. SMKN 1 Gunung Sindur, with its more practice-oriented students, represents a strategic site for implementing this program. The multi-sector approach through PkM-KDN facilitates the development of sustainable waste management practices and supports the school's preparation to achieve the Adiwiyata Excellent School recognition (Salamah *et al.*, 2024).

METODE

Implementation Method

This Community Service Program (PkM) was conducted using a participatory approach, combining socialization/education, workshops/projects, and continuous mentoring activities. The method aimed to enhance the awareness, knowledge, and skills of the Adiwiyata Team—comprising students and teachers—in managing inorganic waste into ecobricks as eco-friendly plant pots. The program was implemented at SMKN 1 Gunung Sindur in collaboration with the PkM Team from Mercu Buana University (UMB) and the Rawakalong Village Government as strategic partners under the Domestic Cooperation (KDN) scheme.

The participants included:

- Adiwiyata School Team: 20 students and 4 teachers
- School Representatives: Principal and Vice Principal
- Village Government: Representatives from the Rawakalong Village Office

The implementation process followed systematic stages, including preliminary assessment, training material design, material procurement, practical workshops, monitoring and evaluation, and sustainability planning. This structured approach ensured that the program not only focused on knowledge transfer but also strengthened institutional support and cross-sector collaboration with the village government to ensure program sustainability.

Implementation Stages

1. Preliminary Assessment

A location survey and needs analysis were conducted to evaluate the sources and volume of inorganic waste, particularly plastic, generated from school activities. Interviews with school authorities and the Rawakalong Village

Government were carried out to identify collaboration opportunities and community support for the ecobrick program implementation.

2. Training Material Design

The training modules covered the 4R concept (Reduce, Reuse, Recycle, and Rework), safe and efficient ecobrick production techniques, and the use of ecobricks as plant pots to support the school's greening initiatives. The materials were designed in line with the objectives of the Adiwiyata Unggulan Program to ensure practical application within the school environment.

3. Procurement of Materials and Tools

The main materials—used plastic bottles and solid inorganic waste—were collected by the Adiwiyata Team from the school area, especially from the canteen and schoolyard. Supporting tools, such as scissors, funnels, and pressing sticks, were provided to facilitate ecobrick production according to established safety and quality standards.

4. Training and Practical Implementation

The workshop was conducted on-site at the school. Participants were divided into small groups to ensure active engagement and effective practice. The UMB PkM Team provided technical guidance, covering material preparation, bottle filling, compaction, and arrangement of ecobricks into plant pots. The resulting ecobricks were placed in various school areas as part of environmental greening and aesthetic improvement activities.

5. Monitoring and Evaluation

Evaluation was conducted through direct observation and digital questionnaires to assess participants' understanding and the effectiveness of the training. Indicators included: (1) increased knowledge of inorganic waste management, (2) ecobrick-making skills, (3) active participant engagement, and (4) environmental impact on the school area.

6. Sustainability Plan

To ensure program continuity, the Adiwiyata Team is responsible for regularly producing ecobricks and expanding their application to other school areas. The UMB PkM Team and Rawakalong Village Government provide periodic mentoring to maintain the program and promote it as a best-practice model for other schools in the region. This initiative is expected to cultivate a culture of sustainable inorganic waste management while supporting the school's vision of achieving the Adiwiyata Unggulan designation.

HASIL DAN PEMBAHASAN

Implementation of the Community Service Program

The Community Service Program (PkM) conducted at SMKN 1 Gunung Sindur from March to April 2025 involved the Adiwiyata Team (students and teachers), the Mercu Buana University (UMB) PkM Team, and the Rawakalong Village Government as strategic partners. The program employed a participatory approach that combined educational sessions with practical workshops focused on ecobrick production. Selected documentation of the PkM activities is presented in Figure 1.



Figure 1. Documentation of the Community Service Program Activities.

The results demonstrated a substantial increase in enthusiasm and active engagement among both students and teachers during the workshop. The use of ecobricks as plant pots functioned as an effective contextual learning tool, integrating the 4R principles (Reduce, Reuse, Recycle, and Rework) within the school environment. Beyond reducing plastic waste, ecobrick plant pots enhanced the school's aesthetics and reinforced the practice of sustainable environmental education at SMKN 1 Gunung Sindur.

Outputs of the Community Service Program

The implementation of this community service program is expected to generate several essential outputs, including a poster summarizing the program results, publication in mass media, a YouTube video documenting the activities, copyright registration for the products or materials developed, and the publication of a scientific article. Collectively, these outputs serve as a form of academic responsibility and ensure that the program's outcomes are properly documented and widely disseminated.

To date, four outputs have been successfully achieved, namely:

1. A poster presenting the results of the community service activities, which outlines the implementation process and the program's achievements.
2. A Mass media publication, featured by Metro Bogor on May 6, 2025, covering the PKM activities at SMKN 1 Gunung Sindur (metrobogor.com)
3. A Video documentation of the activities, which has been uploaded to YouTube and is publicly accessible through the following link: <https://www.youtube.com/watch?v=EdNv0St2Gjk>.
4. A Work program report prepared by the team adiwiyata.

The outputs are presented in Figures 2, 3 and 4).



Figure 2. Poster of The Community Service Activities.



Figure 3. Media Coverage and Video Documentation of The Community Service Activities



Figure 4. Work Program Report of the Adiwiyata Team

Evaluation of the Community Service Program

The post-training evaluation conducted through a Google Form questionnaire indicated that participants perceived the program as highly beneficial, with significant improvements in their understanding of inorganic waste management and their skills in ecobrick production. Following the workshop and mentoring sessions, a subsequent evaluation using the same questionnaire further confirmed the high effectiveness of the activities, as presented in Table 1 and Figure 5. These findings were supported by field observations, which revealed positive behavioral changes, including the establishment of an ecobrick corner within the school and the implementation of a more structured waste-sorting system. Overall, the program successfully enhanced students' practical competencies, fostered environmental awareness, and strengthened SMKN 1 Gunung Sindur's position as a model Adiwiyata school.

Table 1. Results of the Community Service Program Evaluation.

No	Indicator	Positive Response (%)
1	The material presented	100
2	The benefits of the material	100
3	Ease of understanding	100
4	Clarity of delivery	100
5	Adequacy of time	93.3

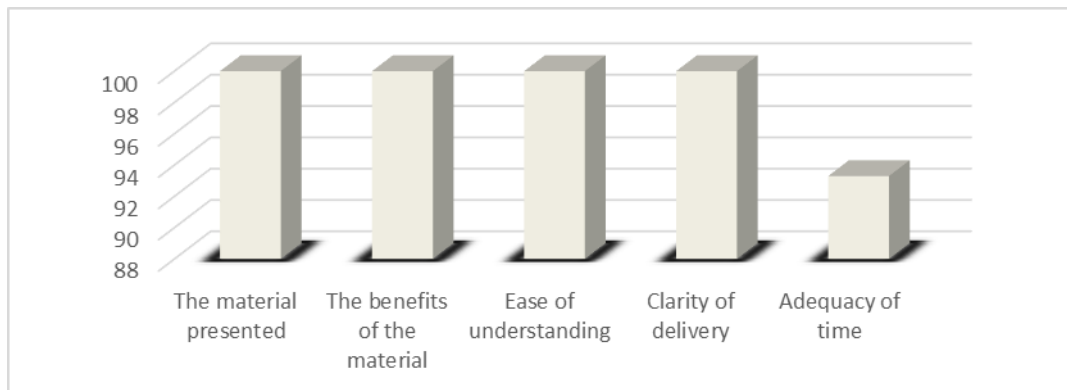


Figure 5. Community Service Program Evaluation Results Chart.

KESIMPULAN

The results of this community service activity indicate that the ecobrick training program effectively enhanced participants' awareness and skills in managing inorganic waste within the school environment. This aligns with the findings of Ardiansari et al. (2024), who emphasized that ecobrick projects in schools function as strategic environmental education tools that motivate students to actively participate in waste reduction. Similarly, Salamah et al. (2024) reported that ecobrick initiatives implemented in both schools and communities offer practical solutions to plastic waste problems while fostering environmental responsibility among participants. The hands-on approach implemented in the program provided students with direct exposure and meaningful learning experiences, contributing to behavioral changes in their daily waste management practices.

The use of ecobricks as plant pots also represents an innovative application of the 4R principles—Reduce, Reuse, Recycle, and Rework—within school-based sustainability programs. Consistent with Akbar et al. (2023), converting plastic waste into functional plant containers or garden decorations transforms environmental challenges into valuable educational resources while improving school aesthetics. Through this initiative, inorganic waste—particularly used plastic bottles—was successfully repurposed into ecobricks, thereby reducing the volume of plastic waste generated, especially from the school cafeteria.

The positive response from students—as reflected by consistently high agreement scores across all questionnaire indicators—reinforces the findings of Wardani & Khotimah (2021), who noted that ecobrick projects can empower students and increase environmental awareness through creative and participatory learning. The collaboration among the school, Mercu Buana University, and the Rawakalong Village Government illustrates a quadruple helix model that supports the objectives of the Adiwiyata Program and strengthens the sustainability of environmental initiatives in educational settings. From a theoretical perspective, the success of this activity reflects the principles of experiential learning theory, in which knowledge is constructed through reflection on practice. The integration of education, hands-on training, and mentoring facilitated the development of both cognitive and affective aspects of environmental awareness. Moreover, the installation and application of ecobricks within the school environment demonstrate the emergence of a new culture of sustainability,

consistent with the observations of Manurung et al. (2025), Nursanti et al. (2024), and , Salamah et al. (2024), who reported behavioral transformation among students following school-based environmental programs.

Overall, this program provides empirical evidence that ecobrick-based training is not only an effective solution for managing inorganic waste but also a transformational educational tool that instills sustainability values within the school community. The outcomes suggest that similar approaches could be adopted by other educational institutions seeking Adiwiyata recognition or aiming to strengthen their environmental education initiatives.

Recommendations for Program Sustainability

To ensure that the benefits of this community service program continue to support the school and its stakeholders in the long term, the following recommendations are proposed:

1. Establishment of a Permanent Ecobrick Team

The school is encouraged to form a permanent ecobrick team consisting of Adiwiyata students, supervising teachers, and school staff. This team would be responsible for the routine production of ecobricks and the continuous management of the ecobrick corner as part of the school's environmental culture.

2. Integration of the Program into the Curriculum

Waste management and ecobrick-making activities should be integrated into subjects such as Craft, Science, or the Pancasila Student Profile Strengthening Project (P5). Formal integration will ensure systematic, structured, and sustainable implementation within the learning process.

3. Development of Ecobrick-Based Products

Ecobricks can be further developed into products such as garden benches, small tables, or decorative school elements. These innovations not only enhance school aesthetics but also strengthen the educational impact of the program.

4. Strengthening Collaboration with External Partners

Collaboration with Mercu Buana University and the Rawakalong Village Government should be strengthened through periodic mentoring, advanced training sessions, and cross-school initiatives. These collaborations could position SMKN 1 Gunung Sindur as a regional ecobrick education center.

5. Implementation of Continuous Environmental Campaigns

The school is encouraged to regularly conduct 4R campaigns, ecobrick competitions, and environmental clean-up activities to sustain student enthusiasm and reinforce environmentally responsible behavior.

Limitations of the Activity

Despite the positive outcomes achieved through this community service program, several limitations should be acknowledged to provide a comprehensive and balanced understanding of its implementation. These limitations reflect constraints related to time, participant involvement, and monitoring mechanisms, all of which may have influenced the scope and long-term effectiveness of the program. Recognizing these shortcomings is essential for improving the design and sustainability of similar initiatives in the future

. The ecobrick training program carried out at SMKN 1 Gunung Sindur effectively addressed challenges related to inorganic waste management within the school environment. By transforming plastic waste into functional ecobricks used as plant pots, the program successfully increased environmental awareness and encouraged students' active engagement in sustainable practices. These results align with the goals of the Adiwiyata Program and demonstrate that participatory learning approaches can generate meaningful behavioral change among students. Theoretically, the findings highlight the relevance of experiential learning and environmental pedagogy in community-based educational settings, underscoring the importance of hands-on experience in promoting sustainability.

From a community service perspective, the collaboration between Mercu Buana University, the Adiwiyata Team, and the Rawakalong Village Government exemplifies the effectiveness of the quadruple helix model in nurturing eco-innovation within educational institutions. This partnership produced tangible social impacts, including increased environmental responsibility, improved school aesthetics, and strengthened institutional commitment to sustainability.

For future initiatives, expanding the ecobrick program to include community-level involvement is recommended to build broader waste management networks. Further research should explore the long-term effects of ecobrick education on students' environmental behavior and examine the potential integration of ecobrick activities into formal sustainability curricula across various educational levels.

UCAPAN TERIMA KASIH

The authors sincerely express their gratitude to the Rector of Mercu Buana University and the Institute for Research and Community Service (LPPM) for providing financial support for this community service program. Special appreciation is extended to the Government of Rawa Kalong Village for their valuable collaboration as a community partner. The authors also gratefully acknowledge the Headmaster, teachers, and the Adiwiyata Team of SMKN 1 Gunung Sindur for their active participation and continuous support throughout the program's implementation.

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