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Turning Waste into Wealth: Empowering Rural Communities through TPS3R and Circular Economy Innovation in Collaboration with Kopernik in Bali

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ABSTRACT

The issue of household organic waste in rural areas remains a significant environmental and socioeconomic challenge, particularly in Gulingan Village, Mengwi District, Badung Regency. The high volume of organic waste, low awareness of waste separation, and the untapped economic potential of processed waste form the background of this initiative. This community service program was carried out in collaboration with the NGO Kopernik as a strategic partner through technical training, environmental education, and institutional strengthening based on the circular economy. The implementation methods included public outreach, participatory mapping, training in making compost and eco-enzymes, household mentoring, as well as pre-test and post-test evaluations to assess participants' improved understanding. The results showed a significant increase in participants' awareness and skills. Based on the evaluation, understanding of waste separation rose from 52% to 82%, while active participation in processing practices increased from 44% to 72%. This activity demonstrates that practice-based and collaborative approaches can strengthen community capacity in realizing a sustainable and environmentally resilient village.

Keywords: Circular Economy, Community Empowerment, Organic Waste Management, Rural Sustainability, TPS3R.

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INTRODUCTION

Household organic waste is the largest contributor to overall waste generation in the Badung Regency, Bali. According to data from the National Waste Management

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Information System (SIPSN, 2024), approximately 60–65% of the total waste produced consists of organic waste, most of which remains poorly processed. Communities typically still mix organic and inorganic waste, causing the volume of waste entering landfills (TPA) to continue to increase. This results in significant environmental burdens, including air pollution from decomposition processes and declining groundwater quality in densely populated residential areas.

This situation is clearly evident in Gulingan Village, Mengwi District, and Badung Regency. The TPS3R facility, which functions as a center for waste processing and community learning, currently operates merely as a temporary storage site. Low awareness of waste separation, limited infrastructure, and weak institutional support are the main obstacles. However, if managed using a circular economy approach, organic waste can be processed into compost, eco-enzymes, or livestock feed of economic value (Suasih et al., 2024; Li et al., 2023). Various studies have shown that community-based waste management can reduce waste volume by up to 30% while simultaneously strengthening household economic resilience (Helpiastuti et al., 2024; Donacho et al., 2023).

This issue is not merely local in nature but also part of a global challenge in achieving Sustainable Development Goals (SDGs), particularly Goal 11 (Sustainable Cities and Communities) and Goal 12 (Responsible Consumption and Production). In this context, community-based organic waste management initiatives have become essential as environmental mitigation strategies align with low-carbon development principles (Nanda & Berruti, 2021; Paritosh et al., 2023). Moreover, recent studies indicate that the application of circular economy principles at the household level not only reduces waste but also creates microeconomic opportunities through the utilization of organic by-products such as liquid fertilizer, compost, and natural cleaners made from eco-enzymes (Morseletto, 2020; Kirchherr et al., 2022).

In the context of Bali, the role of traditional communities and local institutions such as BUMDes and youth organizations (karang taruna) is crucial in driving behavior changes in waste management (Suasih et al., 2024). A collaborative approach involving academics, village governments, and partner institutions such as the NGO Kopernik has become a strategic step in strengthening community capacity. Kopernik is known for its extensive experience in implementing appropriate technology and social innovations in the environmental sector, making this collaboration well positioned to promote a simple, economical, and sustainable organic waste management model.

Therefore, this community engagement program focused on optimizing organic waste management through community empowerment and strengthening the function of TPS3R. Through a practice-based and participatory approach, this initiative aims to increase community awareness, build technical capacity in organic waste processing, and encourage the development of a circular economic model capable of strengthening village economic independence. By integrating the environmental, social, and economic dimensions, this program is expected to serve as a practical example of sustainable rural living in Bali, emphasizing local innovation and community empowerment.

METHODS

This community service program was conducted in Gulingan Village, Mengwi District, Badung Regency, Bali Province, over a period of two months, from October to November 2025. The village was selected because it faces serious challenges in managing household organic waste and because the role of the TPS3R (Reduce, Reuse, Recycle Waste Processing Facility) has not optimally functioned as a center for education and processing practices. The programme was implemented by a team from the Faculty of Economics and Business, Udayana University, in collaboration with the NGO Kopernik, known for its appropriate technology initiatives and social innovation in the environmental sector.

The methods used in this program are participatory and pratical. This approach is grounded in the principles of community empowerment, in which community members are not only beneficiaries but also active participants at every stage of the program (Arefi et al., 2021; Ingkadijaya & Bilqis, 2020). The activities began with public outreach and participatory mapping aimed at aligning the perspectives of village stakeholders, including village officials, BUMDes, TPS3R managers, women's groups (PKK), and youth organizations (karang taruna). Pilot households and community groups were identified as primary training participants.

The next stage consisted of technical training and hands-on mentoring in organic waste processing. The materials covered included composting, eco-enzyme production, and the conversion of organic residues into livestock feed. The training was conducted using a learning-by-doing method, which has proven effective in increasing the participants' retention of knowledge and skills (Putra et al., 2025). Key resources from Kopernik delivered materials on circular economy principles and simple technologies for organic waste processing. Meanwhile, the community service team from FEB Udayana focused on entrepreneurship, product packaging, and the marketing of organic waste–derived products.

During the training, the participants were divided into small groups to conduct hands-on practice at the TPS3R facility and selected pilot households. Mentoring was conducted intensively to ensure that the community members properly understood the stages of composting and eco-enzyme fermentation. The activities were also supported by the provision of simple tools such as household composters and organic waste shredding machines, which form part of the program's sustainability strategy.

To strengthen institutional integration, a Village Waste Management Forum was established consisting of representatives from BUMDes, youth organizations, PKK, and traditional leaders. This forum serves as a platform for coordination and joint monitoring to ensure that waste processing activities continue even after the programme ends. Such institutional approaches have been shown to enhance the sustainability of community service activities at the village level (Helpiastuti et al., 2024; Suasih et al., 2024).

Program evaluation was conducted using pre- and post-test methods, with ten simple yes/no questions designed to assess improvements in participants' knowledge and awareness before and after training. In addition, an evaluation using the Kirkpatrick model was conducted, covering three key dimensions: reaction, learning, and behavior (Kirkpatrick & Kirkpatrick, 2016). Pre- and post-test data were analyzed

descriptively to identify knowledge improvements, while qualitative evaluations were analyzed through participatory observations and brief interviews with participants.

Overall, this implementation model integrates four key elements—education, technical assistance, institutional strengthening, and value creation—each of which support the development of a sustainable organic waste management ecosystem. Such a model has been recognized as effective in increasing community self-reliance while strengthening socioeconomic resilience in rural areas (Syafmaini et al., 2025; Kamaruddin et al., 2022). Thus, this program not only provides technical skills but also cultivates behavioral change and shifts community perspectives toward viewing waste as a resource with economic and social value.

RESULTS AND DISCUSSION

General Overview of Program Implementation

The community service activities were carried out in Gulingan Village, Mengwi District, Badung Regency, involving 50 participants consisting of TPS3R managers, housewives, PKK members, youth groups (karang taruna), and BUMDes representatives. The program was conducted over two months and included outreach activities, technical training, hands-on practice, and household mentoring.

The implementation received full support from the Gulingan Village Government and the NGO Kopernik, which served as the technical partner and main resource organization. The outreach phase included presentations on the concept of circular economy and the role of TPS3R in reducing household waste volume. The activities then continued with participatory mapping and selection of pilot households.

During the training, participants were given the opportunity to learn directly how to process organic waste into value-added products such as compost, eco-enzymes, and livestock feed. Resource personnels from Kopernik introduced simple technologies that can be applied at the household level without significant costs. Observations showed a high level of community participation, marked by strong enthusiasm during the discussions and field practice sessions.

Figure 1. Documentation of Organic Waste Processing Education Activities in Gulingan Village
Source: Program Documentation, 2025

This activity was not only educational but also transformative, as community members began to understand that waste management is part of a sustainable lifestyle. This is in line with the findings of Syafmaini et al. (2025) and Putra et al. (2025), which indicate that practice-based training fosters more lasting environmentally friendly behavior than conventional outreach methods.

Increase in Participants Knowledge and Awareness

The effectiveness of the activities was measured using pre- and post-test instruments consisting of ten simple yes/no questions. The purpose of this study was to assess improvements in participants' knowledge, attitudes, and awareness regarding organic waste management. The results showed a significant increase in nearly all the indicators.

Table 1. Results of Participants Pre-Test and Post-Test

No	Evaluation Statements	Pre-Test (Yes)	Post-Test (Yes)
1	I know the difference between organic and inorganic waste	52%	82%
2	I sort waste in my household	44%	72%
3	I know how to make simple compost at home	28%	84%
4	I have heard about eco-enzymes and their benefits	46%	92%
5	I am aware that organic waste can have economic value	52%	86%
6	I am interested in managing my household waste	52%	94%
7	I know the function of the TPS3R in the village	48%	86%
8	I am ready to take part in waste management activities in my community	50%	92%
9	I believe that waste management can increase community income	38%	80%
10	I feel confident that I can make products from organic waste	34%	80%
	Average	44%	85%

Source: Authors work (2025)

The results showed an average increase of 41%, or nearly double that of the initial condition. This evaluation reinforces the effectiveness of the participatory and

practice-based approaches. Participants demonstrated heightened awareness and knowledge, particularly regarding the technical aspects of composting and eco-enzyme production. These findings align with Kamaruddin (2022), who emphasizes that direct involvement in environmental activities accelerates the internalization of sustainability values.

Behavioral Changes and Socioeconomic Impacts

After the training, the participants began applying waste management practices in their homes. Based on field observations and interviews, 82% of participants started sorting their waste routinely. Several families haeve formed small groups to collectively collect and process organic materials.

Economic impacts were observed through the formation of two new community enterprises: Gulingan Hijau, which produces solid and liquid compost, and Ecozyme Bali Asri, which develops natural cleaning products from eco-enzymes. These groups began selling their products at local markets and village events. This development reflects a paradigm shift from viewing waste as a burden to seeing it as an economic resource.

Beyond the economic aspect, the programme strengthened social cohesion within the village.The Village Waste Management Forum has become a coordination platform among local institutions such as BUMDes, PKK, youth groups, and traditional leaders. This forum acts as a communication bridge and provides an overview of theTPS3R activities. Similar models have been successfully implemented in several Southeast Asian regions and have proven to be effective in strengthening local environmental governance (Kamaruddin et al., 2022).

Increased collective awareness is also evident from community initiatives involving elementary school children in educational activities and organic material collection. This intergenerational approach reflects the program's success in embedding sustainability values as a part of village culture.

Academic Discussion and Collaborative Reflection

From an academic perspective, the results of this program demonstrate strong synergy between the community empowerment approach and the circular economy concept. The knowledge transfer process, facilitated by academics and NGO, resulted in increased technical skills and environmental awareness among the village community. This proves that empowerment combined with social innovation can be an effective tool for acceleratinge the transition toward a green economy (Kirchherr et al., 2022; Morseletto, 2020).

The collaborative model implemented in Gulingan Village can be considered a living laboratory for the university and its external partners to apply research findings in a real-world context. The university acted as a learning facilitator, while the NGO Kopernik focused on the technical aspects and environmental innovation. This cross-sector approach aligns with the principles of quadruple helix collaboration among academia, the government, the private sector, and civil society, which promotes sustainable village development (Carayannis & Campbell, 2018).

Furthermore, the program illustrates that behavioral change in community waste management can be achieved not only through technical training but also through

instilling social values, building local institutions, and creating economic incentives. This aligns with the findings of Paritosh et al. (2023), which emphasize that the sustainability of waste management systems heavily depends on collective awareness and the direct economic benefits experienced by the community.

Thus, the success of the activities in Gulingan Village can be concluded not only in terms of improving technical skills but also in creating a new culture: managing waste as a resource. This model is worthy of use as a reference for other villages in developing circular economy–based and multi-stakeholder collaborative waste management programs.

CONCLUSION

The community service program carried out in Gulingan Village, Badung Regency, demonstrated that a practice-based and participatory approach can effectively increase community awareness, knowledge, and skills in organic waste management. Through collaboration between the Faculty of Economics and Business, Udayana University, and the NGO Kopernik, community members not only gained a new understanding of waste separation and processing but also learned to transform household waste into value-added products such as compost and eco-enzymes. The pre and post-test results showed a nearly twofold increase in participants' understanding, while social impacts were evident through the establishment of small business groups and a village forum as a platform for ongoing coordination.

Conceptually, this program illustrates the successful implementation of a community empowerment model integrated with circular economic principles at the village level. The collaborative process between academics, NGO, and the village government successfully created a learning ecosystem that promoted behavioral transformation regarding waste. The program also makes a tangible contribution to the achievement of Sustainable Development Goals (SDGs), particularly in sustainable consumption and production (SDG 12) and resilient community development (SDG 11). With local institutional support and an innovative, low-cost technology-based approach, this model is suitable for replication in other villages in Bali and across Indonesia as an example of agood practice in sustainable, community-based organic waste management.

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Conflict of Interest declaration

The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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