

Community Empowerment in Organic Waste Management in The Tourist Villages of Batumadeg and Batukandik, Nusa Penida, Bali

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Abstract Waste management in the Nusa Penida tourism area, Bali Province, is a major environmental and tourism sustainability concern. Serious problems related to waste management in the Nusa Penida region, especially in Batumadeg and Batukandik Villages, Nusa Penida, inspired the Gadjah Mada University (UGM) Period 2 Nirwana Kuliah Kerja Nyata (KKN) or Community Service Program team to carry out activities to empower the public. Through qualitative methods using Focus Group Discussions (FGD) and interviews, the Community Service Program team successfully identified multidimensional waste problems, including cultural and structural dimensions in the region, as well as program interventions. The Community Service Program team developed a four-step solution, which includes education on waste sorting, a TOSS (Local Waste Processing Site) survey, the introduction of eco-enzymes from organic waste, and the creation of a plastic waste melting machine to demonstrate plastic waste processing. Significant results can be seen in increasing public and local government awareness regarding waste issues, fulfilling community aspirations regarding waste management facilities, and the effectiveness of TOSS. The eco-enzyme program saw enthusiastic participation in four sub-districts, with a 70% knowledge increase, as shown by improved post-test scores. Students at SMPN Satu Atap 1 Batukandik demonstrated a strong understanding of organic waste management and participated eagerly in the eco-enzyme creation process, with enthusiasm to apply the knowledge in daily life. The mini plastic melting machine tool also received positive feedback, especially from village officials, who expressed interest in adopting the technology. These outcomes affirm the program's success in raising awareness, meeting community needs, and driving actionable results.

1. INTRODUCTION

The development of tourist areas should ideally always take into account the sustainability of the surrounding environment so that tourist destinations managed by the community can be sustainable over time. This is important because environmental cleanliness not only plays an

important role in providing comfort for tourists but also in preserving the natural and cultural attractions of a tourist destination. As one of the most popular tourist destinations at home and abroad, the Bali Province region offers a variety of natural riches, biodiversity and cultural

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uniqueness. However, tourism development in the area does not always go according to plan, especially in the matter of tourism's negative implications for environmental sustainability.

The sustainability of Bali tourism is seriously threatened by waste. According to the Indonesian National Waste Management Information System (SIPSN), waste generation in Bali increased by 30% between 2000 and 2024, finally reaching 1.2 million tons in 2024 (Hasjanah & Simanjuntak, 2025). While more than half is organic waste, the real hazard comes from plastic waste, which ends up polluting the ocean. To make things worse, the processing capacity of private recycling centres is unable to keep up with the rise in waste production (Wiantara & Hendrawan, 2021). Although the Bali government planned to build a waste-to-energy power plant (PLTSa), this technology has had low success, with only two PLTSa in Indonesia still fully operating (ANTARA, 2025).

Through the Minister of Maritime Affairs and Fisheries Decree Number 24 of 2014, Nusa Penida was designated as one of the Marine Conservation Areas (KKP) in Bali, boasting an extraordinary wealth of marine biota and attracting many tourists. Administratively, the Nusa Penida tourist area is located in Klungkung Regency, Bali Province. In 2017, the number of tourists visiting Nusa Penida reached 292,734 people, making it the most popular tourist destination in Klungkung Regency. Head of the Klungkung Tourism Office, Ni Made Sulistiawati, stated that the number of tourists visiting Nusa Penida has increased this year (Sad, 2024). In May, there were 114,503 tourists, followed by 102,983 people in June, 108,272 people in July, and by August 10, 2024, the number of visits had reached 44,479 tourists (Kementerian Kelautan dan Perikanan, 2014).

However, behind the beauty of this island, environmental problems such as waste are often ignored by the community. According to I Wayan Karta, manager of the Taksu Tridatu Foundation, before 2019, Nusa Penida did not have a Waste Disposal Site (TPS) installation adequately based on the 3R principle (Reduce, Reuse, Recycle), so the waste produced was simply thrown away without a proper sorting process. This is part of the cause of the problem of plastic debris in the ocean (Hendrawan et al., 2023). In fact, Nusa Penida District has a population of around 67 thousand people, with production and consumption activities resulting in large amounts of waste, around 37.47 tons/day (Wijaya et al., 2020). In addition, this condition is worsened by serious over-tourism and underdeveloped infrastructure (Widyastiti, 2023).

In that context, community empowerment in waste management is very important to support the development of sustainable tourism areas. One of the interesting tourist attractions studied in this regard is the Batumadeg and Batukandik Village tourist area in Nusa Penida District, Klungkung Regency, Bali Province. Like other villages in Nusa Penida, these two villages are known for their natural and cultural tourist attractions. In this tourist area,

community empowerment efforts in waste management are a very important solution to maintaining tourism's sustainability in Nusa Penida (Setiawan et al., 2025). The community's active role in overcoming the waste problem is very necessary (Suhardono et al., 2024). Based on these problems, researchers aim to analyze the process and output of community empowerment carried out by the UGM Period 2 Nirwana Community Service Program team through a community service program in waste management in Batukandik and Batumadeg Villages, Nusa Penida District, Klungkung Regency.

The Nirwana Community Service Program team is known for conducting a survey of Local Waste Processing Sites (TOSS), providing education about sustainable integrated waste management, introducing eco-enzyme, and introducing management models through Holzewiq. The aim is to encourage community empowerment in waste management and increase awareness of their important role in maintaining environmental cleanliness and tourism sustainability.

2. METHOD

In order to overcome serious problems related to the management of the Nusa Penida tourist area, Universitas Gadjah Mada Community Service Program (KKN) students carried out community service activities in Batukandik and Batumadeg Villages, Nusa Penida District, Klungkung Regency, Bali Province. The main focus of this activity is to provide outreach and education to the public regarding sustainable waste management.

The research method used was a qualitative approach: Focus Group Discussion (FGD) and interviews. The choice of this method is based on the aim of understanding in depth and, specifically the views and experiences of the individual people involved. The FGD process involved discussions between KKN students and a number of community members. The discussion covered various aspects, such as waste production flows, community behavior in waste management, and the impact of waste problems on social life and the surrounding environment. This approach was expected to produce a comprehensive understanding of the effectiveness of the dissemination and education programs implemented by KKN students. Figure 1 briefly describes the stages of activities that Tim KKN Nirwana have implemented during at least a fifty-day period. These stages of activities consist of two basic approaches, including the technical and community-based approaches.

3. RESULT AND DISCUSSION

3.1 Waste problem identification process through TOSS survey

In identifying waste problems, the KKN Team Team implemented several methods and schemes to increase public understanding of the importance of protecting the environment from the impacts of waste. This effort involves

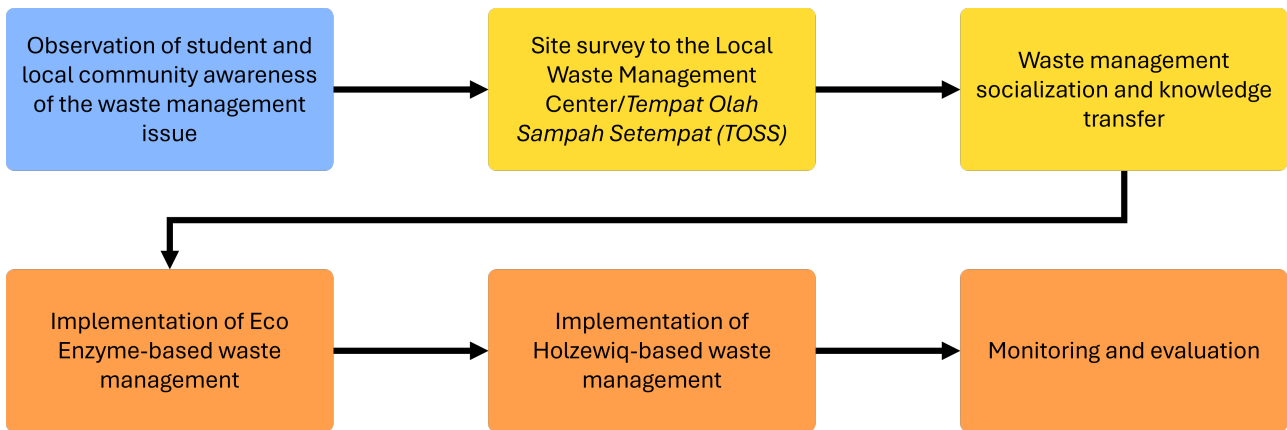


Figure 1 . Stages of activities implementation

collecting data through discussions and interviews with several parties in Nusa Penida. The KKN Team focuses on three steps: surveying local waste processing sites (TOSS), making eco-enzymes, and operationalizing equipment.

The initial step was carried out through a TOSS survey in Batumadeg village, Nusa Penida. The KKN team used three basic questions as analytical instruments. These questions involve how waste is processed at TOSS Batumadeg, the daily routine of waste officers at that location, and the waste collection process, which then undergoes further sorting and processing.

Based on these three questions, local citizens—Mrs. Kadek and Mrs. Tri Diani—explained that waste sorting activities had so far been categorized only into organic and inorganic waste. Some of the waste had been directly processed at TOSS, while the remaining portions had been sent to the Nusa Penida TPA. When asked about waste processing activities, they further explained that the primary focus had been on converting organic waste into compost as highlighted by Sudaryatno et al., (2024).

Regarding the waste collection process, they stated that collection had taken place on Tuesdays and Fridays at 8 a.m. in Batumadeg Village, ensuring even waste transportation from the Tembeling tourist area to the local village office. The discussion and interview process took place near the Batumadeg Village Office, involving 13 participants—an increase from the previous year when only 10 people had participated. From these interviews, the KKN Team concluded that the local community demonstrated environmental awareness and had successfully formulated and implemented solutions for waste sorting and processing.

In addition to analyzing problems through interviews, the TOSS survey generated innovative ideas, such as creating bottle ornaments at TOSS BTM. These ornaments were intended to inspire public participation in waste recycling activities. Furthermore, the KKN Team successfully designed a waste management reporting application as a further step toward addressing waste issues. This application included features to help users locate and track various points of interest, such as waste collection sites, Micro, Small, and Medium Enterprise (UMKM) points, and tourist destinations. The application aimed to

facilitate access to essential information for both residents and visitors of Nusa Penida. However, updates to the application were planned to continue under the Nusa Penida KKN team in 2024.

This process involved repurposing plastic waste into decorative bottle ornaments, promoting environmental awareness and sustainability (Figure 2). The initiative encouraged waste reduction while fostering community engagement by transforming discarded plastic materials into creative and functional art pieces. The project also served as an educational tool, inspiring local residents and tourists to adopt eco-friendly practices. Ultimately, this effort supported environmental conservation and contributed to the development of sustainable livelihoods for the local community (Budiarto et al., 2023; Sulistiyani et al., 2025).



Figure 2 . The process of making bottle ornaments using plastic waste

This website collects data on garbage points, plantation locations, Balinese cattle farms, cultural information, and tourist destinations (Figure 3). It aims to broaden the reach of information, allowing both the community and tourists to easily access facilities and holiday recommendations on Nusa Penida Island, Bali. The website seeks to enhance the overall tourist experience and promote local attractions by providing this information. Ultimately, the goal is to create a positive domino effect for local entrepreneurs and community activists, boosting regional economic growth.



Figure 3 . Nusa Penida website application

3.2 Stages of material preparation and dissemination of waste sorting

This dissemination activity was held at elementary school Sekolah Dasar Negeri 2 Batukandik (Figure 4), with participants ranging from first to sixth grade. The purpose of this activity was to enhance students' familiarity with waste management, with the hope that they would implement these practices in their daily lives as part of a mainstreaming agenda. The material presented covered fundamental topics, including the types of waste and the steps involved in sorting it (Widhyharto et al., 2023). Interestingly, despite the rarity of waste sorting educational activities, the students showed high enthusiasm and keen interest in the material presented by the KKN Team.



Figure 4 . Dissemination of waste sorting at SDN 2 Batukandik

However, the findings showed that the facilities and infrastructure in schools were still inadequate to support the optimal implementation of waste sorting. Therefore, the next steps should include the provision of physical facilities and adjustments to the curriculum, incorporating designs that prioritize environmental conservation principles and enhance awareness of responsibility toward the natural

environment, such as ecotourism (Wiradika & Jaedun, 2019).

3.3 Stages of making eco-enzymes from organic waste

In an effort to empower the community in waste management, the KKN Team emphasized an educational approach through the production of eco-enzyme. This educational initiative was carried out through various dissemination programs, targeting the village government and students from Sekolah Menengah Pertama Negeri Satu Atap 1 Batukandik (Figure 5). This innovation was designed to reduce the negative impact of artificial chemical waste and plastic waste by utilizing organic kitchen waste, including fruit and vegetable scraps, which were fermented with sugars such as brown sugar or cane sugar mixed with water. The resulting eco-enzyme was dark brown and had a distinctive sweet and sour fermented aroma.

Considering that approximately 70% of the total waste disposed of at Final Processing Sites (TPA) in Indonesia



Figure 5 . Education on making eco-enzyme

consists of organic waste, the creation of eco-enzyme was expected to help address a significant portion of the waste

problem. The benefits of eco-enzyme are diverse, ranging from utilizing organic waste to creating natural cleaning products and reducing pollution. Additionally, eco-enzyme can be used as a pesticide and organic fertilizer to enhance soil fertility (Samadikun et al., 2023).

The manufacturing process began with preparing a container of approximately 10 liters, filling it with 6 liters of water, and adding 600 grams of sugar. Next, 1,800 grams of fruit and vegetable scraps were added to the water and sugar mixture. All ingredients were stirred thoroughly, and the container was covered with gauze before being stored in a shaded area at a temperature of approximately 25–30°C for around three months. After this period, the eco-enzyme was ready for use santosa2023.

The KKN Team implemented two programs to introduce eco-enzyme. The first program was a thematic training session on eco-enzyme production, conducted in collaboration with the Agricultural Extension Center (BPP) in Klungkung. In this activity, the KKN Team, along with agricultural extension workers, provided training to farmers from Klungkung Regency. The training included theoretical instruction as well as hands-on demonstrations of eco-enzyme production.

The eco-enzyme training program for farmers in Nusa Penida, covering four sub-districts, received a highly positive response. Farmers showed great enthusiasm during the dissemination, actively engaging in discussions and training sessions. Evaluations conducted through pre-tests, post-tests, and quizzes demonstrated a 70% increase in participants' knowledge, as reflected in the higher number of correct answers in the post-test compared to the pre-test.

The second program involved training sessions at junior high school SMPN Satu Atap 1 Batukandik, where the KKN Team conducted practical exercises in eco-enzyme production using organic waste. Each student brought organic waste as a raw material for the process. The aim of this program was to introduce students to eco-enzyme production while providing them with hands-on experience. The public response to this initiative was overwhelmingly positive, particularly regarding its practical benefits, such as the use of processed products as fertilizers.

During the eco-enzyme dissemination at SMPN Satu Atap 1 Batukandik, students demonstrated a solid understanding of organic waste management concepts and

their real-world applications. Throughout the eco-enzyme-making session, students participated enthusiastically and successfully grasped the entire process, from ingredient selection to final harvesting. Evaluations through quizzes and tests showed that students could accurately answer questions about the technical process of eco-enzyme production. Additionally, student feedback indicated high satisfaction with the activity, with many expressing their intention to apply the knowledge gained in their daily lives.

The eco-enzyme product (Figure 6) was the result of a series of training programs conducted by the KKN Team in collaboration with local communities and educational institutions. This initiative aimed to introduce eco-enzyme as an environmentally friendly solution for organic waste management, with applications in agriculture, household cleaning, and wastewater treatment. Through hands-on training sessions, participants, including farmers and students, actively engaged in the production process, from selecting organic waste materials to applying fermentation techniques. The final product demonstrated the potential of eco-enzyme to reduce waste while promoting sustainable practices.



Figure 6 . Product eco-enzyme

3.4 Waste processing through tools Holzewiq

In this activity (Figure 7), UGM students, together with the local government and the community, carried out the process of plastic waste processing using the Holzewiq



Figure 7 . Product eco-enzyme

tool to create various accessory molds. The process involved several stages, including plastic waste collection, pressing, shredding, melting, and molding.

The Holzewiq tool, named by the KKN Team, was introduced as an innovative device capable of melting plastic waste into solid, durable products in the shape of tubes and hearts. Following the dissemination conducted by the KKN Team and community members, plastic waste was collected, enumerated, and sorted from other types of waste. The sorted plastic waste was then placed into the Holzewiq tool, where it was melted into a liquid form over approximately two and a half hours.

This tool successfully transformed plastic waste into several new objects (Figure 8), such as tubes, keychains, and other small accessories. The Holzewiq tool processed 5 kg of plastic waste, demonstrating its effectiveness in reducing plastic waste volume. The strong community interest and positive response during dissemination and simulation sessions were further reinforced by the commitment of village officials to address local waste management issues. The program's success was also reflected in the high level of engagement from village authorities, who showed significant enthusiasm for plastic waste management solutions. A concrete example of this commitment was the village government's plan to acquire a plastic waste melting machine, highlighting their dedication to implementing innovative waste management practices.

These quantitative and qualitative indicators underscore the program's success in raising awareness, fulfilling community aspirations, and producing tangible, sustainable waste management outcomes. Thus, the Holzewiq tool is expected to play a crucial role in reducing plastic waste, which remains a pressing issue in Nusa Penida. Moving forward, it is hoped that future KKN programs will continue to enhance and expand the capabilities of the Holzewiq tool, further improving plastic waste reduction efforts in the region.



Figure 8. The final result of waste processing using Holzewiq

4. CONCLUSION

In implementing community empowerment activities focused on waste management in Batumadeg and Batukandik Villages, Nusa Penida, the UGM 2nd Period KKN Nirwana Team was deemed successful, particularly in designing and executing empowerment programs that were educational, aspirational, and responsive to community needs. The high level of enthusiasm observed during dissemination activities—especially among students at SDN 2 and SMPN Satu Atap 1 Batukandik—demonstrated the effectiveness of the KKN Team in delivering essential education on waste management.

Furthermore, through waste processing initiatives such as TOSS surveys, the production of eco-enzymes from organic waste, and the use of the Holzewiq tool to process plastic waste, the KKN Team successfully converted approximately 5 kg of inorganic waste into more eco-friendly products. The active participation of the community in these activities highlighted the significant potential for fostering long-term behavioral change in waste management practices. Therefore, it is hoped that community service initiatives, such as the Community Service Program (KKN), will continue to be implemented sustainably, ensuring a lasting positive impact on communities across Indonesia.

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CONFLICT OF INTERESTS

The authors declare there are no conflicts of interest.

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