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Optimization of Organic Waste Management with a Circular Economy Approach : The Case of Food Recycling in Bantul Regency, Indonesia

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Abstract: The purpose of this community service activity is to encourage and increase community empowerment in managing waste, increase community income, and open up employment opportunities in the Griya Cendekia YBW UII Fostered Village, Bantul, DIY. In this community service activity, a circular economy approach is applied by empowering the community. This program involves 25 participants through maggot cultivation training and organic waste management to produce eco-enzyme products. The methods used include stages of socialization, training, and technical assistance. The results of the community service show that this activity improves the community's ability to manage organic waste productively, producing products such as laundry soap, facial soap, and hand sanitizer. This activity concludes that organic waste management through maggot cultivation and eco-enzyme production not only supports environmental sustainability but also creates new economic opportunities for the community.

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Introduction

The problem of waste management in Indonesia, especially in big cities, is a crucial issue because this country is one of the largest waste producers in the world (Rahayu & Erza, 2022). According to data from the Ministry of Environment and Forestry (KLHK) through SIPSN (2023b), Indonesia produced more than 34.9 million tons of waste in 2023, but only 55.47% was managed properly. This less-than-optimal waste management causes environmental pollution, health problems, and a decrease in the quality of life which has a negative impact on the economy and social welfare (Anum & Pawarangan, 2018). As consumption increases, the volume of waste continues to increase, exacerbating the challenges of its management (Purwanto, 2019).

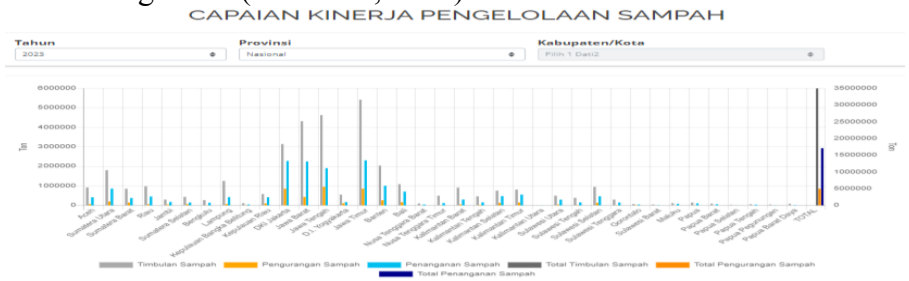

Figure 1. Waste Management Performance Achievements in All Provinces of Indonesia (SIPSN, 2023a)

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In the Special Region of Yogyakarta Province, the problem of waste management is also significant, with more than 549.9 thousand tons of waste per year and only 52% of it is managed properly (SIPSN, 2023b). Bantul Regency, in particular, faces the problem of the dominance of organic waste, especially food waste from households, restaurants, and public facilities. Organic waste that is not managed properly becomes a source of odor, a breeding ground for pests, and environmental pollution. Handling waste directly from its source through independent community efforts is considered effective, but its success is highly dependent on regulation, awareness, and active involvement of all parties.

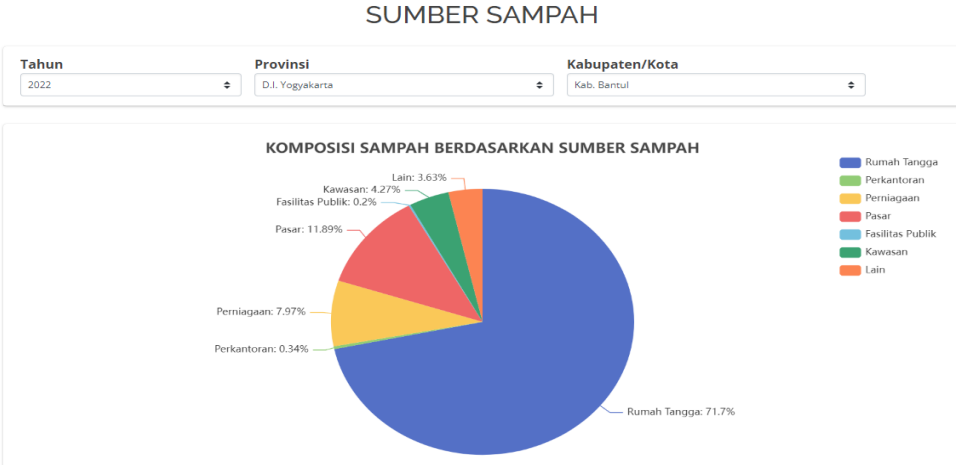

Figure 2. Waste Composition in Bantul Regency Based on Source (SIPSN, 2022)

In 2022, in Bantul, this problem became even more apparent with a large amount of food waste and agricultural waste. Around 71.7% of the total waste composition is not managed properly (SIPSN, 2022). The sorting system in waste management is regulated in Government Regulation Number 81 of 2012, which requires waste sorting directly from the source (Yudhistirani et al., 2015). This approach views waste as a resource that has the potential to generate income (Utomo & Priyadi, 2024). Organic waste has many benefits if managed properly, because of its high nutritional content, including as a source of protein (Aisy et al., 2024). However, the lack of public knowledge and awareness and limited infrastructure worsen this situation. Government and community support is needed in the form of strong regulations, education, and training in environmentally friendly and economically valuable waste management.

Circular economy-based waste management approaches have been implemented in several countries with significant results. For example, in Sweden, the "Food Waste to Biogas" program has successfully converted organic waste into renewable energy used for household needs and public transportation (Liu et al., 2022; Abrahamsson & Abrahamsson, 2023). In India, the "Zero Waste Cities" initiative in Kerala has integrated organic waste management with earthworm cultivation, producing organic fertilizer that supports the agricultural sector (Conlon, 2023; Mandpe et al., 2020). These approaches are inspiring and demonstrate that sustainable waste management not only reduces environmental impacts but also supports local economic growth.

Empowering a productive community-based economy is key to creating economic and social sustainability at the local level. The circular economy approach offers an effective solution for reducing waste while providing added value to the community (PKM, 2021). The circular economy development program through waste processing to produce eco-enzymes

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and maggot cultivation is expected to be an innovative and sustainable empowerment model (Setyoningrum et al., 2024).

Eco-enzyme is a product of organic waste fermentation such as fruit and vegetable waste, which can be used as a natural cleaner, organic fertilizer, and pest control (Firdayetti et al., 2024). This process not only reduces the amount of waste that ends up in landfills, but also produces environmentally friendly products that have economic value. Maggot cultivation, especially Black Soldier Fly (BSF) larvae, is another very effective approach to processing organic waste. Maggots are able to convert organic waste into biomass rich in protein and fat, which can then be used as high-quality animal feed. In addition, the residue produced from this process can be processed into organic fertilizer that is useful for agriculture (Yanto & Fatkhuri, 2024). The integration of these two technologies allows for more efficient waste management while providing new economic opportunities for the community.

This community service program aims to empower the community, administrators and members of the KUB (Joint Business Group) of the Griya Cendekia Fostered Village of the Endowment Foundation of Universitas Islam Indonesia (YBW UII), Sedayu Bantul, located in Kaliberot Hamlet with a population of around 350 families totaling 1,200 people. The urgency of this community service activity lies in its ability to provide real solutions to environmental and economic problems faced by village communities. In addition to improving skills and knowledge, this activity is also the first step in building an independent, productive, and ecologically and economically sustainable village. This program is carried out through technical and entrepreneurial skills training in eco-enzyme production and maggot cultivation, which will later become one of the solutions to the problems of waste processing and empowering the productive economy. This training will be followed by assistance in marketing, business management, and developing distribution networks. According to Suratman et al. (2020), the training aims to improve the skills and behavior of the community to be better than before. This program is expected to be a circular economic development by creating new jobs, increasing the income of KUB members, supporting environmental conservation, and improving the welfare of the local community. Improving the welfare of the local community can be carried out sustainably in order to improve the level of the economy (Priyadi et al., 2021).

With the principle of sustainability (Ilalfiah & Agustina, 2023), this program has the potential to be a model that can be applied in other areas and contribute to the sustainable development goals (SDGs), especially SDG 12 (Responsible Consumption and Production) and SDG 8 (Decent Work and Economic Growth). Collaboration between researchers, government, and communities is essential to ensure the success of this program.

Method

This community service activity was carried out in the Griya Cendekia YBW UII Fostered Village, Sedayu District, Bantul Regency, DIY. This activity is carried out with a circular economy approach by empowering communities that are designed to manage waste not as waste that is discarded, but as a resource that can be reprocessed into useful and economically valuable products, while actively involving the community in the process. The implementation of the activity used a classical and individual approach (Mustika et al., 2018). The classical approach focuses on delivering material in general, while the individual approach emphasizes direct assistance to participants so that participants gain practical

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experience that can be applied in the field (Sadikin et al., 2021). This activity is carried out through several interrelated stages.

The first stage is the analysis of needs and program agreements, where the activity begins with a discussion between the community service team and the leadership of the Griya Cendekia YBW UII Fostered Village, as well as a review of the activity location to prepare a plan that is in accordance with the needs of the local community. After the initial stage, a program socialization was carried out which aims to increase public awareness of the importance of organic waste processing. At this stage, the community is expected to be able to realize professional and productive values in waste management that are not only economically beneficial, but also for the welfare of the community.

Furthermore, the training stage is carried out to increase the capacity of human resources and the practice of making products from household waste. This process begins with preparation that includes the preparation of an activity plan, team coordination, identification of participant criteria, and determination of training and implementation schedules. Then a coordination meeting of the implementing team is held to ensure that all tasks are distributed properly, and activities run according to the predetermined schedule. After that, trainers and mentors who have expertise in the field of organic waste management are prepared to provide training to participants. The trainers who directly teach and socialize how to make maggots and eco enzymes consist of two people who are indeed experts in their fields. The first is a Director of BUMDes and waste management practitioners from Potorono Village, Bantul Regency and the second trainer is an expert from the Lecturer of Faculty of Medicine, Universitas Islam Indonesia who has long been involved in the field of eco enzymes. At this stage, participants not only receive materials but are also directly involved in the practice of making products from household waste.

In the next stage, mentoring and monitoring are carried out continuously to ensure that participants can apply the knowledge they have learned in their daily lives. The implementing team carries out direct monitoring and provides direction to participants to overcome various obstacles that may arise. Evaluation is also carried out after the implementation of the activity to assess the effectiveness of the program. In the evaluation, what was done was to hold discussions and interviews with the community of the Griya Cendekia UII Sedayu Bantul Fostered Village regarding the maintenance of maggot cultivation and the manufacture of eco-enzymes. In addition, monitoring the results of the fermentation of the mixture of eco-enzyme solutions and the results of maggot cultivation in the field.

Participants in this activity are selected based on two main criteria, namely involvement in waste management and interest in entrepreneurship. Involvement in waste management is expected to increase their activeness in training activities, while interest in entrepreneurship will support the application of skills acquired to create business opportunities based on organic waste.

As part of the evaluation, several indicators were used to assess the success of this activity, including the amount of waste that was successfully processed, additional income obtained by participants, and the level of participant satisfaction with the training provided. With this holistic approach, it is hoped that this community service activity can provide maximum benefits to the community, both in improving skills, economic welfare, and positive impacts on the environment.

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Result and Discussion

The implementation of the maggot cultivation and eco-enzyme production training program in order to realize a circular economy in the KUB of Griya Cendekia YBW UII Sedayu Bantul Village consists of several stages through socialization, counseling, and practice. These three stages are carried out as a form of education that is expected to make the community independent in empowering maggot cultivation and making eco-enzymes. So that by practicing maggot cultivation and making eco-enzymes, the community will be able to obtain additional income as one of the solutions to the problems faced by the community in Griya Cendekia YBW UII Village, Sedayu District. The stages carried out are as follows:

1) Analysis Stage

The initial step taken before direct program socialization is the preparation of all the necessities that will be used at the location and determining the initial actions as a means of socialization and education for the community in the Griya Cendekia YBW UII Fostered Village, Sedayu District, then conducting a review of the activity location.

Figure 3. Planning Discussion with Village Community Service Partners

2) Socialization of Activity Programs

Socialization is one of a person's efforts to convey information about values and standards so that they are easily understood by the community According to (Iriyanto, 2013). Furthermore, the implementation of socialization can be carried out directly or indirectly (Agung, 2017). In order to prepare a professional community in processing organic waste in the Griya Cendekia YBW UII Fostered Village environment, Sedayu District, socialization is very much needed in order to increase the community's ability to process organic waste productively, as well as an alternative solution to existing household waste management problems, as well as providing persuasive information to increase community knowledge about maggot cultivation and eco-enzyme production.

Figure 4. Socialization activities for the maggot cultivation and manufacture of eco-enzymes program with partner village residents

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3) Training on Increasing Human Resources Capacity and Household Waste-Based Product Manufacturing Practices

This community service activity was carried out as an effort to realize a circular economy through maggot cultivation and eco-enzyme production towards an advanced village. From the results of observations, previously partners had not been optimal in cultivating maggots and did not know what was meant by eco-enzyme production and how to apply eco-enzymes to household organic waste processing. This activity was attended by 25 participants and presented practitioners in the field of eco-enzyme processing and manufacturing from the Faculty of Medicine, Islamic University of Indonesia, as well as maggot cultivation practitioners from the waste processing socialization group, Potorono Village, Banguntapan District, D.I. Yogyakarta.

The next activity was training and direct practice by practitioners regarding maggot cultivation in waste processing buckets together with partner residents, it was seen how enthusiastic the partner residents were in participating in the activities in this session, this shows that the community service efforts for managing household organic waste through maggot cultivation and eco-enzyme production are very useful and influential for the development of partners.

This training aims to address the knowledge gap, especially the lack of community experience in waste utilization technology into resources. Participants showed strong enthusiasm and motivation to replicate this practice at home. This approach is in line with previous research showing that skills-based training improves community capacity and environmental management (Suparno et al., 2020; Yuliana & Wicaksono, 2022).

Figure 5. Training activities and direct practice in organic waste processing buckets with partner village residents.

4) Mentoring and monitoring

Sustainable mentoring and monitoring were carried out for the next three months to ensure the successful implementation and adoption of maggot and eco-enzyme techniques. The mentoring included two main activities:

a) Maggot Cultivation and Harvesting

After a cultivation cycle of 15–20 days, the maggots were harvested using an automatic separator. The larvae were dried and processed into high-protein animal feed, while the organic residue was converted into compost through vermicompost. This model demonstrates the application of the circular economy concept, where organic waste is

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converted into economically valuable and environmentally friendly products (Kusrini et al., 2021).

b) Eco-enzyme Maintenance and Utilization

After undergoing a three-month fermentation period, the eco-enzyme was filtered and stored for multipurpose use as a natural cleaner, fertilizer, and waste decomposer. This environmentally safe product helps reduce chemical waste and contributes to sustainable household practices (Nugroho et al., 2020).

Figure 6. Monitoring Activities for Maggot Cultivation Harvest and Eco-Enzyme Production

Contribution to Sustainable Waste Management and Economic Empowerment

The results achieved from this activity provide a significant contribution to sustainable waste management. By utilizing maggots as waste decomposing agents and eco-enzymes as environmentally friendly products, the community has not only succeeded in reducing household waste but also gained economic benefits from the products produced. The implementation of maggot and eco-enzyme cultivation reduces the burden of landfill waste and minimizes greenhouse gas emissions associated with organic decomposition (Rahman et al., 2021). This approach supports the principle of a circular economy, where waste is converted into value-added products that can support environmental sustainability.

In terms of economic empowerment, this training provides new skills that can increase community income through the sale of maggot and eco-enzyme products. The sale of maggots as animal feed and eco-enzymes as organic products provides new income streams, supports household economies, and encourages entrepreneurship. This holistic model is in line with the principles of the circular economy, which promotes sustainability, community resilience and inclusive development (Geissdoerfer et al., 2017). Thus, the community not only becomes more independent in waste management, but also has the opportunity to develop businesses based on organic waste products. The success of this program can also inspire other business groups in the village and surrounding areas to adopt a sustainable and economically profitable waste management model.

Conclusion

The maggot cultivation and eco-enzyme production training program in the Griya Cendekia YBW UII Fostered Village, Sedayu District, Bantul, has succeeded in providing significant benefits both in terms of organic waste management and community economic empowerment. Through socialization, counseling, and direct practice, the community has gained new skills in managing household waste in a productive and environmentally friendly

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way. The results of this training are seen in the improvement of waste processing, the manufacture of valuable products such as maggots and eco-enzymes, and additional income for the community. This program also contributes to the reduction of organic waste that can damage the environment and provides solutions for more sustainable waste management. Overall, the success of this program demonstrates the great potential to transform waste into valuable products that can improve the economic welfare of the community. With increased skills, knowledge, and income of the community, this program has had a significant positive impact on the social and economic life in the Griya Cendekia YBW UII Fostered Village.

Recommendation

Although this program has been successfully implemented, there are several suggestions and recommendations to expand its impact and ensure the sustainability of this program. First, the integration of this program with local government policies will be an important step to strengthen sustainable waste management. Local governments can include this program in waste management policies, by providing support in the form of facilities, funding, and broader training to village communities. Second, expanding the program to other villages in Bantul Regency or other areas can accelerate the adoption of sustainable waste management techniques. This program can be used as a model that can be applied in many places, with adjustments that are in accordance with the characteristics and needs of the local community. In addition, developing cooperation with non-governmental institutions or organizations working in the environmental sector can increase the capacity of this program. Third, to increase the economic impact of this program, it is necessary to form business groups based on maggot and eco-enzyme products, which can utilize the results of the training to create products that can be marketed more widely. Fourth, the local village government should support this program through policy integration, funding, and community training. Establishing waste-based businesses, enforcing waste sorting, and expanding to other villages can increase impact. Collaboration with external partners and regular monitoring will ensure sustainability, support SDG 12, and promote a circular economy through community empowerment. The government and financial institutions can also provide assistance in the form of micro-business credit to support the development of this business.

This program directly supports SDG 12 (Sustainable Consumption and Production), which emphasizes the importance of reducing waste through better and more efficient management. By processing organic waste into valuable products such as animal feed and natural cleaners, the program contributes to waste reduction and more sustainable use of natural resources. In addition, by involving the community at every stage, the program creates wider awareness and knowledge about the importance of responsible consumption and production, and encourages a more environmentally friendly lifestyle. With wider implementation and development, the program has the potential to provide a greater positive impact, not only for waste management but also for sustainable community economic empowerment.

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