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Transformation of Waste Banks: Realizing a Community- Based Circular Economy in Kwadungan Gunung Village,Kledung District,Temanggung Regency

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Abstrak

Permasalahan pengelolaan limbah di Desa Kwadungan Gunung, Kecamatan Kledung, Kabupaten Temanggung, merupakan tantangan signifikan dalam mewujudkan lingkungan berkelanjutan dan ketahanan ekonomi komunitas. Peningkatan volume limbah rumah tangga dan pertanian, rendahnya pemahaman masyarakat terhadap prinsip ekonomi sirkular, serta pengelolaan bank sampah yang belum optimal menjadi isu utama yang dihadapi. Pengabdian ini bertujuan untuk mengoptimalkan fungsi bank sampah sebagai pusat edukasi, inovasi, dan pemberdayaan ekonomi berbasis komunitas. Metode yang digunakan meliputi kegiatan sosialisasi dan edukasi tentang ekonomi sirkular, pelatihan pemanfaatan limbah, serta pendampingan pelaku UMKM dalam mengolah limbah menjadi produk bernilai ekonomi. Strategi pelaksanaan mencakup pengembangan sistem operasional bank sampah yang lebih terstruktur, pemberian insentif bagi masyarakat, serta kolaborasi lintas sektor dengan pemangku kepentingan lokal. Luaran utama dari program ini meliputi publikasi artikel ilmiah pada jurnal nasional terindeks Sinta, poster kegiatan yang menggambarkan alur kerja dan dampak program, dokumentasi implementasi, serta pengajuan hak cipta atas modul pelatihan dan sistem manajemen bank sampah. Hasil yang dicapai diharapkan menjadikan Desa Kwadungan Gunung sebagai model desa berkelanjutan yang berhasil mengimplementasikan prinsip ekonomi sirkular secara efektif melalui optimalisasi bank sampah berbasis komunitas.

Abstract

Waste management issues in Kwadungan Gunung Village, Kledung District, Temanggung Regency, present significant challenges to achieving environmental sustainability and community economic resilience. The increasing volume of household and agricultural waste, limited public awareness of circular economy principles, and suboptimal management of the existing waste bank constitute the core problems in this community. This study aims to optimize the role of the waste bank as a center for education, innovation, and community-based economic empowerment. The implemented methods include socialization and education on circular economy practices, training in waste utilization, and assistance for micro, small, and medium enterprises (MSMEs) in transforming waste into economically valuable products. The strategies involve developing a more structured operational system for the waste bank, providing community incentives, and fostering cross-sector collaboration with local stakeholders. The primary outputs of this program include publication of a scientific article in a nationally indexed (SINTA) journal, activity posters illustrating the workflow and program impact, implementation documentation, and copyright registration for the training module and waste bank management system. The outcomes are expected to position Kwadungan Gunung Village as a model of sustainable rural development, effectively implementing circular economy principles through the optimization of a community-based waste bank.

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INTRODUCTION

The increasing volume of improperly managed waste has become a significant environmental issue in various regions of Indonesia, including Kwadungan Gunung Village, Kledung District, Temanggung Regency. Household waste and agricultural residues that are inadequately managed lead to soil and water pollution, negatively impacting the quality of life for local communities. Furthermore, the limited public understanding of circular economy principles, which emphasize managing waste as an economic resource through reduction, reuse, and recycling, presents a major challenge. Waste banks, as an innovative solution for community-based waste management, play a crucial role not only as waste collection points but also as platforms for education and economic empowerment for the community. This concept, rooted in the 4R principles (Reduce, Reuse, Recycle, Replant), encourages communities to sort their waste and process it into valuable products (Siregar *et al.*, 2023; Septiarini *et al.*, 2023). The purpose of this research is to develop a community-based waste bank transformation model in Kwadungan Gunung Village as a means to realize a sustainable circular economy. This research also aims to increase public awareness and encourage active participation in waste management through education and training focused on utilizing waste as an economic resource. The presence of a waste bank in the village functions not only as a waste management tool but also as a catalyst for creating new economic opportunities that can increase household income (Siregar, 2024; Posmaningsih *et al.*, 2024). The position of this research relative to previous community service activities lies in the integration of digital technology into waste bank management, which has not been widely implemented in similar activities in rural areas. The novelty of this research is the use of a digital-based management system that enables the recording of transactions, tracking community participation, and managing incentives in a more transparent and efficient manner (Fatah *et al.*, 2023; Yunita *et al.*, 2021). With this approach, it is expected that the waste bank in Kwadungan Gunung Village can become a model that not only reduces environmental impact but also provides economic benefits for the local community.

METHOD

Tools and Materials

This study uses household waste consisting of organic and inorganic waste, as well as agricultural waste in the form of organic residues as the primary materials. To support the management system, digital tools are used for waste management and data recording, as well as educational media such as printed guides, posters, and multimedia presentations. Large tools used in waste processing include composting containers for organic waste, eco-brick molds for hard plastics, and craft tools for recycling products made from paper and other materials. Organic waste is processed into compost, while inorganic waste, such as hard plastics, is used to make eco-bricks and craft products. Additional materials used include compost-making materials, eco-brick production materials, and craft materials such as used paper and plastic waste.

Implementation Method

The implementation of this community service activity is carried out through the following phases :

1. Waste Sorting
   Samples for this study are prepared through a community-based sorting process, starting from households. Sorting is done based on organic and inorganic categories. Organic waste is processed into compost through a strictly controlled decomposition process, while inorganic waste is classified based on its potential for reuse. For example, hard plastic is used for eco-brick production, and used paper is used for craft products. The sorting process is carried out participatively by the community, which is trained to sort the waste according to the predetermined categories.
2. Waste Processing
   The sorted organic waste is processed into compost using the prepared composting containers. Inorganic waste, such as plastic and paper, is further processed into eco-bricks and craft products. Each stage of processing is carried out with training facilitated by the research team to ensure the quality of the products meets the desired standards.

3. Digitization of Waste Bank Management
   The waste bank management system is implemented using an online-based management application that facilitates transaction recording, tracking community participation, and accelerating the process of waste collection and classification. This application allows waste bank managers to monitor in real-time the volume of waste collected, as well as facilitate the provision of incentives for participating community members. The data collected through this application is used for program evaluation and to ensure transparency and operational efficiency.
4. Assistance and Training for MSMEs
   In addition to waste processing, this research also focuses on economic empowerment through the assistance of MSMEs in the waste management sector. The training focuses on how to process waste into economically valuable products, such as compost, eco-bricks, and other craft products. The assistance activities are carried out in stages, starting with basic training on circular economy principles, followed by more advanced waste processing techniques. MSMEs are also provided with access to necessary production facilities to improve the quality and quantity of the products.
5. Community Involvement in Every Stage
   Community participation is a key factor in the success of waste bank management. The community is involved from the planning phase through to implementation. Intensive training is conducted to improve the community's capacity to manage waste independently. Furthermore, the community is also involved in monitoring and evaluating the program to ensure they can manage the waste bank sustainably after the program concludes.

Evaluation and Monitoring

To measure the effectiveness of the program, several key parameters are observed, including :

1. Community Participation Level
   Measuring the level of community involvement in waste sorting and collection activities.
2. Recycled Waste Volume
   Measuring the amount of waste successfully recycled each month after the intervention
3. Number of Recycled Products
   Measuring the number of products produced from processed waste, such as compost, eco-bricks, and craft products.
4. Economic Feasibility of Micro-Enterprises
   Assessing the potential of the formed MSMEs and their impact on the household income of participants.
5. Operational Efficiency
   Measuring the efficiency of using digital applications and management systems to accelerate the waste collection, sorting, and recycling processes.

This approach is expected to raise environmental awareness among the community, strengthen the local economy, and create a sustainable community-based waste management.

RESULT AND DISCUSSION

The implementation of the community-based waste bank transformation program in Kwadungan Gunung Village yielded significant positive outcomes, especially in raising community awareness and enhancing participation in waste management activities. Early results indicate a marked improvement in waste sorting and recycling practices, following the establishment of a more organized operational framework. This framework includes a digital recording system and an incentive-based approach, both of which proved effective in improving the efficiency of waste collection, sorting, and overall management. Additionally, the program stimulated the development of new micro-enterprises that utilized waste materials to create economically valuable products, such as compost, eco-bricks, and crafts.The program also included a robust educational and training component for the village residents, focusing on the principles of the circular economy and the 4R practices (Reduce, Reuse, Recycle, Replant). These initiatives played a pivotal role in enhancing the community's participation and deepening their understanding of the importance of sustainable waste management.

The documentation of these activities (Figures 1 and 2) highlights the active involvement of residents in educational and mentoring sessions, underlining the crucial role of direct engagement between program implementers and the community in driving the program's success. This is consistent with the research by (Suwerda *et al*., 2019) and (Santi *et al*., 2023), which suggests that participatory education and community empowerment are essential for effective waste bank management.Figures 1 and 2 depict the active involvement of Kwadungan Gunung Village's residents in the waste bank program and educational activities. To quantify the program's impact, Table 1 compares the state of waste management before and after the intervention. Notably, there was a significant increase in the volume of recycled waste, a growth in the number of waste-based micro-enterprises, and higher engagement of housewives in waste-related productive activities.

Figure 1. Group photo of the service team and residents of Kwadungan Gunung Village in the waste bank program.

Figure 2. Educational Activities and Coordination with Residents of Kwadungan Gunung Village.

Table I. Impact of the Community-Based Waste Bank Implementation in Kwadungan Gunung Village.

Indicator	Before Intervention	After Intervention	Notes
Community participation in waste sorting	Low, unorganized	High, supported by incentives and training	Increased environmental awareness and active participation from resident
Monthly recycled waste volume	± 10–15 kg	± 60–75 kg	Increased fivefold after training and active waste bank management
Number of waste-based micro-enterprises	Not available / not formed	New SMEs formed	Products: compost, eco-bricks, recycled bags, crafts
Waste management system	Manual, undocumented	Digital, systematically documented	Using digital recording and incentive systems
Female involvement (housewives)	Limited	High	0% of active training participants are housewives
Operational efficiency	Unmeasured	Measured through digitization and classification	Daily monitoring and routine reporting by waste bank managers
Educational and training activities	None	Regular: 3 community training sessions	Materials: 4R, sorting, recycling, waste bank digitalization

This quantitative shift is also illustrated in Figure 3, which highlights the improvement in key indicators of communication and participation in waste management. n comparison to prior studies, these findings echo the conclusions drawn by (Siregar *et al.*, 2023), which illustrate the effectiveness of circular economy principles in the industrial sector. However, this study demonstrates that these principles can be successfully adapted and implemented at the community level. Furthermore, (Pramudyastuti *et al.*, 2023) underscore the potential of sustainable business models to strengthen MSME competitiveness, as seen in the increased household income resulting from waste management initiatives. This aligns with research by (Darmansyah *et al.*, 2023; Ariefahnoor *et al.*, 2020; Auliani 2020), who emphasize the importance of community involvement in managing local waste resources, particularly in rural and agricultural settings. The visual diagram illustrates eight transformative stages of community-based waste management, leading toward the realization of a circular economy. Each stage represents a progressive advancement in social engagement, technological integration, and economic empowerment within the waste bank ecosystem.Stage 1 (Initial State) depicts a low level of community participation and reliance on manual waste management practices. This condition reflects a common situation in rural areas lacking infrastructure and systematic waste handling (Suwerda *et al.*, 2019). Through Stage 2 (Incentives & Training), strategic interventions such as community training and incentive programs are introduced to increase awareness and motivation. This approach has been proven effective in enhancing public involvement in waste bank management (Doyan, 2019; Ummah *et al.*, 2020).In Stage 3 (Increased Awareness), the community begins to show heightened environmental awareness and active participation, which is a critical turning point in developing sustainable, community-based waste systems (Santi *et al.*, 2023). As a result, Stage 4 (Fivefold Increase) follows, demonstrating a significant increase in the volume of recycled waste. (Ariefahnoor *et al.*, 2020) reported similar outcomes, emphasizing the impact of optimized collection and sorting mechanisms in boosting recycling efficiency.Stage 5 (Micro-Enterprises) signifies the emergence of community-driven micro-enterprises based on waste management activities. These ventures not only improve household income but also strengthen the local economy, particularly through the empowerment of women (Pravasanti *et al.*, 2020; Maimunah *et al.*, 2024). This aligns with the broader sustainable business models discussed by (Muafi *et al.*, 2022; Pramudyastuti *et al.*, 2023), who highlight waste-based micro-enterprises as viable components of circular economic strategies.Stage 6 (Digital System) introduces digital transformation through the implementation of information systems in waste bank operations. Several successful case studies illustrate how digital platforms have enhanced efficiency, transparency, and data accuracy (Budiarto *et al.*, 2020; Yunita *et al.*, 2021; Septiarini *et al.*, 2023). (Fatah *et al.*, 2023) further support the role of Android-based applications in expanding access and participation.In Stage 7 (High Female Involvement), the model underscores the significant involvement of housewives in waste management activities. (Auliani *et al.*, 2024) revealed that increasing women's engagement substantially contributes to the success and sustainability of community-based environmental programs.Finally, Stage 8 (Operational Efficiency) is achieved through the full integration of digital tools and community

participation, leading to streamlined and sustainable operations. (Kristina 2014; Kharisma *et al.*, 2023) emphasize that adaptability, technological innovation, and operational continuity are key factors in maintaining the long-term viability of waste banks.Overall, these transformative stages reflect a strategic trajectory toward implementing a community-based circular economy, echoing the circular economy models in agriculture and industrial sectors in Indonesia (Velasco-Muñoz *et al.*, 2021; Siregar *et al.*, 2023).Support for the technology-driven transformation is also evident through the integration of digital systems into waste bank management. As discussed by (Fatah *et al.*, 2023; Yunita et al. 2021; Budiarto *et al.*, 2020), the use of digital applications and web-based systems significantly enhances transparency and efficiency in waste management.

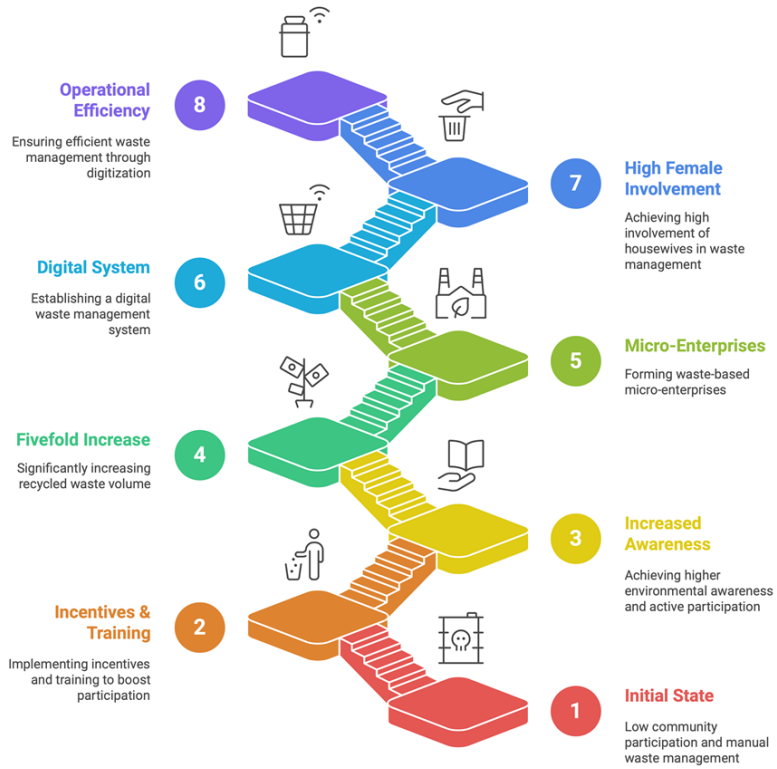

Figure 3. Transformation of waste management.

In conclusion, the results of the Kwadungan Gunung Village waste bank program confirm that its success is largely attributed to the combination of efficient management systems, participatory education, and community empowerment. The increased community involvement, creation of new micro-enterprises, and successful adoption of circular economy principles are clear indicators of the program's effectiveness. These findings are in line with (Maimunah *et al.*, 2024), who argue that empowerment through waste banks not only benefits the environment but also strengthens local economic resilience. Ultimately, the Kwadungan Gunung Village case study reinforces the importance of sustainable business models, as suggested by (Muafi *et al.*, 2022), where well-structured waste management systems and community participation are key factors in building resilient and sustainable local economies. Therefore, the experience of Kwadungan Gunung Village can serve as a valuable reference for other communities looking to develop community-participatory circular economy initiatives, supported by applied technology.

CONCLUSION

The implementation of a community-based waste bank transformation in Kwadungan Gunung Village demonstrates the effectiveness of a participatory approach in creating a structured and sustainable waste management system. The research findings indicate that increased awareness and community participation in waste sorting and recycling activities can be achieved through the application of a digital operational system supported by an incentive mechanism. Additionally, this

program has encouraged the emergence of micro-enterprises based on waste utilization, contributing to increased household income and local economic resilience.

This success affirms that local-scale interventions with a community-based approach can act as a catalyst for the application of circular economy principles, while having a tangible impact on strengthening the economy and environmental preservation. The study also presents an integrative model that can be replicated in other regions facing similar challenges. To support the sustainability and scalability of the program, further research is recommended to explore waste-based product innovations and to conduct long-term analysis on its impact on local economies and environmental sustainability.

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