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Empowerment of Local Government Officials in Managing Waste to Support Sustainable Development (Case Study in Lebak Regency)

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Abstract

The circular economy emerged as a response to the aspiration to realize sustainable development in anticipation of production and consumption pressures on natural resources and the environment. In this economic system concept, waste management is carried out optimally, where the result of recycling waste will be a value-added product while reducing waste residue. The objectives of the community service program are to provide solutions to waste management problems in Lebak Regency, provide alternative business development using appropriate technology so that there is an increase in the economy of the community in Lebak Regency, and at the same time, build disciplined behavior in maintaining the environment. This service method uses Participatory Action Research (PAR), which involves community members as co-researchers in identifying educational needs, developing strategies, and implementing solutions. Furthermore, the method used was through the delivery of socialization to participants in a hybrid manner. The socialization material includes (i) the importance of waste processing, (ii) how to sort waste, and (iii) economic added value from waste processing. The results of community service are in the form of solving problems the community faces by utilizing the expertise of relevant academicians related to waste management in Lebak Regency, West Java. Furthermore, the implication of this community service is to increase literacy and awareness among government officials about adequate waste management so that they can manage waste in their areas to reduce the negative impact of landfills.

Keywords Circular Economy; Community Service; Economic Added Value; Lebak Regency; Waste Management

1. INTRODUCTION

In Indonesia, waste management has become a significant environmental challenge. The rapid increase in waste production is primarily due to the country's growing population and economic expansion production (Arafah et al., 2018; Nugroho et al., 2017; Utami et al., 2021). According to the World Population Review, Indonesia was among the top four plastic waste-producing countries in 2018, alongside China, India, and the United States (Mutia, 2022). Data from the Ministry of Environment and Forestry indicate that Indonesia generated approximately 67.8 million tons of waste in 2020, with an average daily production of 185,753 tons by its 270 million inhabitants (Setiawan et al., 2021). Despite these staggering numbers, the waste management infrastructure remains inadequate, with numerous landfills failing to meet proper standards (Meidiana & Gamse, 2011; Munawar et al., 2018).

To better understand Indonesia's waste management challenges, comparing its practices with other countries facing similar issues is helpful. For instance, Japan has developed an advanced waste management system with strict regulations, extensive recycling programs, and public education on waste separation (Mekonnen & Tokai, 2020; Ogushi & Kandlikar, 2007). In Germany, implementing the Green Dot system and producer responsibility regulations have significantly reduced waste generation and increased recycling rates (Brindha et al., 2023; Ferreira et al., 2016)). South Korea has also made significant strides by adopting a pay-as-you-throw system, where citizens are charged based on the amount of waste they produce, thus encouraging waste reduction and recycling (Shvetsova & Lee, 2020; Yoon et al., 2022). Moreover, South Korea's waste management initiatives, including the pay-as-you-throw system, are part of the country's broader efforts to transition towards a resource-circulating society focused on conservation and sustainability (Bułkowska et al., 2023). Adopting innovative waste management strategies, such as the pay-as-you-throw scheme, reflects South Korea's proactive approach to addressing environmental challenges and promoting a circular economy model.

In contrast, Indonesia still faces several hurdles, including limited recycling facilities, inadequate enforcement of waste management regulations, and a lack of public awareness regarding waste segregation and recycling. The large amount of waste, coupled with these systemic challenges, makes controlling the waste problem in Indonesia particularly difficult. To address these challenges, Indonesia could benefit from adopting best practices from these countries. For example, improving the enforcement of waste management laws, increasing public awareness and education on waste separation, and implementing economic incentives for waste reduction could

help Indonesia achieve more effective waste management. By learning from the successes and challenges faced by other countries, Indonesia can develop a more robust and sustainable waste management strategy that aligns with global standards and addresses its unique environmental challenges.

Thus, the large amount of waste, the lack of adequate waste management facilities, and the need for more public understanding of waste management are the main obstacles to controlling the amount of waste in Indonesia. Landfills or piles of waste that are not handled properly can cause various negative impacts, both on the environment and human health. If illustrated, the negative impacts of garbage piles include:

Figure 1. Negative Impacts of Landfill that is not Managed Properly

Source: Siddiqua et al. (2022), Hussain et al. (2020), Alam & Ahmade (2013), and Arrigo (1994)

Following Figure 1 above, it can be explained the negative impacts of landfills that are not appropriately managed as follows:

- Soil and Water Pollution: Decomposing garbage in sewage piles produces a residual liquid called "leachate." This leachate can contaminate soil and water with harmful substances such as heavy metals, chemicals, and pathogenic bacteria (Siddiqua et al., 2022). This pollution can damage ecosystems and threaten the quality of water used for drinking and agriculture.
- Air Pollution: The decay and incomplete combustion of garbage in waste piles produces toxic gases such as methane and carbon monoxide (Hussain et al., 2020). These gases contribute to the greenhouse effect and air pollution, which can lead to respiratory health problems and climate change.
- Public Health: Poorly handled garbage piles can become breeding grounds for disease vectors such as mosquitoes, rats, flies, and other insects (Alam & Ahmade,

2013). This increases the risk of transmission of diseases such as malaria, dengue, and other infectious diseases to humans.

- Drainage Congestion: If garbage accumulates in drainage canals or rivers, it can cause congestion in the water flow. This can potentially cause flooding, especially during the rainy season (Arrigo, 1994).
- Habitat Destruction: Landfills often destroy natural habitats, damage ecosystems, and disrupt the lives of local flora and fauna (Angelis-Dimakis et al., 2022; Dontala et al., 2015).

Furthermore, based on data from the Lebak Regency Environmental Office in 2022, 80 percent of waste in Lebak Regency cannot be handled optimally. Of the 553.70 tons of waste daily, only 132 tons can be handled. The waste that enters the landfill is only about 20 percent or 132 tons of waste. The rest are thrown into gardens, landfills, or rivers and sewers. In handling waste, the Lebak Regency Government (Pemda) only relies on the General Allocation Fund (DAU) amounting to Rp 2 M. The budget was divided into fleet, officer honor, and mobility costs. Therefore, there is a desire for the Lebak Regency Government for waste management composted but constrained by the scarcity of resources (human resources and funding). Compost is an environmentally friendly natural fertilizer that can improve soil structure and increase water storage capacity in Lebak Regency.

Furthermore, the problem of unhandled waste management occurs in landfills (TPA) in various sub-districts in the Lebak Regency. The garbage piles occur, especially in Rangkasbitung Market, which has resulted in a disturbing odor because the fleet of garbage carriers is minimal. However, based on data from the Lebak Regency Government in 2020, the waste composition reveals that public facilities are the dominant source, generating 134.2 tons of waste. This is followed closely by industrial estates, which produced 131.3 tons, and offices contributing 119.8 tons. Household waste accounted for 1.3 tons, while markets, businesses, and miscellaneous sources contributed 8 tons, 50.3 tons, and 69.3 tons, respectively (Permana et al., 2024). Given that waste from public facilities constitutes the most considerable portion, the Lebak Regency government must implement an effective waste management strategy specifically tailored to address the substantial waste generated by these public spaces.

Referring to the phenomena mentioned above, community service from lecturers at Mercu Buana University in collaboration with the University of Malaysia Terengganu held a socialization of waste handling in Lebak Regency aimed at village officials and managers of village-owned enterprises (BUMDes) in Lebak Regency, especially to village officials and BUMDes managers whose areas have landfills. The

material presented in this socialization focused on three key aspects: (i) the importance of waste treatment, (ii) how to sort waste effectively, and (iii) the economic added value that can be derived from waste processing. This community service initiative aimed to enhance government officials' literacy and awareness regarding adequate waste management practices. Equipping them with the necessary knowledge will empower these officials to implement effective waste management strategies in their areas, ultimately reducing the negative environmental impacts associated with landfills. This research specifically focuses on evaluating the effectiveness of policy implementation in waste management, examining the potential of technological solutions, and assessing the broader environmental impacts of waste management practices in Indonesia.

2. METHODS

The Participatory Action Research (PAR) approach was employed, which views community members as active collaborators in understanding and addressing their educational needs. This method involves a cooperative and ongoing process where community members, educators, and researchers join forces to pinpoint educational challenges, devise strategies to tackle these issues and implement lasting solutions. By placing community voices and perspectives at the center, PAR fosters a sense of ownership and empowerment throughout the process. The method used in this community service is socialization with village officials and BUMdes managers in Lebak Regency. The socialization method is an approach or a way to introduce and improve literacy related to waste processing among village officials and BUMDes managers. The socialization was carefully designed and divided into several sessions, each with specific objectives to address key areas of waste management. The first session focused on raising awareness about the importance of waste treatment, emphasizing the environmental and health impacts of improper waste disposal. This session aimed to equip participants with a foundational understanding of why effective waste management is crucial for sustainable community development.

The second session provided practical training on how to sort waste effectively. The objective was to ensure that participants could apply waste sorting techniques in their communities, reducing the volume of waste sent to landfills and facilitating recycling and composting processes. This session included demonstrations and interactive activities to reinforce learning.

The third session introduced the concept of adding economic value to waste processing. Participants were trained on how waste can be transformed into valuable

products, such as compost or recycled materials, creating potential income streams for their communities. This session aimed to shift the perspective of waste from being a problem to an opportunity for economic development.

The socialization was conducted in a hybrid format. Prof. Wiwik Utami from Mercu Buana University led the on-site training at the Multipurpose Building in Lebak Regency, attended by 50 village officials and BUMDes managers. Dr. Zuha Rosufila Binti Abu Hasan from the University of Malaysia Terengganu and Rido Nataatmaja, Secretary of the Village Community Empowerment Office in Lebak Regency, also contributed to the sessions. The event occurred on March 18, 2023, from 09:00 to 15:00.

Nevertheless, a detailed questionnaire was administered to participants at the end of the training to evaluate the program's effectiveness. The questionnaire included a Likert scale to gauge participants' understanding of the material, their confidence in applying the skills learned, and their overall satisfaction with the training. The data collected were analyzed using statistical methods to assess the program's success rate, identifying areas of strength and aspects needing improvement. This thorough evaluation ensured the program's impact was measurable and provided insights for future community service activities. Moreover, the flyers for the community service event are as follows:

Figure 2. Community Service Event Flyer

3. FINDINGS AND DISCUSSION

The international community service collaboration between Mercu Buana University, the Lebak Regency Government in West Java, and Malaysia Terengganu University brought together 50 participants, including village officials and managers of BUMDes (Village-Owned Business Entities) in Lebak Regency. The program was

carefully designed to address pressing waste management issues. It was divided into three comprehensive training sessions, each targeting key areas for the participants to implement in their communities.

The first session, titled "Training on the Importance of Waste Treatment," was delivered by a diverse team of experts, including Rido Nataatmaja, Wiwik Utami, Yusliza Mohd. Yusoff, Zikri Muhammad, and Zuha Rosufila Binti Abu Hasan. This session began with an in-depth discussion of Indonesia's significant challenges in waste management and landfills. The trainers highlighted five primary causes of these issues: rapid population growth, a general lack of public awareness, insufficient regulation and law enforcement, unsustainable industrial development, and poor consumption patterns. These factors have led to an escalating waste crisis, exacerbated by the country's urbanization and economic growth. Participants were mainly engaged during the discussion on the role of rapid population growth, which, as Lestari & Trihadiningrum (2019) Explained contributes to the increasing volume of waste produced by communities.

The session also addressed the critical issue of low environmental awareness among the Indonesian populace, which Kurniawan et al. (2023) Identified as contributing to widespread littering and the irresponsible use of harmful chemicals. This lack of awareness is compounded by the weak regulatory framework and poor enforcement of existing environmental laws, as discussed by Van Rooij (2010), which allows both companies and communities to contribute to environmental pollution with little accountability. Participants were encouraged to consider the role of governance in improving these conditions and were provided with examples of how effective regulation and enforcement could significantly mitigate waste-related issues.

As highlighted by Ariana et al. (2022), unsustainable industrial practices were another focal point, with the trainers emphasizing how industrial activities that do not prioritize environmental sustainability lead to high levels of waste and emissions. The participants were introduced to circular economy principles, which promote redesigning industrial processes to minimize waste and maximize resource efficiency. The session concluded with a discussion on poor consumption patterns, particularly the excessive use of disposable products, which Rodić & Wilson (2017) They were identified as a significant contributor to the waste problem in Indonesia. The participants were encouraged to promote sustainable consumption practices within their communities, advocating for reduced use of single-use plastics and other disposable items.

To address these multifaceted challenges, the trainers outlined a series of recommended actions, emphasizing the need for collaborative efforts among the government, industry, and the broader community. Key strategies included raising public awareness about the importance of environmental protection, enhancing regulations and law enforcement, developing and implementing environmentally friendly technologies, reducing reliance on fossil fuels, and promoting policies that support renewable energy. The session provided practical steps that participants could take to implement these strategies in their communities, such as organizing local awareness campaigns and advocating for more robust environmental policies at the local government level.

The second session, "Training on How to Sort Waste," was conducted by Agustin Fadjarenie, Lin Oktris, and Lucky Nugroho. This session focused on the practical aspects of waste management, specifically sorting waste into various categories based on its characteristics and sources. The trainers explained the different types of waste—organic, inorganic, hazardous (B3), and electronic (E-waste)—and their respective management practices. Participants were given hands-on experience in waste sorting, with activities designed to help them understand the significance of proper waste segregation in reducing environmental impact.

The session began with a discussion on organic waste, which consists of biodegradable materials such as food scraps, leaves, fruit peels, and plant debris. Ayilara et al. (2020) and Ahmad et al. (2007) They noted that organic waste could be effectively processed into compost, a valuable resource for improving soil fertility. The trainers demonstrated the composting process and explained how village officials and BUMDes managers could implement community composting programs. This practical demonstration was particularly well-received by the participants, many of whom expressed interest in starting composting initiatives in their villages.

Next, the session covered inorganic waste, which includes materials like plastic, paper, metal, glass, and synthetic fabrics. Brunner & Rechberger (2015) They highlighted the challenges associated with inorganic waste, which does not decompose naturally and often requires advanced recycling or processing methods to mitigate its environmental impact. The trainers provided examples of successful recycling programs and discussed how these could be adapted to the local context in the Lebak Regency. Participants were encouraged to identify and categorize inorganic waste in their communities and were given tools and strategies to promote recycling initiatives.

Hazardous waste (B3), which includes chemicals or materials that pose a risk to human health and the environment, was another critical topic. Vandecasteele et al. (2007) and Karthikeyan et al. (2018) emphasized the importance of carefully managing and disposing of hazardous waste to prevent contamination and harm. The trainers discussed the challenges of managing hazardous waste in rural areas and provided guidelines on safe disposal practices, including the use of protective equipment and adherence to regulatory standards. The session also addressed electronic waste (E-waste), which comprises discarded electronic devices such as mobile phones, computers, and household appliances. Kiddee et al. (2013) and Heacock et al. (2016) highlighted the environmental hazards posed by e-waste, particularly toxic materials like mercury and lead. The trainers provided strategies for safe E-waste management and encouraged participants to explore opportunities for recycling and repurposing electronic components.

In addition to these detailed explanations, the trainers offered practical tips for waste sorting, such as using color-coded bins to distinguish between different types of waste and labeling containers clearly to facilitate proper disposal. Participants were also encouraged to engage in community education efforts, sharing their knowledge with family members, friends, and colleagues to promote better waste management practices. Feedback from participants indicated that this session was one of the most valuable aspects of the training, with many noting that the hands-on activities helped them better understand the complexities of waste sorting and management.

The third session, "Training to Add Perspective on the Economic Added Value of Waste Processing," was led by Apollo Daito, Ronny Andesto, and Ratna Mappayunki. This session focused on the economic potential of waste processing using modern technologies. The trainers introduced participants to various waste processing technologies that could reduce waste's negative environmental impact and increase waste management practices' efficiency. This session was particularly relevant for BUMDes managers, as it provided insights into how waste could be transformed from a burden into a valuable resource that contributes to local economic development.

The trainers began by discussing recycling technologies, which allow plastic, paper, metal, and glass to be reprocessed into new products. They explained the different methods used in recycling plants, including mechanical separation, washing, and chemical processing, and provided examples of successful recycling businesses. Participants were encouraged to explore opportunities for establishing local recycling

initiatives, with the trainers highlighting the potential economic benefits of creating new business opportunities in the recycling industry.

Next, the session covered composting technology, which processes organic waste into compost as Ayilara et al. (2020) and Mohamed et al. (2020) compost is a natural, valuable fertilizer that can significantly enhance soil fertility. The trainers demonstrated the composting process and discussed how participants could implement composting projects in their communities as standalone initiatives or in collaboration with local agricultural businesses. The potential for selling compost as a commercial product was also discussed, with participants expressing interest in exploring this avenue to generate income while contributing to environmental sustainability.

Thermal processing technologies, including incineration and pyrolysis, were also discussed. Incineration involves burning waste at high temperatures, converting it into ash and thermal energy that can be used to generate electricity or heating (Singh & Prakash, 2007). Conversely, pyrolysis decomposes waste without oxygen to produce gas and fuel oil (Kabeyi & Olanrewaju, 2023). The trainers emphasized the importance of carefully managing these processes to minimize environmental impact and maximize energy recovery. Participants were introduced to the concept of Waste-to-Energy (WTE) technology, which has the potential to transform waste into a valuable energy resource. This discussion was particularly well-received, with many participants wanting to learn more about how WTE technologies could be implemented in their communities.

The session also covered anaerobic composting technology, a biological process that decomposes organic waste without oxygen, producing biogas that can be used as an energy source and a nutrient-rich liquid fertilizer (Sofiyah & Fikri, 2021). Participants were provided with examples of successful anaerobic digestion projects and were encouraged to consider this technology as a viable option for waste management in their areas.

Another key topic was Mechanical-Biological Treatment (MBT), which combines mechanical and biological processes to manage waste (Ham et al., 2019). The trainers explained how MBT systems could separate different types of waste and process them according to their characteristics, resulting in a more efficient and sustainable waste management system. Participants were given an overview of how MBT technology works and how it could be integrated into existing waste management practices.

Finally, the session covered smart technologies, such as automated waste collection systems with sensors, IoT-based surveillance (Internet of Things), and data

analysis tools designed to optimize waste management efficiency and timeliness (Vishnu et al., 2021). The trainers discussed the potential benefits of adopting smart technologies in waste management, including improved accuracy in waste sorting, reduced operational costs, and enhanced data-driven decision-making. Participants were encouraged to explore incorporating these technologies into their local waste management strategies, particularly in urban areas with more complex challenges.

The economic value of waste processing was a central theme throughout the session. The trainers emphasized the importance of viewing waste as a problem and a potential resource that can generate income and contribute to local economic development. Several steps were outlined to increase the economic value of waste, including focusing on recycling programs to turn waste into reusable raw materials, selling or exchanging recycled materials with recycling collectors or plants, processing organic waste into compost for sale as organic fertilizer, and utilizing Waste-to-Energy (WTE) technology to generate electricity or heat that can be sold or used locally. Participants were particularly interested in the potential for developing green industries and using clean technology to reduce waste and emissions while creating new business opportunities.

A detailed questionnaire was administered to participants at the end of the training to evaluate the program's effectiveness. The questionnaire provided both quantitative and qualitative data on participants' experiences and the impact of the training on their knowledge and skills. The results indicated that 80% of participants (40 out of 50) found the socialization highly beneficial and desired future sessions to be held in their areas. These participants highlighted the practical aspects of the training, particularly the waste sorting techniques and the introduction to Waste-to-Energy technologies, as the most valuable components. They also appreciated the hands-on activities, which helped them better understand and apply the concepts in their communities.

Regarding suggestions for improvement, participants recommended that future sessions include more in-depth training on specific waste processing technologies and extended hands-on activities that allow for more practical experience. Additionally, some participants expressed interest in learning more about securing funding and resources to implement waste management projects in their communities. The trainers acknowledged these suggestions and noted that they would be considered in the planning of future programs.

Quantitative data from the questionnaire showed a 25% increase in participants' knowledge and skills related to waste management, demonstrating the program's

effectiveness. This increase was particularly notable in areas related to waste sorting and the economic value of waste processing, indicating that these were the areas where participants gained the most new knowledge. The program's success was further evidenced by the positive feedback from participants, many of whom expressed a commitment to implementing the practices they had learned in their communities.

The community service initiative is expected to serve as a foundation for further empowerment efforts in Lebak Regency, with village heads and BUMDes managers crucial in promoting sustainable waste management practices. The program can significantly impact the region's environmental sustainability and economic development by equipping these local leaders with the knowledge and skills they need to manage waste effectively. The collaboration between Mercu Buana University, the Lebak Regency Government, and Malaysia Terengganu University models future international partnerships to address global environmental challenges through local action.

Furthermore, evidence of the implementation of this empowerment program to the community is shown in the documentation in the form of photographs at the time of implementation as follows:

Figure 3. Documentation of Community Service Implementation

4. CONCLUSION

The implementation of community socialization and empowerment in Lebak Regency in 2023 has been carried out in line with the fulfillment of the Community Service Results Standard, which is the minimum criterion for community service in applying, practicing, and cultivating science and technology to advance the general welfare and educate the nation's life, especially in waste management. The results of community service are in the form of solving problems the community faces by utilizing the expertise of relevant academics related to waste management. Problem-solving was faced by the community in Lebak Regency by providing socialization and education to the village head and BUMDes manager.

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