

INTEGRATED PLASTIC WASTE MANAGEMENT INNOVATION IN BANYUMAS: TRANSFORMING ENVIRONMENTAL THREATS INTO ECO-FRIENDLY PRODUCTS AND ECONOMIC OPPORTUNITIES

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Abstract

Plastic waste management is one of the pressing environmental challenges in Indonesia. Banyumas Regency responded to this problem by developing an integrated plastic waste management innovation through the “SUMPAH BERUANG” (acronym in Bahasa Indonesia: Sulap Sampah Menjadi Uang; Magic Waste into Money) program. This program aims to transform the environmental threat posed by plastic waste into environmentally friendly products with economic value. This innovation involves using two digital applications, namely SALINMAS for organic waste management and JEKNYONG for inorganic waste, as well as the application of mechanical technology that accelerates the recycling process. Plastic waste is processed into products such as paving blocks, which have been applied in several locations, including around Menara Teratai and pedestrian area in Purwokerto. This study analyzes the program's impact from various aspects, such as the environment, economy, and society. The results show that plastic waste management has succeeded in significantly reducing the volume of waste, reducing the use of natural materials such as sand, and encouraging the implementation of recycling practices in the community. From an economic perspective, this program also creates new jobs in the recycling and construction sectors. However, there are challenges related to initial investment costs and potential gas emissions during recycling. This plastic waste management innovation provides a sustainable solution to minimize adverse environmental impacts while opening up new economic opportunities.

Keywords: Plastic Waste Management, Recycling, Environmental Innovation, Environmentally Friendly Products, Banyumas.

A. INTRODUCTION

The environment is where all creatures live, from humans to plants and animals, and is the most significant factor influencing human health (Saputra et al., 2022). However, the increasing human population and rapidly developing social and economic activities have caused the environment to face various unavoidable problems. One of the biggest problems is environmental damage caused by massive land clearing to meet human needs (Hussain & Reza, 2023). This land-clearing process often produces waste or garbage, either in solid, liquid, or gas form. Waste is considered useless material, significantly impacting environmental health if not managed properly (Choudhary et al., 2024).

Waste has various types that can be grouped based on origin and nature. Organic waste comes from natural materials such as food scraps, leaves, and twigs, which are more easily decomposed by microorganisms. On the other hand, inorganic waste such as plastic, metal, and glass have properties that are difficult to decompose and take a very long time to decompose naturally. In addition, in this modern era, electronic waste and hazardous or toxic waste (B3) present their own challenges in their management (Lu et al., 2020). The stigma of society regarding waste also worsens the situation because many consider all types of waste dirty and disgusting. As a result, the solutions taken are often not environmentally friendly, such as burning waste that produces air pollution or throwing it carelessly, leading to environmental pollution.

According to data collected in 2022, Indonesia produced 19.45 million tons of waste, and 6.79 million tons of that amount was unmanaged. This situation indicates a significant challenge that must be faced in waste management efforts (KEMENKO PMK, 2023). The World Economic Forum warns that if this situation continues, plastic in the ocean could exceed the number of fish by 2050 (Zero Waste Indonesia, 2024). This strongly warns us to take preventive and strategic steps immediately. Based on data from the National Waste Management Information System (Sistem Informasi Pengelolaan Sampah Nasional/ SIPSN), Central Java became the province with the most significant waste contribution in 2022, contributing 5.76 million tons. In total, 364 districts/cities in Indonesia produce 38.2 million tons of waste per year, but only around 13.67% has been reduced, and 48.12% can be handled. This means that 38.21% of waste is still not appropriately managed (Kementerian Lingkungan Hidup dan Kehutanan, 2024).

This waste management problem requires serious attention from various parties, including the government, the community, and international organizations. Data from the National Research and Innovation Agency (Badan Riset dan Inovasi Nasional/ BRIN) in 2024 showed that 38.21% of unmanaged waste could pollute the environment, create pollution, and reduce the quality of public health (BRIN, 2024). Therefore, a more effective and integrated waste management strategy is needed. One proposed approach is to strengthen waste reduction and management regulations, increase the capacity of waste processing infrastructure, and educate the public to care more about waste management. Education programs involving the community will increase awareness of the importance of sorting and managing waste.

Banyumas Regency, with a population of 1.80 million (Meliyana et al., 2023), faces significant waste management challenges. With an average waste production of 532 to 550 tons daily, Banyumas face land limitations that make waste management increasingly complex. The lack of adequate final disposal sites, landfill (Tempat Pembuangan Akhir/ TPA) and the suboptimal waste transportation system results in much waste that is not managed correctly. The community feels negative impacts directly in the form of air, soil, and water pollution (Ma'rup & Kurniasih, 2023). Therefore, innovative and sustainable efforts are needed to address this problem, such as increasing waste processing sites and promoting effective recycling practices.

One solution that can be implemented is community-based waste management. In this strategy, the community actively manages their waste, from sorting to recycling the waste produced. On the other hand, the government acts as a motivator and facilitator that provides the infrastructure and education needed by the community (Suryani, 2014). This approach is considered adequate because the community understands the conditions of the environment around them better, and the decisions taken can be adjusted to the needs and priorities of each region. Programs like this can also create new economic opportunities, for example, by supporting the recycling industry or making environmentally friendly products from managed waste.

Efficient and sustainable waste management does require strong collaboration between the government, community, and private sector. Without this cooperation, waste management challenges will continue to grow as the population increases. Increasing public awareness and participation in managing waste is essential to creating a healthy and sustainable environment. With a planned strategy, commitment, and cooperation, the waste problem in Indonesia can be resolved gradually, and a cleaner and healthier environment can be realized for future generations.

This article emphasizes the importance of adopting an integrated and sustainable waste management strategy involving synergy between government, communities, and the private sector. The increasing waste problem requires a data-driven approach and solid international collaboration to reduce the negative impact on the global environment. We can create a healthier and more sustainable ecosystem by strengthening public awareness, introducing technological innovations in waste management, and implementing appropriate policies. This article is expected to provide insights and inspiration for researchers, practitioners, and policymakers to play an active role in developing real solutions that can be implemented globally. This collaborative effort is essential for a greener and more sustainable future.

B. RESEARCH METHOD

This research method uses a literature-based approach, which emphasizes collecting data and information from secondary sources. These sources include scientific articles, research reports, government publications, and other relevant and reliable academic documents. This process aims to understand the issues raised comprehensively (Saputra et al., 2023), namely plastic waste management and recycling efforts that can support environmental sustainability. This study not only relies on one type of source but also combines various in-depth perspectives to ensure the completeness and validity of the data.

The initial step in the data collection process involves identifying and selecting high-quality literature sources. The selection of sources is based on criteria such as relevance, accuracy, and contribution to understanding the research topic (Hermawan et al., 2024). In this context, previous research on the characteristics of plastic waste is fundamental, especially to understand the properties of plastic that affect the recycling process. In addition, different recycling methods, both conventional and innovative, are also studied in detail to determine the effectiveness and efficiency of each technique. Relevant literature also includes case studies in various countries that have successfully implemented plastic recycling solutions with positive impacts on the environment.

Furthermore, this study further examines the environmental and economic impacts of using recycled paving blocks as a product of plastic waste processing. This study evaluates how much-recycled products can reduce plastic waste and provide significant economic value. Through this literature-based approach, the study is expected to identify best practices in plastic waste processing that are environmentally friendly and provide financial benefits. Thus, the study's results can provide concrete recommendations and contribute sustainably to global efforts in dealing with plastic waste problems.

C. FINDINGS AND DISCUSSION

Banyumas Regency became one of the leading causes in 2016 of the impacts due to waste that was not handled properly. The Gunung Tugel TPA's closure was caused by residents' reactions to local air pollution, including healthy water turning brown, polluted rice fields, and the resulting

odor. Waste management at the TPA uses the open dumping method or is built as a whole so as not to cause prolonged impacts. Not only that, but limited land also contributed to the development of the Gunung Tugel TPA (Darmawan, 2018). Because of this, the number of samples that have been used cannot be used anymore. From the samples that have been used and cannot be used anymore, it is estimated that only around 65% of all local waste can be taken. Based on research, the Kaliori TPA is the longest TPA with an area of 4.5 hectares, and 3.5 hectares are used. The TPA capacity reaches 1.4 million m³. The Kaliori TPA has become a disposal site that almost accommodates all waste in Banyumas after the closure of the Gunung Tugel TPA. After the Gunung Tugel landfill was closed, the final waste disposal was moved to the Kaliori landfill (Ma'rup & Kurniasih, 2023).

The same thing happened again in early 2018; in April, the villagers around the Kaliori landfill in Kaliori Village, Kalibagor District, Banyumas, held a demonstration by blocking the road to the village landfill. Their reason for doing this was none other than environmental pollution caused by the existence of the landfill. They said that the pollution caused was not only odor but also water pollution. The residents' wells in the area were initially able to be used by the surrounding community. Now, they can no longer be used because of the water pollution. In addition to pollution in healthy water, pollution from the landfill also spreads to residents' rice fields, where the water that enters the residents' rice fields is brown, making the rice fields unsuitable for planting rice.

The various types of pollution mentioned above have caused significant losses for residents around the landfill. This can happen because at least 960 tons of waste are dumped at landfills. Nine hundred sixty tons of trash is not a tiny number of garbage dumped daily; it is only natural that environmental pollution occurs because of it. In addition, the community around the Karangklesem landfill, South Purwokerto, also complained about a landfill around their homes. This is because the landfill causes an unpleasant odor to the surrounding environment. This makes the air produced also interfere with the breathing of residents. The limited number of landfills causes the existing problems.

Furthermore, it leads to over-capacity or excess capacity. From this phenomenon, social deviations will later arise in society. The wider community considers Waste and the environment trivial, so many people throw garbage in rivers, roadside gutters, and other places. In addition, the community around the landfill in Karangklesem, South Purwokerto, also complained about a landfill around their homes. This is due to the emergence of an unpleasant odor in the surrounding environment so that the air produced also interferes with residents' breathing. This is due to the limited number of landfills, which leads to over capacity or capacity. On the contrary, the result is the emergence of social deviations in society. Many people take the waste and the environment lightly. Many people in society throw garbage in rivers, roadside gutters, and other places (Pradana & Yuwono, 2023).

The Banyumas Regency government is trying to overcome environmental pollution by innovating "SUMPAH BERUANG," or Magic Waste into Money (Ma'rup & Kurniasih, 2023). This innovation is carried out through 3 stages, including providing two applications at the household level, namely the SALINMAS application for organic waste and JEKNYONG for inorganic waste, changing manual processing to mechanical so that the process will be faster. Furthermore, plastic waste is being changed into goods (Nurisusilawati & Qista Karima, 2023).

Through this SUMPAH BERUANG, it is hoped that the waste problem in Banyumas can be resolved. This policy is stated in Regional Regulation No. 8 concerning Waste Management, Banyumas Regent Regulation No. 45 of 2018 concerning the Strategic Policy of Banyumas Regency

concerning Household Waste Management and Similar Waste, with a target of 30% waste reduction, and 70% waste handling in 2025, and Circular of Banyumas Regent Number 660.1/7776/2018, concerning Changes in Waste Handling from Collecting, Transporting, Disposing of to TPA Changed to Sorting Waste, Utilizing Waste, and Destroying the Rest at the Source.

The SUMPAH BERUANG Program has been implemented in 25 Integrated Waste Disposal Site (Tempat Pembuangan Sampah Terpadu/ TPSP), one of which is TPSP Kedungrandu. This TPSP serves waste from 3,100 customers consisting of at least 3,067 KK (Family Card) household waste and 33 non-household waste. This TPSP is processed and managed through cooperation between Community Self-Help Groups (Kelompok Swadaya Masyarakat/ KSM) and regional owned enterprises (Badan Usaha Milik Daerah/ BUMD), namely PT. BIJ (Banyumas Investama Jaya). There is also a TPA Based on the Environment and Education (Berbasis Lingkungan dan Edukasi/ BLE) in Wlahar Wetan Village, Banyumas Regency, one of the superior innovations in waste management that has become a pilot project for TPA development nationally.

What distinguishes this BLE TPA from other conventional TPAs is the educational approach applied. This TPA is often a visiting location for the community, students, and academics who want to learn about effective waste management. Educational programs at this landfill provide visitors with an understanding of the importance of reducing, sorting, and recycling waste from the source. Through socialization and training, this landfill has changed people's mindsets to care more about the environment. As a national model, the BLE landfill in Wlahar Wetan Village has also inspired other local governments in Indonesia to develop a sustainable waste management system. This landfill proves that with proper management, waste that has been considered a significant problem can be turned into a valuable resource while contributing to preserving the environment. This innovation also encourages community participation in maintaining cleanliness and creating a healthier environment.

In this SUMPAH BERUANG program, the existing waste must be sorted into organic and inorganic. This sorting uses the SALINMAS application for organic waste and JEKNYONG for inorganic waste. This application has been operating for the past two years and has over a thousand users. This shows a high level of enthusiasm from the community (Agustono et al., 2024). After sorting through the application, the organic waste will be purchased by KSM through the application for Rp. 400/kg. Later, the organic waste will be processed into compost and maggot feed. The Environmental Service will later purchase this product for Rp. 1,000/kg will then be distributed to farmer groups for free per the Regent's policy.



Figure 1. SALINMAS Website

Source: (salinmas.banyumaskab.go.id, 2024)

As for inorganic waste, through the JEKNYONG application managed by PT. BIJ. Inorganic waste is divided into two types: high and low. For low-value inorganic waste, most of which is plastic, will be processed into paving blocks and plastic tiles, which the Regional Government will then purchase through the Public Works Department for IDR 160,000/M² for road construction in the local area, such as those that have been built around Menara Teratai, Purwokerto. Another processed material is RDF (Refuse-Derived Fuel), an alternative fuel for cement factories to replace coal. RDF processed by TPST in the Banyumas area is sent to PT. Solusi Bangun Indonesia (PT.SBI) Plant Cilacap by the KSM Cooperative. This KSM Cooperative was formed on KSM's initiative to bridge the partnership between PT. SBI Cilacap with KSM. The amount of RDF sent to SBI averages 30 tons daily for IDR 375,000/ ton. In addition, PT. Unilever Indonesia participates in this program with an IDR 125,000/ ton cost sharing. If calculated, the total RDF sales are IDR 500,000/ ton. Meanwhile, high-value inorganic waste will later be processed with a Gibrik machine to shred the waste into plastic pellets (BanyumasKab, 2022).

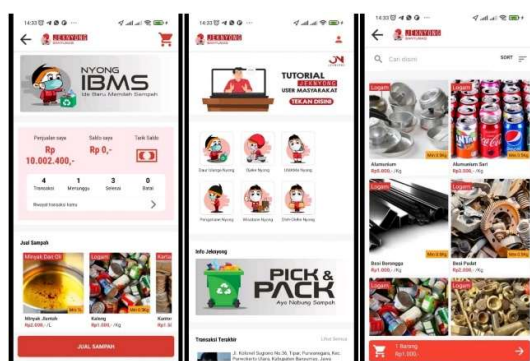


Figure 2. JEKNYONG Application
Source: (jeknyong.banyumaskab.go.id, 2024)

Waste management in Banyumas Regency has shown significant results, especially in reducing plastic waste. Banyumas have succeeded in processing around 98% of waste, with only 2% still going to the TPA. This is much better than many cities in ASEAN, which can only manage around 20% of their waste. One of the main approaches is using plastic waste in RDF, which is used as an alternative fuel for cement factories, replacing coal (Das et al., 2023).

Several negative impacts need to be considered when processing plastic into paving blocks. The improper plastic burning process can later produce hazardous gas emissions such as dioxins and furans. This will later hurt human health and the surrounding environment. Burning waste using an incinerator will produce flue gas containing various pollutants. Following existing government regulations, flue gas must go through a series of cleaning processes before being disposed of to meet quality standards. The flue gas produced by waste incinerators consists of particles and toxic gases. To meet environmental quality standards before being discharged into the environment, this flue gas must be processed using Air Pollution Control (APC) equipment. Various pollutants in the exhaust gas must be reduced using a series of pollutant control devices to meet the emission quality standards (Baku Mutu Emisi/ BME) by the Regulation of the Minister of Environment and Forestry No. 70 of 2016 concerning Emission Quality Standards for Thermal Waste Processing Businesses and Activities. Residues from the flue gas can pollute the environment if not managed properly.

Dioxin or fluorine is a hazardous material in the flue gas. Dioxin and furan are compounds with almost the same physical and chemical properties. In addition, this material is persistent, accumulative, and toxic. With these properties, dioxin or fluorine can cause environmental, health, and economic pollution. Pollution caused by dioxin or furan can mostly occur through the free air, reducing air quality in the surrounding environment. The quality of paving blocks from recycled plastic is also not as strong as conventional products, limiting its application in construction.

In addition, several types of plastic contain hazardous chemicals, such as bisphenol A (BPA) and phthalates. If both of these materials are found in plastic that will be recycled, it will pollute the environment when the product is damaged or decomposed. Another challenge faced is the production costs, which may be higher if processing technology is not widely available, as well as the scalability constraints in its application. Considering these risks, developing more environmentally friendly technologies and strict regulations are needed to minimize the potential negative impacts of processing plastic into paving blocks (Marlina et al., 2021).

The role of the community, both individually or as households and communities, is constructive in making this Banyumas government program successful. As previously explained, every step of its processing, starting from selecting household and non-household waste through existing applications, continued with processing organic waste by KSM and inorganic waste by PJ. BIJ. The Banyumas Regency Environmental Service (Dinas Lingkungan Hidup/ DLH) is also one of the institutions that supports this waste processing innovation. Where DLH acts as a supervisor of waste management in Banyumas Regency. DLH has a vital role, especially regarding socialization to KSM Waste Management at the Village level. DLH has formed a team whose members are from the Banyumas community. Later, DLH will assign this team as an extension worker for KSM. The community will feel the results. Therefore, community involvement in overcoming waste problems in Banyumas is crucial (Pradana & Yuwono, 2023).

The impacts that the community has felt include reduced waste in the community environment through waste management; residents who participate in this program as managers at TPST are helped economically, both individually and collectively, increasing awareness of the Banyumas community about the importance of waste management. The challenges faced in implementing this program include the difficulty of implementing technology in rural communities that have difficulty accessing it, changes in community behavior towards this program, lack of funding, and inadequate sustainable infrastructure.

Waste management in Banyumas Regency through this program has shown significant results, especially in reducing plastic waste. Banyumas have succeeded in processing around 98% of waste, with only 2% still going to the TPA. This is much better than many cities in ASEAN, which can only manage around 20% of their waste (Hamid, 2023).

With the waste management innovation in the form of the SUMPAH BERUANG, Banyumas Regency has qualified for the Top 45 in the Public Service Innovation System (Sistem Inovasi Pelayanan Publik/ Sivonik) competition in 2022. The Ministry of State Apparatus Empowerment and Bureaucratic Reform held the competition. The award was presented by the Minister of State Apparatus Empowerment and Bureaucratic Reform (MenPAN-RB), Abdullah Azwar Anas, to the Regent of Banyumas who was represented by the Inspector of Banyumas, Drs. Nugroho Purwoadi, MM. at the Joint Awarding of Public Service and Bureaucratic Reform at the Bidakara Grand Pancoran Hotel, Jakarta, Tuesday, December 6, 2022 last year.

D. CONCLUSION

The SUMPAH BERUANG program is very creative and effective in Banyumas Regency. With this program, waste management in Banyumas is getting better. The impact can also be felt by the surrounding community, whether from individuals or groups. Awareness of good waste management will later have a good impact on the environment. The SUMPAH BERUANG program can be developed even better and reach various villages in remote areas in Banyumas Regency so that later, waste management can be evenly controlled in all areas of Banyumas Regency. This program shows significant success in waste management, as it managed 98% of the total waste produced, especially plastic waste.

The introduction of applications such as SALINMAS and JEKNYONG not only streamlines the waste sorting process but also increases the efficiency of waste management practices, converting organic and inorganic waste into valuable resources. This innovative approach reduces the environmental impact of increasing waste and provides economic benefits by converting waste into money, as evidenced by the production of paving blocks from recycled materials. Overall, the success of this program can serve as a model for other areas facing similar waste management issues, highlighting the importance of community engagement and technology integration in creating sustainable solutions to environmental challenges.

The environment, especially waste management, is a critical issue in Indonesia, and Banyumas Regency faces significant challenges. In 2022, Indonesia will produce 19.45 million tons of waste, of which 6.79 million tons are not appropriately managed. In Banyumas, the average waste production reaches 532-550 tons per day, and the closure of the Gunung Tugel landfill due to environmental pollution underscores the need for better and more sustainable management.

The innovation of the SUMPAH BERUANG focuses on waste management and involves the community and government's active participation in raising awareness of environmental issues. Although there are challenges in implementation, community involvement is critical to the success of this program. Hopefully, this program can be expanded to rural areas so that waste management can be carried out evenly and sustainably and the community can continue to be involved.

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