SUPPORTING FACTORS THE SUCCESS OF WASTE MANAGEMENT REPLICATION IN BANYUMAS REGENCY, CENTRAL JAVA, INDONESIA

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ABSTRACT

Effective waste management needs to involve stakeholders so that it can create a clean, healthy, beautiful environment, and become a model for other regions. This research aims to provide an overview of the waste management system in Banyumas Regency which has three levels from upstream to downstream. This study uses a qualitative approach, primary data is obtained through in-depth observation and interviews with TPST/TPST3R/PDU managers managed by KSM, and TPA BLE. Data validation was carried out by confirming the results of primary and secondary data acquisition, and analysis using the help of Atlas-ti software. The results show that the factors that support the success of replication are location attributes, water availability, wage rates, and machine capacity, while the challenges are human resources, regions, and communities. Understanding the replication factors of waste management is a valuable consideration for regions that want to adopt it.

Keywords: replication aspect; success; challenge; waste management

INTRODUCTION

Waste that has not been managed properly in many regions in Indonesia has an impact on disasters and even results in fatalities. This crisis can be used as an opportunity to restructure and increase the strength of a better waste management system (Fan et al., 2021) thereby contributing to human development and health (Sarkodie & Owusu, 2021). Mismanagement of waste (Lebreton & Andrady, 2019), incompetence, and inefficiency of waste management systems, as well as increased dependence on plastics (Vanapalli et al., 2021), unreliable recycling techniques, and low percentage of waste utilization, as well as management systems including inadequate recyclers (Ardusso et al., 2021) can trigger a new environmental crisis.

An economic model known as a "closed-loop economy" (Circular Economy) aims to minimize waste, retain long-term value, reduce the use of primary resources, and produce closed-loop products, product parts, and materials while maintaining environmental protection and socioeconomic benefits (Morseletto, 2020). The discipline of managing solid waste involves controlling its generation, storage, collection, transfer, and transportation as well as its processing and disposal. This is done in a way that adheres to the highest standards of engineering, economics, public health, conservation, aesthetics, and other environmental and public concerns (Vergara & Tchobanoglous, 2012). All administrative, financial, legal, planning, and engineering functions are included within this scope.

The transition to a Circular Economy (CE) can be done in several ways, for example by reducing waste, closing the production cycle, using resources more efficiently, or maximizing the retention of the economic value of materials and products (Morseletto, 2020). Increase awareness of sustainability and technological advances for solid waste management to reduce unnecessary waste. Organic waste recycling can be applied to produce organic matter that can be used as fertilizer or to improve soil structure (Chew et al., 2019).

Every individual will produce waste in their daily lives therefore it is necessary to understand the 3R (Reduce, Reuse, and Recycle) principle as an effort to reduce waste. A safer and greener environment needs to be supported by various measures considering the complexity of various issues that are important goals for each individual (Klemeš et al., 2020). 3R efforts need to be constantly reminded because they are related to changing habits. The demand for plastics by end-users is dominated in areas with temperate climates, and it is projected to shift one of them to Southeast Asia (Lebreton & Andrady, 2019). Furthermore, increasing knowledge about waste management that can improve financial performance, economic growth, competitive advantage, and sustainable development also needs to be carried out (Derhab & Elkhwesky, 2023).

Temporary waste storage and reduction sites are places with special logistical characteristics that make it possible to store waste and debris while waiting for final disposal (Kulkarni & Anantharama, 2020). Sustainability assessments to obtain the best available technology are required by considering technical, social, economic, and environmental performance. Processing approaches can be more flexible (various raw materials), decentralized, and sophisticated, such as internet-based (Hantoko et al., 2021).

Most of the plastic produced each year is used to make single-use packaging and other short-lived consumer products that are thrown away quickly, increasing the volume of waste. This requires waste management that is managed appropriately by the principles of the circular economy (Jeswani et al., 2021). Waste recycling and energy efficiency not only have an impact on economic growth but also significantly reduce carbon emission levels in both the short and long term (Razzaq et al., 2021). Furthermore, the target can be used to determine the roadmap to properly implement CE (Morseletto, 2020). Lack of environmental awareness, education, and inappropriate policies can pose a threat to the environment through waste and plastic pollution. Significant efforts are needed to shift to sustainable waste management, or new alternatives by redesigning goods based on biodegradable plastics and recycling plastics into liquid fuels through pyrolysis (De-la-Torre et al., 2021).

Plastic reduction policies and innovations for sustainable and green plastic solutions, as well as developing dynamic and responsive waste management systems need to be done immediately (Patrício Silva et al., 2020). The same thing was also stated by Vanapalli et al. (2021) that reducing the use of plastic along with the use of sustainable plastic waste processing technologies can be achieved by prioritizing policies to embed individual, social, and institutional behavior change. Furthermore, the results of the research by Jeswani et al. (2021) showed that compared to the energy recovery option, pyrolysis recycling of chemicals offers a 50% reduced life cycle energy consumption and impact on climate change. If the quality of the recyclate is taken into consideration, the energy consumption and climate change impact of pyrolysis and mechanical recycling of MPW (multiplastic waste) are comparable. Moreover, pyrolysis-recycled MPW has a substantially smaller climate change impact than its virgin fossil resource-based counterpart. On the other hand, pyrolysis has much greater external implications than energy recovery, mechanical recycling, and virgin manufacture.

Banyumas Regency has a waste system with three levels, starting from the upstream, namely households. In the middle, there is TPST/TPST3R/PDU (*Tempat Pengolahan Sampah Terpadu/ Tempat Pembuangan Sampah Terpadu* Reduce, Reuse, and Recycle/*Pusat Daur Ulang*/ Integrated Waste Processing Place/ Integrated Waste Processing Place Reduce, Reuse, Recycle/Recycling Center) managed by KSM (*Kelompok Swadaya Masyarakat*/Non-Governmental Group). Downstream there is a TPA BLE (*Tempat Pengolahan Akhir Berwawasan Lingkungan dan Edukasi*/Environmentally and Educational Sound Final

Processing Place) managed by the Regency Government. The collaborative model in handling the waste problem, the aspect of leadership with a collaborative style at the community level is the key to the success of handling the household waste problem (Ngambut et al., 2022).

KSM as the manager of TPST/TPST3R/PDU is a service organization that collects contributions from residents' needs to pay attention to perceived service value, perceived service quality, perceived service recovery, and perceived service price fairness which is an important success factor to form and measure customer satisfaction and customer delight (Alzoubi et al., 2020). Inconsistent and less adaptive management practices as a barrier to waste management (Stegmann et al., 2020).

The success of waste management in Banyumas Regency can be adopted by other regions by paying attention to the replication aspect, including challenges and factors that support success. The integration of different approaches to waste management can be done by accommodating existing systems and then adapting them to be able to implement new waste management systems (Kulkarni & Anantharama, 2020). Significant efforts are needed to transition to sustainable solid waste management (De-la-Torre et al., 2021).

Each region has a waste management system to the policies of their respective local governments but has not shown success because it is not accommodated in the local landfill (Final Disposal Site). An understanding of the factors that support the success and challenges of waste management in Banyumas Regency can be used as a consideration for regions that want to replicate so that they do not face problems in their implementation. The waste management model includes a management team, treatment plan, technology, financing, utilization, and collaboration. This waste management model involves various parties and inclusive community participation has been proven to reduce poverty and stunting (Rahmawati et al., 2023)

Replication carried out immaturely is feared to result in waste management through TPST/TPST3R/PDU and TPA BLE being detrimental for various reasons. This research is important because good waste management has an impact on improving environmental cleanliness, health, and welfare. Proper management by utilizing existing processing and recycling facilities can avoid adverse effects that may occur. Waste needs to be handled using innovative ideas and technologies (Sharma et al., 2020), which directly depends on the level of the budget. Management can assess the level of resources needed to support the success of the waste management system (Tirkolaee et al., 2021). Successful replication needs to be linked to time, budget, project management, system quality, user satisfaction, and economic value, and subsequently engagement, support, communication, and commitment. This shows that soft skill support in replication is indispensable (Iriarte & Bayona, 2020).

Replication of waste management in Banyumas Regency allows local governments to manage waste by local environmental conditions effectively, considering the large investment and requires commitment from managers. An understanding of the factors that support the success and challenges of waste management replication in Banyumas Regency provides consideration for local governments who have the desire to replicate.

METHODS

The research method used is qualitative descriptive to determine the challenges and factors that support the success of waste management replication in Banyumas Regency. Primary data collection was carried out through in-depth interviews and direct observation with the manager of TPST Patikraja, Kedung Randu, and TPA BLE Wlahar Wetan, Kalibagor, Banyumas in July 2024, followed by recording and coding. Secondary data was obtained through the results of previous research, books, and journals related to the replication and effectiveness of waste management in an area. The validity test was carried out by the triangulation method, and data analysis using the Atlas-ti software.

RESULTS

Banyumas Regency, Central Java Province has an area of 132,758 hectares, 27 sub-districts, 301 villages, and 30 sub-districts, as well as 1,878,746 residents. The amount of waste generated in 2023 is 522,937 kg/day of waste from 624,523 households. Then waste outside households reaches 10-15 tons, and total waste per day is 450-500 tons or 143 trucks (brin.go.id, 2024). The local government issued a policy after the closure of the landfill in Banyumas Regency with the name 'Sumpah Beruang' (*Sulap Sampah Menjadi Uang*/Magic Waste into Money).

Waste processing is carried out from upstream to downstream. Communities in the upstream are required to sort organic and inorganic waste. The middle of waste processing is carried out by KSM in six TPST/TPS3R/PDU, the equipment and machines owned include three-wheeled motorcycles, conveyors, *gibrig* machines, compost, sieves, presses, plastic choppers, non-insenator pyrolysis to burn residues. Waste downstream is processed in one BLE landfill managed by the local government and does not use the landfill method or open landfill which smells bad. The TPA BLE is a place for the final processing of residues sent from TPST/TPST3R/PDU. In addition, the Banyumas Regency Government also collaborated with PT. PLN (Persero) and PT. Sinergi Utama to Utilize Waste as Biomass Co-firing Raw Material.

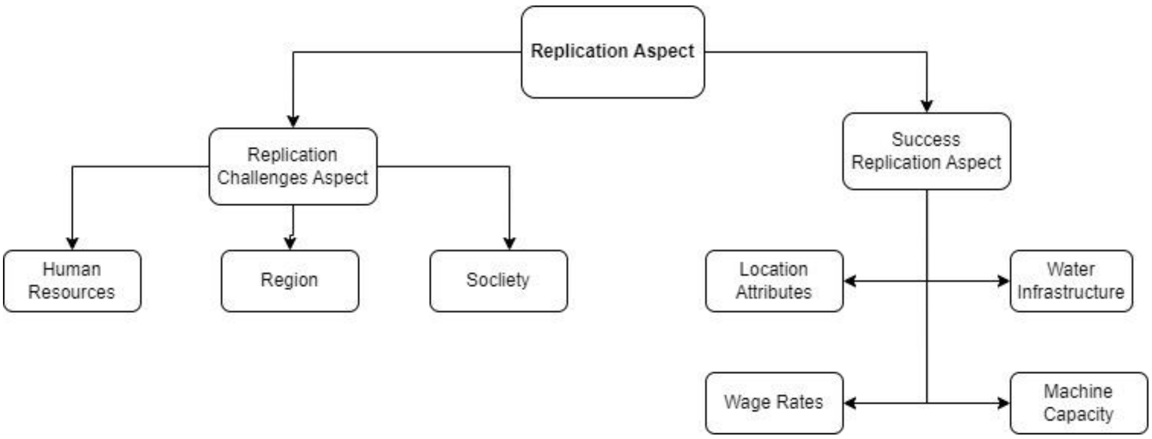
All waste is processed into products of economic value using circular economy principles, absorbing local labor, and residues are processed at the BLE landfill which was inaugurated in 2022 with a waste processing capacity of 75 tons/day. The waste levy regulation was eliminated, and the community paid waste contributions directly to KSM, the amount of which was determined based on the agreement. KSM as a waste manager at the village/village level carries out waste management activities including waste banks. KSM management is formed through village/sub-district deliberation, then determined by the decision of the head of the village/*lurah* and ratified by the head of the agency.

The purpose of the establishment of KSM is as an operator/implementer in waste management activities in villages/sub-districts with its task of carrying out socialization about waste management to the community and collecting customer data. The next task is to determine the amount of waste management fee contributions, and collect, transport, and manage waste. Make implementation reports and financial reports regularly every month to customers, as well as village heads and agencies that handle waste management.

The waste sent to the processing site is sorted into several parts, which are organic for maggots, then the plastic waste is processed into Refused Derived Fuel (RDF) for fuel, paving blocks, and plastic ore, while the final waste residue is burned using pyrolysis. KSM's human resources are mostly former scavengers in former landfills by receive remuneration from UMKs (*Upah Minimum Kabupaten*/District Minimum Wage) and health allowances in the form of daily feeding of whole milk. The provision of hangars or TPST/TPST3R/PDU in Banyumas Regency requires an investment in buildings and equipment of Rp 1.5 billion. The equipment provided in each hangar is a manual waste sorting machine (conveyor) and a plastic waste washing machine (gibrik). TPST/TPST3R/PDU with an area of 1,200 m2 can be used to accommodate 6-8 dump trucks/day.

KSM's source of income is from residents' contributions and the sale of high-value waste, such as plastics, crackers, plastic packaging, and bottles. Income from 8 trucks/day generates an income of Rp 30 million/day. The addition of tools can be done, for example with hot extruders and hydraulic machines that can be used to produce liquid plastics and print them into various products. Waste that cannot be used is burned with a pyrolysis machine that has met the provisions (https://jatengprov.go.id, 2024).

Figure 1 shows the factors that support the success of waste management replication in Banyumas Regency, including location attributes, wage rates, water infrastructure, and machine capacity.



Source: Atlas-ti output

Figure 1. Aspects of Waste Management Replication in Banyumas Regency

The challenges of waste management in Banyumas Regency are human resources, areas, and communities. The support of human resources from upstream to downstream who commit to sorting and managing waste continuously until it is completely exhausted is a big challenge because waste is synonymous with dirty, smelly, and disgusting. Furthermore, the area for waste processing often receives rejection from locals because it causes unpleasant odors, reduces comfort, and is unhealthy for residents, as well as the traffic of large, smelly, and noisy garbage trucks. This also happened in Banyumas Regency in the early days of processing, protests by residents and even road access to the processing site was closed

Community participation at this time is still a problem for waste managers in Banyumas Regency, namely not sorting organic and inorganic waste, so the local government continues to remind the importance of sorting, and then handling waste that sells through *'Sampah Online Banyumas'*/Salinmas and '*Ojeke Inyong*'/Jeknyong (https://www.banyumaskab.go.id, 2024)

DISCUSSIONS

Good waste management needs to be carried out consistently and structured. Banyumas Regency through its leadership policy manages waste by involving the community, the government at the village, and district level. '*Sumpah Beruang*' become principles instilled in the community, TPST/TPST3R/PDU, and TPA BLE managers. TPST, which is generally used as an abbreviation for *Tempat Pembuangan Sampah Terpadu*/Integrated Waste Disposal Site and TPA stands for *Tempat Pembuangan Akhir*/Final Disposal Site, does not apply in Banyumas Regency, but becomes an Integrated Waste Processing Site and Final Processing Site, which is a place to process waste to realize zero waste management. As an organization, TPST/TPST3R/PDU and TPA BLE have objectives, carry out management functions (planning, organizing, staffing, directing, and controlling), have functional management (human resources, finance, operations, and marketing), and have six management elements (human, money, material, machine, method, and market).

The government, TPST/TPST3R/PDU managers, and TPA BLE, NGOs. and the community that cares about the environment must still socialize the 3Rs consistently and continuously to reduce the quantity of waste because this concerns behavior. 'Sumpah Beruang' is a unique motto, turning the image of waste into something that generates income. This is in line with Rahmawati et al. (2023) that waste can be transformed from a 'problem' to a 'potential source' because well-organized waste management will create a prosperous society. A collaborative model in overcoming the waste problem at the community level is an important step in solving the waste problem produced (Ngambut et al., 2022).

The source of funds for the initial investment of the TPA BLE is the Ministry of Public Works and Public Housing (*Pekerjaan Umum dan Perumahan Rakyat*) of Rp 44 billion from the State Budget and the Regional Budget of Rp 6.3 billion, with a land area of 3.5 hectares (https://www.banyumaskab.go.id, 2024). Unlike TPA landfills in general which focus on 3R, this TPA BLE will be equipped with swimming pools, plastic factories, fish ponds, and others. Comprehensive waste management policies present multilateral issues with a multi and interdisciplinary approach to solving them, including planning and awareness of legal, institutional, technical, economic, land use, environmental education, and community participation (Drahansky et al., 2016).

The source of funds for the initial investment in the establishment of TPST/TPST3R/PDU is the district government, then for operational activities sourced from the community who pay a certain amount of contributions based on the agreement, as well as the proceeds from the sale of high-value waste and processed products in the form of paving blocks, compost, and RDF. KSM as an organization in the service sector needs to be managed consistently and professionally to increase customer satisfaction and customer delight which is influenced by perceived service value, perceived service quality, perceived service recovery, perceived service price fairness (Alzoubi et al., 2020).

Location attributes support the successful replication of waste processing in an area, but solar radiation and qualitatively high ambient temperatures are expected to encourage faster weathering (Lebreton & Andrady, 2019). Local government policies can be carried out through a system of consultation, study, and intensive discussion with the community (Drahansky et al., 2016). The characteristics of the location and waste allow each region to use various waste treatment methods, ranging from low to high technology. Generally, high-income cities use more technological methods for waste management – collection, separation, and mechanical processing – while lower-income cities tend to rely on more labor with lower technology options (Vergara & Tchobanoglous, 2012).

For comparison, the final waste disposal location in Kupang City is in Alak District, Kupang City, with a distance of 1 KM to the nearest community settlement. At the landfill location, there are 46 households as scavengers with family members of two to three people. In addition to scavengers who settle down, the surrounding community also looks for leftover food for their livestock (Ngambut et al., 2022). The selection of locations like this overcomes the challenges of human resources, regions, and communities. Furthermore, it also supports location attributes and wage rates.

Human resources at waste treatment sites are given wages by the UMK of Banyumas Regency, which is Rp 2,195,690,- (https://jatengprov.go.id, 2024). This is an attraction for scavengers in landfills who are used to being close to waste but do not earn a fixed income, attracting human resources from the informal sector to formal. Furthermore, there is the provision of whole milk as an effort to support the health of employees, even though health insurance cannot be financed yet. The management of TPS/TPST/PDU and TPA BLE strives to increase revenue to cover operating costs, through community contributions and product sales. Incentives to collect recyclable materials are economical, as their wages come from resale rather than through district government contracts. This shows that waste treatment sites provide livelihoods for residents as well as environmental and waste management services (Vergara & Tchobanoglous, 2012)

Results Jeswani et al. (2021) demonstrate that the technology of processing or recycling plastic waste is needed to address current and future global environmental challenges, namely climate change and the limited availability of non-renewable resources, as well as sustainable production and business. It is difficult to accurately measure the rate of potential generation of microplastics in a given location, but solar radiation and high ambient temperatures qualitatively encourage faster weathering (Lebreton & Andrady, 2019).

The inorganic waste that has been sorted is then separated for sale, and further processed into RDF, plastic ore, and paving blocks. This process requires adequate water supply support to wash the garbage until it is clean, then the laundry wastewater drain is also a serious problem because it is a key element for the control of soil contamination of the surrounding environment and the source of water pollution (Drahansky et al., 2016). Plastic pollution is a planetary threat, affecting almost every terrestrial, water, and air ecosystem globally (Borrelle et al., 2020) Likewise, technologies designed to minimize the environmental impact of waste (Vergara & Tchobanoglous, 2012). Borrelle et al. (2020) stated that the understanding of the transportation, storage, and washing of plastic waste needs to be improved so as not to pollute water sources, rivers, and seas.

The development of new and sustainable technologies for recycling plastics and other materials requires the integration of humans with machines, from sorting and recycling processing to higher product quality. Nicer, layered, and complex plastic packaging needs to be separated from those that are not economically viable for recycling. In addition, incentive policies that encourage homogeneous plastics, environmentally friendly bioplastics, and circular technologies must be formulated and implemented effectively (Sharma et al., 2020).

Stegmann et al. (2020) stated that inconsistent and less adaptive management practices are obstacles to waste management. An approach that involves the community as a waste producer to participate in managing and contributing to overcoming problems. This is in line with the statement of Ngambut et al. (2022) that it is very important to involve or participate in the community in planning and decision-making to overcome the waste problem. The government that is given responsibility has limitations in waste management, both in terms of budget, human resources, and technology. The form and model of community participation, from different layers, are influenced by various external and internal factors.

Consideration of strategies to minimize the impact of plastic by utilizing it needs to be focused on the community with the right use and post-consumption plastic care, not on the plastic (Klemeš et al., 2020). Reducing the negative impact of waste management needs to work with all levels of society through intensive socialization (Rahmawati et al., 2023). The involvement of academics, governments, communities, and entrepreneurs is needed in waste management decision-making to form an adequate network of relationships between generations and knowledge transfer (Drahansky et al., 2016). The same thing was also stated by Ngambut et al. (2022) that waste management is a shared responsibility of all parties. The transition to a circular urban economy requires a cultural shift to innovation in all sectors, and changes in government organization, business strategy, and educational structures that will determine the supply of products and services, as well as society

The replication of a project must contribute to increasing productivity in various dimensions, namely economic, social, and environmental through the optimization of materials, technologies, systems, products and services, reuse, recycling, and repair, recycling production sites, and regeneration of entire regions (Gravagnuolo et al., 2019). The selection of waste treatment locations is a tough challenge faced because residents will refuse, through demonstrations and road closures. Globally, waste management needs to be more formal and regional (Vergara & Tchobanoglous, 2012) the same thing was also stated by Klemeš et al.

(2020) as an effort to optimize waste management planning. Next Razzaq et al. (2021) Suggesting waste management is heterogeneous in different regions, therefore, no single treatment option is recommended for all waste streams. Recycling of organic solid waste is carried out through the study and quantification of food ingredients to produce quality compost to fertilize soil and plants (Drahansky et al., 2016).

CONCLUSIONS

Location factors, water availability, wage rates, and machine capacity are aspects that support the success of waste management replication in the Banyumas Regency so that they do not experience obstacles during operation. The challenge factors are human resources, regions, and communities. *'Sumpah Beruang'* is a motto that is embedded in the residents of Banyumas Regency as an effort to utilize waste that has an impact on increasing income and environmental cleanliness. An understanding of the replication aspects of waste management needs to be considered before investing in facilities and infrastructure with the support of human resources who are committed to managing it. The results of this study cannot be generalized, but provide valuable input for the region to prepare various aspects, especially community support so that they are willing to participate in waste management replication. The aspects that were successfully identified were obtained based on the results of interviews with KSM and TPA BLE managers in Banyumas Regency, further research is needed using quantitative analysis and participation of MSMEs can also be carried out by placing its contribution to waste management.

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