

Evaluating Performance and Sustainability of the Waste Bank in Some Cities in East Java Indonesia

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Abstract

East Java was one of the top five waste Indonesian producers in 2020, and the waste bank is a promising strategy for managing domestic waste better. This study aims to evaluate the performance and sustainability of waste banks in East Java. The research was conducted by observing 40 Surabaya, Malang, and Gresik waste banks. The interview involved managers and 10% of waste bank customers. The bank's performance and sustainability were determined by some indices: effectiveness, elasticity, zero-waste index (ZWI), and diversion rate. Results showed that waste banks varied in the establishment age (6 to 10 years) and performance (moderate to high). The highest proportion of waste managed by waste banks was plastic and paper. However, some of them also managed degradable waste. The Gresik and Malang District waste banks were established younger and performed better than the Surabaya City ones. All waste banks reduced waste slightly, as shown by the ZWI index (0.20 to 0.40) and diversion rate (21 to 40%) in reducing waste volume disposal to landfills. Its sustainability constraints were facilities, prices, partners, community or government support, and the COVID-19 pandemic. Waste banks provided some benefits, including increasing sorted waste, environmental sanitation, income, and culture changes.

Keywords: Covid-19, East Java, performance, sustainability, waste banks

INTRODUCTION

Managing domestic waste is a complex Indonesian environmental problem that threatens ecosystem integrity and the survival of living creatures. In the short or long term, it is a serious problem in all aggregations of Indonesia due to the growth of population size, accumulated nonbiodegradable waste, and improper waste management. It included the East Java Province, nominated as the 1st province ranked in Indonesia as a waste producer in 2020 with 3,8 million tons. years [1]. The 30% increase in waste in East Java is driven by public consumption, lifestyle, and improper waste management. In addition, it is supported by the rise of 7-8 % in the number of people who urbanize from 2016 to 2020. [2]. In addition, there are increasing sources of waste caused by imperfect waste management processes. These problems can cause environmental pollution, such as potential carbon dioxide from combustion residues. This requires the government to create policies and programs to reduce the potential damage caused by waste. Therefore, the government created the waste bank unit program (BSU) [3].

The first Waste Bank Program was established in Bantul in 2008, and it involved some elements of society: the government, villagers, collectors, and you [4].

This waste bank program aligns with Law UU number 18 of 2008 regarding waste management to realize the 3R concept (Reduce, Reuse, Recycle) [5]. BSU is a waste reduction program that will achieve the success index of a waste-free Indonesia by 2025. However, the program was not implemented. The government then enacted PP No. 97 in 2017 as a revision of the previous regulation to support the success of the waste bank program [6].

In East Java Province, a BSU was first established in 2010 in Surabaya City. However, great efforts are still needed to meet the annual target for the waste generated to achieve Indonesia's zero waste goal in 2025. The performer BSU can successfully reduce waste disposal in the environment and promote its sustainability. However, the BSU performance and sustainability in some districts/cities of East Java are still limited and usually partially studied. Therefore, this research was carried out to evaluate the performance and sustainability of the waste bank program, including an analysis of benefits and limiting factors to develop the appropriate strategies for domestic solid waste in the future.

MATERIAL AND METHOD

Determination of research objects

The research was carried out in several BSU in East Java from January 2022 to August 2022, including 10 BSUs in Surabaya City, Malang District, Malang City, and Gresik District. The BSU sampled 40 units in some regencies/cities in East Java. The population size in 2021 at each location as follows: Surabaya City 2,880,284; Malang City 150,371; Malang District 2,668,296 people; and Gresik District

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is 1,320,570 people [7]. The waste disposal in each location varied, with Surabaya City's amounting to 811 million tons. year⁻¹, Malang City 247 million tons. year⁻¹, Malang District 387 million tons. year⁻¹ and Gresik District at 120 million tons. year⁻¹ [8]. These cities/districts were nominated as research objects based on the quantity of waste disposal and population. Moreover, Gresik District was selected as a reference site due to gaining an award for the best waste bank performance in East Java in 2021. The district had a dense population and low waste disposal.

Observation and Interview Techniques

This research was carried out by direct observation and semi-closed interviews. First, a 15-unit waste bank was used for the accurate test with signification $p < 0,05$ [9]. The respondents included the managers of the BSU, 10% BSU customers, 10% non-customers people around the BSU, and local government (Dinas LHK). An interview was held to record data from some questions, as noted in Table 1. The point of the interview was based on Ministry LHK regulation no 76 in 2019 on achievement of management city environment (ADIPURA) and Ministry of LHK regulation No. 14 in 2021 on Waste Management of Waste banks. This interview was then completed by direct observation.

Table 1. Aspects evaluated in this research of BSU in East Java

Respondents	Aspect	Point of question	
Government	Government	Policy	
		Mentoring and socialization	
Manager	Partnership	Active number	
		Pick-up routine	
	Governance	unacceptable category of waste	
		Organizational structure	
		Administration system	
Non customers	Facility	Passbook	
		Operational facilities	
	Income	Infrastructure	
		Information	Income generation
Customers	Participation	Waste banks information	
		Accessibility	
		Motivation	
		Sustainability	Environmental sanitation
		Social aspect	
		Economic benefit	

Waste Bank Performance Analysis

The waste bank unit (BSU) performance was analyzed by determining the effectiveness index, plasticity index, zero-waste index (ZWI), and diversion rate. The effectiveness index showed value by performance based on the facility of the waste bank. It included governance, society support, facility partners, and partnerships. The effectiveness index has high, moderate, and low categories. The elasticity index relates to changes in the economic value of the waste bank process, which is included by many active members and income indicators (high, moderate, and low) [10]. The effectiveness and elasticity index data were compared to the other research [11]. Zero waste value can describe efficiency in waste management to reduce waste sources in the environment. This index was developed by looking at the 3R (Reuse, Reduce, and Recycle) aspects [12]. This index was developed with the following formula:

$$\text{Zero waste Index} = \text{Total WMSi} * \text{SFi} / \text{total GWS}$$

Note:

- WMSi : Waste management system
- SFi : Substitution factors of managed waste
- GWS : Total waste

The waste diversion rate was used to determine a successful recycling program. It represents the amount of waste diverted from landfills for recycling [13]. Using the formula:

$$\text{WDR} = (\text{TWR} / (\text{TWR} / \text{R})) * 100\%$$

Note:

- WDR : Waste Diversion Rate
- TWR : Total Waste Recycle
- R : Residual waste in landfill

All Likert scale data were analyzed using Microsoft Excel and presented in graphs or tables. Data were analyzed using a multivariate analysis of variance of PAST software 4.06 to compare the sustainability of waste banks.

RESULTS AND DISCUSSION

Waste Bank Profile

Among 40 waste bank units sampled, the most were established 6 to 10 years ago, especially in Surabaya cities, followed by Malang District and Malang cities (Figure 1). Waste Bank Surabaya pioneered East Java and started the activity through the 3R program in 2010. The first waste

banks established were 15 units and reduced 7.1 tons of degradable waste per month [14]. Gresik district waste bank was the youngest among them in East Java. In 2018, the first waste bank was established, namely Gemes Sekardadu. It managed domestic and industrial waste by implementing the 3R program to promote the Green Gresik District [15].

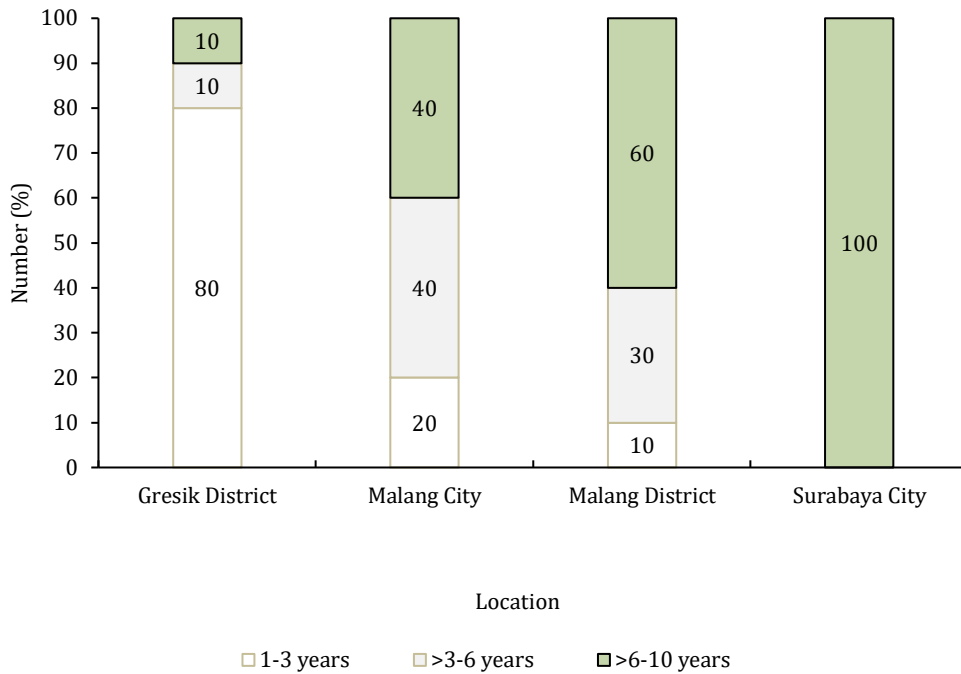


Figure 1. Profile of waste banks unit (WBU) by establishment age in East Java

The sampled waste bank managed around 6.6 tons—per year -1, composed mostly of paper or plastics (Figure 2). Paper consisted of cardboard, paper, and books, while plastics comprised disposable bottles, bags, and food and drink packages. Both had a high selling price, especially the sorted bottles and cardboard. The industries recycled polypropylene (PP) and polyethylene terephthalate (PET) plastic categories at high prices; for example, glass bottles were valued at Rp—7,000 per kg [16]. Some waste bank units also manage biodegradable waste due to longer processes and minimum supporting composting areas and facilities. They managed these wastes to provide compost, eco enzyme, maggot larva, and

liquid organic fertilizer (Table 2). This effort reduced the environmental pollution of organic material and the waste in landfills. The waste banks in Bandung also preferred handling non-degradable waste rather than biodegradable waste because of its higher economic value [17]. Some waste banks in the Gresik district and Surabaya cities provide eco-enzymes, especially during the COVID-19 pandemic. Further, they processed the eco-enzyme as raw materials for soap, room deodorizers, and natural detergents [18]. Moreover, some waste banks in the Gresik District started cultivating maggots to reduce food waste [19].

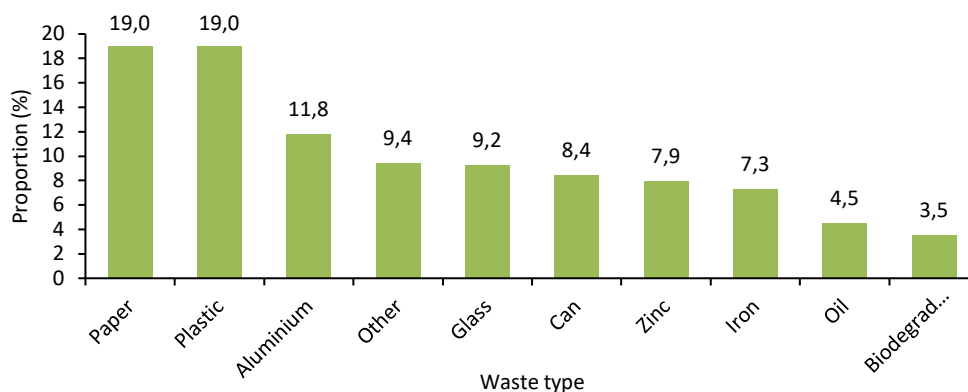


Figure 2. The proportion of waste managed by waste banks in several districts/cities in East Java

Table 2. Management of biodegradable waste in several districts/cities in East Java

City/District	Compost	Eco-enzyme	Maggot	Organic fertilizer
Gresik District	√	√	√	√
Malang District	-	X	-	√
Malang City	X	X	-	-
Surabaya City	√	√	-	-

Description: Active (√), discontinued (X), absent (-)

Waste banks performance

Waste bank performance was assessed based on effectiveness and elasticity indices. The study showed that the waste banks in Malang Districts were generally in a high-ranking category, close to the reference Gresik District waste banks (Figure 3 a,b). the Surabaya City ones followed it. Unfortunately, the waste banks in Malang City mainly were moderate and low categories, especially in the effectiveness index. Government facilities and community enforcement supported the success of Malang District and Surabaya City waste bank. On the other hand, waste banks in Malang City showed a lower elasticity and effectiveness index due to low community participation in waste banks and the COVID-19 pandemic. The waste bank of Malang City was previously reported as an excellent waste manager in East Java, especially before the COVID-19 pandemic [20].

The pandemic stopped some waste bank activities and decreased the number of participating members. The active waste banks in Surabaya City were only 15% of the total during the COVID-19 outbreak [21]. [12] reported that participant members were the critical factors in waste bank performance. Furthermore, the local participants sorted waste from its source, increasing the waste bank income [22]. For this reason, the Gresik District waste bank showed a high performance and was supported by a high

population. Gresik District had a similar characteristic to Surabaya cities, especially in terms of regional geography and demographics. The Surabaya Cities had a population area ratio of 0.53 in 2020, it increased a higher waste disposal from daily consumption [23]. The waste banks in Gresik District could reduce waste dumps better than Surabaya Cities (Table 3). It revealed that the service quality of waste banks in West Java also contributed significantly to customer satisfaction and supported high performance [23]. Finally, the local government and supply chain partnerships supported the waste bank performance. It was reported that the waste banks in Gresik District collaborated with PT. PJB Gresik and Unilever to improve customer service and empower the local community to implement the 3R program [24].

Waste banks significantly reduced environmental pollution in terrestrial and aquatic ecosystems by reducing waste dumps. It was indicated by the value of zero waste and the diversion rate indices [25]. Household wastes are reduced, sorted, and composted; some are involved in the recycling process under waste banks' intervention. Urban waste management strategy is regulated by Law No. 97 in 2017, and it is noted that a zero-waste target removes 70% of total waste. Malang District banks showed a moderate zero waste index similar to the Gresik District, while the cities of Surabaya and Malang were still in the low category (Figure 3c). A high

zero waste index indicated the potential for reduced waste in the surroundings. The target of successful municipal waste management was to at least remove waste 75% of the total waste [12]. In addition, the zero waste program reduced the

waste disposal entered the landfill final process and increased the diversion rate index (Figure 3d). The diversion rate target was to reduce 50% of waste in the landfill [26].

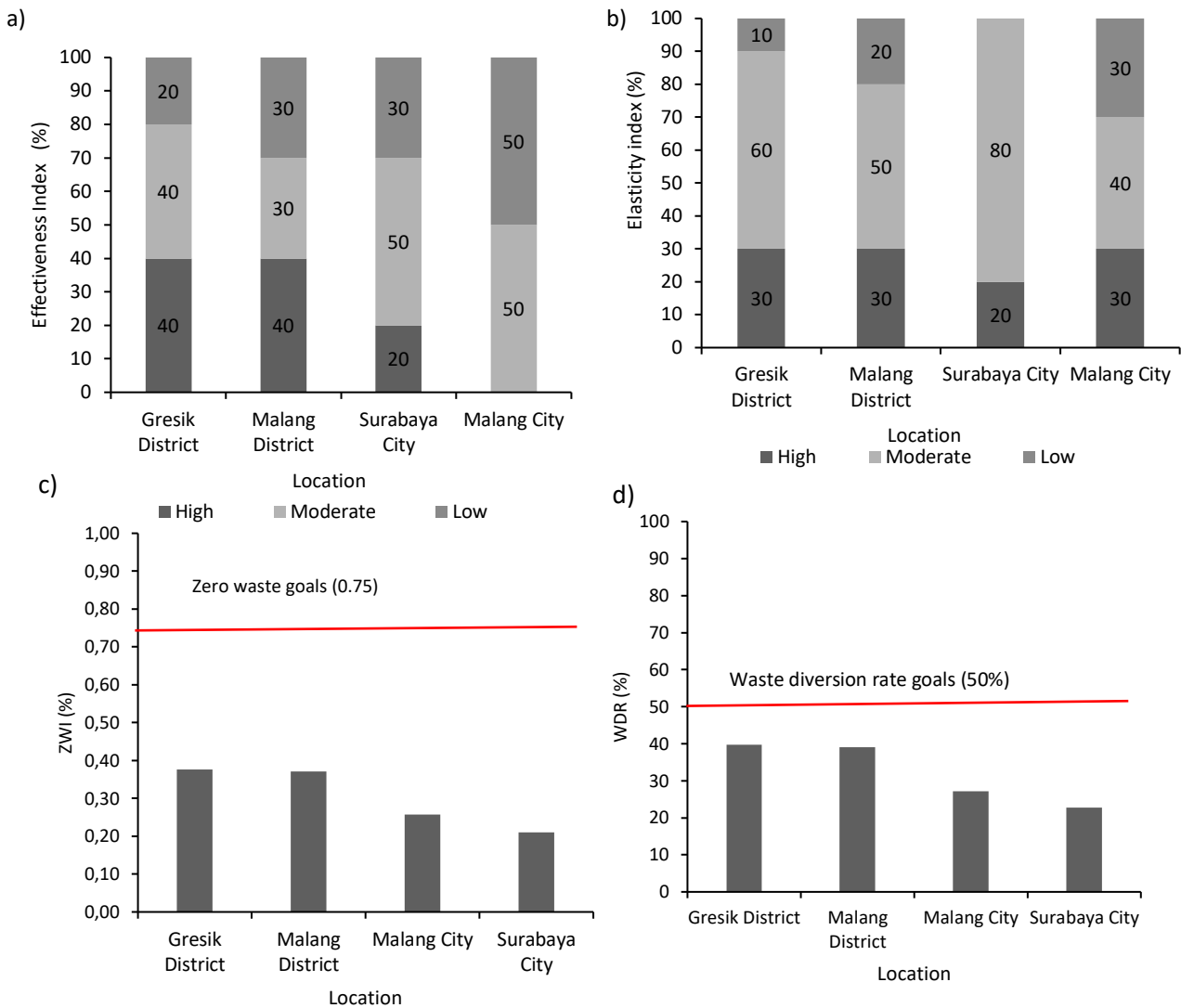


Figure 3. Proportion of waste bank performance indicators

Table 3. Performance of waste bank units in some district/city in East Java

Location	Effectiveness		Elasticity		Performance
	Index	Category	Index	Category	
Gresik District	77.2	Moderate	1.05	High	High
Malang District	74.4	Moderate	1.05	High	High
Surabaya City	65.5	Moderate	1.00	Moderate	Moderate
Malang City	63.9	Moderate	1.00	Moderate	Moderate

Sustainability analysis

Waste banks' performance develops through a long-term business process and good governance. Based on the waste bank manager interview, it was revealed that the strengths and opportunities

included governance, partnership, information, income generation, and customer motivation (Figure 4a). However, some waste banks could not sustain themselves due to some problems. Sustainability

and customer loyalty were mainly influenced by government policy, mentoring, socialization, and facility support. Waste bank governance was reported to be significant in business processes, partnerships, and customer services [27]. Some waste banks in Surabaya City and Malang City faced problems with the facility due to a minimum area of storage waste (Figure 4b). The supporting infrastructure was important for waste bank management [28]. A good government facility supported waste banks in Gresik District and Malang

District. Some waste banks in Surabaya and Malang Cities managed a limited waste category due to supply chains developed with the partnership of the recycling industry. Their partners received only a high quantity and profit of recycled waste. Consequently, the low-value waste is discharged into the landfill. Simultaneously, customers generated more income from managing their valuable domestic waste [29]. Furthermore, partner policies of price and waste category varied in some cities or districts [16].

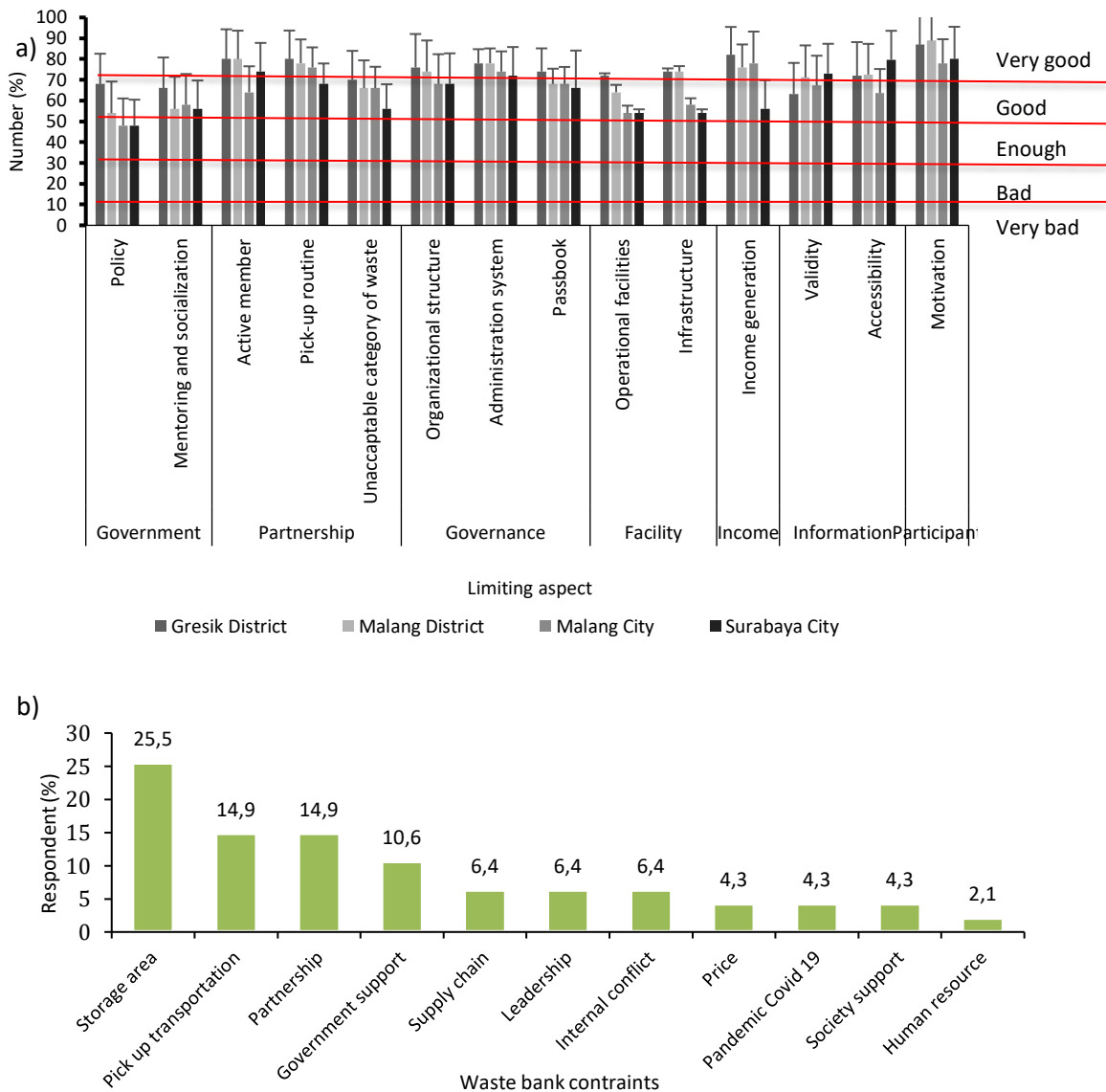


Figure 4. Limiting aspects and constraints of waste banks' sustainability in some districts/cities in East Java. Information: a) Limiting aspect; b) Waste bank management constraints

The sustainability analysis also involved feedback from 207 active customers. Their loyalty was mainly due to environmental and public health (Figure 5). Many waste banks have been sustained until now due to positive social interaction impacts. This social interaction is supported by a collaborative culture,

namely *gotong royong*. Some waste banks in Gresik and Malang Districts, as well as Surabaya Cities, sustained in the long term due to these changing cultural aspects, including the habit of reducing, composting, and sorting waste from home. They did not discard any more of the domestic waste in the

river. In Brazil, the waste bank increased cultural and social interaction while implementing 3R program [30].

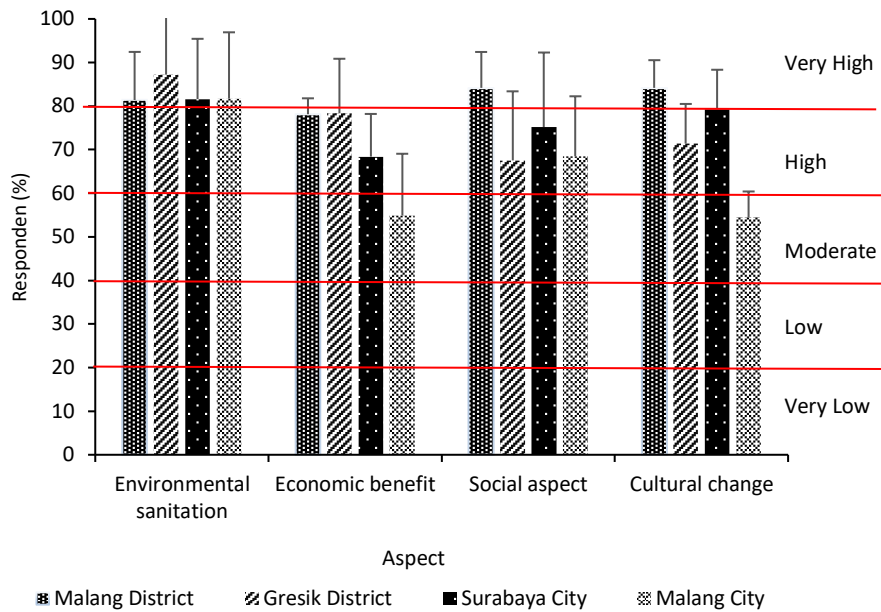


Figure 5. Sustainability aspect for some waste banks in districts/cities in East Java

Multivariate analysis of community participation, culture, environmental sanitation, economy, social, and knowledge of customers showed that among studied waste banks, there was no one similar to the

reference waste banks in Gresik District $p < 0.05$ (Table 4). However, only those of Malang District, followed by Surabaya City, were closer to the performer waste bank ($p < 0.1$), according to [31]. conducting policy socialization, real action movements and forming a special waste

Tabel 4. Multivariate analysis of variance of waste banks sustainability in East Java

Location	Education	Participant	Culture	Environment sanitation	Economic	Social	p <0.05	p <0.10
Gresik District	2.96±0.80	3.61±0.59	2.97±0.45	3.73±0.38	4.02±0.96	3.33±0.46	b	c
Malang District	3.55±0.50	4.40±0.60	3.50±1.00	4.13±0.40	3.90±0.80	4.20±0.70	a	b
Malang City	3.26±1.01	3.89±1.02	3.24±0.92	4.02±1.07	2.75±1.33	3.29±1.07	a	a
Surabaya City	3.72±0.49	4.00±0.42	3.78±0.35	4,08±0.36	3.42±0.54	3.76±0.53	a	ab

The waste banks in Gresik Districts showed a higher economic profitable compared to the others due to their creativity to reuse the waste for raw material of handy crafts, and composting degradable waste. Moreover, [32] reported that the waste banks in Malang City and Malang District showed some similarities with those of Surabaya City in terms of regulatory aspects in managing household waste. The Waste management strategies in the country can involve several stakeholders including the government and the community. The government can encourage a comprehensive zero waste policy by

management team [33]. In addition, the government can utilize information technology to make it easier to provide educational content for the community. The government can also make a policy of not using plastic bags in the shopping process [34]. communities also serve as key actors for the national waste management strategy. People must be aware of environmental sustainability by not littering and burning waste. People should start sorting waste from home before throwing it into the trash. People should reduce the use of plastic and replace it with products that can be used repeatedly [35].

CONCLUSION

This research showed the waste banks established 6 to 10 years ago mainly managed plastic and paper, but some waste banks also managed biodegradable wastes. The waste banks showed high to moderate performances. The waste banks of Malang and Gresik Districts were a high category, while the banks of Malang and Surabaya Cities had a moderate category. Therefore, the waste banks in Malang District were closed to the reference waste bank in the effectiveness index (high-rank category), followed by the Surabaya City ones. Meanwhile, the waste banks in Malang City had a low to moderate effectiveness index. We revealed that the COVID-19 pandemic decreased all waste banks' performance and elasticity index into the mild category. At least the waste banks reduced waste volume disposal to landfills slightly, as shown by the ZWI index (0.20 to 0.40) and diversion rate (21 to 40%). The bank's sustainability was supported by good governance, partnership, information access, income generation, and customer motivation (because of economic, cultural, environmental sanitation, and social interaction). Its constraints were facilities and government support. Some factors contribute to the sustainability of waste banks.

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