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Chapter 2

Household's Willingness to Accept Waste Separation for Improvement of Rural Waste Bank's Effectivity

Christia Meidiana, Harnenti Afni Yakin and Wawargita Permata Wijayanti

Additional information is available at the end of the chapter

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Abstract

Waste Bank, a form of public-community participation (PCP) system in managing the households' solid waste problems, becomes popular in Indonesia. Waste Bank program involves community and provision of incentives to them and requires public acceptance measured through willingness to accept (WTA). Therefore, this study aims to estimate households' WTA compensation in terms of inorganic waste separation adopting the contingent valuation method. It measures also the effectiveness of waste bank (WB) and community adaptability on WB in Gili Trawangan Island (GTI), Indonesia. The community acceptance is measured using Willingness to Accept (WTA) the obligation to separate waste. Fully structured questionnaires are filled in by 94 respondents through random sampling to evaluate the current WB. The result shows that the score for overall equipment effectiveness (OEE), adaptability and acceptance of waste bank is 12.67%, 1.50, and 37.5% respectively. It indicates that waste bank is relatively difficult to be developed, people and waste institution has low adaptability with current waste bank system and only some people want to participate in waste bank. Based on this result, WTA is measured to determine the optimum price of recyclable waste sold to waste bank to improve the WB's performance and to increase community acceptance.

Keywords: waste bank, willingness to accept, overall equipment effectiveness

1. Introduction

Rural solid waste (RSW) has less priority in most of the developing countries [1]. Urbanization and the fast population growth in urban area have come to local authorities' attention in all sectors including municipal solid waste. RSW should be part of integrated solid waste management since the waste in rural areas increases in quality and quantity because of the lifestyle change

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and income increase. Solid waste management (SWM) requires a systematic approach which integrates environmental effectiveness, public acceptance, and economic affordability [2]. Public acceptance refers to the favorable reception and the active approval and adoption of newly introduced technical devices and systems [3]. Public acceptance in waste management can be measured through public participation rate. Public participation is acknowledged as the method to attain sustainable WM, and it can bridge the gap between government and citizens in environmental conflict management [4, 5]. Public participation in solid waste management should be addressed toward the "waste as resource" and the "waste as income generator" in household units [6]. It serves the purpose of daily waste disposal decrease, waste utilization as resources for certain local production, income generator, and benefit agent for the households involved in solid waste management. Households' involvement in solid waste management may be in the form of waste separation and recycling. Waste management (WM) strategies involving waste separation and recycling will only be successful if they are supported by the public including the local residents. Local residents are nonignorable stakeholders in both the daily WM and the decison-making process because they are both the subject and the object of waste management services [7, 8]. The performance patterns and community's attitudes, shaped by the local cultural and social background, determine the structure and functions of public participation [9]. Hence, the challenge for WM is to enhance public participation nowadays. In Indonesia, the number of researches focusing on public willingness to participate in WM and its influencing factors is still low. These factors could be demographic variables, i.e., age, gender, and household typology, knowledge, and recycling time [10–12] as well as educational level, occupation or income level [13–17]. The findings of each study often depend on the sample used. Identifying these factors and their importance may be beneficial for the improvement of public participation in WM since it depends on local situation. Design of a successful scheme may not necessarily be replicable elsewhere [18]. Public acceptance can be reflected by the willingness to accept (WTA).

The contingent valuation method (CVM) was applied in this study to draw people's willingness to accept (WTA) economic sacrifices to separate waste. The contingent valuation method (CVM) was claimed to be the most suitable tool available to measure nonmarket value. Previous studies used it to measure public goods and services [19] and to assess farmers' participation preference [20]. Properly designed willingness to accept (WTA) can estimate the strength of demand for who are willing or never willing to consume a certain good [21].

WTA waste separation of households residing in Gili Trawangan was measured, and the expected compensation for it was assessed by asking the households for their WTA. Gili Trawangan is a famous tourist destination island. Every year, there is 11.8% visit increase to the island leading to waste production increase. The main sources of waste in this island are households, hotels, and restaurants accounting for 602 ton/day of waste, out of which about 42% is inorganic. Currently, there is no waste management in the island provided by the local government. There are community initiatives that conduct waste separation and waste bank to reduce inorganic waste, i.e., plastics, paper, metal, and glasses, and to bring income by selling it. Unfortunately, public participation in waste separation is very low which may be caused by the ineffectiveness of the waste bank. Therefore, this research aims to measure the effectiveness of waste bank, public adaptability, and public acceptance in environmental improvement through waste separation and waste bank.

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This chapter is divided into three main parts. The first part explains the methodology applied. The second part outlines the result of village identification, data collection, and data analysis. This section is followed by the measurement of waste bank effectiveness, public adaptability, and willingness to accept (WTA) waste separation. The last section is conclusions explaining about the findings and the recommendations for waste management improvement in Gili Trawangan Island (GTI).

2. Research method

The area of study is located in Gili Indah Village, Gili Trawangan Island (GTI) Lombok Utara Regency, Nusa Tenggara Barat Province, Indonesia (**Figure 1**). The area belongs to one of the strategic development zones in Nusa Tenggara Barat Province. Tourism sector in GTI contributes 60–70% to the total income of local government [22]. Rapid increase of visit in GTI leads to more waste volume. In 2015, Community forum on Environment measured that the average waste generation in GTI is 17 ton/day where 6.2 ton is inorganic waste. Currently, inorganic waste is managed by WB Bintang Sejahtera. However, WB's performance is relatively low since the amount of inorganic waste that can be treated through this WB is still low. Based on the population in GTI, samples were determined using stratified random sampling. Unit analysis of the study was household. Eighty households were selected as respondents and they were provided with questionnaires to gain required data for measuring the willingness to accept (WTA). Bidding game format was used to assess the WTA of households. Waste bank effectiveness is measured using Eq. (1) which is equation of overall equipment effectiveness (OEE); *A*, *P*, and *Q* represent availability, performance, and quality, respectively. Each variable is calculated using Eq. (2), Eq. (3), and Eq. (4).

$$OEE = A \times P \times Q \tag{1}$$

$$A = \frac{Aa}{Ra} \times 100\% \tag{2}$$

$$P = \frac{W_i \times Tq}{Aa} \times 100\% \tag{3}$$

$$Q = \frac{Aa}{Tq} \times 100\% \tag{4}$$

The effectiveness of waste bank is scored based on the percentage gained from the calculation as shown in **Table 1**.

Analysis on public adaptability was conducted afterward to find out whether the related stakeholders (community and institutions) can accept the continuation of waste bank program. Some indicators were introduced and scoring was given for each indicator ranging from 0 to 4. The result was used as a reference to scale public adaptability on waste bank program. **Table 2** shows the adaptability level based on the score.

Furthermore, willingness to accept (WTA) of the community to separate waste and sell it to waste bank was measured. Bidding game was used to get the optimum price for recyclable materials sold to the waste bank. Bidding game provides flexibility to the respondent for giving answer without losing the context since the lowest value is determined beforehand.

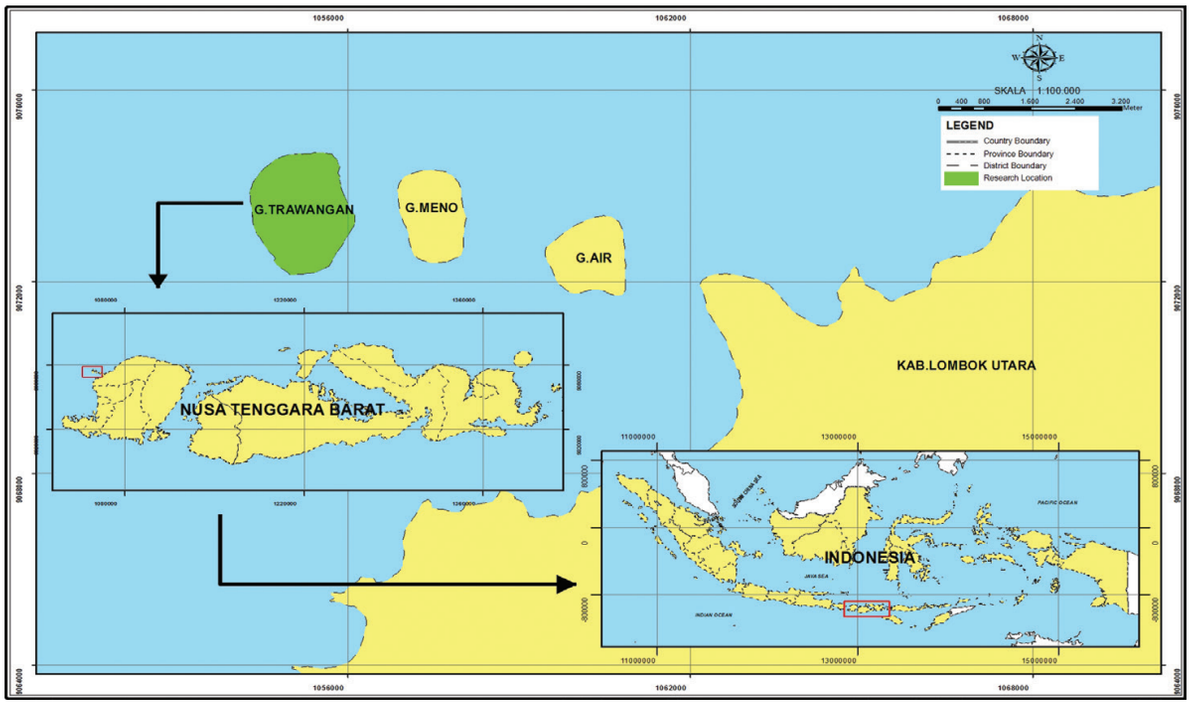

Figure 1. Research location.

Percentage of OEE	Criteria	Score
If OEE = 100%	• Waste bank is perfectly run • Produces only programs with significant outcomes • Fast service and no *downtime*	4
If 85% ≤ OEE <100%	• Waste bank is run optimally but can be more improved • Produces some program and most of them is implemented • Long-term goal: goal-oriented programs	3
If 60% ≤ OEE <85%	• Waste bank is fairly good • Produce some programs and some have not been implemented • Wide opportunity for more *improvement*	2
If 40% ≤ OEE <60%	• Waste bank is average • Produce some programs and only few have not been implemented • Frequent *downtime*	1
If OEE < 40%	• Waste bank is poor • Hard to be improved • Most of the programs are not implemented • Required deep observation to find out the reasons for the poor condition	0

Table 1. Criteria for measuring the OEE.

Scores	Remarks
<1.00	Not capable to adapt
1.00 ≤ x < 2.00	Less capable to adapt
2.00 ≤ x < 3.00	Adequately capable to adapt
3.00 ≤ x < 4.00	Capable to adapt
4.00	More capable to adapt

Table 2. Adaptability level.

3. Result and discussion

3.1. Waste generation and composition

Waste sources in GTI are mainly households (HH) and hotels (HT) generating waste of 20–30 and 100–300 kg/day, respectively. The compositions of organic and inorganic wastes are 65 and 35%, respectively. Totally, about 17.72 ton waste is generated in GTI per day as shown in **Table 3**.

Inorganic waste is mainly comprised of plastic, glass bottles, food wrap, and tin which comes from commercial facilities, i.e., restaurants, hotels, guest houses, bars, and recreation areas. Some of these wastes have been managed by Bintang Sejahtera WB established in 2015.

3.2. Waste bank in GTI

Bintang Sejahtera WB is a community-based waste management system that aims to reduce waste and to get benefit from waste. It accepts inorganic waste separated by the households including plastic bottle/glass, aluminum tin, plastic bag, paper, and cardboard. The condition of Bintang Sejahtera is shown in **Figure 2**.

In 2016, the daily separation rate of Bintang Sejahtera WB was 4.430 ton/day or 25% of total waste generation in GTI in which 3.145 ton was plastic. The waste was sold to some industries in other cities outside the island with the price ranging from Rp 200 to 9000. The selling price for each waste type is shown in **Table 4**.

Location	Waste types	Waste generation (ton/day)	Average waste generation (ton/day/person)
Gili Trawangan	Organic	11.52	0.005
	Inorganic	6.20	0.002
	Total	17.72	0.007

Table 3. Waste generation in GTI (2015).

Figure 2. Condition of Bintang Sejahtera WB.

No	Waste types	Price (USD)
1	Plastic bottle	0.152
2	Plastic glass	0.152
3	Aluminum tin	0.682
4	Cardboard and paper	0.076
5	Plastic bag	0.015
6	Tetrapack	0.023

*One rupiah equals USD 13.198 based on rate from Indonesian Central Bank.

Table 4. Selling price of waste in Bintang Sejahtera WB in 2016.

There are several activities that are conducted every day, such as collecting waste from households, restaurants, bars, and others. Then, WB staffs sort the organic and inorganic wastes, weigh them (**Figure 3**), and record it (**Figure 4**). The organic waste will be used to make a natural fertilizer by the environmental community initiative staffs. Meanwhile, the inorganic waste will be recycled or reused.

Bintang Sejahtera WB addresses not only profit but also social development and environmental improvement. Through waste bank, villager's welfare can be increased though better income and healthier environment. Some programs are offered by Bintang Sejahtera WB, such as health savings, education savings, and electricity and water savings, which can be claimed by the vil-

Figure 3. Weighing the waste in Bintang Sejahtera WB.

lager as a member of WB when it is needed. Bintang Sejahtera WB has cooperation with the environmental community initiative to collect waste from beaches and with the local government to provide collection system to transport the waste. It also offers seminars and trainings for local people in terms of waste treatment (composting and reuse-reduce-recycle method).

3.3. Waste bank effectiveness

Waste bank is an implementation of Reuse, Reduce, and Recycle (3R) of inoragnic waste in GTI. However, there is no evaluation of WB effectiveness so far. Therefore, the evaluation is conducted to measure the level of effectiveness based on three subjects that is availability, performance, and quality.

3.3.1. Availability

Availability is defined as the ability of WB to conduct activities related to waste management within a certain time; it refers to operational time. The ability is the ratio of existing operational time to planned operational time. Currently, the operational time of WB is 8 h in compliance with planned operational time. It indicates that the availability of WB is in proper condition.

3.3.2. Performance

Performance is the achievement of WB in a certain period based on the existing operational time, ideal time allocated for each activity, and the number of WB's activities in a certain

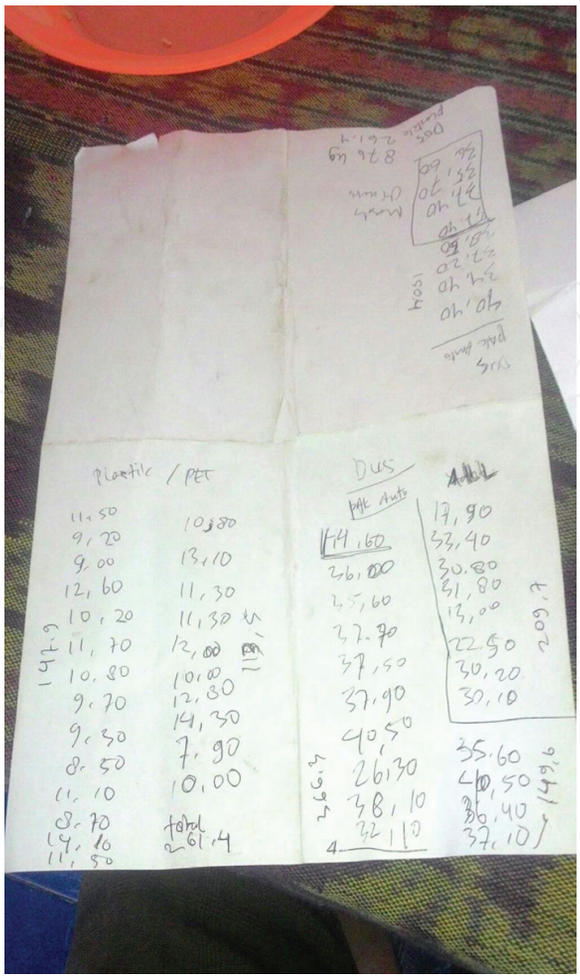

Figure 4. Waste record and list in Bintang Sejahtera WB.

period. The operational time of WB is 8 h accommodating four activities, i.e., waste separation, waste compacting, waste weighing, and data recording. The time allocated for each activity is 4 h, 2 h, 15 min, and 5 min for separation, waste compacting, waste weighing, and data recording, respectively, and an additional 1 h for lunch break.

3.3.3. Quality

WB quality is determined by analyzing the WB program's success in its implementation and its significant contribution to benefit the community. WB has a good quality when the above criteria are fulfilled. The quality is measured based on the number of WB's program which has been implemented. Bintang Sejahtera WB has six programs where five are savings for health, education, holiday, electricity, and water and one is for environmental hygiene and conservation. Calculation of WB effectiveness using Eq. (5) is shown in the **Table 5**.

$$\text{OEE} = \text{Availability} * \text{Performance} * \text{Quality} = 1 * 0.79 * 0.16 = 0.1267 = 12.67\% \quad (5)$$

Variables	Indicators	Results	Notes
Availability	• Current operational time of WB (A) = 8 h = 480 min • Planned the operational time allocated for running the WB (R) = 8 h = 480 min	$A = \frac{A}{Ra} \times 100\% = \frac{480}{480} \times 100\% = 100\% = 1$	Availability of WB is maximum since operational time fulfill planned time allocation (8 h)
Performance	• Current operational time of WB (A) = 8 h = 480 min • Number of WB's activities (N) = 4 i.e., waste separation, compacting, weighing, and recording. • Ideal operational time for each activity (W_i), i.e., separation, compacting, weighing, and recording for 240, 120, 15, and 5 min, respectively.	$P = \frac{W_i \times N}{A} = \frac{((1 \times 240) + (1 \times 120) + (1 \times 150) + (1 \times 5))}{480} = 79\% = 0.79$	Performance Bintang Sejahtera WB is not maximum. There is abandoned 40 min from total 8 h operational time.
Quality	• Number of program implemented (Aq)= 1 program • Number of available total program (Tq) = 6 program	$Q = \frac{Aq}{Tq} \times 100\% = \frac{1}{6} \times 100\% = 16\% = 0.16$	Programs offered by Bintang Sejahtera WB is not maximum. Only one program is implemented caused by the public participation

Table 5. Calculation of WB's effectiveness in GTI.

Multiplying three variables come to the result that OEE is 12.67%. This value is below 40%. Referring to **Table 1**, WB has zero score indicating that waste bank has poor effectiveness and is hard to be improved. Improvement is required to pace waste generation increase in GTI projected to be 23.23 ton/day in 2020 where 35% of it is inorganic waste. Otherwise, GTI will face waste problems because landfill in GTI is approaching its maximum capacity.

Analyzing the OEE, it can be recognized that low OEE value is caused by low quality value of WB. Low quality value is determined by the number of implemented programs which is only one from six programs offered. Low public participation is the reason for this. Waste separation is not common for the villager in GTI, and only small number of HHs is involved in waste separation. Thus, the number of WB customer is also very low. Furthermore, WB's performance is not maximum because there is 40 min remaining time unused for waste management activities.

Improvement of WB' effectiveness may increase public participation which requires public adaptability to WB's program in GTI. Therefore, public adaptability is necessary to be measured. Evaluation of public adaptability in GTI may contribute to find out the adaptability level, its factors, and the possible solutions.

3.4. Public adaptability

Public adaptability to WB is defined as community's and institution's adaptability for being active in WB program and is assessed based on reason/motivation and behavior [23]. Community refers to the villager of GTI, while institution refers to the Bintang Sejahtera WB, the environmental community initiative, and the local government.

3.4.1. Community's motivation and behavior

Community's motivation and behavior is a push factor for the villager in GTI to participate in WB's programs. Survey results showed some reasons for motivation to be engaged or not in WB's program, i.e., 53.8% villagers had no motivation to be active in the programs because of nescience of WB's purposes and benefits and subsequence of WB's program; 42.8% villagers were motivated to be active in which 30.0, 8.8, and 7.5% villagers had both environmental awareness and additional income, only environmental awareness, and only income addition, respectively. The percentage affirms the behavior of the community where 83.8% villager do not separate waste currently.

3.4.2. WB staff's motivation and attitude

WB Staffs have an important role in WB implementation. There are six persons managing the process in WB comprising waste separation, compacting, weighing, and data recording. Their motivation may be the factor influencing WB's effectivity. The result shows that 50% staff has motivation to be involved in WB for environmental awareness and the rest is for additional income.

3.4.3. Community initiative staff motivation and attitude

The environmental community initiative staffs support the WB in waste transportation from waste sources (HHs and commercial facilities) to WB and composting center. All staffs have high motivation and their behavior reflect high commitment to improve waste management in GTI. They also plan to develop organic farming in GTI within 2 years.

3.4.4. Local government officer's motivation and attitude

Some related local planning has been set including transfer point construction, an incinerator erection, and vehicle procurement.

The analysis comes to the result that each stakeholder has different adaptability level. **Table 6** describes the adaptability level of stakeholders of WB in GTI.

It can be summed up that the average adaptability score is 1.80. Referring to **Table 6**, the score indicates that has less capability to adapt WB because the score lies between 1.00 and 2.00.

3.5. Willingness to accept

WTA of HHs is measured to determine the expected compensation to separate waste and sell it to the WB. Furthermore, WTA may reflect the public through eliciting questions in

Stakeholders	Motivation and attitude	Score
Community	Less motivation of GTI community makes most of them not to support WB activities	2.00
WB staff	All of WB staff have been motivated due to economic and environmental added values of WB	3.00
Community initiative staffs	Most of their programs have been well conducted (two out of three programs)	3.00
Local government officers	They only conducted one out of three programs	1.00
Average score		1.80

Table 6. Bintang Sejahtera WB adaptability.

questionnaires. Villager who accepts the WB program is asked further for acceptable price for the waste transported to WB. **Table 7** explains the acceptable price for each waste type for 94 respondents representing the whole HHs in GTI.

Aluminum tin has the highest and plastic bag has the lowest acceptable prices compared to other waste types. Furthermore, a comparison between the acceptable price and the current market price for the waste set by the middleman is conducted to find out whether the price is reasonable to be set or not. It is expected that public participation in WB

Waste types	Expected waste price by community (Rp/kg)		Most acceptable price (Rp)
Plastic bottle	Most expensive	0.189–0.265	0.227
	Cheapest	0.038–0.114	0.114
Glass bottle	Most expensive	0.189–0.265	0.227
	Cheapest	0.076–0.129	0.114
Small beer bottle	Most expensive	0.023–0.045	0.038
	Cheapest	0.008–0.015	0.008
Big beer bottle	Most expensive	0.076–0.114	0.114
	Cheapest	0.023–0.038	0.038
Ketchup bottle	Most Expensive	0.061–0.114	0.076
	Cheapest	0.008–0.038	0.023
Aluminum tin	Most expensive	0.833–1.137	0.985
	Cheapest	0.227–0.492	0.379
Cardboard and paper	Most expensive	0.114–0.189	0.152
	Cheapest	0.038–0.076	0.076
Plastic bag	Most expensive	0.023–0.053	0.038
	Cheapest	0.008–0.015	0.008
Tetrapack	Most expensive	0.038–0.053	0.045
	Cheapest	0.008–0.023	0.008

*One rupiah equals USD 13.198 based on rate from Indonesian Central Bank.

Table 7. Acceptable waste selling price in GTI.

Waste types	Acceptable price (Rp/kg)	WB's selling price (Rp/kg)	Middleman's selling price (Rp/kg)
Plastic bottle	0.114–0.227	0.152	0.152
Plastic glass	0.114–0.227	0.152	0.227
Small beer bottle (glass)	0.008–0.038	0.000	0.023
Big beer bottle (glass)	0.038–0.114	0.000	0.061
Ketchup bottle (glass)	0.023–0.076	0.000	0.045
Aluminum tin	0.379–0.985	0.682	0.758
Cardboard and paper	0.076–0.152	0.076	0.114
Plastic bag	0.008–0.038	0.015	0.000
Tetrapack	0.008–0.045	0.023	0.000

*One rupiah equals USD 13.198 based on rate from Indonesian Central Bank.

Table 8. Waste selling price.

increases when WB offers relatively higher selling price. **Table 8** shows the comparison of waste selling price acceptable for the HHs, set by WB and middleman. It is obvious that WB generally sets lower selling price. Higher selling price offered by the middleman may be an obstacle. Moreover, some waste type such as small beer bottle, big beer bottle, and aluminun tin are not accepted by WB although the generation of these waste types is relatively high.

Acceptable waste selling price is within the price range offered by both WB and middleman indicating that most HHs can accept the WB's program. HH's WTA is reasonable to be implemented with the most acceptable price as a compensation for waste separation done by the HHs.

4. Conclusion

The result from the OEE calculation show that:

1. Availability of waste bank is 100% indicating that time provision for service is very good for conformity of the time allocation.
2. Performance of waste bank is 79% indicating that performance is not optimal since there are 40 min remaining from the whole work hours.
3. Quality of waste bank is 16% indicating that the quality is poor caused by low involvement of community and low implementation rate of existing programs (one out of six).
4. OEE is 12.67% which equals to score 0 indicating that waste bank is difficult to be improved.

Waste type	Acceptable price for recyclable material (Rp/kg)
Plastic bottle	0.114–0.227
Plastic glass	0.114–0.227
Small beer bottle	0.008–0.038
Big beer bottle	0.038–0.114
Ketchup bottle	0.023–0.076
Aluminum can	0.379–0.985
Cardboard/paper	0.076–0.152
Plastic bags	0.008–0.038
Tetrapack	0.008–0.045

Table 9. WTA for waste separation reflected by optimum price for recyclable waste.

5. The availability score is 1.5 and community acceptance is 37.5%.
6. WTA is reflected by the optimum price accepted by the community as a compensation if they separate waste and sell waste to the waste bank. WTA for waste separation reflected by optimum price for recyclable waste is shown in **Table 9**.

5. Recommendations

There are some recommendations for improvement of WB's effectiveness based on the result of the analysis:

1. Provision of pickup service for members.
2. Employment of remaining 40 min to increase the customer service.
3. Cooperating with owners of commercial facilities to separate waste and providing pickup service.
4. Public dissemination about the WB's benefit through regular open hearing.
5. Increasing waste selling price and expanding acceptable waste type.

Author details

Christia Meidiana*, Harnenti Afni Yakin and Wawargita Permata Wijayanti

*Address all correspondence to: c_meideiana@ub.ac.id

Faculty of Engineering, Universitas Brawijaya, Malang, Indonesia

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