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Community participation in 3R (Reduce, Reuse and Recycle) of household plastic waste in Balikpapan

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Abstract. The 3R (Reduce, Reuse, Recycle) effort is focused on reducing plastic waste generated from household activities. Community participation is very necessary in realizing efforts to reduce plastic waste. This research aims to analyse community participation regarding efforts to reduce 3R plastic waste (Reduce, Reuse and Recycle) based on the amount of generation and composition of household plastic waste in Balikpapan City. The data used in this research are primary and secondary data. Measurement of waste generation and composition data refers to SNI 19-3964-1994. Participation data collection was carried out by distributing and filling out questionnaires offline to the public with a total of 100 families of respondents obtained from the Slovin method calculation in determining the sample size. The results of this research showed that the average generation of household plastic waste from 100 families in Balikpapan City was 9.55 Kg/day with the highest composition of plastic waste dominated by PET at 3.14 Kg/day. Community participation in Reduce efforts was 68% in the "good" category, Reuse was 58% in the "good enough" category and Recycle was 29% in "not good" category.

1. Introduction

Plastic waste is organic material or material that has not been used and contains certain components that have flexible properties and require heat and pressure for the decomposition process [1]. Plastic is one of the materials most often used in everyday life because of its practical and durable nature. Plastics used excessively and irresponsibly can cause serious environmental problems [2]. Plastic waste that is not managed properly can pollute the environment because it has characteristics that are difficult to decompose into small particles that are difficult for nature to degrade [3].

Based on data from the Balikpapan Central Statistics Agency [4], Balikpapan City is in the southeastern part of East Kalimantan Province with an area of 511.01 km² or around 0.40% of the area of East Kalimantan Province. Balikpapan City has 6 sub-districts, namely West Balikpapan, Central Balikpapan, North Balikpapan, Balikpapan City, and East Balikpapan, with a total population of 2022 of 703,611 people. Balikpapan is one of the 5 cities in Indonesia that produces the highest generation of plastic waste, with a composition of 33.5 – 44.7% [5]. Based on data from the Balikpapan Central Statistics Agency [6], the number of types of plastic waste entering the UPTD TPAS Manggar (Balikpapan City) in 2022 will be 67.42 tonnes/day. One of the main sources of plastic waste comes from households, where people routinely use plastic



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products in their daily lives, such as food packaging, drink bottles, shopping bags, and others [7]. The Balikpapan City Government has stipulated Mayor Regulation Number 8 of 2018 concerning Reducing Plastic bag use to reduce plastic waste generation. In another effort to increase the reduction of plastic waste, the Balikpapan City Government has also established Regional Regulation Number 1 of 2019 concerning Reducing the Use of Single-Use Plastic Products/ Packaging.

One of the easiest efforts that can be made to reduce the amount of plastic waste generated on a household scale is by applying the 3R principle (Reduce, Reuse and Recycle), which is a sequence of waste management activities. Reduce focuses on maximizing the use of materials to reduce the waste generated. Reuse prioritizes the reuse of items that can still be used to reduce the waste generated. Recycling at this stage involves collecting and processing waste into raw materials to make new products. 3R efforts in the household can provide benefits and have a positive impact on reducing plastic waste because 3R itself is an effort that can be carried out very generally at the household level. Reusing waste materials by recycling is an effective way to avoid environmental pollution and reduce the volume generated at final disposal sites (TPA) [8]. Based on research by Sompie (2022), community participation in managing household waste (3R) in Singkil Dua Village, Singkil District, Manado City is quite high, so the amount of waste disposed of at Final Disposal Sites (TPA) can be reduced [9].

Human behaviour in choosing environmentally friendly plastic alternatives, reuse and proper waste management influences the amount of plastic thrown into the environment. Community participation is very necessary in the 3R plastic waste program. Therefore, this research will be carried out to see the potential amount of plastic produced in Balikpapan City and to analyse community participation in the 3R household plastic waste effort in Balikpapan City.

2. Method

This research was conducted in January-May 2023, located in 6 sub-districts of Balikpapan City

2.1 Calculation of sample size

The sample size calculation in this study used the Slovin Formula. The Slovin formula is a formula for calculating the minimum number of samples from a population. The formula used in determining the sample is as follows:

$$n = \frac{N}{1 + Ne^2}$$

Where:

n = Sampel size

N = Population

e = Percentage of Inaccuracy Tolerance (10%)

Based on the formula above, the sample size is considered to represent the population using a 10% confidence level. The number of families in Balikpapan City is 240,079 families [6]. The number of participants in this study was 100. The division of the number of samples in each sub-district considers the number of families in each sub-district. For sub-districts that have a high number of families will get more samples, so the number of samples per sub-district is shown in Figure 1.

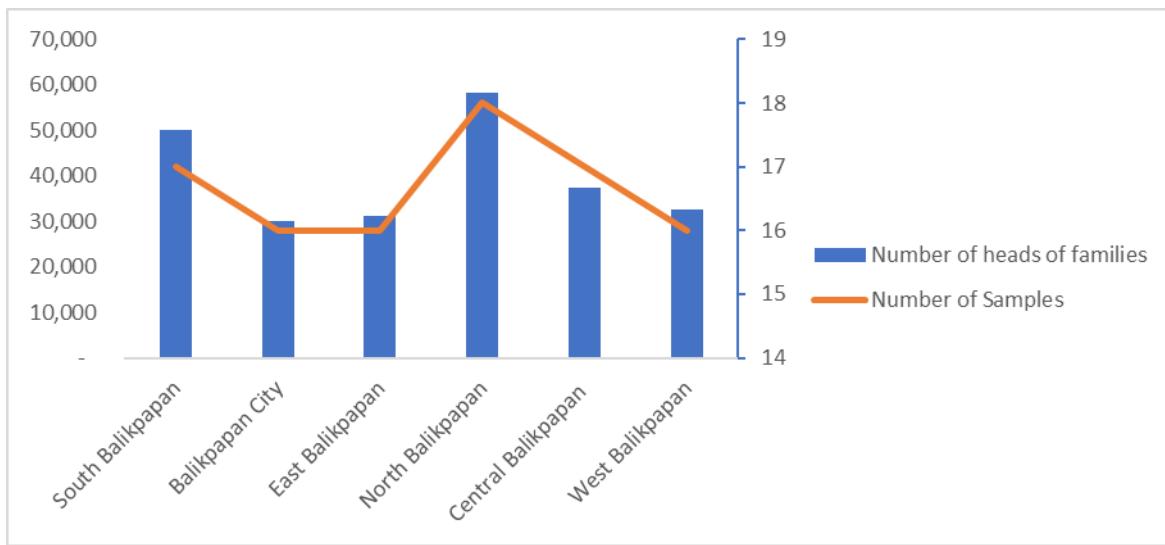


Figure 1. Sample distribution per sub-district

2.2 Analysis of the Amount of Generation and Composition of Household Plastic Waste in Balikpapan City

The work technique for taking plastic waste samples along with calculating the volume, density and composition of plastic waste is carried out based on SNI 19-3964-1994 [12]. Measurement of plastic waste generation was carried out in the period from January 7 to February 25, 2024 with a sampling frequency of 8 consecutive days per sub-district. The waste collection schedule is based on initial coordination with residents in the housing area, starting from requesting a permit and explaining the needs of the waste. The technical calculation of waste generation and composition is as follows:

2.2.1 Waste Generation. Distributing plastic bags to each source of plastic waste one day before the plastic waste is collected, recording the number of units of each plastic waste producer, collecting plastic bags that have been filled with plastic waste, transporting all plastic bags from each source to the measurement site, weighing each plastic bag obtained from each source of plastic waste. In this study, the volume of plastic waste was measured using a 40L sampling box.

Calculation of the volume of waste generated using the following formula:

$$\frac{\text{Waste volume (L)}}{\text{Number of waste producers (people/day)}}$$

Calculation of the weight of waste generated using the following formula:

$$\frac{\text{Waste weight (Kg)}}{\text{Number of waste producers (people/day)}}$$

2.2.2 Waste Composition. After the waste is collected, then sorting of plastic waste samples according to the components of the type of plastic waste (PET, HDPE, PVC, LDPE, PP, PS, OTHER) then weighing the results of sorting each component of the type of plastic waste. The calculation of the composition of waste is done with the formula:

$$\frac{\text{Weight of waste components (kg)}}{\text{Total weight of waste (kg)}} \times 100\%$$

The calculation results are the percentage of plastic waste composition from each type of plastic waste in each sub-district of Balikpapan City.

2.3 Community Participation Analysis

The questionnaire was distributed with the aim of finding out how much community participation there is in the 3R (Reduce, Reuse, and Recycle) efforts to reduce plastic waste. The questionnaire was distributed to respondents (the community) in each house in each sub-district in Balikpapan City according to the number of respondents, which had been calculated based on the Slovin formula. Sampling in the form of distributing this questionnaire used the purposive sampling method, where the respondent criteria were homeowners who were willing for their plastic waste to be used as research objects and were heads of families in a KK.

The questionnaire in this study contained a number of written questions that were used to obtain information from respondents regarding how much respondent participation was in the 3R (Reduce, Reuse, and Recycle) efforts for household plastic waste using the Guttman Scale assessment on the questionnaire answers [10]. The assessment of the answer "Yes" was given a score (1), and the answer "No" was given a score (0). The results of the score assessment will be interpreted using the following equation [9].

$$P(\%) = \frac{n}{N} \times 100$$

Description of the criteria for interpreting community participation scores in managing 3R (Reduce, Reuse, and Recycle) household plastic waste is shown in Table 1.

Table 1. Participation Category

Category	Percentage
Not Good	0 – 33,32%
Good Enough	33,33 – 66,66%
Good	66,67 – 100%

^a Author, 2023.

Analysis of community participation regarding the management of 3R (Reduce, Reuse, and Recycle) household plastic waste was carried out using a quantitative descriptive analysis method using scoring. According to Sugiyono (2017) [11], the quantitative descriptive research method aims to describe an incident that occurs factually, systematically and accurately.

3. Results and Discussion

3.1 Generation and Composition of Household Plastic Waste in Balikpapan City

Measurement and collection of plastic waste generation were carried out with the aim of knowing how much potential plastic waste is generated from household activities in Balikpapan City. The results of household plastic waste generation measurements that have been carried out in Balikpapan City can be seen in Table 2.

Table 2. Results of Household Plastic Waste Generation Measurement in Balikpapan City

Day -	Number of Heads of Families	Waste Weight (Kg)	Volume of waste (m ³)
1	100	12.98	0.18
2	100	11.51	0.18
3	100	10.21	0.18
4	100	10.45	0.19
5	100	8.02	0.17
6	100	8.02	0.18
7	100	7.77	0.17
8	100	7.46	0.17
Total	-	76.42	1.42
Average	-	9.55	0.24

^aAuthor, 2024.

Based on Table 2, it can be seen that the total weight of household plastic waste generated from 100 families in Balikpapan City is 76.42 kg and the total volume of household plastic waste is 1.42 m³. The average weight of household plastic waste generated from 100 families is 9.55 kg/day and the average volume of household plastic waste generated is 0.24 m³/day. The calculation of the average household plastic waste generated by each person per day in Balikpapan City is carried out with the following calculation:

Average weight of plastic waste generated:

$$Bs = \frac{\text{Total weight}}{\text{Number of families} \times \text{Number of people per family}} \times \frac{1}{8 \text{ days}}$$

$$Bs = \frac{76,42 \text{ kg}}{100 \text{ KK} \times 5 \text{ peoples}} \times \frac{1}{8 \text{ days}} = 0,020 \text{ kg/ people/ days}$$

Average volume of plastic waste generation:

$$Vs = \frac{\text{Total volume}}{\text{Number of families} \times \text{Number of people per family}} \times \frac{1}{8 \text{ days}}$$

$$Vs = \frac{1,42 \text{ m}^3}{100 \text{ KK} \times 5 \text{ people}} \times \frac{1}{8 \text{ days}} = 0,00355 \text{ m}^3/ \text{people /days}$$

Based on the calculation, it is known that the weight and volume of household plastic waste produced by each person per day in Balikpapan City are 0.020 kg/person/day and 0.00355 m³/person/day. It is known that the population of Balikpapan City is 703,611 people in 2022 [4]. The calculation of the average household plastic waste generation from each person per day is carried out to determine the amount of household plastic waste generation in Balikpapan City by calculating the generation of plastic waste in Balikpapan City:

$$Ts = TS \text{ per person} \times \text{Number of Balikpapan City Residents}$$

$$Ts = 0.020 \text{ kg/person/day} \times 703,611 \text{ people}$$

$$Ts = 144,072.22 \text{ kg/day}$$

$$Ts = 14 \text{ tons/day}$$

Based on the calculation, it is known that the projection of household plastic waste generated per day in Balikpapan City is 14 tons/day. The plastic waste that has been obtained is then sorted and weighed based on its type so that it can be known how much plastic waste is generated per type in Balikpapan City, which consists of PET, HDPE, PVC, LDPE, PP, PS, and Other plastics with the results in Figure 2.

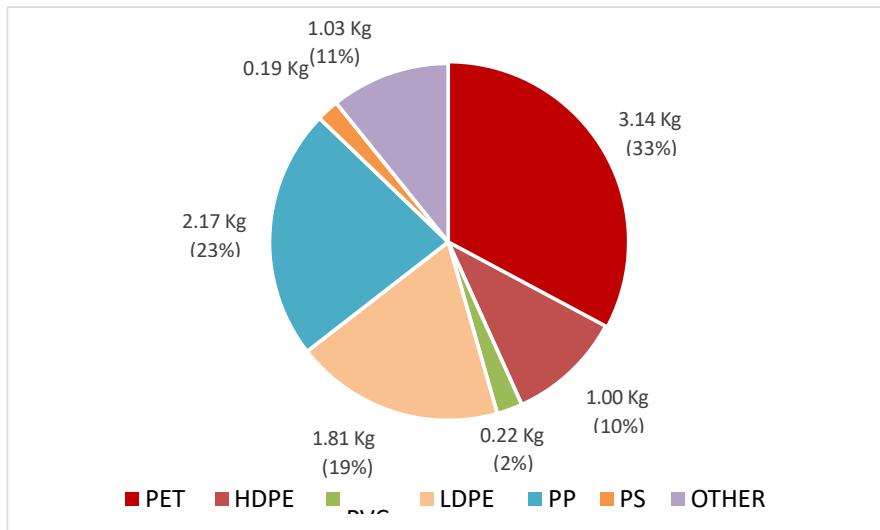


Figure 2. Composition of Household Plastic Waste in Balikpapan City.

Based on Figure 2, it is known that the type of household plastic waste that dominates in Balikpapan City is PET plastic, as much as 3.14 Kg/day or 33%. This is because when weighing each type of plastic waste, this type of plastic is mostly found in drinking water bottles in various sizes. In addition, PET plastic has light and strong properties [12], so PET plastic tends to be used more in everyday products.

HDPE plastic waste is obtained as much as 1 Kg/day or 10%, and the most commonly found are children's toys, soap or shampoo bottles, used food equipment, etc. PVC plastic waste is obtained as much as 0.22 Kg/day or 2%. PVC is rarely found because PVC is generally used as a construction material such as pipes or electronic equipment, so it is rarely produced in household activities. PVC waste has the potential to be an additional material for asphalt mixtures [16].

Plastic waste with the LDPE type was obtained as much as 1.81 Kg/day or 19%, and what was found was single-use plastic bags and food wrappers, according to Bagastyo et al. (2023) [5] said that in Balikpapan City, the largest LDPE type plastic was generated because the use of single-use plastic bags was still used by stalls/kiosks. After all, the price was more affordable. Plastic waste with the PP type was obtained as much as 2.17 Kg/day or 23% Kg/day or 10% and the

most commonly found were used food containers such as thinwall and mica plastic, beverage bottles and others. The type of plastic with the least amount is PS, as much as 0.19 Kg or 2%. This is because polystyrene is more commonly found in styrofoam food packaging obtained from outside and based on the results of the questionnaire, as many as 96% of 100 families prefer to cook at home so that PS type plastic waste is rarely found in household waste, in addition when weighing the type of plastic waste in the field, polystyrene has a lower mass so that the amount of waste produced from this material in the form of volume is not as large as other types of plastic. Other types of plastic waste were obtained as much as 1.03 Kg / day or 11%. The most commonly found were detergent packaging products, cooking oil packaging, food packaging in the form of multi-layer sachets and others.

3.2 Community Participation in 3R Management (Reduce, Reuse, and Recycle) of Household Plastic Waste in Balikpapan City

3.2.1. Reduce. Reduce is a form of community participation in an effort to reduce plastic waste by changing lifestyles or habits from being wasteful and producing a lot of plastic waste to being more economical and producing only a little plastic waste. Questions related to community participation in the reduce program are shown in table 3.

Table 3. Questions about participation in reducing household plastic waste

No.	Questions	Yes	No
1	Do you reuse containers/packaging repeatedly for the same function or different functions		
2	Do you avoid excessive use and purchase of products		
3	Do you bring your own reusable shopping bag when shopping		
4	Do you refuse to use plastic bags		
5	Do you use your own food container/lunch box to buy food outside		
6	Do you bring your own reusable drinking container/tumbler to carry drinks 100		
7	Have you changed your eating pattern from consuming fast food to healthier food		
8	Do you prefer to use stainless steel or paper straws		

^aAuthor, 2024.

The calculation of the number of scores that selected "Yes" on the reduce participation questionnaire, which indicates how much community participation there is in reduce efforts in the community, can be seen in Table 4.

Table 4. Calculation Results of the Total Reduce Score in Balikpapan City

Sub-district	Scor	Total	Percentage
North Balikpapan	111	144	77%
East Balikpapan	82	128	64%
West Balikpapan	80	128	63%
South Balikpapan	98	136	72%
Balikpapan City	83	128	65%
Central Balikpapan	89	136	65%
Average			68%
Category			Good

^aAuthor, 2024.

Based on the calculation in Table 4, it is known that the reduced participation of Balikpapan City is categorized as good, with a percentage of 68%. It can be interpreted that most of the people of Balikpapan City have participated in efforts to reduce or limit the use of single-use plastic in everyday life, especially in households. The results of the questionnaire prove that some people have reduced or limited the use of plastic.

As many as 71% of 100 people reuse containers/packaging repeatedly with the same function or different functions, such as reusing thin-wall, plastic spoons, etc. As many as 92% of 100 people have avoided using and purchasing excessive plastic products, such as stocking snacks in excessive quantities, detergent bags, etc. As many as 90% of 100 people have been aware of bringing their shopping bags when shopping, such as using tote bags or shopping basket bags. As many as 65% of 100 people have refused to use plastic bags when shopping outside. As many as 64% of 100 people prefer to bring their drinking containers or tumblers. From the interview results, according to them, it is healthier and more practical to bring their drinks from home and can save money by not spending money to buy drinks outside again. As many as 96% of 100 people prefer to cook their food at home rather than buy or consume food from outside to reduce the amount of plastic brought home and the amount of plastic waste generated from households. Based on this, reduced participation needs to be maintained to reduce the habit of people who still often use single-use plastics such as plastic bags, plastic drink bottles, disposable food packaging, and plastic straws.

Currently, the Balikpapan City government already has a Regional Regulation in the form of Balikpapan Mayor Regulation Number 8 of 2018 concerning Reducing the Use of Plastic Bags and Regional Regulation Number 1 of 2019 concerning Reducing the Use of Single-Use Plastic Products/Packaging. The city government can strengthen these regulations by implementing rewards and punishments. So that the community can be disciplined in implementing these policies in everyday life.

3.2.2. Reuse. Reuse is a form of community participation in efforts to reduce plastic waste by reusing materials with the same or different functions with the aim of extending the useful life of the item and reducing the amount of plastic waste generated. Questions related to community participation in the reuse program are shown in table 5.

Table 5. Questions about participation in reusing household plastic waste

No.	Questions	Yes	No
1	Do you prefer products with recyclable packaging?		
2	Do you prefer to use refillable products?		
3	Do you use used plastic bags for trash?		
4	Do you use used plastic cups or bottles to make crafts?		
5	Do you use used plastic bowls/jars to make crafts?		
6	Do you reuse used plastic containers from fast food?		

^aAuthor, 2024.

The calculation of the number of scores that selected “Yes” on the reuse participation questionnaire, which indicates how much community participation there is in reuse efforts in the community, can be seen in Table 6.

Table 6. Results of Calculation of Reuse Score in Balikpapan City

Sub-district	Scor	Total	Percentage
North Balikpapan	72	108	67%
East Balikpapan	52	96	54%
West Balikpapan	47	96	49%
South Balikpapan	61	102	60%
Balikpapan City	59	96	61%
Central Balikpapan	58	102	57%
Average			58%
Category			Good Enough

^aPenulis, 2024.

Based on Table 6, it is known that the reuse participation of Balikpapan City is categorized as “good enough”, with a percentage of 58%. Most of the people of Balikpapan City have quite good participation or awareness in efforts to reuse plastic materials that can still be reused in everyday life, especially in households. This is proven by the results of the questionnaire, where some people participated in reusing plastic by choosing products with recyclable packaging and using products that can be refilled, and some others still needed to improve in reusing plastic. As many as 71% of 100 people prefer products with recyclable packaging. As many as 97% of 100 people prefer refillable products, such as soap and shampoo bottles. As many as 57% of 100 people reuse used food containers that can be washed and reused. The results of interviews with the

community showed that many people still use single-use plastic bags when shopping at the market, this is in line with Farin's research (2021) [13], which states that currently there are still many people who have brought their shopping bags but still ask for plastic bags when shopping, and also there are still many people who have very low participation in avoiding the use of plastic. Therefore, reuse participation needs to be increased to extend the life and maximise the reuse of existing plastic materials.

It's crucial to understand that every individual's actions, particularly in reusing plastic materials, can significantly impact the environment. Unfortunately, many people still dispose of plastic directly into the trash, considering it non-reusable waste. As Bagastyo et al. (2023) [5] point out, household attitudes and participation in managing single-use plastic waste are often influenced by habits, lack of awareness, and lack of knowledge about the importance of waste sorting. By increasing reuse participation, we can collectively make a positive difference and extend the life of existing plastic materials.

3.2.3. Recycle. Recycle is one form of community participation in efforts to reduce plastic waste by recycling plastic materials that are no longer useful into new items that can be reused. Questions related to community participation in the reuse program are shown in table 7.

Table 7. Questions about participation in recycling household plastic waste

No.	Questions	Yes	No
1	Do you use a plastic recycling bin at home?		
2	Do you utilize plastic materials into more useful and economically valuable products?		
3	Do you recycle used thick plastic packaging (soap wrappers) into bags or other reusable crafts?		
4	Do you collect plastic bottles or plastic straws to be recycled into crafts?		
5	Have you ever participated in a recycling program held in your area?		
6	Are there many recycled plastic products in your home?		

^aAuthor, 2024.

The calculation of the number of scores that selected "Yes" on the recycling participation questionnaire can be seen in Table 8.

Table 8. Results of Calculation of Recycle Score in Balikpapan City

Sub-district	Score	Total	Percentage
North Balikpapan	31	108	29%
East Balikpapan	38	96	40%
West Balikpapan	34	96	35%
South Balikpapan	10	102	10%
Balikpapan City	29	96	30%
Central Balikpapan	28	102	27%
Average			29%
Category			Not Good

^aAuthor, 2024.

Based on Table 8, it is known that the recycling participation of Balikpapan City is categorized as less than good with a percentage of 29%. The sub-district with the largest percentage of recycling participation is East Balikpapan Sub-district, which is 40%. One of the most common recycling facilities found in residential areas is a waste bank. The large percentage of recycling participation in East Balikpapan Sub-district is influenced by the number of waste banks, which is the largest compared to other sub-districts. Waste bank facilities can increase community participation in recycling because the community benefits from sorting and recycling the waste [14].

This can be interpreted that most of the people of Balikpapan City have less participation or awareness in efforts to recycle plastic waste into reusable items, as evidenced by the results of the questionnaire where there are still few people who recycle plastic waste and the lack of participation in recycling programs that have been held. As many as 50% of 100 people use recycling bins at home, for example, used paint buckets, unused drinking water gallons, and others. The inhibiting factors for low participation in recycling plastic waste are the need for more public awareness, knowledge, and facilities for utilizing recycled goods. Therefore, it is necessary to make efforts such as socialization to the community by teaching how to turn used goods into new, more useful products so that they can be used according to needs at home (Bhisama et al., 2023) in order to increase community participation in reusing plastic materials with the same or different functions in order to reduce the amount of plastic waste in Balikpapan City.

In this case, the government needs to add supporting facilities needed by the community in the plastic waste recycling process. Based on the results of the interviews, in sub-districts with a large number of waste banks, the percentage of plastic waste recycling is higher compared to others. This shows that the existence of waste banks has a good influence on the plastic waste recycling program. Currently, Balikpapan City needs to add waste bank to each sub-district so that later in the community they can create recycling programs that have economic benefits.

4. Conclusion

The average household plastic waste generation from 100 families in Balikpapan City is 9.55 kg/day with a volume of 1.42 m³/day. The composition of household plastic waste that dominates in Balikpapan City is PET plastic at 3.14 kg/day or 33%. Community participation in the 3R (Reduce, Reuse, and Recycle) efforts of household plastic waste in Balikpapan City is reduced by 68% with a “good” category, reuse by 58% with a “good enough” category, and recycle by 29% with a “not good” category. The sub-district with the most waste banks has greater participation compared to others. Balikpapan City Government can add waste banks to improve recycling participation which is currently still in the “not good” category.

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