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MORALITY BEFORE KNOWLEDGE

Optimizing household organic waste management in support of sustainable household waste management in Bekasi City, Indonesia

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ABSTRACT

Introduction: Household waste that is not properly managed has the potential to pollute the environment and disrupt health. Providing information and knowledge to the public on proper household waste management is one of the efforts to preserve the environment and improve independent household waste control. The daily amount of organic waste generated from households reaches up to 40% of the total waste generated. Hence, household waste control heavily contributes to reducing the amount of waste transported to the Final Processing Site. **Method:** Such a program can be carried out by identifying and analyzing an appropriate and beneficial household waste control plan at the household level. Data collecting in this study was conducted online, towards 548 respondents in Bekasi City, Indonesia. Laboratory tests were also carried out on the results of fermentation of household waste samples to analyze the content of organic waste components produced from households. **Result:** The results showed that the community is still not optimal in managing household waste as only 33% of respondents are known to have utilized organic waste generated from households. The results of laboratory analysis showed that organic waste generated from households has components similar to commercial fertilizers. **Conclusion:** Considering the similar components of organic waste generated from households with commercial fertilizer, show the potential benefit from organic waste utilization. Further research regarding the benefits of fertilizer from household organic waste, and the benefit comparison with commercial fertilizers would be able to increase public trust and awareness to manage their household waste. Proper waste management on the household level would significantly reduce the volume of waste transported to the Final Processing Site.

KEYWORDS: household; organic waste; sustainable; waste management; waste optimization

1. Introduction

The most effective way to solve waste problem in the community is by household waste segregation to support environmental recovery and preservation effort (Zhang *et* al., 2022). Proper management and segregation of household waste will reduce negative impacts on the environment, such as waste that accumulates at the final processing site and waste that is littered on the side of roads and rivers. In addition, appropriate and consistent efforts to manage and sort household waste will provide economic benefits and help to achieve sustainable waste managemen (Gupta *et al*., 2022).

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People in general have not practiced household waste management, especial/ly household organic waste management (David *et al*., 2019). The amount of household waste transported to the final processing site reflects this situation (Bernstad, 2014), as happened in Bekasi City

This situation exists due to a several factors, including a lack of public awareness and understanding regarding the urgency to manage household waste. Furthermore, without proper household waste segregation, it would be difficult for the waste collector to separate the waste, resulting in the waste being mixed during transportation to the final processing site (Jusoh *et al*., 2018). It's also worth noting that the government's seriousness in regulating waste management regulations hasn't been seen, as well as the synergy between all parties in managing household waste (Abdul & Syafrudin, 2018; Sharma *et al*., 2019).

Indonesia has had waste management regulations in place since 2008, but based on the content of these regulations, it appears that people are questioning the government's consistency and commitment as a regulator to establish policies for achieving sustainable waste management, particularly in the area of household waste management (Gautier & Salem, 2021). The amount of garbage that has piled up on the side of the road, in waterways/rivers, and even when it is transported by the waste management agency, it only accumulates at the final processing site without being properly managed (David *et al*.,, 2019; Gupta *et al*., 2022). These things are certainly a driving force for the formation of public awareness and concern in managing household waste, which can be solved by a systematic and integrated waste management system that is integrated from upstream to downstream (Zhao *et al*., 2021). However, in reality, a systematic and integrated waste management has never been formulated and implemented by the government and related stakeholders as waste management activities are only carried out by a group of environmental activists and a small part of the community.

The composition of household organic waste, which accounts for about 40-55% of the total waste generated daily is the main target for maximum household waste management (Plasencia-Vélez *et al*., 2019). Given the nature of organic waste, which can be naturally destroyed, it does not need to be transported to the final processing site if each producer follows proper waste segregation and treatment procedures, such as repurposing organic waste as fertilizer or animal feed (Cecchi & Cavinato, 2019; David *et al*., 2019).

Management of organic waste through the composting process is an alternative option that is economical, sustainable and environmentally friendly (Al-Nawaiseh *et al*., 2021). Composting can be done in the simplest way by converting food waste into compost that can replace soil macro nutrients (Rashid & Shahzad, 2021).

The Indonesian government has made efforts to encourage the implementation of household waste management through government regulation number 81 of 2012 concerning the management of household waste and waste similar to household waste, as well as presidential regulation of the republic of Indonesia number 97 of 2017 concerning the National Policy and Strategy for the Management of Household Waste and Similar Waste. However, this effort is still not maximized because these provisions have not been followed up and implemented optimally at the district/city level.

Bekasi City has also followed up on Central Government regulations by enacting Bekasi Mayor Regulation number 65 of 2018 on Bekasi City Government Policies and Strategies in the Management of Household Waste and Household Waste Similar to Household Waste in Bekasi City, where the results have not been encouraging. This is due to the community's low perception, participation, and willingness to manage household waste in their respective places of residence (Ferdinan *et al*., 2021).

The management of household waste in Bekasi City is the same as the implementation of household waste management in other urban areas. The management of household waste, in this case, still only focuses on the process of recycling inorganic waste which has economic value. Meanwhile, household organic waste is still not managed due to limited knowledge and is considered not to provide economic benefits for the community (Azevedo *et al*., 2021).

The lack of information and education provided to the community is the cause of the community's lack of awareness and willingness to sort and manage their household waste independently (Azunre *et al*., 2021). The government's commitment and consistency has not been seen in overseeing policies and building a clean culture of the community, causing household waste management to not work properly so that it has the potential to harm the environmental sustainability (Sanjuan-Delmás *et al*., 2021).

However, it is important to be aware that improper household organic waste management can lead to disease spread and harm the environment (Mashur *et al*., 2021). As a result, all parties must work together to achieve sustainable household waste management, including community education of proper waste segregation, handling and facilities to support the management system.

2. Methods

The study was conducted in 12 sub-districts in Bekasi City, West Java Province, Indonesia. The population is all community members who live in the Bekasi City area who are registered as members of the Waste Bank based on data from the Bekasi City Environmental Service in 2019 with a total of 8,584 people. Samples were taken following the purposive sampling technique from 12 sub-districts and calculated proportionally. Samples were determined by using the Slovin formula (Husein % Sikumbang, 2003).

Based on the calculation of the Slovin formula, the minimum number of samples should be 420 respondents. This research was conducted during the social security period due to the Covid-19 pandemic which was carried out within 3 months starting from March 1, 2020 to May 31, 2020. Due to the covid pandemic situation, data collection was carried out using an electronic questionnaire, with a response rate of 130 percent obtained during the distribution of the questionnaire to respondents, resulting in a total sample size of 548 respondents.

2.1 Respondents by Districts

The respondents in this research are collected from each district in Bekasi City (**Table 1**). This study should be able to show representative results for Bekasi City because the number of respondents exceeds the minimum sample size.

Table 1. The number of target respondents and actual respondent acquisitions

No	District	Target Respondents	Real respondents
1	Bantargebang	8	21
2	Bekasi Barat	22	33
3	Bekasi Selatan	19	43
4	Bekasi Timur	27	48
5	Bekasi Utara	77	85
6	Jatiasih	29	37
7	Jatisampurna	11	29
8	Medansatria	33	38
9	Mustikajaya	74	75
10	Pondokgede	44	46
11	Pondokmelati	9	15
12	Rawalumbu	67	78
	Total	**420**	**548**

2.2 Laboratory Samples

In addition to the analysis, the authors also conducted sampling observations for 4 weeks on household organic waste produced by community members in Pondokmelati District. Based on observations in 12 sub-districts in Bekasi City, similarities were found

in the types of household waste produced. In this study, samples of fermented household organic waste were taken to examine the content of macro and micro nutrients.

The process of making organic compost was done by collecting the remnants of household organic waste as compost material. All organic materials used as samples are presented in **Table 2.** The procedure entails chopping the materials into small pieces and then waiting for them to become homogeneous.

Table 2. The composition of household organic waste that is carried out by laboratory testing

No	Material type	Unit	Volume
1	Egg shell	kg	0.31
2	Leaf	kg	4.62
3	Rind	kg	6.1
4	Vegetables	kg	7.48
5	Spoiled rice	kg	0.55
6	Onion Skin	kg	0.55
	Amount	**kg**	**25.64**

Later on, the components of household organic waste stated in the **Table 2** were fermented. The nutrient contentsfrom the composts were examined at the Soil, Plant, Fertilizer and Water Laboratory of the Agricultural Research and Development Agency to compare the results of laboratory testing with the minimum technical requirements for fertilizers that have been stated in the Decree of Minister of Agriculture of Republic Indonesia regarding fertilizer components.

The results of this study were based on questionnaires, observations and laboratory test results which were further analyzed to identify the proper management of household organic waste. The management is carried out by reusing the organic waste produced for other uses, such as fertilizer.

3. Results and Discussion

3.1 Utilization organic waste for plants

Proper organic and inorganic waste separation within the community or household is the key to success in household waste management (Bucciol *et al*., 2019). According to the results of the study, 206 respondents (38%) have done household waste sorting and 342 respondents (62%) have not done waste sorting in their respective homes. Household organic waste contains nutrients that can fertilize plants, so that household organic waste can be optimized for use into fertilizers that are beneficial to plants, both in the form of liquid and solid fertilizers (Avadi *et al*., 2020).

The results of the study revealed that 470 respondents (86%) have plants and 78 respondents (14%) do not have plants in their respective homes. This finding indicated that that most citizens own house-plants have the potential to become the target of promoting organic household waste on household level (Fig. 1).

The research showed that most of Bekasi City citizens own house-plants. Thus, this population is the proper target for household organic waste control where they are given an understanding of the use of household organic waste as a source of nutrition and fertilizer for house plants. Laboratory analysis showed that the minimum standard of fertilizer needed as a nutrient for plants is to fulfill plant needs for macro and micro nutrients in household organic waste. In other words, the optimization of household organic waste can become nutrients for plants.

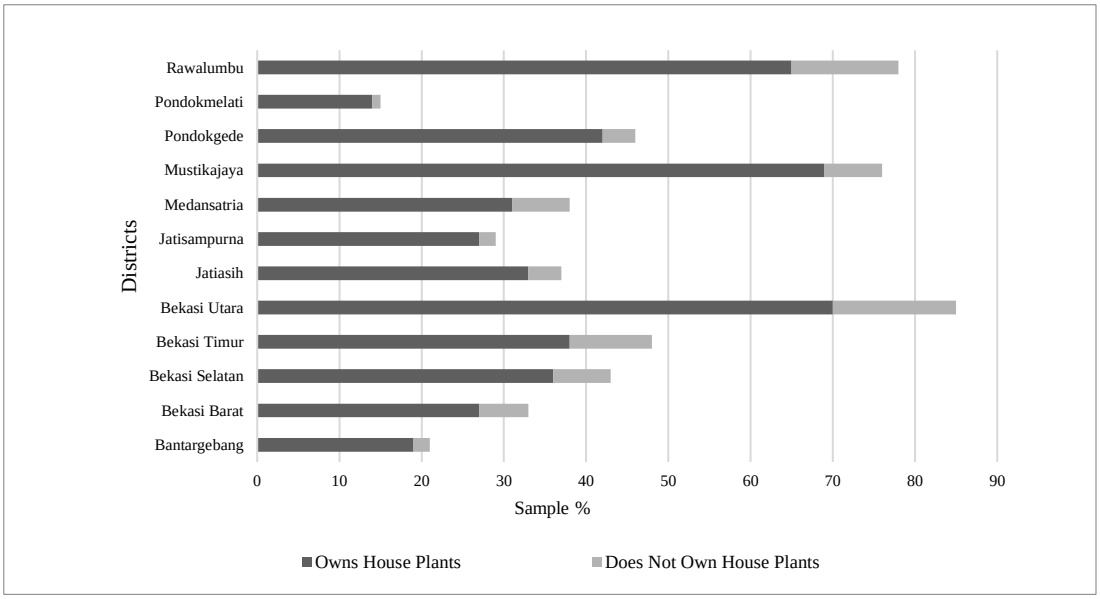

Fig 1. Percentages (%) of respondents owning house plants year 2020

Based on the results of the study, household organic waste can also be used as plant fertilizer since it contains important nutrients which can provide nutrients for plants as stated in Table 3 (Bhat *et al*., 2018; Sharma *et al*., 2019). In addition to reducing the amount of waste produced to the final processing site, optimization of the use of household organic waste needs to be maximized. Increasing the number of plants in the household in this case is expected to improve air quality in the community (Alibardi *et al*., 2020; Husein & Sikumbang, 2003).

Household organic waste has been proven to meet the minimum technical requirements for organic fertilizer based on the comparison of laboratory test data with the minimum technical standard for organic fertilizer as stipulated by the Government through the Decree of the Minister of Agriculture of the Republic of Indonesia Number: 261/KPTS/SR.310/M/4/2019 concerning Requirements Minimum Technical Organic Fertilizer, Biological Fertilizer and Soil Improvement.

Macro and micro nutrients needed by plants are contained in household organic waste, such as: nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), calcium (Ca), sulfur (S), boron (B), copper (Cu), zinc (Zn), ferrous (Fe), molybdenum (Mo), manganese (Mn), chlorine (Cl), sodium (Na), cobalt (Co), silicone (Si) and nickel (Ni) [25] (Table 3)

The findings of research and laboratory tests on the nutritional content of household organic waste in order to achieve household waste control support the notion that optimizing the use of organic waste to be processed into organic fertilizer is critical. As a result, household organic waste that has been properly managed does not require transportation to the final processing facility (Klingmair & Thomsen, 2020).

In general, people process organic food waste in a simple way, while others also carry out processing using the humification treatment method (Gao *et al*., 2022), the black soldier fly method (Alibardi *et al*., 2020; Klinglmari & Thomsen, 2020; Wenli *et al*., 2021), composting using earthworms (Mashur *et al*., 2021) and biodegister way (Chinellato *et al*., 2021).

Table 3. Comparison of household organic waste laboratory test results with organic fertilizer standards set by the Minister of Agriculture of The Republic of Indonesia

Parameter	ehold Organic Waste Test Results (Liquid)	Minimum Standard of Liquid Organic Fertilizer *)	Household Organic Waste Test Results (Solid)	ıum Standard of Solid Organic Fertilizer *)	Unit
Organic - C	1.7	Min. 10	42.07	Min. 15	%
pH H_2O	5.6	4-9	8.9	4-9	-
Macro Nutrient:					
C/N	-	-	12	≤25	-
N	0.47	Min. 0.5	3.39	Min. 2	%
P_2O_3	0.04	2-6	0.65	Min. 2	%
K_2O	0.33	2-6	1.11	Min. 2	%
Na	0.09	Max. 2,000	0.33	Max. 2,000	%
Micro Nutrient:					
Fe	78	90-900	280	Max. 15,000	ppm
Mn	46	25-500	434	Max. 5,000	ppm
Cu	0.8	25-500	28	Max. 5,000	ppm
Zn	1.8	25-500	105	Max. 5,000	ppm
B	14	12-250	141	12-250	ppm
Heavy metal	0.51	Max. 5.0	4.59	Max. 10	ppm
Chlor	0.14	Max. 2,000	0.52	Max. 2,000	ppm

Other advantages of optimizing household organic waste management include encouraging the community to have a large number of plants that use household organic waste as nutrients for plants, thereby improving the aesthetic value of the environment and improving air quality or lowering the level of air pollution due to the oxygen produced by plants (Handoyo *et al*., 2020).

3.2 The existence of regulation in the community

Urban waste management regulations are thought to motivate community members to sort and manage household waste independently, resulting in sustainable waste management (Al-Nawaiseh *et al*., 2021; Ferdinan *et al*., 2021; Rashid & Shahzad, 2021). Based on the results of research related to appeals or regulations made by community administrators to require community members to have plants in their respective homes, it is known that 210 respondents (38%) stated that in the area that has been determined, the community members are required to have plants in their respective homes. Furthermore, it is known that 338 (62%) respondents stated that in the area where they live there is no regulation that requires community members to have plants in their respective homes (Fig. 2).

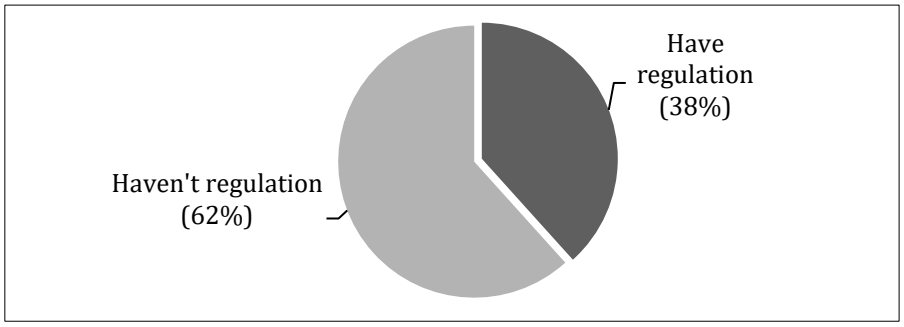

Fig 2. Percentage of areas that have been regulated based on research results, 2020

The research data revaled that most urban communities in Bekasi City do not have regulations that require residents to own plants. In addition to the beauty and greening of the environment, regulations related to plants are also intended to motivate and encourage people to manage household organic waste to be used as nutritional fertilizer for their plants. As a result, household organic waste based on research of 40% of the total household waste can be managed optimally and does not need to be transported to the final processing site.

Existing regulations are not only required to be a guideline for the community to be motivated to manage household waste independently at home, but also must develop and supervise efforts to ensure that the regulations that have been made can be implemented in an orderly and consistent manner. In addition, it is also necessary to give rewards to people who are already good at managing household waste and also punishment for people who are still less concerned about managing household waste (Azevedo *et al*., 2021; Azunre *et al*., 2021).

Strengthening of regulations is a support in the effort to realize household waste control. This is because regulations that require people to have plants can encourage community behavior to participate in managing household organic waste in their respective homes. Furthermore, it is hoped that the existing regulations on a continuous and consistent basis can form a good environmental culture in communities who care and are aware of the need to preserve the environment.

3.3 Community knowledge regarding the benefits of organic waste

Plants as part of living things need nutrients to grow and develop properly. The results of laboratory testing found that the nutrients for plant needs can be met for free by utilizing household organic waste given household waste has the nutrients needed as plant fertilizers (Jusoh *et al*., 2018; Mashur *et al*., 2021; Sanjuan-Delmás *et al*., 2021). Based on the results of the study, it was found that 316 respondents (57%) bought fertilizer as plant nutrition for their plants. Meanwhile, 179 respondents (33%) have used household organic waste as plant nutrition in their homes. As many as 53 respondents (10%) let the plants in their house grow on their own without the need for nutrition/fertilizer (**Fig. 3**).

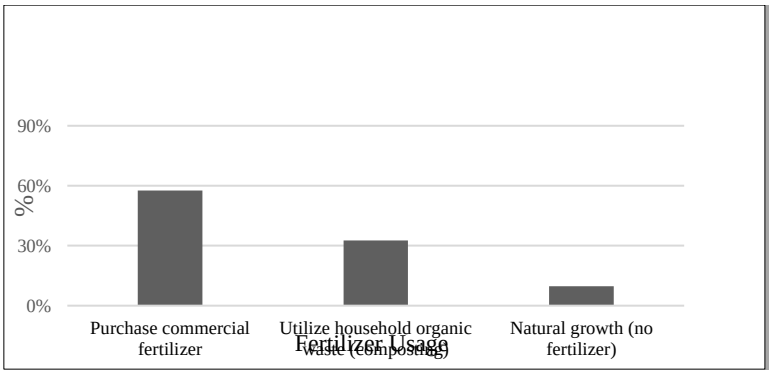

Fig 3. Percentage of community members who utilize household organic waste base on research results, 2020

According to research, the majority of people in Bekasi City purchase fertilizers to provide nutrients for their plants. This demonstrates a lack of community awareness and understanding that household organic waste contains nutrients that are extremely beneficial to plants. Based on the comparison results, the nutrient content of commercial plant fertilizers (Fertilizer X) is similar to that of household organic waste, and is even more effective in meeting the nutritional needs of plants (**Table 4**). Besides, the use of household organic waste is more efficient because the community does not need to spend an additional budget to buy plant fertilizers, but simply by utilizing organic waste generated in their

respective homes using simple methods in household organic waste management, such as: composting, pit biopori infiltration, takakura or other simple methods. These methods can be a major selling point for the community and encourage them to manage and reuse their household organic waste.

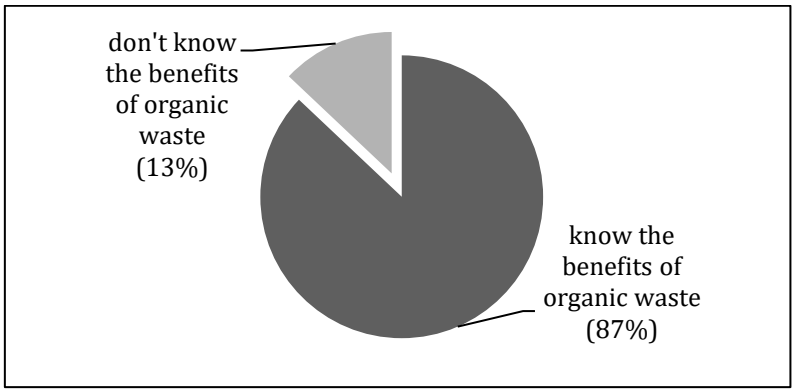

Fig 4. Percentage of community members who know household organic waste benefits based on research results, 2020

Efforts to socialize and deliver education to the public regarding household waste management affect people's perceptions and participation in managing household waste in their respective homes (Banerjee & Sarkhel, 2020; Falasconi *et al*., 2019). It was found that 447 respondents (87%) in this research already know that household organic waste can be a nutrient for plants and 71 respondents (13%) do not know that household organic waste contains nutritional elements needed for plants to grow and develop (**Fig. 4**). This shows that majority of the community understand the benefits of organic household waste, but as shown in **Fig. 3**, the number of respondents depend on commercial fertilizer is still high.

Table 4. Comparison of the nutrient content of household organic waste with the nutrient content of fertilizers sold to the general public (Fertilizer X)

Parameter	**Content of Household Organic Waste** (Liquid)	**Organic Fertilizer "fertilizer X"** (Liquid)	**Household Organic Waste** (Solid)	**Organic Fertilizer "fertilizer X"** (Solid)	**Unit**
Organic-C	1.7	4	42.07	30.72	%
pH H_2O	5.6	7.5	8.9	7.84	-
Macro Nutrient:					
C/N	-	0.86	12	12.63	-
N	0.47	Total (N+ P_2O_3+ K_2O) = 0.18	3.39	Total (N+ P_2O_3+ K_2O) = 8.6	%
P_2O_3	0.04		0.65		%
K_2O	0.33		1.11		%
Na	0.09	0.15	0.33	0.11	%
Micro Nutrient:					
Fe	78	12.89	280	0.45	ppm
Mn	46	2.46	434	80.12	ppm
Cu	0.8	0.03	28	8.43	ppm
Zn	1.8	4.71	105	41.04	ppm
B	14	60.84	141	-	ppm
Heavy metal	0.51	-	4.59	-	ppm
Chlor	0.14	0.29	0.52	1.27	ppm

The more massive socialization and education efforts related to household waste control, especially regarding the use of household organic waste that are conveyed to the

community, are expected to bring about changes in people's behavior in managing household waste that are increasingly significant and ultimately have a positive impact on improving environmental aesthetics and improving environmental quality in society (Falasconi *et al*., 2019).

3.4 Waste management support facilities

The success of household organic waste management is influenced by the household waste management that are owned individually and as a community[22], [23]. Based on the research, 161 respondents (26%) stated that they already had household waste management facilities, while 407 respondents (74%) did not (**Fig. 5**).

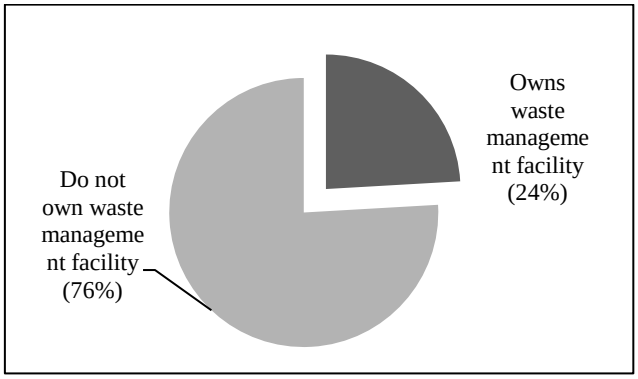

Fig 5. Percentage of community members who owns waste management facilities based on research results, 2020

Based on research data, it is known that most of the people in Bekasi City do not have adequate facilities to support the implementation of household waste management, especially in supporting household organic waste management. This result possibly related to the community dependency towards commercial fertilizers rather than repurposing their organic household waste. There are various reasons that could contribute to low household waste management facilities own by the community, such as limited open area for composting site since Bekasi City is one of the most populated city in Indonesia with limited open area. Therefore, the supporting facilities for waste management needs to be met, both through the Government initiatives and collaboration with other parties who have concerns in waste management and the environment. In the end, the facilities are expected to support the realization of sustainable household waste control by providing community-based organic household waste management facilities[43].

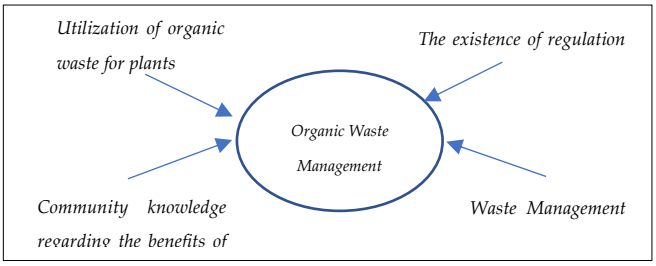

Fig 6. Household organic waste management chart based on research results, 2020

It is expected that efforts by various parties to improve household waste management facilities and infrastructure will assist in the realization of sustainable household waste control, particularly in the area of household organic waste management [44]. The potential for household waste management through household organic waste management is quite large, considering that household organic waste is generated dailyas the consequence of daily life activities. Thus, the support of household organic waste management facilities and

infrastructure to the community, both individually and in the community, needs to be sought to make the implementation of household organic waste management run consistently and sustainably in an effort to support the realization of sustainable household waste control

4. Conclusions

The discussion of research results and observations related to household organic waste in the Bekasi City community can provide an overview of the condition of waste management carried out in almost all communities in other areas. Efforts to optimize the use of household organic waste as a step in handling waste at the source must be carried out thoroughly and consistently to support the realization of sustainable household waste control.

Efforts to achieve household waste control must be made in light of the enormous amount of waste generated at the household level, which has the potential to pollute the environment if not properly managed. Even if the entire community has a good understanding of how to manage household organic waste, it is expected that 100% of household organic waste can be managed and does not need to be transported to a landfill final processing site if efforts to manage household organic waste are carried out effectively and consistently.

Increasing the quantity of plants in the community, consistent enforcement of regulations, increasing socialization and education to the community as well as supporting facilities and infrastructure for household waste management must all be done continuously and consistently by all parties, so that in the final phase it is hoped that the behavior and culture of people who care about the environment will be formed. and is responsible for the sustainability of the surrounding environment.

It must be realized by all parties that efforts to realize the behavior and culture of people who care about the environment and are responsible for the sustainability of environmental sustainability are not easy things and takes time to be realized. This noble goal requires support and assistance from all parties and requires a long process of time travel, so the stages in question must be started as early as possible, from small things, namely the household and community.

People need time to adapt to and learn from changes in environmental behavior and culture towards good and sustainable environmental conditions. Over time, it is hoped that public awareness and responsibility for the environment will grow and become a clean culture, that the responsibility for managing the environment is not only the obligation of the government and environmental groups, but also of all parties, including the community who must change their mindset and habits from what they were used to pollute the environment to become a figure of observers and environmental stewards.

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Author Contribution

The authors made full contributions to the writing of this article.

Ethical Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflicts of Interest

The authors declare no conflicts of interest.

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