

Community-Based Organic Waste Management using Black Soldier Fly Larva Bioconversion

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Received: 13 November 2024

Revised: 13 December 2024

Accepted: 30 January 2025

Available Online: 28 February 2025

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ABSTRACT

Cimahi city has urgent problems in terms of waste volume and management. Source of waste majority generated from household area (63%). Based on waste composition, dominated by organic waste as 50,6%. BSF (Black Soldier Fly) larva or “Maggot” known as the most effective organic waste bioconversion agent. Maggotsuka (Masyarakat Gotong Royong Padasuka) is a community-based organic waste treatment using BSF method, located in RW.07 Mekarsari Village Padasuka Cimahi. Science 2017, Maggotsuka community has been able to treat 85% domestic organic waste in RW 07 or 1,5 ton organic waste per month using BSF bioconversion. This research focused on society perception in the Maggotsuka community to increase participative society and community strategy on organic waste treatment. This study conducted a survey with a quantitative approach supported by qualitative research. The number of respondents used was 100 people who were determined by simple random sampling technique. The research results show that respondents have a neutral perception and high participation in domestic organic waste management. Society's perception of domestic waste management is significantly related to participation in domestic waste management. Society's approach was carried out to improve participation and sense of belonging to the Maggotsuka community. We held a focus group discussion with the core of the community, workshop waste management and the socialization product of Maggotsuka (locally known as *kasgot* fertilizer). After these activities, society in the Maggotsuka area gives positive feedback. Improvement of participation on organic waste treatment still on analysis.

Keywords: Black soldier fly, Organic waste treatment, Participation, Perception

1. Introduction

The rapid increase in domestic waste generation is a direct consequence of evolving consumption patterns, economic growth, and population expansion. As household incomes rise, there is a corresponding increase in the consumption of goods and services, which subsequently leads to higher waste production. In Indonesia, household waste constitutes the largest portion of total municipal solid waste, accounting for approximately 42.23% of the national waste volume. Of this, organic waste forms the dominant fraction, representing 50.5% of the total waste composition (Ministry of Environment and Forestry, 2021). The high proportion of organic waste poses significant environmental challenges, including greenhouse gas emissions, land degradation, and water contamination, which require urgent and sustainable management solutions. Traditional waste management practices, such as landfilling and incineration, are not only environmentally unsustainable but also economically inefficient. Therefore, innovative, cost-effective, and eco-friendly alternatives are essential to address the growing waste crisis. One promising approach is the application of biological waste processing technologies, such as Black Soldier Fly (*Hermetia illucens*, BSF) larvae bioconversion, which has gained global recognition for its effectiveness in organic waste reduction (Listya and Himmatul, 2022). BSF larvae efficiently decompose organic waste, producing valuable by-products such as protein-rich feed for livestock and nutrient-dense organic fertilizer, contributing to sustainable waste management and circular economy principles.

The use of BSF larvae for organic waste treatment has been widely studied and recognized for its multiple benefits, including waste volume reduction, economic potential, and environmental sustainability. According to Ibadurrohman et al. (2020), BSF larvae can process up to 4 kilograms of organic waste per 800 grams of larvae, highlighting their exceptional capacity for bioconversion. The ability of BSF larvae to convert organic waste into high-value biomass has significant economic implications, as their larvae serve as an alternative protein source for poultry and aquaculture feed (Cammack and Tomberlin, 2017). Additionally, BSF waste residue, known as frass, has been demonstrated to be an effective organic fertilizer that improves soil fertility and agricultural productivity (Fauzi et al., 2022). Research also suggests that BSF-based waste processing offers an environmentally friendly solution, as it generates fewer greenhouse gases compared to conventional waste management methods such as open dumping and landfilling (Kim et al., 2021). Moreover, BSF larvae can process organic waste within a relatively short period, with reports indicating that they can consume organic waste 2 to 5 times their body weight within 24 hours, making them a highly efficient biological waste processor. Despite the technical advantages of BSF larvae bioconversion, the successful implementation of this technology at the community level requires strong public participation and institutional support. Studies conducted by Chakrabarti et al. (2009) and Rahmana et al. (2017) suggest that the effectiveness of community-based waste management initiatives depends largely on social acceptance, behavioral changes, and active involvement of stakeholders. Additionally, Koesrimardiyati (2019) highlights that a key factor in the sustainability of such initiatives is the integration of waste management practices into the daily lives of community members. However, existing research has primarily focused on the technical and economic aspects of BSF bioconversion, with limited attention given to the social dimensions, such as community perceptions, participation, and behavioral responses. Understanding these factors is crucial for designing effective strategies to enhance community engagement and ensure the long-term success of waste management programs.

This study contributes to the existing body of knowledge by addressing the social dimensions of BSF-based organic waste management, with a specific focus on community perceptions and participation. The research is conducted in RW 07 Mekarsari Village, Padasuka Subdistrict, Cimahi City, where the Maggotsuka community has successfully implemented BSF bioconversion since 2017, treating approximately 1.5 tons of domestic organic waste per month. The Maggotsuka initiative represents a unique model of community-based waste management that operates independently, with local residents actively involved in waste sorting and processing activities. Unlike previous studies that primarily examined the efficiency of BSF larvae in organic waste decomposition, this study provides a comprehensive analysis of the social aspects that influence the effectiveness and sustainability of such programs. A key aspect of this study's novelty lies in its exploration of the relationship between community perceptions and participation in waste management activities. The research investigates how factors such as economic benefits, environmental awareness, and social responsibility influence residents' willingness to engage in waste sorting and bioconversion practices. Furthermore, the study seeks to identify the challenges faced by the community in sustaining BSF-based waste management initiatives and offers practical recommendations to enhance community involvement. The findings from this study are expected to provide valuable insights that can be applied to other urban and rural areas seeking to implement similar waste management solutions.

The primary objective of this study is to assess community perceptions and participation in domestic organic waste management using BSF technology within the Maggotsuka community. Specifically, the research aims to: (1) analyze the perception of residents regarding the economic, environmental, and social impacts of BSF-based organic waste management; (2) evaluate the level of community participation in waste sorting and processing activities; and (3) propose strategies to enhance public engagement and optimize the sustainability of the Maggotsuka program. By addressing these objectives, this study seeks to provide valuable insights for policymakers, environmental practitioners, and community leaders in promoting scalable and participatory waste management solutions that contribute to environmental sustainability and economic development.

2. Material and Methods

This study employed a survey-based research design utilizing a quantitative approach, complemented by qualitative data to provide a comprehensive understanding of community perceptions and participation in domestic organic waste management. The quantitative data were collected using a structured questionnaire that had undergone rigorous validity and reliability testing to ensure the consistency and accuracy of the responses. The target population consisted of residents of RW 07 Mekarsari Village, Padasuka Subdistrict, Cimahi City. A total of 100 respondents were selected using a simple random sampling technique to achieve a representative sample of the population. In addition to the questionnaire, structured interviews were conducted to obtain supplementary information regarding the respondents' awareness, attitudes, and behaviors related to domestic waste management. To enrich the quantitative findings, qualitative data were collected through in-depth interviews with five key informants, including representatives from the "Maggot Suka" community, the RW Heads who served during the 2015–2020 period, and administrators from the local PKK (Family Welfare Empowerment) organization. These informants provided valuable insights into the operational aspects, challenges, and success factors associated with the implementation of Black Soldier Fly (BSF) technology in waste management. The qualitative component of the study facilitated a deeper exploration of community engagement dynamics and the underlying social factors influencing participation in the waste management program.

The data obtained from the survey were analyzed using descriptive and inferential statistical methods with the aid of the Statistical Package for Social Sciences (SPSS) for Windows, version 20.0. Descriptive statistical analysis was employed to summarize demographic characteristics and key response variables, providing an overview of community perceptions and participation levels. To examine the relationship between perception and participation, the Spearman Rank Correlation Test was utilized, allowing for the assessment of the strength and direction of associations between variables. The combination of quantitative and qualitative approaches in this study ensures a robust methodological framework, allowing for a more comprehensive and nuanced understanding of the factors influencing community participation in domestic organic waste management through BSF technology.

3. Results and Discussion

3.1 Description of Respondents

3.1.1 Respondent Age

The findings indicate that the majority of respondents in this study belong to the early elderly category, accounting for 63% of the total sample. Figure 1 presents the age distribution of respondents, showing that all participants fall within the productive age range (15–64 years). This demographic is significant because individuals in this age bracket are generally capable of contributing to household and community activities, including waste management initiatives. Productive age groups are considered valuable human capital in community development efforts, as their active participation can drive the success and sustainability of environmental programs. A comparison with previous studies reveals similar trends in waste management initiatives. For instance, a study by Chakrabarti et al. (2009) found that the engagement of productive-age individuals in waste sorting and recycling programs in India contributed significantly to the overall effectiveness of community-driven waste management. Similarly, research by Rachmana et al. (2017) in Indonesia highlighted that waste management programs with a majority of participants in the productive age group demonstrated higher levels of community participation and long-term sustainability.

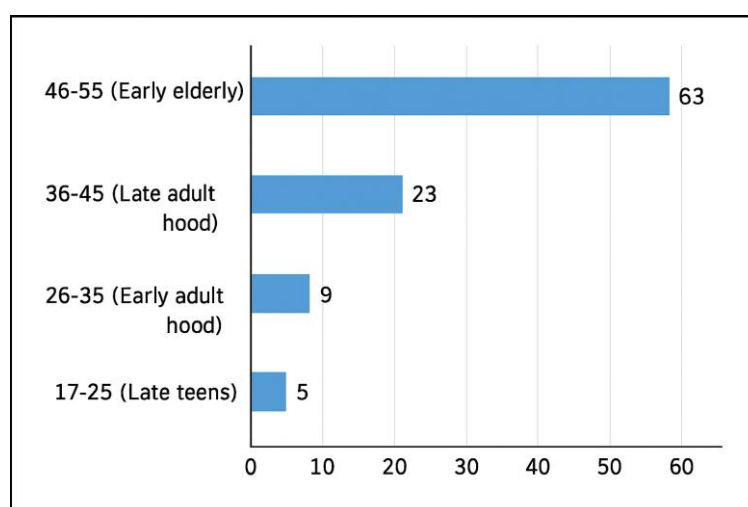


Figure 1. Distribution of Respondents by Age

3.1.2 Gender of Respondents

The gender distribution of the respondents shows a significant gender imbalance, with 98% of the participants being female and only 2% male (Figure 2). The predominance of female respondents indicates that women play a central role in waste management efforts within the community. Women, particularly housewives, are often more involved in household waste sorting and disposal activities and are crucial in driving environmental initiatives at the community level. This finding is consistent with studies conducted by Koesrimardiyati (2019), which reported that women are more likely to participate in community-based waste management programs due to their direct involvement in household waste generation and their intrinsic motivation to maintain a clean living environment. Furthermore, Fauzi et al. (2022) emphasized the importance of developing women-centered waste management initiatives to leverage their active participation and organizational skills in ensuring the success of such programs. The present study highlights the necessity of empowering women through targeted capacity-building initiatives and leadership roles in waste management programs.

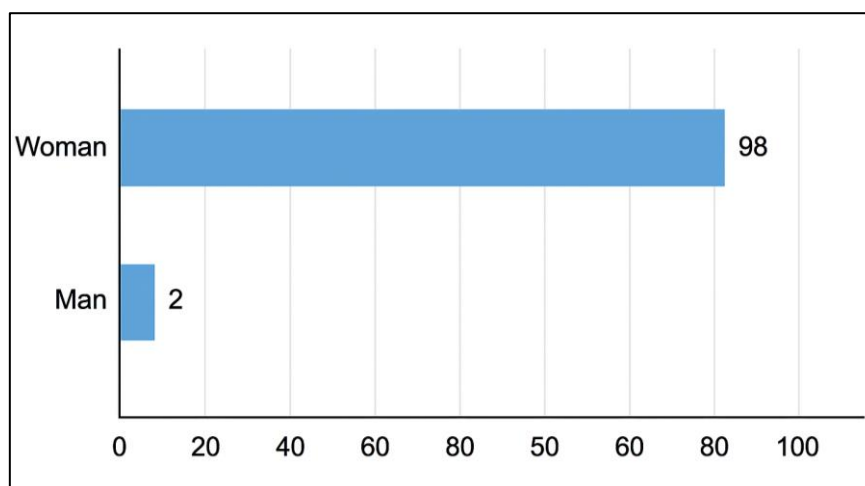


Figure 2. Distribution of Respondents Based on Gender

3.1.3 Respondents Education Level

The educational background of respondents varies, with the majority having completed formal high school education (48 respondents), followed by those with junior high school education (26 respondents) and elementary school education (23 respondents). Only 3 respondents had pursued higher education (Figure 3). The predominance of respondents with a high school education suggests a moderate level of awareness and understanding of environmental issues, including waste management practices. This educational profile provides a solid foundation for implementing awareness programs and training initiatives to further enhance knowledge and encourage active participation in sustainable waste management. The results align with findings from previous research by Budiman et al. (2013), who noted that communities with a predominantly high school-level education demonstrate a higher willingness to engage in environmental initiatives when provided with appropriate training and resources. However, the study also underscores the importance of tailoring educational programs to different literacy levels to ensure inclusive participation. Providing educational interventions that cater to varying levels of understanding can facilitate the adoption of sustainable waste management practices across diverse community groups.

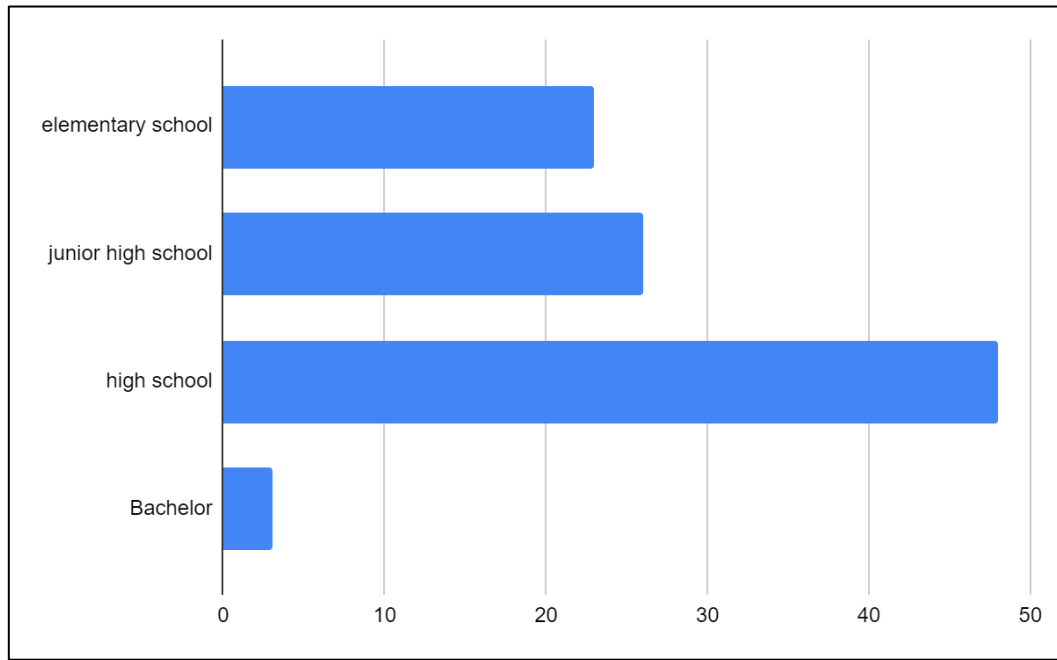


Figure 3. Distribution of Respondents Based on Education Level

3.1.4 Respondent Income

Income levels among respondents were categorized into two groups: high and low, based on the regional minimum wage (UMK) of Cimahi City, which is IDR 3,139,274. The study findings reveal that 77% of respondents fall into the low-income category, with earnings below the UMK, while only 33% earn above the threshold (Figure 4). The high proportion of low-income respondents is largely attributed to the fact that most participants are housewives engaged in micro-businesses or informal employment. This economic condition presents challenges in adopting sustainable waste management practices, as financial constraints may limit access to necessary resources and infrastructure. Comparative studies, such as those conducted by Manurung (2008), suggest that low-income communities face significant barriers to participating in waste management initiatives due to financial limitations and competing livelihood priorities. However, the findings also indicate that economic incentives, such as the potential for generating additional income through composting and organic waste recycling, can motivate greater community involvement. Rachmana et al. (2017) further emphasized that income-generating opportunities within waste management initiatives, such as the production and sale of organic fertilizer, can serve as a crucial driver for participation among low-income households.

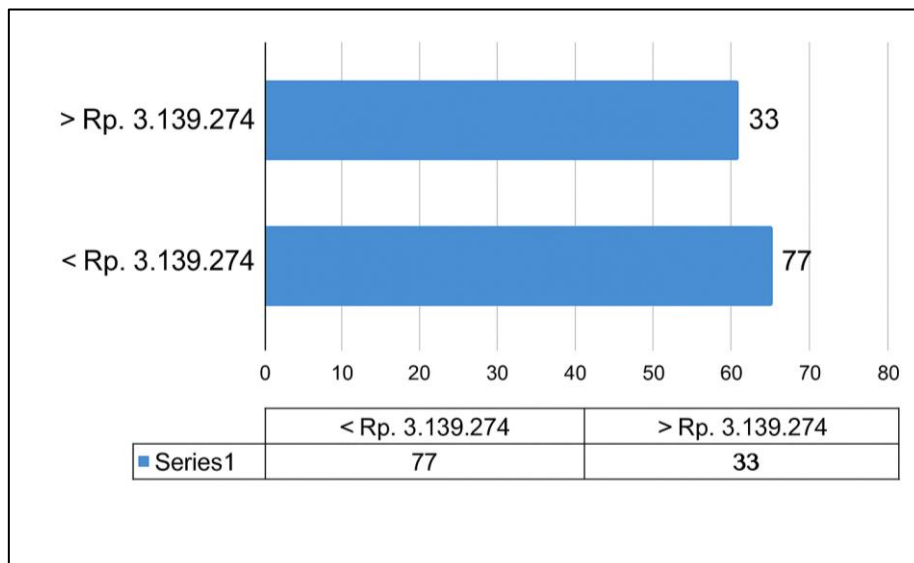


Figure 4. Distribution of Respondents Based on Income.

The demographic profile of respondents in this study largely aligns with findings from previous research on community-based waste management. Studies have consistently shown that productive-age individuals, women, and those with moderate educational backgrounds are key contributors to successful waste management programs. However, the challenges posed by low-income levels require targeted interventions, such as economic empowerment programs and financial incentives, to ensure sustained engagement in waste management efforts. The current study highlights the need for tailored educational and financial support strategies to enhance participation and improve the effectiveness of community-led waste management initiatives. Overall, the demographic characteristics of the respondents suggest that the Magotsuka community possesses significant potential for successful waste management initiatives, provided that appropriate capacity-building and economic support measures are implemented. These findings underscore the importance of a multi-stakeholder approach that includes government support, educational initiatives, and economic incentives to foster sustainable community participation in waste management programs.

3.2 Community perception of domestic organic waste management with BSF technology in the maggotsuka community based on economic, environmental and social aspects

Perceptions of domestic waste management are examined here to see the views of residents of RW 07 Kelurahan Padasuka in assessing domestic organic waste management with BSF technology in the Maggotsuka community. In this study, perceptions of domestic waste management were measured by submitting positive statements to respondents. To respond to this statement using a Likert scale, five response options are given consisting of strongly agree (1), agree (2), quite agree (3), disagree (4), and disagree (5). The following is the calculation of community perceptions regarding waste management organic with BSF technology in the maggot community which was viewed from economic, environmental and social aspects.

Table 1. Community perceptions based on economic aspects

No	Statment	Answer Category					Total score	Indeks Likert (%)	Result
		1	2	3	4	5			
1	Organic waste management usefully BSF Technology for the economy of the local community	1	4	71	17	7	325	65%	Enough agree
2	Community existence maggot likes to be able to absorb lab in the environment around	1	1	74	12	12	333	67%	Enough agree
Average							658	66%	Enough agree

Table 1 shows the likert calculation of respondent's perceptions of waste management BSF technology in the maggot community based on economic aspects. Obtained likert index of 65%. Respondents were considered quite agreeable and aware of the economic benefits of maggot and organic fertilizers when selecting waste. However, most of them have not used it economically. Respondents who are around the location of Maggotsuka who do waste sorting and deposit it directly to maggotsuka, can pick the produce of maggotsuka's garden in the form of vegetables and get organic fertilizer (*kasgot*) to be used in their respective yards. It was sufficient for the respondents to know that there were local residents who worked at Maggotsuka even though only certain residents were involved, such as cadres and residents who were really interested in maggot breeding. So that the Likert index value is 67%. From the total, it can be seen that the respondents' perceptions from the economic aspect quite agree with the existence of the maggotsuka community. Community perceptions based on environmental aspects consist of three question points (Table 2). Based on Likerts calculations, respondents feel the environment is cleaner because of regular waste transportation and no garbage scattered on the road, so the Likert index value is 89.8%.

Table 2. Community Perceptions Based on Environmental Aspects.

No	Statement	Answer Category					Total score	Indeks Likert (%)	Result
		1	2	3	4	5			
1	The existance of the maggot community likes to cause the environment arround to be clean	1	2	20	1	76	449	89.8%	Agree
2	The existance of maggot community tends to cause an upleasant in the surrounding envitonment.	4	19	72	3	2	280	56%	Enough agree

No	Statement	Answer Category					Total score	Indeks Likert (%)	Result
		1	2	3	4	5			
3	The existance of maggot community 10 like management trash with BSF technology	10	58	26	5	1	229	43.8%	Not agree
Averange							948	63.2%	Enough agree

Regarding air pollution caused by organic waste management using the BSF technique, a Likert index value of 56% is obtained, meaning that respondents do not really feel the unpleasant odor coming from the maggotsuka garden. You will smell an unpleasant smell when you are in the maggot garden, like in the organic waste pharmaceutical section, while in the organic waste reduction section with maggot, the smell is not too bad. The majority of respondents also believed that the use of BSF technology in managing organic waste did not cause noise. This can be seen from the Likert scale index of 43.8%, which means that respondents do not agree that the existence of maggot tends to cause noise for the surrounding community. The average noise felt by respondents during the process of providing cages and rehabilitation of maggot cages. Overall, from the environmental aspect, it can be seen that the respondents' perceptions quite agree with the existence of maggot suka gardens which are located in residential areas because they have a positive impact on the environment and do not disturb the environment.

3.3 Participation in the management of domestic organic waste with BSF technology

Community participation in domestic waste management in this study has 2 categories, namely low and high. The classification in this category is based on the accumulated results of direct and indirect community participation described above. The distribution of respondents based on participation in domestic waste management is presented in Table 3.

Table 3. Distribution of participating respondents in the management of household organic waste using BSF technology

Participation	Amount	Percentage (%)	Mean	Standar dev
low (18-20)	17	17	high	2.504
high (21-32)	83	83		
Total	100	100		

Shows that 83 percent of respondents have a high level of participation in the management of organic waste originating from domestics. These results indicate that the majority of respondents participate either directly or indirectly in the management of organic waste originating from domestics using BSF technology. This is because only a few residents have joined the maggot-like garden. This is in accordance with the conditions in the field, residents of RW 07 Padasuka Village. Residents participate significantly in domestic waste management with their main activity of sorting domestic waste in a sustainable manner. According to Astuti (2011), participation will emerge when people begin to become aware of the problems they are facing and are able to identify their needs. The awareness that has grown in the people of RW 07 Kelurahan Padasuka has made them willing to participate in further domestic waste management. Many benefits will be felt by the community, such as social and economic benefits. RW 07 Kelurahan Padasuka often receives visits from various government agencies, the private sector, universities, and people from other areas thanks to the maggot suka community. These visits are a source of pride and motivation for the residents of RW 07 Kelurahan Padasuka to continue to maintain the cleanliness of their environment so that it remains a beautiful environment.

3.4 The relationship between perceptions and community participation in domestic waste management.

According to research conducted [11], a person's perception of waste management affects their participation in waste management. Likewise, the residents of RW 07 Kelurahan Padasuka, who have a neutral perception of organic waste management from domestics using BSF technology carried out by the maggot suka community, tend to have a good level of participation in its management.

Table 4. The relationship between perceptions and community participation in domestic waste

Correlations				
			perception	Participation
Spearman's rho	Perception	Correlation Coefficient	1.000	.279**
		Sig. (2-tailed)	.	.005
		N	100	100

	Participation	Correlation Coefficient	.279**	1.000
		Sig. (2-tailed)	.005	.
		N	100	100
**. Correlation is significant at the 0.01 level (2-tailed).				

Respondents with neutral perceptions have a high level of participation in domestic waste management. Respondents with a neutral perception are respondents who are quite concerned about the management of their domestic organic waste carried out by the maggotsuka community, so that their participation in domestic waste management is quite high. Based on Table 16, it can be seen that there is a significant relationship between perceptions and community participation in domestic waste management. The results of data processing with SPSS show that the value of the linear correlation coefficient (r) between perceptions of participation is 0.279. This means that there is a very strong and positive linear relationship between perception and participation in domestic waste management. That is, the better the public's perception of domestic waste management, the higher the level of community participation in domestic waste management, and vice versa, the more negative a person's perception of domestic waste management, the lower his participation in domestic waste management. The value of $p(0.000) < \alpha(0.05)$ means that the research hypothesis which suspects that there is a real relationship between people's perceptions of domestic waste management and community participation in domestic waste management is acceptable.

4. Conclusion

The community's perception of the implementation of Black Soldier Fly (BSF) technology by the Magotsuka community is currently in a transitional phase, with findings indicating a predominantly neutral stance among residents. This neutrality suggests that while the community acknowledges the potential benefits of BSF technology, there is still a need for ongoing education and outreach efforts to enhance public understanding and foster a more positive perception. A neutral perception does not necessarily indicate resistance; rather, it presents an opportunity for further engagement and capacity-building initiatives to strengthen community support and participation in waste management efforts. Based on the study findings, several key recommendations can be proposed to improve community perception and participation. Firstly, the development and implementation of educational programs are essential to raise awareness about the environmental and economic benefits of BSF technology. Regular outreach activities, conducted by both the Magotsuka community and the Cimahi City government, can serve to reinforce the importance of organic waste management and encourage behavioral change among residents. Strengthening collaboration between stakeholders will be instrumental in achieving long-term success. Secondly, efforts should be directed towards enhancing the capacity of the Magotsuka community management, particularly through targeted training programs and market access facilitation. Providing opportunities for capacity building and market linkages will empower the community to scale up their operations and ensure the sustainability of BSF-based waste management initiatives. Institutions such as the University of Muhammadiyah Bandung and the Cimahi City government can play a crucial role in facilitating these efforts. Furthermore, the CimahiZeroWaste campaign should be promoted as a continuous effort to instill a culture of waste reduction and resource optimization within the community. The findings of this study highlight the community's willingness to engage in waste management activities; thus, sustained advocacy and promotional efforts are needed to maintain and enhance public enthusiasm. Lastly, addressing organic waste management challenges requires a penta-helix collaboration involving key stakeholders, including the government, society, academia, businesses, and the media. The Cimahi City government should take the lead in fostering collaboration among these sectors to create comprehensive and sustainable waste management strategies. Such multi-stakeholder engagement can facilitate the widespread adoption of BSF technology, ultimately leading to the realization of the "Maggotization" initiative in Cimahi City, positioning it as a model for community-driven organic waste management.

Acknowledgments. NA

Declaration of Generative AI and AI-assisted technologies in the writing process. During the preparation of this work, the author(s) used Chat GPT-3.0 to improve readability and language understanding. After utilizing this AI technology, the author(s) meticulously reviewed and amended the content as required, ensuring its accuracy and completeness. The author(s) assume(s) complete accountability for the content of the publication.

Conflict-of-Interest Statement. This research has no conflict of interest whenever.

Funding. This research was financed by the Ministry of Education, Culture and Higher Education - Republic of Indonesia.

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