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Valorization of Waste for Welfare: A Synergy of Knowledge, Innovation, and Community Development

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Abstract: *Waste management remains a classic issue in developing countries such as Indonesia. According to data from the National Waste Management Information System (SIPSN), the waste management performance in 2024 from 312 regencies/municipalities in Indonesia shows the following: waste reduction at 13.14%, waste handling at 46.73%, managed waste at 59.87%, and unmanaged waste at 40.13%. The shift in the waste management paradigm from the conventional collect-transport-dispose pattern to the implementation of the 3R concept (reduce, reuse, and recycle) highlights the need to build awareness of waste management at the upstream level, particularly in households and elementary schools. Waste has both utilitarian and economic value if managed properly. Waste valorization can enhance human resource capacity and household income. This activity is carried out through community service (PkM), which can involve academic institutions, the business sector, and the government through a Triple-Helix approach. Comprehensively, this activity is sustainable in supporting a circular economy. The PkM activity that has been implemented involves a waste bank that utilizes organic waste using Black Soldier Fly (BSF), as well as banks that have processed inorganic waste into other product forms. This PkM activity project is expected to develop a landscape of a community-based waste management system.*

Keywords: *Valorization, Waste, Welfare, Innovation, Community Development*

Introduction

Waste problems remain a classic issue in countries around the world, including Indonesia. Indonesia itself is the fourth most populous country in the world, with a population of 281,603,800 people (BPS, 2025). This large population requires daily food consumption and, inevitably, leads to an increasing amount of organic and packaging waste. In addition to the large population, the variety of economic activities among the people is also growing. This phenomenon increases the demand for products in the market and consequently leads to a rise in the production of those goods.

Indonesia produced 33,820,687.54 tons of trash annually from 314 regencies and municipalities nationwide, according to data from the Ministry of Environment in 2024. The annual amount of unmanaged waste was 13,596,587.77 tons, or 40.2%. Ineffective waste treatment costs, greenhouse gas emissions, the environment (trash pollution), public health (as a source of disease), and the aesthetic appeal of cities (as a deterrent to investment) can all be negatively impacted by poorly handled garbage. Therefore, effective waste management is urgently needed to reduce environmental degradation, gain public acceptance, and provide economic value from garbage. Figure 1 shows that most of the waste in Indonesia comes from food waste (41.4%). Moreover, according to the waste source

(Fig. 2), most of the waste comes from households (37.4%), followed by traditional wet markets (16.4%).

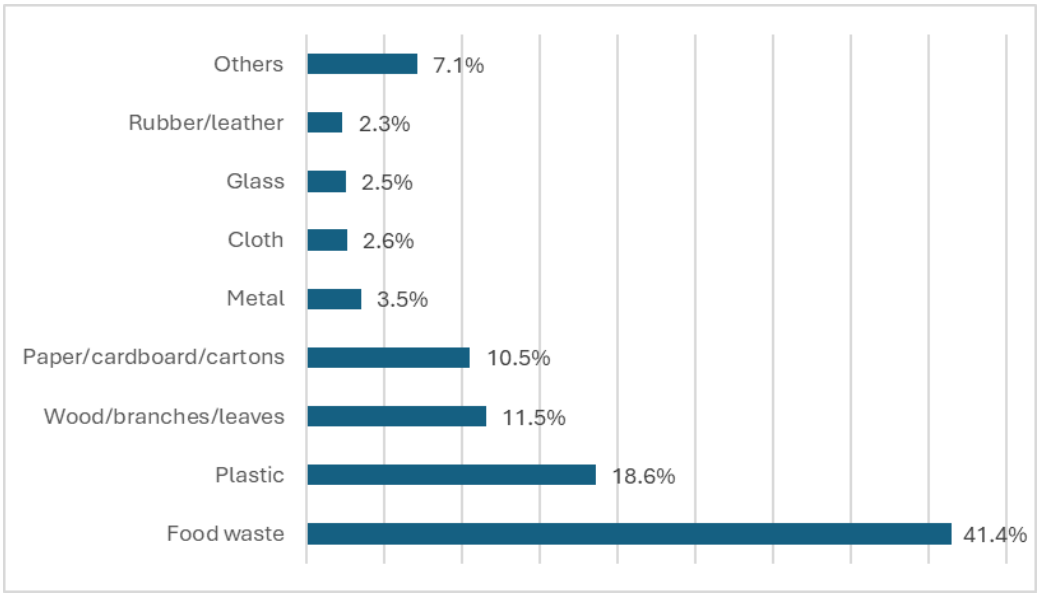

Figure 1. The Composition of Waste in Indonesia (2023)
Source: SIPSN (2023)

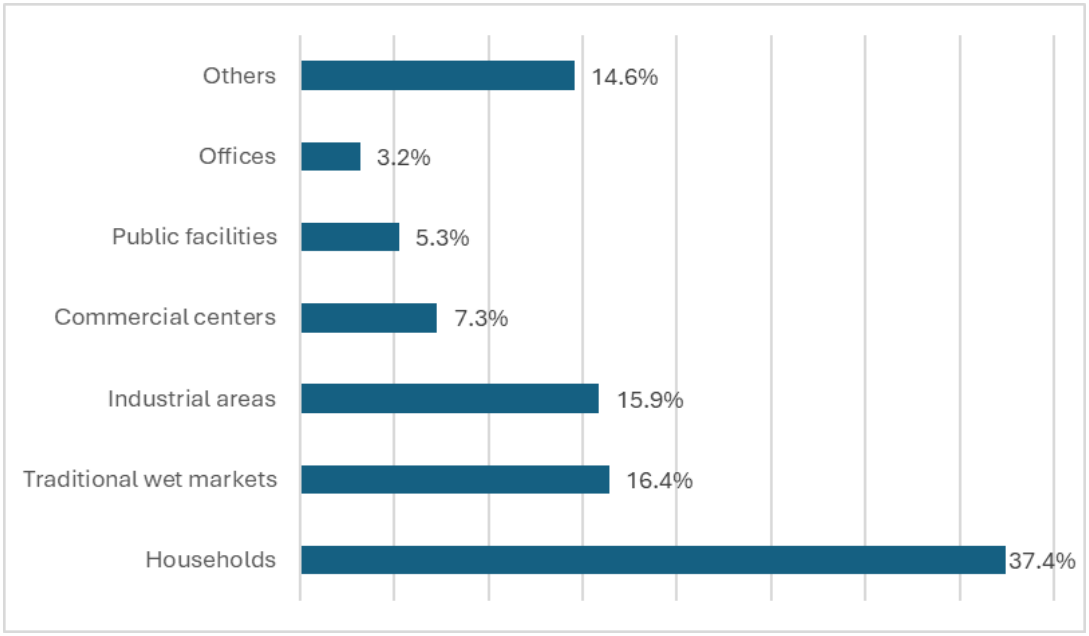

Figure 2. The Source of Waste in Indonesia (2023)
Source: SIPSN (2023)

Waste management is a cohesive system that requires collaboration from several connected sectors, including the community, corporations, academia, and government. Using the Triple-Helix Concept (interactions between academia or university, government, and business sectors), the collaboration could take place locally, nationally, or even internationally. The objective is to integrate academic institutions into the waste management system by empowering local populations to enhance their well-being is one of

the main topics of this community service study. Although the government has acted in managing waste in Jakarta, we can still find a significant amount of waste accumulation on street corners/sidewalks, in rivers/waterways, and in residential areas. Therefore, it is necessary for us to contribute to solving this waste management issue. One form of contribution is through community service activities by university students. Moreover, these community service activities should go beyond observation or visits. They should also involve sharing knowledge from student research conducted on campus with communities. So, the communities can learn from each other.

The approach used in this community service activity is qualitative. We conducted direct field research at waste bank locations in Jakarta that utilizes Black Soldier Fly (BSF) to decompose organic waste from the community or household. The research team, consisting of lecturers and students, carried out observations at two waste banks in Jakarta, namely in Kemayoran and Jatinegara. These two locations were selected because, in addition to processing organic waste using BSF, they also have designated areas for environmental education in Jakarta for school children and the public. Moreover, these waste banks have fully engaged the capabilities of the surrounding community in their operations.

Waste valorization is carried out by utilizing BSF, which is considered a sustainable insect. This means that BSF has the potential to become an alternative food source in the future (alternative protein source based). BSF larvae contains up to 45% protein and essential amino acids, making them an excellent substitute for fishmeal and soybean-based feeds. In addition, BSF possesses unique characteristics, it does not spread disease and does not consume human waste. Each stage of the BSF life cycle presents potential business opportunities. Therefore, waste management using BSF reflects the principles of a circular economy and zero waste, aligning with Sustainable Development Goal (SDG) No. 12: ensuring sustainable consumption and production patterns, and SDG No. 11: making cities and human settlements inclusive, safe, resilient, and sustainable. This community service research concept also aligns with the Indonesian government's *Asta Cita* program, specifically Point 3: improving the quality of employment, promoting entrepreneurship, developing the creative industry, and continuing infrastructure development.

The community empowerment activity highlights the importance of synergy between science/knowledge, local innovation, and community service in optimizing the potential of waste as a source of welfare. The knowledge sharing conducted is two-way in nature, where academics provide information or training on the sorting or separation of organic and inorganic household waste. In addition to training, workshops are also held on the use of BSF at the household level or centralized at waste banks that have designated areas for BSF development facility.

Methodology

This community service activity uses a qualitative approach, where the qualitative descriptive approach with a case study method in two waste bank locations in Jakarta. Data

were collected through participatory observation, in-depth interviews and activity documentation. The main informants were the field coordinators of the two waste banks and members of the waste bank group and accompanying academics. The following are the steps for implementing community service activities:

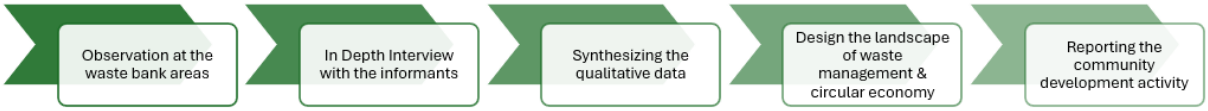

Figure 3. Steps in Conducting the Community Development Activity

The framework of the circular economy in the valorization of BSF in the waste management system through community empowerment activity to improve welfare is as follows:

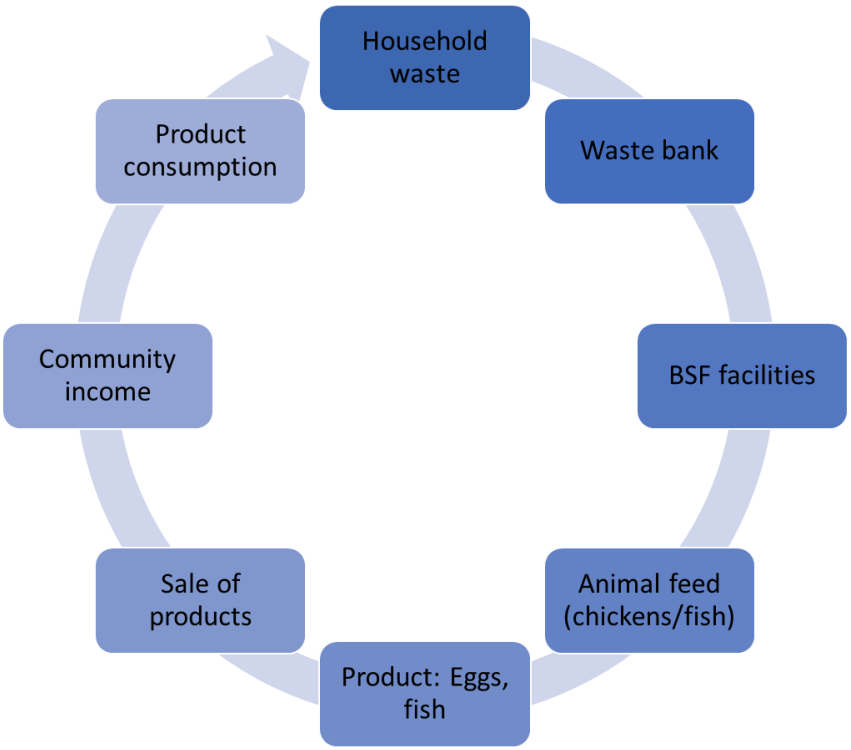

Figure 4. Circular Economy Framework for BSF

In Figure 4 above, we can see that from the household, waste goes to the waste bank or in this case the temporary area for household waste (provided by the government). From this waste bank, the organic waste is being separated from the inorganic waste. The organic waste goes to the BSF facility (BSF life cycle). From this part, BSF can become animal feed to chicken and/or fish (usually the waste bank with BSF facility, they have chicken cage and pond. The chicken and fish can be consumed by the waste bank members and for the

community surrounding the waste bank. There are two ways, either they consume it for daily needs, or they can sell the overproduction. It can increase the household income. Overall activities from household waste can reduce the organic waste problem and increase the standard of living. This supports the circular economic flow.

Figure 5. Circular Economy Framework for Composting

Figure 5 above shows another advantage from the valorization of organic waste using the BSF in the waste management system. From the household, waste goes to the waste bank and this waste becomes BSF food. Part of the BSF life cycle, they can be used as a composting process to make fertilizer. This fertilizer can be used in agriculture, for example eggplant, chili, vegetables, tomatoes, and others. The community harvests the vegetables together and they can consume it for daily needs. Some of them can make more value-added products, such as juice. They can sell this product, and it can increase their household income. Overall activities show a circular economy, and this supports sustainable development by empowering the community based on their ability and capability.

Results and Discussion

The Role of Science in Education and Mentorship

Our team does not only come from a background in life sciences (Biotechnology) but also students from Business Management study program. This PkM team focuses on the valorization of organic waste using BSF in improving community welfare. In addition to the economic aspect, this PkM activity conducts socialization regarding the importance of

sorting waste and BSF's business potential. In this BSF-based waste management, there are two parts, namely:

a. Part I consists of developing BSF cultivation in waste banks and utilizing BSF for animal feed (chicken and fish) to meet the needs of the local community and sell to increase community income. It is shown in Figure 4.
b. Part II consists of increasing community awareness (waste bank members) in terms of sorting waste from downstream/households and processing organic waste for composting and then used as fertilizer for plants (fruits and vegetables). It is shown in Figure 5.

The above activities require assistance from academics and experts in the field of BSF cultivation development. Of course, this PkM activity is not only carried out in one unit of time but is continued in the next PkM activity based on feedback from monitoring and evaluation of previous PkM activities. In an in-depth interview with the field coordinator informant at the waste bank, it was found that the collaboration between the campus and the waste bank is important and sustainable, where the coordinators of the waste bank also need information related to research results from laboratory works. This is very useful information so that the community becomes more aware of the importance of BSF in waste management.

A PkM activity program based on life sciences and business management that is adapted to local culture can create long-term behavioral changes, strengthen a sense of collective responsibility, and encourage the formation of an environmentally conscious community. This is a form of synergy between science, innovation, and social transformation in the context of sustainable development.

Figure 6. The Interview with the Field Coordinators of the Waste Bank in Kemayoran and Jatinegara

Simple Appropriate Technology Innovation

Simple appropriate technology innovations play an important role in encouraging people to be more active in managing waste independently. Technologies such as household composters allow people to process organic waste into compost in a practical and inexpensive way. With tools that are easy to use and do not require electricity, the waste decomposition process can take place more quickly and hygienically, even in densely populated areas. Innovations like this not only reduce the volume of waste disposed of in landfills but also provide direct benefits in the form of natural fertilizers that can be used for agriculture or household gardens.

In addition to composters, the use of BSF larvae is also an example of a simple but significant innovation. BSF can decompose large amounts of organic waste in a short time and produce protein-rich larval biomass for animal and fish feed. BSF cultivation technology is now starting to be widely adopted by the Small, Micro and Medium Enterprises (SMEs) community because the costs are relatively low, and the results have high economic value. In addition, residues from the BSF process can be used as organic fertilizer, creating a circular waste management system.

Adopting simple technologies such as composters and BSF not only speed up the waste processing process but also increases the utility and economic value of waste that was previously considered useless. This innovation strengthens the economic resilience of communities through the development of environmentally based micro-enterprises. On the other hand, the application of this technology also requires support in the form of training, mentoring, and access to markets, so that communities can manage it sustainably. The synergy between technological innovation and community empowerment is the key to creating an efficient and inclusive waste management system.

Figure 7. The Composting Facility in the Waste Bank of Kemayoran, Jakarta

Figure 8. The BSF Facility in the Waste Bank of Kemayoran, Jakarta

The Impact on Community Welfare

The community empowerment activity using the valorization of the waste through BSF can increase household income and open new jobs. Even though, during our workshop, the household's income does not directly give impact to the community. It needs time to build people's awareness about the importance of sorting the waste and the value-added of the organic waste using BSF. Not all temporary waste places in Jakarta have BSF development facility. There are some considerations to build BSF development facility in crowded housing areas like in the capital city - Jakarta. In our previous research regarding the geographical aspect to build a waste bank, we found that it is important for the willingness of the local people to accept the BSF development facility because of the perception of this BSF is not common in Indonesia and the transportation for the organic waste needs to be considered aesthetically. So, from the waste bank places as on our PkM activity, they already have the BSF facility but still need more help to improve the production of the BSF itself.

One main reason for the PkM activity is to support the local community so that people can have advantages economically from the BSF, such as animal feed. They can open potential jobs for people, and they can reduce their household expenses monthly. For the circular economy impact, we can see the result in the long run because it is sustainable development and building community empowerment. Based on our observation in the waste bank in Jatinegara, the community has strong social bonds among them around 6-7 families. Each of the family has home business, such as cassava crackers, traditional Indonesian snacks, and daily food. They serve it during guest visitation to their waste bank. They are also trying to create environmental education in that waste bank area for the young

children. So, people will understand & aware about the importance of waste management system since young age.

One of our conversations with Ibu Anna (alias):

"We have a very close relationship with other families. Maybe around 6 or 7 families. Husband-wife and their kids. We know each other well. If the waste bank has guests, usually we cook traditional snacks for them. We are planning to make environmental education in this waste bank area for elementary school students but we do not charge them. On the other hand, we need to know how to make BSF have more standard requirements because there is a demand from a company. For this BSF into animal feed. Hopefully, we can get help from campus side."

This community empowerment-based business unit generates additional income for the community and creates new job opportunities. In addition, the environment becomes cleaner and healthier. From this PkM activity, we can receive information about what the local community really needs and what we can contribute to them. So, the Triple-Helix approach can be applied to support sustainability on the local level through the valorization of waste using BSF in the waste management system holistically.

Conclusion

The community empowerment initiative through the valorization of organic waste using Black Soldier Fly (BSF) presents a promising and sustainable solution to the pressing issue of waste management in Indonesia. The integration of science, innovation, and local community involvement aligns with the principles of a circular economy, transforming waste into valuable resources that improve livelihoods, create employment opportunities, and foster environmental stewardship. Despite challenges such as public awareness and infrastructure limitations, the synergy between academia, business, and government—the Triple-Helix model—proves essential for long-term success. This PkM activity demonstrates that with appropriate knowledge transfer, mentoring, and support, communities can shift from being passive waste generators to active agents of change, contributing to both environmental sustainability and economic welfare

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