



# Tackling Organic Waste with a Circular Economy : Case Study in Sukabumi City

Eneng Rahmi  
Nusa Putra University  
Sukabumi, Indonesia  
eneng.rahmi@nusaputra.ac.id

## Abstract

The waste management situation in Sukabumi city is still not well-controlled. The management pattern still follows the linear model, which involves collection, transportation, and disposal. However, for certain types of waste that are considered to have economic value, circular economy principles are indirectly applied. The largest percentage of waste found in the final waste disposal site is organic waste. This type of waste has caused pollution in water, air, and soil, as well as social conflicts due to the discomfort of the local population. Therefore, innovative organic waste management with the application of circular economy principles needs to be implemented at various scales, including household scale, neighborhood scale, and city scale. At the household scale, there is no longer any disposal of organic waste from homes, and there are several alternatives for managing it. At the neighborhood scale, the construction of composting houses will become a new source of income. At the city scale, the processing of various types of organic waste will serve as an educational platform for the community. Based on calculations, the implementation of circular economy principles will have a positive impact on reducing waste disposal to final disposal sites, improving the local economy, and contributing to environmental sustainability.

**Keywords:** Circular Economy, Organic Waste, Innovation

## 1. Introduction

Nowadays, waste is considered a source of problems that can lead to disasters, both natural and social disasters. Natural disasters include fires and environmental pollution that, over time, will poison the surrounding population through water, air, and soil. Meanwhile, social disasters involve the discomfort felt by residents around the final waste disposal site due to the foul odor or waste burning, as well as the presence of scavengers or parties seeking economic benefits, both individually and as a group.

Considering the on-ground conditions surrounding the various waste-related issues in Indonesia, the government has launched a range of programs. However, almost all of

these programs have shown little meaningful progress. Various programs launched include the Adipura program for regional leaders, the 3R program (reduce, reuse, recycle), the Bank Sampah and TPS3R program, the Adiwiyata program for schools and pesantren (Islamic boarding schools), and the green leadership program. Nonetheless, all of these programs have yet to effectively address the waste problem in Indonesia as a whole and in particular of Sukabumi City.

In the case of Sukabumi city, various accolades received have not been able to present effective waste management. Among the awards received are the Adipura trophy and certificate, the Adiwiyata trophy, and the first-place Greenleadership award in 2022. In terms of infrastructure, facilities like plastic-to-oil processors and biogas generators are available at the landfill (TPA). Additionally, infrastructure in areas like waste banks and TPS3R (3R waste management) is also in place. However, all this infrastructure has not led to effective waste management.

Based on the waste generation data, the percentage of organic waste produced reaches 57.1%. Meanwhile, non-organic waste and other residues make up 42.9% [1]. For non-organic waste, some individuals or community groups, often unknowingly, have been implementing the principles of the circular economy. There is a cycle of collection, sorting, distribution to factories through intermediaries, leading to the production of recyclable products. It has existed for a long time. However, for organic waste, a linear system is still used, which involves collection, transportation, and disposal. This is what causes unpleasant odors at all disposal sites and leads to pollution of water, soil, and air, as well as social problems.

The Sukabumi city government has acknowledged the presence of several environmental activists to address organic waste. Their activities include maggot cultivation, composting, and biopores. However, the efforts made are not massive, and as a result, they do not have a significant impact on the environmental conditions at the landfill. According to this situation, the implementation of the circular economy principles for organic waste becomes necessary to focus on, as it will help address the issues at the landfill. The analysis of the implementation of circular economy principles can be conducted at various scales, including household scale, neighborhood scale, and city scale.

## **2. Method**

This research is conducted using a mixed methods approach, followed by a descriptive analysis of all data, including both qualitative and quantitative data.

## **3. Result**

### **3.1 The Existing Waste Management in Sukabumi City**

The rising total population always has an impact on increasing waste volume (see Fig. 1). Certainly, an increase in waste generation that is not accompanied by efficient waste management, so it will add to the environmental burden in disposing of waste. This is

exacerbated by the misconception that the public or private sector has already paid waste fees, leading to the belief that it is solely the government's responsibility to address waste management matters.

According to data from the environment agency, every citizen produce 0.59 kg of waste per person per day. So that, Sukabumi City produce about 211 ton of waste per day. The composition of waste in Sukabumi City, based on waste generation data, indicates that 57.1% is organic waste, 11.7% is paper, 16.4% is plastic, 0.4% is metal, 1.5% is textiles, 1.1% is glass, 1.2% is hazardous waste (B3), and 10.6% is residue [1]. However, the entire waste composition has been processed using circular economy principles for its inorganic components, whether by the community, scavengers, waste banks, or special government procedures for hazardous waste (B3). Consequently, the composition of waste entering the final disposal site (TPA) is different because some inorganic waste has undergone processing and does not enter the TPA.

Based on sampling in the TPA area, the amount of organic waste reaches 80% because some scavengers in the TPA still utilize the waste entering the TPA for their needs. The high percentage of organic waste causes the TPA to be typically wet or have high humidity. Additionally, the odor resulting from waste decomposition is quite strong, and leachate flow is relatively significant. This necessitates the continuous expansion of leachate ponds and disposal areas. This condition is quite challenging for Sukabumi city, which has limited land. Therefore, an innovation is needed in the waste collection pattern to minimize the entry of organic waste into the TPA.

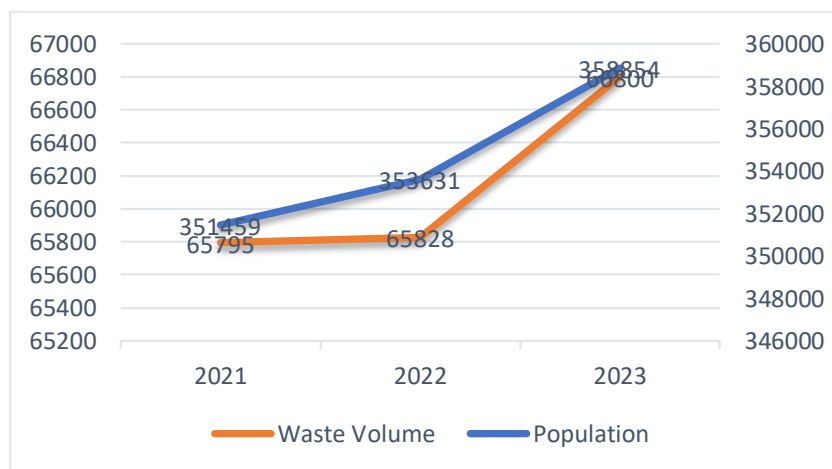
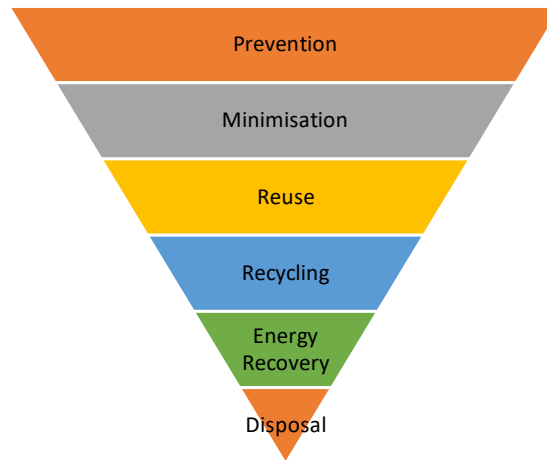


Fig. 1. Illustration between waste volume and population [2]

### 3.2 Circular Economy Approach For Organic Waste Management

The waste hierarchy based on Directive 2008/98/EC (see Fig 2.) is divided into 6 options, including prevention, minimization, reuse, recycle, energy recovery, and disposal [3]. With this hierarchy, the community should be able to choose waste

prevention over waste disposal, meaning to avoid producing waste as much as possible. Achieving this requires collective thinking involving the government, private sector, and the public. The government plays a role in creating regulations, while the private sector is responsible for producing recyclable products, and the public plays a role in choosing of products. This will have an impact on subsequent actions, namely minimization, reuse, and recycling for waste valorization. Although, in the end, some waste may still be disposed of in landfills.



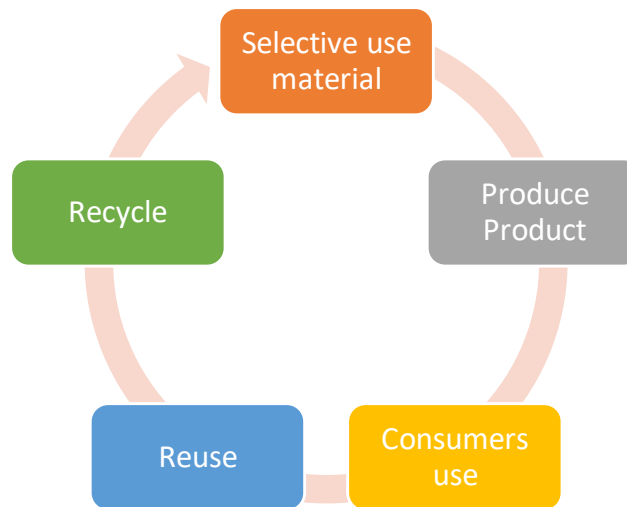
**Fig. 2.** Waste Hierarchy [3]

According to the waste hierarchy in Europe, it can be concluded that the issue of waste is not only happening in Indonesia but the whole worldwide. Globally, waste management is shifting towards resource management by transforming the open system (linear system) into a closed-loop system (circular system) [3, 4]. In Indonesia, waste management still follows a linear system, which involves taking resources from nature (take), transforming them into products (make), used by consumers (use), and ending up as waste (disposal) (see Fig. 3). This linear system in Indonesia is known as "collect, transport, dispose." This process is considered the easiest to implement but it has significant adverse consequences. For individuals, it only involves discarding items when they are no longer needed. For businesses, it is convenient because they often follow the paradigm of producing and leave the waste management to the government. On the other hand, the government's role is primarily limited to providing waste collection personnel, transport fleets, and final disposal locations. In the end, none of these actors take responsibility for the overall environmental condition because they assume that each actor has fulfilled their respective roles. The collected waste is typically placed in landfills without proper management, resulting in environmental pollution and social disruption.



**Fig 3.** Linear System of Waste Management

In Indonesia, a linear system is still in place for the management of organic waste. This is in contrast to inorganic waste, which has already undergone a system transformation due to its economic value or waste valorization. The waste management cycle for inorganic waste in Indonesia starts with the need for used items, either for reuse or for recycling into new products (see Fig. 4). Based on the information obtained from discussions with the community in Sukabumi City, the history of organic waste management in this area before the existence of conventional waste management systems, organic waste was traditionally managed by burying it or using it as fish or livestock feed. However, with cultural changes, this system is no longer used due to environmental sanitation reasons.



**Fig 4.** Circular System of Waste Management

In understanding of the circular system involving economic value or circular economy in waste management, the Indonesian government has issued strategic policies for regional waste management (Jakstrada). In these policies, all regions are required to implement circular economy efforts for all types of waste. For organic waste, the policy mandates the presence of composting facilities, biodigesters, and organic processing

centers (POO). The city of Sukabumi is also attempting to implement this policy. However, based on the gathered data, running a circular economy for organic waste presents significant challenges. In addition to infrastructure issues, there are cultural challenges related to established habits.

Based on the identification results, there are three production stages for organic waste, including food production, sales/distribution, and consumption. Each of these stages currently follows a linear path and ends with waste disposal. In the production stage, some parts of plants like palm leaves, stems, or leaves are discarded without any processing. Then, in the buying and distribution stage, which usually occurs in traditional or modern markets, there are often unsold products due to defects or spoilage, as well as discarded plant parts or product cuttings. The waste products from this stage are typically collected and disposed of at landfill sites without any process. Similarly, in the consumption and use stage, after using or consuming a product, the remaining parts are often discarded directly in the trash or anywhere. It is this kind of culture that hinders the implementation of waste management with circular economic principles. It is necessary to develop a strategy by mapping in every stage of organic water management because the principles of the circular economy can be applied to any condition as a part the future strategies. Thus, this principle not only for government to provide support with their legislation and policy but also give a space for other stakeholders to involve and make better situation [5].

According to the report of waste management condition [6], identified 5 stage of organic waste production (see. Figure 5.). Each stage identified as a point of concern in the context of organic waste issues required innovation to align with the principles of the circular economy. Starting from the production, purchase and distribution, consumption and use, to collection and recycling stages, each stage generates waste without reaching the "grow the material" stage, but rather ends up being disposed of in landfills. Therefore, innovation at each stage is highly necessary.



**Fig 5.** Circular System of Organic Waste Management

In the production stage, organic waste identified originates from plant parts that are not utilized as products when the harvest season arrives. For example, in a banana plantation, the remaining parts of the plant after the harvest are often cut down and discarded; during rice harvesting, rice straw may be stacked or burned; and in onion harvesting, the leftover leaves are often washed away into the river. It's essential to identify the types of waste produced at this harvest stage and find solutions for addressing them. Subsequently, technical guidance and projects should be provided to address organic waste issues at this stage. Some innovations to reduce the disposal of organic waste into the environment or landfills is by creating animal feed products (silage), composting facilities, and biogas production. By implementing these measures, the amount of waste generated during the production stage can be significantly reduced.

Another innovation regarding the availability of organic waste at its source, such as tree branches, leaf litter, and plant residues, is to use them as planting media. So far, consumers in need of planting media and businesses producing planting media have not been well-connected. Therefore, information technology is needed as an innovation to connect them, such as through online shopping platforms. Additionally, the government, as a policy maker, needs to provide full support to ensure that the principles of the circular economy can be applied in organic waste management.

The distribution and purchase stage are often considered a place where little to no waste is generated. In reality, a significant amount of organic waste is produced during this stage, including product packaging (made from banana leaves), leftover product pieces, defective products, and products that have spoiled. According to a report from the Department of Environment and Hygiene (DLH) in Sukabumi City, there are three garbage trucks each day responsible for collecting organic waste from traditional markets to be taken to the landfill. When calculated by the volume of waste, this amounts to 2.4 tons per day. In addition, in some modern markets, organic waste is also generated, consisting of spoiled and defective products, which are then disposed of at the landfill. According to the regional waste management policy (Jakstrada), every location that consistently produces waste should provide independent waste management facilities such as composting houses or biodigesters. If the policy is in place, consistency is required in implementing it, including the provision of infrastructure for building composting houses and biodigesters, technical guidance for organic waste managers, and monitoring and evaluation of their activities.

The construction of composting houses requires a significant financial investment and may not be economically profitable in the conventional sense. However, if we calculate the value based on the environmental service provided, the construction of composting houses is more efficient than the total cost of waste transport and the associated environmental issues. With the construction of composting houses, there is no longer a need to purchase waste containers every year or incur maintenance costs. Another efficiency is seen in the reduction of fuel consumption by garbage trucks and the

workforce involved, including the drivers. These efficiencies can be redirected towards the management and marketing of composting houses and other innovative solutions.

The consumption and use stage are crucial in determining whether implemented the principles of the circular economy. In this stage, consumers and users have the right to choose the products they desire. If consumers and users are well-educated about the products they should use, producers will respond to market demand. Therefore, educating consumers on product choices is an excellent option for preserving the environment. Communication between the government and consumers is essential, particularly in implementing the principles of the circular economy. In this regard, the government can provide input on selecting environmentally friendly products or boycotting products that harm the environment. Additionally, from a circular economy perspective, consumers have an obligation to participate in the success of the Zero Waste movement in reducing waste [5]. Moreover, as consumers or users of organic products who understand environmental sustainability, they will independently create biopores, composting, or cultivating maggots as responsible of their organic waste,

The collecting and recycling stages are the phases that need to undergo evolution in applying the principles of the circular economy. Currently, especially in the collecting stage, the process only involves gathering mixed waste, both organic and inorganic, from households to the area, and then disposing of it in landfills. Similarly, in recycling, the focus is primarily on customers who are aware of recycling inorganic waste. However, the collection and recycling of organic waste are not yet fully operational. Therefore, the Sukabumi city government through the Environmental Agency (DLH) needs to identify the current waste collection and recycling processes by conducting a mapping of existing waste collection routes and recycling centers. By obtaining a waste collection map, the types and routes of waste can be identified, and plans can be made for the construction of central organic waste processing facilities, whether through new construction or reactivation of existing facilities. The construction of these organic waste processing centers (POO) will help significantly reduce the amount of organic waste entering landfills because each area will process its own waste. With the reduction of organic waste entering landfills, environmental pollution resulting from the disposal of organic waste will decrease.

The final stage before re-entering the production process is the "grow material" stage. In this stage, it can be considered a conservation phase because all recycled products are used to benefit the natural environment. For example, the creation of biopores will yield compost and leachate that can be reabsorbed by the surrounding plants, resulting in the growth of lush vegetation without any organic waste left behind. As for composting houses, the residues from biodigesters and the cultivation of maggots can generate income for the operators and nourish plants fertilized with this type of compost. All plants can thrive without harming the environment when the organic waste management process is applied with circular economic principles.



## 4. Conclusion

In applying the principles of the circular economy to organic waste management, there are 5 essential stages that must be well-identified, start from production, distribution and purchasing, consumption and use, collecting and recycling, growing material, and returning to the first stage. The role of all stakeholders is crucial in jointly recognizing that the value of environmental services is greater than economic value. The government's role as a policy maker is paramount in guiding both producers (private sector) and consumers (society) to use products wisely and take responsibility for their waste.

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