Analysis of waste processing potential in Gunung Putri District, Bogor Regency

N U Fitri1, D Indrawati*, Ratnaningsih1

1Department of Environmental Engineering, Faculty of Landscape Architecture and Environmental Technology, Trisakti University, Jakarta, Indonesia
dindrawati@trisakti.ac.id

Abstract. The increase in waste generation in Gunung Putri Subdistrict, Bogor Regency, causes an increased burden at the Landfill Site (TPA). One of the efforts to reduce the burden of Landfill Site (TPA) is to maximize the Waste Processing Site (TPS) by applying the circular economy concept. This study aims to analyze the generation, composition, and potential of waste processing to have economic value. The sampling method used is a combination of purposive sampling and stratified random sampling. The results showed that with a population of 304,672 people and a waste generation rate of 0.48 kg/person/day, it is estimated that the waste generation in Gunung Putri District is 147,156.58 kg/day. The waste material in Gunung Putri Subdistrict consists of 52.86% organic waste components and 47.14% non-organic waste. Organic waste is dominated by food waste by 50.38%. From the results of the characteristic test of the waste, it is known that the water content is 63.16%, the ash content is 29%, the C/N ratio is 7.03%, and the calorific value of the waste is 1.924 kcal/kg by considering the amount of generation, composition, and characteristics of waste, which are then used with standards or criteria for waste processing technology from various references. Organic waste in Gunung Putri Subdistrict has good potential to be processed using the Black Soldier Fly (BSF) and organic waste processing with Peuyeumisasi Method (Biodrying) and recycling for non-organic waste.

1. Introduction
Gunung Putri sub-district is one of the 40 sub-districts in the Bogor Regency area, divided into ten villages that experience an increase in population each year, causing an increase in the amount of waste generated. The problem of solid waste in Gunung Putri District is that it still uses the old pattern. Namely, waste collected from the source, transported and disposed of to the Landfill Site (TPA). Around 6,000 – 8,000 tons of waste produced in one day are transported to the TPA without managing and treating waste optimally. The increase in waste generation increases the burden on the landfill. One of the efforts to reduce the burden of the TPA is to maximize the Waste Processing Site (TPS) by applying the circular economy concept.

Waste processing explained that waste is a national problem, so that its processing needs to be carried out in a comprehensive and integrated manner from upstream to downstream to provide economic benefits, be healthy for the community, and be safe for the environment, and can change people's behaviour [1]. Black Soldier Fly (BSF) and Refused Derived Fuel (RDF) technology can be used for processing organic waste, and others. Meanwhile, non-organic waste can be recycled back into valuable goods and generate economic value.
2. Methodology

2.1. Location
Research conducted for sampling began in April 2021 in the Gunung Putri District, Bogor Regency.

2.2. Data collection
Collecting data, composition, characteristics, and sources of waste using the method of SNI 19-3964-1994 concerning Methods for Collection and Measurement of Samples of Generated and Urban Waste Materials and Stratified Random Sampling Methods. A sampling of data was carried out from residential and non-residential sources. The data needed are primary in the form of field observations and laboratory tests. To determine the number of waste samples originating from the calculation, the number of people is calculated based on SK SNI 19-3964-1994 [2] with the formula equation.

\[ S = Cd \sqrt{Ps} \]  

where:
- \( S \) = Number of samples
- \( Ps \) = Population (people)
- \( Cd \) = Coefficient for medium/small town = 0.5

To calculate the number of samples taken from the comparison of the proportion of residential households consisting of high income, middle income, and low income. The number of samples taken from the data on the total number of settlements in Gunung Putri District is 70 families, with a comparison:
- High income (60%) = 42 Households
- Middle income (30%) = 21 Households
- Low income (10%) = 7 Households

2.3. Data processing and analysis
Data analysis and discussion were written descriptively. The calculation of waste generation and composition refers to SNI 19-3964-1994. Following are the stages of analysis carried out.

1. Calculation of waste generation and composition
2. The potential for waste processing is determined based on the amount of generation, composition, and characteristics of the waste in Gunung Putri District.

3. Result and discussion

3.1. Gunung Putri sub-district
Gunung Putri sub-district is one of the sub-districts located in the eastern part of Bogor Regency. Gunung Putri District is geographically located at coordinates 106°55' - 107°15' East Longitude and 6°15' - 6°35' South Latitude. Gunung Putri sub-district has 56 km² or 5,600 hectares consisting of 10 (ten) villages, 1091 sub-districts, and 273 hamlets. In 2021 the population of Gunung Putri Subdistrict is 304,672 people.

3.2. Waste generation
The calculation results show that the average waste generation data per person per day in Gunung Putri District is 0.48 kg/person/day or 1.80 l/person/day. The calculation of waste generation data can be seen in Table 1.

| Source of Waste | (kg/person/day) | Produced Volume (litres/person/day) |
|-----------------|----------------|------------------------------------|
| Residential area| 0.51           | 1.90                               |
| Shops           | 0.45           | 2.61                               |
| Restaurant      | 0.28           | 1.16                               |
| Source of Waste | (kg/person/day) | Produced Volume (litres/person/day) |
|----------------|----------------|-----------------------------------|
| Office         | 0.25           | 1.26                              |
| Market         | 0.25           | 0.53                              |
| Average        | **0.48**       | **1.8**                           |

In Table 1, the data from the research on the value of waste shows that residential waste has a significant per capita generation. Judging from the residential area of 79% of the total area of Gunung Putri District, the load generated by residential waste is the largest.

3.3. Composition of waste

Based on direct measurements in the field, the data obtained from the composition are processed into the resulting composition presentation as follows:

Table 2. Composition of waste.

| Composition of Waste | Residential | Non-Residential | Composition of Total |
|----------------------|-------------|-----------------|----------------------|
| Organic              | 58.58%      | 42.18%          | 50.38%               |
| Paper                | 10.33%      | 19.53%          | 14.93%               |
| Wood                 | 0.80%       | 4.17%           | 2.48%                |
| Fabrics/Textiles     | 0.27%       | 0.49%           | 0.38%                |
| Rubber/Leather       | 1.82%       | 0.00%           | 0.91%                |
| Plastic              | 13.08%      | 20.65%          | 16.86%               |
| Metals               | 0.09%       | 0.00%           | 0.04%                |
| Glasses/Glass        | 4.84%       | 3.73%           | 4.29%                |
| E-waste              | 1.74%       | 0.00%           | 0.87%                |
| Others               | 8.46%       | 9.24%           | 8.85%                |

3.4. Proximate and ultimate waste analysis

Measurement of the characteristics produced in Gunung Putri District was carried out at the Environmental Laboratory, Trisakti University. When viewed from measuring the water content of waste in Gunung Putri District, organic waste has a water content of 63.16%. The results of the water content analysis of samples from Gunung Putri District can be seen in table 3.

Table 3. Moisture content.

| Type      | Composition | Moisture Content (%) |
|-----------|-------------|----------------------|
| Organic   | Food Waste  | 63.16%               |
|           | Twig Leaves | 23.87%               |
| Paper     | a. HVS Paper| 2.87%                |
|           | b. Carton   | 6.46%                |
|           | c. Cardboard| 4.51%                |
| Non-Organic| Plastic    |                      |
|           | a. PP       | 14.05%               |
|           | b. PET Bottle| 0.79%              |
|           | c. LDPE     | 4.58%                |
|           | d. PS       | 0.15%                |
|           | e. Others (7)| 7.07%             |

The results of the ash content and volatile content analysis in samples from Gunung Putri District can be seen in table 4.
Testing the calorific value of organic waste food scraps and grass leaves in Gunung Putri District using a bomb calorimeter resulted in a calorific value of 1,924 kcal/kg. The results of C-organic content and total N content were used to calculate the C/N ratio so that the obtained value was 7.03.

3.5. Potential of waste processing

The following are the analysis results for the potential for waste processing in Gunung Putri District, which can be seen in Table 5.

### Table 4. Ash content and volatile content.

| Type          | Sample       | Ash Content (%) | Volatile content (%) |
|---------------|--------------|-----------------|----------------------|
| Organic       | Food Waste   | 29%             | 71%                  |
|               | Twig Leaves  | 14%             | 86%                  |
| Non-Organic   | Paper        |                 |                      |
| a. HVS Paper  | 48%          | 52%             |
| b. Carton     | 7%           | 93%             |
| c. Cardboard  | 33%          | 67%             |
| Non-Organic   | Plastic      |                 |                      |
| a. PP         | 80%          | 20%             |
| b. PET Bottle | 98%          | 2%              |
| c. LDPE       | 8%           | 92%             |
| d. PS         | 17%          | 83%             |
| e. Others (7) | 8%           | 92%             |

### Table 5. Waste processing potential.

| Composition           | Percentage (%) | Recovery Factor | Volume (m³/day) | Recovery/BSF (m³/day) | TOSS Peuyenuineh (m³/day) | The residue (m³/day) |
|-----------------------|----------------|-----------------|-----------------|------------------------|---------------------------|----------------------|
| Organic Waste         |                |                 |                 |                        |                           |                      |
| Food Waste            | 45.60%         | 100%            | 250.06          | 250.06                 |                           |                      |
| Twig Leaves           | 4.78%          | 100%            | 26.21           | 26.21                  |                           |                      |
| Non-Organik Waste     |                |                 |                 |                        |                           |                      |
| Paper                 | 14.93%         | *85%            | 81.88           | 69.60                  | 12.28                     |                      |
| Wood                  | 2.48%          | 100%            | 13.63           | 13.63                  | 0.00                      |                      |
| Fabrics/Textiles      | 0.38%          | 100%            | 2.09            | 2.09                   | 0.00                      |                      |
| Rubber/Leather        | 0.91%          | 100%            | 5.00            | 5.00                   | 0.00                      |                      |
| Plastic               | 16.86%         | 100%            | 92.48           | 92.48                  | 0.00                      |                      |
| Metals                | 0.04%          | *90%            | 0.23            | 0.21                   | 0.02                      |                      |
| Glasses/Glass         | 4.29%          | *70%            | 23.52           | 16.46                  | 0.23                      |                      |
| E-waste               | 0.87%          | -               | 4.76            |                        | 4.76                      |                      |
| Others                | 8.85%          | -               | 48.54           |                        | 48.54                     |                      |
| Total                 | 100%           |                 | 10.33           | 178.76                 | 250.06                    | 46.93                |

* Arie Herlambang, Djoko Heru Martono (2008)

The characteristics of the waste that were tested in this study were only the types of waste that could be used as compost, namely leaf waste and food waste. As for non-compostable waste, inorganic waste, and residual waste. Waste characteristics that need to be known are physical properties, chemical properties, namely initial analysis, final analysis, and energy content. Proximate analysis is divided into moisture content, ash content, and fluctuating content. The primary analysis is displaying carbon (C) and nitrogen (N) content to determine the C/N ratio. In comparison, the energy content is the calorific
value of the waste. Tests are helpful to assist in developing methodologies for measuring and reporting the properties of waste materials and can be carried out with proper analysis and appropriate design, the overall characteristics of the waste required.

Based on the measurement results, the waste composition in Gunung Putri Regency consists of 58.58% organic waste and 42.18% non-organic waste. Organic waste is dominated by food waste by 45.60%. One way to overcome the accumulation of organic waste is to use household or organic waste that is not rotten such as vegetables or wilted fruits, as a growth medium for Black Soldier Fly (BSF). The cultivated BSF will be used as an alternative feed for livestock, such as poultry and fish. Provision of quality animal feed is one of the determining factors for the success of 2 industries and is the most significant component in these business activities, which is 50-70% [4]. BSF is a fly (Diptera) that belongs to the family Stratiomyidae. This fly can be found in tropical and subtropical areas (46° N - 42° South Latitude) [5].

The water content of the remaining food meets the optimum water content of BSF larvae feed ranging from 60-90%. Meanwhile, for food waste that will be used as organic fertilizer, based on laboratory tests for carbon and nitrogen levels, the C/N ratio of organic waste is 7.03. Based on the C/N of organic waste, food waste does not meet the value range, which is 30-35. So, it is necessary to add organic fertilizer containing carbon to increase the C/N ratio of the initial waste.

Using local waste processing technology (TOSS), the peuyeumization method (bio drying) is one of the renewable energy technologies. The waste that is utilized through physical conversion into pellets or briquettes can then be used as natural fuel to be converted into gas in a gasifier engine to produce syngas that can be used for household needs or conversion into electricity through a generator [7]. The waste is separated to get combustible waste (high NCV) such as biodegradable waste, etc., which is then fermented with the help of a bio-activator, then chopped and made into pellets or briquettes. Furthermore, pellets or briquettes are dried to increase their calorific value [7].

The maximum ash content for briquettes is a maximum of 8% [8]. Based on laboratory analysis, the ash content of twig leaf litter is 14%. It means that the total burned waste remains at 14%. The greater the ash content, the greater the number of drugs produced. The result of low ash content indicate that the waste has a high calorific value because low ash content results in less combustion so that combustion can run perfectly. So, with the addition of other non-organic materials such as wood, cloth and rubber will get a smaller ash content.

Recycling is waste that can be processed and reused because it has economic value. The recycling process uses waste materials to be returned to the same item or another form. Recycling or recycling of waste is carried out for paper, plastic, metal, and glass waste. Recycling waste is one of the methods provided that the waste used is waste that can be reused, has a high economic value, does not use paper or plastic coated with oil, for the non-organic waste it is carried out before being recycled, and the selection or grouping of waste according to the type of waste.

4. Conclusion

Based on the composition and characteristic testing in moisture content, ash, calorific value and C/N ratio, Gunung Putri Subdistrict waste can be processed using Black Soldier Fly (BSF) TOSS Peuyeumisasi Method (Biodrying), and Recycle or sold to the dealership. Organic waste for food can be processed using Black Soldier Fly (BSF) technology, organic waste for leaves and non-organic waste for twig leaves, wood, cloth and rubber can use TOSS processing technology. Meanwhile, plastic, paper, metal and glass waste can be processed in recycling (sold to dealers).

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