

The analysis of waste generation and waste composition in president university, cikarang, indonesia

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Abstract. Waste is an environmental problem that is the concern of everyone, increasing the volume of waste every year produced from the source. President University is one of the source that is still use the old paradigm in waste management makes President University continues to be one source that can increase the volume of waste that will be disposed of to landfill. This is reinforced by the increasing number of students each year. Therrefore, as a role model from education level, proper waste management is needed. **Objectives:** Based on that, the objective of this research is to describe the existing condition of waste management at President University and to measure the waste generation and waste composition as baseline data for amount of dustbin and temporary waste collection area needed. **Method and results:** The Method implemented in this research using SNI 19-3964-1994 standard. The result showed that the total of waste generation at President University reached 238 gr/day/person with a total of 14% compostable waste, 31% recyclable waste, and 55% residue. **Conclusion:** It was suggested to plan and operate dustbin that following its types with the color-coded for different types of waste generation in President University. Also, recommend some alternative treatment ideas such as composting or anaerobic digester for treatment the waste.

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1 Introduction

Nowadays, waste is an environmental problem that is the concern of everyone. It is also one of the biggest factors causing environmental damage. The Law of Republic Indonesia Number 18 Year 2008 Regarding Waste Management, stated that waste is the residue of daily human activities or natural processes in the form of solid or semi-solid in the form of organic or inorganic that are biodegradable or non-biodegradable which are considered to be no longer useful and thrown into the environment. However, the increase in waste generated by humans every day is the effect of an increase in population that continues to occur from year to year. It makes the problems in waste management more difficult if the management still uses the old paradigm of waste management that relies on the collection, transportation, and disposal system [1]. However, waste management also cannot run properly if the source of the waste producer does not make any movement in reducing the waste generated.

As one source that has the potential to produce high waste for the environment, universities should be able to work on one of the movements in reducing the volume of the waste [2]. This can be supported by a possible initial way that can be done by reducing the volume of waste that will be disposed of to the landfill [3]. However, being one of the universities that still use the old paradigm in waste management makes President University continues to be one source that can increase the volume of waste that will be disposed of to landfill. This is reinforced by the increasing number of students each year, which will also increase the amount of waste generated later. Also, they have two buildings with various activities in it that support the occurrence of the waste problem. Without proper waste management, the different existing activities make it possible to produce waste generation and different waste compositions, which can have an effect on the environment and will make a new problem [4]. This phenomenon is supported by the inadequate conditions of waste collection and disposal. It can be seen from the waste that is still mixing in the same dustbin, and waste management only ends in the effort to

transport the waste to landfills. Another side, the quantity of waste generated, also depends on some factors, such as food habits, the standard of living, degree of commercial activities, and seasons [5].

In the law Number 18 Year 2018 about waste management requires the manager of an area to be able to manage waste properly and environmentally friendly, handling by separating waste according to the type, amount, and/or nature of waste, collecting it into an integrated waste treatment facility, and processing it in shape changes the characteristics, composition, and amount of waste. Thus, the existence of proper waste management is essential in preventing environmental pollution around the campus. Proper waste management starts from the sources of waste producers. However, what is happening right now is that waste management at President University is still not optimal. Problems that occur in waste management include the absence of waste segregation at the source. Besides that, the use of temporary waste collection is still not optimal. On the other hand, an increase in the amount of waste generated is caused by student behavior that is less in reducing waste generated. Therefore, as a role model from education level and as an agent of change for the future, this research carried out of measuring waste generation and composition that can be used as a baseline of recommendation alternative treatment idea for waste management at President University.

2 Method

The population of this research is the waste at President University, which is produced from daily activities. While the sample is determined proportional random at the source. The measurement of the sample generation and composition is based on SNI 19-3964-1994 about "*Metode Pengambilan dan pengukuran Contoh timbulan dan komposisi sampah perkotaan.*"

The activity of measuring the generation and composition of waste is carried out during working days, which is Monday until Friday (16 December 2019 until 20 December 2019). Waste measurement is done by adjusting the time of collection,

which at 1 pm. Also, the measurements are divided into two, which are mass measurements and volume measurement.

Steps to carry out work to measure the generation and composition of waste, as follows: [7]

1. Collect plastic bags that have been filled with trash and taken to the measurement site. Put a mark on the plastic bag according to the specified point.
2. Weigh the empty weight of the measuring box.
3. Take and pour the garbage sample into the measuring box, then stomp the measuring box three times by lifting it as high as 20 cm. Then fall to the ground.
4. Measure and record the volume of waste.
5. Weigh and record the weight of the waste.
6. Pour and sort waste from the measuring box based on the components of the waste composition.
7. Weigh and record the weight of each component of the waste composition.

In carrying out these measurements required equipment used, which consists of:

1. Plastic bags with a volume of 40 liters.
2. A box measuring device with dimension 20 cm x 20 cm x 100 cm.
3. Scales (0 - 5) kg and (0 - 100) kg.
4. Gauges to measuring volume height.
5. Masks and gloves.

Waste generation is the amount of waste generated every day and divided by the number of people there. Waste generation can be expressed in:

1. Units of weight (kg/day/person, gr/day/person, etc).

$$\text{Density} = \frac{\text{Average weight of sampling waste (gr)}}{\text{Average volume of sampling waste (cm}^3\text{)}} \quad (1)$$

$$\text{Total weight} = \text{Density} \times \text{Total Volume} \quad (2)$$

$$\text{Weight/day} = \frac{\text{Total weight (gr)}}{\text{total of student+total of employee}} \quad (3)$$

2. Unit of volume ($\text{m}^3/\text{day}/\text{person}$, $\text{cm}^3/\text{day}/\text{person}$, etc).

$$= \frac{\text{Total volume (cm}^3\text{)}}{\text{total of student+total of employee}} \quad (4)$$

The percentage of waste composition is the weight of each component of waste divided by the total weight of the total waste.

$$\% \text{composition} = \frac{\text{waste weight}}{\text{total of waste generation}} \times 100 \quad (5)$$

In calculating the composition, the waste will be sorted according to its type based on SNI 19-3964-1994, namely organic waste, paper, wood, textile, rubber, plastic, metal, glass. In addition, such as styrofoam, beverage cans, plastic bottles, and tissue.

3 Results and Discussion

3.1 Existing Condition in President University

President University is one of a private university located in Industri Jababeka, Cikarang, West Java. President University has been established since 2004. The university has four faculties with 16 undergraduates programs, also has two buildings that support for campus activities.

Based on the survey, The existing condition of waste management in President University is: (1) still using the old paradigm of waste management, which is collection – transport – dispose. Still using an old paradigm in waste management will become one of the problems in increasing the volume of waste produced. (2) The waste is in one dustbin, thus no waste sorting process.

Waste generated at President University consists of organic and inorganic waste from academic activities, administrative activities, and food consumed by students, lecturers, and staff. The source of the waste at President University also comes from a variety of locations, such as from the lecturer room, classrooms, offices, and toilets. Figure 1 shows the existing waste condition on this campus.



Fig 1. Waste in President University

The waste collection system at President University using one dustbin placed in front of the building, classroom, lecture room, and toilet (Figure 2). If it is adjusted based on SNI 19-2454-2002 about "*Tata Cara Teknik Operasional Pengelolaan Sampah Perkotaan,*" waste storage here is still not following the type of waste that is disaggregated, such as organic waste, inorganic waste, and hazardous toxic waste. The waste collection system at President University collected through the door to door service and disposed-off behind the campus by cleaning service (Figure 3).



Fig 2 Waste Container for Collection in Campus



Fig 3 Temporary Waste Collection

Table 1 shows a summary of the existing conditions of waste collecting, segregation, and handling of waste at President University.

Tabel 1 Existing Condition of Waste Management at President University

Source	Waste Collection	Waste segregation	Handling the waste
Building A	There is no sorting dustbin	There is no the waste sorting	<ul style="list-style-type: none"> - Dispose the waste to temporary waste collection in campus - Taking of plastic waste by third parties
Building B			

3.2 Waste Generation at President University

The sampling was carried out in President University's temporary waste collection. Table 2 below is a calculation of the average generation of waste generated per day.

Tabel 2 Daily Average Waste Generation

Daily Average Generation		
Sampling Location	Volume (cm ³ /day/person)	Massa (gr/day/person)
Building A	7432	214
Building B	857	24
Total	8,289	238

From the table above, it can be seen that the total daily average generation is 238 gr/day/person or 8,289 cm³/day/person. Building B, it is influenced by the attendance of students who are present during this week, while Building A is affected by the presence of employees and administrative activities.

From the results of these studies, it can be concluded that the more people who carry out activities, the more solid waste generated will be. And based on results during this week, students who do not attend will affect the generation of waste generated at President University.

3.3 Waste Composition at President University

The quantity and composition of solid waste vary from one place to another. The different activities such as administrative, campus activities, etc. President

University is one of the factors that will influence the variety of solid waste. The typical composition of President University's solid waste is shown in Table 3 [6].

In Figure 4 below is the total percentage calculation results of the composition of the waste that is in President University, the results of sorting waste according to its type [7].

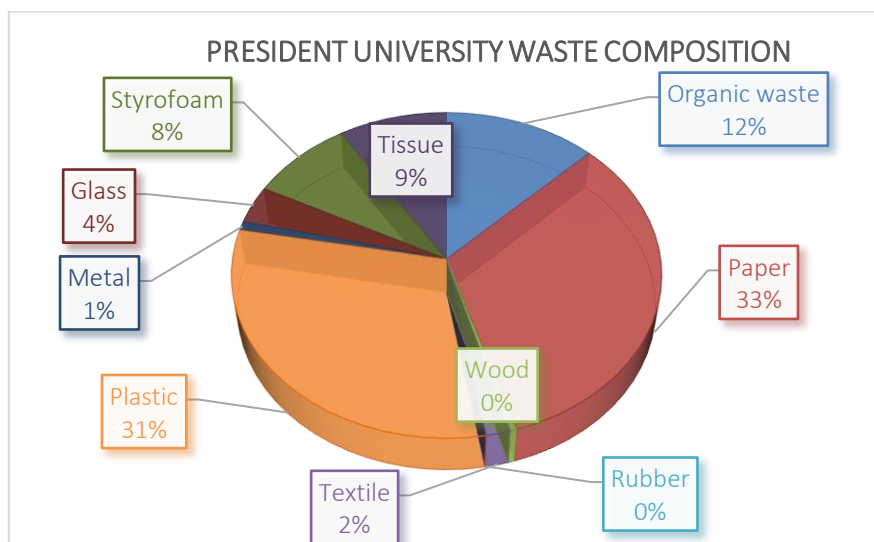


Fig. 4 Percentage Total of Waste Composition at President University

The pie chart above aims to find out the consumption patterns that result from campus activities. Also, it shows that the sampling result of the composition of waste at President University is mostly dominated by recyclable waste such as paper, which has the largest percentage, then plastic, etc. In addition, the second most is an organic waste as much as 12%. And the last composition is residual waste consisting of styrofoam, textile, metal, tissue, etc. For a clearer comparison of President University's waste composition can be seen in the graph in Figure 4 [8].

This is affecting the poor waste management in President University are the weakness of existing regulations in Indonesia, the lack of facilities for the treatment and disposal of solid waste, and there are no policies implemented by President University in the waste disposal and waste management [11]. Such as, the use of

plastic and styrofoam is one of the wastes that is still produced by President University.

3.4 Amount of Dustbin

The dustbin will be divided into three, which are green dustbin for organic waste or compostable waste, light blue dustbin for recyclable waste, and red dustbin for the residue. The dustbin will be placed in front of the room to facilitate the source in collecting the waste [3]. Calculating the amount of dustbin that the campus needed using equation :

$$n = \frac{\text{Volume of waste}}{\text{Volume of dustbin}}$$

Tabel 3 General Data of Waste Volume at President University

Day	Organic (cm ³)	Recyclable (cm ³)	Residue (cm ³)
Total (cm ³)	18,507	41,663	73,374
Percentage (%)	14	31	55

(Source: Data Processing)

Therefore, organic dustbin that university needed is 1 pcs each building. For recyclable waste and residue needed 2 pcs each building.

3.5 Temporary Waste Collection Area Needed

1. Area for Organic Waste

- Alternative 1: Composting

Composting is an alternative method to reduce organic waste [15],[17]. The composting process in this research uses the vessel method [3]. The vessel method is a composting method that can use any form of container and takes about 7-14 days [19]. The area needed for this composting activity can be calculated as follows: [3]

- Volume of the waste = 18.5 liter/day
- Total volume of waste in 14 days = 18.5 liter/day x 14 days

$$= 259 \text{ liter} = 0.259 \text{ m}^3$$

Assume the reactor has p x l x t is 1 m x 1 m x 1m, the number of the reactor is:

$$\begin{aligned} \text{- Number of reactor} &= \frac{\text{Volume of the waste}}{\text{volume of the reactor}} \\ &= \frac{0.259 \text{ m}^3}{1 \text{ m}^3} = 0.259 \approx 1 \text{ reactor} \end{aligned}$$

$$\begin{aligned} \text{- Area for reactor} &= 1 \text{ reactor (p x l)} \\ &= 1 (1 \times 1) = 1 \text{ m}^2 \end{aligned}$$

If, length = width, then:

$$\begin{aligned} \text{- Length and width} &= \sqrt{A} \\ &= \sqrt{1 \text{ m}^2} = 1 \text{ m} \end{aligned}$$

From the calculation, it is known that the planned area requires length and width of 1 m, each of added 1 m to the worker's movements. So, the area needed is 4 m^2 [3].

• Alternative 2: Anaerobic Digester Tank

AD is a promising technology for processing organic waste [31]. Below the calculated AD Tank needed [32]:

Assume = Hydraulic Retention Time 30 days

TS 27.14% ; VS 94.90%

Bioreactor Size

Feedstock = 0.528 kg/day

Density of feedstock = 28.53 m³/kg

Feedstock flow rate (Q) = (0.528/28.53)m³/day = 0.0185 m³/day

Ratio feedstock that is mixed with water 1 : 1, so a total feedstock flow rate of 0.037 m³/day.

The value for Hydraulic Retention time (HRT) is 30 days, so:

Volume of reactor (V_r) is (0.037 m³/day) x (30 days) = 1.11 m³

Organic Loading Rate (OLR)

$(0.528 \text{ kg/day}) \times (27.14\%) = 0.143 \text{ kg of dry matter}$

$S = (0.143 \text{ kg}) \times (94.90\%) = 0.136 \text{ kgVS/day per } 0.0185 \text{ m}^3/\text{day}$

$S = 7.35 \text{ kg/m}^3$

$$\text{OLR} = \frac{Q \times S}{V_r} = \frac{0.0185 \times 7.35}{1.11} = 0.1225 \text{ kgVS/m}^3$$

Gas Holder Size

$$\text{Volume of gas } (V_g) = \frac{V_r}{2} = \frac{1.11}{2} = 0.555 \text{ m}^3$$

Biodigester Volume

$$\text{Volume} = V_r + V_g = 1.11 + 0.555 = 1.665 \text{ m}^3 \approx 2 \text{ m}^3$$

If, reactor is a cylindrical tank and $D = H$, hence:

$$D = \sqrt{\frac{4V_r}{\pi}} = \sqrt{\frac{4(1.11)}{(3.14)}} = 1.2 \text{ m}$$

Thus, $D = H = 1.2 \text{ m}$

From the calculation, the tank is cylindrical with $D = 1.2 \text{ m}$, and volume is 2 m^3 the area needed is 2.25 m^2

2. Area for Recyclable Waste

The area for waste storage is planned to assume a height of 3 m and stored within seven days, and calculations can be calculated using the formula [3] :

$$A = \frac{\text{Volume of waste } (\frac{\text{m}^3}{\text{days}}) \times 7 \text{ days}}{\text{high waste assumption (m)}} = \frac{0.0416 \times 7}{3} = 0.097 \text{ m}^2$$

If, length = width, then:

$$\begin{aligned} \text{Length and width} &= \sqrt{A} \\ &= \sqrt{0.097 \text{ m}^2} = 0.3 \text{ m} \end{aligned}$$

From the calculation, it is known that the planned area requires length and width of 0.3 m, each of added 1 m to the worker's movements. So, the area needed is $1,7 \text{ m}^2$ [3].

3. Area for Residue

The area for residue assuming stored within seven days, which will be placed in a closed container, can be calculated volume requirements of container: [3]

- Volume of waste = 73.36 liter/day
- Total volume of waste = 73.36 liter/day x 7 days
= 513.52 liter = 0.51 m^3

So, the volume of containers is 1 m^3 (1.5 m x 1 m x 0.75 m). For the area needed is 1.5 m^2 .

If, length = width, then:

- Length and width = \sqrt{A}
= $\sqrt{1.5 \text{ m}^2} = 1.22 \text{ m}$

From the calculation, it is known that the planned area requires length and width of 1.22 m, each of added 1 m to the worker's movements. So, the area needed is 5 m^2 [3].

4 Conclusions

Based on the results of research that has been conducted at several points specified, it can be concluded:

1. The existing conditions show that waste management at President University. It still uses the old paradigm, which is collection – transport – dispose of. Also, the condition of waste management, there are some deficiencies such as the container on the campus that has not implemented the separation of the type of waste produced.
2. From this study, waste composition of waste being dominated by residue (54.94%), recyclable waste (31.20%), and compostable waste (13.86%). And

university needed is 1 pcs organic dustbin each building and for recyclable waste and residue needed 2 pcs each building. Thus, The area needed for treatment alternative ideas temporary waste collection around 11 m².

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This journal is far from perfect, but it is expected that it will be useful not only for me as a researcher but also for the readers.

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