Determination of the Waste Production and Level of Willingness to Waste Separation in the Students Living in Boarding Houses in Yogyakarta, Indonesia

Kasam M.T*, Fajri M. Iresha, Eko Siswoyo

Department of Environmental Engineering, Universitas Islam Indonesia, Yogyakarta, Indonesia

Abstract

Boarding houses (student-rented rooms) in Indonesia are generally grouped into two different types, namely Non-Exclusive Boarding House (NEBH) and Exclusive Boarding House (EBH). The different types of boarding house will affect the patterns of solid waste generation. This study aims to determine the level of participation and willingness of the students living in these two types of boarding houses to separate their waste. Based on findings of this study, a waste management system can be designed, including the analysis of solid waste generation, waste composition, and characteristics of residents. The research began with waste generation sampling in the boarding houses around campus of three universities in Yogyakarta, Indonesia. The residents' characteristics were identified using questionnaires. The weight and volume of waste generated in EBH were found slightly larger than NEBH namely 0.36 and 0.31 kg/person/day (weight) and 2.38 and 2.04 liter/person/day (volume), respectively. Regarding the waste composition, a slight difference was observed for organic waste (19.30% and 17.51%) and plastic waste (28.08% and 27.74%) for the NEBH and EBH, respectively. In addition, the level of willingness to separate the waste for students in NEBH was higher than those in EBH with scores of 61% and 41%, respectively. It was concluded that students in NEBH generate more waste than EBH, especially for two main types of waste, but the level of participation and willingness to waste separation in NEBH residents was higher than EBH residents. The results of this study are essential to be considered in developing an effective model of boarding houses regarding waste management system in Indonesia and other developing countries.

Keywords: Boarding house, solid waste generation, solid waste management

1 Introduction

Yogyakarta Special Province is one of the biggest education cities in Indonesia, hosting a great number of students who come from various regions. More than 400,000 students are living in this city, studying at universities (especially at Universitas Gadjah Mada (UGM) as the most prominent university in Yogyakarta), polytechnics, or other institutions. UGM has 53,199 students; most of them reside at the boarding house or dormitory around the UGM campus. Another big university in this city is Universitas Islam Indonesia (UII) that has around 24,000 students (1). A large number of students require a large number of boarding houses. Accommodations spread across the Yogyakarta region are of various types in terms of both the number of rooms and facilities. Based on the level of the facilities, the boarding houses are grouped into two types, they are Non-Exclusive Boarding House (NEBH) and Exclusive Boarding House (EBH). NEBH is defined as a simple dwelling with necessary facilities such as a bed, shared bathroom, and study table, while EBH is a residence with complete facilities such as air conditioning, Wi-Fi, refrigerator, wardrobe, study table, bed, and television. The price of EBH is also higher than NEBH and is occupied generally by students coming from families of higher income. This variety in types of boarding house will cause variety in waste generation pattern and its composition.

Various factors that influence waste generation in these circumstances include socioeconomic parameters such as education, occupation, income of the family, the number of family members, etc. (2, 3). There is a strong correlation between waste generation and family size of a household (4). The consumption pattern of household is directly linked to the family income, which results in composition and quantities of household waste (5). Income is an effective factor on waste generation. More specifically, solid waste generation is directly dependent on the income levels; the upper-income individuals tend to consume more industrialized products and their garbage contains more recyclable materials than that of low-income communities (6, 7). This research aims to measure and characterize the waste generation in the boarding houses around university campuses in Yogyakarta Region and, more specifically, to determine the trends in the volume of waste generated and examine possible integrated solid waste management strategies.

Corresponding author: Kasam M.T, Department of Environmental Engineering, Universitas Islam Indonesia, Yogyakarta, Indonesia. Email: 925110102@uii.ac.id.

2 Materials and Methods

2.1 Sampling Area

Daerah Istimewa Yogyakarta (DIY) Province, Indonesia which lies between 7°33'- 8°12' South Latitude and 110°00'-110°50' East Longitude of Greenwich, encompasses an area of 3,185.80 km², which accounts for 0.17 percent of the whole country (1,860,359.67 km²). Yogyakarta is the smallest province after DKI Jakarta Province. The majority area of DIY (i.e., 65.65%) lies at 100-499 m height above mean sea level, while around 28.84% lies at height less than 100 m, around 5.04% at 500-999 m, and around 0.47% at above 1000 m. The population of DIY in 2016 was recorded as 3.720.912 people; males accounted for 49.45%, while females accounted for 50.55%. Population growth in 2016 to reach 1.18 percent in 2010, up from the previous year's growth, which is 1.13 percent. With an area of 3,185.80 km^2, the population density in the province was recorded as 1,168 people per km^2.

The research locations are boarding houses located at three universities: Universitas Gadjah Mada (UGM), Universitas Islam Indonesia (UII), and Universitas Negeri Yogyakarta (UNY). These three universities were chosen because they are the most prominent universities in Yogyakarta.

2.2 Sampling Method

The sampling activity aims to determine the total weight and volume of the solid waste generated in boarding houses and then to compare the waste volumes between NEBH and EBH. This sampling activity was carried out for eight consecutive days (from 12 December to 19 December 2017), as recommended by SNI 19-2964-1994 on *Method for Taking and Measuring Examples of Urban Waste Collection and Composition* (8). To determine the number of samples, two sampling techniques were used: 1) purposive random sampling, which is a sampling technique with specific considerations, and 2) quota sampling through which researchers determine a sample of a population that has specific characteristics to the amount (quota) as desired (9).

Regarding the quota sampling, the researchers determined the characteristics of the boarding houses through checking the number of rooms of the house. For the purpose of this study, 15 rooms for EBH and 15 rooms for NEBH were taken into consideration. Then for the desired total for the total sample to be sampled, there are 17 exclusive boarding houses and 18 non-exclusive boarding houses. So that the total number of boarding houses to be sampled are 35 boarding houses with 15 rooms for each boarding house. According to the quota sampling technique, the technique adopted in this study for data collection is purposive random sampling. The average weight and volume of solid waste during 8 consecutive days were obtained from both types of boarding room. The composition of solid waste was classified into organic, plastic, paper, metals, glass, textile, and others. These are referred to as the composition that are often appeared in Municipal Solid Waste. Questionnaires were distributed to collect information about the number of residents (students), their characteristics, and also their knowledge about waste management and sorting.

3 Results and Discussion

3.1 Existing Waste Management at the Study Site

Solid Waste Management techniques were implemented in the area around the UGM and UII to find out the consumption patterns of students while staying in the boarding house. The questionnaire was distributed online in the Google E-Form environment using the Slovin method.

At the UII campus, which is mostly a boarding house for the university students, waste is stored at the source, collected at the transfer station, then transported to landfill, as shown in Figure 1. Waste storage at the boarding house around the campuses is of two types, namely individual and communal. In the individual storage type, a trash bin is used by only one boarding house, while in the communal storage, two or more houses use one trash bin. At these campuses, waste is collected and accumulated at the transfer station using pick up. The final stage of solid waste management in settlements around the campuses is transportation to the Piyungan landfill that is about 20-25 km away.
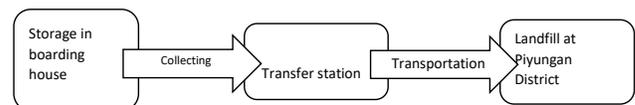

Figure 1: Waste Management System at the Study Location

3.2 Waste Generation

Based on sampling conducted during eight days at EBH and NEBH, it was found that the average amount of solid waste generation per house is 90.19 kg/day for EBH, while it is 95.04 kg/day for NEBH.

Table 1 Comparison of the Weight and Volume of Waste in Each Area of the Boarding Houses

Area	Type of Boarding House	Weight (kg/person/day)	Volume (l/person/day)
UII	Exclusive	0.35	2.72
	Non- Exclusive	0.25	2.00
UGM	Exclusive	0.35	1.82
	Non- Exclusive	0.35	1.85
UNY	Exclusive	0.39	2.61
	Non- Exclusive	0.33	2.26
Total	**Exclusive**	**0.36**	**2.38**
	Non- Exclusive	**0.31**	**2.04**

When compared among boarding houses in the area of UGM, UII, and UNY, the weight of solid waste generation of the EBH in the area of UGM tend to be equal to that of NEBH. Nevertheless, on average, the volume and the weight of waste generated from EBH is slightly larger than NEBH; in terms of volume, 2.38 and 2.04 liter/person/day were produced by EBH and NEBH, respectively, and in terms of weight, it was 0.36 and 0.31 kg/person/day. It was revealed that the students who lived in EBH disposed of more waste than students in NEBH. Therefore, it was confirmed that the economy level can be correlated with the quantity of waste generation (10). Almost no significant difference was observed regarding the composition of the solid waste generation between EBH and NEBH.

3.3 Waste Composition

The general waste composition is slightly different between NEBH and EBH, as shown in Figures 2 and 3. Paper, metals, and others that mostly consist of diapers in EBH are higher than NEBH. It can be identified that paper and metals are material that are often used by luxury product packaging, especially for sustainable, environmental-friendly, or organic products. On the

other hand, organic and plastic in NEBH are higher than EBH. NEBH and EBH produced 19.30% and 17.51% organic waste, and 28.08% and 27.74% plastic waste, respectively.
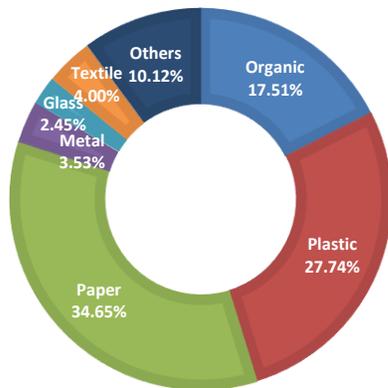

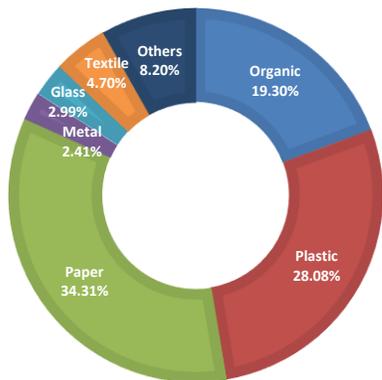Figure 2: Waste Composition for EBH

Figure 3: Waste Composition for NEBH

Further, more comprehensive analyses on waste composition details can help to design a proper system for waste management in the boarding house area. Table 2 shows more details about the waste composition based on the recycle market and also the advance treatment for organic and residues. In case of organic waste, food waste is still the main problem, while in case of plastic waste, all types of recyclable plastic have almost the same composition. However, the concern here is plastic bags whose weight percentage was the same as other types of plastic, but it has a low weight per plastic bag. It shows that people still use plastic bags for their daily activities.

Specifically, analyzing the most general compositions presented in the Table 2, which include organic, recyclable, and residue, it was found that recyclable waste was in the range of 40.5-53.5%, which means high potential of the waste to be recycled and get the economic profit.

3.1 Level of Participation and Willingness to Separate Waste

To determine the level of participation and willingness to separate the waste from EBH and NEBH, questionnaire was used as a tool. According to the questionnaire results shown in Figure 4, the level of willingness to separate in residents of NEBH is

higher than those in EBH, with scores of 61% and 41%, respectively.
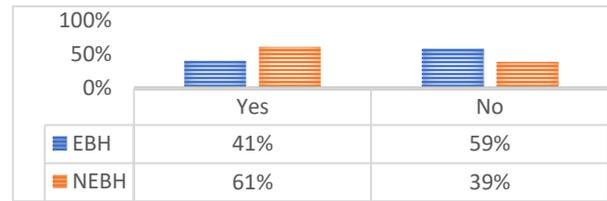

Figure 4: Willingness to Separate the Waste

In terms of students' awareness about how to separate the waste, the percentage of those who knew the way to separate the waste was more than those who did not know how to do that. In a comparison made between EBH and NEBH, it was found that the percentage of students in NEBH who were aware of the ways for waste separation was higher than those in EBH.
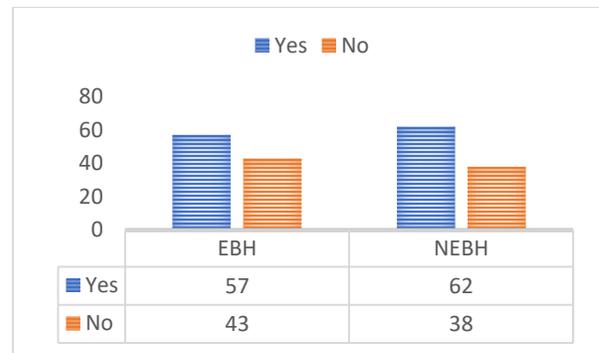

Figure 5: Understanding to Separate the Waste

The last analysis was done on the level of participation. The students from NEBH were more enthusiastic about participating in separating the waste. 72% of the respondents from NEBH admitted that they separate waste in their house compared with EBH where only 67% of students do it.
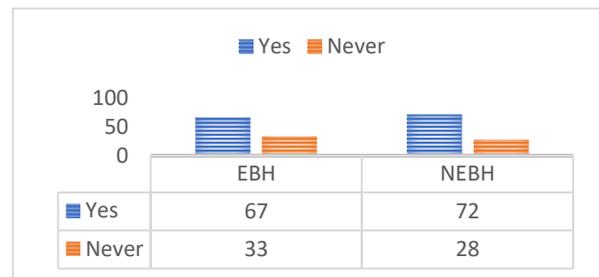

Figure 6: Level of Participation to Separate the Waste

4 Conclusion

Findings showed that students living in EBH produce waste more than those who live in NEBH. This condition is due to the higher lifestyle of EBH residents.

Table 2: Detailed Composition of the Waste in EBH and NEBH

Separated Waste		Percentage (%) UII				Percentage (%) UGM				Percentage (%) UNY			
General Composition	Waste Seller-based Composition	EBH	Total	NEBH	Total	EBH	Total	NEBH	Total	EBH	Total	NEBH	Total
Organic	Food waste -	12.0	16.1	13.9	17.6	12.5	17.7	11.7	14.8	16.8	19.7	22.6	25.4
	Yard waste -	4.1		3.7		5.2		3.1		2.8		2.9	
Recyclable	Transparent plastic bottle	3.5		3.4		3.2		4.4		4.6		3.2	
	Plastic glass	3.4		3.3		1.5		3.8		4.2		3.6	
	Plastic bag	3.9		4.1		1.8		2.6		3.3		3.0	
	Colorful plastic bottle	3.9		3.6		3.9		4.3		3.8		3.6	
	Plastic rigid	3.1		1.9		4		3.5		2.9		2.5	
	Cardboard	4.8		4.7		3.7		4.4		2.8		2.9	
	Colorful HVS	3.1	44.4	4.5	44.2	4.2	48.3	5	53.5	6.4	47.3	4.3	40.5
	White HVS	3.9		3.4		4.2		4.4		4.5		3.1	
	Duplex	4.3		4.0		4.9		5		1.8		2.0	
	Tetraplex	3.7		3.2		4.9		5.1		1.4		1.1	
	Can	1.5		1.2		4.8		2.8		1.7		1.6	
	Iron	0.9		0.9		1.5		0.7		0.3		0.0	
	Glass bottle	2.1		1.7		4		5.7		1.3		1.6	
	Synthesis fiber	0.0		0.7		0.2		0.5		2.8		2.0	
	Clothes	1.0		0.7		0.6		0.9		3.4		3.5	
	Others	1.3		3.0		0.9		0.4		2.1		2.4	
Residue	Packaging plastic	3.8		3.5		2.3		3.2		3.1		2.8	
	Food pack (Plastic)	4.3		4.4		1.9		2		3.5		2.8	
	Food pack (Styrofoam)	2.2		2.3		1.1		1.9		1.6		1.4	
	Plastic bag	4.5		3.8		1.7		2.3		3.9		3.1	
	White HVS	3.8		3.9		4.4		4.2		2.4		2.9	
	HVS Colorful	3.8	39.5	3.8	38.2	3.2	34.1	2.7	31.5	2.1	37.8	3.0	34.1
	Duplex	5.1		5.3		2.2		2.4		4.0		4.2	
	Tissue	5.4		5.3		3.8		2.5		6.5		5.7	
	Diapers	5.8		5.1		10		8.9		7.7		7.0	
	Hazardous waste	0.6		0.4		1.3		1		1.7		0.9	
	Wood	0.2		0.5		2.2		0.4		1.3		0.4	
Total		100		100		100		100		100		100	

Then, the composition of waste was dominated by paper, plastic, and organic waste. However, the volume of organic waste was smaller among the three above-mentioned waste types, which is due to the student's habit of eating outside the boarding house. This condition differs from the condition with the Household Waste in Indonesia where organic waste dominates the other types. Additionally, paper is a dominating type of waste produced in the two types of the residents. This is because the waste produced in the boarding houses where students are living is more like that of offices or commercial areas. Residents in EBH use plastic more than those living in NEBH, which is because of their different lifestyles. Therefore, residents in EBH are more consumable than those in NEBH. Then, in terms of the level of willingness to participate in managing waste, NEBH residents have a stronger desire than residents of EBH. For this reason, the 3R socialization program and waste segregation can be prioritized in NEBH. Then, the EBH residents can be subjected to high fees. Garbage collection can be done using two different methods: commercial waste and regular waste. The former is applicable to residents living in EBH, where waste can be mixed but they must

pay high fees for its collection. On the other hand, the regular method, through which waste is collected for free or much cheaper than the commercial waste collection method, is applicable to NEBH where waste is already separated. It can be concluded that the solid waste management system will run better following socio-economy conditions.

Acknowledgment

Ethical issue

Authors are aware of, and comply with, best practice in publication ethics specifically with regard to authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests and compliance with policies on research ethics. Authors adhere to publication requirements that submitted work is original and has not been published elsewhere in any language.

Competing interests

The authors declare that there is no conflict of interest that would prejudice the impartiality of this scientific work.

Authors' contribution

All authors of this study have a complete contribution for data collection, data analyses.

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