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## THE GENERATION RATE AND CHARACTERISTICS OF MUNICIPAL SOLID WASTE IN SLUMS OF LAWANG KIDUL VILLAGE AT PALEMBANG CITY

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**Abstract.** The problem of municipal solid waste (MSW) is closely related to slums, where houses in slums are stilt house and near the river, and making area under the house as the place of the garbage disposal place which is relatively difficult to clean. Lawang Kidul is a village that has the largest slum area among other villages and located on the edge of Musi River at Palembang City. One cause of slum is a problem of household waste that is not routinely transported to the garbage disposal place around 62,48%, causing garbage to scattered around the resident houses, even not infrequently throw garbage into rivers and waterways. The study aims to measure the generation rate and composition of MSW in slums of Lawang Kidul Village at Palembang City, and then to measure average generation rate and composition of MSW at several cities in Indonesia. Measurements were carried out for 2 days (14 March 2019 and 17 March 2019). Sampling was carried out in 2 pillars of neighbor (15 and 16) which has the highest number of heads of families among 8 other slums. There are 9 components of MSW that are measured (food waste, paper/cardboard, wood, cloth/textile products, rubber/leather, plastic, metal, glass, etc.). MSW generation rate is measured at 0,46 kg/person/day. The measured density of MSW was 244,97 kg/m<sup>3</sup>. The composition of MSW is dominated by food waste (48,81%), followed by plastic waste (33,96%), paper/cardboard waste (6,68%), and other waste components. The average of MSW generation rate in Indonesia was 0,352 kg/person/day. The average composition of MSW at several cities in Indonesia is dominated by food waste (63,63%).

**Keywords:** *average, composition, generation rate, Indonesia, MSW.*

### Introduction

Urban population growth from year to year continues to increase, as well as improved life levels. The rapid development in urban areas become the attraction of urbanization because it provides a lot of ease and also better facilities, but this is not accompanied by the provision of basic infrastructure for society. If basic infrastructure is not fulfilled, it will cause the growth of slums [1]. Slums is a poor quality environment, where the conditions of housing are not clean and unworthy, vulnerable to crime, synonymous

with poor people, and densely population [2]. The problem of MSW is closely related to slums, where houses in slums are stilt house and near the river, and making area under the house as the place of the garbage disposal place which is relatively difficult to clean, even not infrequently throw garbage into rivers and waterways. It is often done by the society because unavailability of household-generated bins, unavailability of communal waste transportation facilities, and unavailability of communal waste collection facilities [3].

Lawang Kidul is a village that has the largest slum area among other villages and is located on the edge of Musi River at Palembang City [4]. One cause of slum is a problem of household waste that is not routinely transported to the garbage disposal place around 62,48%, causing garbage to scattered around the resident houses, even not infrequently throw garbage into rivers and waterways [5]. The slums that exist today are in leave from accumulation of waste everywhere. As long as people continue to do activities, waste will continue to be produced and will continue to increase because the volume of waste will be directly proportional to the population [6].

Each city produces a different number of generation rate of MSW, for urban waste dominated by household waste and generation rate of MSW in Nassiriya City is measured at 0,68 kg/capita and the composition of MSW is dominated by food waste around 70,18%. In Sangamner City of India, organic waste from market is dominant around 61% and inorganic waste around 39% is dominated by stone and sand. The generation rate of MSW in Mosul City, Irak, is measured at 0,68 kg/person and the composition of MSW is dominated by organic waste and food waste. The average generation rate of MSW in Sultanate of Oman is 0,97 kg/day/person with total organic waste of 71,20% and 65,80% collected during winter and summer, and dominated by food waste. The generation rate of MSW in Tuz Khurmatu, Irak, is measured at 0,574 kg/capita/day [7-11].

Research on accumulation and MSW composition has also been conducted in several cities in Indonesia from 2012 to 2019. Based on Table 1, the generation rate of MSW in several cities was different and dominated by food waste.

Table 1

**Generation Rate and Composition of MSW in Indonesia [12-18]**

Location	MSW Generation Rate	Dominant Waste (%)
Kenjeran Coastal Settlement, Surabaya	0,23 kg/person/day	Food waste (76,21%)
Padang Panjang City	0,44 kg/person/day	Food waste (71,23%)
Tanah Datar Regency	0,23 kg/person/day	Food waste (79,4%)
Tampan Sub-district, Pekanbaru	0,19 kg/person/day	Food waste (56,06%)
Sukolilo Sub-district, Surabaya	0,38 kg/person/day	Food waste (75%)
Rungkut Sub-district, Surabaya	0,486 kg/person/day	Food waste (68%)
Pahandut Village, Palangka Raya	0,40 kg/person/day	Food waste (34,31%)

MSW can be grouped into organic waste (wet waste from kitchen activities) and inorganic waste (dry waste such as bottles, paper and plastic), with the density of MSW at sources ranging from 0,01-0,2 tons/m<sup>3</sup> [19]. The study aims to measure the generation rate and composition of MSW in slums of Lawang Kidul Village at Palembang City, and then to measure average generation rate and composition of MSW at several cities in Indonesia.

## Methodology

In order to calculate the volume of MSW, the generation rate survey is done by a saturated sampling method which is all populations are samples [20]. Measurements were carried out for 2 days, weekday and weekend. Measurements of the generation rate and composition of MSW were carried out by directly measuring the volume of MSW in 2 pillars of neighbor (15 and 16) (Figure 1). There are 9 components of MSW that are measured (food waste, paper/cardboard, wood, cloth/textile products, rubber/leather, plastic, metal, glass, etc.) [19].

The weight and volume of MSW are recorded, so the generation and density of MSW were measured based on the dimensions and volume of the MSW container. Then, waste composition was expressed as a percentage of wet weight. The sorting of MSW was carried out based on the types of MSW that have been determined (food waste, paper/cardboard, wood, cloth/textile products, rubber/leather, plastic, metal, glass, etc.) in every waste container. Sorted MSW is weighed and recorded according to the type of waste. The MSW fraction (% of wet weight) for each components was calculated by dividing the total wet weight of each MSW component with total weight of MSW [21].



**Figure 1.** Map of Lawang Kidul Village.

## Result and Discussion

### 1. MSW Generation Rate

Sampling was carried out for 2 days (14 March 2019 and 17 March 2019) and sampling was carried out in 2 pillars of neighbor (15 and 16). The calculated waste is household waste. The rate of waste generation was obtained from the weight of the waste divided the number of people in sampling location.

Table 2

Household Waste Generation Rates				
No.	Day and Date of Measurement	Total Weight of MSW (kg)	Total Number of People (person)	MSW Generation Rate (kg/person/day)
1	Thursday, 14/03/2019	254,4	574	0,44
2	Sunday, 17/03/2019	270,4	574	0,47
Total		524,8	1.148	0,46

From the results of measurements, the highest MSW generation rate is found on Sunday (0,47 kg/person/day) and the lowest MSW generation rate is found on Thursday (0,44 kg/person/day). The average rate of MSW generation for 2 days was 0,46 kg/person/day.

The density of MSW is measured by taking 3x (three times) samples in measuring containers and calculated by dividing the weight of waste by the volume of waste in garbage container [21]. The average of MSW density on Thursday was 282,19 kg/m<sup>3</sup> and The average of MSW density on Sunday was 207,74 kg/m<sup>3</sup>. If MSW density for 2 days combined, the MSW density was 244,97 kg/m<sup>3</sup>

Table 3

Component of Measurements	MSW Density							
	Thursday, 14/03/2019				Sunday, 17/03/2019			
	1st test	2nd test	3rd test	Average	1st test	2nd test	3rd test	Average
Weight of MSW Sample (kg)	9,8	10,2	10	-	7,4	6,6	8,9	-
Volume of MSW Sample (m <sup>3</sup> )	0,03	0,04	0,04	-	0,04	0,04	0,04	-
Density of MSW (kg/m <sup>3</sup> )	284,70	285,16	276,72	282,19	191,77	182,64	248,81	207,74

## 2. MSW Composition

There are 9 components of MSW that are measured (food waste, paper/cardboard, wood, cloth/textile products, rubber/leather, plastic, metal, glass, etc.). The measurement of waste composition was carried out for 2 days, indicates that food waste is greater than other waste components.

Table 4

No.	Components of MSW	MSW Composition			
		Thursday, 14/03/2019		Sunday, 17/03/2019	
		Weight of MSW (kg)	MSW Fraction (%)	Weight of MSW (kg)	MSW Fraction (%)
1	Food waste	131,3	51,61	124,4	46,01
2	Paper/cardboard	18,2	7,15	16,8	6,21
3	Wood	2,5	0,98	1,1	0,41

Continuation Table 4

4	Cloth/textile products	10,6	4,17	16,5	6,10
5	Rubber/leather	5,6	2,20	2,1	0,78
6	Plastic	78,6	30,90	100,1	37,02
7	Metal	1,4	0,55	3,6	1,33
8	Glass	4,4	1,73	5,8	2,14
9	Etc.	1,8	0,71	0	0
Total		254,4	100	270,4	100

If the weight of waste per component is combined, it can be seen that MSW in Lawang Kidul Village was dominated by food waste (48,81%), followed by plastic waste (33,96%), paper/cardboard waste (6,68%), and other waste components, see Figure 2.

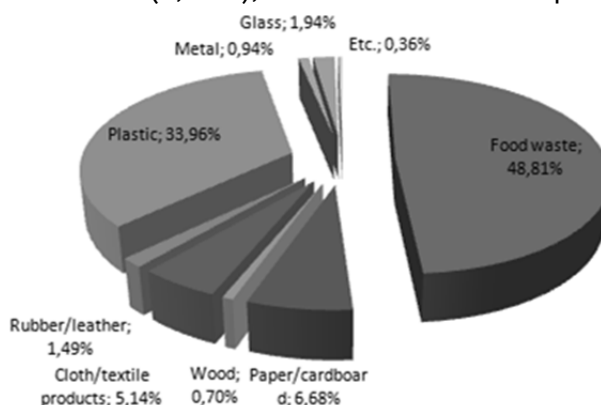


Figure 2. MSW Composition in Lawang Kidul Village.

### 3. The Average of MSW Generation Rate and Composition

The average of MSW generation rate is calculated by collecting data from several cities in Indonesia from 2012 to 2019. There were 7 cities in Indonesia, including Lawang Kidul Village in Palembang City, which is used to calculate the average of MSW generation rate in Indonesia. The average of MSW generation rate in Indonesia was 0,352 kg/person/day, meanwhile the average of MSW composition in Indonesia was dominated by food waste (63,63%).

Table 5

The Average of MSW Generation Rate

Location	MSW Generation Rate (kg/person/day)
Lawang Kidul Village, Palembang	0,46
Kenjeran Coastal Settlement, Surabaya	0,23
Padang Panjang City	0,44
Tanah Datar Regency	0,23
Tampan Sub-district, Pekanbaru	0,19
Sukolilo Sub-district, Surabaya	0,38
Rungkut Sub-district, Surabaya	0,486
Pahandut Village, Palangka Raya	0,40
Average	0,352

Table 6

**The Average of MSW Composition**

No	Components of MSW	MSW Composition (%)								
		X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	$\bar{X}$
1	Food waste	48,81	76,21	71,23	79,4	56,06	75	68	34,31	63,6 3
2	Paper/cardboard	6,68	5,33	4,44	3,31	11,21	7	10,8	21,93	8,84
3	Wood	0,70	1,21	15,14	0,21	0	1	3,7	2,36	3,04
4	Cloth/textile products	5,14	2,27	0	1,43	8,05	1	0,4	3,44	2,72
5	Rubber/leather	1,49	0,23	0	0	0,21	0	0,1	0	0,25
6	Plastic	33,96	10,83	7,18	15,3	19,75	11	12,6	22,64	16,6 6
7	Metal	0,94	0,44	0,51	0,12	0,46	1	1	0,25	0,59
8	Glass	1,94	0,82	0	0,22	4,25	1	0,3	2,31	1,36
9	Etc.	0,36	2,58	1,50	0	0	1	0,4	11,88	2,22

Note :

X<sub>1</sub> = Lawang Kidul Village, Palembang

X<sub>2</sub> = Kenjeran Coastal Settlement, Surabaya

X<sub>3</sub> = Padang Panjang City

X<sub>4</sub> = Tanah Datar Regency

X<sub>5</sub> = Tampan Sub-district, Pekanbaru

X<sub>6</sub> = Sukolilo Sub-district, Surabaya

X<sub>7</sub> = Rungkut Sub-district, Surabaya

X<sub>8</sub> = Pahandut Village, Palangka Raya

### Conclusion

Based on the results, MSW generation rate is measured at 0,46 kg/person/day. The measured density of MSW was 244,97 kg/m<sup>3</sup>. The composition of MSW is dominated by food waste (48,81%), followed by plastic waste (33,96%), paper/cardboard waste (6,68%), and other waste components. The average of MSW generation rate in Indonesia was 0,352 kg/person/day, meanwhile the average composition is dominated by food waste (63,63%). Several cities in Indonesia that are shown in this research are not enough to represent the entire city in Indonesia. The average results of MSW generation rate and composition will be different when the whole city has calculated the same way. Further research is necessary to calculate the MSW generation rate and composition in each city so that the average results of MSW generation rate and composition in Indonesia can be more accurate than now.

### References

1. Marx, B., Stoker, T. and Suri, T. The Economics of Slums in The Developing World. In : *Journal of Economic Perspectives*, 2013, 27(4), pp.187-210.
2. Nuissl, H. and Heinrichs, D. Slums : Perspectives on The Definition, The Appraisal and The Management of an Urban Phenomenon. In : *Journal of The Geographical Society of Berlin*, 2013, 144(2), pp.105-116.
3. Wibowo, H.E. *Community Behavior in Managing Waste Settlements in The Cambodian Village of Pontianak* : Magister. Thesis. Semarang (Indonesia) : University of Diponegoro, 2010.
4. Palembang Mayor Decree number 488 year 2014 about Location Determination of Slum Area.

5. Document of Environment Plan for Settlement of Lawang Kidul Village, Palembang, 2016.
6. Martinawati. *Community of Participation Rate Analysis in Implementing Household Waste Management (A Study in The Village of Sukodadi Sukarami District of Palembang)* : Magister. Thesis. Palembang (Indonesia) : University of Sriwijaya, 2015.
7. Yasir, R.A. and Abudi, Z.N. Characteristics and Compositions of Solid Waste in Nassiriya City. In : *Al-Qadisiya Journal For Engineering Sciences*, 2009, 2(2), pp.136-148.
8. Thitame,S.N., Pondhe, G.M., and Meshram, D.C. Characterisation and Composition of Municipal Solid Waste (MSW) Generated in Sangamner City, District Ahmednagar, Maharashtra, India. In : *Environ Monit Assess*, 2010, 170, pp.1-5.
9. Al-Rawi, S. and Al-Tayyar, T. 2013. A Study on Solid Waste Composition and Characteristics of Mosul City/Iraq. In : *Journal of University of Zakho*, 2013, 1(2), pp.496-507.
10. Palanivel, T.M., and Sulaiman, H. 2014. Generation and Composition of Municipal Solid Waste (MSW) in Muscat, Sultanate of Oman. In : *APCBEE Procedia*, 2014, 10(2014), pp.96-102.
11. Ali, S.M., Ali, Y.M., dan Faris, M.R. 2017. Characterictics of Domestic Solid Wastes in the Judiciary of Tuz Khurmatu/Iraq. In : *Eurasian Journal of Science & Engineering*, 2017, 3(2), pp.224-229.
12. Citrasari, N., Oktavetri, N.I., and Aniwindira, N.A. Generation Rate and Waste Composition Analysis at Kenjeran Surabaya Coastal Settlement. In : *Berk. Penel. Hayati*, 2012, 18, pp.83-85.
13. Komala, P.S., Aziz, R., and Wahyudi, B. Study of Generation Rate and Characteristics of Padang Panjang City. In : *Jurnal TeknikA*, 2013, 20(1), pp.23-32.
14. Dewilda, Y., Darnas, Y., and Zulfa, I. Generation Rate and Domestic Waste Composition of Tanah Datar Regency. In : *Jurnal Teknik Lingkungan UNAND*, 2014, 11(1), pp.28-33.
15. Jaspi, K., Yenie, E., and Elystia, S. Study of Generation Rate, Composition, and Characteristic of Waste in Tampan Subdistrict Pekanbaru City. In : *Jom FTEKNIK*, 2015, 2(1), pp.1-6.
16. Hapsari, D.S.A. and Herumurti, W. Generation Rate and Household Waste Composition in Sukolilo Subdistrict Surabaya. In : *Jurnal Teknik ITS*, 2017, 6(2), pp.421-424.
17. Ratya, H. and Herumurti, W. Generation Rate and Household Waste Composition in Rungkut Subdistrict Surabaya. In : *Jurnal Teknik ITS*, 2017, 6(2), pp.451-453.
18. Apriyani, N. and Lesmana, R.Y. Generation Rate and Waste Composition in Pahandut Village Palangka Raya City and Its Impact on Lindi Water Quality. In : *Jurnal Media Ilmiah Teknik Lingkungan*, 2019, 4(1), pp.5-9.
19. Damanhuri, E. and Padmi, T. *Integrated Waste Management*. Bandung : ITB Press, 2016.
20. Sugiyono. *Education Research Method : Quantitative, Qualitative, and R&D*. Bandung : Alfabeta Press, 2015.
21. SNI 19-3964-1994. Method for Taking and Measuring Samples for Generation and Composition of Urban Waste.