

# Improvement of recycling-based municipal solid waste management in Padang City, West Sumatera, INDONESIA

*by* Slamet Raharjo

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# Improvement of recycling-based municipal solid waste management in Padang City, West Sumatera, INDONESIA

Slamet Raharjo<sup>1</sup>, Vera S. Bachtiar<sup>1</sup>, Yenni Ruslinda<sup>1</sup>, Toru Matsumoto<sup>2</sup>,  
Indriyani Rachman<sup>2</sup>

<sup>1</sup>Department of Environmental Engineering Faculty of Engineering, Universitas Andalas, Padang, 25163, Indonesia

<sup>2</sup>Department of Life and Environmental Engineering, Graduate School of Environmental Engineering the University of Kitakyushu, Kitakyushu, Japan  
sraharjo@eng.unand.ac.id

**Abstract.** Municipal solid waste (MSW) characteristics including generation rates, composition, proximate analysis, and recycling potential were evaluated for suggesting the appropriate recycling-based municipal solid waste management (MSWM) in Padang City. Indonesian National Standard (SNI) 19-3964-1994 was used as guidance for obtaining MSW characteristic through 8 consecutive days sampling in 2016. MSW characteristics from domestic and commercial areas were compared and evaluated to find the most suitable recycling-based MSWM for each area. As a result, both areas show MSW differently in composition. Domestic area generates higher food and yard waste compared to commercial area. On the contrary, commercial area generates higher amount of dry waste. Recycling potential data shows that domestic area generates biodegradable waste (59.420 % weight) higher than that of commercial area (21.816 % weight), while commercial area generates marketable waste (47.949 % weight) higher than that of domestic area (5.730 % weight). Aerobic or anaerobic treatment facility must be implemented for domestic area, while sorting, collecting, sell and recycling activities of marketable dry waste must be carried out more intensive for commercial area. Such treatments and activities must be incorporated into 3R waste treatment facility/TPS 3R, integrated waste treatment facility/TPST, and waste bank (WB).

## 4 Introduction

Indonesia has a regulation (UU No. 18/2008) on municipal solid waste management (MSWM) which encourages a shifting from waste dumping to waste recycling [1, 2]. Unfortunately, most cities in Indonesia do not practice waste recycling. The landfill will be over-capacity by the waste, resulting in land water and air pollution. Therefore, the local government must establish a recycling-based MSWM.

Padang is the capital city of West Sumatera Province located in Sumatera Island with the total area of 695 km<sup>2</sup>. The city has a population number of 914,968 people in 2016, inhabited in 11 sub-districts and 104 villages. Existing MSWM are well explained in our previous work [1]. It explained that most of solid waste is simply transported and dumped to municipal landfill with less activity of waste recycling. The previous paper also suggested that the amount of waste without proper handling (open burning, dumping into the river, etc.) may cause negative impact to the environment [1].

Recycling-based MSWM requires accurate MSW characteristics including generation rates, composition, proximate analysis, and recycling potential. Different sources may generate solid waste with different characteristics, which must also be considered in suggesting an appropriate recycling-based MSWM. It may be conducted in some treatment facilities such as waste bank (WB), 3R waste

treatment facility/TPS 3R, and integrated waste treatment facility/TPST. The facilities were explained more detail elsewhere [1, 2, 3, 4, 5].

This paper collects and evaluate MSW characteristics for the last 10 years from domestic and commercial areas for suggesting an appropriate recycling-based MSWM in Padang City. Domestic and commercial area may be operating slightly different recycling technologies due to the different characteristics of solid waste. Implementation of appropriate recycling technology for each area may increase recycling efficiency.

## 2. Research Methods

MSW characteristics from commercial area in 2016 were done in our previous research [3]. Whereas, MSW characteristics from domestic and commercial area for 2005 and 2009 were collected from other researchers. Indonesian National Standard (SNI) 19-3964-1994 was used as guidance for obtaining MSW characteristics from domestic area through 8 consecutive days sampling in 2016.

Field observations including preliminary surveys and questionnaires were carried out to determine some representative sampling locations in Padang City. 3 sub-districts were chosen based on population level. *Koto Tengah* represents an area with the highest population number, *Lubuk Kilangan* represents an area with the medium population number, and *Padang Barat* represents an area with the lowest population number. For domestic area, sampling locations (households) in each district are divided in 3 categories, namely high income (HI), medium income (MI) and low income (LI) as listed in Table 1. While, Table 2 displays sampling distribution in commercial area [3].

**Table 1.** Sampling distribution in domestic area (2016)

No.	Locations	Number of sample	Categories		
			HI (42%)	MI (45%)	LI (13%)
1.	<i>Koto Tengah</i>	125	53	56	16
2.	<i>Lubuk Kilangan</i>	37	16	17	5
3.	<i>Padang Barat</i>	33	15	15	4
	<b>Total</b>	195	82	87	25

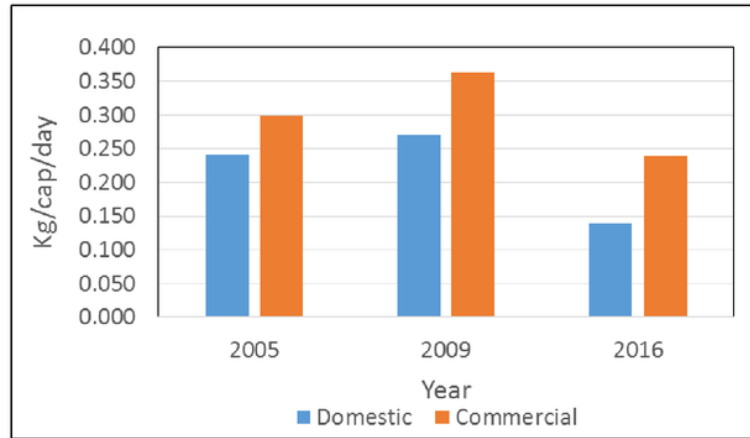
**Table 2.** Sampling distribution in commercial area [3]

No.	Facilities	<i>Kota Tengah</i> (unit)		<i>Lubuk Kilangan</i> (unit)		<i>Padang Barat</i> (unit)		Total sample
		Number of facilities	Number of sample	Number of facilities	Number of sample	Number of facilities	Number of sample	
1.	<b>Restaurant</b>	20	4	12	3	84	9	16
2.	<b>Shop</b>	37	10	23	10	38	10	30
3.	<b>Traditional market</b>	3	3	1	1	2	2	6
4.	<b>Hotel</b>	4	2	-	-	53	7	9
5.	<b>Automobile service</b>	18	4	7	3	18	4	11
	<b>Total</b>	82	23	43	17	195	32	72

8 consecutive days sampling for determining waste generation rate and composition, laboratory works for determining proximate analysis, and recycling potential assessment were explained detail elsewhere [3].

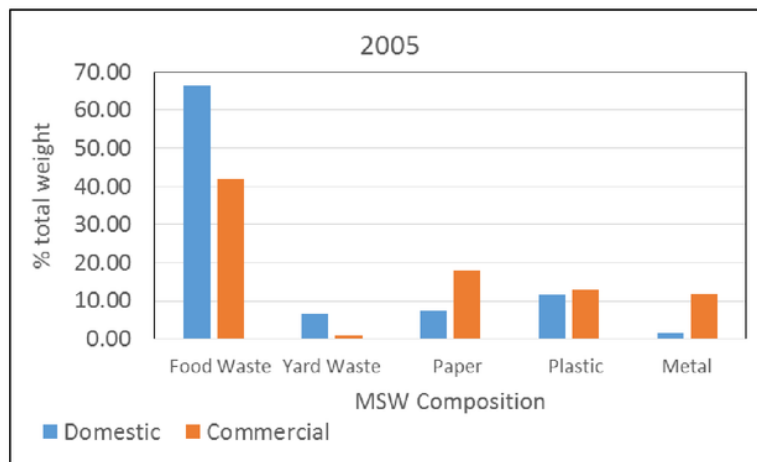
### 3. Result and Discussion

As displayed in Figure 1, 8 consecutive days of MSW sampling in domestic area of Padang City gave an average generation rates of 0.140 kg/cap/day in 2016. Raharjo, *et al.* found that the average generation rate in commercial areas is 0.240 kg/cap/day in 2016 [3]. Figure 1 also compares the current data with the previous data (2005 and 2009) collected from other researchers [6, 7, 8, 9, 10]. As suggested by Raharjo, *et al.*, domestic area also shows that its generation rates tend to decrease for the last 10 years, which may be caused by the awareness of people on waste reduction [3].

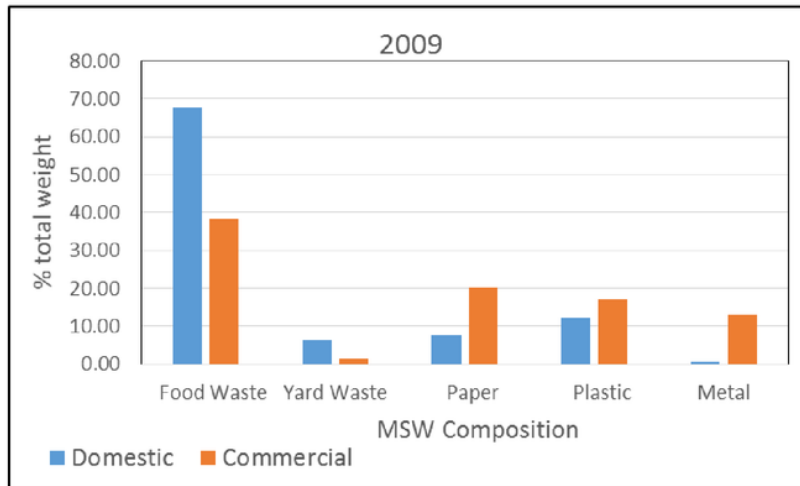


**Figure 1.** Comparison of MSW generation rates in domestic and commercial area for the last 10 years

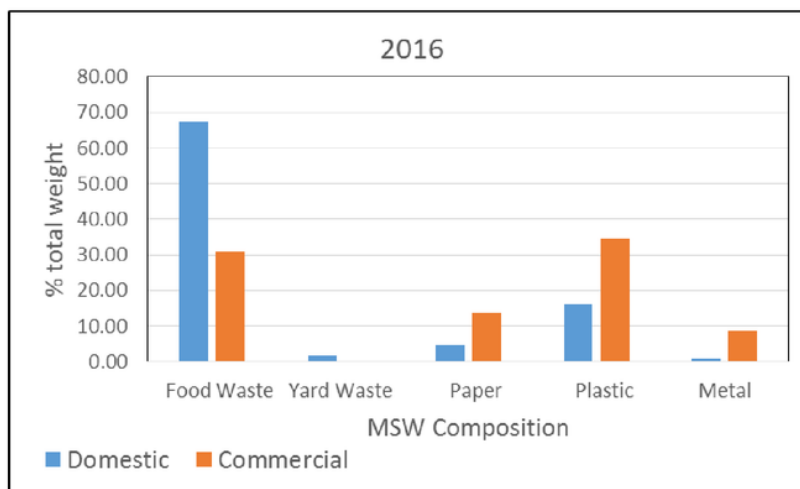
Figure 2 (a), (b), and (c) displays MSW composition for the last 10 years of biodegradable waste (food and yard waste) and marketable waste (paper, plastic, and metal). As displayed in the figure, domestic area generates higher composition of biodegradable waste than marketable waste. Meanwhile, commercial area shows the opposite case.



(a)



(b)



(c)

**Figure 2.** Comparison of food waste, yard waste, paper, plastic, and metal in domestic and commercial area for the last 10 years: (a) 2005; (b) 2009; (c) 2016 [3, 6, 7, 8, 9, 10]

MSW composition data as described in Figure 2(a), 2(b), and 2(c) are not enough to determine an appropriate recycling-based MSWM. Recycling potential data is necessary for both areas as displayed in Table 3. Unfortunately, there was no researcher conducting recycling potential for the last 10 years. Table 3 only shows current study on recycling potential of MSW. It ensures that biodegradable waste is dominant (59.42%) in domestic area, while marketable waste (47.95%) is dominant in commercial area. These important characteristics must be considered for establishing recycling-based MSWM. Furthermore, Table 4 suggests a proposed system of recycling-based MSWM based on the discussed

characteristics. Establishment and operation of *TPS 3R* with main activity of composting/anaerobic digestion in domestic area must be encouraged. WB as a national program in community-based waste management must be intensively operated in commercial area. It is reported that WB has been increasing its number by ten-fold in 5 years (2012 – 2017) in Indonesia, which is good for the program [11]. *TPS 3R* may operate not only compost/anaerobic digester, but also manage marketable waste.

**Table 3** Recycling potential of MSW from domestic and commercial sources in Padang City in 2016

MSW Composition	% total weight	
	Domestic	Commercial*
Food Waste	58.28	21.81
Yard Waste	1.14	0.01
<b>Biodegradable waste</b>	<b>59.42</b>	<b>21.82</b>
Paper	1.64	10.22
Plastic	1.67	27.63
Wood	0.54	0.47
Glass	1.18	2.04
Metal	0.70	7.59
<b>Marketable waste</b>	<b>5.73</b>	<b>47.95</b>
Total	65.15	69.76

\*[3]

**Table 4.** Proposed system for recycling-based MSWM

No.	Area	Recycling facility (priority order)	Technology/activity
1.	Domestic	1. 3R waste treatment facility /TPS 3R	Composter and/or anaerobic digester
		2. Integrated waste treatment facility/TPST	Composter and/or anaerobic digester
		3. Waste bank (WB)	Waste savings, sorting, processing, and selling
2.	Commercial	1. Waste bank (SWB)	Waste savings, sorting, processing, and selling
		2. 3R waste treatment facility /TPS 3R	- Waste savings, sorting, processing, and selling - Composter and/or anaerobic digester
		3. Integrated waste treatment facility/TPST	- Waste savings, sorting, processing, and selling - Composter and/or anaerobic digester

#### 4. Conclusion

Domestic area generates higher food and yard waste compared to commercial area. On the contrary, commercial area generates higher amount of dry waste, especially plastic waste. Recycling potential data shows that domestic area generates biodegradable waste (59.420 % weight) higher than that of commercial area (21.816 % weight), while commercial area generates marketable waste (47.949 % weight) higher than that of domestic area (5.730 % weight). In order to improve recycling-based



MSWM, different MSW characteristics in both areas must be considered. Therefore, composter and/or anaerobic digester must be the main treatment facility for domestic area. Whereas, sorting, collecting, selling and recycling activities of marketable dry waste must be carried out more intensive for commercial area. Such treatments and activities must be incorporated into 3R waste treatment facility/TPS 3R, Integrated waste treatment facility/TPST, and waste bank (WB).

## 2 Acknowledgment

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