FACTORS INFLUENCING WASTE GENERATION IN A TRADITIONAL MARKET A Case Study at Gemolong Market, Sragen Regency, Indonesia

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1. Introduction

Waste generation in Indonesia has tended to increase in recent decades. Sutanto (2007) reported that solid waste generation in Indonesia was 0.031 ton/person/year in 1971^[1]. This number increased to 0.195, 0.236, 0.332, and 0.354 ton/person/year in 1980, 1990, 2000, and 2010, respectively^[1] as the nation's population has increased. Moreover, in 2020 this figure is predicted to be approximately 0.350 ton/person/year^[1]. Waste generation is potentially a pressing environmental problem for Indonesia.

Waste production figures in provincial Indonesian cities such as Jakarta, Bandung, and Surabaya were 6000, 2000, and 2200 tons/day, respectively^[2]. According to Meidina and Gamse (2010), markets contribute about 20% of waste generation; they are the second largest generator of municipal solid waste after households^[3]. Therefore, it is important to reduce market waste generation. Although considerable research has been conducted in large cities such as Palembang^[4] and Bandung^[5], waste generation from traditional markets in small cities is mostly unknown, so research in a traditional market located in a small city such as Gemolong Market in Sragen Regency, Central Java, is valuable. The objectives are to estimate the average amount of waste per square meter, to identify the factors influencing waste generation, to predict the average total quantity of daily waste, to determine waste composition, and to measure the potentiality for waste management in this market.

2. Methodology

The measurement of waste generation in Gemolong Market is based on National Standard of Indonesia (*Standar Nasional Indonesia*, SNI) 19-3964-1994 regarding test methods for sampling and measurement of pile and composition of urban garbage^[6]. Sampling was conducted over eight days from 11 to 19 May 2011 to determine the daily waste generation rate, to predict the daily waste quantity, to determine the waste composition, and to measure the potentiality for waste management in this market.

To identify the factors influencing waste generation, a questionnaire was distributed between 2 and 21 May 2011 using a stratified random sampling method based on population distribution. The number of traders as sampling points and respondents for questionnaires was determined using the Slovin equation with an error tolerance of 0.1, and the number of traders (816) as sampling points was determined by contacting the management of Gemolong Market (*UPTD Pengelola Pasar*). The equation to measure the sampling points is $n = N/(1+Ne^2)$, where n = number of samples, N = total population, and e = error tolerance (= 0.1). The calculation is $n = 816/(1 + (816 \times 0.1^2)) = 89.08$ traders = 90 traders. Therefore, the sampling points are 90 traders.

3. Results and Discussion

3.1 Daily Waste Generation Rate

The sampling results are shown in Table 1. The table shows that waste generation in this market varies considerably from day to day and is probably the result of the variation in number of people attending the market. The number of customers is influenced by economic conditions. Higher incomes send more customers to market, and this is reflected in increased waste generation^[7]. With an average daily waste generation of 0.090 kg/m²/day or 0.336 L/m²/day, that of Gemolong Market is lower than the overall average waste generation for markets in Indonesia (0.1 – 0.3 kg/m²/day or 0.20 – 0.60 L/m²/day)^[8] and the average waste generation of markets in other Indonesian cities such as Palembang (0.21 kg/m²/day or 1.08 L/m²/day)^[4] and Bandung (5.35 L/m²/day)^[5].

3.2 Factors Influencing Waste Generation

Table 2 shows trader activities as potential sources of waste generation. Low waste generation in Gemolong Market can be partially understood, for example, by the fact that spoiled merchandise is given to others such as waste pickers, sold at a discount, or returned to the supplier. Packaging is reused, sold, or given to waste pickers, while the remaining waste is used to feed livestock such as cows and chickens, given to waste pickers or reused. In comparison, the factors reducing waste generation in markets in Vientiane, Lao PDR, include spoiled products sold at discounts, brought home for animals or sold to farmers for animal feed, packaging such as boxes and plastic bags stored for later use or sold to meat vendors, and recyclable materials picked up by waste collectors or kept aside by vendors for themselves^[9].

Table 1.	Waste	Generation	in	Gemolong	Market
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Day	kg/m²/day	L/m ² /day
1	0.100	0.375
2	0.077	0.287
3	0.101	0.377
4	0.075	0.279
5	0.089	0.332
6	0.100	0.373
7	0.074	0.277
8	0.105	0.393
Average	0.090	0.336

Table 2.	Trader's	Activity	Related	to	Potential	Source
	of Wast	e Genera	ation			

No.	Related Activity	%
1	Spoiled merchandise	
	a. Discarded at temporary disposal site (TDS)	21.11
	 b. Collected by official 	1.11
	c. Given to others	7.78
	 d. Sold at a discount 	22.22
	e. Returned	47.78
2	Packaging	
	 Discarded at TDS 	11.11
	b. Reused	40.00
	c. Sold	2.22
	 Given to waste pickers 	14.44
	e. No packaging	27.78
3	Waste	
	a. Discarded at TDS	25.56
	 b. Collected by official 	27.78
	c. Taken home	10.00
	 Given to waste pickers 	34.44
	e Reused	2.22

3.3 Waste Composition, its Daily Estimated Figure and the Potentiality for Waste Management

Table 3 shows average daily waste generation by type. To estimate the daily waste generation figure in Gemolong Market, the average daily waste generation is multiplied by the size of the sampling area $(10,150 \text{ m}^2)$. Table 3 shows that its waste generation is dominated by organic waste (80.16%). Therefore, the market management must focus on vendors who produce organic waste in larger quantities, such as fast food, fruit, and vegetable vendors, by providing adequate garbage receptacles. Organic waste can be divided into

	. Type of Waste		Average		Estin	Composition	
No.			kg/m²/day	L/m²/day	Weight (kg/day)	Volume (L/day)	(%)
1	Organic	Compostable Organic	0.0386	0.0826	391.998	838.498	42.93
		Uncompostable Organic	0.0328	0.0851	333.080	863.274	37.23
2	Inorganic	Non-colored Plastic	0.0035	0.0352	35.384	357.411	3.65
		Colored Plastic	0.0028	0.0294	28.185	298.784	3.32
		PET Bottles	0.0016	0.0455	16.550	461.850	1.91
		Paper	0.0050	0.0338	50.553	343.118	5.49
		Cloth	0.0009	0.0043	9.516	43.253	1.17
		Other materials	0.0050	0.0206	50.503	209.269	4.30
		Total	0.090	0.336	915.768	3,415.456	100.00

Table 3. Estimated Daily Waste Generation Figure in Gemolong Market and its Composition

compostable and uncompostable waste. Compostable organic waste consists primarily of rice, noodles, vegetables, leaves, fruits and fruit skins. Uncompostable organic waste consists primarily of banana stems, wood, bamboo, bone, tree branches, and salak seeds. Plastic is separated into non-colored and colored plastic because it can be sold for higher prices if separated: sorted plastic sells for Rp 1,000/kg while unsorted plastic sells for Rp 700/kg. Judging from its composition, Gemolong Market waste still has a high potentiality for minimization. In compliance with integrated waste management, compostable organic waste can be converted into compost, plastic and PET materials can be sold, and other paper waste can be recycled into paper manufacture. Through integrated waste management, the efficacy of waste management can be maximized and the lifetime of the final disposal site will be extended because the quantity of waste discarded at that site will be reduced to about 42.70% of total market waste (Figure 1).



Figure 1. Scheme of the Efficacy of Waste Management

4. Conclusions

Based on the results and discussion obtained from sampling and questionnaires at Gemolong Market, Sragen Regency, Indonesia, the following can be concluded:

- a. The average quantity of waste per daily trader is 0.090 kg/m²/day or 0.336 L/m²/day.
- b. The factors influencing low waste generation are materials reused or sold, materials given to waste pickers, and materials used to feed livestock.
- c. The daily waste figure is estimated at 915.768 kg/day or 3,415.456 L/day.
- d. The total waste composition is dominated by compostable and uncompostable organic waste (80.16%), while inorganic waste, consisting of non-colored and colored plastic, PET bottles, paper, cloth and materials, accounts for the remaining 19.84%.
- e. The potentiality for improved management of waste to be composted and recycled is approximately 42.93% and 14.37% respectively.

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