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Waste Reduction by Scavengers in Basirih Landfill Banjarmasin South Kalimantan Indonesia: Waste Composition Based Analysis

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ABSTRACT

This study aimed to analyze the amount of waste that can be reduced by scavengers at Basirih landfill Banjarmasin Indonesia, and show the importance of determining landfill management options based on the composition of the waste in the landfill. Data collection was conducted by analyzing the composition of the waste in the landfill and interviewing the scavengers to determine the average amount of waste scavengers obtained. The results showed that the organic waste in Basirih landfill has the largest composition (± 60%). Inorganic waste in Basirih landfill amounted to ± 40%, 26,02% of inorganic waste can still be used, while 13.98% of waste can not be utilized by the scavengers. The amount of waste that can be reduced by scavengers is 414 tons per month. 3.45% inorganic waste is reduced by scavengers compared to the total waste, and 8.5% compared to total inorganic waste, with the highest recovery rate is PET plastic and the highest types of waste can be obtained by scavengers are white and coloured plastic bags. It can be concluded that the role of scavengers in inorganic waste reduction and composting of organic waste are important to improve in Basirih landfill management.

KEYWORDS: inorganic waste, organic waste, scavengers, waste composition, waste reduction

INTRODUCTION

In developing countries, scavengers have an important role on waste management. Scavengers collect waste that can be recycled from the road, municipal transit material and landfill. Although the scavengers play an important role in waste reduction, scavengers are often ignored when waste management policies are formulated [16]. [17, 3, 2, 18, 1, 9] and also the environment that scavenging activities can reduce the impact of global warming [4, 11, 16, 15]. The importance of assessing the contribution of the informal sector to reduce the amount of waste as to reduce the financing of municipal waste management [8].

Scavenging activity is one of the major contributors to the reduction of waste in the landfill burden. One problem that faced in the management of the landfill is less flexible rules to support the growth of the informal sector, including scavengers. The existence of scavengers has not been seen as a crucial and included consideration of waste management by the local government. Waste management will not be success if only managed by experts of engineering and local governments so that it becomes a challenge to pay more attention to political factors (policies) and social factors in the disposal and recycling of waste [6]. Most of the exhaust system in countries in Asia, including Indonesia, is still in the form of open dumping. This system is less well managed by the government and the managers of the landfill [12].

Whatever the method that used in waste management, an understanding of the composition of the waste is a needed. Reliable data on the composition of waste is difficult to obtain, even if such data are available, it is often not the latest composition data [12]. Good planning is started from reviewing the composition of the existing waste. The composition is the basis for the waste management strategy with a system of waste recycling, composting, and waste transportation [14]. Waste composition changes each year.

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[5] links the selection of effective waste management model with the dominant waste composition. Composition of inorganic waste in developed countries is high (estimated to ± 70%), so the potential management of waste is recycling inorganic waste. In contrast with waste composition in developing countries such as Indonesia, the dominant waste composition is organic waste (estimated to be ± 70%), so waste management should focus on the processing of organic waste. Therefore, the waste management model in developed countries can not be applied in developing countries.

Although organic waste is a dominant composition in developing countries, recycling inorganic waste that collected by scavengers is important, because the inorganic waste requires long time to decompose. Inorganic waste is usually collected by scavengers, disposed of to landfill or incinerated [7]. The increasing number of inorganic waste can improve employment opportunities for scavengers. The main purpose of the scavenger is to collect waste material that can be sold from mixed waste. The quality and level of separation of recyclable materials have potential impact on the end use. This study will examine the impact of the presence of scavengers on the reduction of waste in the landfill with a detailed at the composition of waste in accordance with US EPA [20]. In this study, the reduction of waste by scavengers will be analyzed by linking the composition of waste bins with economic value that can be taken by scavengers.

MATERIAL AND METHOD

This research was conducted at the Basirih landfill Banjarmasin South Kalimantan Indonesia from September 2014 to March 2015. Fields visits and interviews among scavengers were conducted. Primary data first needed are the average amount and the composition of waste in the landfill. Measurement of the amount of waste that goes into landfill obtained from local government. Composition analysis on landfill waste using classified tables of waste materials from United States -Environmental Protection Agency (US-EPA) 2006 on "Solid Waste Management and Greenhouse Gases: A Life Cycle Assessment". Waste composition analysis was carried out by the following steps:

a. Preparing equipment namely a large bag for sampling tool to collect 100 kg per day of waste in landfill, 40 liter plastic bags, scales, gloves, masks, boots. Waste sampling was carried out for 8 consecutive days.
b. Sorting of waste according to type based on United State Environmental Protection Agency (US-EPA) in 2006.
c. Scaling each type of sorted waste.
d. Calculating the percentage of waste composition.

The analysis is done by looking at the composition of the waste that goes to landfill in detail and linked with the appropriate waste management method based materials management in accordance with the existing waste composition. The next primary data required is the average quantity and type of waste per day scavenger obtained by interviewing using a questionnaire. The population of this study is scavengers in Basirih landfill. Sample of respondents scavengers taken by random sampling using accidental technique. To determine the number of scavengers sample is using Slovin formula [19]:

$$n = \frac{N}{N.d^2 + 1}$$

n = sample size

N = population size

d = error estimation, d = 10%

With a population of 170 people scavengers (based on data from Banjarmasin sanitary local government in 2014), then it was obtained 64 scavenger as sample. Interview was done in order to determine the average amount of inorganic waste that can be collected per day, the value of the selling price of inorganic waste, waste recovery rate, and the percentage of waste reduction by scavengers.

RESULT

Analysis the Amount and Composition of the Waste in Landfill

Based on secondary data, the average amount of waste that goes to landfill is 394.907 kg per day or as much as 11.847,21 tons per month. The result of waste composition analysis is presented in the table below.

Table 1. Percentages of waste compositions in Basirih Landfill.

No.	Material	Percentages
1	Copper wire	0,13%
2	Glass	2,18%
3	HDPE	0,47%
4	LDPE	0,003%
5	PET	0,66%
6	Corrugated cardboard	1,13%
7	Magazines	0,01%
8	Newspaper	0,47%
9	Office paper	1,37%
10	Textbooks	0,35%
11	Dimensional lumber	3,01%
12	Food scraps	3,01%
13	Yard trimmings	0,86%
14	Mixed paper:	
	Broad definition	1,29%
	Residential definition	0,88%
15	Mixed metal	0,92%
16	Mixed plastic	9,04%
17	Mixed organics	55,78%
18	Mixed MSW	8,13%
19	Carpet	0,10%
20	Computer	2,31%
21	Clay bricks	0,25%
22	Concrete	0,50%
23	Tires	7,20%
Total		**100%**

To compare the proportion of each composition of the waste to total waste generated in Table 1 above, the composition of the waste is described in the form of a pie chart as below (figure 1). Types of waste were compared by primary categories namely organic and inorganic waste. The condition of the existing waste composition in Basirih landfill in 2014 is 60% organic waste, while for inorganic waste is 40%. The organic waste is categorized as biodegradable waste. Inorganic waste consists of the types of plastic, paper, mixed MSW (Municipal Solid Waste), metals, and other types such as carpets, computers, clay brick and concrete.

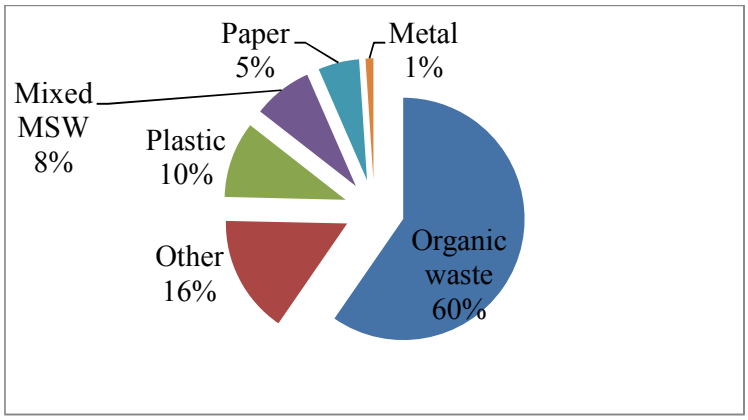

Figure 1. Comparison of Composition of Organic and Inorganic Waste in Basirih landfill

The primary categories are subdivided into a secondary form to find out more detail types of waste contained in the Basirih landfill. Figure 2 illustrates the composition of organic waste which consists of three secondary categories namely mixed organic, food scraps and yard trimmings. Mixed organic waste consists of waste that came from traditional markets such as waste of vegetables, fruits, coconut and others. While food scraps consist of household waste in the form of foods that are not eaten, and yard trimming consist of tree leaves fall off or cut down.

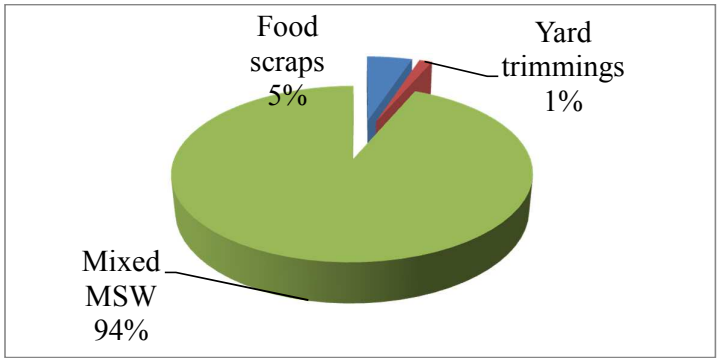

Figure 2. Comparison Composition of Organic Waste in Basirih landfill

Types of plastic waste is divided into four categories, namely HDPE, LDPE, PET and mixed plastic from various waste sources. Largest proportion of mixed plastic consisting of plastic cups, plastic bags of white and colored plastic bags (as shown in Figure 3).

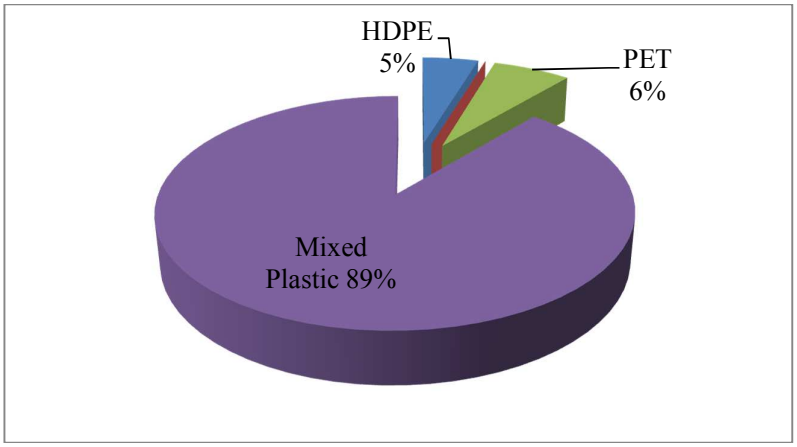

Figure 3. Comparison Composition of Plastic Waste in Basirih landfill

Types of waste paper amounted to only 5% of the total waste in Basirih landfill. Paper types are divided into 7 secondary categories. The types of waste on average from households like eating paper, cigarette boxes, notebooks, receipt, paper and magazines, such as HVS offices and others, workshops such as boxes of spare parts and others and delivery services that use cardboard for packaging. Paper waste in landfill has less economic value because it is already dirty, wet and destroyed by rain. Comparison of the proportion of waste paper can be seen in figure 4.

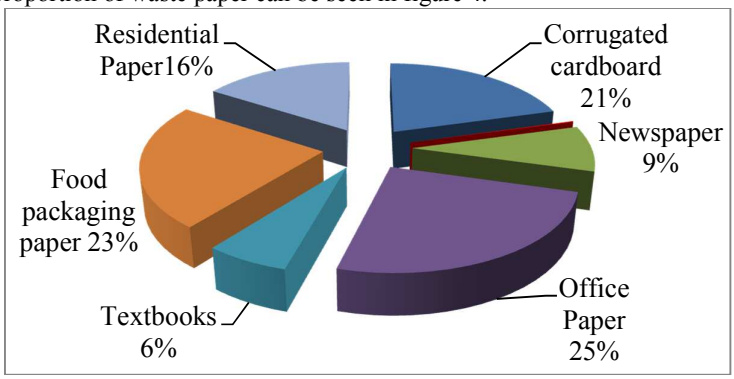

Figure 4. Comparison Composition of Paper Waste in Basirih landfill

The type of metal waste is divided into two categories: copper wires and mixed metal. The example of waste in this composition is can of soda, milk can that comes from households and markets, copper wire, and the rest is metal from building materials. 16 % of other types of waste consists of a tire that comes from the workshop, concrete, brick, wood that comes from the rest of the building, computers, carpets, and broken glass from households.

Analysis of the amount, rate of recovery and the percentage reduction made by scavengers
From the interviews to the scavengers, it was obtained data as follows:

Table 2. The average amount of waste that scavengers obtained per day

No.	Material	Average amount of waste by one scavenger per day
1.	White plastic bag	32,2 kg
2.	PET and HDPE	16,1 kg
3.	Can	3 kg
4.	Coloured plastic bag	27,7 kg
5.	Tires	20 kg
6.	Compact disc, cable*	Rp. 7.000,-

*can not be found everyday, only several scavengers take it

The highest types of waste in the landfill that scavengers get is white plastic bag (32.2 kg per day) and coloured plastic bag (27.7 kg per day). While the types of cans is a type that is the smallest type that can be obtained (3 kg per day). For comparison, [14] found that the amount of waste that can be obtained by scavengers at the landfill Bendo in the city of Yogyakarta Indonesia is 52.05 kg per day for plastic and paper.

DISCUSSION

Developing Landfill Management Based on Waste Composition

The existing management of waste in the landfill is controlled landfill where the waste will be covered with soil when it reaches a certain height. There is a center of composting that only treats the organic waste transported from certain markets, but it does not process the organic waste that goes to the landfill. So it can not reduce the amount of organic waste in landfill. Inorganic waste reduction was done by 170 scavengers.

Waste that goes to landfill potentially can be recycled. Inorganic waste can be recycled as a substitute for raw materials and it has greater economic value. While organic waste will be have economic value when it is composted. The recycling process must pay attention to the composition and characteristics of waste. One goal of this study is to provide data on the percentages of waste that potentially to be recycled and composted. The data presented in table 2.

Table 3. Type and percentage of waste that has the potency to be recycled and composted

No.	Percentages of inorganic waste potentially recycled		Percentages of organic waste potentially composted	
1.	Mixed plastic	9,04%	Food scraps	3,01%
2.	HDPE	0,47%	Yard trimmings	0,86%
3.	PET	0,66%	Mixed organic	55,78%
4.	Mixed metal	0,92%		
5.	Glass	2,18%		
6.	Carpet	0,10%		
7.	Tires	7,20%		
8.	Copper wire	0,13%		
9.	Computer	2,31%		
10.	Dimentional lumber	3,01%		
Total		26,02%	59,65%	

Refers to the percentage of the overall composition of the table 3, there are 10 materials of inorganic waste that still have economic value or can be sold. The existence of scavengers at the landfill has reduced the number of existing inorganic waste but it is difficult to obtained all types of material. The materials that are not taken up by scavenger is a type of glass that has been broken and the computer because there are no collectors who buy them. Residual inorganic waste that can not be utilized amounted to 13.98%, such as waste paper (broken and dirty due to rain and contamination from organic waste), broken clay bricks and concrete, and mixed MSW that consists of baby diapers and sanitary napkins.

The most abundant waste in landfill is organic waste (± 60%). It means the most appropriate choice for waste processing in landfill is composting. By doing composting, it will extend the life of the landfill, since the amount of waste that should be dump will decrease significantly. This is supported by waste dump research in Dhaka city "According to required landfilling areas, projected assuming 50% collection efficiency, on the year 2020, land requirements with composting of 40-80% of the organic wastes range from 167.11 acres/yr. to 96.97 acres/yr., while that without any composting stands at 206.31 acres/yr" [10]. Center of composting in landfill of Yogyakarta City can process 25 tons per day of organic waste and produce compost more than 8.3 tons per day, this is equivalent to reduce 10.33% of organic waste in the landfill [15]. The reduction of organic waste in the landfill will reduce the smell of decaying organic material, the number of flies, and emission of greenhouse gases such as uncontrolled methan. Determination of intensive composting method has been applied by the government of Bangladesh in 64 districts where the composition percentage of organic waste is high (60-75%) [13].

Although organic waste potentially can be completely composted (± 60% and that most of the types of organic mixture coming from the rest of the vegetables traditional market), but not all organic waste can not be composted because of the difficulty of separation of organic waste and inorganic waste in the landfill. The contaminated compost will have a low quality. Therefore, organic and inorganic waste segregation is important to be done starting from the center of the household or other activities that highly generate waste, for example the traditional market. To increase the quality and quantity of compost that will be processed, local governments can use special trucks for organic waste so that organic waste can be directly processed in the composting facility at the landfill.

Waste reduction by Scavengers in Basirih landfill

26.02% of inorganic waste is able to be recycled (from total 40% inorganic waste in the landfill). Scavengers collect the types of waste such as white plastic bag, coloured plastic bag, kind of bottle (bottles of drink, shampoo, milk, lotion, powder, medicine, etc.), cans (aluminum and steel). The other type is also taken up by scavenger including sacks, carpets, sandals, shoes, copper, glass bottles, and waste that scavengers called by arma (compact disk and cables). Definition of waste material obtained scavengers is adapted to the definition of waste materials in accordance to Waste Reduction Material (WARM) US EPA. The type of white and coloured plastic bag is categorized as a type of mixed plastics. From the interviews to the scavengers, an average weight of waste collected each month can be known. It is presented in table 4.

Table 4. The amount of waste reduction by scavenger per month

Material	Waste composition percentage	Waste reduction percentages compared to total landfill waste	The amount of waste entered landfill per month	The amount of waste reduction by scavengers per month	Recovery rate
Mixed plastic	9,04%	2,53%	1071 ton	300 ton	28,52%
PET and HDPE	1,13%	0,69%	134 ton	82 ton	61,33%
Mixed metal (can)	0,92%	0,13%	109 ton	15,4 ton	0,14%
Tires	7,2%	0,14%	853 ton	16,6 ton	2%

The total of reduced waste by scavengers is 414 tons per month. Waste that have the highest waste reduction percentages is white and coloured plastic bag. According to US EPA Waste Guidelines explain that recovery is a process that extracts or take material or energy from the waste stream [20]. Material that have the highest recovery rate is PET bottle which has code 1 and HDPE plastic which has a code 2. In Ormoc City Philippines were also found that PET has the highest recovery rate [10].

From the result, the amount of waste reduction from scavenging activities seems low whereas scavenging activities has important role in reducing inorganic waste. The reasons for the results can be explored in three points; the dominant waste in landfill is organic waste (60%), the number of incoming

waste (394.907 kg / day) is not balanced by the number of scavengers that can sort waste (± 170 scavengers), and the last, scavenging activities is determined by supply and demand by waste recycling industry. The more types of waste recycling industry, the more types of waste that had economic value can be taken by scavengers. It means that it will be more amount of waste that can be reduced in the landfill and significantly will increase resource recovery, recycling of waste materials and increase scavengers profits. One way to increase waste reduction by scavengers is organizing of scavenger work under the umbrella of municipalities or private companies [1].

The calculation is performed by comparing the reduction of inorganic waste to total landfill waste (see table 5, the total percentage of reduction of 3.35%) and against any kind of inorganic waste (see table 6, the total percentage of reduction of 8.5%). The percentage of waste reduction that most represents the presence of scavengers is the percentage by comparison to the amount of inorganic waste that can be reduced (Table 6). This data is useful to maximize the role of waste pickers economic value.

Tabel 5. The percentage of inorganic waste reduction by scavengers compared with the total of all the waste that goes to landfill

Material	Plastic		Cans	Tires
	White and coloured bag	PET and HDPE		
Waste percentages in landfill	9,04%	1,13%	0,92%	7,20%
Waste reduction percentages	2,53%	0,69%	0,13%	0,14%
Total	3,49%			

Tabel 6. The percentage of inorganic waste reduction by scavengers compared with the amount of inorganic waste that goes to landfill

Material	Plastic		Cans	Tires
	White and coloured bag	PET and HDPE		
Waste reduction percentages	6,45%	1,73%	0,32%	0,35%
Total	8,85%			

From the analysis of the composition, it shows the overall comparison of waste composition so it can be concluded that the best waste processing for landfill management.

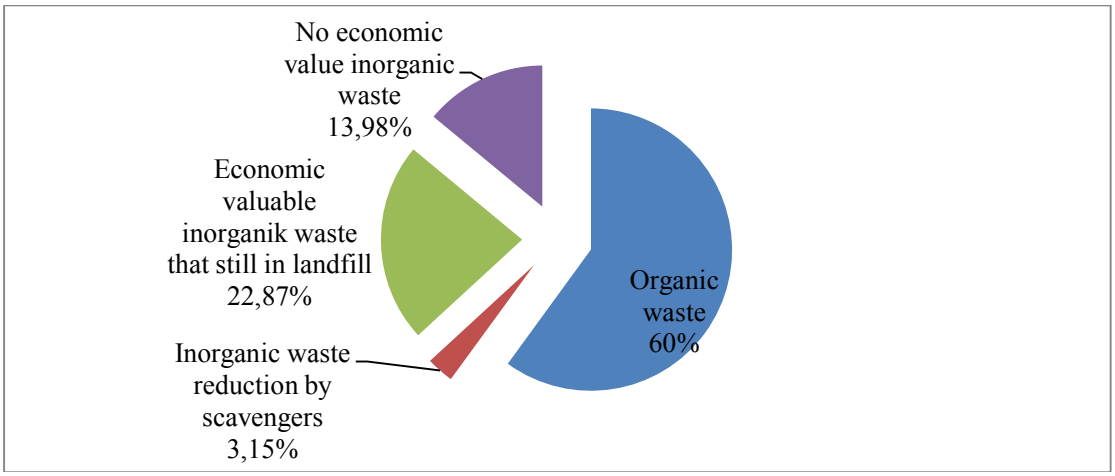

Figure 5. Percentage composition of waste reduction by scavengers

Inorganic recycling waste trough waste picking by scavengers is the best ways to reduce the amount of inorganic waste in landfill. This result is supported by the previous studies. Chintan research in Delhi found that the informal sector is able to reduce the amount of waste around 15-20% [4]. If all scavengers (400 people) are assumed to work in Bendo landfill Yogyakarta City, the amount of waste that can be reduced in the landfill is 42.56 tons / day or 13.14% from total waste [15]. Scavengers in Payatas City of Philippines can obtain 65 tons of waste to be recycled every day [8]. So it is needed an appropriate strategy to increase the amount of waste that can be taken by the scavengers.

Conclusion

The conclusion of this results can be explored in three points; less flexible of government regulations to support the growth of the informal sector, including scavengers; and detail waste composition data is really importance related to making decision for landfill management. 26.02% of inorganic waste has potential of recycling (percentage of total inorganic waste is 40%). Inorganic waste that can be reduced by scavengers is 3.45% when compared to the total landfill waste and 8.5% when compared to total inorganic waste, with the highest recovery rate is plastic types PET and highest types that can be obtained by scavengers are white and coloured plastic bag. Residual inorganic waste that can not be utilized is 13.98%. Improving landfill management such as waste reduction by scavengers unrecognized and should be improved as a form of effective management in the landfill.

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