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Recovery Practice of Unsorted Solid Waste: from Landfill towards Economic Benefits in Semarang, Indonesia

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Abstract. The field study in Jatibarang landfill in Semarang was conducted by quantifying the solid waste that had been collected and transferred to the landfill to obtain the amount of the solid waste generated by the residents of Semarang. The gross weight of the waste was calculated by randomly selecting and weighing the shipments on the scale before the load was dumped by the vehicle. The solid waste received by Jatibarang landfill is about 651.5 tons per day, with a density of 245 kg/m^3. The composition of domestic waste in Jatibarang landfill is 77.7% organic waste, 14.19% plastics, 5.31% mixed paper, and 1.36% others. The inorganic wastes in Jatibarang landfill still retain economic value of IDR 141 million per day when fully recovered. The current recovery practices are performed by scavengers who live in the surrounding area of Jatibarang landfill.

1 Introduction

The city of Semarang is the capital of the Central Java Province, one of the most developed and densely populated provinces in Indonesia. As a big city in a developing country, the local authorities of Semarang face environmental problems mainly related to the solid waste generated by its residence. Similar to cities in other developing countries, the solid waste management in Semarang consists of collection, transport, and final processing, which is basically landfilling [1, 2].

Most of the solid waste generated in Semarang municipality ends up at Jatibarang landfill. The solid waste transported to landfill generally consists of a mixture of organic and inorganic matter, as the practice of solid waste separation at the source for recycling purposes has not been well implemented. The organic substances will undergo the decomposition process, but the inorganic substances which mostly consist of plastic, paper, and fabric will retain their original forms for long periods of time. The accumulation of inorganic substances over time can cause the landfill to reach its capacity limit too soon [3].

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Jatibarang landfill performs some optimization efforts, such as recycling the old zone of the landfill to extend its service time. However, as the percentage of the solid waste being generated is increasing every day, another approach should be considered to be implemented at Jatibarang landfill. One visible way to reduce the amount of the solid waste to be landfilled is by conducting a recovery practice of inorganic waste in the landfill. By reducing the volume of the waste dumped at the landfill, the life span of the landfill can be extended. Furthermore, the inorganic waste still has potential economic worth if handled and treated properly [4, 5]. Therefore, this paper aims to investigate the amount and characteristics of the solid waste disposed of at Jatibarang landfill and analyze the economic benefits of the recoverable material.

2 Methods

The research was conducted at the Jatibarang landfill area by quantifying the solid waste that has been collected and transferred to the landfill to obtain the amount of the solid waste generated by the residents of Semarang City. The gross weight of the waste was calculated through randomly selecting and weighing the shipments on the scale before the load was dumped by the vehicle [6]. The tare weight was the weight of truck container.

The number, volume, and source of the waste of each vehicle were recorded. Waste characterisation was also conducted during solid waste sampling. Solid waste is divided into organic and inorganic waste plastic (HDPE, PE, and PP), paper, fabrics and miscellaneous) [7, 8]. Interviews also were done to depict participation level of the residents living adjacent the landfill area and existing scavengers who involved in the recovery process, potential of plastic recycler, and to find out the market value of the recovered material.

3 Results and Discussion

3.1. Amount of solid waste

The amount of the solid waste generated by Semarang city residents which is handled by the city's local authorities fluctuates between days. In order to get a precise amount, the sampling was conducted for 8 consecutive days which served to cover the solid waste generation during both work days and the weekend. As shown in Figure 1, the amount of the solid waste transferred to the Jatibarang landfill varied about 600-750 tonnes per day. The lowest amount was found to be for Sunday which was 609 tonnes. This result gave the average daily amount of 651.5 tonnes per day of the solid waste received by the Jatibarang landfill. The density of the solid waste was found to be 245 kg/m^3.

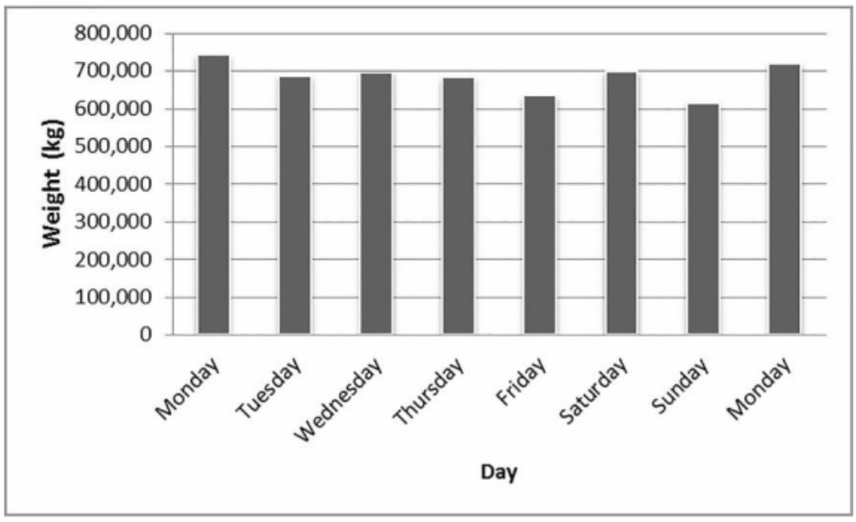

Fig 1. Solid waste received by Jatibarang landfill

3.2. Composition of solid waste

The composition of domestic waste in the Jatibarang landfill is shown in Figure 2. The prevailing composition of organic waste (in wet weight percentages) includes food waste, kitchen waste, and garden waste, etc. which was biodegradable, with a total proportion of 77.7%. The proportion of the recoverable waste, including some types of plastics, ran up to 14.19% and mix paper which was 5.31%. The category 'others', including batteries and other indistinguishable waste, was only 1.28%. The plastic category was then broken down into more specific classifications which were HDPE, PE, PP and PPs. This plastic categorisation was based on the initial survey to the local plastic recycler to increase the economic value of the recovered plastic since each type of plastic has a different price and the lowest price is for the mixing/unsorted plastic.

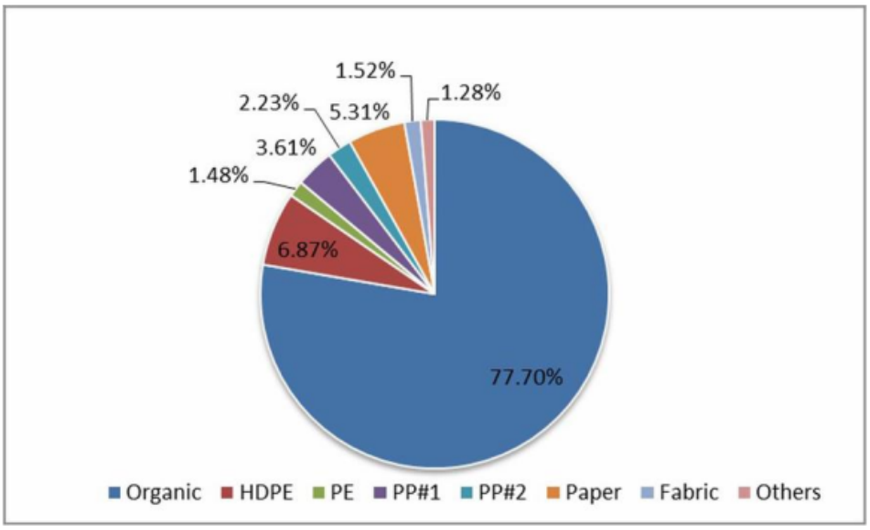

Fig 2. The composition of solid waste

3.3. Economic value of the recoverable materials

The solid waste that is being transferred to the Jatibarang landfill still retains some economic value since it contains some recyclable materials. The economic value of the waste varies according to the composition of the waste and the required treatment of the recoverable material prior to selling. Based on the survey of the local recycler industries, the individual price for each category is shown in Table 1. Economic value that shown in Table 1 was calculated from multiplication of the average daily amount solid waste per day (kg), the percentage of proportion each types/product, and the price of each product. The result shows that the solid waste dumped into Jatibarang Landfill potentially can be recovered with value about IDR 141 million per day.

Table 1. Price of the recovered selected inorganic waste

No	Product	Price (IDR/Kg)	Economic value (IDR)
1	HDPE	1,200	53,709,660.00
2	PE	3,000	28,926,600.00
3	PP#1	1,300	30,574,895.00
4	PP#2	1,200	17,434,140.00
5	Paper (mix)	300	10,378,395.00
		Total	141,023,690,00

3.4. Local Community Involvement

There are hundreds of people (scavengers), most of them local resident who work to recover sellable materials from incoming solid waste in Jatibarang landfill. They sort the waste which still has value to sell to the local recycle collector resided in surrounding Jatibarang landfill. Their activities actually help to reduce waste to be piled up in the landfill zone. However, those people work less thorough, only waste that is still highly valuable and visible (on the surface) that they recover. The rest of the solid waste that is actually still being able to be reprocessed and has economic value becomes residue. This residue will rest in landfill zone and take space of the landfill.

However, the present of scavengers in landfill also create come issues. Since they are unmanaged, they tend to rush into the garbage truck when the garbage truck starts to dump the load. They disturb the truck activity and delay the disposal process. Once the garbage truck finish unloading, they still try to get more material and delay the activity of the bulldozer to push and spread the waste into dumping area.

4 CONCLUSION

The average daily amount of 651.5 tonnes per day of the solid waste received by Jatibarang landfill with density of 245 kg/m^3. The composition of domestic waste in the Jatibarang landfill is 77.7% organic waste, 14.19% some types of plastics, 5.31% mix paper, and 1.36% others (including batteries and other indistinguishable waste). The solid waste dumped into Jatibarang Landfill potentially can be recovered with value about IDR 141 million per day. Some of the waste has already been recovered by scavengers who mainly reside adjacent Jatibarang landfill. However, their activities are not managed properly by

Jatibarang landfill authorities and might delay the unloading and spreading process of the solid waste.

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