Current Solid Waste Management and Waste Composition Survey in Gili Trawangan, Indonesia

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1. Introduction

As a developing country, Indonesia has been facing a solid waste management problem for years. Indonesia is an archipelago country with more than 17,000 islands. Many of the small islands are popular tourist destinations. Although the tourists bring economic benefits to the islands, the tourism industry provokes environmental threats including waste issues (Shamsiry, *et al.* 2011). Gili Trawangan in North Lombok Regency, West Nusa Tenggara Province (NTB), is an example of a threatened island due to the accumulation of garbage generated from the tourism industry. A new waste management system on the island is required to facilitate proper waste disposal.

In this study, current solid waste management (SWM) on the island is summarized, and the quantity and composition of the solid waste is identified. Opinions of stakeholders in the island's waste management were obtained and reveal the problems. Finally, a suitable system for the island's waste management is proposed.

2. Current Waste Management in Gili Trawangan

Local stakeholders in the island, such as the Businessman Association of Gili Trawangan (APGT), the Gili Eco Trust (GET), and some key persons among the island's local residents established the Forum Masyarakat Peduli Lingkungan (FMPL) in 2003 to deal with solid waste issues. FMPL collects and transports solid waste from sources to a final disposal site (2,000 m^2) on the island. Because the local law, which is called "*Awig-awig*" and was established by mutual agreement among the island's stakeholders, prohibits the use of vehicles powered by fossil fuel to protect the island's environment, horse drawn carts are used to collect and transport the solid waste. Recycling activities are conducted by FMPL and by informal sectors. For example, glass bottles are recovered by GET and reused in bricks and glass blocks. Approximately 3.59 tons/day of recyclable materials (plastic bottles, buckets, jerrycans, beer bottles, cardboards, aluminum and iron cans, and scrap metals) were sold to private recycling businesses on the main land (Lombok Island) in 2015.

FMPL charges customers, such as households, hotels and restaurants, to collect the waste. The total amount charged in May 2015 was Rp. 96,000,000. Since June 2015, FMPL, GET and Waste Bank (Bintang Sejahtera) have collaborated to compost 600 kg/day of food waste generated from hotels and restaurants on the island. Although the product is utilized in only FMPL's garden as a pilot project, FMPL plans to sell the compost to hotels, restaurants and other businesses in the future.

3. Research Method

Table 1 shows the outline of this research. Generated waste form 10 hotels with restaurants (large hotels), 9 small hotels with no restaurants (small hotels), 5 restaurants, 4 public facilities (mosque, market and seashore public space) and 39 households were investigated to estimate the island waste generation rate.

Table 1.The outline of facilities and households investigated.

	The number of objects on the island	The number of objects for investigation	Remarks
Households	471	39	1,709 people
Large hotels with restaurants	71	10	1,788 beds and 3,700 seats in total
Small hotels with no restaurants	255	9	2,287 beds in total
Restaurants	31	5	969 seats in total
Others (Mosques, Market, Public Space)	6	4	2 markets, 2 mosques, 2 public spaces

The composition of wastes from 5 large hotels, 15 small hotels and 39 households was investigated. The samples were separated into 3 categorizes: organic (food waste, grass clippings and leaves), recyclable (papers, plastics and metals), and others (young coconut shells, diapers, toilet papers).

Questionnaires were distributed to 70 households. The following six questions were asked: a). Do you think equipment used for the collection of waste is adequate?; b). Does FMPL take your suggestion into account in its policies?; c). Does FMPL educate people about waste management in households?; d). Do regional government and local government educate people about waste management in households?; e). Do you receive adequate support, such as waste management facilities and infrastructure, from local government and regional government?; and f) Are the activities of GET adequate?. In response to each question, the respondents provided a score from 1 to 10. Additionally, key persons of APGT, FMPL, the governments of North Lombok Regency and NTB Province, and GET were interviewed to learn their opinions about waste management on the island.

4. Results

4.1 Waste Generation and Composition

Based on the waste generation survey, it was estimated that 10.1 tons/day of solid waste was generated on the island. The large hotels, small hotels, households, restaurants and others generated 44%, 31%, 12%, 5% and 8% of the total waste, respectively.

The waste generation rates of households, large hotels, restaurants in hotels and restaurants were 0.68 kg/person/day, 0.78 kg/bed/day, 1.19 kg/seats/day and 0.53 kg/seats/day, respectively. The waste generation rate of the market was 379 kg/day; mosque was 17.9 kg/day; and 2 seashore public spaces were 71.38 kg/day.

Figure 2 shows the result of waste composition. The waste was dominated by organic material, such as food waste and leaves. The following was comprised of recyclable materials, such as paper, plastics, and metals.

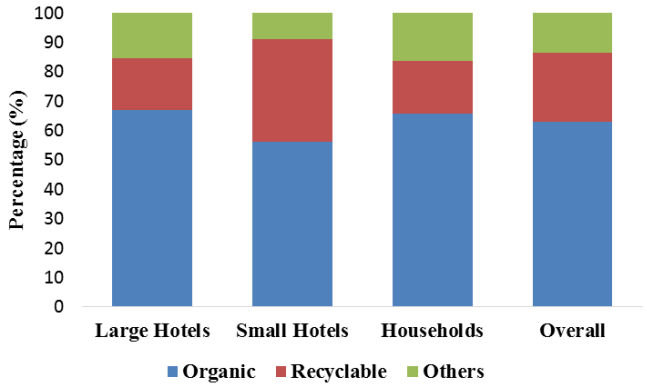

Figure 2. Composition of waste samples

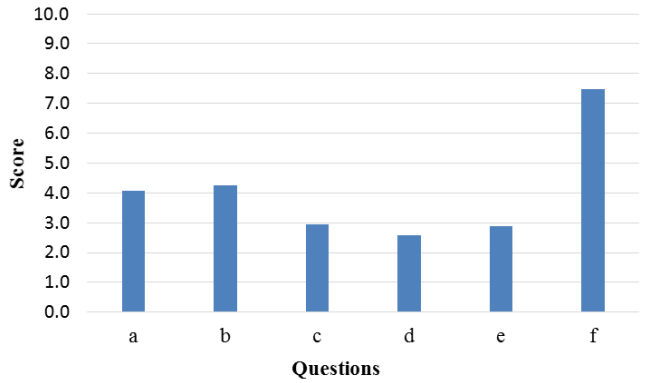

Figure 3. Local residents' opinions about other stakeholders.

4.2 Opinions of Stakeholders related to Waste Management

Figure 3 shows the scoring of the responses to the questions. Score range was 1 to 10. Score 1 indicates that the performance was significantly poor, and score 10 indicates that the performance was significantly good. Because the scores in response to questions (a), (b), (c), (d) and (e) were less than 5, the residents on the island consider that the FMPL, the local government and the regional government perform SWM relatively poorly. On the other hand, the residents consider that the performance of GET on SWM was good, because the score of the responses to question (f) was 7.5.

According to their interviews, all of the stakeholders agreed that the main constraints in waste management were land shortage, insufficient and improper waste transportation and a lack of community participation. APGT, FMPL, and GET considered that training concerning waste separation and reduce, reuse, recycle principle, facilities such as warehouses, and spaces for waste processing were insufficient.

The regional government of NTB Province preferred an incineration technology for the future SWM on the island. The local governments of North Lombok Regency had no ideas for waste management, because they have no authority to provide land that can be used for waste management facilities. APGT considered that waste transportation to the main island will resolve the waste issue. FMPL and GET assumed that composting and managing recyclable waste will improve waste management on the island. FMPL and APGT invited Waste Bank to recycle food waste as composting and recyclable waste. One of the Waste Banks in the Central Lombok Regency has already been established to recover household kitchen waste and compost.

4.3 Option for a Waste Management System

The compositions survey indicated that the dominant waste with 63% was organic waste and followed by 23% of recyclable waste (Figure 2). Therefore, the recycling of organic waste is important to reduce the amount of waste carried to the dumping site. Applying composting combined with the Waste Bank will reduce the amount of waste that goes to the disposal site by 86%, and the residue waste should be sent back to the disposal site on Lombok Island. The current dumping site is already overloaded. Despite the capacity was 2,000 m^2, the area of dumped waste has been expanded to 4,400 m^2. To support FMPL's collection and transportation of waste, the use of fossil fuel vehicles to collect the waste should be permitted to save collection and transportation time and cost.

The introduction of an incineration facility requires very high cost for construction and operation to complete the combustion and reduction of environmental load (Cheng and Hu, 2010). In the past, incinerators have been installed in several South East Asian countries such as Indonesia (Kepulauan Seribu Regency) and Malaysia (Pulau Langkawi, Pulau Pangkor, Pulau Tioman, and Pulau Labuan). However most of these facilities could not continue to operate because of faulty designs, improper operation, poor maintenance, high energy usage and waste characteristics due to high moisture content (Jereme *et al*, 2013). Building an incinerator on the island will be a huge burden for the waste managers and the local government of North Lombok Regency, because they have a very limited budget and human resources to operate the facility.

4. Conclusion

Generated waste in Gili Trawangan is dominated by organic waste. Residents considered the performance of FMPL, the local government of North Lombok Regency and the regional government of NTB Province to be poor. Stakeholders in SWM agreed that the main constraint for improving SWM was land shortage. Based on the results, composting organic waste and introducing the Waste Bank would be adequate to manage the waste adequately on the island. In the future, a supply and demand analysis of compost and the island's waste flow investigation will be beneficial to propose a feasible SWM.

References

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