



Solid Waste Management for Sustainable Ecovillage: A Case Study of Tanjung Dam Ecovillage, Mojokerto

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Abstract. This study aims to observe the waste characteristic and analyze the solid waste management system in the tourism destination of Tanjung Dam Ecovillage, Mojokerto, Indonesia. The sampling and interviews were conducted to estimate solid waste's characterization and management practice. The findings show that the tourism destination generated around 25.19 kg/day of solid waste. The percentage of solid waste was 11.67% organic (food waste), 3.45% inorganic, and 2.02% residue. Another waste generated from this destination was yard waste, which was around 20.8 kg daily (82.57%). The interview results of the visitors present that waste management awareness was still low. The solid waste management of the ecovillage was collect-transport-dispose with low rates and efficiency. Furthermore, there was no waste separation, no regular waste collection schedule, a lack of waste bins, no landfill, and no education about waste management for the tourists. These facts must be overcome to improve the solid waste management system and ensure the sustainability of the ecovillage.

Keywords: Sustainable ecovillage · tourism destination · waste management

1 Introduction

Solid Waste Management (SWM) is becoming a serious challenge in many tourism regions since large amounts of waste are generated, particularly by tourism activities. In addition, the cost of ensuring a sustainable concept is considered high. The areas where the economy relies on the tourism industry have become increasingly concerned about the environmental and socio-cultural problems related to unsustainable tourism. Activities related to SWM in tourism areas cover solid waste collection, infrastructure development for waste collection, treatment, disposal, and waste collection and recycling. Improper SWM management can negatively impact the destination's attractiveness since environmental resources are inputs of production in creating the tourist experience. Research of Martins & Cró [1] state that it is worth observing the correlation between tourist activity and solid waste generation for at least three reasons. First, the tourism region is notably comprehensive in solid waste generation. Second, international tourist

arrivals are a particular mode of export, as consumption is made in the exporting country, so the coming of these tourists adds up to an extra source of solid waste in the tourist destination. Third, there may be negative affects of inappropriate solid waste management on the profile of the destination since environmental assests are inputs of producing in the formation of the tourist experience.

SWM is considered one of the most significant environmental aspects of tourism activities. As part of the businesses, tourism industries use large amounts of single-use packaging, consumer goods, and large sums of organic and food waste [2]. According to Edmundo & Rodrigo [2], waste generation in tourism areas depends on many factors, such as the type and occupation rate of the tourism transactions, tourists' activities and seasons, and environmental regulation at the national and local levels. In addition, waste collected from street bins and sweeping activities is considered a part of SWM. This consists of waste that accumulates from sweeping streets. In this study, there is another waste type: yard waste, which consists of leaves and grasses. Rodrigues et.al. [3] revealed that the application of waste collection systems in tourism sites influences public health, the condition of the area, and the recovery of materials for recycling and reusing purposes.

Tanjungan Dam Ecovillage is one of the ecovillages in Mojokerto. The ecovillage still needs to estimate its solid waste generation and composition. Waste characterization is an important activity of any solid waste management program, and it requires permanent function contributing to better short, medium, and long solid waste management planning. The waste characterization survey will describe what types of components consist of significant parts of waste generation. It also discovers the origin of the materials and serves the information required to arrange the priority of recycling and other waste reduction actions. The results of a waste characterization report represent the information required to set up redirection programs effectively. The study provides some of the baseline data needed for solid waste management. With the increasing number of tourists, it is important to quantify waste generation and composition at Tanjungan Dam Ecovillage. This study aims to observe the waste characteristic and analyze the solid waste management system in the tourism destination of Tanjungan Dam Ecovillage, Mojokerto, Indonesia. There is a new study of waste characterization at tourist destinations. The study is essential for further waste management planning and to ensure the sustainability of the ecovillage.

2 Methods

2.1 Sampling Site

The study was conducted at Tanjungan Dam Ecovillage, Mojokerto in April-May 2022. The research comprised of four main steps as follows:

1. Quantifying the amount of daily generated solid wastes.
2. Solid waste sampling.
3. Identifying waste composition.
4. Data compilation and analysis of the quantities and types of wastes.

Ten spots often visited by tourists around the dam were determined as collection points. All collection spots have trash bags to dispose of the waste.

2.2 Solid Waste Sampling

In order to determine the generation of the solid waste, sampling was carried out for 12 days around Tanjungan Dam Ecovillage. The first 4 days were about preliminary sampling to determine the primary waste categories. The aim was to simplify the sorting activity. The following 8 days were the main part of solid waste sampling. Sampling methods and procedures for the characterization of the wastes were derived using the Standard Test Method for Determining the Composition of Unprocessed Municipal Solid Waste (SNI 19-3964-1994). All samples were taken during operating hours of the destination to ensure that the sampling results describe the ecovillage's waste generation. The next day, the waste in the collecting spots was collected and weighed. All samples were separated into organic and inorganic wastes in the isolated area. Another waste generated at Tanjungan Ecovillage was yard waste. Yard waste consists of leaves and grass collected daily from roads around the ecovillage. Workers take the waste out of the ecovillage. In this study, yard waste generation was also estimated. Interviews with ecovillage visitors and officers were also conducted in the study due to their solid waste management understanding.

3 Results and Discussion

3.1 Amount of Solid Waste Generation

Observing the solid waste characteristics (the amount and composition) at Tanjungan Dam Ecovillage is an important step in assisting sustainable waste management alternatives and carrying out further research. Generation rate research is crucial to ameliorate at all levels of scopes to prevent solid waste generation in the future. Table 1 below represents the quantity of the solid waste.

The sampling results show that the average weight of solid waste generation in the destination area is 25.19 kg daily. Yard waste dominates waste generation. Wastes from street sweeping are caused by many plants and grass around the dam. The worker cuts the grass and sweeps the falling leaves. The waste will be disposed to the open dumping area because no specific landfill exists.

The organic waste consists of visitors' food waste. Food waste is the central portion of solid waste generated by the destination, representing 11.67% of solid waste. This

Table 1. Solid Waste Quantity and Percentage

Type of waste	Average generation rate (kg/day)	Percentage (%)
Organic	3.01	11.67
Inorganic	0.87	3.45
Residue	0.51	2.02
Yard waste	20.8	82.57
Sum	25.19	100

consists of food waste from breakfast and lunch packs. Food waste is highly varying depending on its sources. The higher the percentage of food waste, the higher the recycling potential. Inorganic waste is the second-largest component in the waste generated at the destination. Organic waste consists of plastic food packaging and plastic bag. Considering the non-biodegradable plastics and their immense environmental destruction, the best way to control the waste is to eliminate and minimize the generation of these wastes.

3.2 Reducing the Waste Potential

The interview with ecovillage officers shows that the overall collection system of solid waste in the destination is not very promising. Open dumping is also observed to be a common practice. The solid waste management of the ecovillage was collect-transport-dispose with low rates and efficiency. Furthermore, there was no waste separation, no regular waste collection schedule, a lack of waste bins, no landfill, and no education about waste management for the tourists. The interview with visitors shows that the visitors' awareness of waste management is still low because their knowledge about waste is minimal.

The solid waste management system must be upgraded to fit the waste's quality, quantity, and composition. The study shows that 15.12% of total waste, such as food waste and plastic, can be reduced. Food waste composting can be applied because food waste constitutes the highest waste composition. Food waste (organic) has the potential for recovery to produce fertilizers.

3.3 Purpose Scenario for SWM

The purpose scenario is to ensure the sustainability of the ecovillage. Considering that the amount of waste will increase due to the escalation of ecovillage visitors, the ecovillage officers are responsible for ensuring the sustainability of the ecovillage. The purpose scenarios are:

1. Public education, sharing awareness with local citizens, and communicating what stakeholders require.
2. Waste sorting at source: in order to improve material recovery and collection, waste segregation and separation at source could support the efforts to reduce waste generation and reduce SWM costs (collection, transporting, landfilling, etc.).
3. Green waste composting can be an alternative to managing organic waste.
4. Organic waste sorting at source: Tourism establishments should collect organic waste separately to guarantee clean raw materials for composting.

Integrated approaches are suitable, especially in the governance of solid waste management. Strong collaboration is needed among society, government, businesses, and researchers to describe the best approach for waste handling with government-friendly strategies, consumer responsibility, and advanced materials and methods from researchers [4]. A study conducted by [5] suggested that to better manage solid wastes in the study area, the ecovillage officers should improve the organization of collection and

sanitation by allocating more staff to increase cleaning frequency. Moreover, the officers should minimize this by imposing an extra charge for the food and items brought in from outside. Promoting propaganda and education to raise awareness and responsibility for the environmental protection of visitors is necessary. Diversifying propaganda and disseminating tourism regulations to officials, employees, and tourists regarding solid waste management is urgently needed.

4 Conclusion

The findings show that the tourism destination generated around 25.19 kg/day of solid waste. The percentage of solid waste was 11.67% organic (food waste), 3.45% inorganic, and 2.02% residue. Another waste generated from this destination was yard waste, which was around 20.8 kg daily (82.57%). The interview results of the visitors present that waste management awareness was still low. The solid waste management of the ecovillage was collect-transport-dispose with low rates and efficiency. These facts must be overcome to improve the solid waste management system and ensure the sustainability of the ecovillage.

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