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DESIGN OF A WASTE MANAGEMENT MODEL USING INTEGRATED ORGANIC AND SOLID WASTE MANAGEMENT: A CASE OF GAMBIRONO SUB-DISTRICT, JEMBER

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Abstract. The aim of this article is to design a waste management model for Gambirono sub-district, Jember based on integrated organic and solid waste management system. The increasing organic and solid waster generation in the sub-district of Gambirono is evidenced by increased number of illegal dumping of waste in the rural communities. In this article, a model that identifies recycling processing that generates additional income to manage organic and solid waste and also incorporating the key performance indicators or metrics for organic and solid waste management services has been designed. The design shows a clear depiction of the environmental management acts and the municipality by-laws. Performance measurement which is very critical in waste management has been incorporated. Model design focus was on separation of types of waste, collection, waste treatment, disposal methods of useless waste and waste bank management have therefore been depicted in the model. The model provides easy access to data for the formation and implementation of effective organic and solid waste management policies, strategies and programs to achieve sustainable waste management.

Keywords-Environment, integrated waste management, organic waste, solid waste, waste bank management

1. Introduction

The growth of population in Indonesia has given significant impact on several development aspects including environment. The main issue related to environmental has faced an increase of waste in urban and rural area because of high population activities and daily consumption needs. The increase in volume of waste should be followed by improved waste management in the community so that it does not cause environmental impacts such as floods, diseases, and bad odors. Community education related with environmental problems due to illegal dumping of waste in urban and rural communities is needed to raise community awareness. The main challenge in dealing with waste problems is to change people's habits to keep environmental clean. Based on [1], the knowledge of environmental and community attitudes assist environmental awareness of community, their perceptions and participations to the community-based recycling project. Furthermore, demographic attributes and socio-economic factors play a little role in waste separation and recycling behavior at household level. To encourage household recycling behavior according to [2], campaigning activities should be integrated into a project at community- based level. In return, waste separation and recycling could also provide economic opportunities for poor families to generate supplementary income to meet their basic needs.

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Gambirono sub-district is one of rural in Jember district, East Java, Indonesia facing waste management problem in which community environmental awareness is low. Many organic waste left over from agricultural products or wood processing is left scattered or stacked in the yard. The production of plastic and other inorganic waste from households, schools or industries is increasing, but because it does not have a landfill or waste processing, the garbage many are thrown into rivers, highways, yards or buried by making puddle of land for residents who own a yard. Environmental problems are occurred in Gambirono sub-district shown in Figure 1. In addition, flood conditions in the season rain has become commonplace due to piles of garbage clogging gutters, overflow of rivers due to siltation due to garbage. This is a source of dengue fever and diarrhea. There is standing water when it is raining community mobility to work because there are still many village road infrastructure unpaved or asphalt.

Figure 1. Dumping of waste at Gambirono sub-district, Jember

Based on these conditions, it is needed to change the community's perspective of waste not as something useless but is something that is valuable for reuse into other products. Communities must leave garbage dumps in any place or method of being piled up in the ground through the provision of knowledge, insights, and training in processing waste into something useful, educating and accustoming the community to sorting out, selecting, and valuing waste while developing the people's economy through developing a waste bank [3]. Waste bank system was introduced firstly in Thailand in 2006 as a breakthrough in 'saving waste'. The inorganic waste is collected and sorted based on several categories to be a saving account. The amount of the saving can be withdrawn in occasional time. The public waste saving is sold to waste-collector for further reuse or recycle. Waste bank can be categorized as an attempt of household waste management, stated in Government Ordinance No.81 year 2012, which necessitate producer to commit reduces, re-use, and recycle in waste management. Waste bank also has now become one of Innovation of Urban Management (IMP) in the waste management program by involving public and private sectors. Waste bank management is stated in Ordinance of State Minister for The Environment No.13 year 2012, consists of waste bank management in general and the scope of the works, consequently illustrated that waste bank has taken part in waste management system with participation of public as the basic principle. In addition, waste bank could function as dropping point, a place for community to collect waste collectively and turns it into saving. The economic value of saving becomes an "incentive" for the community to sort and

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collect the waste. The indicators of success waste bank as a part of waste management are: 1) the decreasing of waste tonnage in a landfill area; 2) increasing of the number of settlements (kampungs or residential) which implement waste bank.

To solve waste problems at Gambirono sub-district, we have conducted a community service program supported by Ministry of Research, Technology and Higher Education of the Republic of Indonesia to implement waste bank management. In this article, we report the implementation of community service programs that have been carried out in waste recycling at Gambirono sub-district.

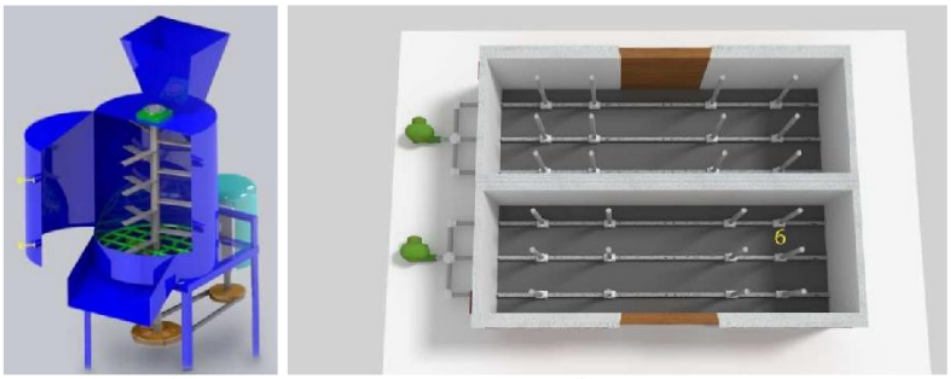
2. Methods

2.1. Time and location

Location of the waste bank program activities is carried out in the Gambirono sub-district, Jember, East Java, Indonesia which has been started in August to December 2019.

2.2. Waste handling procedures

To support waste bank management at Gambirono sub-district, We divide waste management methods into two types, namely organic waste and plastic waste. To handle organic waste collected from local residents, it will be processed into compost using aerated static pile (ASP) method. ASP composting, refers to any of a number of systems used to biodegrade organic material without physical manipulation during primary composting. The blended admixture is usually placed on perforated piping, providing air circulation for controlled aeration . It may be in windrows, open or covered, or in closed containers. The design of organic waste chopper machine and ASP to produce composts is shown in Figure 2.



(a) (b)

Figure 2. Handler of organic waste for generating compost: a) organic waste chopper; b) aeration system for a closed chamber composting facility

Furthermore, for plastic waste such as bottles, glasses can be sold directly to garbage collectors, while plastic waste that cannot be sold will be further processed into plastic paving products. The design of plastic chopper machine and paving machine to produce paving plastic products is shown in Figure 3.

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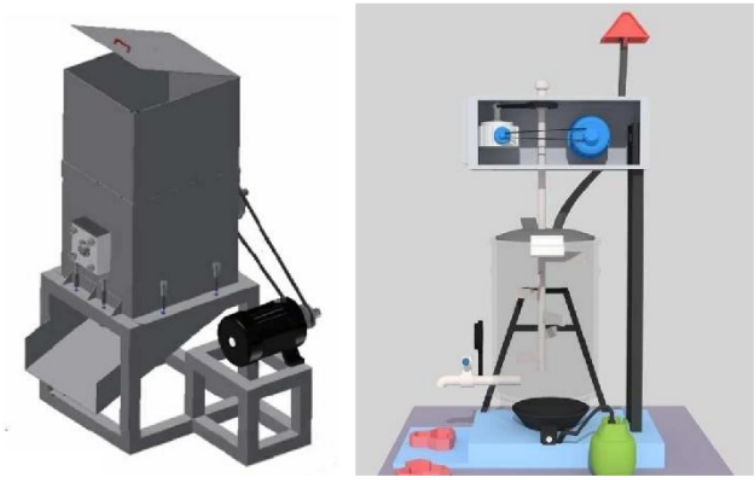

(a) (b)

Figure 3. Handler of plastic waste for generating paving: a) plastic waste chopper; b) paving machine

2.3. Waste bank management

To manage waste bank management successfully, there are nine activities that must be carried out, namely 1) socialization of waste banks to the community (the definition of waste bank, how waste bank works, profit of waste bank); 2) waste bank training; 3) sorting organic and plastic waste at home; 4) preparation of waste collection facilities; 5) the formation of the management of the waste bank; 6) preparation of waste depositing schedules; 7) administration and recording system; 8) processing organic waste and plastic waste; 9) cooperation with waste collectors and sale of compost and plastic paving products.

3. Results

3.1. Infrastructure of waste bank management

To support the waste bank management activities, aeration system for a closed chamber composting facility has now been built as shown in Figure 4. Furthermore, to process organic waste and plastic waste has been built organic waste chopper machines, plastic waste chopper machines, and paving machines as shown in Figure 5.

3.2. Waste bank training and its implementation

Without local community participation in waste bank management, waste bank program cannot run successfully. Waste bank training teaches people to sort the waste, raising public awareness to process waste wisely in order to reduce waste dumped carelessly. In addition, local community who collects waste to waste collection facility can get additional income for economic welfare. Participation of local community is shown in Figure 6. Guidance for women citizens has shown the ability of women citizens in moving their communities to play an active role in managing waste in their environment while at the same time exercising social control in their communities. The impact of changes that occur in the local community location of the waste bank management can be seen in Table 1.

Based on Table 1 it can be seen that the socialization of the waste bank and the availability of waste treatment facilities has changed the habits of the local community at Gambirono sub-district to be active in sorting household waste and collected it to the garbage bank. Local community participation was initially low on waste management. However, after some focus group discussions and training on waste management has provided positive feedback to encourage more local

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community to collect waste to the waste bank. Waste that has no economic value has turned into compost for plant and agricultural seedlings and has generated profits from the sale of plastic waste and plastic paving products. Profits from selling rubbish can be exchanged for household or health needs. In addition, landfills in some places have been significantly reduced. Flood conditions in the Gambirono environment when the rain came began rarely because the water channel has been free from waste.

Figure 4. Material recovery facility for waste processing

Figure 5. Waste processing technology including compost and plastic paving

Figure 6. Dialogues and focus group discussion with local community at Gambirono sub-district

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Table 1. Changes in conditions before and after the development of waste bank education

Initial Conditions	Activities	Current Conditions
Minimal waste management knowledge, waste processing technology does not yet exist	Mapping the problem by holding meetings and dialogues with local community about the impact of waste problems on the environment and health, introduction and manufacture of waste processing technology	Local community has knowledge about the impact of the waste problem, changes in habits begin to occur, start actively doing household waste sorting
Low local community participation	Conducting meetings to promote environmental awareness to local community, as well as conducting directions and dialogues to provide knowledge about environmental awareness and making plastic paving for village roads	Local community begins depositing waste into the waste bank and actively contributed to the management of the waste bank
Waste is considered to have no economic value and benefits	• Collecting data on the price of plastic waste on the market by observing and cooperating with collectors. A collaboration with 4 collectors has been carried out, namely 1 large collector and 3 small collector • Collaboration with building shop owners in Gambirono for the sale of plastic paving products	Start to see changes in physical environmental conditions with a decrease in the amount of waste thrown into the river or that is littered, and the environment looks cleaner.
Lot of waste dumps	Publication of activities on the RRI Jember	Support from the RT, RW, and local goverment in dialogue activities with residents and training provided
Buried waste, limited land for waste disposal	Through dialogue and training, local community has been able to sort waste and are able to make recycled products	Local community are saving to waste bank and starting to make some plastic paving products and compost fertilizer
Flooding arises from drains covered with waste	Effort to encourage local community to care about cleaning waterways and sorting plastic waste and then motivating them to save money into waste bank	Environmental conditions are cleaner and healthier

Conclusion

The presence of a waste bank has encouraged capacity building for local community at Gambirono sub-district by seeking to create self-reliance and self-sufficiency of local community through the formation of awareness, knowledge, and abilities that encourage participation in managing the environment in their communities. Local community knowledge and skills in managing waste have stimulated creativity and innovation in the craft of waste recycling.

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