Realities of Agricultural Waste Management in Indonesia's Rural Areas: Regulations, Village-level Practices, and Local Capacities

47-216807, Hany Nabila Shabrina
Supervisor: Maiko Sakamoto

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1. INTRODUCTION

Reducing greenhouse gas (GHG) emissions must be done effectively by knowing which sectors contribute to global emissions. According to the World Resources Institute, Indonesia ranked as the third-highest emitter of GHG emissions in the waste sector globally in 2019. The waste sector demands a focal concern as it becomes a significant contributor of methane and nitrous oxide, where they are respectively 80 times and 280 times more potent than CO2 in causing global warming (Garthwaite, 2021). Among the different categories of waste, food waste accounted for the most extensive composition in Indonesia (SIPSN, 2022). Currently, Indonesia loses about 39% of agriculture crops, 22% of fisheries, and 20% of horticultural commodities (Bappenas, 2021).

Furthermore, as agricultural activities are intensified to address the growing global population's dietary needs, the generation of agricultural waste will increase accordingly. Thus, such waste from agriculture harms global environmental sustainability efforts. Given that agricultural activities in Indonesia predominantly take place in rural areas, it is crucial to prioritize agricultural waste management in rural areas.

However, rural waste management issues are less debated in the literature than urban areas and very few studies have targeted case studies at the village level. Most of the studies have primarily concentrated on specific waste rather than comprehensively addressing agricultural waste.

Therefore, the purpose of this study is to provide perspective on the current Indonesia's agricultural waste management situations through exploring the existing regulations, practices at the village level, and local capacities.

2. METHODOLOGY

2.1 Literature review

The urgency of managing waste in the agricultural sector in Indonesia is addressed under the term "Food Loss and Waste." However, it involves food waste from the market and consumption that is not covered in this research. To avoid confusion, the term "agricultural waste" is used for this research, which means waste originating from agricultural production, post-harvest and storage, and the processing and packaging stage. The analyzed agriculture sectors include food crops, horticulture, plantation, forestry, livestock, and fisheries. Nevertheless, agricultural waste is not included in any waste categories regulated in Indonesia's existing regulations. I have confirmed this issue to Indonesia's Ministry of Environment and Forestry, and they acknowledged it.

2.2 Efficiency analysis of general waste management

Estimating the current agricultural waste management practices at the village level poses challenges due to the unavailability of data. Hence, the selection of study areas started at the regency level, as more data is available. Moreover, the National Waste Management Information System (SIPSN), as a reliable data source, only provided general waste data with no detailed information about agricultural waste.

Data Envelopment Analysis (DEA) is employed as a tool to evaluate the relative efficiency of general waste management for each regency in Indonesia. The results allow us to distinguish which regency is relatively efficient and inefficient. If the waste management in one regency is efficient according to the DEA result, case studies of this research could say otherwise about its agricultural waste. Regency is used as decision-making unit (DMU), which is a unit under evaluation in DEA. Input variables contributing to the amount of waste and output variables reflecting the regency's effort in managing waste are considered: the input variables are Waste Generation Potential, Waste Bank Unit, and Waste Bank Center, and an output variable is Treated Waste. Waste Bank is a facility designed to manage waste with the 3R principles. Treated Waste is a measure of the sum of handled and reduced waste at the officially recorded waste facilities. DEA is performed using MaxDEA 8 Basic, with radial and Variable Return to Scale model, followed by the input-oriented model since it is harder to control the output. This study encompasses 204 regencies/DMUs out of 416 regencies across Indonesia, due to the data availability.

2.3 Selection process of study areas

As 204 regencies from DEA calculation are still related only to general waste, agricultural area size (ha) and the number of agricultural households per population (%) were chosen as the agriculture-related variables to select the study areas. Gross Regional Product (GRP) and Digital Literacy Index (DLI) as social variables are also accounted as external factors that might influence the efficiency scores, thereby facilitating the selection process of study areas. Additionally, the geographical distribution of efficiency scores is also considered. Unique combinations of efficiency scores, two agricultural-related variables, and two social variables are examined, ensuring that no other regencies shared the same combinations. As a result, seven regencies are selected, namely Southeast Minahasa, Southeast Maluku, Central Aceh, Nganjuk, Donggala, Musi Rawas, and Bondowoso Regency.

Regency to subdistrict selection is further conducted, and the subdistricts that serve as primary producers of the main agricultural commodities were selected. Then,

villages within the chosen subdistricts were finally selected by considering the presence of village-owned enterprises (BUMDes) because villages with BUMDes are presumed to be more approachable and likely to offer rich information due to their direct involvement and firsthand experiences. Finally, a total of sixteen villages were selected for the case study.

2.4 Questionnaire Survey at regency and village level

A questionnaire survey at the regency level was conducted to address the first research objective on examining the existing regulatory approaches of waste management and explore the potential. The local authorities at the seven regencies, specifically Regional Environmental Agency (DLHK) and the Community and Village Empowerment Department (DPMD) are targeted. This survey utilized open-ended questions and since the data obtained is mainly qualitative, thematic analysis has been applied to the transcripts.

Consequently, a questionnaire survey at the village level aims at investigating the second and third research objectives. The second objective is to capture the current condition of general and agricultural waste management and disclose the gap. The third objective focuses on identifying the factors that influence agricultural waste management. The Respondents comprised leaders, secretaries, treasurers, or members from BUMDes and the Farmer Group (Poktan). Descriptive statistics analysis is employed to provide a concise summary, as most of the collected data is quantitative.

Both regency and village level surveys are disseminated using Google Form.

3. RESULTS

Based on the regency level survey, a comparison is made between regencies with high and low-efficiency scores, focusing on the local governments' efforts in Regional Waste Management Policy and Strategy (Jakstrada). The responses shared one similar answer that Jakstrada's performance has not yet reached its target. The evidence of the four regencies with the high-efficiency scores demonstrates good implementation of waste management practices. However, although the overall implementation is good, numerous unresolved issues were reported as remained. On the other hand, the findings from the three regencies with the low-efficiency scores do not entirely portray poor waste management practices. There have been some initiatives to address waste issues. Although associations between regencies' efficiency scores and social variables (GRP and DLI) were observed, they do not appear to impact waste management practices directly. In summary, the efficiency scores and the survey outcomes do not perfectly correspond.

The village level survey helps this study conclude that the efficiency scores of general waste management only provide insights into the conditions at the regency level. It fails to capture the distinct situation at the village level, which can be significantly different. For instance, villages under the low-efficiency regencies are more likely to commit poor practices of waste sortation, collection, and transportation compared to the villages under the high-efficiency regencies; however, there is only one village difference on each category, and the other good waste sortation, collection, and transportation practices also happened in the villages under the low-efficiency regencies.

A deeper focus on agricultural waste was done within this survey and confirmed that most agricultural waste is generated from the post-harvest stage, followed by the production and processing stage. Additionally, rice plants are recognized as the most occurred agricultural waste. This study also revealed that open-air burning has emerged as the prevalent method for the locals to manage their agricultural waste. However, many respondents believed that there are no environmental issues directly linked to agricultural waste. This finding highlights the need for increased education and awareness campaigns to bridge the gap between the environmental consequences and the local communities' perceptions.

4. CONCLUSION

The five influential factors in village level agricultural waste management have been identified. People's role is the first one, as their awareness and active participation are necessary for the management practices to function well. Organizations such as BUMDes and Poktan are also essential in mobilizing individuals and fostering collective action. While it was revealed that they prioritized the socioeconomic aspect of the agricultural sector over waste management, there is room for improvement, as survey respondents expressed an eagerness for education and willingness to participate in agricultural waste management initiatives. Budgeting support at the local authority level also considerably impacts the provision of waste facilities and equitable distribution. Finally, sustainable waste facilities and innovation are needed along with collaboration and support from various stakeholders who share a common vision with local communities.

This study, conducted in three main islands of Indonesia, identified common issues that call for a unified solution. While the findings cannot be generalized to all rural areas in Indonesia, they reflect the agricultural waste management situation in the studied villages, shedding light on the overall scenario across Indonesia's rural areas.

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