Determination of Criteria and Sub-criteria in Urban Solid Waste Processing Technology

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Abstract. Solid waste is known as waste, which it recommends is often undesirable because it has no economic value. One of the factors that affect the amount of waste is the amount or population density. The high population has caused the amount of waste to be higher. The waste management system in the landfill (TPA) is open transportation, so that it can increase the amount of land needed every year. Therefore, in research, it is necessary to have a technology for municipal solid waste treatment with appropriate criteria and subcriteria. Determination of criteria and sub-criteria for urban solid waste processing technology using the Delphi method with 3 respondents. The results obtained are that the criteria consist of three aspects, namely economic aspects, environmental aspects, and technological aspects. It also consists of 12 subcriteria, namely, Equipment Costs, Material Costs, Maintenance Costs, Residual Quantity, Emis Rate, Impact of Odor, Operating Temperature, Performance, Product Quality, Duration of Process, Area, Easy Operation.

1. Introduction

Waste is produced from a production process both industrial and domestic (household). Solid waste is defined by the Organisation for Economic Co-operation and Development (OECD, 2003) as useless and often dangerous material that presents low liquid contents. It has become the subject of several studies and concern given its exponential growth in volume as a consequence of large urban agglomerations and manufacture production intensification in the capitalist system [1]. Sources of waste can including from households, markets, stalls, offices, public buildings, industry, and roads. Rapid development and population growth in urban areas has resulted in increasingly large and dense residential areas. Waste treatment and its management has become one of the most critical environmental issues of today. In many sectors, the treatment and disposal of waste contribute a large part of the production cost. Waste treatment will usually increase the production cost and lead to price differences between similar products that are and are not treated [2].

The high population growth rate is always directly proportional to the level of consumption and activity of the community, causing the amount of waste (solid waste) produced is also higher. The population growth affects the amount of waste generated. Increasing population in each region/city, the amount of waste produced by each household is increasing. Industrial activities ranging from raw materials to produce products will disrupt the lives of people around the factory. There are many alternative technologies available to process other industries, but problems that often occur are difficult to implement the most appropriate technology [3].
Many cities still use open dumping as a waste management system in the Final Disposal Site (TPA) so that land expansion needs to be done as the amount of waste increases. The negative impact that can be caused by a high volume of waste that is not managed properly is health problems, decreases the quality of the environment, decreases environmental aesthetics and hampers the country's development. Therefore, good waste management technology is needed.

Assessing and selecting the optimal technological alternatives in the industrial sector is a fundamental tool to improve and adapt the industrial processes, which encourages the incorporation of new technologies for minimising the environmental impacts of companies [4]. In selecting solid waste processing technology, there is a need for selection indicators, in the form of criteria and subcriteria used to choose the best technology. Developing assessment criteria and methods that provide sustainability measurement are a prerequisite for choosing the best alternative [5]. So, in this study, the indicators of the selection of municipal solid waste treatment technology were carried out.

The Delphi method is a systematic method of gathering opinions from a group of experts through a series of questionnaires, where there is a mechanism feedback through rounds / rounds of questions held while maintaining anonymity of respondents' responses (experts). The Delphi method is a structured communication technique, originally developed as an interactive forecasting method that depends on a number of experts [6].

The Delphi method was developed by the RAND Corporation during the 1950s and 60s, with key contributions by Dalkey and Helmer. It has a long background and tradition as a management decision tool. The key elements are: (a) anonymous responses by experts to multiple rounds of formal questionnaires; (b) an exercise incorporating iterative, controlled feedback with respect to the information provided at each round; and (c) statistical summary of the group's responses. Integrated approach using Delphi and the analytic hierarchical process (AHP) is proposed [7]. Evaluating the performance of the recycling programs under uncertainty. The Delphi method is used for identifying the appropriate evaluation criteria in order to adequately consider the interest of various stakeholders in the decision making process [8]. The approach was designed to minimize the influence of dominant individuals, group pressure, and irrelevant communication and to reduce (statistical) noise [9].

2. Methodology

The research was conducted in a City. The type of research conducted is descriptive research. This descriptive research is in the form of survey research, namely research conducted to obtain facts from existing symptoms by looking for factual information to get the truth. In this case, the instrument was used in the form of a questionnaire distributed to respondents. Respondents were taken using purposive sampling sampling technique. Filling out questionnaires is done with or without the help of surveyors depending on their needs. [10]

In this study, the selection of criteria and subcriteria in the municipal solid waste treatment technology was carried out. The method used is the Delphi method. Data collection techniques used with questionnaires. Technique sampling that used in this research is purposive sampling. The questionnaire was distributed to 3 respondents who understood and had knowledge of the technology of municipal solid waste treatment according to researchers.

The questionnaire used was a semi-open questionnaire. Data sources are divided into two, primary data and secondary data. Primary data is data obtained directly by the researcher with observation, in this case the primary data is the semi-open questionnaire results data. Secondary data is data obtained not from the results of direct observation by researchers. Secondary data in this study are criteria and subcriteria obtained from literature or book studies [11].

3. Result and Discussion

From the literature study there are 3 criteria and 12 sub-criteria for the selection of municipal solid waste treatment technology. The criteria dan subcriteria can be seen in Table 1.
Table 1. Criteria and subcriteria from literature

| Number | Criteria                  | Sub-Criteria                  |
|--------|---------------------------|-------------------------------|
| 1      | Economical Aspects        | 1. Equipment Costs            |
|        |                            | 2. Material Costs             |
|        |                            | 3. Maintenance Costs          |
| 2      | Environmental Aspects     | 1. Residual Quantity          |
|        |                            | 2. Emis Rate                  |
|        |                            | 3. Impact of Odor             |
| 3      | Technological Aspects     | 1. Operating Temperature      |
|        |                            | 2. Performance                |
|        |                            | 3. Product Quality            |
|        |                            | 4. Duration of Process        |
|        |                            | 5. Area                       |
|        |                            | 6. Easy Operation             |

Then these criteria and subcategories are arranged into a semi-open questionnaire and distributed to three respondents who are considered by the researcher to understand the technology of urban solid waste treatment.

From the results of questionnaires to three respondents, the following recapitulation was obtained in Table 2.

3.1. Criteria and Sub-criteria

Delphi is used to get the weight of each criterion, sub-criteria, and alternatives. The results of the weighted criterion, sub-criteria, and alternatives can be seen in Table 2.

Table 2. Recapitulation of the Open Questionnaire

| Number | Criteria dan Sub-Criteria | Total | Average |
|--------|---------------------------|-------|---------|
| 1      | Economical aspects        | 15    | 5       |
| 1.1    | Equipment costs           | 14    | 4,667   |
| 1.2    | Material costs            | 12    | 4       |
| 1.3    | Maintenance costs         | 15    | 5       |
| 2      | Environmental aspects     | 15    | 5       |
| 2.1    | Residual quantity         | 15    | 5       |
| 2.2    | Emis rate                 | 14    | 4,667   |
| 2.3    | Impact of odor            | 13    | 4,333   |
| 3      | Technological aspects     | 15    | 5       |
| 3.1    | Operating temperature     | 15    | 5       |
| 3.2    | Performance               | 12    | 4       |
| 3.3    | Product quality           | 14    | 4,667   |
| 3.4    | Duration of process       | 13    | 4,333   |
| 3.5    | Area                      | 12    | 4       |
| 3.6    | Easy operation            | 15    | 5       |
4. Conclusion
From the research that has been done, the criteria and subcriteria used in solid waste processing technology consists of 3 criteria and 12 subcriteria, which cover economic aspects, environmental aspects and technological aspects.

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