Decision Support Model for Selection Technologies in Processing of Palm Oil Industrial Liquid Waste

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Abstract. The palm oil industry continues to grow from year to year. Processing of the palm oil industry into crude palm oil (CPO) and palm kernel oil (PKO). The ratio of the amount of oil produced by both products is 30% of the raw material. This means that 70% is palm oil waste. The amount of palm oil waste will increase in line with the development of the palm oil industry. The amount of waste generated by the palm oil industry if it is not handled properly and effectively will contribute significantly to environmental damage. 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. The purpose of this research is to develop a database of waste processing technology, looking for qualitative and quantitative criteria to select technology and develop Decision Support System (DSS) that can help make decisions. The method used to achieve the objective of this research is to develop a questionnaire to identify waste processing technology and develop the questionnaire to find appropriate database technology. Methods of data analysis performed on the system by using Analytic Hierarchy Process (AHP) and to build the model by using the MySQL Software that can be used as a tool in the evaluation and selection of palm oil mill processing technology.

Keywords: technology liquid waste processing mills, Delphi method, Sustainability, AHP (analytic hierarchy process), Decision Support System (DSS), and software MySQL

1. Introduction

The palm oil industry continues to grow from year to year. The palm oil industry processes palm oil into Crude Palm Oil (CPO) and Palm Kernel Oil (PKO). The comparison of the coconut quantity produced by both products is only 30% of the raw material. This means that 70% is industrial waste. In the production process, palm oil will contribute significantly to the processing of palm oil mills at boiling stations and destruction stations. In addition to producing products, palm oil processing also produces various types of waste, one of which is liquid waste. The amount of palm oil mill effluent will increase as the palm oil mill grows. Oil palm fruit bunch processing (FFB) for palm oil production produces several types of waste. The oil extraction, cleaning and cleaning processes in the factory produce liquid waste or palm oil mill effluent (POME). In the extraction of palm oil, there are three main processes that produce POME, among others: sterilization process, crude palm oil clearance process, which is extortion, separating and clarifying the sterilization of empty fruit bunches. The palm oil mill produces 0.7-1 m³ of POME for every ton of freshly processed fruit bunches. The newly generated POME is generally hot (60⁰-80⁰C), acidic (pH 3.3-4.6), thick, brownish with solids, oils and fats, chemical oxygen demand (COD) and biological oxygen demand (BOD) tall one.
Palm mill waste is a colloidal suspension consisting of 95-96% water, 0.6-0.7% oil, a total 4-5% solid waste comprising suspended solids of 2-4% [1]. The palm oil mill effluent contains organic materials of BOD, COD, oils and fats, solid waste in varying amounts [2]. Organic materials found in wastewater cause environmental damage if waste processing technology is not available. The most common problem with choosing palm oil processing technology is that it is difficult to apply the most appropriate technology from a range of palm oil processing alternatives to a particular company. Factors such as capital costs, operating costs and maintenance and land use, are important considerations in the choice of oil waste processing technology.

Developing assessment criteria and methods that provide sustainability measurement are a prerequisite for choosing the best alternative, identifying palm oil industry’s processing technology requirements, informing the integrated design of alternative show manufacturers and the effects of social environmental monitoring. The diversity of criteria and the latest gauges in this rapidly expanding field demonstrates the importance of conceptual work and methodology in this area. Development and selection of criteria requires parameters relating to reliability, suitability, practicality and size limits. Many of the weak technologies developed by the technological options are difficult because there is no database and technology valuation method. Database development can facilitate the search and identification of waste processing technologies. The results of the database become inputs in searching for and choosing waste processing technology criteria.

1.1. Waste processing technology

1.1.1. Pond System
In general, the most popular method of processing and use of liquid waste is used by more than 85% of the palm oil industry. Pool systems typically encompass sand and trap oil traps, cooling ponds, ponds, anaerobic ponds, facultative ponds and aerobic ponds. Sand and oil are manually trapped at the beginning of the processing operation unit. In the cooling pool, raw POME is cooled lower than 35 °C before transferring to the next pool [3].

1.1.2. Composting
Other common systems are conventional anaerobic and aerobic systems (digestion and ventilation openings) [4]. In the anaerobic process of processing, the organic matter contained in the wastewater is converted by bacteria into dissolved organic matter. Then, dissolved organic matter undergoes the process of acetogenesis and fermentation so that biogas consists of methane and carbon dioxide [5].

1.1.3. RANUT
The RANUT method uses a bioreactor tank where the anaerobic process takes place. The RANUT technology was developed through an increase in the organic microbial population of organic substances found in liquid waste [5].

1.2. Sustainability
Generally the criteria used in decision making have been widely discussed in research and have been widely publicized primarily for sustainability assessment. In general, the literature review of good criteria is grouped into social, economic and environmental categories [6]. Application of indicators to measure the sustainability of the manufacturing process is very difficult. Most sustainability indicators are already available which are focused on national and regional development sustainability [7]. Therefore the indicator set has been published focus on continuous product processing. In setting criteria and indicators for sustainable production at the level of process / product the performance of the energy is not taken into account. [8] proposes measures of sustainability achievement in unit processing processes such as environmental, economic, technological and social development. Most decision support system frameworks use traditional economic indicators that are not sustainability measures [7].
1.3. Decision Support System (DSS)
The main purpose of the research Decision Support System (DSS) is to provide users with tools that improve the decision-making process, so that decisions are better [9]. In a decision-making process, companies will face difficulties with the existence of various alternative options in a stage of the process to be implemented. These conditions require companies to know and understand the problems faced, alternatives and criteria for measuring or comparing each alternative to find the best alternative to choose from. DSS is the most widely used in the field of enterprise management at the functional level [10]. Turban and Aronson (2001) in [12] define the DSS as a computer-based interactive system that can assist decision makers in using data and models to solve unstructured problems. While [11] define the DSS is an interactive, flexible, and adaptable computer-based information system, specifically developed to solve non-structured management problems to improve the effectiveness of human decision-making. With the flexible and interactive characteristics of the DSS, the system helps decision makers adopt a problem-oriented approach to solve the problem of selective processing technology of waste products effectively and efficiently. This is achieved by enabling decision makers:
(a) To express linguistic preferences and
(b) To examine the relationship between the evaluation criteria, the available alternatives and the results of the selection.

Many AHP-based decision support systems have dealt with the inaccuracy and ambiguity inherent in information by applying fuzzy logic [12]. A serious practical constraint on the PHA method is the inconsistent and unclear information problem in most of the MCDM [13]. The DSS framework is designed to assist decision makers to select the most appropriate waste processing technology in a manner appropriate to the user and enable decision makers to express their needs in a linguistic manner, and to fully explore the relationship between the criteria and waste processing technologies available in the selection process. Through interactive information exchange between decision makers and DSS, decision makers can adopt a problem-oriented approach in the problem-solving process. This problem-oriented approach is essential to effectively and efficiently solve the evaluation and selection of waste processing technologies.

The rational choice of manufacturing technology and equipment is a decisive factor for the design and overall performance of the manufacturing process [14]. Decision makers often face the problem of choosing alternatives. In establishing incompatible criteria requires additional technical assistance. Multi-criteria decision making is a useful tool in CMS for conflicting criteria [15]. One of the most commonly used methods is the AHP method [16]. Effective in dealing with inconsistencies [17], as well as with complex and unstructured decisions [19].

2. Method
The first phase of the study was to collect questionnaires through literature reviews derived from books, references, international journals, websites related to other palm oil industries, waste processing technologies, decision making and technology selection over the last period. Surveys were conducted to obtain the availability of palm oil mill processing technology. To obtain data on waste processing technology is done using interview techniques designed for guided interviews with members involved in the formulation of this system problem using the Delphi method. Created a literature review to find the right criteria for waste technology. Information on these criteria is obtained from published journals and from stakeholders, as well as from expert knowledge. The results are expected to include criteria and indicators for waste technology. Created a literature review to find criteria appropriate to waste processing technology.

Furthermore, it is designed the hierarchical structure of waste processing technology consisting of objectives, criteria, sub criteria, and alternatives with AHP methods, MySQL software (database) and PHP (scripting language) with user friendly user interface.

The flow diagram in Figure 1 describes the methodology to be applied in this study.
Figure 1. Flowchart of Research
3. Result and Discussion

3.1. Results of the hierarchical structure of Liquid Waste Processing Technology
The results of the questionnaire for waste processing technology aim to give users an idea of how to determine which technology will be selected for waste treatment. The result of this view is the available waste processing technology which can be used as the basis for further selection and evaluation.
In liquid waste processing technology, there are three types of liquid waste processing technology, namely:

3.1.1. Composting
Composting system is a liquid waste processing system with the utilization of liquid waste which is processed as empty stack that has been stacked and stacked in advance to produce fertilizer products.

3.1.2. Pond System
The pond system is a liquid waste processing system using several ponds that are useful for lowering quality values such as BOD, COD, and pH in liquid wastes from processing palm oil processing.

3.1.3. Ranut
Ranut is a liquid waste processing system that uses two reactors to reduce the value of waste in liquid waste and can utilize methane gas for biogas.
Figure 2. presents the hierarchy structure of the AHP hierarchy of liquid waste processing technology for the entire palm oil industry. Based on Figure 2 it can be seen that the objective is to select all palm oil mill processing technologies to be achieved.
Creation of hierarchy of management is a very important stage in the process of Analytic Hierarchy Process. At this stage each criteria and sub-criteria to be determined affect each other. Determining the relationship between the sub-criteria of influence is done through interviews with experts in the selection of waste treatment technology. The importance and dependency rating data is obtained from the survey results of squats / pairwise comparisons. The results of the overall responses from the list of questions are then formulated in the Paired Comparison Matrix. Each position in the matrix, the perspective on the left is compared with the perspective on the right value obtained from the questionnaire included in the provision. All results of the survey questionnaire recapitulation will be included in the form of Paired Comparison Matrix.

In application of Palm Oil Selling Technology, decision support systems use AHP algorithms to help determine better waste processing technology options based on criteria, sub criteria, and alternatives.

In the processing of data used in the MySQL database to store a list of data for each alternative option sub criteria. Then phpMyAdmin is used as MySQL MySQL database processing medium.

3.2. Software Design Decision Support System
The database management system is a blend of central savings, processing and data entry. This database management system has the capability to change the structure and content of data elements, ie phpMyAdmin program. This database provides the convenience of adding, editing, storing and deleting in order to exchange data that can be executed as desired by the user. The database view of waste processing technology can be presented in figure 3.

![Figure 3. Waste processing technology database](image)

Here are the results for each sub model of waste treatment technology selection.

- Display Process Algorithm.
  In this form, the user can see all the comparative values that have been entered in the previous two forms and see the best alternative of the input data. The process view of the algorithm can be presented in Figure 4.
Based on this decision, overall Consistency ratio value is less than 0.1, which means that all experts in completing this questionnaire are consistent. In this form, the user can see the comparison of each visually assisted weighted alternative with the graph. Selection results can be given in Figure 5.

**Figure 4. View Process Algorithm**

**Figure 5. Election Decision View**
The structure of the AHP hierarchy in selecting palm oil processing technology consists of four stages of optimum hierarchy structure of palm oil processing technology, i.e. objective elements, criteria, subcriteria and alternatives.

The valuation value of palm oil processing technology used in this research consists of three nominal values, namely economic point of view, environmental point of view, and technology point of view. The prospect develops into 13 sub values of cost, maintenance cost, human resources cost, operating cost, waste quality value, sludge, emission level, performance, maintenance, human resources, area, durability, and user-friendly.

4. Conclusion
This research suggests that 3 points are associated with palm oil waste processing technology:

- The database is made from data collected from the residual processing subdata of each type of palm oil industry waste. Database creation was created.
- A nominal value search for liquid waste technology is obtained, where parsecond searches use AHP (Analytical Hierarchy Process) questionnaires to help determine palm oil processing technology based on objective value, criteria, subcriteria and alternative value.
- Developing software can be created. In the design used in phpMyAdmin MySQL database software interface. Kes study has been realized.

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