Identification criteria and indicators of palm oil industrial liquid waste processing technology

Aulia Ishak¹, Amir Yazid Bin Ali²

¹Faculty of Engineering Universitas Sumatera Utara, Jl. Almamater Kampus USU Medan 20155
²School Mechanical Engineering Universiti Sains Malaysia, Malaysia
E-mail: aulia.ishak@gmail.com

Abstract. Every year the development of the palm oil industry continuously. Crude palm oil (CPO) and palm kernel oil (PKO) are processed in the palm oil industry. Comparison of the amount of oil produced with the product produced is 30% of the raw material, so that 70% of the processed oil will be solid or liquid waste. The development of the palm oil industry then result in an increase in the amount of waste that will be produced. The amount of waste that will be produced by the oil palm industry if not handled properly and effectively will result in a significant damage to the environment which is dangerous. Oil palm industry activities that are processed starting from raw materials to producing finished products will disrupt the environment of people around the plant because of the waste and engine noise that occurs. There are many alternative technologies available to process the palm oil industry, the problem is that it is difficult to determine the right technology. This study can explain the application of various criteria analysis (MCA) in assessing indicators and criteria for palm oil waste that occur both solid and liquid in the palm oil industry. These methods are used when participatory decision making will be carried out by experts representing various stakeholders and professionals in their fields using their opinions and analysis and expert opinions in assessing various criteria and indicators (C & I).

1. Introduction

The production of the palm oil industry in Indonesia grew rapidly from 27,782,004 tons in 2013 to reach 35,359,384 tons in 2017. As much as 6.22% every year the palm oil industry continues to grow and increase in Indonesia. Processed palm oil products are Crude Palm Oil (CPO) and Palm Kernel Oil (PKO). Comparison of the amount of coconut produced with oil yield is only 30% of the available raw material. So that the waste produced is 70%. The palm oil production process will have a significant influence on the processing of oil palm mills at boiling stations and extermination stations. In addition to producing palm oil products, palm oil processing also produces various types of waste, one of which is solid waste. The increasing oil palm industry will affect the amount of waste that continues to increase.
There are several types of waste from the processing of palm fruit bunches (FFB). The oil extraction, cleaning and cleaning process in the plant produces palm oil mill waste (POME). Processed palm oil has three main stages that produce POME, including: the sterilization stage, the phase of cleaning crude palm oil, namely extortion, separation and clarification of empty fruit bunch sterilization. Every ton of fruit that has just been processed will produce 0.7-1 m³ POME. The newly produced POME is generally hot with temperature (600-800°C), acid (pH 3.3-4.6), thick, brownish with solids, oil and fat, chemical oxygen requirements (COD) and high biological oxygen (BOD) requirements. colloidal suspension consisting of 95-96% water, 0.6-0.7% oil, a total of 4-5% solid waste consisting of suspended solids 2-4% [1]. Palm oil industry waste contains organic materials such as BOD, COD, solid waste, oil and fat in various quantities [2]. Inaccurate Selection of waste treatment technology can cause organic matter found in waste water to cause environmental damage. the difficulty of applying the most appropriate technology from various alternatives to process palm oil is the most common problem in processing palm oil. Indicators such as capital costs, costs of production and maintenance and use of land or land, are important comparative factors in choosing liquid or solid waste treatment technology.

Developing assessment criteria and methods that have sustainability measurements is a prerequisite for selecting the best option, identifying the processing requirements of the oil palm industry, informing the integrated design of producers of alternative performances and the impact of social environmental monitoring. The importance of indicative of conceptual and methodological work in this field has resulted in the emergence of a variety of criteria and the latest measurement tools in determining the best alternative. Innovation and selection of criteria requires parameters related to suitability, reliability, practicality and size limits. Already a lot of outdated technology developed by technology options is difficult because there is no database assessment method and the latest technology. Database development can be facilitated by search and identification of liquid and solid palm oil processing technology.

2. Method
Data collection is done by looking for questionnaires through a review of literature from books, references, international journals, websites related to other palm oil industries, waste processing technology, decision making and the selection of appropriate technology during the last period is the first stage of this method. The survey was conducted to obtain the availability of technology in the palm oil mill process. To obtain data about waste management technology is carried out by using interview techniques designed to interview guided with members involved in formulating this system problem using the Delphi method. Experts who participated in research in this field involved in the Delphi process were identified in personal knowledge and literature review. To find the right criteria and quality for palm oil waste technology, this journal uses literature studies. Information about these criteria is obtained from published literature and from stakeholders, as well as from expert knowledge. The expected results include the criteria and factors for oil palm waste treatment technology. To find the right criteria for waste treatment technology, a literature review study was used. The research method can be seen in Figure 1.

3. Result and Discussion
3.1. Delphi Results
Below is a table showing the percentage of answers on the questionnaire being seen in five experts who are proficient in their respective fields. The Delphi Result can be seen in Table I
3.2. Results of Liquid Waste Processing Technology
Selection criteria and subcriteria are conducted by interviewing experts in the criteria and sub criteria for wastewater treatment technology which are considered to have an effect on alternative liquid processing technology. A summary of interviews with sub-criteria for selection and criteria for the technology for processing liquid material assessments can be shown in Table 2.
Determine Issues to be studied:
- Determining residual types based on criteria
- Determining residual criteria, if there are subcriteria and alternative alternatives

Make the Questionnaire in accordance with the defined criteria

Conducted a survey on the Palm Oil Industry

The data to be processed

Figure 1. Research Methodology
| Questionnaire                                                                 | Percentage | Agreed |
|------------------------------------------------------------------------------|------------|--------|
| There is the right technology                                                | 7.53       | 5      |
| Eco-friendly products                                                         | 6.27       | 5      |
| Pollution levels are low                                                      | 6.27       | 5      |
| The maintenance of nature around life                                        | 6.27       | 5      |
| Higher profit                                                                | 6.02       | 4      |
| Security reassignment                                                         | 6.02       | 4      |
| Arrange clear rules or regulations                                            | 6.02       | 4      |
| Can provide input to be used for palm oil industry                            | 5.02       | 5      |
| There is no social conflict                                                   | 5.02       | 4      |
| Enough physical infrastructure                                                | 5.02       | 4      |
| Access to information and data                                                | 5.02       | 4      |
| Public welfare                                                                | 4.52       | 4      |
| The use of original sources is around optimally and non-polluting             | 4.52       | 4      |
| Low waste management Cost                                                     | 4.52       | 3      |
| Facilities or infrastructure are adequate                                     | 4.52       | 3      |
| The existence of a network of academics with business and government         | 4.02       | 4      |
| Increase in foreign exchange                                                  | 3.39       | 3      |
| Trust or community support                                                    | 2.51       | 2      |
| Processing equipment tray                                                     | 2.51       | 2      |
| Clean water                                                                   | 2.51       | 2      |
| Support from donor agencies                                                   |            |        |
| **Total**                                                                    | **100.00** | **78** |
| Criteria | Sub-Criteria | Explanation |
|----------|--------------|-------------|
| Economy  | Installation cost | Costs incurred during the initial manufacturing of liquid waste processing technology. |
|          | Maintenance cost | Costs incurred during the maintenance of liquid waste processing technology. |
|          | Operation cost | Costs incurred for the operation of liquid waste processing technologies such as electricity costs, water costs, and others. |
|          | Human Resource Cost | Costs incurred for human resource costs in implementing liquid waste processing technology. |
| Environmental | Waste Quality Value | Chemical content of liquid waste processing results such as KOB, KOK, pH. |
|          | Sludge level | The substance of the sludge is still contained in the liquid waste processing result. |
|          | Release stage | The substance released from the liquid waste process into the air. |
| Technology | Performance | The final results of processing wastewater will affect the performance of the wastewater treatment technology. |
|          | Maintenance | Maintenance of the liquid waste processing technology used. |
|          | Human resources | Human resources are a major factor in carrying out wastewater treatment technology. |
|          | Area | Requires the land area needed to create wastewater processing technology. |
|          | Resistance | Technology in the process of making palm oil waste can last for a certain period of time so it does not harm the company. |
|          | User friendly | Operation and comfort in processing technology for processing palm oil wastewater. |

4. Conclusion
The criteria to be evaluated for the palm oil industry wastewater treatment technology used in this study consisted of three criteria namely the economic, environmental, and technological fields. This field developed into 13 sub-criteria for installation costs, exhaust gas emissions, human resource costs, operating costs, waste quality, sludge, waste maintenance costs, worker performance, equipment maintenance, human resources, wide area, durability, and user friendliness.

5. References
[1] [Anonim]. 2006. Pedoman Pengelolaan Limbah Kilang Kelapa Sawit. Subdit Pengelolaan Alam sekitar, Ditjen PPHP, Deptan. http://www.agribisnis.deptan.go.id. [15 January 2009].
[2] Chan, Y.J., Chong, M.F., Law, C.L., 2010. Biological Treatment of Anaerobically Digested Palm Oil Mill Effluent (POME) using a Lab-scale Sequencing Batch Reactor (SBR). (J. Environ. Manag). 9, 1738-1746
[3] IChemE - Institution of Chemical Engineers. 2002. Sustainable Development Progress Metrics: Recommended for Use in the Process Industries. (Institution of Chemical Engineers, Warwickshire, UK).
[4] Joung, C.B., Carrell, J., Sarkar, P., Feng, S.C., 2013. Categorization of indicators for
sustainable manufacturing. (Ecol. Indic). 24, 148-157.

[5] Lattimore B, Smith CT, Titus BD, Stupak I, Egnell G. 2009. Environmental factors in woodfuel production: opportunities, risks, and criteria and indicators for sustainable practices. (Biomass & Bioenergy). 33:1321–42.

[6] Lohsomboon P, Palapleevalya P, Worathanakul P, Jirajjariyavech A, Liangsakul R. 2002. Competitiveness for Thai Industri through Environmental Management Benchmarking Case Study: Palm Oil Industry. (Thailand Environmental Institute).

[7] Parveen Fatemeh Rupani, Rajeev Pratap Singh, M. Hakimi Ibrahim and Norizan Esa. 2010. Review of Current Palm Oil Mill Effluent (POME) Treatment Methods: Vermicomposting as a Sustainable Practice. Accessed from https://www.idosi.org/wasj/WASJ10(10)/12.pdf

[8] S. Eom, S. Lee, E. Kim, C. Somarajan, 1998, A survey of decision support system applications, (1988–1994). (The Journal of the Operational Research Society) 49 (2), 109–120.

[9] Thanh, N.C., Muttamara, S., Lohani, B.N., 1980. Palm Oil Wastewater Treatment Study in Malaysia and Thailand. Final Report No.114. (International Development Research Centre, Canada)

[10] Turban, E., Aronson, J. E., Liang, T. P., and Sharda, R. 2007. Decision support and business intelligence systems (eighth ed.). (New Jersey: Prentice Hall).

[11] Wibowo, S., Deng, H. 2012. Intelligent decision support for effectively evaluating and selecting ships under uncertainty in marine transportation (Expert Syst. Appl). 39, 6911–6920.

[12] Wibowo, S., Deng, H. 2013. Consensus-based decision support for multicriteria group decision making. Comput. (Ind. Eng). 66, 625–633.

[13] Wu, T.Y., Mohammad, A.W., Md Jahim, J., Anuar, N. 2010. Pollution Control Technologies for the Treatment of Palm Oil Mill Effluent (POME) through End-of-Pipe Processes. (J. Environ. Manag). 91, 1467-1490.

[14] Wong, S.A. 1980. Ponding System for Palm Oil Effluent Treatment, Palm Oil Research Institute of Malaysia PORIM Malaysia. pp: 18-23