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Analytical Hierarchy Process (AHP) Application for Cement Industry in Indonesia

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ABSTRACT

The objective of this work is to analyze the cement industry which is one of the largest industrial greenhouse gas (GHG) producers in Indonesia. The cement industry produces GHG due to the process of combustion of raw materials, combustion of fuel and using electricity. The raw materials used are limestone and clay, and the processing process uses a dry process. The cement production process consists of three main stages, namely Raw Meal Extraction, Blending and Clinkerization and Grinding and Packing. Few of action need to be made to reduce the environmental impact produced, especially on GHG emissions. The method used to determine alternative programs that can be applied to reduce environmental impact is the Analytical Hierarchy Project (AHP) method. AHP method has the advantage of being able to facilitate the determination of alternative programs that have complex criteria, complicated structures and other determinants that are difficult to quantify. AHP method valuation calculation uses Expert Choice software version 11. Alternative programs that are the subject of this research are three, namely alternative fuel usage, clinker ratio reduction and increasing use of alternative raw material.

Keywords: Analytical Hierarchy Process, Cement Industry, Greenhouse Gas.

1. INTRODUCTION

The cement industry is one of the largest greenhouse gas (GHG) producers in Indonesia. Greenhouse Gas is a combination of gases that form a layer, thus holding the sun's heat entering the earth. Some of the gases included in Greenhouse Gases are carbon dioksida (CO_2), methan (CH_4), nitrogen dioxide (N_2O), perfluorocarbon (PFCS), hidrofluorokarbon (HFCS), sulfurheksafluorida (SF_6) dan uap air (H_2O) [1].

The government is targeting a reduction in GHG emissions to reach 2,75 jutan ton CO_2 pada tahun 2020.

One of the cement industries located in Tuban, East Java, Indonesia named PT. Solusi Bangun Indonesia (PT. SBI). The cement production process at PT. SBI uses the dry process method. The production process at PT. SBI is divided into 3 (three) main stages, namely raw material extraction, blending and clinkerization; grinding and packing. At each stage it produces impacts that can pollute the environment and disrupt human health, so different treatments need to be handled [2]. Some alternative efforts to reduce the environmental impact resulting from the cement industry process include alternative fuel usage, reduced clinker ratio, increased use of alternative raw materials, kiln combustion system improvements, optimize heat recovery [3], [4].

The method used to determine the alternative program that can be applied is the Analytical Hierarchy Process (AHP). The principle procedure of the AHP method is to simplify complex, complicated and unstructured problems using hierarchy for the analysis process. AHP method helps in calculations that cannot be quantitatively measured [5]. The AHP calculation method uses Expert Choice software version 11. The advantage of Expert Choice software is that it is easy to operate because it uses a simple interface pattern. Expert Choice calculates the results of comparisons between criteria, between alternative programs and between criteria and alternative

programs based on scale of interest. Selection of respondents based on the level of understanding of the problem and the objectives to be achieved in detail, so as to provide real value.

2. MATERIAL AND METHODS

This study uses data from PT. Solusi Bangun Indonesia with locations in Tuban Factory, East Java Province, Indonesia. The data used as material for analysis is 2018 data related to the production process, production results, environmental impacts produced and the financial report. Selection of alternative programs, determination of criteria and determination of the number of respondents based on the scope of the discussion of research, the level of understanding and professionalism as well as the objectives to be achieved. The selection of respondents uses a purposive sampling method where the researcher selects and determines the subject based on specific determinants. Expected output results are an alternative program that can be applied in the medium term at the Tuban Plant.

The respondents used in this study came from the Environmental and Quality Management System (EQS), Sustainable Development Specialists and experts in waste air pollution control. The steps in preparing the AHP method are as follows:

- Determine hierarchical arrangements for existing problems;
- Assessment of criteria and alternatives using a comparison scale;
- Determine priorities using pairwise comparisons;
- Analyze the level of consistency logically and accordingly.

Analytical Hierarchy Process (AHP) method analysis uses software Expert Choice version 11. The first step in Expert Choice is to determine the goal, which is to determine the best alternative to reduce the environmental impact of GWP. The following are the results of the assessment of the comparison of each criteria, to determine the most influential criteria. Next is to assess alternatives based on each criteria.

3. RESULT AND DISCUSSION

The purpose of hierarchy is to solve problems by describing the elements contained. Elements contained in the hierarchy are criteria and alternatives. The criteria used in this study are 3 (three), namely:

a. The cost of implementing technology includes the company's ability in terms of financing for investment in the form of tools, systems and management.
b. The efficiency of technology, including the ability of the application of technology to reduce environmental impacts
c. Easy and long-term technology, the selection of technology must be adapted to the conditions and capabilities of the company.

The following is an alternative program proposed to reduce Greenhouse Gases in the cement production process:

a. Alternative use of fuel in the cement production process

Alternative Fuel (AF) is one form of effort to support sustainable development programs. Utilization of waste and residues from other industries as fuel is a form of effort in reducing waste. One example of AF is Refuse Derived Fuel (RDF), biomass, and oil sludge. Source: (Mousavi, 2013); (Nugraha, 2017)

b. Decreasing Clinker Ratio on cement products

The clinker ratio in each type of cement varies. The type of PCC cement has a standard mixture of inorganic materials ranging from 6% - 35% (SNI 15-7064-2004). The addition of inorganic materials will reduce the use of clinker in cement products, so that it can reduce the GWP.

c. Increased use of Alternative Raw Material (ARM) in the cement production process

PT. SBI has used ARM for the cement production process, but its use is still relatively small at 0.5%. The types of ARM used are fly ash, bottom ash, and cooper slag. The increase in ARM will reduce the use of non-renewable natural resources.

Hierarchy in this study see in **Figure 1**.

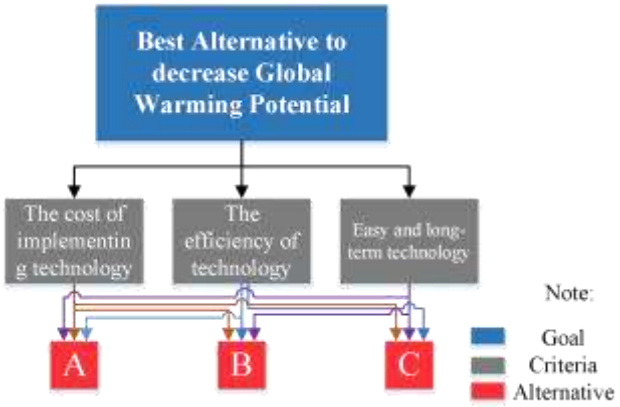

Figure 1 Hierarchy dalam AHP

Based on the results of analysis using Expert Choice version 11, the most influential criteria in selecting the best alternative are "easy and long-term

technology criteria" (can be seen in Figure 2). The percentage of easy and long-term technology criteria is 48.9%. The ease of application of technology and the duration of use that has a long term is the right choice to be applied. The factors behind the selection of these criteria include:

a. The balance sheet of PT. SBI is in an unstable condition
b. Limitations of professional workers in terms of knowledge about work for construction work.

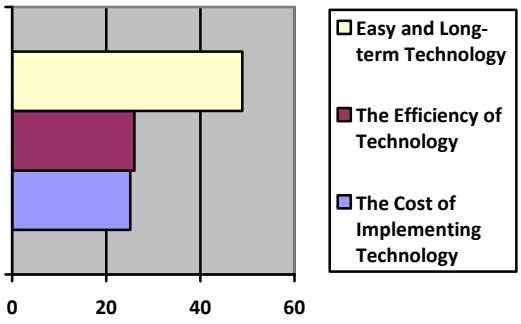

Figure 2 Criteria Comparation

In the best alternative selection section, which has the largest percentage is the use of Alternative Fuel (AF) (See Figure 3). The percentage of AF use is 44.9%. The factors behind the selection of alternative uses of AF include:

a. Alternative Fuel has relatively the same calorific value as the raw material of Industrial Diesel Oil.
b. The use of AF is in harmony with the principle of sustainable development because it uses waste as an energy source.
c. The cost requirement for investment in applying AF use is relatively small.

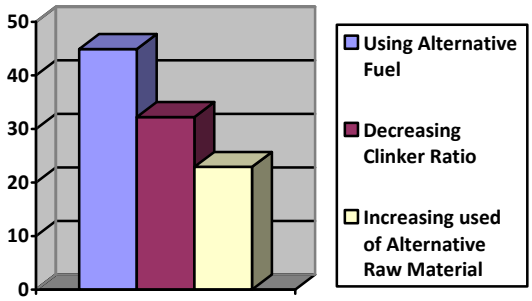

Figure 3 Alternative Comparation

4. CONCLUSION

In this study The best alternative to reduce the environmental impact produced by the cement production process was chosen using the AHP method. The most important criteria in determining the best alternative is easy and long-term technology. Based on the results of the best alternative weighting that is possible to be applied in the near future at PT. The Tuban SBI Factory is the use of Alternative Fuel.

5. ACKNOWLEDGEMENT

PT. Solusi Bangun Indonesia, Tuban Plant, Jawa Timur, Indonesia.

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