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Alternative organic fuel determination with Analytical Hierarchy Process (AHP)

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Abstract. Fuel is a main staple consumption of the industry, especially in Indonesia which is an industrial zone. Availability of fosil fuel is become decline day by day, according to that fenomena finding new fuel come from non fossil resources become important. This research is studied about finding potential fuel resources come from organic resources, such as cassava, cocoa, corn, pineapple, & potato. Factors that observed in this research namely availability of resources, social responsiveness, capability production, economy, technology, education, and policy. Data come from stakeholders that involved in produce, manage, and using the resources observed in the form of subjective preference. To anticipate the complexity of taking a decision in this research, analytical hierarchy process model used to formulate and proceed multi variable impact come from the factors that affected the determination new fuel resources to develop. The final result showed that an organic fuel resources determine by the biggest weight is policy factor. It means that people live around organic fuel resources must be supported first, by the government policy to operate the activity of transforming pineapple peel to be gasoline in the small scale industry.

1. Introduction

Fuel Stock pile will be decline in seventy years in the future [1], meanwhile the amount of vehicle will be doubled in the thirty years in the future. This phenomenon will cause energy crisis which resources come from fossil, so people have to find new potential resources with non-fossil basis to produce fuel. Some researcher has conducted observation to formulate, resources to produce fuel from vegetables and fruit, namely cassava, cocoa, paddy, palm, coconut, ricin's, wheat, potato, sweet potato, pineapple, and corn [2-4]. The research focus on waste that produce from utilization that resources, which transformed to variety of fuel such as diesel fuel oil (solar) or gasoline. This research will be focus on the fuel resources which produce gasoline, which able to produce by small scale society in the village, in order to enhance their economic life.

The requirement of fuel in Indonesia cases is about seventy-five million kiloliters in 2018, besides having the rate of consumption about 1,74% per year meanwhile crude oil production decline about 4,07% and the stock pile is only serve to explore more or less fifty years [5,6]. Fortunately, Indonesia is an agricultural country which abundant with vegetable and fruits, so it can be utilize to produce fuel. Fuel utilization in Indonesia dominated by gasoline about fifty-one million kiloliters per year or 68% consumption of fuel absorb by vehicle [5]. This condition needs to handle in near time, with producing easy gasoline in small scale by the people, to fulfill the supply in Indonesia.

In this research we are looking for five best gasoline fuel resources commodity, namely cassava, corn, potato, cocoa, and pineapple [7]. This choice is base on land availability and production consistency along the years. Cassava commodity is one of staple food that popular in Indonesia, land area for agriculture reaches 1.1 million hectares with production reaching twenty-five million tons per year [8]. Corn is one of the favorite foods in Indonesia, which has an area of 5.73 hectares, with production reaching 30.56 million tons [9]. Potatoes are a prominent agricultural commodity in Indonesia with an area of 66 thousand hectares and agricultural production close to 1.1 million tons [10]. Cacao is a crop that has become a leading export commodity as a raw material for making chocolate, in Indonesia the area of cocoa reaches 1.94 million hectares with a production of 817,322 tons per year [11]. Final commodity braved in this research is a tropical fruit which called pineapple that thrives in Indonesia with an area of 3.68 million hectares and annual production of 2.69 million tons [12].

The potential raw material for gasoline in this study will be assessed by several factors, which consist of social awareness [13], production capability [14], availability of raw material [15], technological [16], economic [17], educational [18], and policy concerns [19]. social awareness in this research is a form of responsibility from the community to protect the environment, and activities to utilize waste [13,20] are transformed into something useful. The technology in this research is intended that the community has the ability to operate and maintain technology [14,21] to convert waste into bioethanol, and use it to meet their daily needs. The technology in this study not only relates to devices for converting waste into bioethanol, but also with regard to health and safety [14] when operating a device. Economic factors are specific to efforts to increase income, and improve the lives of people [17,20] living around plantations from raw materials to fuel. The policy in this research is emphasized on the government's efforts to support [22] the development of renewable energy, especially those related to bioethanol as a substitute for gasoline. Regard to the description of the supply of gasoline fuel and its raw material alternatives, the purpose of this study is to determine the raw materials among cassava, corn, potatoes, cocoa, and pineapple that are suitable as raw materials for bioethanol, as substitutes for gasoline fuel.

2. Methods

The effort to determine which commodities are suitable to be used as fuels is carried out by providing an assessment, in the form of the weight of preferences of respondents who have an interest or need for the development of organic-based energy. The respondents in this study were forty people who live around the agricultural land. The assessment was obtained by giving questions derived from influential factors, on the selection of gasoline fuel commodities based on organic materials, namely: availability of raw materials, community responsibilities, economic conditions, mastery of technology, education, the ability to produce sustainability and the government in the form of policies that support the development of bioethanol in the community.

In this study, five agricultural commodities, in the form of three foods and two fruits, namely: cassava, corn, potatoes, cocoa, and pineapple will be assessed for eligibility. The appropriateness of the assessment is based on the preferences of respondents who give statements on the availability of raw materials, economy, technology, education, community responsibility, production capabilities and policies. Paying attention to the phenomenon of the relationship between commodities and valuation preferences, it is a multiple criteria decision making (MCDM) relationship, where each commodity is valued by seven preferences, so that decision making is complicated subjectively.

Noting the difficulties in taking decisions, then in this study used an approach model called the analytical hierarchy process (AHP), which has the characteristics of being able to provide an assessment in the form of sleepy weight, a complicated problem subjective. In this study the assessment was assisted by Expert Choice software version 11.0, in order to avoid errors in mathematical calculations. Several studies relating to the use of the AHP model, which are applied to determine new fuels, with basic ingredients of agricultural commodities including: determination and selection of fuels from corn-based materials [23] which are converted into ethanol, as well as the selection of potential plants into biomass conducted by Cobologlu and Buyuktahtakin [18] and Garcia et al. [19], who conducted research on determining the location of agricultural storage warehouses. Other researchers are more focused on the determination and selection of agricultural land conducted by [20], which discusses the determination of the sustainability of agricultural land, while Cobologlu and Buyuktahtakin discusses the selection of agricultural land with a boundary environment that is often uncertain (fuzzy environment) [18]. Romeijn et al. [22] and Kahraman et al. [24] discuss research related to the selection of agricultural land affected by climate changes.

Research on the selection of agricultural land was carried out by Zarakayaci [14], which focused on factors that had a dominant influence on plants for sowing on a land, while Cobologlu and Buyuktahtakin [18] and Saediman [25] made observations to prioritize the availability of land for certain agricultural commodities. Subiyanto et al. conducted a study on factors that could support the sustainability of soybean cultivation on a land [13], which was strengthened by Barati et al. who proposed the key factor for choosing agricultural potential that must be carried out on a land [15]. Other research is more focused on the cocoa agribusiness system with an emphasis on the agribusiness sub-system [21], which needs to be supported by the selection of stakeholders who use agricultural commodities for biofuels [17] besides must be supported by the selection of renewable energy that is cheap and simple production [24], and evaluation of the use of fuels based on agricultural products [16].

This research is in line with several researchers, especially Quintero et al. [23], Garcia et al. [19], Barati et al. [15], Harli et al. [21], Turcksin et al. [17] and Kahraman et al. [24], especially in the selection Corn commodity, while soybean was not observed in this study, focused more on food and fruit outside of soybean, namely: Potatoes, cassava, cocoa, and pineapple. while for factors that influence the determination of commodity priorities to produce bioethanol, research is in line with Barati et al. [15] for government policy, and [13] for community economic development, besides research is also in line with research Yalew et al. [20] and Cobuloglu and Buyuktahtakin [26] for factors of social care and education. Research is also in line with Zarakayaci [14] and Turcksin et al. [17] for technology and production capabilities, and in line with Kahraman et al. [24] and Tsita and Pilavachi [16] for the availability of raw materials and education.

The stages of the study are divided into three stages, which are explained into the following descriptions:

Stage 1

Disseminating data on respondents who are stakeholders of cassava, corn, potatoes, cocoa, and pineapple. forty respondents consisting of people who live around agricultural land, business people and the government.

Stage 2

Build a diagram of the priority hierarchy structure for commodity of bioethanol raw material, as material for processing data using expert choice version 11.0.

Stage 3

Execute stakeholders' preferences on the priority hierarchy diagram for ethanol raw material commodities. so we get priority weights, for each commodity being valued.

Stage 4

Discuss the results of data testing, to see other potential commodities

Stage 5

Draw conclusions regarding commodities worth producing as gasoline substitutes

3. Result and discussion

The first step in this research is to collect data from 40 respondents. In this study overall data is not displayed, but the summary will be presented in step three, at the time of execution with the AHP model. The second step is the formation of a hierarchy diagram from the research model to determine the priority of commodities that are suitable for bioethanol raw material. Figure 1 shows the relationship of each commodity to the factors that influence commodity selection.

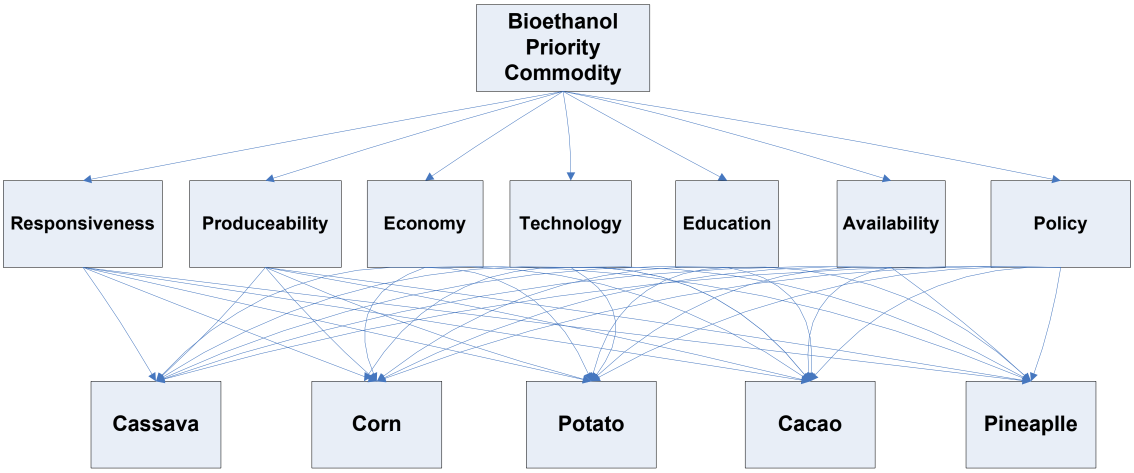

Figure 1. Hierarchy diagram.

After obtaining a hierarchy diagram, the next step is to enter data as shown in figure 2 and figure 3, produced from Expert Choice software version 11.0.

Compare the relative importance with respect to: Goal: Location A Prority Industry

	Responsiveness	Produceability	Economy	Technology	Education	Availability	Policy
Responsiveness		1,0	7,0	3,0	2,0	3,0	2,0
Produceability			7,0	3,0	4,0	3,0	2,0
Economy				2,0	2,0	2,0	7,0
Technology					2,0	2,0	7,0
Education						3,0	5,0
Availability							8,0
Policy	Incon: 0,06						

Figure 2. Relative importance data for responsiveness vs produceability**.**

Compare the relative preference with respect to: Responsiveness

	Corn	Cassava	Pineapple	Cacao	Potato
Corn		2,0	2,0	3,0	7,0
Cassava			2,0	2,0	4,0
Pineapple				5,0	6,0
Cacao					2,0
Potato	Incon: 0,02				

Figure 3. Preference comparison of commodities for responsiveness factor.

Figure 4 shows the results of the AHP, which shows that pineapple is the top priority, followed by cassava, corn, cocoa and potatoes. while the factors influencing the selection of pineapple are government policies (policy) which are preferred, to ensure business continuity, followed by social responsibility (responsiveness) and production capability (produceability). While the aspects of education, technology, availability of raw materials, and the economy only get weighting around 3 to 7%, where economic factors get the lowest preference weights. This phenomenon shows that the substitution of gasoline by pineapple commodities, has not given promises to be able to increase the level of the people's economy.

Another phenomenon that needs attention is the high weight of the government policy of around 37.3%, this shows that to run a small-scale business regarding the production of bioethanol from pineapple skin material, the people living around pineapple plantations need regulatory support and protection from government. Other priorities for bioethanol can be produced from cassava (25.5%), corn (18.1%), cocoa (16.1%) and potatoes (10.1%). Potatoes are given the last priority because of the relatively small availability of land, and its consumptions are more on complementary food, unlike corn and cassava, while cocoa is used more for cocoa for export, as well as inadequate community knowledge in utilizing cocoa waste.

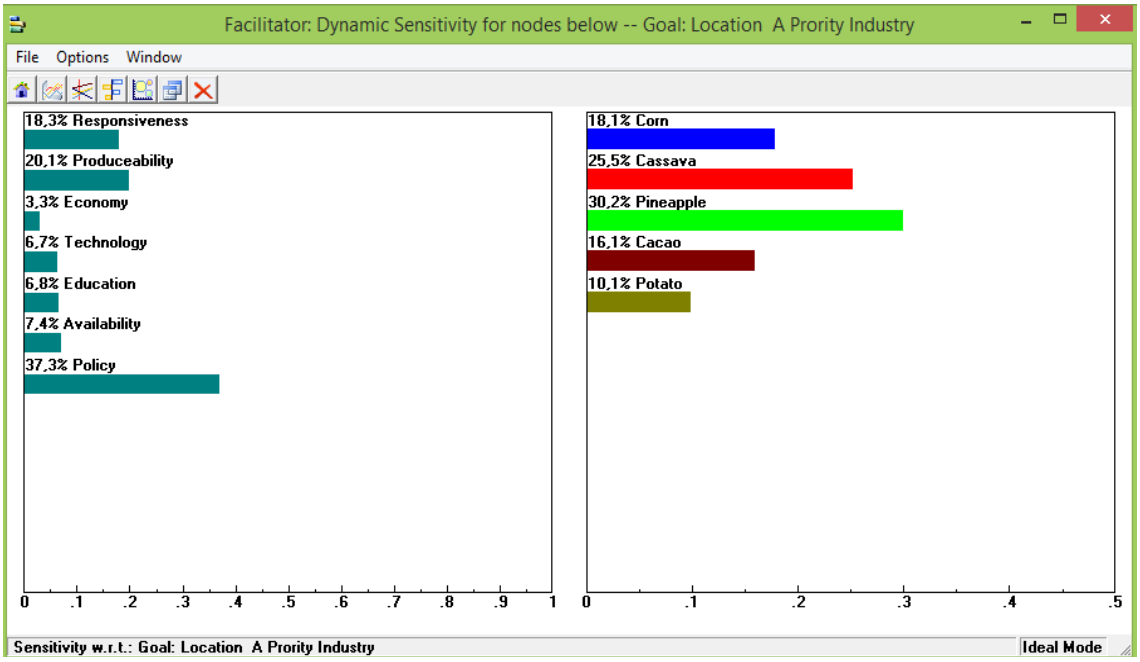

Figure 4. Result from AHP**.**

In this study, a simulation is carried out, if all factors have the same weight which shows that inter-factors support each other to form a unity between the community, entrepreneurs, and the government to utilize cassava, corn, potato, cocoa, and pineapple waste as raw material to produce, gasoline substitute fuel. the simulation results show that (Figure 5) the use of pineapple, is still a priority to be a strong candidate to be used to replace gasoline, with a weight value of 30.9%, while the position of casava (21.5%) is lower than corn (19.3 %), but the position of potatoes (17.8%) remains lower than cocoa (10.5%). The simulation results show that a balanced factor weight will increase the commodity of corn and cassava, to be an alternative raw material to replace gasoline fuel, this is due to the easy availability of resources, supported by a large supply volume, and the level of understanding to convert cassava and corn into gasoline, which is more easily understood by the public.

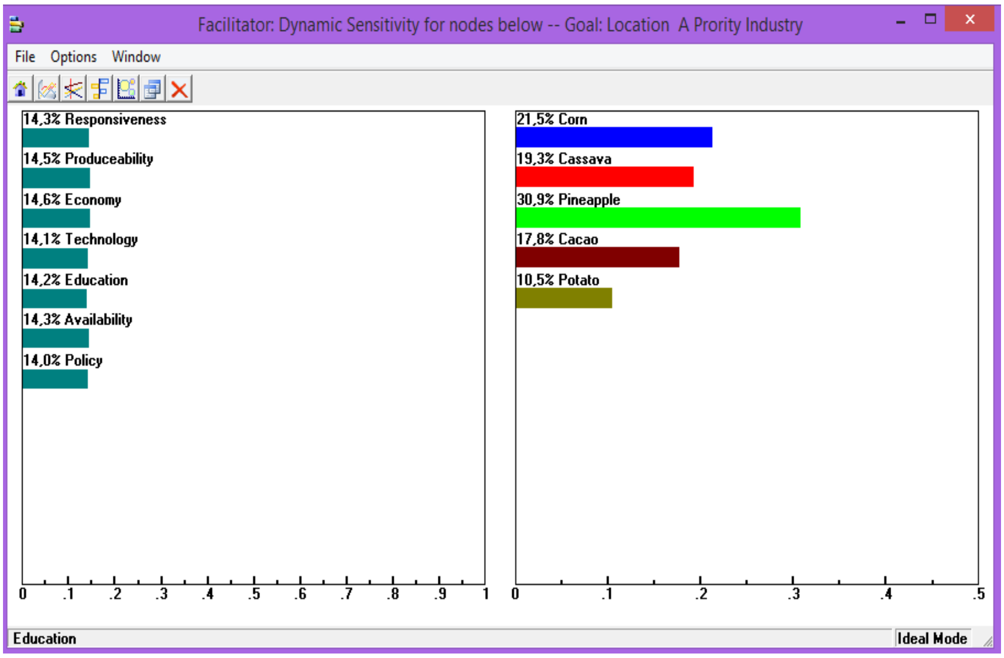

Figure 5. Simulation result.

4. Conclussion

Pineapple shell is a raw material substitute for gasoline fuel which is a priority, while cassava shells, corn, cocoa, and potatoes become companion priorities that can be utilized converted into bioethanol, as a compound that can substitute gasoline fuel. the choice of pineapple shells is a priority for conversion to bioethanol on a small scale of production, which can be cultivated by communities around pineapple plantations, influenced by government policies, which support the operation of the pineapple-based bioethanol industry, capital support and skills to operate and care for the bioethanol-producing industry, and instill awareness and responsibility, that pineapple shell waste is a treasure that can provide an economic level for the community.

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