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# DETERMINATION OF CASSAVA WASTE PROCESSING ALTERNATIVES AT UMKM UD. SUMBER MUTIARA USING AHP AND SAW METHODS

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## ABSTRACT

Cassava is one of the raw materials that are widely cultivated to be used as various processed foods. Cassava raw materials have a strategic role in improving the economy in Sampang District. One of the businesses that process cassava raw materials is UD Sumber Mutiara. The large scale of production is one of the factors for uncontrolled production waste, causing various problems. This waste problem can be overcome by further processing the waste generated in each production. The purpose of this study is to determine the general description of the company, especially the waste generated in each production, determine the best alternative from several alternatives to be applied in processing cassava skin waste, and determine the process of processing cassava waste based on the selected alternative. The method used in analyzing is using the Analytical Hierarchy Process (AHP) method and the Simple Additive Weighting (SAW) method as an advanced method. The results of this study are based on the calculation of the AHP method obtained the weight value of each criterion, namely the product criteria of 0.291, price criteria of 0.051, process criteria of 0.330, and engineering criteria of 0.328. The results of the calculation of the weight value are used in further calculations using the SAW method to obtain the best alternative rating value. The selected alternative is processed cassava skin chips with an alternative value of 0.836. The aspects that need to be considered in processing cassava waste consist of 4 aspects, namely, product quality, production costs, production time, and energy efficiency.

**Keywords**: Alternative, Waste, Processing, Cassava

## 1. INTRODUCTION

### 1. 1 Background

Micro, Small and Medium Enterprises (MSMEs) is one of the businesses with the ability to produce various new product processing innovations owned by individuals or business entities that have met the criteria as micro businesses. The formation of MSMEs is able to help the problem of the fall of the economy in Indonesia. According to Ananda and Susilowati (2017) in 1998 the large-scale company sector experienced stagnation and even stopped its activities, but MSMEs were able to survive and become economic restorers in the midst of the downturn due to the monetary crisis in various economic sectors. One of the supporting factors for the continuation of MSMEs is the existence of sufficient natural resources, so that the products produced by entrepreneurs can be fulfilled and can also develop their businesses (Hartono and Hartomo, 2016).

UD Sumber Mutiara is one of the MSMEs that processes various processed agricultural raw materials such as processed cassava, taro, purple sweet potatoes and other processed agricultural products. One of the typical preparations from this MSME is processed cassava chips. The production of processed cassava is certainly not free from waste products or what is often referred to as waste. The weekly production of processed cassava chips at Sumber Mutiara is approximately 60 kg per week with a total solid waste of 10% in the form of cassava skin from the amount of raw material. Details of the amount of waste generated every time production at UD Sumber Mutiara can be seen in Table 1.1.

**Table 1.1.** Amount of Solid Waste and Liquid Waste of Cassava Processed Production UD Sumber Mutiara.

| **Minggu Ke-** | **Jumlah Produksi (Kg)** | **Limbah Padat (Kg)** |
|---|---|---|
| 1 | 57 | 5,7 |
| 2 | 60 | 6 |
| 3 | 65 | 6,5 |
| 4 | 70 | 7 |
| 5 | 75 | 7,5 |
| 6 | 64 | 6,4 |
| 7 | 50 | 5 |
| **Rata-Rata** | 63 | 6,3 |

Source: UD. Sumber Mutiara, 2023

Table 1.2 shows details of the amount of solid waste generated by UD Sumber Mutiara in one production of cassava chips. Solid waste in the form of cassava skin is still not optimally utilized, but only discarded. This can cause pollution and foul odors caused by the waste itself. The resulting cassava peel waste needs further processing so that it does not rot, if left unchecked this waste will quickly rot by microorganisms produced from the cassava peel waste itself. This problem needs to be carried out an innovation related to the processing of cassava waste, so that it can maximize production results in terms of quality or quantity.

The processing of cassava peel waste at UD Sumber Mutiara MSMEs can provide feedback, where this processing applies the concept of zero waste. This concept aims that in every production UD Sumber Mutiara does not leave waste but utilizes the waste until it is not left. Therefore, researchers determined the best alternative related to processed products produced from cassava waste. The processed products from cassava skin that will be analyzed include processed cassava skin into chips, processed cassava skin into flour, processed cassava chips into compost fertilizer, and processed cassava chips into animal feed. The stages of analysis related to determining alternatives in processing cassava skin waste use 2 methods in their application, namely the Analytical Hierarchy Process (AHP) method and the Simple Additive Weighting (SAW) method.

## 1. 2 Problem Formulation

Based on this background, the problem formulations contained in this research are as follows:

1. What is the general description of the company, production process, and waste generated?
2. Which alternative has the best value for further processing?

## 1.3 Benefits of Research

Based on the formulation of the problem, the objectives to be achieved in this research are as follows:

1. Knowing the general description of the company, the production process, and the waste produced.
2. Determining the best alternative from several alternatives from processed cassava waste derivative products..

### 1.4 Research Benefits

The benefits obtained from this research are:

1. For Research

For researchers, this research is to obtain additional information about the analysis of the best decision-making alternatives in processing cassava waste derivative products from cassava production waste at UMKM UD Sumber Mutiara by applying the Analytical Hierarchy Process (AHP) method and the Simple Additive Weighting (SAW) method in decision making.

**2. For the Company**

The company can find out how efficient waste treatment is in every production process and provide an overview to the company about the concept of zero waste in waste treatment.

**3. For Academics**

It is hoped that this research can be a reference for other researchers in conducting similar research.

## 2. RESEARCH METHODOLOGY

### 2.1 Cassava Waste Processing

Cassava peel waste, which is often considered useless waste by the community because it causes unpleasant odors and can cause pollution, can actually be reprocessed and has a fairly high economic value. Cassava waste processing is a form of processing obtained from cassava waste which is generally made from cassava skin. There are various derivative products from cassava skin, one of which is chips from cassava skin. Although cassava skin contains cyanide (HCN), with good and correct processing, the products derived from cassava skin can be useful for living things.

Based on the journal references used, there are 4 alternatives selected in determining the derivative products of cassava peel waste. These alternatives consist of chips, flour, compost, and animal feed. The details of the stages of making cassava peel waste derivative products are as follows:

**1. Cassava Skin Chips**

Based on research conducted by (Rohimah and Tuti Kurnia, 2021) the implementation of community service activities gave rise to the idea of developing small and medium enterprises by utilizing cassava skin waste to make chips with attractive packaging in improving the economy of the people of Mekarjaya Village. The stages of making cassava skin chips are carried out in several stages such as boiling, washing, cutting, frying, processing and packaging. The details of the stages of making cassava skin chips.

**2. Cassava Peel Flour**

Research conducted by (Sari and Eka, 2018) found new innovations related to processed cassava peel waste, namely to be used as raw material in the form of flour in steamed sponge cake processing. The utilization of cassava peel into raw materials in making steamed sponge cake aims to utilize waste from cassava and increase the nutritional value of crude fiber in the product. The stages of making flour raw materials from cassava skin.

**3. Cassava Peel Compost Fertilizer**

Research conducted by (Yuhanna et al., 2021) waste from processed cassava production can be used as a soil fertilizer which is used as compost. The processing of cassava peel waste into compost aims to replace the use of expensive chemical fertilizers which cause reduced soil fertility when used excessively. The stages of making cassava peel waste to be used as compost fertilizer.

**4. Cassava Peel Fermented Animal Feed**

The same research by (Yuhanna et al., 2021) waste from processed cassava production can be used as livestock growth and development in the form of fermented animal feed. Processing waste into animal feed aims to develop ruminants and improve their reproductive processes. The processing stages to be used as fermented animal feed.

## 2.2 Analytical Hierarchy Process Method

According to Thomas L. Saaty quoted in the journal Parida and Merina (2019) the Analytical Hierarchy Process (AHP) method is a form of framework used in effective decision making on complex problems by simplifying and breaking the problem into its parts or variables used, thus forming a hierarchical arrangement that has a numerical value. This division of the problem can be used as a consideration to determine which variables have the highest priority and act to influence the outcome of the situation. This method can provide different answers to decision-making problems and rank alternative solutions. This method is designed to place issues into a hierarchy which will then be weighted (prioritized) based on the vision of the decision maker to make the right and best decision (Ramadhan et al., 2023).

In general, according to Latif and Wahyuning (2024) the stages that need to be followed in applying the Analytical Hierarchy Process (AHP) to solve a problem are as follows:

1. Identify the problem and formulate the desired solution (goal).
2. Create a decision hierarchy structure to enable specific and measurable analysis of complex aspects of the problem.
3. Assign priorities to each element in the problem at various levels of the hierarchy. This process generates a weighting of each element towards achieving the goal which involves a matrix of pairwise comparisons between all elements at the same level of the hierarchy.
4. Consistency checking of the comparisons between elements at each level of the hierarchy is done through a per-matrix evaluation of the comparisons as well as the entire hierarchy structure. The consistency of the comparison value between elements can be determined from the consistency ratio (CI/RC) value. If the consistency value is more than 10%, then the data analysis results need to be improved, but if the consistency value is less than 10%, the data analysis results are declared correct (Rosyiidi and Subagyo, 2021).

## 2.3 Expert Choice 11

Expert Choice is one of the Decision Support System (DSS) systems that helps in determining a decision. Expert choice is software that can help solve problems with AHP principles and support collaborative decisions that can make the determination of a decision more analytical, efficient, and justified (Putra and Diana, 2022). According to Latif and Wahyuning (2024) the stages in descriptive analysis for decision making through the AHP method by implementing the Expert Choice 11 application include:

1. Defining and preparing the hierarchical structure of the problem being studied, namely determining the best alternative from each existing criterion and sub-criteria.

2. Selection of criteria and alternative solutions and priority weights through the results of interview activities.
3. Implementing the results of interviews including goals to be addressed, criteria, alternative solutions, and the weight value of each element through the AHP method with the help of the Expert Choice 11 application.
4. Analyzing the calculation results from the Expert Choice 11 application by looking at the highest priority results of the tested criteria and alternative solutions as a result of decision making to solve the problem being studied.

### 2.4 Simple Additive Weighting Method

The Simple Additive Weighting (SAW) method is a method of weighted summation of ratings on each existing alternative. According to Fajar et al. (2023) Simple Additive Weighting (SAW) method is a method used in finding the optimal alternative from a number of alternatives using certain criteria guidelines. The application of this method requires a normalization process on the decision matrix (X) into a scale that can be compared with all existing alternative ratings. The stages of completion in the application of this method are as follows:

1. Determine what criteria will be used in the alternatives
2. Determine the type of criteria used. For criteria whose value is minimized, it is categorized as Cost, while for criteria that are maximized are categorized as Benefit.
3. Giving weight to each criterion that is calculated. This stage contains the calculation of the rating value, the assessment of each and the calculation of normalization. The normalization of the X decision matrix uses the rules of equation (1):

$$Rij=\begin{cases}\dfrac{X_{ij}}{\text{Max}\{X_{ij}\}}\\ \dfrac{\text{Min}\{X_{ij}\}}{X_{ij}}\end{cases} \dots\dots\dots\dots\dots (1)$$

4. Calculating the value for each alternative Vi. This calculation aims to get the result of the value of the recommended alternative decision. The determination of alternative decision values uses the rules of equation (2):

$$V_i = \sum_{j=1}^{n} W_{ij} r_{ij} \dots\dots\dots\dots\dots (2)$$

## 3. RESEARCH METHODS

### 3.1 Time and Place of Research

The method used in this research is the survey method in micro, small and medium enterprises (MSMEs), precisely in Sampang District. The selection of this research location was carried out purposively based on the consideration that the cassava chips agro-industry in Sampang District was still active in carrying out production. MSMEs that are used as research centers are located at UD Sumber Mutiara Cassava Agroindustry located on Jl. Mutiara No.66, Taman Arum, Desa Banyuanyar, Kecamatan Sampang, Kabupaten Sampang, Jawa Timur.

### 3.2 Respondent Determination Method

Determination of respondents was carried out using a purposive sampling technique, namely the selection was

carried out by determining specifically the respondents according to certain considerations based on the objectives of the study. Respondents selected as parties to interviews and filling out questionnaires are people who are considered experts and understand the existing problems. According to research conducted by (Rosyiidi & Subagyo, 2021) it is said that, interviews and questionnaire filling must be carried out by parties who have expertise and experience in accordance with the problems in this research field. Based on this, the researcher chose UD Sumber Mutiara as the respondent to obtain data in accordance with the objectives of the study. The number of respondents used in this study were three people including the owner / owner, financial manager and business manager.

### 3.3 Types and Data Collection

The types of data used in the study are as follows:

**1. Qualitative Data**

Qualitative is a type of data in the form of not numbers that can be calculated and measured, but rather a type of data that is generally in the form of a narrative. The qualitative data in this study are in the form of company history, organizational structure and production processes.

**2. Quantitative Data**

Quantitative data is a type of data in the form of numbers that can be mathematically calculated and measured. The characteristics of this type of data are that it has a definite scale, can be measured numerically and is not affected by subjective points of view. The quantitative data in this study are waste data, production data, and the results of questionnaire tabulation data.

The data collection stage of the research was carried out in the following ways:

**1. Primary Data**

Data primer merupakan data yang Primary data is data taken directly from the research subject by researchers either by using interview, observation and documentation methods. The data obtained was generated from interviews and questionnaires as instrumentation. Interviews and filling out questionnaires must be carried out with the MSMEs themselves as decision makers.

**2. Secondary Data**

Secondary data is data obtained from books, journals, and the internet. This type of data is data obtained from sources that have been collected by others before. This data relates to company history, company location, company organizational structure, products produced and all data related to the research.

### 3.4 Research Implementation Flow

The implementation of this research is carried out in a flow of 6 stages including, research licensing, location surveys, company data collection, determination of waste derivative products, discussion of analysis and product manufacturing. The flow of this research implementation can be seen in the flow chart listed in Figure 3.1.


**Figure 3.1** Flowchart of research implementation Efficiency Analysis of Cassava Waste Processing at UD Sumber Mutiara.

### 3.5 Data Analysis

This analysis is carried out using 2 methods, namely, using the Analytical Hierarchy Process (AHP) method and the Simple Additive Weighting (SAW) method. The results of this analysis can be used as decision making in the selection of alternatives to overcome the problem of cassava skin waste generated in each production at UD Sumber Mutiara. Based on the method used, the stages of the solution flow can be seen in Figure 3.2.

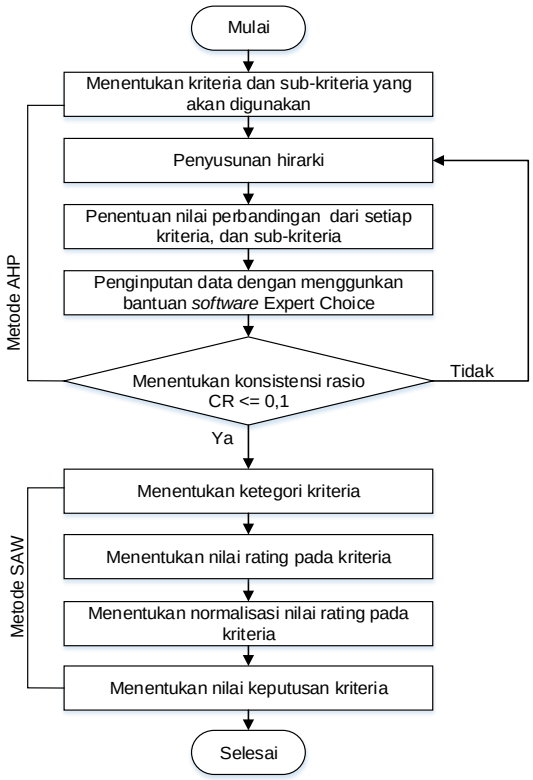


**Figure 3.2** Flowchart of the completion of the Analytical Hierarchy Process (AHP) method and the Simple Additive Weighting (SAW) method.

### 3.6 Framework of Thought

Based on the existing problems, there is waste from cassava production in the form of cassava peels that are not further processed. This problem can be solved by further processing the waste produced to be made into more useful derivative products. The framework based on this problem can be seen in Figure 3.3.

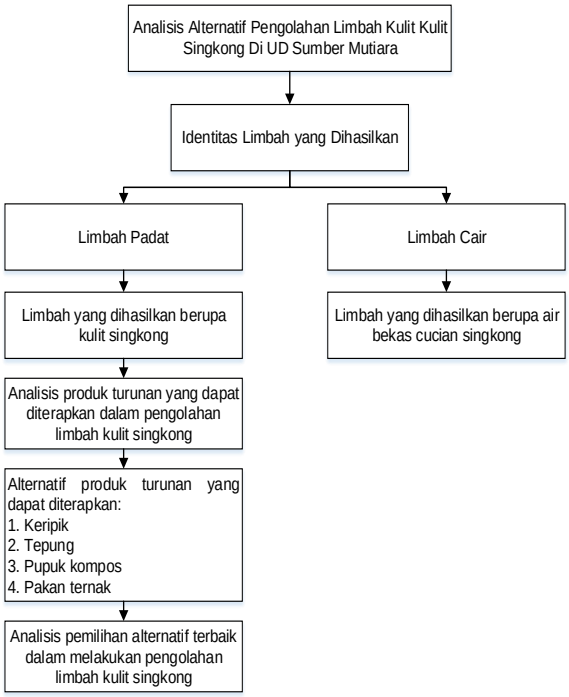


**Figure 3.3** Framework for analyzing alternative cassava peel waste processing UD Sumber Mutiara.

## 4. RESULTS AND DISCUSSION

### 4.1 Company Overview

#### 4.1.1 Company Profile


**Gambar 4.1** UD Sumber Mutiara produksi produk turunan agroindustri.

UD Sumber Mutiara is one of the entrepreneurs founded by Hj. Siti Fatimah in the form of MSMEs which has been established since 1977 until now. UD Sumber Mutiara produces many products derived from agricultural products such as cassava chips, fish crackers, pohong, and other agricultural derivative products. This business is located in Banyuanyar Village, Sampang. This UMKM is located at Jln. Mutiara No.66, Taman Arum, Desa Banyuanyar, Kec. Sampang, Kab. Sampang, Jawa Timur. One of the preparations that is often produced and is still in great demand until now is processed cassava. The processed cassava produced

at UD. Sumber Mutiara includes processed cassava chips, tette chips and anchovy cassava chips. The amount of production of processed cassava chips at UD Sumber Mutiara in one month is able to process 5 quintals or 500 kg of cassava raw material in 1 month of production which can produce a total of 1,250 packages with a weight of 400 g / package.

### 4.1.2 Organizational Structure

The organizational structure applied by the entrepreneurs at UD Sumber Mutiara, namely, with a straight line organizational structure in the form of top-down flow. As for the composition of the organizational structure of UD Sumber Mutiara at the top or the first part, there is a director/owner as the owner of UD Sumber Mutira and also as a planner in every decision making in the company. The second part of the organizational structure at UD Sumber Mutiara has 3 sections consisting of financial managers, business managers, and marketing managers. The organizational structure of UD Sumber Mutiara can be seen in Figure 4.2.

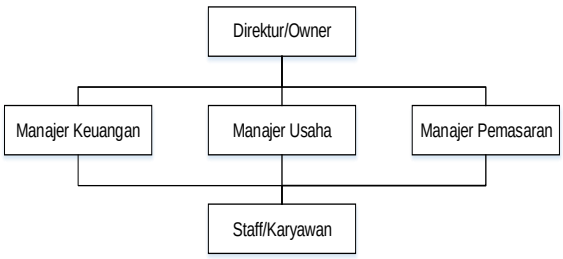


**Figure 4.2** Organizational structure of UD Sumber Mutiara.

### 4.1.3 Production Process

UD Sumber Mutiara sebagai pelaku pihak agro-industry that focuses on manufacturing in processing post-harvest raw materials into finished products by carrying out several stages of production. The stages of the production process include sorting, peeling, washing, slicing, soaking, drying, frying, draining, mixing seasonings, and packaging. Based on the description of the process stages of cassava chips production at UD Sumber Mutiara, an operation map is obtained which can be seen in Figure 4.3..

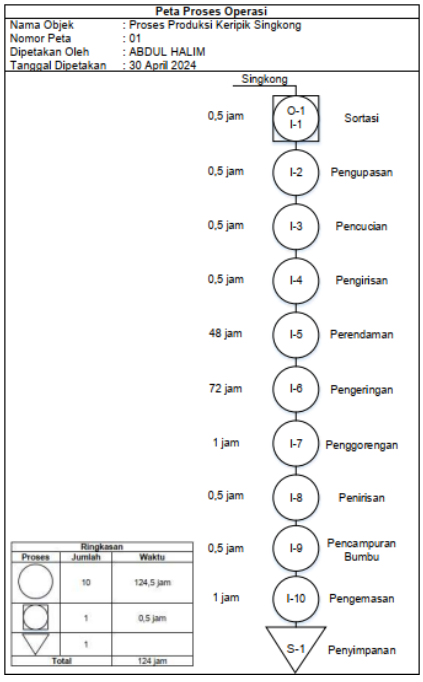


**Figure 4.3** Operation map of cassava chips production process ud source pearl.

## 4.2 Data Analysis Results and Discussion

### 4.2.1 Analytical Hierarchy Process (AHP)

### A. Determination of Criteria, Sub-criteria, and Alternatives

Determination of criteria and sub-criteria on the utilization of cassava peel waste is carried out by conducting interviews with UD Sumber Mutiara. Respondents are given the freedom to determine the criteria and sub-criteria for the utilization of cassava peel waste, in order to assist researchers in determining what criteria and sub-criteria are related to the alternatives used. Based on this explanation, the criteria and sub-criteria used in related problems regarding the utilization of cassava peel waste can be seen in Table 4.1.

**Table 4.1** Weight value on cassava waste utilization sub-criteria.

| No. | Kriteria | | Sub-kriteria |
|---|---|---|---|
| 1. | Produk (Product) | a. | Kualitas Produk |
| | | b. | Variasi Produk |
| 2. | Harga (Price) | a. | Biaya Produksi |
| | | b. | Harga Jual |
| 3. | Proses (Process) | a. | Waktu Produksi |
| | | b. | Peralatan Produksi |
| 4. | Teknis (Technical) | a. | Efisiensi Energi |
| | | b. | Kapasitas Produksi |

The determination of alternatives in this cassava peel waste processing problem is obtained from reference to previous research journals. The alternatives used in the processing of cassava peel waste consist of 4 alternative derivative products, namely, chips, flour, compost, and animal feed. The details of the alternatives used can be seen in Table 4.2.

**Table 4.2** Alternative cassava waste derivative products**.**

| No. | Produk Turunan Limbah Singkong |
|---|---|
| 1. | Keripik Kulit Singkong |
| 2. | Tepung Kulit Singkong |
| 3. | Pupuk Kompos Kulit Singkong |
| 4. | Pakan Ternak Fermentasi Kulit Singkong |

### B. Hierarchical Structure Compilation

The problem that has been identified is then carried out a hierarchical arrangement accompanied by 4 levels of elements. The first element is the Ultimate Goal to be applied in the problem, the second element is the criteria that affect the problem, the third element is the sub-criteria related to the criteria that have been determined and the fourth element is the alternatives used in the decision-making problem. The preparation of a hierarchical structure is used to make it easier to identify problems accompanied by the desired solution or solution. The hierarchical structure used in this study can be seen in Figure 4.4.

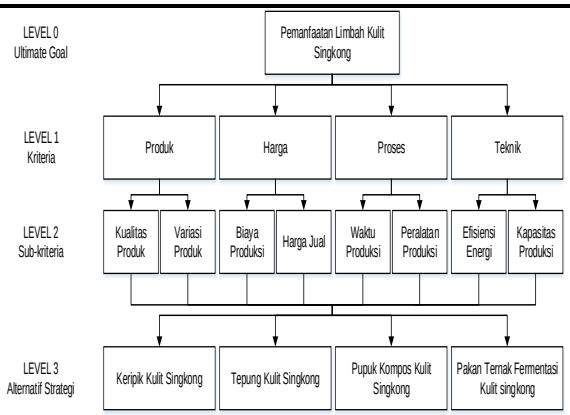


**Figure 4.4** Hierarchical structure of cassava peel waste utilization.

## C. Determination of Comparative Value of Criteria and Sub-criteria

Determination of the value of this comparison is obtained from the tabulation of questionnaire data. This comparison value is used to be inputted into the software that supports the calculation of the Analytical Hierarchy Process method, namely, using the help of Expret Choice software. The data inputted in this software is obtained from filling out a questionnaire filled out by the respondent, where the questionnaire is filled out by UD Sumber Mutiara. Respondents selected as parties to conduct interviews and fill out questionnaires are people who are considered experts and understand the problems that exist.

The results of filling out the questionnaire were obtained from three respondents or experts, namely Ach. Junaidi as owner, Retnowati as Finance Manager, and Moh. Iwan as Business Manager. The data input of the results of this questionnaire was carried out using Expert Choice 11 software, where the results of this software calculation consisted of the weight values of the criteria and sub-criteria. The output results of this calculation consist of two output results, namely, the value of each respondent and the combination value of each respondent. The details of the results of the calculation of the weight value using Expert Choice 11 software are as follows:

### 1. Ach. Junaidi

Based on the results of interviews using a questionnaire by Ach. Junaidi obtained data related to the comparison value between each element, where this data is used in determining the weighting value of each element. The results of the calculation through Expert Choice software obtained the weighting value of the criteria which can be seen in Table 4.3.

**Table 4.1** Ach. Junaidi cassava waste utilization criteria.

| Kriteria | | Bobot Kriteria |
|---|---|---|
| Produk | (C1) | 0,397 |
| Harga | (C2) | 0,045 |
| Proses | (C3) | 0,315 |
| Teknik | (C4) | 0,243 |

The results of calculations through Expert Choice software obtained sub-criteria weighting values which can be seen in Table 4.4.

**Table 4.4** Ach. Junaidi sub-criteria utilization of cassava waste.

| | Sub-kriteria | Nilai Bobot |
|---|---|---|
| a. | Kualitas Produk | 0,900 |
| b. | Variasi Produk | 0,100 |
| a. | Biaya Produksi | 0,833 |
| b. | Variasi Harga Jual | 0,167 |
| a. | Waktu Produksi | 0,875 |
| b. | Peralatan Produksi | 0,125 |
| a. | Efisiensi Produksi | 0,750 |
| b. | Kapasitas Produksi | 0,250 |

**2. Retnowati**

Based on the results of interviews using a questionnaire by Retnowati, data related to the comparison value between each element was obtained, where this data was used in determining the weighting value of each element. The results of the calculation through Expert Choice software obtained the weighting value of the criteria which can be seen in Table 4.5..

**Table 4.5** Retnowati weight value of cassava waste utilization criteria.

| Kriteria | | Bobot Kriteria |
|---|---|---|
| Produk | (C1) | 0,250 |
| Harga | (C2) | 0,054 |
| Proses | (C3) | 0,289 |
| Teknik | (C4) | 0,407 |

The results of calculations through Expert Choice software obtained sub-criteria weighting values which can be seen in Table 4.6.

**Table 4.6** Retnowati weight value of cassava waste utilization sub-criteria.

| | Sub-kriteria | Nilai Bobot |
|---|---|---|
| a. | Kualitas Produk | 0,875 0,125 |
| b. | Variasi Produk | |
| a. | Biaya Produksi | 0,833 |
| b. | Variasi Harga Jual | 0,167 |
| a. | Waktu Produksi | 0,875 |
| b. | Peralatan Produksi | 0,125 |
| a. | Efisiensi Produksi | 0,833 0,167 |
| b. | Kapasitas Produksi | |

**3. Moh. Iwan**

Based on the results of interviews using a questionnaire by Moh. Iwan, data related to the comparison value between each element was obtained, where this data was used in determining the weighting value of each element. The results of the calculation through the Expert Choice software obtained the weighting value of the criteria which can be seen in Table 4.7.

**Table 4.7** Weight value of Moh. Iwan cassava waste utilization criteria.

| Kriteria | | Bobot Kriteria |
|---|---|---|
| Produk | (C1) | 0,237 |
| Harga | (C2) | 0,048 |
| Proses | (C3) | 0,369 |
| Teknik | (C4) | 0,346 |

The results of calculations through Expert Choice software obtained the weighting value of sub-criteria which can be seen in Table 4.8.

**Table 4.8** Retnowati weight value of cassava waste utilization sub-criteria.

| Sub-kriteria | | Nilai Bobot |
|---|---|---|
| a. | Kualitas Produk | 0,900 |
| b. | Variasi Produk | 0,100 |
| a. | Biaya Produksi | 0,875 0,125 |
| b. | Variasi Harga Jual | |
| a. | Waktu Produksi | 0,800 |
| b. | Peralatan Produksi | 0,200 |
| a. | Efisiensi Produksi | 0,833 |
| b. | Kapasitas Produksi | 0,167 |

**4. Combined**

Combined is a feature found in Expert Choice 11 software, where this feature combines the results of the comparison value data for each respondent. The results of this calculation can also be said to be the result of the overall calculation of the results of the questionnaire tabulation of the comparison value. The results of the calculation through the Expert Choice software obtained the weighting value of the criteria which can be seen in Table 4.9.

**Table 4.9** Combined weight value of criteria and sub-criteria of cassava waste utilization.

| No. | Kriteria | Bobot |
|---|---|---|
| 1. | Produk (C1) | 0,291 |
| 2. | Harga (C2) | 0,051 |
| 3. | Proses (C3) | 0,330 |
| 4. | Teknik (C4) | 0,328 |
| **Total** | | 0,100 |

Based on the weight value of each criterion, the weighting value of each sub-criteria is also obtained which is used to determine the ranking value of existing alternatives. The weighting value of these sub-criteria can be seen in Table 4.10.

**Table 4.10** Combined weight value of cassava waste utilization sub-criteria.

| No. | Sub-Kriteria | Nilai Bobot |
|---|---|---|
| Sub-kriteria yang berkaitan dengan kriteria produk | | |
| 1. | Kualitas Produk | 0,892 |
| 2. | Variasi Produk | 0,108 |
| Sub-kriteria yang berkaitan dengan kriteria harga | | |
| 1. | Biaya Produksi | 0,848 |
| 2. | Harga Jual | 0,152 |
| Sub-kriteria yang berkaitan dengan kriteria proses | | |
| 1. | Waktu Produksi | 0,853 |
| 2. | Peralatan Produksi | 0,147 |
| Sub-kriteria yang berkaitan dengan kriteria teknik | | |
| 1. | Efisiensi Energi | 0,808 |
| 2. | Kapasitas Produksi | 0,192 |

## D. Determination of Comparative Value of Criteria and Sub-criteria

The determination of ratio consistency aims to determine whether the calculation results are consistent or inconsistent. The rule of ratio consistency is in accordance with L. Saaty's theory, namely if the ratio consistency value ≤ 0.1 then the calculation is declared consistent, whereas if the ratio consistency value > 0.1 then the calculation is declared inconsistent. The inconsistent ratio consistency value needs to be recalculated, starting from determining the comparison value to determining the ratio consistency stage. Based on the calculation results, the ratio consistency value of the overall weight value of each respondent can be seen in Table 4.11.

**Table 4.11** Priority weighting value and consistency value of criteria ratio.

| Responden | Kriteria | Prioritas Nilai Bobot | Konsisitensi Rasio |
|---|---|---|---|
| Ach. Junaidi | Produk | 0,397 | 0,02 |
| | Proses | 0,315 | |
| | Teknik | 0,243 | |
| | Harga | 0,045 | |
| Retnowati | Teknik | 0,407 | 0,08 |
| | Proses | 0,289 | |
| | Produk | 0,250 | |
| | Harga | 0,054 | |
| Moh. Iwan | Proses | 0,369 | 0,05 |
| | Teknik | 0,346 | |
| | Produk | 0,237 | |
| | Harga | 0,048 | |
| Combined | Proses | 0,330 | 0,02 |
| | Teknik | 0,328 | |
| | Produk | 0,291 | |
| | Harga | 0,051 | |

### 4.2.2 Simple Additive Weighting (SAW)

The first stage in determining the weighted sum using the Simple Additive Weighting method is to determine the category of criteria used. Criteria whose value is minimized are categorized as Cost attributes, while criteria whose value is maximized are categorized as Benefit attributes (Hidayat and Saleh, 2023). The stages in the calculation of this method can be done using Exel software. The categories of each criteria that have been determined can be seen in Table 4.13..

**Table 4.13** Criteria and categories used.

| Kriteria | Kategori | Alasan |
|---|---|---|
| Produk | Benefit | Apabila daya tahan produk semakin tinggi, maka kualitas produk baik |
| Harga | Cost | Apabila tingkatan harga produk yang ditawarkan rendah, maka akan menarik banyak konsumen |
| Proses | Cost | Semakin singkat proses produksi, maka efisiensi waktu produksi yang digunakan lebih maksimal |
| Teknik | Cost | Apabila teknik penggunaan energi lebih sedikit, maka dapat mengurangi biaya produksi |

The stage after determining the category of each criterion is to determine the weighting value of each criterion used. The weight value used in the analysis of the Simple Additive Weighting method, namely, by using the weight value of the combination results of each questionnaire comparison value based on the results of the Analytical Hierarchy Process calculation which can be seen in Table 4.6 above. The next stage is to determine the rating value of each criterion. This rating is used to evaluate alternatives to each criterion. The description of the rating value can be seen in Table 4.14.

**Tabel 4.14** Rating nilai indikator kriteria.

| Kode | Indikator | Nilai |
|---|---|---|
| C1 | Daya tahan produk rendah (≤ 7 hari) | 1 |
| | Daya tahan produk sedikit rendah (≤ 14 hari) | 2 |
| | Daya tahan produk lumayan tinggi (≤ 28 hari) | 3 |
| | Daya tahan produk cukup tinggi (≤ 56 hari) | 4 |
| | Daya tahan produk tinggi (≤ 112 hari) | 5 |
| C2 | Produk murah (≤ 10.000/kg) | 1 |
| | Produk cukup murah (≤ 20.000/kg) | 2 |
| | Produk lumayan murah (≤ 30.000/kg) | 3 |
| | Produk mahal (≤ 40.000/kg) | 4 |

| | | |
|---|---|---|
| | Produk sangat mahal (≤ 50.000/kg) | 5 |
| C3 | Produksi singkat (≤ 1 hari) | 1 |
| | Produksi cukup singkat (≤ 3 hari) | 2 |
| | Produksi lumayan singkat (≤ 5 hari) | 3 |
| | Produksi lama (≤ 10 hari) | 4 |
| | Produksi sangat lama (≤ 14 hari) | 5 |
| C4 | Energi yang digunakan rendah | 1 |
| | Energi yang digunakan sedikit rendah | 2 |
| | Energi yang digunakan lumayan tinggi | 3 |
| | Energi yang digunakan cukup tinggi | 4 |
| | Energi yang digunakan tinggi | 5 |

Rating values and indicators in Table 4.14 are obtained from one of the studies conducted by (Poluan et al., 2022). This rating assessment is used to determine the category of criteria types and determine the value for the normalization calculation stage based on the alternative rating values obtained. The results of alternative assessments of each criterion can be seen in Table 4.15..

**Table 4.15** Rating of alternative values of each criterion.

| Kode | C1 | C2 | C3 | C4 |
|---|---|---|---|---|
| A1 | 5 | 1 | 3 | 2 |
| A2 | 4 | 2 | 3 | 3 |
| A3 | 2 | 5 | 4 | 1 |
| A4 | 3 | 4 | 5 | 1 |

The next stage after determining the rating value of the alternatives used, namely, making the X matrix form from the assessment table. The following X matrix based on the rating assessment can be seen as follows.

$$X = \begin{bmatrix} 5 & 1 & 3 & 2 \\ 4 & 2 & 3 & 3 \\ 2 & 5 & 4 & 1 \\ 3 & 4 & 5 & 1 \end{bmatrix}$$

After creating the matrix, the next step is matrix normalization. The mechanism for calculating this normalization is by using the weight value of the combination results of each questionnaire comparison value based on the results of the Analytical Hierarchy Process calculation and divided by the criterion rating value based on the Simple Additive Weighting calculation. The equation used in the calculation of matrix normalization is using equation (1). The results of the matrix normalization calculation based on the normalization equation are as follows.

$$X = \begin{bmatrix} 1 & 1 & 1 & 0{,}5 \\ 0{,}8 & 0{,}5 & 1 & 0{,}3 \\ 0{,}4 & 0{,}2 & 0{,}75 & 1 \\ 0{,}6 & 0{,}25 & 0{,}6 & 1 \end{bmatrix}$$

The last stage after normalizing the X matrix is to calculate the value for each alternative Ai using equation (2). This stage is used to determine which alternative has the highest ranking value performance to be used as a decision in selecting from several existing alternatives. The calculation of the value for each alternative can be considered as follows.

A1 = (0,291*1) + (0,051*1) + (0,330*1)
+ (0,328*0,5)
= 0,836

A2 = (0,291*0,8) + (0,051*0,5) +
(0,330*1) + (0,328*0,3)
= 0,687

A3 = (0,291*0,4) + (0,051*0,2) +
(0,330*0,75) + (0,328*1)
= 0,702

A4 = (0,291*0,6) + (0,051*0,25) +
(0,330*0,6) + (0,328*1)
= 0,713

So, based on the results of calculations using the Simple Additive Weigthing method, the results of the recommended alternative decisions based on the greatest value for alternative selection of cassava waste derivative products can be seen in Table 4.16..

**Table 4.16** Highest to lowest alternative value.

| Alternatif | Nilai |
|---|---|
| Keripik Kulit Singkong | 0,836 |
| Tepung Kulit Singkong | 0,713 |
| Pupuk Kompos Kulit Singkong | 0,702 |
| Pakan Ternak Fermentasi Kulit Singkong | 0,687 |

## 5. RESULTS AND DISCUSSION

### 5.1 Conclusion

Based on the results and discussion of related research on the determination of cassava waste processing at UD Sumber Mutiara MSMEs, the following conclusions are obtained:

1. UD. Sumber Mutiara is one of the businesses founded by Hj. Siti Fatimah in the form of MSMEs which has been established since 1977 until now. This business is in the field of agro-industry, where in production it processes various processed agricultural products, one of which is processed cassava products. The production of processed cassava at UD Sumber Mutiara is able to process as much as 500 kg in 1 month of production which can produce as many as 1250 packages weighing 400 g / package. Cassava waste generated from production in the form of cassava skin is as much as 10% of the raw material..
2. Based on the above calculations, data through filling out questionnaires to 3 experts obtained the results of a combination of output values using the application of AHP and SAW methods. The results of the calculation of the AHP method using Expert Choice 11 software obtained the results of the combination of each criterion based on the respondent's questionnaire data obtained the most dominant criterion weight value is in the technical criteria of 0.330. This result can be interpreted that, to obtain more efficient and quality

derivative products in the processing of cassava peel waste, the aspect that needs to be considered is the process aspect. The results of the calculation of the dominant value of the weighting of each related sub-criteria obtained sub-criteria of product quality of 0.892; sub-criteria of production costs of 0.848; sub-criteria of production time of 0.853; and sub-criteria of energy efficiency of 0.808. Based on further calculations using the SAW method, the final results of the ranking value of each alternative ranging from the highest to the lowest, namely, cassava skin chips (A1) of 0.836; cassava skin fermented animal feed (A4) of 0.713; cassava skin compost fertilizer (A3) of 0.702; and cassava skin flour (A2) of 0.687..

### 5.2 Suggestions

Suggestions that can be given in this study are more focused on data collection. In distributing questionnaires, researchers must be able to explain in detail about filling out the questionnaire, so that the data to be calculated can be declared consistent. Determination of the criteria and sub-criteria used in the application of the AHP method can be adjusted to the object of research. This is so that the criteria and sub-criteria are interrelated with the object of research used..

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