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Analysis of the Factors Affecting the Quality of Palm Oil Using the Analytical Hierarchy Process Method

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Abstract. Riau is a province that has many oil palm plantations. One of the industries that manages palm oil is PT. Tasma Puja having the address jl. The kuamang river, kampar, where it produces crude oil or vegetable oils and animal oils. To calculate the quality of palm oil at PT. Tasma Puja is carried out laboratory tests based on water and dirt content, free fatty acid content, color and peroxide number. The process of storing free fatty acid data produced every time the production from laboratory test results is still stored manually using the Microsoft Excel application. By storing these data, there are weaknesses, namely the difficulty in assessing the quality of palm oil production produced. This study was conducted to better analyze and store production data from PT. Tasma Puja. The results of this study will be able to provide benefits to PT. Tasma Pujasehing will later facilitate PT. Tasma Puja in storing and processing palm oil production data. Analysis of these problems uses the concept of decision support systems Analytical Hierarchy Process (AHP) method which is supported by PHP programming applications.

1. Introduction

Indonesia is a producer of palm oil in the world and has many oil palm plantations. Oil palm is a factory producing oil, both cooking oil, industrial oil, fuel oil (biodiesel). Information from the Central Bureau of Statistics, data on the total area of oil palm plantations found in Indonesia currently reaches 11.9 million hectares. Riau is a province that has many oil palm plantations. One of the industries that manages palm oil is PT. Tasma Puja, having its address at Jalan Sungai Kuamang, Kampar, where it produces crude from vegetable and animal oils.

To calculate the quality of palm oil at PT. Tasma Puja is carried out laboratory tests based on water and dirt content, free fatty acid content, color and peroxide number. The process of storing free fatty acid data produced every time the production from laboratory test results is still stored manually using the Microsoft Excel application. By storing these data, there are weaknesses, namely the difficulty in assessing the quality of palm oil production produced. This research was conducted to better analyze and store production data from PT. Tasma Puja. The results of this study will be able to provide benefits to PT. Tasma Pujasehing will later facilitate PT. Tasma Puja in storing and processing palm oil production data. Analysis of these problems uses the concept of decision support systems Analytical Hierarchy Process (AHP) method which is supported by PHP programming applications

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2. Literature

2.1 Decision Support System

Decision Support System is a system that helps decision makers, who are computer-based, produce a decision with alternatives to help management as decision makers in solving semi-structured problems, which are a combination of structured and unstructured problems, with problem solving that applies several models. The Decision Support System (DSS) was first put forward by G. Anthony Gorry and Michael S Scoot Morton in 1971, this concept was first expressed in terms of the Management Decision System. This system is a computer-based system by utilizing certain data and models in resolving decision making to resolve various unstructured problems. DSS is a system that utilizes computer support to assist the decision making process (Marilin Kristina, Sulantiwi, 2015).

Michael S. Scott Morton revealed in the early 1970s that SPK is a Management Decision System, a computer-based system that aims to help determine decisions using existing models, using data obtained and resolving unstructured, structured or semi-structured problems. SPK is a system that is able to provide problem solving and communication skills used to solve problems that are semi-structured, structured and unstructured. This system is utilized in helping decision making with semi-structured problem situations and unstructured problem situations, with uncertainty about how decisions should be made. The components of a decision support system are

- Data Management is a component of the SPK as a data provider for the system, where data is stored in the Database Management System (DBMS), so that it can be retrieved and extracted quickly.
- The Management Model looks at financial models, statistics, management science, or various other quantitative models, so that it can provide the system with the analytical skills and software management needed.
- Communication (dialog subsystem) Users can communicate and give commands to the SPK through this subsystem. This means providing an interface.
- This optional knowledge management subsystem can support other subsystems or act as a stand-alone component.

2.2 Analytical Hierarchy Process (AHP)

Based on Thomas L. Saaty, Analytical Hierarchy Process can solve complex problems with the aspects or criteria used quite a lot. And this complexity is caused by problems that are not structured, which are unprecedented, resulting in uncertainty in perception and uncertainty in the availability of accurate or even nonexistent statistical data. The decision making process is basically choosing alternatives. The main AHP equipment is a functional hierarchy with the main data input which is a perception of humans. With hierarchies, complex and unstructured problems are solved into several groups. Then the group will be arranged in a hierarchical form.

The steps in the AHP method include the following:

- Define the problem and determine the solution.
- Determine the hierarchical structure consisting of general purpose, criteria, sub criteria and alternatives needed.
- Create a matrix.
- Make a paired comparison matrix that influences each element for each goal or criterion. Pairwise comparison matrices are made based on "judgments" of decision making by comparing one element with another element.
- Create a paired comparison matrix so that the values are n x [(n-1) / 2], with n being the number of elements compared.
- Calculate the eigenvalue and consistency test, if it is inconsistent, re-evaluate the respective elements.
- Repeat steps 3, 4, and 5 for all levels of the hierarchy.
- Calculate the eigenvectors of each paired comparison matrix. The value of the eigenvector is the weight of each element. This step is to synthesize judgments in determining priorities at the lowest hierarchy level until the goal is reached.

- If the value of the consistency of the hierarchy is more than 10 percent, then the assessment of assessment data must be corrected again (Kadarsah Suryadi and Ali Ramdhani, 2002).

Table 1. Scale of Pair Comparison Assessment

Intensity of Interest	Information	Explanation
1	Both elements are equally important	Two elements have the same effect on objectives
3	One element is slightly more important than the other elements	Experience and assessment have little support for one element compared to other elements
5	One element is more important than the other elements	Experience and assessment are very strong in supporting one element compared to other elements
7	One element is clearly more important than the other elements	One strong element that is supported and dominant is seen in practice
9	One element is absolutely important than the other elements	Evidence that supports one element against another element has the highest level of affirmation that might strengthen
2, 4, 6, 8	Values between two consideration values are close together	This value is given if there are two compromises between two choices
The opposite	If for activity i gets one number compared to activity j, then j has the opposite value compared to i	

3. Results and discussion

Analytical Hierarchy Process is a functional hierarchy with the main input of human perception. which allows for compile problem solving, then converts it into a hierarchical form that uses paired matrix comparisons to produce relative weights between criteria and alternatives, then the Criteria will be compared with other criteria to achieve the goal. Assessment in comparing one criterion with another criteria is free from each other, and this can lead to inconsistency. L.Saaty (1990) has proven that the consistency index of the order n order can be obtained by the formula: CI = (λmaks-n) / (n-1), Where : CI = Consistency Index, λmax = eigenvalue the biggest of the matrix is n. The biggest eigen value is obtained by summing the results of multiplying the number of columns with the Eigen Vector. The inconsistency limit is measured by using a consistency ratio (CR), which is the comparison of the consistency index (CI) with the random generator value (IR). This value depends on the order of matrices n. The consistency ratio can be formulated: CR = CI / IR If the CR value is less than 10%, the inconsistency of opinion is still considered acceptable.

- Make a Criteria Comparison Matrix

  This stage gives the weight of each criterion using the AHP model. Criteria data are obtained from companies that directly compare criteria and criteria in accordance with interest labels. Pairwise comparison matrix can be seen in table 2 below:

Table 2. Pairwise Comparison Matrix Criteria

CRITERIA	WATER	DIRT	**GOOD FATTY ACID**
WATER	1,000	2,000	3,000
DIRT	0,500	1,000	3,000
GOOD FATTY ACID	0,333	0,333	1,000

Table 3. Comparative Matrix of Alternative Pairing Based on Water Criteria

WATER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
JANUARY	1,000	3,000	2,000	2,000	2,000	3,000	2,000	2,000	2,000	3,000	3,000	3,000
FEBRUARY	0,333	1,000	3,000	2,000	3,000	2,000	3,000	0,333	0,500	2,000	3,000	2,000
MARCH	0,500	0,333	1,000	3,000	2,000	2,000	2,000	3,000	0,333	3,000	2,000	2,000
APRIL	0,500	0,500	0,333	1,000	2,000	3,000	3,000	0,500	3,000	2,000	3,000	3,000
MAY	0,500	0,333	0,500	0,500	1,000	3,000	3,000	2,000	3,000	3,000	3,000	0,333
JUNE	0,333	0,500	0,500	0,333	0,333	1,000	2,000	2,000	0,333	2,000	2,000	3,000
JULI	0,500	0,333	0,500	0,333	0,333	0,500	1,000	3,000	2,000	2,000	3,000	3,000
AUGUST	0,500	3,000	0,333	2,000	0,500	0,500	0,333	1,000	2,000	0,333	3,000	2,000
SEPTEMBER	0,500	2,000	3,003	0,333	0,333	3,003	0,500	0,500	1,000	2,000	2,000	2,000
OCTOBER	0,333	0,500	0,333	0,500	0,333	0,500	0,500	3,003	0,500	1,000	2,000	2,000
NOVEMBER	0,333	0,333	0,500	0,333	0,333	0,500	0,333	0,333	0,500	0,500	1,000	2,000
DECEMBER	0,333	0,500	0,500	0,333	3,003	0,333	0,333	0,500	0,500	0,500	0,500	1,000

Table 4. Alternative Pairing Comparison Matrix Based on Dirt Criteria

DIRT	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
JANUARY	1,000	2,000	2,000	3,000	3,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
FEBRUARY	0,500	1,000	3,000	2,000	3,000	2,000	3,000	0,333	2,000	2,000	3,000	2,000
MARCH	0,500	0,333	1,000	3,000	3,000	2,000	2,000	3,000	0,333	3,000	2,000	2,000
APRIL	0,333	0,500	0,333	1,000	2,000	3,000	3,000	2,000	3,000	2,000	3,000	3,000
MAY	0,333	0,333	0,333	0,500	1,000	3,000	3,000	2,000	3,000	3,000	3,000	2,000
JUNE	0,500	0,500	0,500	0,333	0,333	1,000	2,000	2,000	0,333	2,000	2,000	3,000
JULI	0,500	0,333	0,500	0,333	0,333	0,500	1,000	3,000	2,000	2,000	3,000	2,000
AUGUST	0,500	3,000	0,333	0,500	0,500	0,500	0,333	1,000	2,000	2,000	2,000	2,000
SEPTEMBER	0,500	0,500	3,003	0,333	0,333	3,003	0,500	0,500	1,000	3,000	2,000	2,000
OCTOBER	0,500	0,500	0,333	0,500	0,333	0,500	0,500	0,500	0,333	1,000	2,000	3,000
NOVEMBER	0,500	0,333	0,500	0,333	0,333	0,500	0,333	0,500	0,500	0,500	1,000	2,000
DECEMBER	0,500	0,500	0,500	0,333	0,500	0,333	0,500	0,500	0,500	0,333	0,500	1,000

Table 5. Comparative Alternative Pair Matrix Based on Good Fatty Acid Criteria

GOOD FATTY ACID	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
JANUARY	1,000	3,000	3,000	2,000	2,000	3,000	2,000	3,000	2,000	3,000	3,000	3,000
FEBRUARY	0,333	1,000	3,000	2,000	3,000	2,000	3,000	3,000	2,000	2,000	3,000	3,000
MARCH	0,333	0,333	1,000	3,000	2,000	3,000	2,000	3,000	3,000	3,000	2,000	2,000
APRIL	0,500	0,500	0,333	1,000	2,000	3,000	3,000	3,000	3,000	2,000	3,000	3,000
MAY	0,500	0,333	0,500	0,500	1,000	3,000	3,000	2,000	3,000	3,000	3,000	3,000
JUNE	0,333	0,500	0,333	0,333	0,333	1,000	2,000	2,000	2,000	2,000	2,000	3,000
JULI	0,500	0,333	0,500	0,333	0,333	0,500	1,000	3,000	2,000	3,000	3,000	3,000
AUGUST	0,333	0,333	0,333	0,333	0,500	0,500	0,333	1,000	2,000	2,000	3,000	2,000
SEPTEMBER	0,500	0,500	0,333	0,333	0,333	0,500	0,500	0,500	1,000	2,000	3,000	3,000
OCTOBER	0,333	0,500	0,333	0,500	0,333	0,500	0,333	0,500	0,500	1,000	2,000	2,000
NOVEMBER	0,333	0,333	0,500	0,333	0,333	0,500	0,333	0,333	0,333	0,500	1,000	3,000
DECEMBER	0,333	0,333	0,500	0,333	0,333	0,333	0,333	0,500	0,333	0,500	0,333	1,000

- Results of Analysis of the AHP Method
  The results of the weight analysis of the criteria and alternatives that have been calculated can be seen in the table below:

Table 6. Results of Criteria Analysis

CRITERIA	WATER	DIRT	GOOD FATTY ACID
WATER	0,545	0,600	0,429
DIRT	0,273	0,300	0,429
GOOD FATTY ACID	0,182	0,100	0,143

α Maks = 3.054
CI = 0.027 and CR = 0.046 <0.1

Table 7. Results of Alternative Analysis Based on Water Criteria

WATER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
JANUARY	0,176	0,243	0,160	0,158	0,132	0,155	0,111	0,110	0,128	0,141	0,109	0,118
FEBRUARY	0,059	0,081	0,240	0,158	0,198	0,103	0,167	0,018	0,032	0,094	0,109	0,079
MARCH	0,088	0,027	0,080	0,237	0,132	0,103	0,111	0,165	0,021	0,141	0,073	0,079
APRIL	0,088	0,041	0,027	0,079	0,132	0,155	0,167	0,028	0,191	0,094	0,109	0,118
MAY	0,088	0,027	0,040	0,039	0,066	0,155	0,167	0,110	0,191	0,141	0,109	0,013
JUNE	0,059	0,041	0,040	0,026	0,022	0,052	0,111	0,110	0,021	0,094	0,073	0,118
JULI	0,088	0,027	0,040	0,026	0,022	0,026	0,056	0,165	0,128	0,094	0,109	0,118
AUGUST	0,088	0,243	0,027	0,158	0,033	0,026	0,019	0,055	0,128	0,016	0,109	0,079
SEPTEMBER	0,088	0,162	0,240	0,026	0,022	0,155	0,028	0,028	0,064	0,094	0,073	0,079
OCTOBER	0,059	0,041	0,027	0,039	0,022	0,026	0,028	0,165	0,032	0,047	0,073	0,079
NOVEMBER	0,059	0,027	0,040	0,026	0,022	0,026	0,019	0,018	0,032	0,023	0,036	0,079
DECEMBER	0,059	0,041	0,040	0,026	0,198	0,017	0,019	0,028	0,032	0,023	0,018	0,039

α Max = 0.998
CI = 0.089 and CR = 0.060 < 0.1

Table 8. Results of Alternative Analysis Based on Dirt Criteria

DIRT	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
JANUARY	0,162	0,203	0,162	0,247	0,205	0,109	0,110	0,115	0,118	0,088	0,078	0,077
FEBRUARY	0,081	0,102	0,243	0,164	0,205	0,109	0,165	0,019	0,118	0,088	0,118	0,077
MARCH	0,081	0,034	0,081	0,247	0,205	0,109	0,110	0,173	0,020	0,131	0,078	0,077
APRIL	0,054	0,051	0,027	0,082	0,136	0,164	0,165	0,115	0,176	0,088	0,118	0,115
MAY	0,054	0,034	0,027	0,041	0,068	0,164	0,165	0,115	0,176	0,131	0,118	0,077
JUNE	0,081	0,051	0,041	0,027	0,023	0,055	0,110	0,115	0,020	0,088	0,078	0,115
JULI	0,081	0,034	0,041	0,027	0,023	0,027	0,055	0,173	0,118	0,088	0,118	0,077
AUGUST	0,081	0,305	0,027	0,041	0,034	0,027	0,018	0,058	0,118	0,088	0,078	0,077
SEPTEMBER	0,081	0,051	0,243	0,027	0,023	0,164	0,028	0,029	0,059	0,131	0,078	0,077
OCTOBER	0,081	0,051	0,027	0,041	0,023	0,027	0,028	0,029	0,020	0,044	0,078	0,115
NOVEMBER	0,081	0,034	0,041	0,027	0,023	0,027	0,018	0,029	0,029	0,022	0,039	0,077
DECEMBER	0,081	0,051	0,041	0,027	0,034	0,018	0,028	0,029	0,029	0,015	0,020	0,038

α Max = 0.998
CI = 0.088 and CR = 0.060 < 0.1

Table 9. Results of Alternative Analysis Based on Good Fatty Acid Criteria

GOOD FATTY ACID	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
JANUARY	0,188	0,375	0,281	0,182	0,160	0,168	0,112	0,137	0,094	0,125	0,106	0,097
FEBRUARY	0,063	0,125	0,281	0,182	0,240	0,112	0,168	0,137	0,094	0,083	0,106	0,097
MARCH	0,063	0,042	0,094	0,273	0,160	0,168	0,112	0,137	0,142	0,125	0,071	0,065
APRIL	0,094	0,063	0,031	0,091	0,160	0,168	0,168	0,137	0,142	0,083	0,106	0,097
MAY	0,094	0,042	0,047	0,045	0,080	0,168	0,168	0,092	0,142	0,125	0,106	0,097
JUNE	0,063	0,063	0,031	0,030	0,027	0,056	0,112	0,092	0,094	0,083	0,071	0,097
JULI	0,094	0,042	0,047	0,030	0,027	0,028	0,056	0,137	0,094	0,125	0,106	0,097
AUGUST	0,063	0,042	0,031	0,030	0,040	0,028	0,019	0,046	0,094	0,083	0,106	0,065
SEPTEMBER	0,094	0,063	0,031	0,030	0,027	0,028	0,028	0,023	0,047	0,083	0,106	0,097
OCTOBER	0,063	0,063	0,031	0,045	0,027	0,028	0,019	0,023	0,024	0,042	0,071	0,065
NOVEMBER	0,063	0,042	0,047	0,030	0,027	0,028	0,019	0,015	0,016	0,021	0,035	0,097
DECEMBER	0,063	0,042	0,047	0,030	0,027	0,019	0,019	0,023	0,016	0,021	0,012	0,032

α Maks = 0.993
CI = 0.089 and CR = 0.060 <0.1

Table 10. Results of Manual Calculation Ranking Analysis

ALTERNATIVE	WATER	DIRT	GOOD FATTY ACID	THE FINAL RESULT	RANK
JANUARY	0,077	0,046	0,024	0,147	1
FEBRUARY	0,059	0,041	0,020	0,120	2
MARCH	0,055	0,037	0,017	0,109	3
APRIL	0,054	0,036	0,016	0,105	4
MAY	0,050	0,032	0,014	0,097	5
JUNE	0,034	0,022	0,010	0,066	7
JULI	0,040	0,024	0,010	0,074	6
AUGUST	0,043	0,026	0,008	0,077	9
SEPTEMBER	0,047	0,027	0,008	0,082	8
OCTOBER	0,028	0,016	0,006	0,049	10
NOVEMBER	0,018	0,012	0,005	0,035	11
DECEMBER	0,024	0,011	0,004	0,039	12

It was concluded that data in January can be used as a reference in determining the quality of palm oil based on the content.

4. Conclusion

a. The results of the adoption of the Decision Making System are able to store and search data quickly and easily, which helps the promotion of PT. Tasma Puja in making decisions about the quality reference of palm oil.
b. This Decision System provides an assessment based on the criteria contained in the content of palm oil, where we can look for a priority assessment of the consistency ratio with the criteria contained in the content of palm oil which will be used as a consideration in decision support.
c. The decision-making system using the AHP (Analytical Hierarchy Process) method can provide solutions to solve problems regarding the quality of palm oil, so that the decisions obtained are in accordance with the right targets.

5. Suggestions

a. To be able to produce a maximum Decision Support System, it is necessary to develop the system regularly.
b. In maintaining the system, a person who is competent in their field is needed.
c. Other developments are expected in this Decision Support System.
d. Maintenance is needed for the application that has been made, so that it can be used continuously in decision making.

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