Determination Of Priority Criteria Which Influences CPO Factory Productivity

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Abstract. One of the factor in a company's competitiveness is productivity, and each company expects to have high productivity. However, the reality is, their performance is not necessarily in line with company expectations [1-2]. The purpose of determining priority criteria using the Analytical Network Process method is to rank the known CPO mill productivity criteria. Based on the calculation results, there are three perspectives on the perspective of identifying factors of productivity in palm oil processing factories, namely: the quality of oil palm fruit, palm fruit processing machines and labour skills. Then for the ranking of sub-criteria, the highest priority productivity criteria for palm oil processing factories with the ANP method are the quality criteria for FFB, followed by the criteria of labour skills, and the criteria for processing machinery. The Mature Fruit Quality sub-criteria based on ANP method calculation are the most dominant, followed by the Working Hours, Work Experience, Transportation, Harvest Technology, Machine Hours, Fruit Origin, Types of Technology Used, and Education / Training.

Keyword: Productivity, Analytical Network Process, Perspectives

1. Introduction
A factor in a company's competitiveness is productivity, and each company expects to have high productivity. However, the reality is, their performance is not necessarily in line with company expectations [1-2]. One factor that influences company productivity is the utilization of production resources. Utilization of these resources must be optimal to increase the company's productivity. As the productivity of a company is a very important element to see the company's efficiency, especially in terms of the use of existing resources to produce company products[3-5].

PT. X is a company engaged in the processing of palm oil and kernels (palm kernel) with CPO as the product. PT. X is engaged in processing Oil Palm Fruit Bunch (FFB) into palm oil. PT. X has a target in achieving CPO production. This is shown by the existence of production planning with the production results realized every year. The problem with the company is the gap in actual productivity and target productivity at the CPO plant at PT. X. There are various factors that affect the productivity of a factory that produces CPO, such as machine condition, quality of FFB, and also the expertise or skills of the labour force employed. The sub criteria used are Mature Fruit Quality, Harvest Technology, Fruit Origin, Transportation, Machine Hours, Types of Technology, Employee Work Hours, Work Experience and Education / Training[6-8]. Therefore, a research is needed to determine the priority criteria that support the productivity of the plant. In making the network structure, first, the literature is reviewed to determine the factors affecting CPO factory productivity. Second, using the concept of Analytical Network Process (ANP) in the framework of network structure modelling [9-11].

2. Research Methods
A descriptive research was chosen as the type of research, which is a type of research that aims to describe the facts and properties of a particular object or population. The object observed was the factory productivity factor at PT. X.

2.1. Research Variables
The variables of the research are as follows [12-13]:
1. Dependant Variable
   The dependent variable is the one that is determined by the value of other variables. Factory productivity is the dependent variable in this study.
2. Independent Variables
   The independent variable is a variable that affects negatively or positively the dependent variable. The independent variables are:
   a. Quality of FFB
   b. Processing Machine
   c. Labour Skills

2.2. Research Design
The research design was carried out in several stages, beginning with identifying the problem to produce a conclusion. The stages of data processing in the research design are:
1. Structure of factory productivity criteria and sub-criteria
2. Factory productivity network design
3. Factory productivity network validation
4. Pairwise comparison questionnaire
5. Calculation of the average weight of the criteria
6. Partial weight and consistency of the matrix were calculated.
7. Super matrix preparation with Super decisions
8. Unweighted super matrix, weighted super matrix and limit matrix are calculated.
9. Priority criteria and factory productivity sub-criteria

3. Results and Discussion
3.1. Data Collection
The criteria used are three criteria of productivity factors used, namely, the quality of FFB, processing machinery and labour skills. The determination of sub-criteria are as follows.

| No. | Criteria       | Sub-criteria               |
|-----|----------------|----------------------------|
| 1.  | Quality of FFB | Fruit Origin              |
|     |                | Transportation            |
|     |                | Harvest Technology        |
|     |                | Mature Fruit Quality      |
| 2.  | Processing     | Types of Technology Used  |
By interviewing the production manager, the relationship of influence between these Sub-Criteria is prepared. The mechanism used is in the form of a closed questionnaire. The results of the interview can be seen in the Figure 1.

The making of a paired appraisal questionnaire is done to give weight to each Criteria and Sub Criteria to identify which one has the highest weight. This step is called pairwise comparison between Criteria and also Sub Criteria.

### 3.2. Data Processing

The method of calculating the Consistency Ratio for the paired comparison matrix FFB Quality Criteria is shown as follows:

1. The weighting average are calculated by calculating the geometric average with these formulation:

\[
GM = \sqrt[n]{X_1 \cdot X_2 \cdot \ldots \cdot X_n}
\]

\[
GM = \sqrt[4]{0.5976 \cdot 1.6735} = 2.5840
\]

With \(GM\) = Geometric Mean  
\(X_1, X_2, X_n\) = Data  
\(n\) = Number of Data

Calculation of geometric averages for the pairwise comparison matrix as can be seen in Table 2.

### Table 2. Pairwise Comparison Matrix

|       | FFB Quality | Processing Machine | Labor Skill |
|-------|-------------|--------------------|------------|
| FFB Quality | 1.0000      | 1.6735             | 2.5840     |
| Processing Machine | 0.5976      | 1.0000             | 0.7677     |
| Labor Skill     | 0.3870      | 1.3026             | 1.0000     |
| **Total**       | **1.9846**  | **3.9761**         | **4.3517** |
2. Calculation of normalization matrix and partial weight of FFB quality:

\[
\text{Normalization} = \frac{\text{Weight}}{\text{Total Weight}} = \frac{2.5840}{4.3517} = 0.5938 \quad \text{........................................... (2)}
\]

\[
\text{Partial Weight} = \frac{\text{Normalization value}}{3} = \frac{0.5039+0.4209+0.5938}{3} = 0.5062 \quad \text{........................................... (3)}
\]

| Tabel 3. FFB Quality Cluster Normalization Matrix |
|-----------------------------------------------|
| FFB Quality | Processing Machine | Labor Skill | Weight |
|-------------|---------------------|-------------|--------|
| 0.5039      | 0.4209              | 0.5938      | 0.5062 |
| 0.3011      | 0.2515              | 0.1764      | 0.2430 |
| 0.1950      | 0.3276              | 0.2298      | 0.2508 |
| 1.0000      | 1.0000              | 1.0000      | 1.0000 |

3. Calculating Eigen Vector

Eigen Vector calculation is shown as below:

\[
\begin{align*}
1.0000 & \quad 1.6735 & \quad 2.5840 & \quad 1.0000 & \quad 0.5062 & \quad 1.560929 \\
0.5976 & \quad 1.0000 & \quad 0.7677 & \quad 0.5976 & \times 0.2430 & = 0.738028 \\
0.3870 & \quad 1.3026 & \quad 1.0000 & \quad 0.3870 & \quad 0.2508 & \quad 0.763236
\end{align*}
\]

4. Calculating Entry Value

Eigen Vector : Weight

\[
\begin{align*}
1.560929 & \div 0.5062 = 3.0837 \\
0.738028 & \div 0.2430 = 3.0371 \\
0.763236 & \div 0.2508 = 3.0432
\end{align*}
\]

5. Calculating Average Entry value

\[
Z_{\text{max}} = \frac{Z_1+Z_2+Z_3}{3} = \frac{3.0837 + 3.0371 + 3.0432}{3} = 3.0546 \quad \text{........................................... (4)}
\]

Where \(Z_1,Z_2,Z_3 = \text{Entry Value}\)

6. Calculating consistency index

\[
CI = \frac{Z_{\text{max}}-n}{n-1} = \frac{3.0546 - 3}{3-1} = 0.0273 \quad \text{........................................... (5)}
\]

With Random Index (RI) \(n = 3\) is 0.58. then:

\[
CR = \frac{CI}{CI_{\text{Random Consistency Index}}} \quad \text{........................................... (6)}
\]

\[
\begin{align*}
CR & = \frac{0.0273}{0.58} = 0.0471
\end{align*}
\]

Because of \(CR < 0.1\), the respondents' answers are consistent. The same step is done for all elements.

Super matrix is the result of priority vectors from comparisons between all elements. Super matrix consists of Unweighted Super matrix, Weighted Super matrix, and Limiting Super matrix. To obtain these, Super Decisions software version 2.6.0 is used to assist the processing. Unweighted Super matrix is a conversion of the weight of each cluster and sub-criteria stored into a matrix table.
The next step is to create a Weighted Super matrix achieved by reproducing all the elements in the unweighted super matrix. The Weighted Super matrix is then multiplied by itself in several iteration to keep the weight of the matrix stable. This step is done to keep the row values of each element are the same. When the weights in each column have the same value, the Limiting super matrix has been found. Figure 2 shows the global weights for each sub-criteria.

![Global Weight](image)

**Figure 2. Global Weight**

4. Conclusion

Conclusion from the research is as shown below:

1. The criteria that most identify the productivity factor in a palm oil processing factory with the ANP method are the quality criteria for FFB (0.49065), followed by the criteria of labor skills (0.18253), and the criteria for processing machinery (0.33222). The rank of sub-criteria by using the ANP method, are the Mature Fruit Quality (0.1460) sub-criteria, followed by the Working Hours (0.14335), Work Experience (0.13636), Transportation (0.13605), Harvest Technology, (0.11783), Machine Hours (0.11121), Fruit Origin (0.09077), Types of Technology (0.07132), and Education / Training (0.05251).

2. The priority criterion in the productivity of a palm oil processing factory is the quality of oil palm fruit with a global weight of 0.49065.

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