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Priority Proposal in Selecting Fresh Fruit Bunch Suppliers Using Analytical Hierarchy Process (AHP) and Weighted Scoring Model

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Abstract. This article discusses the proposed priority in selecting suppliers of fresh fruit bunches in a company engaged in agribusiness that produces crude palm oil (CPO). The problem faced by the company is that the FFB Internal plantation has not been able to supply all the needs of the fresh fruit bunch. In addition, the supply of fresh fruit bunches from farmer groups is not sufficient for processing capacity. In order to overcome this problem the company must determine potential suppliers to meet the processing capacity of the plant. To determine potential suppliers is done by selecting suppliers based on the appropriate criteria. In determining suppliers, the analytical hierarchy process (AHP) and weighted scoring models are used. The AHP method is used to determine the weighting of the quality criteria for fresh fruit bunches, then the weighted scoring model is used to rank suppliers based on the results of the questionnaire provided. Based on the results of the AHP calculation, the criteria for the quality of fresh fruit bunches, namely clean loose, have the highest weight of 0.24. Then based on the weighted scoring model, the supplier sequence is B (83), C (83), D (83), H (83), E (83) G (81.5), J (80.5), L (80.5), F (80), E (79), I (78.5), K (78), and A (71.5).

1. Introduction

Basically, strategic supplier selection criteria assess whether the purchasing mechanism is important enough for suppliers to get preferred customer status, which can be a sufficient condition for successful collaboration [1]. Companies must choose the most appropriate supplier, because the selection of suppliers that can significantly reduce the cost of purchasing and increase the competitiveness of the company, while the selection of suppliers that are inaccurate can cause financial and operating problems. On the other hand, the selection of suppliers can make the company more efficient and can produce higher quality products. Supplier evaluation and selection problems have been solved by several methods in the literature such as linear weighting methods, total cost approaches, mathematical programming methods, statistical methods and AI methods [2].

Literature reviews show that among the many and various types of methodologies and techniques to address supplier selection processes, models based on the Analytic Hierarchy Process (AHP) and extensions are the most extensive tools in the literature. Moreover, the survey also highlights that AHP-based models can be used in combination with many other approaches [3]. Other research on supplier selection and order allocation is done by [4], according to them management science techniques are useful tools for such decision-making problems. The purpose of this paper is to use fuzzy analytic hierarchy process (AHP) to choose the best supplier company that provides the highest satisfaction for the specified criteria. The



purchasing manager from the manufacturer of a product interviewed and the most important criteria calculated by managers when they choose a supplier company are determined by the questionnaire. Fuzzy AHP is used to compare these supplier companies. [5] which examines the dynamic Total Value Purchasing model, it is recommended to establish a good relationship between supplier selection and buyer's company policy. This model signifies the number of orders to suppliers so that the Total Value Purchasing becomes maximum using integrated AHP and linear programming. This model also allows management to trade off between several real and unreal factors with different priorities..

PT XYZ is a plantation company engaged in the palm oil industry. The production of this company is crude palm oil (CPO) and kernel. In the production process, this company requires raw materials to produce CPO and kernel oil, namely fresh fruit bunches (FFB) or also called palm fruit. The company has an oil palm plantation with an area of 5,467 ha. The results from the company's oil palm plantations are the main raw material suppliers of CPO and kernel production. FFB originating from the company's oil palm plantation, namely FFB Internal, so that the quality of FFB has guaranteed quality. This company has an external FFB supplier commonly called FFB outside. FFB external is a supplier of raw materials for producing CPO oil and kernel, because the FFB supply from FFB core is not sufficient for the production of raw materials every day. Within a day, the core FFB produces / harvests FFB around ± 500 -600 tons / day. Whereas in one day the factory requires FFB ± 900 -1080 tons / day. From the lack of FFB raw materials, the company purchases FFB to suppliers to fulfill its production process. Therefore researchers focus on research on supplier selection criteria with the research title "Priority Proposal in Selecting Fresh Fruit Bunch Suppliers Using the Analytical Hierarchy Process (AHP) and Weighted Scoring Model".

2. Data collection method

Data collection in this study was conducted by means of interviews, observations, literature studies, and questionnaires. Interviews were conducted by question and answer about outside fresh fruit bunch suppliers. Observations are made by observing directly to get information, review, and explore various information that can be used as supporting data. The literature study only focuses on solving problems that can solve problems. While the questionnaire was conducted by giving a questionnaire to the respondents regarding the assessment of outside fresh fruit bunch suppliers.

3. Result and discussion

This section discusses the analysis of data obtained from interviews, observations, and questionnaires using the AHP method and the weighted scoring model. Then the data from the questionnaire results are processed.

3.1. Selection of supplier criteria

To determine the FFB supplier, it is necessary to choose what criteria are needed to choose the best FFB supplier. During this selection phase the researcher interviewed the FFB Outside Partnership Assistant using the supplier selection criteria from Dickson. Of Dickson's 22 criteria regarding supplier selection criteria, the company selected 20 of the 22 supplier selection criteria. Two criteria that are not chosen are financial position and packaging ability. Then after determining supplier criteria, the researcher synchronizes the criteria that have been chosen by the FFB Outside Partnership Assistant to determine supplier selection using the weighted scoring model. The weighted scoring model was created as a result of synchronization from the previous Dickson criteria selection. Table 1. shows the supplier criteria desired by the company.

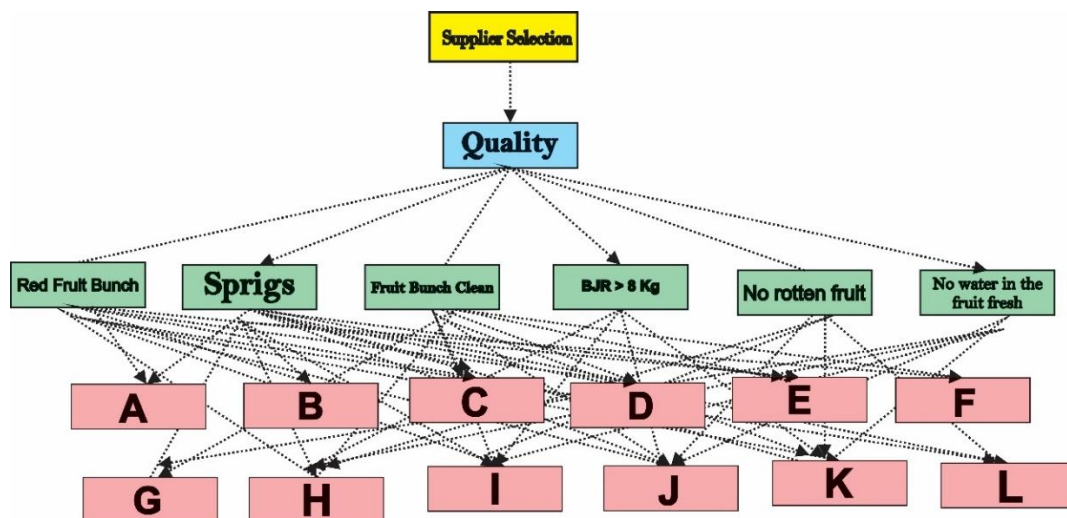
Table 1. Criteria for PT XYZ suppliers

Supplier name:						
Description of items evaluated	Very good (5)	Good (4)	Fair (3)	Less (2)	Very (1)	Less
General condition of suppliers						
Size and / or production capacity						
Financial condition						
Operational conditions						
Geographical location						
Trade relations with companies						
Service state						
Time for submission of material						
Material arrival conditions						
Following the buyer's request						
Order quantity rejected						
Handling complaints from buyers						
Help in an emergency						
FFB material information provided						
Material condition						
FFB material quality						
FFB uniformity						
Guarantees provided by suppliers						

Then from all the criteria above, the company has a special focus on material quality criteria / FFB. There are several sub-criteria in the material / FFB quality criteria from the company, namely the sprigs, average weight > 8 kg, red fruit bunch, fruit bunch clean, no rotten fruit, no water in the fruit fresh bunch / not watered. Therefore material quality / FFB is carried out using the AHP (Analytical Hierarchy Process) method.

3.2. Analytical Hierarchy Process Method

After obtaining specific criteria from the company, namely quality, then sub-criteria have been determined from these qualities, namely the decision hierarchy structure made from FFB supplier selection based on criteria, sub-criteria and alternatives used in the company can be seen in Figure 2.

**Figure 1.** Hierarchy of selection of FFB suppliers outside PT XYZ

Then after determining the hierarchy, proceed with the calculation of pairwise comparisons of each FFB quality sub-criteria. Table 2 shows the results of the calculation of pairwise comparisons of each quality sub-criteria.

Table 2. Calculation of paired comparisons

Sub criteria	Sprigs	BJR>8Kg	Red Fruit Bunch	Fruit Bunch Clean	No rotten fruit	No water in the fruit fresh bunch / not watered
Sprigs	1	1	1	1	1	1
BJR > 8Kg	1	1	1	1/7	1	1
Red Fruit Bunch	1	1	1	1	1	1
Fruit Bunch Clean	1	7	1	1	1	1
No rotten fruit	1	1	1	1	1	1
No water in the fruit fresh bunch / not watered	1	1	1	1	1	1
Sum	6	12	6	5.14	6	6

Then the compilation has been obtained from the calculation of pairs of sub-criteria, then the priority weight calculation of the sub-criteria is performed. Table 3 shows the calculation of priority weights from the sub-criteria:

Table 3. Calculation of priority weight from subcriteria

Sub kriteria	Sprigs	BJR>8Kg	Red Fruit Bunch	Fruit Bunch Clean	No rotten fruit	No water in the fruit fresh bunch / not watered	1 Total weight matrix / amount	2 Eugen vector / average
Sprigs	0.1667	0.0833	0.1667	0.1944	0.1667	0.1667	0.9444	0.1574
BJR > 8Kg	0.1667	0.0833	0.1667	0.0278	0.1667	0.1667	0.7778	0.1296
Red Fruit Bunch	0.1667	0.0833	0.1667	0.1944	0.1667	0.1667	0.9444	0.1574
Fruit Bunch Clean	0.1667	0.0833	0.1667	0.1944	0.1667	0.1667	1.4444	0.2407
No rotten fruit	0.1667	0.0833	0.1667	0.1944	0.1667	0.1667	0.9444	0.1574
No water in the fruit fresh bunch / not watered	0.1667	0.0833	0.1667	0.1944	0.1667	0.1667	0.9444	0.1574
Sum	1.000	0.0833	1.000	1.000	1.000	1.000	1.000	1.000

After getting the priority weight from each sub-criteria, consistency ratio calculation is carried out where this calculation is to assess whether the selection of weights in the sub-criteria

of the FFB supplier outside is consistent in the selection of each sub-criteria. The following is the calculation of the consistency ratio.

Table 4. Calculation of consistency ratio

Sub kriter ia	Spri gs	BJR>8 Kg	Red Frui t Bun ch	Fruit Bun ch Clea n	No rott en frui t	No water in the fruit fresh bunc h / not water ed	Spri gs	BJR>8 Kg	Red Fruit Bun ch	Fruit Bun ch Clea n	No rotte n fruit	No water in the fruit fresh bunc h / not water ed
Sprigs	1	1	1	1	1	1	0.1667	0.8333	0.1667	0.1944	0.1667	0.1667
BJR > 8Kg	1	1	1	1/7	1	1	0.1667	0.8333	0.1667	0.0278	0.1667	0.1667
Red Fruit Bunch	1	1	1	1	1	1	0.1667	0.8333	0.1667	0.1944	0.1667	0.1667
Fruit Bunch Clean	1	7	1	1	1	1	0.1667	0.8333	0.1667	0.1944	0.1667	0.1667
No rotten fruit	1	1	1	1	1	1	0.1667	0.8333	0.1667	0.1944	0.1667	0.1667
No water in the fruit fresh bunch / not water ed	1	1	1	1	1	1	0.1667	0.8333	0.1667	0.1944	0.1667	0.1667
Sum	6	12	6	5.14	6	6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

(Cont.)

Sub criteria	1	2	3	4=3/2	5=Sum 4/Sum 1	6=(Sum 1)/Sum 1	7	8=6/7
	Total weight matrix / amount	Eugen vector / average	Matrix multiplication	Eugen value	Λ maks	Cl	IR	Consistency ratio
Sprigs	0.9444	0.1574	1.000	6.3529				
BJR > 8Kg	0.7778	0.1296	0.7937	6.1124				
Red Fruit Bunch	0.9444	0.1574	1.000	6.3529				
Fruit Bunch Clean	1.4444	0.2407	1.7778	7.3846	6.4865	0.0973	1.2400	0.0785
No rotten fruit	0.9444	0.1574	1	6.3529				
No water in the fruit fresh bunch / not watered	0.9444	0.1574	1	6.3529				
Sum	1.000	1.000	6.5714	38.9188				

Then after the results of the calculation of the consistency of the ratio are obtained, the next step is the researcher gives a questionnaire to the respondent where the questionnaire is the result of the criteria that have been determined at the beginning of the interview with the respondent. The questionnaire is a form of the weighted scoring model of FFB supplier selection criteria outside the company. Then after filling out the questionnaire by the respondent, then the results of the questionnaire are then entered into the total calculation regarding the weights of each of the criteria that have been determined before the weighting calculation above. Table 5 shows the results of supplier selection decisions that come from the overall weighting of the calculations that have been made.

Table 5. Decision-making

Attribute weight	Attribute											
	General condition of suppliers						State of service					
	1						15					
	Production size / capacity	Financial condition	Operational conditions	Geographical location	Trade relations with companies	Time for submission of material	Material arrival condition	Following the buyer's request	Order quantity rejected	Handling complaints from buyers	Help in an emergency	Material information (FFB) given
Alternative												
A	2	3	3	4	4	4	4	4	3	4	3	4
B	4	4	4	4	4	4	4	4	5	4	4	4
C	4	4	4	4	4	4	4	4	5	4	4	4
D	4	4	4	4	4	4	4	4	5	4	4	4
E	3	4	4	4	4	4	4	4	4	4	4	4
F	4	4	4	4	4	4	4	4	4	4	4	4

	Production size / capacity	Financial condition	Operational conditions	Geographical location	Trade relations with companies	Time for submission of material	Material arrival conditions	Following the buyer's request	Order quantity rejected	Handling complaints from buyers	Help in an emergency	Material information (FFB) given
G	4	4	4	4	4	4	4	4	4	4	4	4
H	4	4	4	4	4	4	4	4	4	4	4	4
I	4	4	4	4	4	4	4	4	4	4	3	4
J	3	4	4	4	4	4	4	4	4	4	4	4
K	3	3	4	4	4	4	4	4	4	4	4	4
L	3	4	4	4	4	4	4	4	4	4	4	4

(Cont.)

Attribute weight	Attribute											
	Material condition											
	15											
	Material quality						Material uniformity	Guarantees provided by suppliers	Alt. weight evaluation			
	Sprigs	BJR>8Kg	Red Fruit Bunch	Fruit Bunch Clean	No rotten fruit	No water in the fruit fresh bunch / not watered						
	0.1574	0.1294	0.1574	0.2407	0.1574	0.1574						
A	4	4	4	4	4	4	3	4	71..50			
B	5	5	5	5	5	5	4	4	83.00			
C	5	5	5	5	5	5	4	4	83.00			
D	5	5	5	5	5	5	4	4	83.00			
E	4	4	4	4	4	4	4	4	79.00			
F	4	4	4	4	4	4	4	4	80.00			
G	5	5	5	5	5	5	4	4	81.50			
H	5	5	5	5	5	5	5	4	83.00			
I	4	4	4	4	4	4	4	4	78.50			
J	5	5	5	5	5	5	4	4	80.50			
K	4	4	4	4	4	4	4	4	78.00			
L	5	5	5	5	5	5	4	4	80.50			

Then after the calculation above, it can be seen in the right side of the final calculation table from each alternative / supplier. The results of the calculation are sorted from the largest to the smallest from the supplier. Table 6 shows the order of suppliers based on the calculation results.

Table 6. Supplier sorted

Supplier Selection Sorted	Score
B	83.00
C	83.00
D	83.00
H	83.00
G	81.50
J	80.50
L	80.50
F	80.00
E	79.00
I	78.50
K	78.00
A	71.50

So from the above sequence, it can be seen that suppliers B, C, D, and H have the highest score with a score of 83.00 while supplier A has the lowest value with a score of 71.50. So from the discussion above, the company can prioritize suppliers based on the order of the above suppliers in terms of supplying FFB to companies both in terms of the quantity of FFB to be received as well as the ease of transactions with these suppliers. Then from the above results it can be used as an evaluation material to improve supplier performance where suppliers who have good value and good performance will find more FFB orders so that other suppliers will race against each other to become the best FFB supplier outside the company. Then for suppliers whose values or performance are in, there is less need for guidance and development for suppliers so that suppliers can improve their performance and quality. So that later if the FFB supplier outside is in accordance with the criteria of the company there needs to be certification for the FFB supplier so that the results of the external FFB are the same as the FFB core. The result in the future is that the yield / extraction rate of the factory can increase because the raw material / FFB received is the quality that matches the criteria of the company so that the company has no difficulty in finding good FFB, because with the selection of good suppliers who supply FFB from suppliers that are in accordance with the criteria of the company, the company already has a strategic supplier to supply FFB where the certified supplier will continue to monitor its performance and quality for a certain period of time so that strong relationships / suppliers are formed with the company with a strategic partnership model with suppliers with high quality FFB will produce quality CPO which will reduce costs, especially purchasing costs and production costs.

4. Conclusion

Based on the results of the research that has been done, it can be concluded that the determination of suppliers in the company is determined by the quality of fresh fruit bunches in accordance with company quality criteria, namely the sprigs, average bare weight > 8 kg, red fruit bunch, clean loose fruit, no rotten fruit, no water in the fresh fruit bunch.

By using the Analytical Hierarchy Process method, the results of supplier selection for PT XYZ are A (83), B (83), C (83), D (83), E (83), F (81.5), G (80.5), H (80.5), I (80), J (79), K (78.5), and L (78). From the order of suppliers that have been described, the researchers propose to prioritize FFB suppliers that have a value of ≥ 80.00 to become suppliers that have good partnerships with companies to become strategic suppliers of the company.

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