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Optimization of Selection Suppliers for Rice Raw Material Using AHP (Analytical Hierarchy Processes) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) Methods in CV Gembira

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A B S T R A C T

CV Gembira is engaged in the production of Rice Mill with the trademark Osing Rice, and has 3 variants, namely Osing Super, Osing Premium and Osing Gold. Problems CV Gembira one of them is the delay in the delivery of rice raw materials carried out by supplier and also the quality of goods that do not meet the criteria. The AHP method is the preferred method. There are several reasons, namely, AHP provides a hierarchical representation of a problem that is useful in assisting decision making. The selection of the TOPSIS method as an auxiliary method is based on simple logic and has the farthest distance to the negative ideal solution. After performing calculations using the AHP and TOPSIS methods, alternative sequence results are obtained supplier the best that can be used by CV Gembira with a preference value of 0.6249 is owned by UD Bintang Timur.

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1. INTRODUCTION

Supplier is a company or individual that provides the resources needed by other companies to produce certain goods or services. Supplier has an important role in the availability of raw materials for the continuity of production activities for a company. CV Gembira is engaged in the production of Rice Mill with the trademark Osing Rice, and has 3 variants, namely Osing Super, Osing Premium and Osing Gold. The problems encountered at CV Gembira one of them is the delay in the delivery of rice raw materials carried out by supplier and also the quality of goods that do not meet the criteria. Delivery delays can be caused by supplier who sent wrong specifications of raw materials requested by the company, damage to goods received at the warehouse CV Gembira, or supplier experienced other problems during the delivery process which could hamper the production process. The damage in selecting supplier raw materials will have an impact on decreasing company productivity. This is because raw materials are one of the important factors in the production process activities because they directly affect the product produced. To overcome the above problems, it is necessary to build a decision support system by applying a ranking method that can make it easier to determine alternative suppliers that need to be prioritized using the method Analytical Hierarchy Process and Technique For Order Preference by Similarity to Ideal Solution (AHP and TOPSIS).

In the case of supplier selection, the AHP method is the preferred method. There are several reasons, namely, AHP provides a hierarchical representation of a problem that is useful in assisting decision making. The selection of the TOPSIS method as an auxiliary method is based on simple logic, a calculation process that is relatively easy to understand, and the best alternative to choose from is alternative which has the closest distance to the positive ideal solution and has the farthest distance to the negative ideal solution.

2. LITERATURE REVIEW

Many firms form partnerships with suppliers, and involve them in the early stages of product research and development (Somboonwiwat, 2019). Product is a key element in the market offer marketing planning begins with formulating offers to meet targeted customer needs or wants (Rasyid, 2019). Supplier selection methods are examined extensively in the literature by multicriteria decision analysis models. This model contains techniques such as data envelopment analysis (DEA), hierarchical process analytics (AHP), and process network analytics (ANP). (Vorosmarty, 2019) Selecting the right suppliers has a positive impact on the supply chain performance (Tayyab, 2021). In traditional SCM, price, cost, quality and delivery are the most important criteria for supplier selection (Stevic et al., 2019). Choosing criteria must of course reflect the supply chain strategy and the characteristics of the material being supplied (Amanda et al., 2023). To obtain a stable competitive environment,on supplier selection and order allocation are very important aspects to consider for the company (Kumar, 2021). Basically, supplier selection can be divided into two types including single sourcing and multiple sourcing. (Zhang et al., 2019); in fulfilling all company requests, multiple sourcing is more often used by companies (Mohammed Et al., 2019). To anticipate possible drug-shortage issues and propose improvement actions, supplier evaluations are carried out on a regular basic (Pelissari, 2019).

Supplier selection is a multi-criteria decision making problem involving qualitative and quantitative methods. Nugroho stated that a supplier selection process is important. The decisionmaking process is carried out by evaluating each supplier so that the right supplier can be selected (Nugroho Et al., 2023). Besides selecting the right supplier, MCDM are used in many fields. These methods help to compare alternatives and find the best one (Medic Et al., 2019). Into help improve the quality of decisions to become more explicit, rational, and efficient, the MCDM method is used (Arvind and Janpriy, 2018). MCDM methods provide a possibility to evaluate these and other conflicting factors. (Bhardwaj Et al., 2019) Most of the MCDM methods make it possible to integrate a wide variety of data typologies with varying degrees of freedom into the assessment (Marttunen Et al., 2017). In the late 70's, Thomas Lorie Saaty developed the AHP method (Petruni Et al., 2019). To date, there are many AHP applications to problems of assessment in various industries and several studies are dedicated on AHP application to occupational safety problems (Caputo et al., 2018). To get priorities and weights to improve the judgment of decision makers, AHP decomposes obstacles into a hierarchical structure (Sangiorgio Et al., 2021).

TOPSIS method is based on comparing the alternative solutions by the negative ideal solution and a positive ideal solution in order to select the optimal solution (Kwok Et al., 2019). The proposed approach extends the TOPSIS method to solve complex production planning process problems faced by many manufacturing companies (Yu Et al., 2022). Traditionally the weights of TOPSIS presented as crisp numbers which cannot be applicable in real environment (Nabeeh Et al., 2019). For conditions of uncertainty, TOPSIS AHP is combined with neutrosophic illustrated in various fields to reach the ideal decision (Basset Et al., 2018). The fact, between the research that has been done with the facts on the ground creates a gap. Another fact was found that hierarchical process analytics (AHP) combined with TOPSIS can create an accurate ranking to answer optimization problems in a company. This gap can be used by future researchers to answer the question of whether using these two methods is in accordance with the quality standards provided by the company.

3. RESEARCH METHOD

The research is using primer data for analysis from two questionnaires there are level of importance between criteria and sub-criteria and an evaluation of Supplier performance. The respondents came from experts in CV Gembira, namely five staff who play a direct role in the selection of suppliers. Also, do the interviews with staff who are experts in their fields and are involved in the production process and the level of performance of raw material suppliers. Proven those with literature techniques from books and journals from previous researchers regarding. The analytical method can be seen in Figure 1.

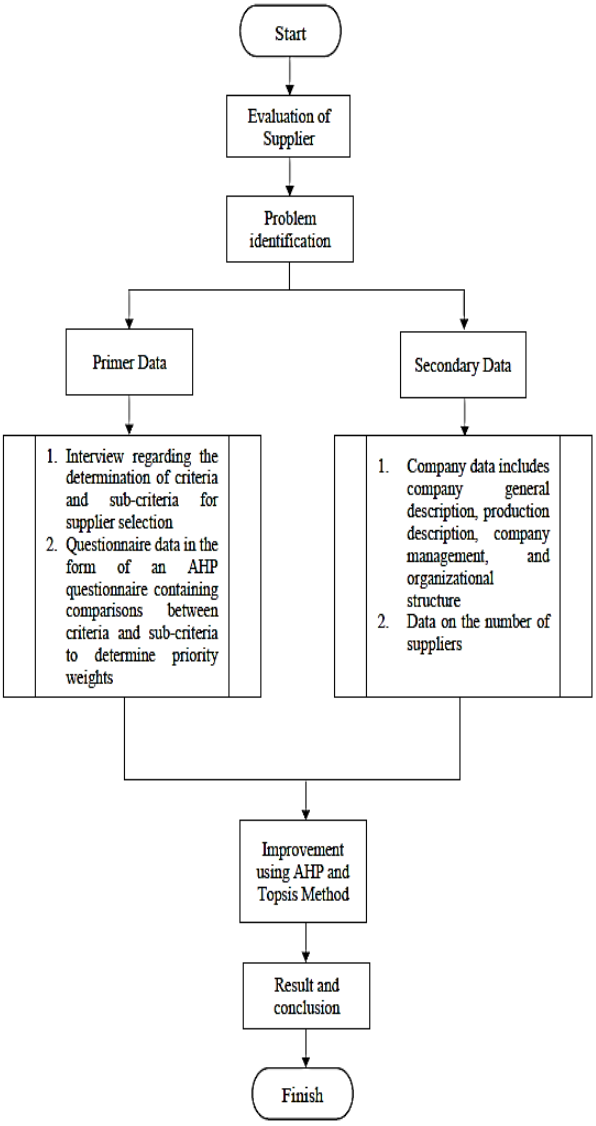

Figure 1. Flow chart analysis stage

4. RESULT AND DISCUSSION

A. Questionnaire Of Supplier Criteria and Sub-Criteria

In selecting the best supplier, it is important for companies to evaluate suppliers in terms of criteria and sub-criteria. This is because the criteria and sub-criteria will be the basis for assessing supplier performance. The results of the assessment are used as a basis for making decisions related to the continuation of cooperation between the company and suppliers as raw material suppliers. CV Gembira has seven suppliers of rice that can seen in Table 1.

Table 1. Rice supplier data

No	Suppliers name
1	CV. Sumber Ekonomi
2	CV. Sumber Gangsar
3	CV. Sumber Akbar
4	UD. Jaya Tani
5	UD. Sumber Rejeki
6	UD. Bintang Timur
7	UD. Karya Sehat

Based on the Table 1 know that there are seven suppliers of rice raw material for CV Gembira. Those suppliers have criteria and sub-criteria based on interviews with the five staffs who play a direct role in the selection of suppliers in and table Dickson's literature. It can be seen in Table 2.

Table 2. Criteria and sub-criteria of suppliers

No	Criteria	Sub-criteria
1	Quality (Q)	Compliance with specifications (K1) Quality consistency (K2)
2	Price (P)	Raw material prices (P1) Shipping price (P2)
3	Delivery (D)	The accuracy of the amount sent (D1) On time delivery (D2)
4	Capacity (C)	Amount of raw rice sent (C1) Rice supply provided in accordance with the agreement (C2)
5	Warranty (W)	Ease in the claim process (W1) Provide raw material guarantee (W2)

Based on Table 2, know that in the hierarchy of supplier selection for rice raw materials, the first level is the goal of supplier selection. The second level are five criterias and the third level are ten sub-criterias that relevant from criterias. Table 3 is a recapitulation of the results by Supplier evaluation level questionnaire for the five staff respondents.

Table 3. Recapitulation of supplier evaluation level questionnaire

Suppliers name	Quality		Price		Delivery		Capacity		Warranty	
	Q1	Q2	P1	P2	D1	D2	C1	C2	W1	W2
CV. Sumber Ekonomi	4	5	4	5	5	5	4	5	4	5
CV. Sumber Gangsar	5	5	5	5	5	5	5	5	5	5
CV. Sumber Akbar	4	4	5	4	4	5	4	4	5	5
UD. Jaya Tani	4	5	4	5	5	5	4	5	4	5
UD. Sumber Rejeki	5	5	5	5	5	5	5	5	5	5
UD. Bintang Timur	4	4	5	4	3	4	4	4	4	5
UD. Karya Sehat	3	4	5	4	3	4	5	4	4	5

B. Pairwise Comparison Matrix

The next step is to calculate the geometric mean average for each criterion.

$$G = \sqrt[n]{X_1 \times X_2 \times \ldots \times X_n}$$
$$= \sqrt[3]{9 \times 5 \times 7 \times 9 \times 7}$$
$$= 7 \quad (1)$$

Total = quality + price+ delivery + capacity + warranty

= 1 + 1/7 + 1/6 + 1/5 + 1/5

= 1.71 (2)

Table 4. The pairwise comparison matrix

Criteria	Quality	Price
Quality	1	7
Price	1/7	1
Delivery	1/6	1/2
Capacity	1/5	1
Warranty & Service	1/5	1/2
Total	**1.71**	**10**

The results for each criterion and sub-criteria are entered into the pairwise comparison matrix can be seen in Table 5 and 6.

Table 5. Pairwise comparison matrix for the quality sub-criteria

Quality	Specification Conformance	Quality Consistency
Specification Conformance	1	0.71
Quality Consistency	1.4	1
Total	**2.4**	**1.71**

From the results above, it is known that there is a relationship between the sub-criteria that are worth 0.71 and 1.4. This value indicates that there is a consideration between the two criteria with a slightly more important consideration being the quality consistency criterion.

Table 6. Pairwise comparison matrix for the price sub-criteria

Price	Raw Materials Price	Shipping Price
Raw Materials Price	1	4
Delivery Price	0.25	1
Total	**1.25**	**5**

From the results of the pairwise comparison matrix for the price sub criteria above, it is known that there is a relationship between the sub criteria which are worth 4 and 0.25. This value indicates a consideration between the two criteria with a slightly more important consideration being the raw material price criterion.

Table 7. Normalization of pairwise comparison matrix criteria

Criteria	Quality	Price	Delivery	Capacity	Warranti	Mean
Quality	0.585	0.707	0.504	0.654	0.408	0.5715
Price	0.084	0.098	0.149	0.120	0.136	0.1174
Delivery	0.097	0.049	0.087	0.065	0.123	0.0843
Capacity	0.117	0.098	0.173	0.120	0.250	0.1516
Warranti	0.117	0.049	0.087	0.040	0.083	0.0752
Total	**1**	**1**	**1**	**1**	**1**	**1**

Table 8. Normalization of pairwise comparison matrix for the quality sub-criteria

Quality	Specification	Consistency	Mean
Specification	0.42	0.42	0.42
Consistency	0.58	0.58	0.58
Total	**1**	**1**	**1**

From the Table 8, it can be seen that the highest sub-criteria weight of the quality sub-criteria is the consistency of quality with a value of 0.58. Meanwhile, the value for the conformity sub-criteria for the specifications of the quality sub-criteria is 0.42.

Table 9. Normalization of pairwise comparison matrix for the price sub-criteria

Price	Raw material price	Delivery cost	Mean
Raw material price	0.80	0.80	0.80
Delivery cost	0.20	0.20	0.20
Total	**1**	**1**	**1**

Can be seen that the highest sub-criteria weight of the price sub-criteria is the price of raw

materials with a value of 0.80. The value on the shipping price sub-criteria is from the price sub-criteria is 0.20.

C. Normalized Decision Matrix

In evaluating supplier based on 2 criteria quality and. The following is an evaluation decision matrix supplier which will then be normalized.

Table 10. Normalized supplier evaluation decision matrix

Rice Supplier	Quality		Price	
	K1	K2	P1	P2
S1	0.3930	0.4073	0.3800	0.4261
S2	0.3573	0.3365	0.3469	0.3551
S3	0.3751	0.3896	0.3800	0.4084
S4	0.3930	0.4073	0.3800	0.4084
S5	0.3930	0.3896	0.3965	0.3729
S6	0.3751	0.3719	0.3965	0.3729
S7	0.3573	0.3365	0.3635	0.2841

The next step is to determine the weighted normalized decision matrix. The following is the result of the evaluation decision matrix supplier weighted normalized.

Table 11. Evaluation decision matrix supplier weighted normalized

Rice Supplier	Quality		Price	
	K1	K2	P1	P2
S1	0.1636	0.2377	0.3040	0.0852
S2	0.1488	0.1964	0.2775	0.0710
S3	0.1562	0.2274	0.3040	0.0817
S4	0.1636	0.2377	0.3040	0.0817
S5	0.1636	0.2274	0.3172	0.0746
S6	0.1562	0.2170	0.3172	0.0746
S7	0.1488	0.1964	0.2908	0.0568

The weighted normalized matrix is obtained by multiplying each column of the normalized decision matrix by the associated weight. The following is an example of calculating a weighted normalized matrix on supplier 1 criteria K1 (conformance specifications).

D. Preference Value And Supplier Ranking

Calculation of preference value is used to obtain decision results from the closeness value of each alternative to the ideal solution that has the greatest value. A larger preference value indicates that the alternative has been selected. The following is a table of preference values for each alternative supplier.

Table 12. Preference value

Supplier	Preference
S1	0.5969
S2	0.4436
S3	0.4836
S4	0.5459
S5	0.5641
S6	0.6249
S7	0.3852

Table 13. Supplier ranking

Supplier	Preference	Ranking
S6	0.6249	1
S1	0.5969	2
S5	0.5641	3
S4	0.5459	4
S3	0.4838	5
S2	0.4436	6
S7	0.3852	7

From the ranking table Supplier on shows sequence supplier with the greatest value. Supplier with rank 1 is UD Bintang Timur, rank 2 is CV Sumber Ekonomi, rank 3 is UD Sumber Rejeki, rank 4 is UD Jaya Tani, rank 5 is UD Sumber Akbar, rank 6 is CV Sumber Gangsar and rank 7 is UD Karya Sehat. Based on previous research, the use of the AHP method in combination with TOPSIS can still be used optimally to determine the best supplier ranking. Also, from this research, companies can get benefit from choosing the best suppliers so they can avoid mistakes that often occur, such as not sending the raw material specifications requested by the company, damage of raw material, and delays in delivery. This will improve cooperation between companies and suppliers as well as increase profits of CV. Gembira.

5. CONCLUSION

After conducting interviews with the staff of CV Gembira, it was found that the criteria that became the basis of the company when choosing supplier are the criteria of quality, price, delivery, capacity. After performing calculations using the AHP and TOPSIS methods, alternative sequence results are obtained supplier the best that can be used by CV Gembira with a preference value of 0.6249 is owned by UD Bintang Timur. For future research, the researcher hope not only to analyze suppliers but to provide the latest solutions to replace suppliers who are deemed unprofitable.

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