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SUPPLIER SELECTION USING FUZZY ANALYTIC NETWORK PROCESS (FANP) AT PT PUTRA GUNUNG KIDUL

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Abstract Supplier selection is very important in the purchase of raw materials that require a good cooperative relationship between the supplier and the company. The interaction between the company and the supplier is required to ensure the availability of raw materials needed in the production process. PT Putra Gunung Kidul is a company that produces noodles. The problems that occurred in PT Putra Gunung Kidul is the order delivery of raw materials from suppliers that do not fit the schedule so that a delay in delivery so that production companies to be blocked. Objectives to be achieved in this study, the first objective is to determine the criteria most influential in the choice of supplier PT Putra Gunung Kidul and determine the best suppliers based on the results of ranking supplier using Fuzzy Analytic Network Process (FANP). FANP calculations done using pairwise comparison matrix pairs of the five criteria, 16 sub-criteria, as well as three alternative suppliers in order to obtain the weight of each criteria, sub-criteria and alternatives. Based on calculations of the most influential criterion is quality with a weight of 0.24686. Subcriteria most influential of weighting results based on the criteria of the most influential is the ability to deliver consistent quality (Q2) of 0.094531. Best Supplier in supplying raw materials to PT Putra Gunung Kidul based on the ranking and the greatest weight is PT B is at the first place with a weight of 0.137086, PT C ranks second with a weight of 0.079240, and PT A ranks third with a weight of 0.062575.

Keyword : Supplier, Selection criteria, Alternative, ANP

1. Introduction

Supplier selection is very important in the purchase of raw materials so that requires a good cooperation between the supplier and the company. Companies generally have different criteria in choosing suppliers according to company standards to ensure the quality of products produced in accordance with the wishes of consumers.

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PT Putra Gunung Kidul is a company producing noodles. Problems that occur in PT Putra Gunung Kidul is the delivery of raw materials from suppliers that do not fit the schedule so that there is a delay in the delivery so that the company's production activities become obstructed. Therefore, the company needs supply chain management that includes supplier selection activity with the method used is Fuzzy Analytic Network Process (FANP) taking into account the selection criteria specified by the company. Fuzzy analytic network process (FANP) method is used because of the problem of corporate problem that is difficult to predict in the company so that solution in problem solving is difficult to model. The purpose of this study is to determine the most influential criteria in supplier selection in PT Putra Gunung Kidul and determine the best supplier based on the supplier's ranking using Fuzzy Analytic Network Process (FANP) method.

2. Method

The object of research was conducted on PT Putra Gunung Kidul located in Depok Tengah area. Initial stages in the research is to identify the problems contained in the company. Problems that occur in the company based on the identification process is the delivery of raw material orders from suppliers that are not on schedule so that there is delay in delivery. This causes the company's production activities to be hampered. The next step is literature study and field study. Library study aims to collect information through literature review that contains the source or theories. The literature review used is obtained from books and scientific journals related to the theme of writing the final project. Field studies conducted to obtain information by conducting direct observation to the field or company. The next step in the methodology of this research is to determine the purpose of the study There are two objectives to be achieved in this research, the first objective is to determine the most influential criteria in supplier selection in PT Putra Gunung Kidul. The second objective is to determine the best supplier based on the supplier's ranking using Fuzzy Analytic Network Process (FANP) method. The next step is to conduct preliminary research that aims to determine criteria, sub criteria, and alternative suppliers obtained through interviews with relevant sources. The next step in the research methodology is a questionnaire consisting of two stages. The first stage is the determination of the respondents involved in decision making. The respondents selected in the questionnaire consisted of two respondents, namely the owner of the company and the head of the production department. The reason for choosing both respondents is the first respondents role in the process of ordering raw materials and payment of raw materials. The second respondent was chosen because of the role in the process of receiving raw materials from suppliers and checking the amount of raw materials and quality of raw materials that have reached the warehouse. The second stage is the distribution of questionnaires to the respondents who have been set. The next step in the methodology of this research is data processing using Fuzzy Analytic Network Process (FANP) which consists of several stages.

Data processing is done manually and data processing using Super Decision software. Initial stages in data processing is an ANP network model that aims to describe the relationship between the criteria and subcriteria. The second stage is to calculate the value of Consistency Ratio (CR) which aims to assess the consistency of respondents in conducting the assessment of the questionnaire. The next step is to convert linguistic variables into fuzzy triangular. Linguistic variables obtained from the results of pairwise comparison questionnaires are converted into fuzzy numbers is triangular fuzzy number. The next step is to calculate the geometric mean of the questionnaire aimed at obtaining a single fuzzy triangular number from some respondents. The next step is to calculate the priority weight of the local aims to know the priority weight of each element. The next step is to make supermatrik from each alternative and criteria. Supermatrics to be prepared are unweighted supermatrics, weighted supermatrics and supermatrik limits. The next step is the ranking of alternatives sorted

according to the highest ranking of each alternative. The next step in the research methodology is to analyze the results of data processing that aims to analyze the results of calculation using Fuzzy Analytic Network Process (FANP) method. The final stages in writing this final task is the conclusion of the results of calculations that have been done and provide advice to the company and further research. and deliver a product into the hands of end users (Pujawan, 2010). SCM is not only oriented to internal problems of a company, but also an external company that deals with relationships with partner companies. The purpose of the supply chain is to satisfy consumers through inter-company coordination and collaboration by making cheap products, delivering them on time, and with good quality (Indrajit, 2002).

The selection of suppliers in PT Putra Gunung Kidul using Fuzzy Analytic Network Process (FANP) was done based on questionnaire result from both respondents. Results from interviews with both respondents obtained some criteria in the selection of suppliers as well as some alternative suppliers that supply raw materials in the company. Below is Table 1 grouping criteria, subcriteria, and alternative suppliers that supply raw materials to PT Putra Gunung Kidul.

3. Result

Supply chain is a network of companies that work together to create

.

Table 1 Grouping Criteria, Subcriteria and Alternative Supplier

Supplier Selection Criteria and Subcriteria	
Price	Payment method (P1)
	Giving a discount (P2)
	The merit of price with the quality of goods (P2)
	Grace period of payment (P4)
Delivery	Timed delivery (D1)
	Delivery of goods on time (D2)
	The accuracy of the number of shipments (D3)
Quality	Conformity of goods with specified specifications (Q1)
	Ability to provide consistent quality (Q2)
	Provision of goods without defects (Q3)
Service	Easy to contact (S1)
	Speed in response to customer demand (S2)
	Ability to provide information clearly (S3)
	Quick response in resolving customer complaints (S4)
Location	Distance between locations (L1)
	Condition of infrastructure (L2)
Alternative	PT A
	PT B
	PT C

(**Source: Respondents Interview Result)**

The results of grouping criteria, subcriteria and alternative suppliers then made a network model. Figure 1 is a network selection model of raw material suppliers in PT Putra Gunung Kidul.

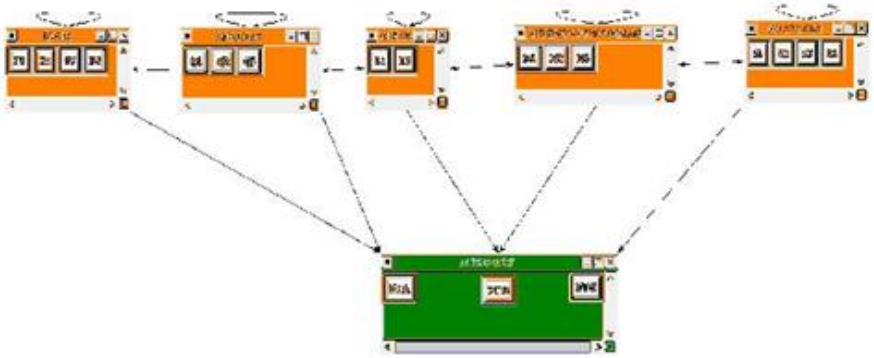

Figure 1 Supplier Network Selection Model
(Source: Results of Data Processing)

An ANP network model is used to identify the interplay relationships between supplier selection criteria and subcriteria with supplier alternatives in PT Putra Gunung Kidul. Selection criteria, subcriteria, and alternatives used were obtained through interviews with respondents and adjustments were made to the respondents. Based on the election network model, there is an inner dependency relationship and outerdependence relation on each criterion. The relationship of inner dependency is a relationship that interplay between an element with other elements that are in one cluster. Outerdependence relationships are interrelated relationships between an element with other elements contained in different clusters. Results of questionnaires with respondents involved tested the value of consistency ratio aims to determine the consistency of answers questionnaires that have been filled by respondents that will affect the stability of the results. The value of the consistency ratio is acceptable if if the value of CR $\leq$ 0.1, if the value of the consistency ratio of the

questionnaire answers has CR value of 0.1 then the questionnaire should be revised again because there are inconsistencies of respondents in filling out the questionnaire answer. Consistency value calculation is done by using super decision software.

Data obtained from the questionnaire distributed using linguistic variables. The questionnaire that has been tested for consistency ratio value is then converted into fuzzy triangular number using the membership function of triangular fuzzy number. The change of linguistic variables into fuzzy numbers is shown in Table 2.

Table 2 Triangular Fuzzy Number Membership Function

Fuzzy Number	***Linguistic Variable***	***Membership Function of Fuzzy Number***
1	*Equality Important*	(1, 1, 3)
3	*Moderately Important*	(1, 3, 5)
5	*Important*	(3, 5, 7)
7	*Very Important*	(5, 7, 9)
9	*Extremely Important*	(7, 9, 9)

The following table 3 is an example of changing linguistic variables into fuzzy triangular numbers on site criteria with questionnaires used are first responders.

Table 3 Questionnaire Assessment Site Criteria

Criteria	Absolute More Important	Very More Important	More important	Slightly More Important	Equally Important	Slightly More Important	More important	Very More Important	Absolute More Important	Criteria
	9	7	5	3	1	3	5	7	9	
L1							v			L2

The results of the questionnaire show that the ratio between subcriteria spacing between locations L1 and infrastructure condition L2 is 5 and is on the right, meaning that the condition of infrastructure is more important than the distance between locations. The change of linguistic variables into fuzzy triangular numbers in the questionnaire is (1/3, 1/5, 1/7), if the value 5 is on the left then the fuzzy triangular number changes to (3, 5, 7).

Questionnaire that has been converted into fuzzy triangular number, then calculated the geometric mean value by combining the questionnaire result from all related responders. The combined questionnaire, then calculated the geometric mean value. The following is an example of a geometric mean calculation based on the incorporation of a questionnaire on the price criteria. The combined questionnaire, then calculated the geometric mean value. The following is an example of a geometric mean calculation based on the incorporation of a questionnaire on the price criteria.

$$c = \sqrt[2]{c1 \times c2} = \sqrt[2]{\frac{1}{5} x \frac{1}{3}} = 0{,}258$$

$$b = \sqrt[2]{b1 \times b2} = \sqrt[2]{\frac{1}{7} x \frac{1}{5}} = 0{,}169$$

$$a = \sqrt[2]{a1 \times a2} = \sqrt[2]{\frac{1}{9} x \frac{1}{7}} = 0{,}126$$

The results of the calculation of the average geometry of both respondents can be seen in Table 4.

Table 4 Average Geometric Location Criteria

Criteria	Absolute More Important	Very More Important	More important	Criteria
	c	b	a	
L1	0,258	0,169	0,126	L2

The value of the calculated mean of the geometry will be defuzzed to obtain a single value that will be used in constructing a paired matrix using the Center of Gravity (COG) method. Calculations using the Center of Gravity (COG) method in the defuzzyfication process are as follows.

$$F_{ij} = \frac{\left[\left(a_{ij} - c_{ij}\right) + \left(b_{ij} - c_{ij}\right)\right]}{3} + c_{ij}$$

$$F_{ij} = \frac{\left[\left(0,126 - 0,258\right) + \left(0,169 - 0,258\right)\right]}{3} + 0,258 = 0,184$$

The defuzzification result will be entered into pairwise comparison matrices. Comparison matrix in pairs on the location criteria can be seen in table 5.

Table 5 Matched Comparison Matrices Location Criteria

Criteria	Distance between locations (L1)	Infrastructure Condition (L2)
Distance between locations (L1)	1	0,184
Infrastructure Condition (L2)	5,435	1

(Source: Results of Data Processing)

The pairwise comparison matrix is then normalized. The result of normalization on pairwise comparison matrices on site criteria can be seen in Table 6.

Table 6 Local Priority Criteria Location Weight

Criteria	Distance between locations (L1)	Infrastructure Condition (L2)	Average
Distance between locations (L1)	0,1554	0,1554	0,1554
Infrastructure Condition (L2)	0,8446	0,8446	0,8446
Total	1	1	1

(Source: Results of Data Processing)

Subsequent calculations in Fuzzy Analytic Network Process (FANP). Is the calculation of supermatrics. Supermatriks to be arranged in the calculation of ANP is divided into three, namely unweighted supermatriks, weighted supermatriks, and limiting supermatriks. Supercatrix calculations are performed by collecting all priority weight values on pairwise comparison matrices. The calculation of the third value of supermatriks in this study was conducted using superdecision software. The data used in the calculation of suermatriks is the result of comparing matrix of pairwise comparison. Pairwise comparisons are not only done between elements, but also pairwise comparison between clusters(group matrices). The value of comparison between clusters will be used at the time of calculation of supermatriks. Comparison of paired clusters between clusters can be seen in Table 7.

Table 7 Comparison of Pairs of Clustered Between Groups

Cluster	Alternative	Price	Delivery	Quality	Location	Service
Alternative	0	0.572082	0.252486	0.214532	0.201026	0.434429
Price	0	0.427918	0	0.27577	0	0
Delivery	0	0	0.247538	0	0.238719	0.300569
Quality	0	0	0	0.233657	0.419213	0
Location	0	0	0.249988	0.249041	0.141042	0
Service	0	0	0.249988	0	0	0.265002

(Source: Results of Data Processing)

The unbalanced supermatrics obtained are local priority weights that do not take into

consideration the relationship of paired pairs between clusters (group matrices). The criteria or above are the means that affect, while the criteria or alternatives below are affected. The meeting between the criterion and the alternate that has no relationship then filled with 0 (zero). Weighted supermatriks are supermatriks that consider the relationship of paired pairs between clusters (group matrices). The weighted supermatric calculation is performed by multiplying the value obtained in unweighted supermatrics by the value of paired comparisons between clusters (group matrices). The calculation results of supermatriks limiting is furthermore normalized to obtain the priority value of each criterion, subcriteria, and alternative. Priority results from each of the criteria, subcriteria, and alternatives can be seen in Table 8.

Table 8 Priority Criteria, Sub Criteria, and Alternatives

Name	*Normalized By Cluster*	*Limiting*
PT A	0.22436	0.062575
PT B	0.49152	0.137086
PT C	0.28412	0.079240
P1	0.18681	0.028654
P2	0.17210	0.026398
P3	0.41304	0.063355
P4	0.22806	0.034981
D1	0.14305	0.018200
D2	0.58646	0.074612
D3	0.27049	0.034413
Q1	0.27801	0.068630
Q2	0.38293	0.094531
Q3	0.33906	0.083700
L1	0.50000	0.081479
L2	0.50000	0.081479
S1	0.20745	0.006362
S2	0.32500	0.009967
S3	0.21257	0.006519
S4	0.25499	0.007820

(Source: Results of Data Processing)

Based on the calculation limiting supermatriks then obtained the value of the limit of each alternative. Limit values obtained from the calculation results will

Table 9 Alternative Rank

Alternative	Ideal	Normal	Total	Rank
PT A	0,45642	0,22436	0,062575	3
PT B	1,00000	0,49152	0,137086	1
PT C	0,57804	0,28412	0,079240	2

(Source: Results of Data Processing)

4. Conclusion

There are five criteria that determine the selection of suppliers in PT Putra Gunung Kidul, namely price, delivery accuracy, quality, location, and service. Based on the results of calculations performed using Fuzzy Analytic Network Process (FANP) of the five criteria is the most influential criteria of quality with a weight of 0.24686. The most influential subcriteria of weighting based on the most influential criteria is the ability to provide consistent quality (Q2) of 0.094531. The result of Fuzzy Analytic Network Process (FANP) calculation is done by using pairwise comparison matrix from several criteria and subcriteria, and third alternative supplier that is PT A, PT B, and PT C. Based on calculation result, it is found that the best supplier in supplying raw material in PT Putra Gunung Kidul based on the rank and weight of the largest is PT B is in the first rank with a weight of 0.137086, PT C is in second with a weight of 0.079240, and PT A is in third with weight of 0.062575. Suggestions given for improvement in subsequent research as well as provide suggestions for improvements that affect the company. Advice for the company is the company should consider and pay more attention to the criteria

in the selection of suppliers so that the supplier selection process becomes more objective and get the best solution. Suggestions for further research should be in subsequent research the research process is not only done by considering the criteria and subcriteria in the selection of suppliers, but also pay attention to the risks arising from each criteria and subcriteria in the selection of suppliers by using other methods.

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