

Potential Supplier Selection in Motorcycle Main Stand using TOPSIS Method

Qlea Roskiando, Isti Surjandari, and Ricky Bagus Andriawan

Abstract— In face of increasing industrial world’s stringent, supplier selection is required to produce good quality products with competitive prices. It makes the manufacturers have to improve the efficiency.

Keywords— TOPSIS, Motorcycle, Supplier Selection, Supply Chain Management.

I. INTRODUCTION

SUPPLY Chain Management (SCM) is about flow material management, information, and finance in a network consist of supplier, company, distributor, and customer so that products are produced and distributed with the good quality, the right location, and right time to minimize costs with good service. SCM connects various business processes such as interaction between supplier and customer. A company that sell of goods, must work together with suppliers to ensure the availability of goods. Supplier selection is a key of SCM success because it connects to raw material cost.

Supplier selection has a long process. Supplier is evaluated for several criteria such as cost, delivery, quality, and others. Several criteria has trade off such as the suppliers who offer low price product with good quality but uncertain delivery [1]. As many as companies desired criteria for supplier selection makes this problem more complex, and therefore required an engineering decision making in supplier selection. Number of criteria is necessary to the proper method of multi-criteria decision making. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is used to obtain the ideal supplier in the selection process. TOPSIS is a method of multi-criteria decision-making that uses the principle that the chosen alternative is an ideal alternative to the existing criteria. TOPSIS is used because the concept is simple, easy to understand, and have the ability to measure the relative performance of supplier alternatives in the form of a simple mathematical. Supplier selection is one way to improve efficiency. In this research, the ideal supplier selection uses TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method with 20 criteria. As the results of TOPSIS, can be known the ideal supplier’s ranking. Results

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from this research is a better supplier selection framework.

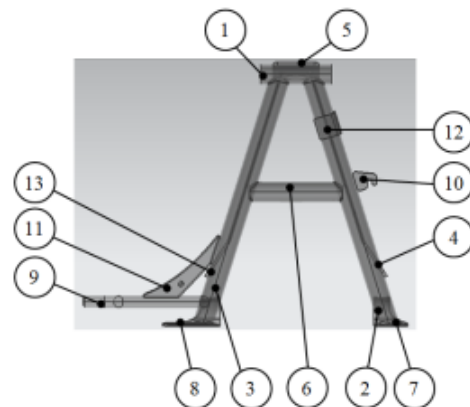


Fig. 1 The parts of Main Stand

TABLE I
ANNOTATION OF PART OR MAIN STAND

No.	Part Name	No.	Part Name
1.	Pivot or Stand Pipe	8.	Plate, L Tread
2.	Pipe, Main (R)	9.	Bar, Stand Tread
3.	Pipe, Main (L)	10.	Hook, Spg
4.	Plate, R Main	11.	Patch, Tread Bar
5.	Plate, Stopper	12.	Patch
6.	Pipe, M/Stand Cross	13.	Plate, L Main
7.	Plate, R Tread		

In order to produce a main stand, the company requires suppliers surveyed. In the selection of prospective suppliers, the company implemented the steps listed in Figure 2.

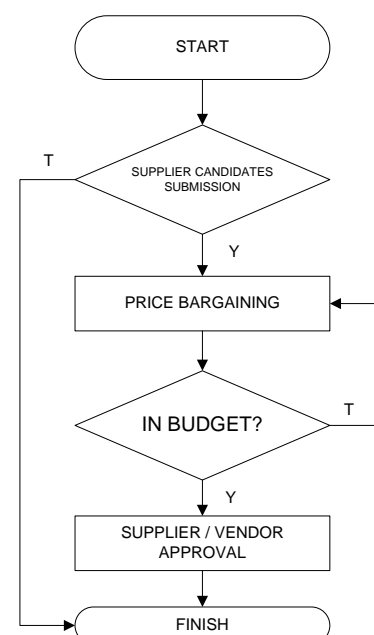


Fig. 2 The flow chart on the company selection Supplier

TOPSIS will maximize the criteria that must be maximized while minimizing the criteria to be minimized so that the value will be positive ideal solution and negative ideal solution. The criteria must be maximized and minimized shown in Table II.

Five criteria were used in this study which are: quality, delivery, customer service, the company's commitment in promoting products, services, and costs. 1st questionnaire was developed based on these criteria. 2nd questionnaire aims to provide an assessment of the performance of each candidate supplier. TOPSIS was used to find the required preference weights (i.e., using the entropy method). TOPSIS calculation will result in an ideal supplier ranking. The results of 1st questionnaire can be seen in Table III.

Criteria used in subsequent questionnaires are the criteria that have an average rating above 4, the criteria that are considered important by the respondents represented company in this study. Subsequent questionnaires, the 2nd questionnaire is a questionnaire that aims to assess the performance of each potential supplier-related criteria. The results of the 2nd questionnaire can be seen in Table IV. Obtained from the 2nd questionnaire suitability rating so each alternative on each criteria. Then from this questionnaire can be calculated entropy weighting followed by calculation of TOPSIS.

TABLE II
MAX/MIN CRITERIA

No	Criteria	Max/min
1	Product Quality	max
2	Product Warranty	max
3	Product Price	min
4	Accuracy Delivery Time	max
5	Accuracy Delivery Quantity	max
6	Supplier easily contacted	max
7	Responsive to customer	max
8	Communication completeness (e-mail, fax, phone number)	max
9	Production Capacity	max
10	Production Facility	max
11	Operator Skill	max
12	NG percentage of total production	min
13	Available SOP and Checksheet	max
14	Safety system	max
15	Clear organization structure	max
16	Financial Stability	max
17	Production schedule and its realization	max
18	Has minimum stock level reference	max
19	Drawing and document control	max
20	New product knowledge	max

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is a method of Multi-Criteria Decision Making (MCDM) which was first introduced by Yoon and Hwang in 1981. TOPSIS using the principle that the chosen Alternative should have the shortest distance from the positive ideal solution and the farthest from the negative ideal solution from the point of view of geometric using Euclidean distance to determine the relative closeness of an alternative to the optimal solution. Positive ideal solution is defined as the sum of all value that can be achieved for each attribute, whereas the ideal solution negatif consists of all the worst values achieved for each attribute. TOPSIS take into account both the distance to the positive ideal solution and the distance to the negative ideal solution by taking the relative closeness to the positive ideal solution. Based on a

Comparison of the relative distance, alternative priority order can be obtained. This method is widely used to solve a practical decision. This is because the concept is simple and easy to understand, computationally efficient, and has the ability to measure the relative performance of decision alternatives.

TABLE III
1st QUESTIONNAIRE RESULT

NO.	SUPPLIER SELECTION CRITERIA	TOTAL	Average
1	Product Quality	40	5,00
2	Product Warranty	36	4,50
3	Product Price	36	4,50
4	Delivery Cost	26	3,25
5	Accuracy Delivery Time	36	4,50
6	Accuracy Delivery Quantity	36	4,50
7	Product Packaging	31	3,88
8	Delivery Truck Availability	30	3,75
9	Supplier easily contacted	36	4,50
10	Responsive to customer	37	4,63
11	Communication completeness (e-mail, fax, phone number)	34	4,25
12	Production Capacity	38	4,75
13	Production Facility	34	4,25
14	Operator Skill	32	4,00
15	NG percentage of total production	37	4,63
16	ISO Certification	28	3,50
17	Available SOP and Checksheet	35	4,38
18	Safety system	32	4,00
19	Clear organization structure	33	4,13
20	Financial Stability	36	4,50
21	Total order were handled in the past	29	3,63
22	Production schedule and its realization	36	4,50
23	has minimum stock level reference	34	4,25
24	Supplier Location	31	3,88
25	Drawing and document control	35	4,38
26	New product knowledge	34	4,25
27	R & D Skill	31	3,88

In general, the procedure TOPSIS follow the following steps [2] :

- Create normalized decision matrix
- Create a weighted normalized decision matrix
- Determine the positive ideal solution matrix and the negative ideal solution matrix
- Determine the distance between the value of each alternative to the ideal solution matrix positive and negative ideal solution matrix
- Specifies a preference value for each alternative

TOPSIS require A_1 , the performance of each alternative on each criteria C_1 are normalized, i.e.:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \tag{1}$$

for $i = 1, 2, \dots, m$; and $j = 1, 2, \dots, n$

Positive ideal solution A^+ and A^- negative ideal solution can be determined based on normalized weight rating (y_{ij}) as:

$$y_{ij} = w_i r_{ij} \tag{2}$$

$i = 1, 2, \dots, m$; and $j = 1, 2, \dots, n$

$$A^+ = (y_1^+, y_2^+, \dots, y_n^+) \tag{3}$$

$$A^- = (y_1^-, y_2^-, \dots, y_n^-) \tag{4}$$

For :

$$y_j^+ = \begin{cases} \max y_{ij}; & \text{if } j \text{ is an attribute of profit} \\ \min y_{ij}; & \text{if } j \text{ is an attribute of cost} \end{cases} \quad (5)$$

$$y_j^- = \begin{cases} \min y_{ij}; & \text{if } j \text{ is an attribute of profit} \\ \max y_{ij}; & \text{if } j \text{ is an attribute of cost} \end{cases} \quad (6)$$

For : $j = 1, 2, \dots, n$

The distance between the alternative A_i with positive ideal solution is defined as:

$$D_i^+ = \sqrt{\sum_{j=1}^n (y_{ij}^+ - y_{ij})^2}, \quad i = 1, 2, \dots, m \quad (7)$$

The distance between the alternative A_i with negative ideal solution is defined as:

$$D_i^- = \sqrt{\sum_{j=1}^n (y_{ij} - y_{ij}^-)^2}, \quad i = 1, 2, \dots, m \quad (8)$$

Preference value for each alternative (V_i) is given as:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+}, \quad i = 1, 2, \dots, m \quad (9)$$

V_i greater value indicates that the preferred alternative A_i .

The Entropy is a weighting method. There are six stages in Entropy

- a. Determining the value of importance of each criteria
- b. Reducing the value of interest-Rated Ideal called k_{ij}
- c. Dividing The total value Such a criteria value:

$$a_{ij} = \frac{k_{ij}}{\sum_{i=1}^m \sum_{j=1}^n k_{ij}} \quad (10)$$

Where,

- m = number of decision-makers
- n = number of criteria

d. Calculating Entropy value for each criteria

e.

$$E_j = \left(\frac{1}{\ln(m)} \right) \times \sum_j a_{ij} \ln(a_{ij}) \quad (11)$$

f. Calculating dispersion of each criteria

$$D_j = 1 - E_j \quad (12)$$

g. Gaining weight from normalizing dispersion

$$W_j = \frac{D_j}{\sum D_j} \quad (13)$$

III. RESULT AND ANALYSIS

Figure 4 shows that the most important criteria considered in the supplier selection is the product quality and completeness of communication (e-mail, fax, and no. Tel. Offices) with equal weights is 0.11. Then followed the criteria of the SOP and the weight Checksheet 0.06. This differs from the current main criteria: price criteria. Price criteria ranking of 17th position with weights 0.03 and last criteria is the accuracy criteria deliveries weighing 0.00.

TOPSIS method is used to determine which suppliers are ideal candidates according to existing criteria. Then the criteria that have been computed using the weighted entropy method, TOPSIS incorporated into the formula using the formula 2. Figure 5 shows the value of each supplier. The primary consideration in choosing a prospective supplier is price

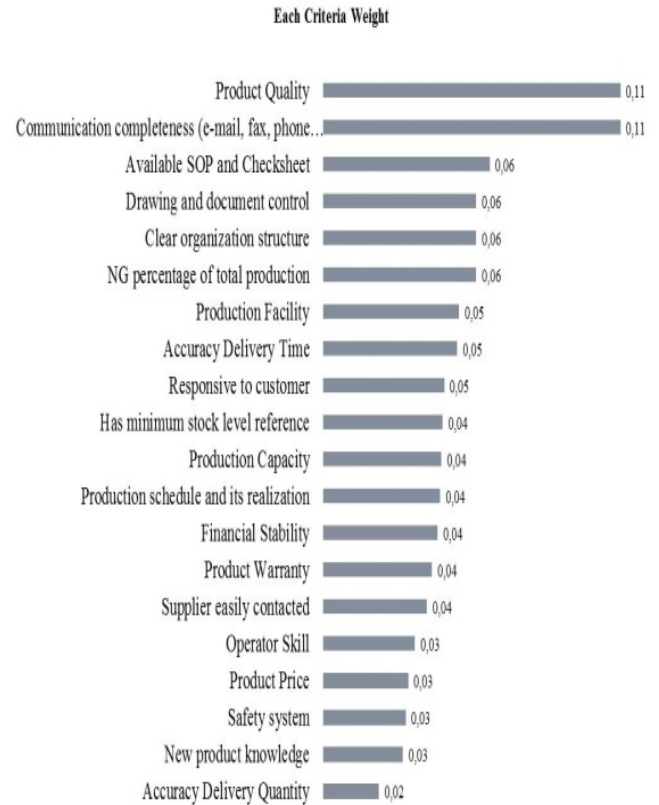


Fig. 3The weight of each criteria

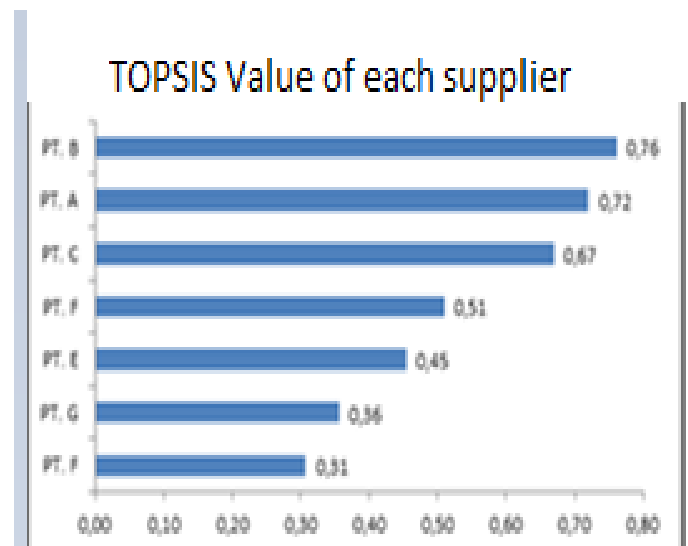


Fig. 4 TOPSIS value chart on each supplier

TABLE IV. 2ND QUESTIONNAIRE RESULT

No	Criteria	Supplier Name	Average	No	Criteria	Supplier Name	Average	No	Criteria	Supplier Name	Average
1	Product Quality	PT. A	3,75	8	Communication completeness (e-mail, fax, phone number)	PT. A	2,88	15	Clear organization structure	PT. A	4,13
		PT. B	4,13			PT. B	4,38			PT. B	3,88
		PT. C	4,13			PT. C	3,50			PT. C	3,75
		PT. D	2,75			PT. D	4,63			PT. D	3,63
		PT. E	3,63			PT. E	3,63			PT. E	2,75
		PT. F	2,88			PT. F	2,50			PT. F	2,38
		PT. G	3,25			PT. G	3,00			PT. G	3,13
2	Product Warranty	PT. A	3,50	9	Production Capacity	PT. A	3,00	16	Financial Stability	PT. A	4,00
		PT. B	3,38			PT. B	2,88			PT. B	3,63
		PT. C	3,50			PT. C	2,00			PT. C	4,25
		PT. D	3,38			PT. D	4,00			PT. D	4,50
		PT. E	3,13			PT. E	4,00			PT. E	4,38
		PT. F	2,38			PT. F	3,63			PT. F	2,50
		PT. G	2,75			PT. G	3,00			PT. G	3,50
3	Product Price	PT. A	1,38	10	Production Facility	PT. A	4,38	17	Production schedule and its realization	PT. A	4,00
		PT. B	1,38			PT. B	4,25			PT. B	4,13
		PT. C	2,13			PT. C	4,38			PT. C	4,13
		PT. D	4,00			PT. D	4,00			PT. D	4,00
		PT. E	4,50			PT. E	3,38			PT. E	3,63
		PT. F	3,25			PT. F	2,50			PT. F	3,38
		PT. G	3,50			PT. G	3,00			PT. G	3,38
4	Accuracy Delivery Time	PT. A	3,75	11	Operator Skill	PT. A	2,63	18	Has minimum stock level reference	PT. A	4,00
		PT. B	3,38			PT. B	3,00			PT. B	4,00
		PT. C	3,38			PT. C	3,00			PT. C	4,00
		PT. D	3,88			PT. D	3,00			PT. D	3,63
		PT. E	3,00			PT. E	3,00			PT. E	3,50
		PT. F	3,00			PT. F	2,88			PT. F	3,63
		PT. G	2,75			PT. G	3,00			PT. G	3,75
5	Accuracy Delivery Quantity	PT. A	4,75	12	NG percentage of total production	PT. A	4,00	19	Drawing and document control	PT. A	3,63
		PT. B	4,63			PT. B	4,13			PT. B	3,63
		PT. C	5,00			PT. C	4,00			PT. C	4,00
		PT. D	4,50			PT. D	3,63			PT. D	4,00
		PT. E	4,88			PT. E	2,50			PT. E	2,75
		PT. F	4,50			PT. F	2,25			PT. F	2,88
		PT. G	5,00			PT. G	3,13			PT. G	2,75
6	Supplier easily contacted	PT. A	4,63	13	Available SOP and Checksheet	PT. A	4,00	20	New product knowledge	PT. A	4,38
		PT. B	4,38			PT. B	4,00			PT. B	4,50
		PT. C	3,88			PT. C	4,00			PT. C	4,50
		PT. D	4,25			PT. D	3,25			PT. D	4,00
		PT. E	4,38			PT. E	3,13			PT. E	4,00
		PT. F	2,63			PT. F	2,75			PT. F	4,13
		PT. G	3,25			PT. G	2,75			PT. G	4,00
7	Responsive to customer	PT. A	3,88	14	Safety system	PT. A	3,00				
		PT. B	3,75			PT. B	3,00				
		PT. C	3,38			PT. C	3,00				
		PT. D	3,75			PT. D	3,00				
		PT. E	2,63			PT. E	2,63				
		PT. F	2,25			PT. F	2,25				
		PT. G	3,00			PT. G	3,00				

IV. CONCLUSIONS

This study choose ideal supplier by TOPSIS with 20 criteria. By using these criteria will get better supplier than only use price criteria hopefully. Then based on TOPSIS calculation result, ideal supplier ranking are supplier 2, supplier 1, supplier 3, supplier 4, supplier 5, supplier 7, and supplier 6. In order to work properly be made supplier selection framework with SOP.

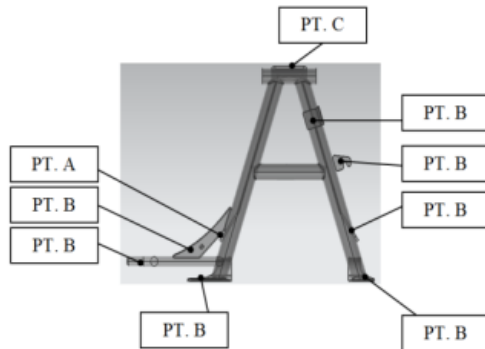


Fig. 5 Supplier of Each Component part

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