Multiple-Criteria Decision Making Approach for Pickup Truck Supplier Selection

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Abstract. *There has been a significant increase in the production and export of several products in Roi-et province, Thailand, recently. Thus, many companies are considering an appropriate supplier for their transportation vehicles to reduce the total transportation cost. The objective of this study is to examine crucial criteria influencing the selection of a pickup truck supplier. Factors affecting a pickup truck supplier selection in this research were reviewed and collected from the literature relating to a supplier selection in automotive and other related industries. All collected criteria were classified into a group systematically and then an analytical hierarchy diagram of pickup truck supplier selection was constructed for the interview process. Sixty-nine respondents, consist of ten respondents in a large business and fifty-nine respondents in a small business, were interviewed using a rating scale questionnaire. Rank order centroid (ROC) was considered as an appropriate method for weighting the criteria. After that, a Fuzzy TOPSIS technique was used as a decision-making tool to select the most suitable pickup truck supplier in this problem. The results revealed that the product quality and price are considered as the most important criterion, while maintainability and customer relationship have gained more attention from customer. In addition, it can be found that supplier B is the best supplier among four main suppliers in Thailand.*

1. Introduction

Road transportation is the most selected method for product transportation in Thailand. The demand for cars and pickup trucks increased due to the growth in Thailand economics, during 2010 to 2015, the car and pickup truck sale growth is 70.48% [1]. In this competitive market environment, automotive manufacturing companies are now facing the market of more demanding customers, many new criteria have become the important selection criteria in supplier selection. Customer relationship and after sale service have received growing attention over the last 10 years.

The supplier selection has attracted wide attention from several studies over the past few decades. Since 1996, the study by Gray [2] showed that product quality was the most important criteria in supplier selection follows by product delivery time and supplier efficiency. Weber et al. [3] analyzed 74 related studies on the supplier selection criteria and concluded that product price, product delivery time, and product quality were very important criteria for supplier selection while the selection methods had been classified into three categories as linear weighting, statistical approaches, and mathematical programming models. In [4], reviewed on various papers related to an economic sustainability criterion for supplier selection.

The important of product quality and price criteria in supplier selection were studied by many researches [5] [6]. However, the recent changes in customer behavior show that there are different criteria needed to be considered specific by industry, for example, customer preference was a major criteria for apparel manufacturing [7], manufacturer professionalism and customer service become significant criteria in automotive industry [8]. Quality standards, long term relationship, trust, responsiveness and certified had gained more importance for supplier selection [9] [10]. Apart from that, the supplier who had better product development and technical capability would have advantage over competitors [11]. Furthermore, the environmental performance of suppliers was becoming a generally recognized criteria for all industry [12] [13].

Several different methods were developed to take supplier selection criteria priorities into account [14]. The Rank Order Centroid (ROC), as one of linear weighting approach, is used to convert the ordinal ranking of several criteria into numerical weights. The advantage of ROC is that it will rely only on ordinal information about attribute importance. ROC was shown to perform better than the other rank-based schemes, e.g. equal weights (EW) rank sum (RS) and rank reciprocal (RR), in terms of choice accuracy [15]. Another well-known multiple criteria decision-making method is TOPSIS, proposed by Hwang and Yoon [16] in

1981. The concept of TOPSIS is to define the positive ideal solution and the negative ideal solution, which maximizes and minimizes the criteria, respectively. The optimal alternative is the closest alternative to the positive ideal solution and farthest to the negative ideal solution.

However, some criteria are difficult to measure using rating system as it is difficult to answer the qualitative questions in quantitative form. Most of the time, scale-based measurement does not represent customer preference. It is much easier to represent the performance of suppliers as lingual expressions, for example: good, very good, poor, very poor, etc. than in numbers. These lingual expressions are regarded as the natural representation of the preference or judgement and the evaluation is resulted from the different evaluator's view of linguistic variables, its evaluation must therefore be conducted in an uncertain, fuzzy environment. [17].

Recently, Fuzzy multiple criteria decisions making with the Technique of Order Preference Similarity to the Ideal Solution (fuzzy TOPSIS) method had been used to handle this kind of problem. Lo et al. [18] presented a fuzzy TOPSIS for analyzing available web services with fuzzy opinions. The results have shown that fuzzy TOPSIS can reduce the computational complexity in the decision-making process. Kim et al. [19] developed a framework that prioritized the best sites for treated wastewater, and fuzzy TOPSIS technique was shown to employed less controversially for the site selection problem. In [20], the AHP is used to analyze the structure of the project selection problem and to determine weights of the criteria, and fuzzy TOPSIS method is used to obtain final ranking. Kaur and Singh [21] developed the Fuzzy Analytical Hierarchical Process and TOPSIS (FAHP-TOPSIS) with Data Envelopment Analysis (DEA) to evaluate the supplier selection based on set of criteria suitable in Industry 4.0 environment. Experimental results shown that the criteria weight is very important factor for criteria ranking in fuzzy TOPSIS method.

In this research, we use ROC method to find the criteria weights for pickup truck supplier selection, and then, fuzzy TOPSIS method is used for selecting the best suitable supplier. The rest of this study is structured as follows: We explain the proposed method in Section 2. Section 3 presents the results of using the fuzzy TOPSIS in a real case application. In Section 4, discusses the conclusions about this research work.

2. Methodology

The review of the literature was done to identify the related criteria. This was followed by first questionnaire survey, which includes 16 main criteria and 40 secondary criteria. We used the Stratified Random Sampling method [22] to calculate the suitable sample size. Each criterion was evaluated using 1 to 5 rating (Likert) scales. Then, the criteria with 4.21 to 5.00 score, which is the highest rating score interval, was used to formulate the second questionnaire survey [23].

In the second questionnaire survey, the criteria were evaluated using ranking system. Each fuzzy criterion weight ($\widetilde{w}_j$) was calculated from the collected questionnaire results using ROC method:

$$\widetilde{w}_j = \frac{1}{n} \sum_{l=j}^{n} \frac{1}{l} \tag{1}$$

where n is the total number of all considered criteria

    j is the rank of considered criteria

After the weights were calculated, the third questionnaire survey was formulated to collect a pickup truck supplier data. The same criteria from the second questionnaire were used to evaluate the suppliers and rated by using linguistic variables. The survey results were transformed to fuzzy triangular numbers. Then, fuzzy TOPSIS was applied to aggregate the criteria and the alternative ratings to generate an overall score for assessing the performance of alternatives (pickup truck suppliers).

The fuzzy TOPSIS method involves fuzzy assessments of criteria and alternatives in TOPSIS. Assuming there are m possible candidates which are to evaluate against n criteria, the fuzzy decision matrix can be created using the fuzzy ratings of all decision makers described as triangular fuzzy number (TFN):

$$\tilde{x}_{ij}^{k} = \left(\tilde{a}_{ij}^{k}, \tilde{b}_{ij}^{k}, \tilde{c}_{ij}^{k} \right) \, , \quad i = 1, 2, 3, \ldots, m \quad \text{and} \quad j = 1, 2, 3, \ldots, n$$

where:
    k is the order of questionnaire respondents
    a_{ij} is the minimum score for candidate i and criteria j
    b_{ij} is the average score for candidate i and criteria j
    c_{ij} is the maximum score for candidate i and criteria j

The survey data were normalized using linear scale transformation to bring the various criteria scales into a comparable scale. The normalized TFN performance value ($\tilde{r}_{ij}$) for positive criterion and negative criterion can be calculated by:

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_i^+}, \frac{b_{ij}}{c_i^+}, \frac{c_{ij}}{c_i^+} \right), c_i^+ = \max_j c_{ij} \tag{2}$$

$$\tilde{r}_{ij} = \left(\frac{a_i^-}{c_{ij}}, \frac{a_i^-}{b_{ij}}, \frac{a_i^-}{a_{ij}} \right), a_i^- = \min_j a_{ij} \tag{3}$$

The weighted normalized TFN performance value ($\tilde{v}_{ij}$) is computed by multiplying the fuzzy criteria weight weights ($\widetilde{w}_j$) with the normalized TFN performance value ($\tilde{r}_{ij}$):

$$\tilde{v}_{ij} = \widetilde{w}_j \cdot \tilde{r}_{ij} \tag{4}$$

The Fuzzy Positive-Ideal Solution (FPIS: A^+) and Fuzzy Negative-Ideal Solution (FNIS: A^-) are determined by:

$$A^+ = (\tilde{v}_1^+, \tilde{v}_2^+, \dots, \tilde{v}_n^+) \qquad (5)$$

$$A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \dots, \tilde{v}_n^-) \qquad (6)$$

Then, the distance of each alternative from FPIS and FNIS can be calculated by:

$$d_i^+ = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^+), i = 1, 2, 3, \dots, m \qquad (7)$$

$$d_i^- = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^-), i = 1, 2, 3, \dots, m \qquad (8)$$

The distance measurement is calculated using Euclidean distance between two fuzzy numbers $\tilde{A}_1$ and $\tilde{A}_2$, which can be calculated using the following equation:

$$d(\tilde{A}_1, \tilde{A}_2) = \sqrt{\frac{1}{3}[(a_1\text{-}a_2)^2 + (b_1\text{-}b_2)^2 + (c_1\text{-}c_2)^2]} \quad (9)$$

where:

a_1, b_1, c_1 is the fuzzy ratings of the fuzzy numbers $\tilde{A}_1$

a_2, b_2, c_2 is the fuzzy ratings of the fuzzy numbers $\tilde{A}_2$

We can calculate the relative closeness (RC_i) for each alternative where $RC_i \in [0, 1]$ by:

$$RC_i = \frac{d_i^-}{d_i^+ + d_i^-}, i = 1, 2, 3, \dots, m \qquad (10)$$

Finally, all alternatives are ranked according to the RC_i in decreasing order. The best alternative is the alternative that has the highest RC_i, which is closest to the FPIS and farthest from the FNIS.

3.　Experimental Results

There are 214 transport companies located in Roi-et Province that use pickup trucks to transport goods (28 large-size companies and 186 small-size companies). In this research, the sampling size for questionnaire survey is calculated using Yamane's formula [24] with ±10% precision level and 90% confidence level, so that the data was collected by using questionnaire survey from 69 transportation service companies (10 large-size companies and 59 small-size companies).

Four pickup truck supplier companies in Thailand were selected and labelled as supplier A, B, C and D. 16 main criteria and 40 secondary criteria from 122 reviewed criteria were used in the first questionnaire survey. Then, the criteria with average score above 4.21 are selected as shown in Table 1.

The selected criteria were evaluated using ROC ranking system. From Table 3, we can see that product quality is the most important criteria due to the fact that the pickup truck is high price product and customer expects it to have a long-life cycle. While delivery and after service criteria had the lowest ranked among 8 selected criteria since all the suppliers have common service standard.

No.	Main criteria	Secondary criteria	Average score
1	Product quality	ISO 9000 status	4.217
		Warranty	4.450
		Certificate	4.275
2	Product price and promotion	Product price	4.217
		Payment terms	4.217
		Price competition	4.217
3	Delivery and after service	Delivery punctuality	4.217
		Process time	4.232
		After sale service	4.217
4	Company structure	Professionalism	4.217
5	Customer relationship	Long-term customer relationship	4.217
		Trust	4.348
6	Sale service	Response	4.319
		Convenience	4.217
		Impression	4.377
7	Ease-of-use	Ease-of-use	4.348
8	Maintenance	Maintenance	4.232
		Spare part availability	4.217
		Number of technicians	4.217

Table 1 Average score of the selected criteria from first questionnaire survey

Linguistic variables	TFN		
	a	b	c
Very Poor	1	1	3
Poor	1	3	5
Fair	3	5	7
Good	5	7	9
Very good	7	9	9

Table 2 Membership of triangular fuzzy numbers

The same criteria were used to evaluate the suppliers and rated by using linguistic variables. Membership for any TFN(a, b ,c) can be obtained using Table 2. Then, the TFN for each supplier were calculated using (2), and normalized using (3), as shown in Table 4.

The weighted normalized TFN performance value (v_{ij}) for each supplier, Fuzzy Positive-Ideal Solution (FPIS: A^+) and Fuzzy Negative-Ideal Solution (FNIS: A^-) were calculated using (4) – (6) as shown in Table 5. Then, the distance of each alternative from FPIS and FNIS were calculated using (7) – (9) as shown in Table 6.

Rank.	No.	Main criteria	Weight	No.	Secondary criteria	Weight	$\widetilde{w}_j$
1	1	Product quality	0.340	C1	ISO 9000 status	0.611	0.208
				C2	Warranty	0.278	0.095
				C3	Certificate	0.111	0.038
2	2	Product price and promotion	0.215	C4	Product price	0.611	0.131
				C5	Payment terms	0.278	0.060
				C6	Price competition	0.111	0.024
3	7	Ease-of-use	0.152	C7	Ease-of-use	1.000	0.152
4	8	Maintenance	0.111	C8	Maintenance	0.611	0.068
				C9	Spare part availability	0.278	0.031
				C10	Number of technicians	0.111	0.012
5	5	Customer relationship	0.080	C11	Trust	0.750	0.060
				C12	Long-term customer relationship	0.250	0.020
6	6	Sale service	0.054	C13	Response	0.611	0.033
				C14	Convenience	0.278	0.015
				C15	Impression	0.111	0.006
7	4	Company structure	0.034	C16	Professionalism	1.000	0.034
8	3	Delivery and after service	0.016	C17	Delivery punctuality	0.611	0.010
				C18	After service	0.278	0.004
				C19	Process time	0.111	0.002

Table 3 Ranked score of the selected criteria from second questionnaire survey

No.	Triangular fuzzy number (a, b, c)												$\tilde{r}_{ij}$											
	A			B			C			D			A			B			C			D		
C1	1.00	7.70	9.00	5.00	8.40	9.00	1.00	5.60	9.00	1.00	3.50	9.00	0.11	0.86	1.00	0.56	0.93	1.00	0.11	0.62	1.00	0.11	0.39	1.00
C2	5.00	8.10	9.00	3.00	8.20	9.00	1.00	6.50	9.00	1.00	5.40	9.00	0.56	0.90	1.00	0.33	0.91	1.00	0.11	0.72	1.00	0.11	0.60	1.00
C3	3.00	8.10	9.00	5.00	8.40	9.00	1.00	6.90	9.00	1.00	5.60	9.00	0.33	0.90	1.00	0.56	0.93	1.00	0.11	0.77	1.00	0.11	0.62	1.00
C4	3.00	7.30	9.00	3.00	8.30	9.00	1.00	5.60	9.00	1.00	4.60	9.00	0.11	0.14	0.33	0.11	0.12	0.33	0.11	0.18	1.00	0.11	0.22	1.00
C5	3.00	7.60	9.00	3.00	8.40	9.00	1.00	5.20	9.00	1.00	7.70	9.00	0.33	0.84	1.00	0.33	0.93	1.00	0.11	0.58	1.00	0.11	0.86	1.00
C6	1.00	7.50	9.00	1.00	7.70	9.00	1.00	4.60	9.00	1.00	4.10	9.00	0.11	0.83	1.00	0.11	0.86	1.00	0.11	0.51	1.00	0.11	0.46	1.00
C7	5.00	7.50	9.00	3.00	8.50	9.00	1.00	5.40	9.00	1.00	4.10	9.00	0.56	0.83	1.00	0.33	0.94	1.00	0.11	0.60	1.00	0.11	0.46	1.00
C8	3.00	7.90	9.00	3.00	8.50	9.00	1.00	6.30	9.00	1.00	4.70	9.00	0.33	0.88	1.00	0.33	0.94	1.00	0.11	0.70	1.00	0.11	0.52	1.00
C9	1.00	6.80	9.00	3.00	8.60	9.00	1.00	4.50	9.00	1.00	3.20	9.00	0.11	0.76	1.00	0.33	0.96	1.00	0.11	0.50	1.00	0.11	0.36	1.00
C10	1.00	7.20	9.00	3.00	8.00	9.00	1.00	4.80	9.00	1.00	4.00	9.00	0.11	0.80	1.00	0.33	0.89	1.00	0.11	0.53	1.00	0.11	0.44	1.00
C11	5.00	8.30	9.00	1.00	8.20	9.00	1.00	6.10	9.00	1.00	4.90	9.00	0.56	0.92	1.00	0.11	0.91	1.00	0.11	0.68	1.00	0.11	0.54	1.00
C12	1.00	7.60	9.00	1.00	8.00	9.00	1.00	5.90	9.00	1.00	4.90	9.00	0.11	0.84	1.00	0.11	0.91	1.00	0.11	0.66	1.00	0.11	0.54	1.00
C13	3.00	7.70	9.00	1.00	8.20	9.00	1.00	6.70	9.00	1.00	6.40	9.00	0.33	0.86	1.00	0.11	0.91	1.00	0.11	0.74	1.00	0.11	0.71	1.00
C14	3.00	7.90	9.00	3.00	8.40	9.00	1.00	6.40	9.00	1.00	5.70	9.00	0.33	0.88	1.00	0.33	0.93	1.00	0.11	0.71	1.00	0.11	0.63	1.00
C15	1.00	8.00	9.00	1.00	8.10	9.00	1.00	6.20	9.00	1.00	5.00	9.00	0.11	0.89	1.00	0.11	0.90	1.00	0.11	0.69	1.00	0.11	0.56	1.00
C16	3.00	8.00	9.00	5.00	8.60	9.00	1.00	6.80	9.00	1.00	5.40	9.00	0.33	0.89	1.00	0.56	0.96	1.00	0.11	0.76	1.00	0.11	0.60	1.00
C17	3.00	7.90	9.00	3.00	8.30	9.00	1.00	6.70	9.00	1.00	6.40	9.00	0.33	0.88	1.00	0.33	0.92	1.00	0.11	0.74	1.00	0.11	0.71	1.00
C18	5.00	7.80	9.00	3.00	8.30	9.00	1.00	6.40	9.00	1.00	5.70	9.00	0.56	0.87	1.00	0.33	0.92	1.00	0.11	0.71	1.00	0.11	0.63	1.00
C19	3.00	7.60	9.00	3.00	7.90	9.00	1.00	6.40	9.00	1.00	6.00	9.00	0.11	0.13	0.33	0.11	0.13	0.33	0.11	0.16	1.00	0.11	0.17	1.00

Teble 4 Triangular fuzzy number of pickup truck supplier from third questionnaire survey

No.	$\tilde{v}_{ij}$												FPIS A^+			FNIS A^-		
	A			B			C			D								
C1	0.023	0.178	0.208	0.116	0.194	0.208	0.023	0.129	0.208	0.023	0.081	0.208	0.1160	0.1940	0.2080	0.0230	0.0810	0.2080
C2	0.053	0.086	0.095	0.032	0.087	0.095	0.011	0.069	0.095	0.011	0.057	0.095	0.0320	0.0870	0.0950	0.0110	0.0570	0.0950
C3	0.013	0.034	0.038	0.021	0.035	0.038	0.004	0.029	0.038	0.004	0.024	0.038	0.0210	0.0350	0.0380	0.0040	0.0240	0.0380
C4	0.015	0.178	0.044	0.015	0.016	0.044	0.015	0.023	0.131	0.015	0.028	0.131	0.0150	0.0280	0.1310	0.0150	0.0160	0.0440
C5	0.020	0.051	0.060	0.020	0.056	0.060	0.007	0.035	0.060	0.007	0.051	0.060	0.0200	0.0560	0.0600	0.0070	0.0350	0.0600
C6	0.003	0.020	0.024	0.003	0.021	0.024	0.003	0.012	0.024	0.003	0.011	0.024	0.0030	0.0210	0.0240	0.0030	0.0110	0.0240
C7	0.085	0.127	0.152	0.051	0.143	0.152	0.017	0.091	0.152	0.017	0.069	0.152	0.0510	0.1430	0.1520	0.0170	0.0690	0.1520
C8	0.023	0.060	0.068	0.023	0.064	0.068	0.008	0.048	0.068	0.008	0.035	0.068	0.0230	0.0640	0.0680	0.0080	0.0350	0.0680
C9	0.003	0.023	0.031	0.010	0.003	0.031	0.003	0.016	0.031	0.003	0.011	0.031	0.0030	0.0230	0.0310	0.0030	0.0110	0.0310
C10	0.001	0.010	0.012	0.004	0.011	0.012	0.001	0.006	0.012	0.001	0.005	0.012	0.0040	0.0110	0.0120	0.0010	0.0050	0.0120
C11	0.033	0.055	0.060	0.007	0.055	0.060	0.007	0.041	0.060	0.007	0.033	0.060	0.0330	0.0550	0.0600	0.0070	0.0330	0.0600
C12	0.002	0.017	0.020	0.002	0.018	0.020	0.002	0.013	0.020	0.002	0.011	0.020	0.0020	0.0180	0.0200	0.0020	0.0110	0.0200
C13	0.011	0.028	0.033	0.004	0.030	0.033	0.004	0.025	0.033	0.004	0.023	0.033	0.0040	0.0300	0.0330	0.0040	0.0230	0.0330
C14	0.005	0.013	0.015	0.005	0.014	0.015	0.002	0.011	0.015	0.002	0.009	0.015	0.0050	0.0140	0.0150	0.0020	0.0090	0.0150
C15	0.001	0.005	0.006	0.001	0.005	0.006	0.001	0.004	0.006	0.001	0.003	0.006	0.0010	0.0050	0.0060	0.0010	0.0030	0.0060
C16	0.011	0.030	0.034	0.019	0.033	0.034	0.004	0.026	0.034	0.004	0.020	0.034	0.0190	0.0330	0.0340	0.0040	0.0200	0.0340
C17	0.003	0.009	0.010	0.003	0.009	0.010	0.001	0.007	0.010	0.001	0.007	0.010	0.0030	0.0090	0.0100	0.0010	0.0070	0.0100
C18	0.002	0.003	0.004	0.001	0.004	0.004	0.000	0.003	0.004	0.000	0.003	0.004	0.0010	0.0040	0.0040	0.0004	0.0030	0.0040
C19	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.002	0.000	0.000	0.002	0.0002	0.0003	0.0007	0.0002	0.0003	0.0020

Teble 5 Weighted triangular fuzzy number of pickup truck supplier, FPIS and FNIS

No.	$d(\tilde{v}_{ij}, \tilde{v}_j^+)$				$d(\tilde{v}_{ij}, \tilde{v}_j^-)$			
	A	B	C	D	A	B	C	D
C1	0.055	0	0.066	0.084	0.056	0.084	0.028	0
C2	0.012	0	0.016	0.021	0.029	0.021	0.007	0
C3	0.005	0	0.010	0.012	0.008	0.012	0.003	0
C4	0.110	0.052	0.003	0	0.094	0	0.050	0.051
C5	0.003	0	0.014	0.008	0.012	0.014	0	0.009
C6	0.001	0	0.005	0.006	0.005	0.006	0.001	0
C7	0.002	0	0.036	0.047	0.052	0.047	0.013	0
C8	0.002	0	0.013	0.019	0.017	0.019	0.008	0
C9	0	0.012	0.004	0.007	0.007	0.006	0.003	0
C10	0.002	0	0.003	0.004	0.003	0.004	0.001	0
C11	0	0.015	0.017	0.020	0.020	0.013	0.005	0
C12	0.001	0	0.003	0.004	0.003	0.004	0.001	0
C13	0.004	0	0.003	0.004	0.005	0.004	0.001	0
C14	0.001	0	0.002	0.003	0.003	0.003	0.001	0
C15	0	0	0.001	0.001	0.001	0.001	0.001	0
C16	0.005	0	0.010	0.011	0.007	0.011	0.003	0
C17	0	0	0.002	0.002	0.002	0.002	0	0
C18	0.001	0	0.001	0.001	0.001	0.001	0	0
C19	0	0	0.001	0.001	0.001	0.001	0	0
SUM	0.204	0.079	0.210	0.255	0.326	0.253	0.126	0.060

Teble 6 Distance $d(\tilde{v}_{ij}, \tilde{v}_j^+)$ and $d(\tilde{v}_{ij}, \tilde{v}_j^-)$ for each pickup truck supplier

	A	B	C	D
d_i^+	0.204	**0.079**	0.210	0.255
d_i^-	0.326	**0.253**	0.126	0.060
RC_i	0.615	**0.762**	0.375	0.190
Rank	2	**1**	3	4

Table 7 Sum of distance, relative closeness and rank for each pickup truck supplier

From Table 7, The relative closeness (RC_i) for each alternative were calculated using (10) and ranked in decreasing order. We can see that the best alternative is supplier B, since it has the highest RC_i, follows by supplier A, C and D, respectively.

4.   Conclusion and Discussion

The challenges for many companies are how to evaluate the supplier's performance on various criteria. The proposed research is helpful for companies to identify the crucial criteria influencing the selection of a pickup truck supplier, so that, each company can select the best suitable supplier for their transportation vehicles. A supplier can also focus on improving the performance of that crucial criteria to obtain more competitiveness in the industry. In this research, we present a multi criteria decision making approach for evaluating various criteria of pickup truck supplier under fuzzy environment. Firstly, the criteria for supplier evaluating performance are identified by using ROC ranking system. These main criteria are product quality, product price, product delivery, company structure, customer relationship, sale service, ease-of-use and maintainability. This is followed by questionnaire survey, formulated using related criteria. Then, Fuzzy TOPSIS is used to aggregate the ratings and generate an overall performance score for measuring the performance of each alternative (supplier).

There are 8 vital criteria that suppliers need to meet the expectations of its customer and gain the upper hand in this industry. From the results, we can conclude that product quality and price are still a major concerned in pickup truck supplier selection. The final ranking results show that supplier B is the best of the four suppliers in terms of overall rating. However, maintainability and customer relationship have gained more attention from customer for selecting a supplier. Supplier A, which is better in maintainability and customer relationship criteria compared to supplier C and D, is ranked in the second.

This research still has some limitations, and several extensions are possible as possible future work. First, only 4 pickup truck suppliers located in Roi-et province are considered. Second, a comparison of the results of the proposed work with other fuzzy MCDM methods can be performed. Furthermore, researchers can utilize various data mining, machine learning and Artificial intelligence techniques to capture the input of fuzzy parameters. Such information will further enhance designing of more accurate decision-making system. Third, researchers are encouraged to examine the interrelationship between main criteria and their secondary criteria using some suitable tools. Future research work may also include an environment and social criteria to establishing an effective sustainable practice in the industry.

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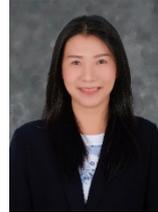
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