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Research Article

A Fuzzy TOPSIS based Approach for Distributor Selection in Supply Chain Management: An Empirical Study of an Agricultural Enterprise in China

[1, 2]Shi Haoran, [1]Du Wen and [1]Zhou Ling
[1]School of Transportation and Logistics, Southwest Jiaotong University, Chengdu, Sichuan 610031, China
[2]School of Energy and Environment, Xihua University Chengdu, Sichuan 610039, China

Abstract: Distributor selection plays an important role in the supply chain management, particularly in the current competitive environment. The recent researches are mainly focused on the conceptual, descriptive and simulation. However, analyzing qualitative information is difficult by standard statistical analysis, which means that a proper quantitative method is desired for distributor selection in fuzzy environment. This study is an attempt to identify the factors which have impact on the distribution cost and the selection for better distributors in an agricultural enterprise in China based on fuzzy TOPSIS.

Keywords: Agricultural enterprise, china, distributor selection, empirical study, fuzzy TOPSIS, quantitative study

INTRODUCTION

Industry is now strongly recognizing that total management of the supply chain enhances the competitive edge of all “players” there in. As a result, supply chain management has received more attentions from both academicians and practitioners in the past decade.

Supplier selection has caused the concern of many scholars and industry at home and abroad and an amount of research about it has been made (Lee *et al*., 2003; Murthy *et al*., 2004; Zou *et al*., 2011). Lee and Yang (2008) argue that selecting the correct suppliers can have a significant impact on the competitiveness of firms and provide a bidding strategy guideline for a demander to achieve the goals of supplier selection in varying order conditions. Weber *et al*. (1991) summarize the research achievements of the supplier selection criteria and discovered that price, delivery, quality and ability criteria are mentioned in most papers in terms of supplier selection. Johnson (1995) suggest that time, quality, cost and service are the key factors of success of the factors affecting supplier selection.

There are many researchers focus attention on evaluation methods: Zhu (2004) employs the buyer and seller two-phase game model and constructed an efficiency interval to evaluate suppliers; Wang *et al*. (2002) propose a Euclid norm evaluation method based on the relative inferior membership degree; Bai and Cui (2006) apply TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method for supplier evaluation.

Apart from these traditional methods for supplier selection and the recent researches show that fuzzy systems theory has been successfully applied to supplier selection problems (Chan and Kumar, 2007; Kahraman *et al*., 2004; Kumar *et al*., 2006) considering the ratings and the weights of the selection criteria are known precisely and thus are inadequate for dealing with the imprecise or vague nature of linguistic assessment

To date, numerous literatures have explored the issues of supplier selection. In contrast, few researches have been done in selection of distributor. It should be noted that distributor evaluation and selection have not been studied deeply and the theoretical methods developed by academics have not been fully applied in industry, so fuzzy TOPSIS is employed for the distributor selection in an agricultural enterprise in China.

LITERATURE REVIEW

Literature review on distributor research: Distributor’s selection is an important issue in Supply chain management, particularly in the current competitive environment. Ross (1973) studies the selection of the overseas distributor and he get the conclusion that whether or not the exporter will be able to achieve his goals depends to a great extent on how well he has carried out his analysis of which firm will do the best possible job for him in a particular market. Zuo *et al*. (2011) show a method for preferred distributor selection based on Rough set theory, which

Corresponding Author: Shi Haoran, School of Transportation and Logistics, Southwest Jiaotong University, Chengdu, Sichuan 610031, China

has been recognized as a powerful tool in dealing with qualitative data in the literature. The author derives certain decision rules which are able to facilitate distributor selection and identified several significant features based on an empirical study conducted in China. Mazaher *et al*. (2012) argue that distributor selection and categorization have been conducted through the fuzzy Adaptive Resonance Theory (ART) algorithm. The authors get the conclusion that the fuzzy ART not only determine the best distributors, but also cluster all distributors. This procedure has been very effective in partner selection and evaluation problems. The research by Rosenbloom (2004) shows that marketing channel success is often dependent on strong channel members who can efficiently perform the distribution tasks necessary to reach the channel target. Lin and Chen (2008) develop a research framework for manufacturers' selection of distributors. Four key constructs were derived from marketing, supply chain and logistics literature to investigate their influences on distributor selection: firm infrastructure, marketing capabilities, relationship intensity and logistics capabilities. They suggest that distributors can strengthen their competitive advantage by improving their competence in these four dimensions. For many small and medium-sized firms which lack sophisticated market research/ decision analysis tools to assist them in the foreign distributor decision, the AHP is a highly flexible and versatile substitute (Yeoh and Calantone, 1995).

Literature review on fuzzy TOPSIS: There are many factors influencing the selection of distributors, which determines that the issue is Multiple Criteria Decision-Making (MCDM) (Vincke, 1992). It is often difficult for a decision-maker to assign a precise performance rating to an alternative for the attributes under consideration. The merit of using a fuzzy approach is to assign the relative importance of attributes using fuzzy numbers instead of precise numbers for suiting the real world in fuzzy environment.

The TOPSIS method selected for the data analysis in this research was first proposed in 1981 (Hwang and Yoon, 1981) and it is employed to solve the related MCDM problems under the fuzzy environment (Muralidhar *et al*., 2013; Ataei *et al*., 2008; Zeki and Rifat, 2012).

Sun (2010) employs the fuzzy analytic hierarchy process and fuzzy TOPSIS to evaluate different notebook computer companies and proves that this approach can provide a more accurate, effective and systematic decision support tool. Yu *et al*. (2011) propose an evaluation model based on the fuzzy TOPSIS for the ranking of B2C e-commerce in e-alliance. Zouggari and Benyoucef (2012) apply fuzzy TOPSIS for order allocation among the selected suppliers.

In summary, the selection of the right distributors both in theory and in practice has proven to be very important and since China is one of the developing countries which experience the highest economic growth, it is necessary to identify the related measures and proper method to evaluate and select the distributors for Chinese companies in order to yield higher profits. However, there are few studies focusing on the quantitative method of choice and evaluation distributors in supply chain in China, which is the primary motivation of this research.

METHODOLOGY

Fuzzy sets and fuzzy numbers:
Definition 1: A Fuzzy set $\tilde{a}$ in a universe of discourse X is characterized by a membership function $\mu_{\tilde{a}}(x)$ which associates with each element x in X, a real number in the interval (0, 1). The function of $\mu_{\tilde{a}}(x)$ is termed the grade of membership of x in $\tilde{a}$ (Zadeh, 1965). The present study uses triangular Fuzzy numbers. $\tilde{a}$ can be defined by a triplet (a_1, a_2, a_3). Its conceptual schema and mathematical form are shown as below:

$$\mu_{\tilde{a}}(x)\begin{cases} 0 & x \le a \\ \dfrac{x-a_1}{a_2-a_1} & a_1 \prec x \le a_2 \\ \dfrac{a_3-x}{a_3-a_2} & a_2 \prec x \le a_3 \\ 1 & x \succ a_3 \end{cases}$$

Definition 2: Let $\tilde{a} = (a_1, a_2, a_3)$ and $\tilde{b}$ (b_1, b_2, b_3) be two triangular fuzzy numbers. According to Wang and Lee (2009), a distance measure function $(\tilde{a}, \tilde{b})$ can be defined as below:

$$d(\tilde{a},\tilde{b}) = \sqrt{\frac{1}{3}[(a_1-b_1)^2+(a_2-b_2)^2+(a_3-b_3)^2]}$$

Definition 3: Let a triangular Fuzzy number $\tilde{a}$, then α-cut defined as below:

$$\tilde{a}_\alpha = [(a_2-a_1)\alpha + a_1, a_3-(a_3-a_2)\alpha]$$

Definition 4: Let $\tilde{a} = (a_1, a_2, a_3)$, $\tilde{b}$ (b_1, b_2, b_3) be two triangular Fuzzy number and $\tilde{a}_\alpha, \tilde{b}_\alpha$, be α-cut, $\tilde{a}$ and $\tilde{b}$, then the method is defined to calculate the divided between $\tilde{a}$ and $\tilde{b}$ as follows:

$$\frac{\tilde{a}_\alpha}{\tilde{b}_\alpha} = [\frac{(a_2-a_1)\alpha+a_1}{-(b_3-b_2)\alpha+b_3}, \frac{-(a_3-a_2)\alpha+a_3}{(b_2-b_1)\alpha+b_1}]$$

When α = 0,

$$\frac{\tilde{a}_0}{\tilde{b}_0} = [\frac{a_1}{b_3}, \frac{a_3}{b_1}]$$

Table 1: Transformation for fuzzy membership functions

Rank	Sub-criteria grade	Membership function
Very Low (VL)	1	(0.00, 0.10, 0.25)
Low (L)	2	(0.15, 0.30, 0.45)
Medium (M)	3	(0.35, 0.50, 0.65)
High (H)	4	(0.55, 0.70, 0.85)
Very High (VH)	5	(0.75, 0.90, 1.00)

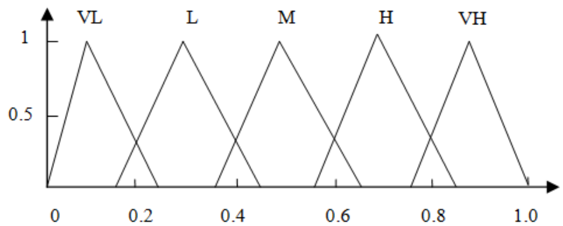

Fig. 1: Fuzzy triangular membership functions

When α = 1:

$$\frac{\tilde{a}_1}{\tilde{b}_1} = [\frac{(a_2 - a_1) + a_1}{-(b_3 - b_2) + b_3}, \frac{-(a_3 - a_2) + a_3}{(b_2 - b_1) + b_1}]$$

$$\frac{\tilde{a}_1}{\tilde{b}_1} = [\frac{a_2}{b_2}, \frac{a_2}{b_2}]$$

So the approximated value of $\tilde{a}/\tilde{b}$ will be:

$$\frac{\tilde{a}}{\tilde{b}} = [\frac{a_1}{b_3}, \frac{a_2}{b_2}, \frac{a_3}{b_1}]$$

Definition 5: Assuming that both $\tilde{a} = (a_1, a_2, a_3)$ and $\tilde{b}$ (b_1, b_2, b_3) are real numbers, the distance measurement $d(\tilde{a}, \tilde{b})$ is identical to the Euclidean distance.

The basic operations on Fuzzy triangular numbers are as follows (Yang and Hung, 2007):

For approximation of multiplication: $\tilde{a} \otimes \tilde{b} = (a_1 \times b_1, a_2 \times b_2, a_3 \times b_3)$

For addition: $\tilde{a} \oplus \tilde{b} = (a_1 + b_1, a_2 + b_2, a_3 + b_3)$

Fuzzy membership function: In the evaluating process, the weights expressed with the linguistic terms, represent the important degrees of criteria from experts via surveys on subjective assessments. These linguistic terms are categorized into Very Low (VL), Low (L), Medium (M), High (H) and Very High (VH). Assume that all linguistic terms can be transferred into triangular fuzzy numbers and these fuzzy numbers are limited in (0, 1). As a rule of thumb, each rank is assigned an evenly spread membership function that has an interval of 0.30 or 0.25 (Yang and Hung, 2007).

Based on assumptions above, a transformation table can be found as shown in Table 1. Figure 1 illustrates the Fuzzy membership function (Yang and Hung, 2007).

Fuzzy TOPSIS model: It is formulated that a Fuzzy Multiple Criteria Decision Making (FMCDM) problem about the comparative evaluation of the selected websites. The FMCDM problem can be concisely expressed in matrix format as follows:

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ \vdots \\ A_n \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & C_3 & \cdots & C_n \end{array} \\ \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \tilde{x}_{13} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \tilde{x}_{23} & \cdots & \tilde{x}_{2n} \\ \tilde{x}_{31} & \tilde{x}_{32} & \tilde{x}_{33} & \cdots & \tilde{x}_{3n} \\ \vdots & & & & \\ \tilde{x}_{n1} & \tilde{x}_{n1} & \tilde{x}_{n1} & \cdots & \tilde{x}_{n1} \end{bmatrix} \end{array}$$

$$\tilde{W} = [\tilde{w}_1, \tilde{w}_2, \cdots \tilde{w}_n]$$

where, $x_{ij}, i = 1, 2, \cdots, m; j = 1, 2, \cdots, n$ and $\tilde{w}_j, j = 1, 2, \cdots, n$ are linguistic triangular Fuzzy numbers, $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ and $\tilde{w}_j = (a_{j1}, b_{j2}, c_{j3})$. The normalized Fuzzy decision matrix is denoted by $\tilde{R} = [\tilde{r}_{ij}]_{m \times n}$.

The weighted Fuzzy normalized decision matrix is shown as follows:

$$V = \begin{bmatrix} \tilde{v}_{11} & \tilde{v}_{12} & \tilde{v}_{13} & \cdots & \tilde{v}_{1n} \\ \tilde{v}_{21} & \tilde{v}_{22} & \tilde{v}_{23} & \cdots & \tilde{v}_{2n} \\ \tilde{v}_{31} & \tilde{v}_{32} & \tilde{v}_{33} & \cdots & \tilde{v}_{3n} \\ \vdots & & & & \\ \tilde{v}_{n1} & \tilde{v}_{n1} & \tilde{v}_{n1} & \cdots & \tilde{v}_{n1} \end{bmatrix}$$

$$= \begin{bmatrix} \tilde{w}_1\tilde{r}_{11} & \tilde{w}_2\tilde{r}_{12} & \tilde{w}_3\tilde{r}_{13} & \cdots & \tilde{w}_n\tilde{r}_{1n} \\ \tilde{w}_1\tilde{r}_{21} & \tilde{w}_2\tilde{r}_{22} & \tilde{w}_3\tilde{r}_{23} & \cdots & \tilde{w}_n\tilde{r}_{2n} \\ \tilde{w}_1\tilde{r}_{31} & \tilde{w}_2\tilde{r}_{32} & \tilde{w}_3\tilde{r}_{33} & \cdots & \tilde{w}_n\tilde{r}_{3n} \\ \vdots & & & & \\ \tilde{w}_1\tilde{r}_{m1} & \tilde{w}_2\tilde{r}_{m2} & \tilde{w}_3\tilde{r}_{m3} & \cdots & \tilde{w}_n\tilde{r}_{mn} \end{bmatrix}$$

Given the above Fuzzy theory, the proposed Fuzzy TOPSIS procedure is then defined as follows:

Step 1: Choose the $x_{ij}, i = 1, 2, \cdots, m; j = 1, 2, \cdots, n$ for alternatives with respect to criteria and $\tilde{w}_j, j = 1, 2, \cdots, n$ for the weight of the criteria.

Step 2: Construct the weighted normalized Fuzzy decision matrix V.

Step 3: Identify positive ideal (A^+) and negative ideal (A^-) solutions:

$$A^+ = \{\tilde{v}_1^+, \tilde{v}_2^+, \cdots \tilde{v}_n^+\}$$
$$= \{(\max_i \tilde{v}_{ij} \,|\, i = 1, 2, \cdots, m), j = 1, 2, \cdots, n\}.$$

$$A^{-} = \{\tilde{v}_1^{-}, \tilde{v}_2^{-}, \cdots \tilde{v}_n^{-}\}$$
$$= \{(\min_i \tilde{v}_{ij} | i = 1,2,\cdots,m), j = 1,2,\cdots,n\}.$$

Step 4: Calculate separation measures: The distance of each alternative from A^+ and A^- can be identified as follows:

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

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

Step 5: Calculate the similarities to ideal solution:

$$CC_i = \frac{d_i^{-}}{d_i^{+} + d_i^{-}}$$

Step 6: Rank alternatives according to CC_i in descending order (Yang and Hung, 2007).

DATA COLLECTION AND RESULT ANALYSIS

The measures of distributor selection: An example depicted here is about the distributor selection indexes, including the difficulty to develop the business, the ability of the distributors and the other related measures which have an impact on the selection of the distributors, as shown in Fig. 2.

Data collection: The data in Table 2 is collected from an agriculture enterprise in China, which has more than one hundred employees. As shown in Table 2, SC_1 to SC_9 represent the nine sub-criteria in Fig. 2, while A_1 to A_8 represent the eight distributors of this company.

SC_1, SC_3, SC_4, SC_5, SC_6 and SC_7 can be derived from the actual data of each distributor and SC_2, SC_8 and SC_9 are rated with the widely used Little Scale method, i.e., from a scale of 1 (being the worst) to 10 (meaning excellent) accordingly.

Result analysis: The important degrees of the above sub-criteria weights are given with linguistic terms, i.e.,

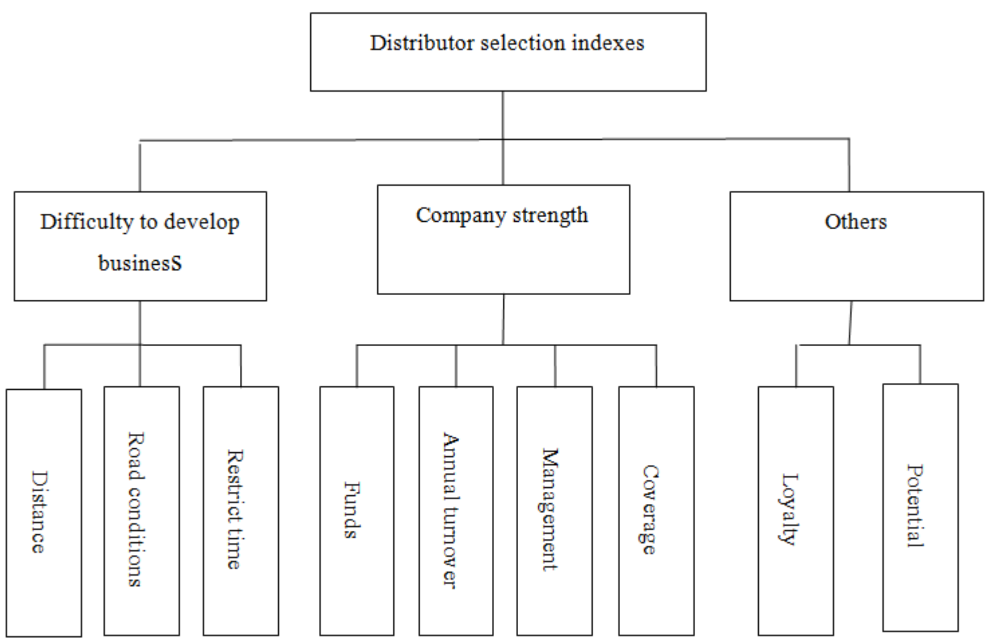

Fig. 2: Distributor selection indexes

Table 2: Transformation for fuzzy membership functions

	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6	SC_7	SC_8	SC_9
A_1	3506.41	5	1.5	50	5.5	8	200	7	9
A_2	1054.38	9	1	60	8.5	5	43.5	9	5
A_3	3854.87	7	1	100	7.8	9	322	4	6
A_4	1504.16	6	1	150	4.0	10	580	10	10
A_5	1648.91	10	2	70	5.0	6	429.2	8	10
A_6	5203.99	8	1	80	3.0	7	392	6	4
A_7	1700.37	8	1	30	2.5	6	400	7	8
A_8	3347.13	3	1	50	2.0	5	278.3	7	8

Table 3: The linguistic weights given by seven experts

No.	Measures	E_1	E_2	E_3	E_4	E_5	E_6	E_7
SC_1	Distance	M	L	M	VL	M	M	H
SC_2	Road conditions	VH	VH	VL	L	VH	VL	VH
SC_3	Restrict time	L	M	VL	M	VH	H	M
SC_4	Funds	VH	M	VL	VH	L	VH	VL
SC_5	Annual turnover	VH	VH	VH	L	M	VL	L
SC_6	Management	VL	H	VL	M	VL	L	L
SC_7	Coverage	VH	H	VL	VL	VL	VL	L
SC_8	Loyalty	M	VL	VL	VL	VL	VL	M
SC_9	Potential	M	L	M	VL	M	M	H

Table 4: Normalized decision matrix for TOPSIS analysis

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6	SC_7	SC_8	SC_9
A_1	0.41	0.29	0.50	0.17	0.54	0.60	0.71	0.50	0.83
A_2	1.00	0.86	0.00	0.25	1.00	0.00	1.00	0.83	0.17
A_3	0.33	0.57	0.00	0.58	0.89	0.80	0.48	0.00	0.33
A_4	0.89	0.43	0.00	1.00	0.31	1.00	0.00	1.00	1.00
A_5	0.86	1.00	1.00	0.33	0.46	0.20	0.28	0.67	1.00
A_6	0.00	0.71	0.00	0.42	0.15	0.40	0.35	0.33	0.00
A_7	0.84	0.71	0.00	0.00	0.08	0.20	0.34	0.50	0.67
A_8	0.45	0.00	0.00	0.17	0.00	0.00	0.56	0.50	0.67

Table 5: Normalized decision matrix using fuzzy linguistic variables

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6	SC_7	SC_8	SC_9
A_1	M	L	M	VL	M	M	H	M	VH
A_2	VH	VH	VL	L	VH	VL	VH	VH	VL
A_3	L	M	VL	M	VH	H	M	VL	L
A_4	VH	M	VL	VH	L	VH	VL	VH	VH
A_5	VH	VH	VH	L	M	VL	L	H	VH
A_6	VL	H	VL	M	VL	L	L	L	VL
A_7	VH	H	VL	VL	VL	VL	L	M	H
A_8	M	VL	VL	VL	VL	VL	M	M	H

Table 6: Part of the fuzzy decision matrix

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6
A_1	(0.35, 0.50, 0.65)	(0.15, 0.30, 0.45)	(0.35, 0.50, 0.65)	(0.00, 0.10, 0.25)	(0.35, 0.50, 0.65)	(0.35, 0.50, 0.65)
A_2	(0.75, 0.90, 1.00)	(0.75, 0.90, 1.00)	(0.00, 0.10, 0.25)	(0.15, 0.30, 0.45)	(0.75, 0.90, 1.00)	(0.00, 0.10, 0.25)
A_3	(0.15, 0.30, 0.45)	(0.35, 0.50, 0.65)	(0.00, 0.10, 0.25)	(0.35, 0.50, 0.65)	(0.75, 0.90, 1.00)	(0.55, 0.70, 0.85)
A_4	(0.75, 0.90, 1.00)	(0.35, 0.50, 0.65)	(0.00, 0.10, 0.25)	(0.75, 0.90, 1.00)	(0.15, 0.30, 0.45)	(0.75, 0.90, 1.00)
A_5	(0.75, 0.90, 1.00)	(0.75, 0.90, 1.00)	(0.75, 0.90, 1.00)	(0.15, 0.30, 0.45)	(0.35, 0.50, 0.65)	(0.00, 0.10, 0.25)
A_6	(0.00, 0.10, 0.25)	(0.55, 0.70, 0.85)	(0.00, 0.10, 0.25)	(0.35, 0.50, 0.65)	(0.00, 0.10, 0.25)	(0.15, 0.30, 0.45)
A_7	(0.75, 0.90, 1.00)	(0.55, 0.70, 0.85)	(0.00, 0.10, 0.25)	(0.00, 0.10, 0.25)	(0.00, 0.10, 0.25)	(0.00, 0.10, 0.25)
A_8	(0.35, 0.50, 0.65)	(0.00, 0.10, 0.25)	(0.00, 0.10, 0.25)	(0.00, 0.10, 0.25)	(0.00, 0.10, 0.25)	(0.00, 0.10, 0.25)
W	(0.10, 0.22, 0.37)	(0.31, 0.46, 0.61)	(0.51, 0.54, 0.69)	(0.55, 0.70, 0.84)	(0.59, 0.74, 0.88)	(0.75, 0.90, 1.00)

VL, L, M, H and VH, employed by seven experts E_1, E_2, E_3, E_4, E_5, E_6 and E_7 as shown in Table 3.

The fuzzy linguist variables of the above matrix are then transformed into a Fuzzy triangular membership function. In the next step, we calculate the average of the elements of each row, then the average criteria weights are derived:

$W_1 = (0.55, 0.70, 0.84)$, $W_2 = (0.61, 0.76, 0.89)$, $W_3 = (0.52, 0.67, 0.82)$, $W_4 = (0.44, 0.59, 0.74)$, $W_5 = (0.55, 0.70, 0.84$, $W_6 = (0.55, 0.70, 0.84)$, $W_7 = (0.58, 0.73, 0.86)$, $W_8 = (0.66, 0.81, 0.94)$, $W_9 = (0.64, 0.79, 0.91)$

The original decision matrix is identified by the raters by observing the websites and the normalized decision matrix is then derived from the original data as shown in Table 4.

The larger, the better type (Yang and Hung, 2007):

$$r_{ij} = \frac{\left[x_{ij} - \min\left\{x_{ij}\right\}\right]}{\left[\max\left\{x_{ij}\right\} - \min\left\{x_{ij}\right\}\right]}$$

The smaller, the better type:

$$r_{ij} = \frac{\left[\max\left\{x_{ij}\right\} - x_{ij}\right]}{\left[\max\left\{x_{ij}\right\} - \min\left\{x_{ij}\right\}\right]}$$

For the present study, SC_1 and SC_3 belong to the smaller-the-better type and the others belong to the larger-the-better type. Then the normalized decision matrix using Fuzzy linguistic variables shown in Table 5 can be identified by the Fuzzy membership function proposed in above section.

The Fuzzy linguistic variable is then transformed into a Fuzzy triangular membership function as shown in Table 6 and then the resulting Fuzzy weighted

Table 7: Part of the weighted fuzzy decision matrix

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6
A_1	(0.19, 0.35, 0.55)	(0.09, 0.23, 0.40)	(0.18, 0.34, 0.53)	(0.00, 0.06, 0.18)	(0.19, 0.35, 0.55)	(0.19, 0.35, 0.55)
A_2	(0.41, 0.63, 0.84)	(0.46, 0.68, 0.89)	(0.00, 0.07, 0.21)	(0.07, 0.18, 0.33)	(0.41, 0.63, 0.84)	(0.00, 0.07, 0.21)
A_3	(0.08, 0.21, 0.38)	(0.21, 0.38, 0.58)	(0.00, 0.07, 0.21)	(0.15, 0.29, 0.48)	(0.41, 0.63, 0.84)	(0.30, 0.49, 0.72)
A_4	(0.41, 0.63, 0.84)	(0.21, 0.38, 0.58)	(0.00, 0.07, 0.21)	(0.33, 0.53, 0.74)	(0.08, 0.21, 0.38)	(0.41, 0.63, 0.84)
A_5	(0.41, 0.63, 0.84)	(0.46, 0.68, 0.89)	(0.39, 0.60, 0.82)	(0.07, 0.18, 0.33)	(0.19, 0.35, 0.55)	(0.00, 0.07, 0.21)
A_6	(0.00, 0.07, 0.21)	(0.33, 0.53, 0.76)	(0.00, 0.07, 0.21)	(0.15, 0.29, 0.48)	(0.00, 0.07, 0.21)	(0.08, 0.21, 0.38)
A_7	(0.41, 0.63, 0.84)	(0.33, 0.53, 0.76)	(0.00, 0.07, 0.21)	(0.00, 0.06, 0.18)	(0.00, 0.07, 0.21)	(0.00, 0.07, 0.21)
A_8	(0.19, 0.35, 0.55)	(0.00, 0.08, 0.22)	(0.00, 0.07, 0.21)	(0.00, 0.06, 0.18)	(0.00, 0.07, 0.21)	(0.00, 0.07, 0.21)
A^+	(0.41, 0.63, 0.84)	(0.46, 0.68, 0.89)	(0.39, 0.60, 0.82)	(0.33, 0.53, 0.74)	(0.41, 0.63, 0.84)	(0.41, 0.63, 0.84)
A^-	(0.00, 0.07, 0.21)	(0.31, 0.08, 0.22)	(0.00, 0.07, 0.21)	(0.00, 0.06, 0.18)	(0.00, 0.07, 0.21)	(0.00, 0.07, 0.21)

Table 8: The distance of each alternative from A^+ and A^-

No.	d_i^+	d_i^-	CCi
A_1	0.281774	0.272617	0.491741
A_2	0.223727	0.329941	0.595918
A_3	0.324993	0.229175	0.413548
A_4	0.213602	0.340324	0.614386
A_5	0.191457	0.362547	0.654413
A_6	0.430485	0.123635	0.223120
A_7	0.359083	0.194938	0.351860
A_8	0.422223	0.131707	0.237768

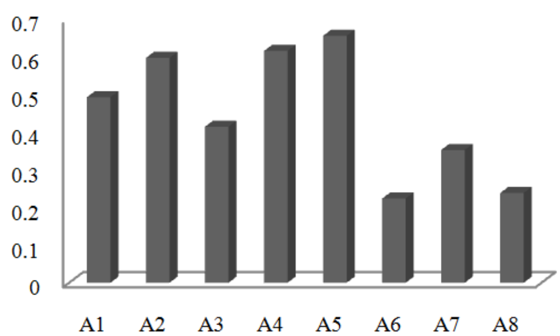

Fig. 3: Evaluation of the eight distributors

decision matrix can be derived based on Table 6 and the weights identified before, as shown in Table 7. The distance of each alternative from A^+ and A^-, as well as the similarities to an ideal solution (*CCi*), is obtained in Table 8.

The result shows that A_6, A_7 and A_8 score less than 0.4, implying that more distribution cost is needed for these distributors and it is highly recommended that this agriculture enterprise shall not select them and select A_1, A_2, A_3, A_4 and A_s instead.

In order to see the result more clearly, the resulting Fuzzy TOPSIS analysis is shown in Fig. 3.

CONCLUSION

This study is an attempt to identify the factors that may have an impact on distributor selection. The specific measures are proposed and Fuzzy TOPSIS is employed to evaluate the distributors in terms of distribution cost and benefit. The primary data for this research are collected from the actual data from the companies in China. Fuzzy TOPSIS is employed to evaluate the current status and distribution cost of the distributors.

It can be seen from the result of the empirical study that there is a large gap between the ideal distributor (0.65) and the anti-ideal distributor (0.22), implying the necessity to select the better distributors for the enterprise.

Nine measures are identified to evaluate the distributors in terms of the difficulty to develop the business and the strength of the company. According to the criteria weights derived from this section earlier by seven experts, the loyalty is most important factor among the nine measures (0.66, 0.81, 0.94), implying that the distributors which are not very loyal to the enterprise should not been selected. That makes sense because these distributors may take the partnership with the competitors, which would be a great loss for the enterprise before them, not mention the increase of the time and cost to look for a new distributor.

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