Integration of Linear Goal Programming and Fuzzy VIKOR Method for Marketing Strategy Selection: A Case Study

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Abstract: The objective of this paper is to present a new methodology for selecting of marketing strategy by integration of Linear Goal Programming model and Fuzzy VIKOR. LGP method is used to determine the fuzzy weights of criteria and Fuzzy VIKOR aims to rank strategies. We apply the integrated approach in real case to demonstrate the application of the proposed method.
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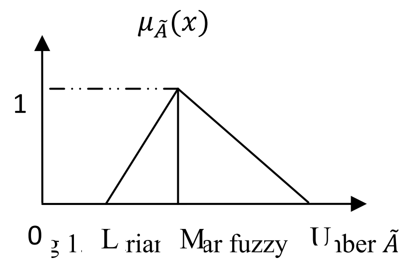
1. Introduction

Marketing is a critical function that helps corporations in surviving crises. For the past 20 years, greater emphasis has been placed on the role of marketing considerations in the managerial process, underscoring the important role that marketing plays in contributing to a firm's competitive success (Brooksbank et al., 2003). Based on marketing resource combinations as drivers of advantage, the previous studies as Barney (1991) and Campbell-Hunt (2000) suggest there are approaches for maximizing advantage above a focus on specific marketing resources and capabilities. For marketing strategy alternatives, Porter (1980) introduced a typology of three generic strategies-including overall cost leadership, differentiation, and focus strategies for creating a sustainable position and outperforming competitors in a given industry (Panayides, 2004). With regard to cost strategy, firms might be in a superior position to achieve cost decrement, if they acquire and develop the necessary resources immediately after deciding on a strategy. In the differentiation strategy, the resource-based theory of the firm suggests that similarities in resource requirements among rival companies may increase competition (Barney 1991). In addition, Boyt and Harvey (1997) stated that pursuing differentiation through offering superior customer service would be particularly important, while Grant (1998) pointed out that successful product/service differentiation could be achieved through innovations and improvements across different parts of the value chain. On the basis of Porter's focus strategy, Panayides (2004) investigated the impact of the major beliefs about marketing and suggested that market segmentation is a fundamental precursor to a focused strategy and thus, an important product-market strategy. According to Porter (1980), Hooley et al. (1992) developed the generic marketing strategy (GMS), including positive growth strategy with high valuable position, growth strategy with alternative objective position, stable growth strategy with general objective position, stable growth strategy with high quality differentiation, and objective defense strategy with low cost. Nevertheless, Kotler (1998) based on the marketing concept proposed; mass marketing strategy, product-variety marketing strategy and target marketing, and developed the market leader strategy, market challenger strategy, marketing follower strategy, and market niche strategy basing on the perspectives of competitive position. McDaniel and Kolari (1987) quoted organization strategy (Miles and Snow, 1978) to demonstrate marketing implementation of defenders, prospectors, analyzers, and reactors. Due to outside and inside surroundings of each corporate, the practitioners would adopt different marketing strategies in the same industry. In respect to marketing strategy, some studies conduct the category and application of marketing mix (Pitt and Kannemeyer, 2000), and some studies apply Porter's generic marketing strategies (Knight, 2000). In addition, the generic marketing strategies could be identified to treat as competitive marketing strategies (Campbell-Hunt, 2000). Hence, the current study adopts Porter's generic strategies of differentiation strategy, cost leadership strategy, and segmentation strategy as marketing strategies for determining the appropriate marketing strategy, based on organization's specific marketing resources and capabilities. A comprehensive survey of Kaleka (2002), Srivastava et al. (2001), and Stewart (1997) reveal that in spite of various marketing resources and firm performance capabilities, not all resources and capabilities can be owned or fully controlled by an organization. Hooley et al. (1998) proposed four types of marketing assets, including customer based assets, supply chain assets, alliance-based assets, and internal assets. Srivastava et al. (1998) distinguished marketing resources into relational assets and intellectual assets. The typical marketing assets include corporate name and reputation, customer relationship, distribution network, relationship with critical supplier, market knowledge, information system, customer database, legal patent, innovation skills, and optional managerial resources (Olavarietta and Friedmann, 1999). In addition, Luo et al. (2005) also demonstrate the relationship between marketing resources and firm performance; marketing resources include market orientation, entrepreneurial orientation, and innovative orientation. Spillan and Parnell (2006) pointed that marketing resources are: interaction with customer, speed capabilities, systemic analysis, customer-orientation action, coordination, and speedy responsive. The most interesting criteria for determining marketing strategies are provided by Hooley et al. (2005) who encapsulated the resources that can gain value in the market place, including market-based resources and marketing support resources, within the term "marketing resources." Thus, marketing resources are those resources that can be immediately deployed in the market-place to create or maintain a competitive advantage, including customer linking capabilities, market innovation capabilities, human resource assets, and reputational assets. On the other hand, the marketing support resources, including managerial capabilities and market orientation, primarily serve primarily to support marketing activities and have an indirect impact on the competitive advantage. The performance-orientated marketing strategy has been driven by marketing resources and capabilities such as human resources and the organization's resources (Edelman et al., 2005). The large number of criteria that should typically be considered in the marketing strategy evaluation process makes it very difficult for marketing strategists. Using the structure of the five aspects as the base and synthesizing the other literature as well as the practical considerations, this study as Lin and Wu (2008) and Lin et al. (2009) incorporate the marketing resources proposed by Hooley et al. (2005), including managerial capabilities (MC), customer linking capabilities (CLC), market innovation capabilities (MIC), human resource assets (HRA), Capabilities in product distribution (CIPD) and reputational assets (RA). The remainder of this paper is organized as follows. Fuzzy sets and Fuzzy numbers are briefly explained in Section 2. Then in Section 3, Linear Goal Programming method is introduced. In Section 4, fuzzy VIKOR method is explained. In Section 5, the application of proposed methods is illustrated and finally, conclusion is provided in Section 6.

2. Fuzzy sets and Fuzzy Numbers

Fuzzy set theory, which was introduced by Zadeh (1965) to deal with problems in which a source of vagueness is involved, has been utilized for incorporating imprecise data into the decision framework. A fuzzy set $\tilde{A}$ can be defined mathematically by a membership function $\mu_{\tilde{A}}(X)$, which assigns each element x in the universe of discourse X a real number in the interval [0,1]. A triangular fuzzy number $\widetilde{A}$ can be defined by a triplet (a, b, c) as illustrated in Fig 1.



g 1. riar ar fuzzy ıber $\tilde{A}$

The membership function $\mu_{\tilde{A}}(X)$ is defined as

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x-a}{b-a} & a \le x \le b \\ \frac{x-c}{b-c} & b \le x \le c \\ 0 & oterwise \end{cases} \qquad (1)$$

Basic arithmetic operations on triangular fuzzy numbers $A_1 = (a_1,b_1,c_1)$, where $a_1 \le b_1 \le c_1$, and $A_2 = (a_2,b_2,c_2)$, where $a_2 \le b_2 \le c_2$,can be shown as follows:

Addition: $A_1 \oplus A_2 = (a_1 + a_2 ,b_1 + b_2,c_1 + c_2)$ (2)

Subtraction: $A_1 \ominus A_2 = (a_1 - c_2 ,b_1 - b_2,c_1 - a_2)$ (3)

Multiplication: if k is a scalar

$$k \otimes A_1 = \begin{cases} (ka_1 ,kb_1,kc_1), & k > 0 \\ (kc_1 ,kb_1,ka_1), & k < 0 \end{cases}$$

$A_1 \otimes A_2 \approx (a_1a_2 ,b_1b_2,c_1c_2)$, if $a_1 \ge 0$, $a_2 \ge 0$ (4)

Division: $A_1 \oslash A_2 \approx (\frac{a_1}{c_2}, \frac{b_1}{b_2}, \frac{c_1}{a_2})$,
if $a_1 \ge 0$, $a_2 \ge 0$ (5)

Although multiplication and division operations on triangular fuzzy numbers do not necessarily yield a triangular fuzzy number, triangular fuzzy number approximations can be used for many practical applications (Kaufmann & Gupta, 1988). Triangular fuzzy numbers are appropriate for quantifying the vague information about most decision problems including personnel selection (e.g. rating for creativity, personality, leadership, etc.). The primary reason for using triangular fuzzy numbers can be stated as their intuitive and computational-efficient representation (Karsak, 2002). A linguistic variable is defined as a variable whose values are not numbers, but words or sentences in natural or artificial language. The concept of a linguistic variable appears as a useful means for providing approximate characterization of phenomena that are too complex or ill-defined to be described in conventional quantitative terms (Zadeh, 1975).

3. The Linear Goal Programming Method

Wang et al (2008) explained the Linear Goal Programming Model. In this paper, we obtain the weights of criteria based on their method. The LPG method explained as follow (Wang et al, 2008):

Consider a fuzzy pairwise comparison matrix:

$$\begin{bmatrix} (1,1,1) & (l_{12},m_{12},u_{12}) & \cdots & (l_{1n},m_{1n},u_{1n}) \\ (l_{21},m_{21},u_{21}) & (1,1,1) & \cdots & (l_{2n},m_{2n},u_{2n}) \\ \vdots & \vdots & \cdots & \vdots \\ (l_{n1},m_{n1},u_{n1}) & (l_{n2},m_{n2},u_{n2}) & \cdots & (1,1,1) \end{bmatrix} \quad (6)$$

where $l_{ij} = 1/u_{ji}$, $m_{ij} = 1/m_{ji}$and u_{ij}, $= 1/l_{ji}$ for all i, j = 1,. . .,n;$i \neq j$ i. The above fuzzy comparison matrix can be split into three crisp nonnegative matrices:

$$\begin{bmatrix} 1 & l_{12} & \cdots & l_{1n} \\ l_{12} & 1 & \cdots & l_{1n} \\ \vdots & \vdots & \cdots & \vdots \\ l_{n1} & l_{1n} & \cdots & 1 \end{bmatrix} \quad \begin{bmatrix} 1 & m_{12} & \cdots & m_{1n} \\ m_{12} & 1 & \cdots & m_{1n} \\ \vdots & \vdots & \cdots & \vdots \\ m_{n1} & m_{1n} & \cdots & 1 \end{bmatrix} \quad \begin{bmatrix} 1 & u_{12} & \cdots & u_{1n} \\ u_{12} & 1 & \cdots & u_{1n} \\ \vdots & \vdots & \cdots & \vdots \\ u_{n1} & u_{1n} & \cdots & 1 \end{bmatrix} \quad (7)$$

where $\widetilde{A} = (A_L, A_M, A_U)$. Note that A_L and A_U are no longer reciprocal matrices. For the fuzzy comparison matrix $\widetilde{A}$, there should exist a normalized fuzzy weight vector, $\widetilde{W}\ ((W_1^L, W_1^M, W_1^U), \dots, (W_n^L, W_n^M, W_n^U))$ which is close to $\widetilde{A}$ in the sense that $\widetilde{A}\ =(l_{ij}, m_{ij}, u_{ij}) \approx \frac{(w_i^l, w_i^m, w_i^u)}{(w_j^l, w_j^m, w_j^u)}$ for all $i, j = 1, \dots, n; j \neq i$. According to Wang et al (2006), the fuzzy weight vector $\widetilde{W}$ is normalized if and only if

$$\textstyle\sum_{i=1}^{n} w_i^U - \max_j\left(w_j^U - w_j^L\right) \geq 1, \quad (8)$$
$$\textstyle\sum_{i=1}^{n} w_i^L - \max_j\left(w_j^U - w_j^L\right) \leq 1, \quad (9)$$
$$\textstyle\sum_{i=1}^{n} w_i^M = 1, \quad (10)$$

which can be equivalently rewritten as

$$W_i^L + \textstyle\sum_{j=1, j\neq i}^{n} W_j^U \geq 1, \quad i = 1, \dots, n, \quad (11)$$
$$W_i^U + \textstyle\sum_{j=1, j\neq i}^{n} W_j^L \leq 1, \quad i = 1, \dots, n, \quad (12)$$
$$\textstyle\sum_{i=1}^{n} W_j^M = 1, \quad (13)$$

If the fuzzy comparison matrix $\widetilde{A}$ defined by Eq. (6) is a precise comparison matrix about the fuzzy weight vector $\widetilde{W}$, namely,

$$\tilde{a} = \left(l_{ij}, m_{ij}, u_{ij}\right) \approx \frac{\left(w_i^l, w_i^m, w_i^u\right)}{\left(w_j^l, w_j^m, w_j^u\right)}$$

for all i, j = 1, … , n; but j ≠ i, then $\widetilde{A}$ must be able to be written as

$$\begin{bmatrix} 1 & \frac{(w_1^l, w_1^m, w_1^u)}{(w_2^l, w_2^m, w_2^u)} & \cdots & \frac{(w_1^l, w_1^m, w_1^u)}{(w_n^l, w_n^m, w_n^u)} \\ \frac{(w_2^l, w_2^m, w_2^u)}{(w_1^l, w_1^m, w_1^u)} & 1 & \cdots & \frac{(w_2^l, w_2^m, w_2^u)}{(w_n^l, w_n^m, w_n^u)} \\ \vdots & \vdots & \cdots & \vdots \\ \frac{(w_n^l, w_n^m, w_n^u)}{(w_1^l, w_1^m, w_1^u)} & \frac{(w_n^l, w_1^m, w_1^u)}{(w_2^l, w_2^m, w_2^u)} & \cdots & 1 \end{bmatrix} \quad (14)$$

According to the division operation rule of fuzzy arithmetic, i.e. $\frac{(b^L, b^M, b^U)}{(d^L, d^M, d^U)} = (b^L/d^U, b^M/d^M, b^U/d^L)$, where (b^L, b^M, b^U) and (d^L, d^M, d^U) are two positive triangular fuzzy numbers, the fuzzy comparison matrix $\widetilde{A}$ defined by Eq. (14) can be further expressed as

$$\begin{bmatrix} 1 & \left(\frac{w_1^l}{w_2^l}, \frac{w_1^m}{w_2^m}, \frac{w_1^u}{w_2^u}\right) & \cdots & \left(\frac{w_1^l}{w_n^l}, \frac{w_1^m}{w_n^m}, \frac{w_1^u}{w_n^u}\right) \\ \left(\frac{w_2^l}{w_1^l}, \frac{w_2^m}{w_1^m}, \frac{w_2^u}{w_1^u}\right) & 1 & \cdots & \left(\frac{w_2^l}{w_n^l}, \frac{w_2^m}{w_n^m}, \frac{w_2^u}{w_n^u}\right) \\ \vdots & \vdots & \cdots & \vdots \\ \left(\frac{w_n^l}{w_1^l}, \frac{w_n^m}{w_1^m}, \frac{w_n^u}{w_1^u}\right) & \left(\frac{w_n^l}{w_2^l}, \frac{w_n^m}{w_2^m}, \frac{w_n^u}{w_2^u}\right) & \cdots & 1 \end{bmatrix} \quad (15)$$

which can be split into three crisp nonnegative matrices, as shown below:

$$A_L = \begin{bmatrix} 1 & \frac{w_1^l}{w_2^l} & \cdots & \frac{w_1^l}{w_n^l} \\ \frac{w_2^l}{w_1^l} & 1 & \cdots & \frac{w_2^l}{w_n^l} \\ \vdots & \vdots & \cdots & \vdots \\ \frac{w_n^l}{w_1^l} & \frac{w_n^l}{w_2^l} & \cdots & 1 \end{bmatrix}$$

$$A_M = \begin{bmatrix} 1 & \frac{w_1^m}{w_2^m} & \cdots & \frac{w_1^m}{w_n^m} \\ \frac{w_2^m}{w_1^m} & 1 & \cdots & \frac{w_2^m}{w_n^m} \\ \vdots & \vdots & \cdots & \vdots \\ \frac{w_n^m}{w_1^m} & \frac{w_n^m}{w_2^m} & \cdots & 1 \end{bmatrix} \quad A_U = \begin{bmatrix} 1 & \frac{w_1^u}{w_2^l} & \cdots & \frac{w_1^u}{w_n^l} \\ \frac{w_2^u}{w_1^u} & 1 & \cdots & \frac{w_2^u}{w_n^u} \\ \vdots & \vdots & \cdots & \vdots \\ \frac{w_n^u}{w_1^u} & \frac{w_n^u}{w_2^u} & \cdots & 1 \end{bmatrix}$$

It is easy to verify that

$$A_L W_U = W_U + (n-1)W_L, \tag{16}$$
$$A_U W_L = W_L + (n-1)W_U, \tag{17}$$
$$A_M W_M = nW_M, \tag{18}$$

Eqs. (16) – (18) cannot always hold. In the case that they do not hold, we introduce the following deviation vectors:

$$E = (A_L - I)W_U - (n-1)W_L, \tag{19}$$
$$\Gamma = (A_U - I)W_L - (n-1)W_U, \tag{20}$$
$$\Delta = (A_M - nI)W_M, \tag{21}$$

where $E = (\varepsilon_1, \dots, \varepsilon_n)^T$, $\Gamma = (\gamma_1, \dots, \gamma_n)^T$, $\Delta = (\delta_1, \dots, \delta_n)^T$, I is an $n \times n$ unit matrix, ε_i, γ_i and δ_i for $i = 1, \dots, n$ are all deviation variables. It is most desirable that the absolute values of the deviation variables be kept as small as possible, which enables us to construct the following nonlinear goal programming (NGP) model for determining the fuzzy weight vector $\widetilde{W}$:

Minimize $J = \sum_{i=1}^{n}({\varepsilon_i}^+ + {\varepsilon_i}^- + {\gamma_i}^+ + {\gamma_i}^- + \delta_i) = e^T(E^+ + E^- + \Gamma^+ + \Gamma^- + \Delta)$

$$(A_L - I)W_U - (n-1)W_L - E^+ + E^- = 0,$$
$$(A_U - I)W_L - (n-1)W_U - \Gamma^+ + \Gamma^- = 0,$$
$$(A_M - nI)W_M - \Delta = 0,$$
$$W_i^L + \sum_{j=1, j\neq i}^{n} W_j^U \geq 1, \quad i = 1, \dots, n,$$
$$W_i^U + \sum_{j=1, j\neq i}^{n} W_j^L \geq 1, \quad i = 1, \dots, n,$$
$$\sum_{i=1}^{n} W_j^M = 1,$$
$$W_U - W_M \geq 0,$$
$$W_M - W_L \geq 0,$$
$$W_L, E^+, E^-, \Gamma^+, \Gamma^-, \Delta \geq 0, \tag{22}$$

4 .Fuzzy VIKOR method

The optimum in multi-criteria decision-making is the process to decide the compromise ranking in the ensured rules. In reality, there is no avoidance of the coexistence of qualitative and quantitative data, and they are often full of fuzziness and uncertainty. So, the optimum is often the noninferior solutions or compromise solutions depend on the decision-maker. The concepts of compromise solutions were first initiated by Yu et al (1973). The compromise solutions will be presented by comparing the degree of closeness to the ideal alternative. The method of VIKOR initiated by Opricovic (1998), works on the principle that each alternative can be evaluated by each criterion function; the compromise ranking will be presented by comparing the degree of closeness to the ideal alternative. To solve fuzzy multi-criteria decision-making problems with a best solution and compromise solution in reality confirmed situation, Fuzzy VIKOR was described by Wang et al (2005). The following was the stages in Fuzzy VIKOR.

Step1: Form a group of decision-makers (denoted in n), then determine the evaluation criteria (denoted in k) and feasible alternatives (denoted in m).

Step2: Identify the appropriate linguistic variables for the importance weight of criteria, and the rating for alternatives with regard to each criterion (as shown in Table 1 and Table 2). The membership degree of fuzzy numbers in the weight of criteria and the rating of alternatives will be presented in Figure 2 and Figure 3.

Table l: Linguistic Variables for the Weight of Criteria

Linguistic Variables	Fuzzy Numbers
Very Low (VL)	(0.00,0.00,0.25)
Low (L)	(0.00,0.25,0.50)
Medium (M)	(0.25,0.50,0.75)
High (H)	(0.50,0.75,1.00)
Very High (VH)	(0.75,1.00,1.00)

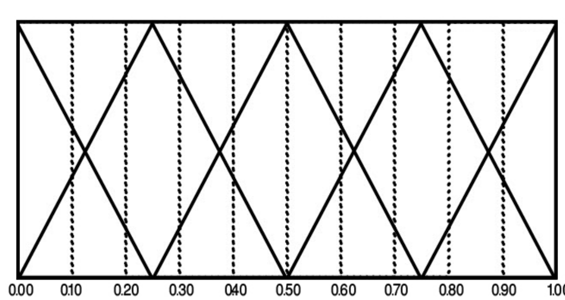


Figure 2. The Membership Degree of Fuzzy Numbers in the Weight of Criteria

Table 2: Linguistic Variables for the Rating of Alternative

Linguistic Variables	Fuzzy Number
Worst (W)	(0.0,0.0,2.5)
Poor (P)	(0.0,2.5,5.0)
Fair (F)	(2.5,5.0,7.5)
Good(G)	(5.0,7.5,10)
Best (B)	(7.5, 10, 10)

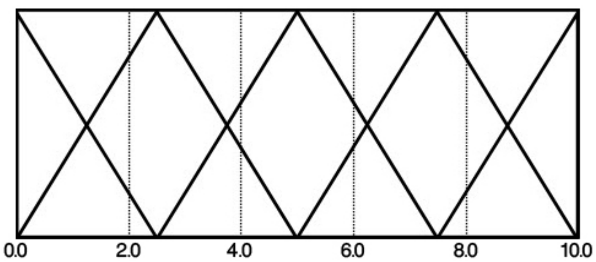


Figure 3. The Membership Degree of Fuzzy Numbers in the Rating of Alternative

Step3: Pull the decision makers' opinions to get the aggregated fuzzy weight of criteria, and aggregated fuzzy rating of alternatives. If there are *n* persons in a decision committee, the importance weight of each criterion and rating of each alternative can be measured by:

$$\widetilde{W_j} = {}^1/_k\,[\widetilde{W_j}^1 \oplus \widetilde{W_j}^2 \oplus \ldots \oplus \widetilde{W_j}^k] \qquad (23)$$

$$\widetilde{x_{ij}} = {}^1/_k\,[\widetilde{x_{ij}}^1 \oplus \widetilde{x_{ij}}^2 \oplus \ldots \oplus \widetilde{x_{ij}}^k] \qquad (24)$$

Step 4: Construct a fuzzy decision matrix. Formally, a typical fuzzy multicriteria decision making problem can be expressed in matrix format as:

$$\widetilde{D} = \begin{pmatrix} \tilde{x}_{11} & \Lambda & \tilde{x}_{1n} \\ M & M & M \\ \tilde{x}_{m1} & \Lambda & \tilde{x}_{mn} \end{pmatrix}, \text{ i=1,2,…,m ;}$$

j=1,2,…,n (25)

$$\widetilde{W} = [\widetilde{W}_1, \widetilde{W}_2, \ldots, \widetilde{W}_n], j = 1,2,\ldots,n \qquad (26)$$

where $\tilde{x}_{ij}$ the rating of alternative A_i with respect to C_j, $\widetilde{w}_j$ the importance weight of the *j* th criterion holds, $\tilde{x}_{ij}$ and $\widetilde{w}_j$ are linguistic variables denoted by triangular fuzzy numbers.

Step 5: Construct the normalized aggregated fuzzy performance decision matrix. If the supports of triangular fuzzy numbers do not belong to the interval [0,1] then scaling is needed to transform them back in this interval. Thus, the fuzzy numbers are normalized in the fuzzy decision matrix as the fuzzy performance matrix $\tilde{P}$ to preserve the values to [0,1].

$$\tilde{P} = [\tilde{P}_{ij}],$$

Where

$$\tilde{P}_{ij} = \left(\frac{x_{ij1}}{M}, \frac{x_{ij2}}{M}, \frac{x_{ij3}}{M}\right),$$
$$M = \max_i x_{ij3}, \qquad C_j \quad \textit{is benefit criterion}$$

And

$$\tilde{P}_{ij} = \left(\frac{N-x_{ij1}}{N}, \frac{N-x_{ij2}}{N}, \frac{N-x_{ij3}}{N}\right),$$
$$N = \max_i x_{ij3}, \qquad C_j \quad \textit{is cost criterion}$$

Step 6. Compute the values of $\tilde{S}_i$ and $\tilde{R}_i (i = 1,2,\ldots,m)$ by

$$\tilde{S}_i = \sum_{j=1}^{n} \widetilde{w}_i \tilde{p}_{ij},$$

And

$$\tilde{R}_i = \max_i \widetilde{w}_i \tilde{p}_{ij},$$

where $\tilde{S}_i$ and $\tilde{R}_i$ are used for formulating the ranking measure of group utility and the individual regret for each DM, respectively. It is noteworthy that the relative importance of selected criteria is utilized.

Step 7. Defuzzify the values of $\tilde{S}_i$ and $\tilde{R}_i$

Step 8. Compute the proposed index value $\tilde{Q}_i (i = 1,2,\ldots,m)$ by:

$$\tilde{Q}_i = \frac{v(S_i - S^*)}{(S^- - S^*)} + (1 - v)\frac{(R_i - R^*)}{(R^- - R^*)} = \frac{S^- - S^*}{S^- - S^* + R^- - R^*}\frac{(S_j - S^*)}{(S^- - S^*)} + \frac{R^- - R^*}{S^- - S^* + R^- - R^*}\frac{(R_j - R^*)}{(R^- - R^*)} \qquad (27)$$

Where

$S^* = \min_i S_i$, $S^- = \max_i S_i$

$R^* = \min_i R_i$, $R^- = \max_i S_i$

v is introduced as the weight of the strategy of the majority of criteria. Using the definition of the Minkowski functional of U and according to its properties presented in Appendix, we have:

$P(S_j - S^-) = inf\left\{S^- - S^* > 0{:}\frac{S_j - S^-}{S^- - S^*} \in K'\right\}$ and

$P(R_j - R^*) = inf\left\{R^- - R^* > 0{:}\frac{R_j - R^-}{R^- - R^*} \in K'\right\}$.

By using convexity phenomenon in the proof of Lemma properties, we have:

$$\frac{(S_j - S^-) + (R_j - R^-)}{(S^- - S^*) + (R^- - R^*)} = \frac{S^- - S^*}{S^- - S^* + R^- - R^*}\frac{(S_j - S^*)}{(S^- - S^*)} + \frac{R^- - R^*}{S^- - S^* + R^- - R^*}\frac{(R_j - R^*)}{(R^- - R^*)}$$

Then,

$P\left(\nu\left(\frac{S_j-S^*}{S^--S^*}\right)+(1-\nu)\left(\frac{R_j-R^*}{R^--R^*}\right)\right)\leq \nu\frac{P(S_j-S^*)}{S^--S^*}+$
$(1-\nu)\frac{P(R_j-R^*)}{R^--R^*}\leq 1.$

Hence, we have

$$\nu=\frac{S^--S^*}{S^--S^*+R^--R^*} \tag{28}$$

$$1-\nu=\frac{R^--R^*}{S^--S^*+R^--R^*} \tag{29}$$

In the proposed ranking index, the relative importance of positive ideal solution (PIS) and negative ideal solution (NIS) is determined by the Minkowski's functional and convex linear combination. In this case, the values of ν and $1-\nu$ are determined by the distances R^- _ R^* and S^-_ S^*. Because of the simplicity of alternative ranking, as the main advantage of the proposed fuzzy VIKOR method, there is no need to calculate the v for all alternatives. Hence, a global v is introduced without the DMs' judgments for all alternatives, unlike the previous VIKOR methods in the literature.

Step 9. Rank the alternatives, sorting by the values Q_i in decreasing order.

5. Application of Proposed Method

This research has been conducted in Pars Tire Company which produces Tire. The problem is the evaluation of strategies and selection of the most appropriate one. For this reason, five criteria are determined according to Mohaghar et al (2011). Secondly, a two-step LGP and fuzzy VIKOR methodology is proposed to realize the evaluation. Via considering these criteria which is including managerial capabilities (C_1), customer linking capabilities (C_2), market innovation capabilities (C_3), human resource assets (C_4), reputational assets (C_5), the weights of three alternatives that include Differentiation strategy (A_1), Cost Leadership strategies (A_2), and Segmentation strategy (A_3) are calculated by using LGP model, and these calculated weight values are used as fuzzy VIKOR inputs. Then, after fuzzy VIKOR calculations, evaluation of the alternatives and selection of the most appropriate one is realized.

Linear Goal Programming:

In LGP, firstly, we should determine the weights of each criterion by utilizing pair-wise comparison matrices. We compare each criterion with respect to other criteria. You can see the pair-wise comparison matrix for Flexible Manufacturing System criteria in Table 3.

Table 3.Inter-criteria comparison matrix

	C_1	C_2	C_3	C_4	C_5
C_1	(1.00,1.00,1.00)	(1.00,2.00,3.00)	(2.00,3.00,4.00)	(0.20,1.20,2.20)	(1.00,2.00,3.00)
C_2	(0.33,0.50,1.00)	(1.00,1.00,1.00)	(0.50,1.50,2.50)	(0.75,1.75,2.75)	(0.30,0.43,0.74)
C_3	(0.25,0.33,0.50)	(0.40,0.67,2.00)	(1.00,1.00,1.00)	(1.55,2.55,3.55)	(1.35,2.35,3.35)
C_4	(0.45,0.83,5.00)	(0.36,0.57,1.33)	(0.28,0.39,0.65)	(1.00,1.00,1.00)	(1.00,2.00,3.00)
C_5	(0.33,0.50,1.00)	(1.35,2.35,3.35)	(0.30,0.43,0.74)	(0.33,0.50,1.00)	(1.00,1.00,1.00)

After forming the model (22) for the comparison matrix and solving this model, the fuzzy weight vectors are obtained and are shown in Table 4 as follow:

Table 4. Fuzzy weight

	Fuzzy weight
W_1	(0.1333, 0.3498, 0.3549)
W_2	(0.0283, 0.1957, 0.2499)
W_3	(0.1982, 0.2115, 0.2115)
W_4	(0.1074, 0.1411, 0.2848)
W_5	(0.1020, 0.1020, 0.1205)

Fuzzy VIKOR:

The weights of the criteria are calculated by LGP up to now, and then these values can be used in Fuzzy VIKOR. So, the Fuzzy VIKOR methodology must be started at the second step.

Thus, weighted normalized decision matrix can be prepared. This matrix can be seen from Table 5.

Table 5. The weighted normalized decision matrix

	C_1	C_2	C_3	C_4	C_5
A_1	(0.07,0.27,0.35)	(0.01,0.14,0.24)	(0.09,0.15,0.21)	(0.05,0.10,0.28)	(0.05,0.08,0.12)
A_2	(0.06,0.24,0.32)	(0.01,0.15,0.24)	(0.09,0.15,0.20)	(0.05,0.10,0.27)	(0.05,0.07,0.11)
A_3	(0.04,0.19,0.27)	(0.01,0.11,0.20)	(0.06,0.12,0.17)	(0.03,0.08,0.24)	(0.04,0.06,0.10)

By following VIKOR procedure steps and calculations, the ranking of strategies are gained. The results and final ranking are shown in Table 6.

Table 6. The result of Fuzzy VIKOR method

	S_i	Rank by S_i	R_i	Rank by R_i	Q_i	Rank by Q_i
A_1	0.7596794	1	0.24233482	1	1	1
A_2	0.729921	2	0.22210548	2	0.771	2
A_3	0.6041684	3	0.17955448	3	0	3

In this paper, we rank strategy with respect to Q_i. According to result, Differentiation strategy is selected as a best strategy for this company. Other strategies are ranked as follow: $A_1>A_2>A_3$.

6. Conclusion

For optimal marketing strategy, the current study proposes a marketing strategy decision making process that should also be more operable and practical. An appropriate and simple prioritization method for determining the best marketing strategy would be helpful to firms and marketing strategists. In this paper, Linear Goal Programming model and Fuzzy VIKOR are combined that Fuzzy VIKOR uses LGP result weights as input weights. Then a real case study is presented to show applicability and performance of the method. It can be said that using linguistic variables makes the evaluation process more realistic. Because evaluation is not an exact process and has fuzziness in its body. Here, the usage of LGP weights in Fuzzy VIKOR makes the application more realistic and reliable.

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