MARKETING STRATEGY SELECTION IN NEW PRODUCT DEVELOPMENT
USING FUZZY LINEAR PROGRAMMING

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Abstract

The relationship between production and consumption shows that marketing plays an important role in enterprises. Nowadays, the concept of marketing is customer-oriented and aims to meet the needs and expectations of customers to increase their satisfaction. And the basics of marketing decisions are the choice of appropriate target markets, their analysis and the creation of strategic marketing plans with the elements of the marketing mix. The aim of this paper is to evaluate pricing strategies and select the best strategic marketing solution while considering the multi attributes associated with new product development. The fuzzy linear programming technique (FLP) is investigated for multiple attribute group decision making (MAGDM) problems in marketing strategy planning with preference information on pricing alternatives.

Keywords: Marketing Strategy, Pricing Strategy, MCDM, FLP

1. Introduction

The first of two major functions of the enterprises is producing goods and services, and the second is selling them. Effectively for the success of a company, the invented core product is crucial in the first place and a good product is more likely to bond market.
Nowadays, marketing approach is customer-focused and products are directly oriented to meet customer needs. According to actual definition of Kotler, marketing is managing profitable customer relationships (Kotler & Armstrong, 2012). Marketing is a long process thus it needs organization and management. Therefore the term “marketing strategy” is widely used. At the most macro level, marketing strategy focuses on manipulations of marketing mix variables – product, price, place and promotion (Schnaars, 1991). Strategic marketing planning becomes more and more important in today’s competitive conditions.

One of the marketing mix variables is the price of the product and decisions surrounding the overall pricing strategies of company. Pricing is the process of determining what a company will receive in exchange for its products. Price, is basically about the charging of the product however, pricing is not that simple. Price should be considered with the segmentation and the positioning of the product because price always brings a classification to the product. Besides, pricing strategy proceeds with the product’s life cycle. List price, discounts, allowances, payment periods, credit terms etc. should be considered throughout the process. For a company, decisions concerning price determination depend on determinants in the market as well as the consumer portfolio or the target market of the company, the financial and organizational structure of the company itself and the characteristics of the product. Therefore, it is a multi-criteria decision making (MCDM) problem.

The aim of this paper is to evaluate pricing strategies and select the best strategic marketing solution while considering the multi attributes associated with new product development. We investigate the fuzzy linear programming technique (FLP) for multiple attribute group decision making (MAGDM) problems in marketing strategy planning with preference information on pricing alternatives. In multiple attribute decision-making (MADM) problems, a decision maker (DM) is often faced with the problem of selecting, evaluation or ranking alternatives that are characterized by multiple, usually conflicting,
attributes. In this paper, to reflect the decision maker’s subjective preference information and to determine the weight vector of attributes, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) developed by Hwang and Yoon (Hwang & Yoon, 1981), the linear programming technique for multidimensional analysis of preference (LINMAP) developed by Srinivasan and Shocker (Srinivasan & Shocker, 1973) are used. In MADM problems, fuzzy set theory is well suited to deal with such decision problems (Ross, 2004; Van Laarhoven & Pedrycz, 1983; Y. M. Wang & Parkan, 2005; Zadeh, 1965). In this paper, fuzzy LINMAP method is used to capture the fuzziness in decision making process (Albayrak, 2008; Albayrak & Erensal, 2006, 2009; Bereketli, Genevois, Albayrak, & Ozyol, 2011; D. F. Li, 2008; D. F. Li, Chen, & Huang, 2010; D. F. Li & Sun, 2007; D. F. Li & Yang, 2004). The fuzzy LINMAP method is a linear programming model based consistency and inconsistency indices of the preferences given by decision maker. According to the concept of fuzzy and TOPSIS, we define the fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solution (FNIS) (Chen, 2000). By solving the linear programming problem, FPIS, the weights of attributes and the distance of each alternative from the FPIS are calculated. According to the increasing order of these distances, the best alternative is obtained and the ranking order of all alternatives is determined.

During the last years, many studies have been published about marketing strategy selection and strategic marketing; by Rekik et al., proposing a multi-criteria decision making support system to aid the marketing strategy selection in e-commerce (Denguir-Rekik, Montmain, & Mauris, 2009), by Lin et al., implementing fuzzy analytic network process for the selection of the best marketing strategy as a multiple criteria decision making problem (Lin, Lee, & Wu, 2009), by Wu et al., modeling the marketing strategy decision-making problem as a multi-criteria decision-making problem, implementing of the integration of the Analytic Network Process (ANP) and TOPSIS to determine the appropriate marketing
strategy (Wu, Lin, & Lee, 2010), by Li & Li, investigating the use of multi-agent based hybrid intelligent systems in support of international marketing planning (S. L. Li & Li, 2010), by Wierenga, formulating interesting and relevant research questions about marketing decision making (Wierenga, 2011), by Tsai et al., proposing an integrated model for evaluating airlines’ websites effectiveness which is based on the perspectives of ‘‘marketing mix 4Ps’’ and ‘‘website quality’’ for the web-based marketing using the ANP (Tsai, Chou, & Leu, 2011), by Liao, proposing a method that will guide the product development team to select the best marketing strategy by taking into account the price level and product/market segmentation (Liao, 2011), and by Wang, providing a reference for planning brand marketing with a hybrid MCDM model combining the Decision Making Trial and Evaluation Laboratory (DEMATEL) with ANP and VIKOR methods (Y. L. Wang & Tzeng, 2012).

2. Basic Concepts of Marketing Strategy

In order to propose a marketing strategy selection model, marketing and marketing strategy should be defined. The essence of marketing is a transaction – an exchange – intended to satisfy human needs and wants (Stanton, 1981). Marketing is not just an activity of a department in a company; it is a management requiring process. Marketing consists of five main steps; (1) research, (2) segmentation, market targeting, positioning, (3) marketing mix constitution, (4) implementation of the strategy and (5) control (Kotler, 1999). The second and the third steps form the marketing strategy. Marketing strategy involves two key questions: Which customers will the company serve? How to create a value for these customers? (Kotler & Armstrong, 2012)

Marketing strategy starts with segmentation. Segmentation is to find customer groups which are homogeneous between them and heterogeneous compared to other groups (Freter & Baumgarth, 2004). Segmentation aims to find the distinctive qualities of current markets,
divide markets into segments according to these qualities, determine the size and the growth of these segments and observe the competitors. Next comes the market targeting. Basically the target market is the segment served. The target market must be clearly identifiable to simplify the marketing communications and large enough to achieve required profit. A company might consider five basic strategies for target market selection: (1) single segment targeting, (2) selective targeting, (3) mass market targeting, (4) product specialization, (5) market specialization (Ferrell & Hartline, 2011). Once the target market is defined, the company must consider creating a value for its customers. This step is called positioning. A position is a complex set of perceptions, impressions and feelings and it is important to note that customers position the company’s value offering with or without its help (Bradley, 2003). Positioning step is more important for the new products because once a product is positioned for the customer, it is nearly impossible to change. Last step of the marketing strategy is creating the marketing mix. Marketing mix elements, also known as 4P’s, are product, price, promotion and place (McCarthy, 1960). Each P represents different strategies for marketing and is vital for the success. It is a framework which helps to structure the approach to each market. The mix is a bundle of variables which are offered to the customer.

3. Methodology

3.1. Fuzzy LINMAP Method

In MADM problems, the decision maker’s preference information is used to rank alternatives. In this paper, we propose a FLP technique for MAGDM problems where the DM gives his/her preference on alternatives in a fuzzy relation. The weights are estimated using the fuzzy linear programming model based on group consistency and inconsistency indices.

Consider a MADM problem with \( n \) alternatives \( A_i \), \( i = 1, 2, ..., n \) and \( m \) decision attributes \( C_j \), \( j = 1, 2, ..., m \). \( d_{ij} \), component of a decision matrix denoted by \( D = (d_{ij})_{n \times m} \), is the
rating of alternative $A_i$ with respect to attribute $C_j$. A MADM problem can be expressed as the following decision matrix:

$$D = \begin{bmatrix}
A_1 & C_1 & C_2 & ... & C_m \\
A_2 & d_{11} & d_{12} & ... & d_{1m} \\
... & d_{21} & d_{22} & ... & d_{2m} \\
A_n & d_{n1} & d_{n2} & ... & d_{nm}
\end{bmatrix}$$

Let $w = (w_1, w_2, ..., w_n)^T$ be the vector of weights, where $\sum_{j=1}^{m} w_j = 1$, $w_j \geq 0$, $j = 1, 2, ..., m$ and $w_j$ denotes the weight of attribute $C_j$ (Hwang, Chen, & Hwang, 1992).

### 3.2. Fuzzy Group LINMAP Model

The main focus of this paper is to provide a LINMAP. This paper uses fuzzy LINMAP to model the problem of selecting, evaluating, or ranking alternatives that are characterized by multiple, usually conflicting, attributes. This paper offers a methodology for analyzing individual and multidimensional preferences with linear programming approach in multi attribute group decision making under fuzzy environments (FLINMAP) (Hwang et al., 1992; Xia, Li, Zhou, & Wang, 2006). The LINMAP method is based on pairwise comparisons of alternatives given by decision makers and generates the best compromise alternative as the solution that has the shortest distance to the positive ideal solution (Srinivasan & Shocker, 1973).

### 3.3. Consistency and Inconsistency Indices

Let $\bar{X}^* = (\bar{x}^*_1, \bar{x}^*_2, ..., \bar{x}^*_m)$ is the fuzzy positive ideal point, i.e., the alternative location most preferred by the individual, the square of the weighted Euclidean distance between the normalized matrix $\bar{Y}_i^P$ and $\bar{X}^*$, where $\bar{x}^*_j = (x_{jl}^*, x_{jm}^*, x_{jr}^*)$ are triangular fuzzy numbers, can be calculated as

$$d_i(\bar{Y}_i^P, \bar{x}^*_j) = \frac{1}{3} \left[ (y_{ijl} - x_{jl}^*)^2 + (y_{ijm} - x_{jm}^*)^2 + (y_{ijr} - x_{jr}^*)^2 \right]^{1/2} \text{ for } i \in A$$

(1)
The squared distance $s_i = d_i^2$ is given by

$$S_i^P = \sum_{j=1}^{m} w_j \left[ d(\tilde{y}_{ij}^P, \tilde{x}_j^P) \right]^2$$

(2)

$S_i^P$ can be rewritten using triangular fuzzy numbers $\tilde{x}_j^P$ as (Fan, Hu, & Xiao, 2004; D. F. Li & Yang, 2004; Xia et al., 2006)

$$S_i^P = \frac{1}{2} \sum_{j=1}^{m} w_j \left[ (y_{ijL} - x_{jL}^*)^2 + (y_{ijM} - x_{jM}^*)^2 + (y_{ijR} - x_{jR}^*)^2 \right]$$

(3)

Suppose that the DM $P_p (p = 1, 2, ..., P)$ gives the preference relations between alternatives by

$$\Omega^p = \{(k, l); A_k \rho_p A_l; k, l = 1, 2, ..., n \}$$

where $\rho_p$ is a preference relation given by the DM $P_p$. Then the solution would be consistent with the weighted distance model if $S_i^P \geq S_k^P$ and there is no error attributable to the solution (Srinivasan & Shocker, 1973). If $S_i^P < S_k^P$, ($S_k^P - S_i^P$) gives error. We define an index $(S_i^P - S_k^P)^-$ to measure inconsistency between the ranking of alternatives and preferences, i.e., to denote the error of the pair $(k, l)$;

$$(S_i^P - S_k^P)^- = 0 \quad \text{if} \quad S_i^P \geq S_k^P \quad \text{and} \quad (S_i^P - S_k^P)^- = S_k^P - S_i^P \quad \text{if} \quad S_i^P < S_k^P$$

(6)

Then the inconsistency index can be rewritten as,

$$(S_i^P - S_k^P)^- = \max \{0, S_k^P - S_i^P \}$$

(7)

For all the pairs in $\Omega^P$, the total inconsistency is

$$B^P = \sum_{(k, l) \in \Omega^P} (S_i^P - S_k^P)^-$$

(8)

and the total poorness of fit for the group is
Our objective is to minimize the sum of errors for all pairs in \( \Omega^p \). Similarly, the total goodness of fit \( (G) \) for the group is

\[
G = \sum_{p=1}^{P} G^p = \sum_{p=1}^{P} \sum_{(k,l) \in \Omega^p} (S_l^p - S_k^p)^+
\]

By definition of \((S_l^p - S_k^p)^+ \) and \((S_l^p - S_k^p)^- \),

\[
(S_l^p - S_k^p) = (S_l^p - S_k^p)^+ - (S_l^p - S_k^p)^-
\]

Substituting for \( B \) and \( G \) from (9) and (10), we get;

\[
\sum_{(k,l) \in \Omega^p} (S_l^p - S_k^p)^+ - \sum_{(k,l) \in \Omega^p} (S_l^p - S_k^p)^- = \sum_{(k,l) \in \Omega^p} (S_l^p - S_k^p) = G - B = h
\]

\( h \) is an arbitrary positive number. The constraint imposes the condition that the goodness of fit \( G \) should be greater than the poorness of fit \( B \).

### 3.4. Fuzzy LINMAP Model

The problem of finding the best solution \((w, \bar{x}^*)\) reduces to finding the solution \((w, v)\) (Crainic, Ricciardi, & Storchi, 2009) which maximizes Eq. (13) subject to the constraints (D. F. Li & Yang, 2004)

We construct the following mathematical programming;

Maximize \( \left\{ \sum_{p=1}^{P} \sum_{(k,l) \in \Omega^p} \max\{0, (S_l^p - S_k^p)\} \right\} \)

s.t. \[
\begin{align*}
G - B & \geq h \\
\sum_{j=1}^{m} w_j & = 1 \\
w_j & \geq 0, \ j = 1,2,...,m
\end{align*}
\]

where \( h \) is strictly positive.

Using \( V = \{v_j\} = (w_j\bar{x}_j^*) \) we can write as

\[
v_{jL} = w_j\bar{x}_{jL}^*, \quad v_{jM} = w_j\bar{x}_{jM}^* \quad \text{and} \quad v_{jR} = w_j\bar{x}_{jR}^*
\]

By solving this linear programming problem (Eq. 13) using Simplex method, \( w_j, v_{jL}, v_{jM}, v_{jR} \) can be obtained. The best values of \( \bar{x}_j^* \) are computed using Eq. (14).
4. Proposed Model

4.1. Criteria of the Model

The criteria of the model are the strategic marketing criteria mostly effective in the marketing strategy selection process as shown in Figure 1.

![Criteria of the Model Diagram]

Innovation is the first criterion. The word innovation is derived from the Latin word “innovare”, which means to renew or change. Nowadays it represents the new product development (NPD) process and Research and Development (R&D) operations for the companies. Second criterion, Manufacturing / Operations, consists of the production processes and other operations (logistics, outsourcing etc.) of the company except managerial activities. Capacity, flexibility, efficiency, effectiveness of the operations and cost structure are included in this criterion. Management criterion consists of quality of top and middle management, knowledge of business, culture, strategic goals and plans, entrepreneurial thrust, planning / operation system, loyalty / turnover, quality of strategic decision making (Aaker & McLoughlin, 2010). Market criterion is related to the market that the company serves. Consumer criterion represents the company’s potential customers who compose the
company’s target market/segment. Product criterion is one of the 4P’s, which represents the substantial product acquired by the consumer.

4.2. Alternatives of the Model

The alternatives of the model are the 5 base pricing strategies classified by Ferrell & Hartline (Ferrell & Hartline, 2011).

• **Price Skimming:** The idea behind price skimming is to intentionally set a high price relative to the competition, thereby skimming the profits off the top of the market. Price skimming is designed to recover the high R&D and marketing expenses associated with developing a new product. It may also be used to initially segment the market based on price, or to control the initial demand for the product.

• **Prestige Pricing:** Firms using prestige pricing set their prices at the top end of all competing products in a category. This is done to promote an image of exclusivity and superior quality. The company competes only on service and the value of the unique, high-quality experience that they deliver to customers.

• **Value-Based Pricing:** Firms that use a value-based pricing approach set reasonably low prices but still offer high-quality products and adequate customer services. Many different types of firms use value-based pricing; however, retailing has widely embraced this approach, where it is known as everyday low pricing or EDLP. The goal of value-based pricing is to set a reasonable price for the level of quality offered. Prices are not the highest in the market, nor are they the lowest. Instead, value-based pricing sets prices so they are consistent with the benefits and costs associated with acquiring the product.

• **Competitive Matching:** In many industries, particularly oligopolies, pricing strategy focuses on matching competitors’ prices and price changes. Although some firms may charge slightly
more or slightly less, these firms set prices at what most consider to be the “going rate” for the industry.

• **Penetration Pricing:** The goal of penetration pricing is to maximize sales, gain widespread market acceptance, and capture a large market share quickly by setting a relatively low initial price. This approach works best when customers are price sensitive for the product or product category; when research and development and marketing expenses are relatively low; or when new competitors will quickly enter the market.

5. **Application**

5.1. **General Information**

In order to evaluate the first application of the model, a computer and mobile phone manufacturer company has been chosen. This company has an important market share around the world. Since its foundation, this company uses the Blue Ocean Strategy as its general marketing strategy. Blue Ocean Strategy suggests that an organization should create new demand in an uncontested market space, or a "Blue Ocean", rather than compete head-to-head with other suppliers in an existing industry (Kim & Mauborgne, 2005). As a result, the demand of the products of this company considerably high and the brand image is reliable. The company is advantageous about the economies of scale and its fixed costs are minimized. Since this company is one of the market leaders, the last two alternatives are eliminated by the decision makers. In this application, the model has three alternatives: Price Skimming, Prestige Pricing and Value-Based Pricing.

The main focus of this paper is to provide a fuzzy LINMAP application. The proposed method is currently applied to evaluate marketing strategies and select the best pricing strategy while considering the preferences of several decision makers.
5.2. Step by Step Procedure

The computational procedure is summarized as follows:

*Step 1*: The experts, strategic marketing managers, identify the evaluation attributes.

*Step 2*: The experts, \( P_p (p = 1,2,3) \) give their preference judgments between alternatives with paired comparisons as \( \Omega_1 = \{(1,2),(1,3)\}, \Omega_2 = \{(3,2),(1,3)\}, \Omega_3 = \{(2,1)\} \). Here (1,2) stands for 1 is preferred to 2 and (1,2) denotes 1 is preferred to 2.

*Step 3*: The experts use the linguistic variables (shown in Table 1) to evaluate the rating of alternatives with respect to each attributes.

<table>
<thead>
<tr>
<th>Table 1 Linguistic variable for the ratings</th>
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<tbody>
<tr>
<td>Very Poor (VP)</td>
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<tr>
<td>Poor (P)</td>
</tr>
<tr>
<td>Fair (H)</td>
</tr>
<tr>
<td>Good (G)</td>
</tr>
<tr>
<td>Very Good (VG)</td>
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*Step 4*: Obtain the data and ratings of all alternatives \( A_i (i=1,2,3) \) on every attribute \( C_j (j=1,...,17) \) given by three experts \( P_p (p=1,2,3) \).

*Step 5*: Construct the fuzzy decision matrices and normalized fuzzy decision matrices for each expert.

*Step 6*: Construct the linear programming model Eq. (13)

*Step 7*: Solve linear programming problem: To obtain the best weights and the fuzzy positive ideal point, taking \( h = 1.0 \) and using \( \tilde{r}^p \) and \( \Omega^p \), Eq. (13) is solved.

By solving linear programming problem, using MATLAB R11 on a Pentium IV PC with a 3 GHz CPU and 4 GB RAM, results are obtained;
\[ \omega = (\omega_1, \omega_2, ..., \omega_{17}) \]
\[ = (0.07, 0.04, 0.02, 0.07, 0.1, 0.03, 0.08, 0.02, 0.02, 0.11, 0.11, 0.03, 0.01, 0.06, 0.1, 0.02, 0.11) \]

and
\[ \bar{\bar{v}} = (\bar{v}_1, \bar{v}_2, ..., \bar{v}_{17}) = (0.46, 0.46, 0.4, 0.7, 0.5, 0.49, 0.48, ..., 0.34, 0.33, 0.34) \]

Using \( \omega \) and \( \bar{\bar{v}} \) values with Eq. (14), the positive ideal solutions set is calculated
\[ \bar{x}^* = (\bar{x}_1^*, \bar{x}_2^*, ..., \bar{x}_{12}^*) = (6.99, 6.88, 5.99, 13.8, 13.7, 13.3, ..., 3.05, 2.99, 3.02) \]

**Step 8**: Calculate the square of the weighted Euclidean distance \( S_i \) between each pair of alternative, \( \tilde{y}^p_i \), and the fuzzy positive ideal solution, \( \bar{x}^* \). The results are obtained using Euclidian distance and shown in the Table 2.

<table>
<thead>
<tr>
<th></th>
<th>( P_1 )</th>
<th>( P_2 )</th>
<th>( P_3 )</th>
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<tr>
<td>( A_1 )</td>
<td>135.89</td>
<td>137.68</td>
<td>136.15</td>
</tr>
<tr>
<td>( A_2 )</td>
<td>136.12</td>
<td>137.20</td>
<td>136.29</td>
</tr>
<tr>
<td>( A_3 )</td>
<td>136.43</td>
<td>136.54</td>
<td>136.27</td>
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</table>

According these distances, the ranking orders of the three alternatives for the three experts are as follows:

For \( P_1 \): \( A_3 \rho A_2 \rho A_1 \) (Symbolizing “the expert \( P_1 \) prefers \( A_3 \) to \( A_2 \)” by \( A_3 \rho A_2 \))

For \( P_2 \): \( A_1 \rho A_2 \rho A_3 \)

For \( P_3 \): \( A_3 \rho A_2 \rho A_1 \)

**Step 9**: The group ranking order of all alternatives can be obtained using social choice functions such as Borda’s function (Hwang & Lin, 1987). Borda’s function ranks the alternatives in the order of the value of \( f_b(x) \), Borda scores are shown in Table 3.
The ranking order of the three alternatives is $A_2$, $A_3$ and $A_1$ according to the Borda’s scores; in other words, the best alternative is $A_2$. The best alternative is Prestige Pricing.

6. Conclusion

The aim of this paper is to evaluate strategic marketing and select the best pricing strategy solution while considering the preferences of several decision makers. This study searches the answers of questions why strategic marketing is required to be implementing to enterprises, and what the most suitable solutions for business are. This paper offers a methodology for analyzing individual and multidimensional preferences with linear programming approach under fuzzy environments and a systematic methodology is proposed to select the best pricing strategy. The fuzzy LINMAP is a multi attribute group decision making technique, where decision makers give their preferences on alternatives in a fuzzy relation. This method is a fuzzy prioritization method based on an optimization problem with linear constraints, considering the imprecise judgments of decision-makers which model the uncertainty with fuzzy numbers and uses paired comparison judgments directly to derive crisp priorities.

In this paper, the use of FLP to strategic marketing development has been discussed and this approach to marketing problems has not yet been appeared in the literature. Three pricing strategies alternatives are determined in the study: (A1) Price Skimming, (A2) Prestige Pricing, and (A3) Value-based Pricing. 17 attributes; 2 innovation attributes, 3
manufacturing/operations attributes, 3 management attributes, 3 market attributes, 2 consumer attributes and 4 product attributes based on these alternatives are also stated. To reflect the DM’s subjective preference information and to determine the weight vector of attributes, the fuzzy LINMAP model is constructed. The obtained weights of the alternatives are then ranked by using a social choice function.

At the end of this study, the method set “Market / Segment Size” (C10) as the key attribute; and the ranking of the three alternatives has been obtained as A1, A3 and, A2. The best alternative is Prestige Pricing.

The usefulness of the model was observed by its effect on the decision-making process in selecting an appropriate alternative and the case study shows that the LINMAP method is applicable as an evaluation technique for marketing strategies alternatives. The current fuzzy linear programming model offers the decision maker some flexibility to incorporate his/her own priority in the model. Consequently, managers can use such approaches in making their strategic decisions in case of incomplete information and vagueness. The model provides a useful conceptual framework for evaluating pricing strategies alternatives and marketing managers can use such approaches in making their strategic decisions.

References


