Abstract—Marketing establishes a communication network between producers and consumers. Nowadays, marketing approach is customer-focused and products are directly oriented to meet customer needs. Marketing, which is a long process, needs organization and management. Therefore strategic marketing planning becomes more and more important in today’s competitive conditions. Main focus of this paper is to evaluate pricing strategies and select the best pricing strategy solution while considering internal and external factors influencing the company’s pricing decisions associated with new product development. To reflect the decision maker’s subjective preference information and to determine the weight vector of factors (attributes), the fuzzy linear programming technique for multidimensional analysis of preference (LINMAP) under intuitionistic fuzzy (IF) environments is used.

Keywords—IF Sets, LINMAP, MAGDM, Marketing.

I. INTRODUCTION

Marketing is a vital factor in accelerating economic activities between producers and consumers. Finding needed goods and services at desired location with readily available amounts is very important for consumers. Thereby consumers can easily benefit from goods and services in the extent of their purchasing power.

Marketing, which is a long process, 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 (4P) – product, price, place and promotion [1]. Another definition of strategy in marketing with a broader perspective of strategy claims that strategic market planning is a four-step process: defining the business, setting a mission, selecting functional plans for marketing, production, and other areas, and budgeting for those plans [2]. Thus the 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 naturally brings a classification to the product. Besides, pricing strategy proceeds with the product’s life cycle.

II. 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 [12]. 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 [13]. 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 [14]?
Marketing strategy starts with segmentation. Segmentation
is to find customer groups which are homogeneous between
them and heterogeneous compared to other groups [15].
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 [16]. Once the target
market is defined, the company must consider creating a value
for its customers. This step is called positioning. A position is
defined, the company must consider creating a value
for its customers. This step is called positioning. A position is
market is defined, the company must consider creating a value
for its customers. This step is called positioning. A position is

\[ \pi_A(x_i) = 1 - \mu_A(x_i) - \nu_A(x_i) \]

is Atanassov’s intuitionistic fuzzy index, the degree of indeterminacy membership, of the
element \( x_i \) in the set \( A \) and for every \( x_i \in X, 0 \leq \pi_A(x_i) \leq 1 \).

**B. Distance between IFSs**

Distance between intuitionistic fuzzy sets was first introduced
by Atanassov [6]. Let

\[ A = \{ (x_i, \mu_A(x_i), \nu_A(x_i)) | x_i \in X \} \]

and

\[ B = \{ (x_i, \mu_B(x_i), \nu_B(x_i)) | x_i \in X \} \]

be two IFS sets in the set \( X \). \( \pi_A(x_i) \) and \( \pi_B(x_i) \) are their IF indexes respectively.

An Euclidean distance between IF sets A and B is [6], [20],

\[
d(A, B) = \sqrt{\sum_{i=1}^{n} \left( \left( \mu_A(x_i) - \mu_B(x_i) \right)^2 + \left( \nu_A(x_i) - \nu_B(x_i) \right)^2 \right)}
\]

C. Multi-Attribute Group Decision Making (MAGDM)

**Problems Using IFSs**

A. Definition of Intuitionistic Fuzzy Sets (IFS)

IFSs were first introduced by Krassimir T. Atanassov in
1986 and were developed in 1999 [5, 6]. The concept of an
intuitionistic fuzzy set (IFS) can be viewed as an alternative
approach to define a fuzzy set in cases where available
information is not sufficient for the definition of an imprecise
concept by means of a conventional fuzzy set [19].

Let \( X = \{ x_1, x_2, ..., x_n \} \) be a finite universal set. An IF set
A in X is defined as:

\[ A = \{ (x_i, \mu_A(x_i), \nu_A(x_i)) | x_i \in X \} \]

with the functions:

\[ \mu_A : X \to [0,1], \quad x_i \in X \to \mu_A(x_i) \in [0,1] \]

and

\[ \nu_A : X \to [0,1], \quad x_i \in X \to \nu_A(x_i) \in [0,1] \]

defining the degree of membership (\( \mu_A(x_i) \)) and the degree of
non-membership (\( \nu_A(x_i) \)) of the element \( x_i \in X \) to the set
\( A \subseteq X \) and for every \( x_i \in X, 0 \leq \mu_A(x_i) + \nu_A(x_i) \leq 1 \).

Let

\[ \mu_{ij}^p, v_{ij}^p \]

be the vector of Atanassov’s IFSs of all m attributes for
alternative \( A_i \) in \( A \) where \( D_{ij} = (\mu_{ij}, v_{ij}) (i = 1,2, ..., n; j = 1,2, ..., m) \) is an Atanassov’s IFS.

The evaluation of the alternative \( A_i \) in \( A \) with respect to the attribute \( C_j \) in \( C \) is an
IFS. The intuitionistic indices \( \pi_i = 1 - \mu_i - \nu_i \) are the
degree of satisfaction and the degree of non-satisfaction, respectively.

Let

\[ D_{ij} = \left( \mu_{ij}, v_{ij} \right) \]

be the vector of Atanassov’s IFSs of all m attributes for
alternative \( A_i \) in \( A \) where \( D_{ij} = (\mu_{ij}, v_{ij}) (i = 1,2, ..., n; j = 1,2, ..., m) \) is an Atanassov’s IFS.

Then the MAGDM problem is defined in the matrix format;

\[
D^p = \left( \begin{array}{cccc}
\mu_{11}^p & \mu_{12}^p & ... & \mu_{1m}^p \\
\mu_{21}^p & \mu_{22}^p & ... & \mu_{2m}^p \\
\vdots & \vdots & & \vdots \\
\mu_{n1}^p & \mu_{n2}^p & ... & \mu_{nm}^p \\
\end{array} \right)
\]


$D^p$ is an Atanassov’s IF decision matrix for decision maker $p$ and is used to represent the MAGDM problem under Atanassov’s IF environment [7], [21].

**D. Consistency and Inconsistency Measurements**

Let $A^*_p$ be an Atanassov’s IF positive ideal solution (IFPIS) represented by an IF set $A^*_p = \{(\mu_{i}^p, v_{i}^p), (\mu_{j}^p, v_{j}^p), \ldots, (\mu_{m}^p, v_{m}^p)\}$. It is known a priori and needs to be determined, where $A^*_p = \{(\mu_{i}^p, v_{i}^p)\} (j = 1, 2, \ldots, m)$ is an Atanassov’s IF set on attribute $C_j$.

Using (1), the square of the weighted Euclidean distance between the alternative $i$ and the IFPIS $A^*_p$ can be calculated as

$$S^p_i = \sum_{j=1}^{m} \omega_j \left[ d(D^p_{ij}, A^*_j) \right]^2 = \frac{1}{2} \sum_{j=1}^{m} \omega_j \left[ (\mu_{i}^p - \mu_{j}^p)^2 + (v_{i}^p - v_{j}^p)^2 + (\tau_{i}^p - \tau_{j}^p)^2 \right]$$

(3)

where $\omega_j$ is the weight of each attribute $C_j \in C \ (0 \leq \omega_j \leq 1$ and $\sum_{j=1}^{m} \omega_j = 1)$, the vector of weights $\omega = (\omega_1, \omega_2, \ldots, \omega_m)^T$ is unknown a priori and needs to be determined [7].

The decision maker’s choice gives her/his preferences between alternatives by $\Omega = \{(k, l)|A_k \wr A_l, \ (k, l = 1, 2, \ldots, n)\}$ from his/her knowledge and experience, where the symbol “$\wr$” is a preference relation given by the decision maker.

Using (3) the decision maker can calculate the squares of the weighted Euclidean distance between each pair of alternative $(k, l) \in \Omega$ and the Atanassov’s IFPIS as follows [7]:

$$S^p_k = \sum_{j=1}^{m} \omega_j \left[ d(D^p_{kj}, A^*_j) \right]^2 \quad (4)$$

$$S^p_l = \sum_{j=1}^{m} \omega_j \left[ d(D^p_{lj}, A^*_j) \right]^2 \quad (5)$$

The alternative $A_k$ is closer to the Atanassov’s IFPIS than the alternative $A_l$ if $S^p_k \geq S^p_l$. So the ranking order of alternatives $A_k$ and $A_l$ is determined by $S^p_k$ and $S^p_l$ based on $(\omega, A^*_p)$ which must be consistent with the preference given by the decision maker. $(\omega, A^*_p)$ should be properly chosen for consistency of the ranking order of alternatives $A_k$ and $A_l$ determined by $S^p_k$ and $S^p_l$, and the preference provided by the decision maker [7]. To measure inconsistency between the ranking order of alternatives $A_k$ and $A_l$, an index $(S^p_k - S^p_l)^-$ is defined as follows [7]:

$$\begin{align*}
(S^p_k - S^p_l)^- = & \left\{ \begin{array}{ll}
S^p_k - S^p_l & (S^p_k \geq S^p_l) \\
0 & (S^p_l \geq S^p_k)
\end{array} \right.
\max (0, S^p_k - S^p_l) \quad (6)
\end{align*}$$

$(S^p_k - S^p_l)^-$ is defined to be 0. The ranking order of alternatives $A_k$ and $A_l$ is inconsistent with the preferences given by the decision maker if $S^p_k < S^p_l$ [7].

A total inconsistency index of the decision maker $p$ is defined as:

$$B^p = \sum_{(k,l) \in \Omega^p} (S^p_k - S^p_l)^- = \sum_{(k,l) \in \Omega^p} \max (0, S^p_k - S^p_l) \quad (7)$$

An index $(S^p_i - S^p_j)^+$ to measure consistency between the ranking order alternatives $A_k$ and $A_l$ and the preferences given by the decision maker preferring $A_k$ to $A_l$ can be defined as follows [7]:

$$(S^p_i - S^p_j)^+ = \left\{ \begin{array}{ll}
S^p_i - S^p_j & (S^p_i \geq S^p_j) \\
0 & (S^p_j \geq S^p_i)
\end{array} \right.
\max (0, S^p_i - S^p_j) \quad (8)$$

A total consistency index of the decision maker $p$ is defined as:

$$G^p = \sum_{(k,l) \in \Omega^p} (S^p_i - S^p_j)^+ = \sum_{(k,l) \in \Omega^p} \max (0, S^p_i - S^p_j) \quad (9)$$

The total inconsistency and consistency indices $B$ and $G$ are all IFSSs.

**E. LINMAP Model for MAGDM Using IFSs**

Maximize $\{\sum_{p=1}^{P} \sum_{(k,l) \in \Omega^p} Z^p_{kl} \}$ subject to:

$$\begin{align*}
\sum_{j=1}^{m} \omega_j \sum_{p=1}^{P} \sum_{(k,l) \in \Omega^p} & \left[ (\mu_{i}^p - \mu_{k}^p)^2 + (v_{i}^p - v_{k}^p)^2 + (\tau_{i}^p - \tau_{k}^p)^2 \right] \\
& + 2(\mu_{i}^p - \mu_{k}^p)^2 + 2(v_{i}^p - v_{k}^p)^2 \\
& + 2(\tau_{i}^p - \tau_{k}^p)^2 \\
& - \sum_{j=1}^{m} \omega_j [4(\mu_{i}^p - \mu_{k}^p)^2 + 2(v_{i}^p - v_{k}^p)^2] \\
& - \sum_{j=1}^{m} \omega_j [2(\mu_{i}^p - \mu_{k}^p)^2 + 4(v_{i}^p - v_{k}^p)^2] \geq 2h
\end{align*}$$

$$\begin{align*}
\sum_{j=1}^{m} \omega_j \sum_{p=1}^{P} \sum_{(k,l) \in \Omega^p} Z_{kl} & \geq 0, (k, l) \in \Omega^p, \quad p = 1, 2, ..., P \\
u_{j} + v_{j} & \leq w_{j}, \ u_{j} \geq 0, v_{j} \geq 0, \quad j = 1, 2, ..., m \\
\sum_{j=1}^{m} w_{j} & = 1, \ w_{j} \geq \epsilon, \quad j = 1, 2, ..., m
\end{align*}$$

where $\{u_{j}, v_{j}\}$ are calculated using (11).
IV. PROPOSED MODEL

A. Alternatives of the Model

Many internal and external factors influence pricing decisions, including the nature of the market, economic conditions, the company’s overall marketing strategy, objectives, and marketing mix, as well as organizational considerations. Price is only one element of the company’s broader marketing strategy. If the company has selected its target market and positioning carefully, then its marketing mix strategy, including price, will be fairly straightforward [14]. The price creates a positioning in customers’ minds. Setting an initial price for a new product is vital for the success of this product. Therefore, the purpose of the model proposed in this study is to select the best pricing strategy for the company in NPD process.

Therefore the alternatives of the model are the base pricing strategies classified by Ferrell & Hartline [16]:

- **Price Skimming:** Setting a high price relative to the competition, thereby skimming the profits off the top of the market.
- **Prestige Pricing:** Setting the prices at the top end of all competing products in a category to indicate a higher quality.
- **Value-Based Pricing:** Setting reasonably low prices but still offer high-quality products and adequate customer services.
- **Competitive Matching:** Setting the prices by focusing on matching competitors’ prices and price changes.
- **Penetration Pricing:** Setting relatively low prices to maximize sales, gain widespread market acceptance, and capture a large market share quickly.

B. Attributes of the Model

The attributes of the model are the strategic marketing criteria mostly effective in the marketing strategy selection process as shown in Table I.

<table>
<thead>
<tr>
<th>Heading</th>
<th>Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation</td>
<td>C1: New Product Capability</td>
</tr>
<tr>
<td></td>
<td>C2: Research &amp; Development</td>
</tr>
<tr>
<td>Manufacturing / Operations</td>
<td>C3: Cost Structure</td>
</tr>
<tr>
<td></td>
<td>C4: Economies of Scale</td>
</tr>
<tr>
<td></td>
<td>C5: Logistics</td>
</tr>
<tr>
<td>Management</td>
<td>C6: Management Style</td>
</tr>
<tr>
<td></td>
<td>C7: Marketing Communication</td>
</tr>
<tr>
<td></td>
<td>C8: Accessibility to Capital</td>
</tr>
<tr>
<td>Market</td>
<td>C9: Market Share</td>
</tr>
<tr>
<td></td>
<td>C10: Market / Segment Size</td>
</tr>
<tr>
<td></td>
<td>C11: Number of Competitors</td>
</tr>
<tr>
<td>Consumer</td>
<td>C12: Consumer Fidelity</td>
</tr>
<tr>
<td></td>
<td>C13: Brand Image</td>
</tr>
<tr>
<td>Product</td>
<td>C14: Product Type Convenience</td>
</tr>
<tr>
<td></td>
<td>C15: Breadth of the Product Line</td>
</tr>
<tr>
<td></td>
<td>C16: Product Support</td>
</tr>
<tr>
<td></td>
<td>C17: Price Elasticity of the Demand</td>
</tr>
</tbody>
</table>

V. APPLICATION

A. 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 [23]. 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.

Launching of a new laptop of this company is selected for the application. With a marketing insight, this is a specialty product; which is unique, one-of-a-kind product that consumers will spend considerable time, effort, and money to acquire [16]. The product’s type is convenient with the target market and the product line of this product has a broad range. This is not a new-to-the-world laptop however it has a faster micro-processor than the other laptops which belong to the same product line. Three decision makers, chosen by the company from the marketing department, will evaluate the alternatives for these attributes and will give their preference relations. 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. Briefly, the model has 17 attributes and 3 alternatives, as shown in Fig. 1, which will be evaluated by 3 decision makers.
Step 3. The experts use IF sets corresponding the linguistic variables (as shown in Table II) to evaluate the rating of alternatives with respect to each attribute [21].

<table>
<thead>
<tr>
<th>Linguistic Variables and Corresponding IF Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Poor (VP)</td>
</tr>
<tr>
<td>Poor (P)</td>
</tr>
<tr>
<td>Fair (F)</td>
</tr>
<tr>
<td>Good (G)</td>
</tr>
<tr>
<td>Very Good (VG)</td>
</tr>
</tbody>
</table>

Table II

Step 4. Obtain the data and ratings of all alternatives $A_i$ ($i = 1, 2, 3$) on every attribute $C_j$ ($j = 1, 2, ..., 17$) given by three experts $P_p$ ($p = 1, 2, 3$) as partly shown in Table III.

Step 5. Construct the decision matrices $D^p$ using IF sets for each expert. In the same vein, construct the matrices $D^g$ and $D^f$ for the experts $P_2$ and $P_3$.

Step 6. Construct the linear programming model using (10):

- Maximize $Z_{21}^2 + z_{12}^2 + z_{23}^2 + z_{13}^2 + z_{21}^2$

subject to

\[
0.11w_1 + \ldots + 1.55v_{17} - 2z_{21}^2 \leq 0 \]
\[
-0.45w_1 + \ldots - 0.60v_{17} - 2z_{21}^2 \leq 0 \]
\[
-0.45w_1 + \ldots + 1.30v_{17} - 2z_{21}^2 \leq 0 \]
\[
0.24w_1 + \ldots + 1.50v_{17} - 2z_{21}^2 \leq 0 \]

Step 7. Solve linear programming problem: To obtain the best weights and the IF Positive Ideal Solution (IFPIS), taking $h = 1.0$ and using $D^p$ and $\Omega^p$, solve (10).

By solving linear programming problem, using MATLAB R11 on a Pentium IV PC with a 3 GHz CPU and 4 GB RAM, the results are obtained:

\[
\omega = (\omega_1, \omega_2, \ldots, \omega_{17}) = (0.032, 0.038, \ldots, 0.060) \]
\[
u = (u_2, u_2, \ldots, u_{17}) = (0.012, 0.005, \ldots, 0.002) \]
\[
u = (v_2, v_2, \ldots, v_{17}) = (0.010, 0.025, \ldots, 0.054) \]

Using $w$, $u$, and $v$ values with (11), the IFPIS set is calculated.

\[
A^+ = \{u^*_j, v^*_j\} (j = 1.2, \ldots, 17) \}
\]
\[
= \{0.37, 0.33, (0.16, 0.66), \ldots, (0.03, 0.91)\} \]

Step 8. Calculate the square of the weighted Euclidean distance $S^p$ between each pair of alternative, $D^p$, and the IF positive ideal solution, $A^*$. The results are obtained using (3) and shown in Table IV.
TABLE IV
WEIGHTED EUCLIDEAN DISTANCES

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>0.1635</td>
<td>0.1302</td>
<td>0.1702</td>
</tr>
<tr>
<td>A2</td>
<td>0.3654</td>
<td>0.4356</td>
<td>0.4380</td>
</tr>
<tr>
<td>A3</td>
<td>0.0977</td>
<td>0.0730</td>
<td>0.1122</td>
</tr>
</tbody>
</table>

According to these distances, the ranking orders of the three alternatives for the three experts are as follows:
For \( P_1: A_3 \rho A_1 \rho A_2 \) (Symbolizing “the expert \( P_1 \) prefers \( A_3 \) to \( A_1 \)"")
For \( P_2: A_3 \rho A_2 \rho A_1 \)
For \( P_3: A_3 \rho A_1 \rho A_2 \)
Step 9: The group ranking order of all alternatives can be obtained using social choice functions such as Borda’s function [24]. Borda’s function ranks the alternatives in the order of the value of \( f_B(\alpha) \). Borda’s scores of the alternatives are shown in Table V.

TABLE V
BORDA’S SCORES

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>Borda’s Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>A2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A3</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

The ranking order of the three alternatives is \( A_3, A_1 \) and \( A_2 \) according to the Borda’s scores; in other words, the best alternative is \( A_3 \). The best alternative is Prestige Pricing, the second alternative is Value-Based Pricing and the last alternative is Price Skimming.

C. Concluding Remarks

In the application, the best solution is determined as Prestige Pricing strategy. This result is significant for a company whose products do not differ from the competitors’ in terms of functionality and who stays distant from the highly competitive area, positions its products in an uncontested market neutralized of the competition.

“Market/Segment Size” criterion is determined as the most important criteria. Indeed, the company presents the products to a narrow target market and provides competitive advantage with superior design features.

The second important criterion is determined as “Product Support”. This is significant for a company who adopts Blue Ocean positioning strategy, bringing the product criterion into the forefront, as well as multiplies and expands the core product with an improved product support service.

VI. CONCLUSION

In this paper, the use of intuitionistic fuzzy linear programming to strategic marketing development has been discussed. Three pricing strategies alternatives are determined in the study: \( (A_1) \) Value-Based Pricing, \( (A_2) \) Price Skimming, and \( (A_3) \) Prestige 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 LINMAP model under IF environment is constructed. The weights of the alternatives are obtained 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 “Prestige Pricing” as the best pricing strategy solution.

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 model under IF environment is applicable as an evaluation technique for marketing strategy 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 strategy alternatives and marketing managers can use such approaches in making: their strategic decisions.

REFERENCES


