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A Fuzzy Inference System Proposal for Selecting Marketing Strategy

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Abstract

Changes in customer demands and advances in technology have led to the emergence of various marketing sectors. As a result of this, the expectation of each generation from brands or companies has become different. In addition, customers have begun to consider alternatives before purchasing a product, taking into account the various features that best meet their needs. Due to changing conditions, companies have forced to consider various criteria when determining their target markets and the types of products they introduce into the market. In this study, a fuzzy inference system has been proposed to provide support for the decision-making process related to the marketing strategy of the firm. When the proposed system was evaluated by experts, it was seen that satisfactory results were achieved.

Keywords: Fuzzy inference system, Fuzzy logic, Marketing strategy, Risk level.

Pazarlama Stratejisi Seçmek için Bulanık Çıkarım Sistemi Önerisi

Özet

Müşteri taleplerindeki değişmeler ve teknolojideki gelişmeler, çeşitli pazarlama sektörlerinin ortaya çıkmasına neden olmuştur. Bunun sonucu olarak, her neslin markalardan veya şirketlerden beklentileri farklılaşmıştır. Ek olarak müşteriler, bir ürünü satın almadan önce gereksinimlerini en üst düzeyde karşılayan çeşitli özellikleri göz önünde bulundurarak alternatifleri değerlendirmeye başlamıştır. Değişen koşullar nedeniyle şirketler, hedef pazarlarını ve pazara sundukları ürün türlerini belirlerken çeşitli kriterleri göz önünde bulundurmak zorunda kalmaktadır. Bu çalışmada, firmanın pazarlama stratejisiyle ilgili karar verme sürecine destek sağlamak için bulanık bir çıkarım sistemi önerilmiştir. Önerilen sistem uzmanlar tarafından değerlendirildiğinde tatmin edici sonuçlara ulaşıldığı görülmüştür.

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Anahtar Kelimeler: *Bulanık çıkarım sistemi, Bulanık mantık, Pazarlama stratejisi, Risk seviyesi.*

1. Introduction

Marketing is defined by American Marketing Association as is a set of processes and organizational functions for generating value, delivering it to customers and for conducting customer management in ways that benefit the organization and its stakeholders (Marketing News, 2004; Varadarajan, 2010). Marketing strategy is related to create a marketing-mix that enables the business to succeed in its objectives in a target market. When a business chooses a marketing strategy in accordance with current conditions and implements this marketing strategy effectively, the performance of this business can be maximized. But cultural conflicts, competition, and the limited sources may make it difficult to increase performance. Therefore, managers' decisions regarding the allocation of resources are important for the performance of the businesses (Slater et al., 2010).

Nowadays, in addition to the development of technology rapidly and the emergence of new products, in the 21st century, consumers have become more aware, well informed, quality-conscious, knowing global brands, having access to products globally. So, these situations have changed market conditions and caused competitive conditions to become difficult. Changes in consumer behavior have forced firms to improve themselves continually, namely, to have a dynamic structure to create marketing strategies or to adapt these strategies according to the changing conditions. Given the changing needs of customers and varying purchasing behaviors, firms need to provide quality service to customers by following the right strategies to protect their assets in competitive conditions. For this reason, firms need to select a proper marketing strategy according to the target market that they determine in accordance with their current conditions (Laroche, 2010; Samli, 2012; Forrest et al., 2017). Marketing strategy selection is one of the most important marketing decisions for many businesses. In addition, many decisions of businesses such as supply, marketing mix, and distribution channels are affected by this decision. In view of this, a suitable marketing strategy must be selected considering many factors such as segment size, competitors, risk and profitability (Aghdaie and Alimardani, 2015).

When analyzed studies related to marketing, it was seen that most studies have usually focused on marketing generalization, market positioning or application and interpretation of marketing strategies. Moreover, these studies evaluated in terms of techniques used and it was noticed that in these studies generally multi-criteria decision-making tools were used for evaluating

different criteria. Aghdaie and Alimardani (2015) are among authors who contribute to literature within this scope using multi-criteria decision-making techniques. They offered a novel hybrid method including AHP (Analitik Hiyerarşi Proses) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) techniques to select a suitable target market. In another study on this subject, Yurdakul and Yıldırım (2014)'s study, alternative marketing strategies that generally used by thermal spas were evaluated with AHP. In the evaluation results, it was determined that the most appropriate marketing strategy was the differentiation strategy. Mohaghar et al. (2012) proposed a hybrid fuzzy approach including AHP and VIKOR methods for selecting a marketing strategy. In a similar study, Hamal (2011) aims that model a marketing strategy decision problem as a multivariable problem and assist the manager in selecting the most appropriate marketing strategy for the firm with that model. In that study performed within the scope of this aim to select the most appropriate marketing strategy, the FANP (Fuzzy Analytical Network Process) method was offered. It has been observed that there are studies that contribute to the marketing field by using multi-criteria decision-making methods in the selection of marketing strategy or target market (Toksarı, 2007; Lin and Wu, 2008; Wu et al., 2010).

Market segmentation, widely used to target a smaller market, is one of the important subjects of marketing. Ruziye et al. (2012) investigated the strategy of the market segmentation applied by hotel firms and the positioning strategies of hotel firms. The data obtained in order to determine the benefits of the applied strategies to the hotel operators were analyzed by using the content analysis technique from qualitative research methods. Although it was seen that the importance of target market selection strategies is understood by hotel enterprises, it has been determined that there was no marketing department in the hotels' majority. Gaston-Breton and Martín Martín (2011) presented a two-stage market selection and segmentation model to help decision-makers identify the most suitable countries and groups of consumers. In the first stage, the macro-segmentation screening process was offered and in the second stage, the micro-segmentation process was suggested to identify which groups are similar across Europe in the sense of social and personal characteristics. The authors specified that this model allowed to cluster the European countries by market, personal and social values. In addition to these studies, it was discovered that data mining techniques also were utilized for market segmentation (Huang et al., 2007; Liu and Ong, 2008; Muley and Joshi, 2015, Murray et al., 2017).

When the studies on the selection of marketing strategies are examined, mostly it is seen that preference ranking is made with multi-criteria decision-making methods. But it is identified that there is no system that provides support for the decision-making process by considering different

criteria for firms and presents the level of risk that the chosen strategy carries. In order to fill this gap in the literature and form the basis for the studies to be carried out on this subject, a fuzzy inference system is developed to support the marketing strategy selection process. Since the terms used in marketing are often expressed as linguistic, it was preferred that a fuzzy system has been used. For example, numerical values cannot be clearly used to indicate that a company's resources are limited or that the product placed on the market is in the maturity stage. In such cases, fuzzy logic helps to provide the most realistic values.

The inputs of the fuzzy inference system that serve as the decision support system are the competitor's growth strategy, product life cycle, product type, and operating assets. The output of the system is a marketing strategy proposed considering inputs. The risk level of the strategy proposed by the fuzzy inference system is calculated through the membership function of the strategy. The main contributions of this study are listed below.

(i) This study fills a gap related to marketing strategy selection in the literature,

(ii) The proposed system offers the most appropriate marketing strategy regardless of the firm's industry,

(iii) The system presents the opportunity to see the risks levels before they invest operating assets and to develop marketing mixes considering recommended strategy,

(iv) The system suggests strategy taking into account the different situations of different firms and indicates the risk levels of the strategies offered under fuzzy conditions in the real world,

(v) This study provides a basis for studies to be held about marketing strategy selection in the future.

The rest of this paper is organized as follows. Section 2 explains the fuzzy inference system and some other information about this system. The input and output of the proposed fuzzy inference system as a decision support system are defined in Section 3. Section 4 presents the proposed system and its development process. The results obtained from applications performed with this system are presented in Section 5. Finally, this paper is concluded in Section 6.

2. Material and Method

For systems that are indefinite, not well defined, time-varying, or undefined within certain bounds, solutions cannot be produced with Aristotelian logic. Fuzzy logic has been developed to create solutions to such systems that cannot be generated solution by Aristotelian logic. Fuzzy logic is a mathematical discipline based on the fuzzy set theory. It uses to evaluate linguistic values such

as "little", "very", "medium", "high", "normal" instead of binary evaluations such as "yes-no", "0-1" (Kokoç et al., 2017). Some of the fuzzy logic terminologies used fuzzy inference systems are explained in this section.

2.1. Linguistic Expressions

Linguistic variables are defined as variables that use words or phrases as numbers. It is used to quantitative express situations that are too complex or well not defined (Rodriguez et al., 2012). The value of technical numbers describing the linguistic variables is determined subjectively considering experts' opinions (Casabayó et al., 2015).

2.2. Fuzzy Set and Fuzzy Number

The fuzzy set was introduced by Zadeh as a new mathematical approach (Zadeh, 1965). Although it wasn't accepted by many scientists initially, this theory was widely disseminated thanks to Japanese researchers' approach to new technologies very quickly. Let A be a set of linguistic values and X represent the fuzzy set of this set. The membership function values of A are in the range [0, 1] ($f_A: X \rightarrow [0,1]$). In this case, set A can be shown as $A = \{f_A(x) | x \in X\}$ (Rodriguez et al., 2013).

Membership values of elements included in the set are assigned as 1 otherwise membership values are assigned as 0. But, in uncertainty situation, elements, which are uncertain whether they include in any set or not, are assigned values between 0 and 1 (Akın and Oruç, 2012). Normal and convex fuzzy set is called fuzzy number (Kumar et al., 2013). If the membership value of at least one element in the fuzzy set is 1, this set is normal. And when $\forall x_1, x_2 \in X,\ \forall \lambda \in [0,1]$, fuzzy set A is convex when it provides Inequation (1) (Kumar et al., 2013; Dalgıç, 2017).

$$\mu_{\tilde{A}}(\lambda x_1 + (1-\lambda)x_2) \geq min\big(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2)\big) \quad (1)$$

Fuzzy numbers can be triangular, trapezoidal, and gaussian. In general, triangular and trapezoidal fuzzy numbers are preferred due to their ease of use in operation. Under the assumption that $\tilde{A} = (a, b, c)$ is membership function of triangular fuzzy number shown in Equation (2). Where a is the lower limit value and c is the upper limit value.

$$\mu_{\tilde{A}}(x) = triangle(x; a, b, c) = \begin{cases} 0 & for \quad x < a \\ (x-a)/(b-a) & for \quad a \leq x \leq b \\ (c-x)/(c-b) & for \quad b \leq x \leq c \\ 0 & for \quad c < x \end{cases} \quad (2)$$

Under the assumption that $\tilde{A} = (a, b, c, d)$ is membership function of trapezoidal fuzzy number shown in Equation (3) where *a* is the lower limit value, *d* is the upper limit value; *b* and *c* are the x values with membership function value 1.

$$\mu_{\tilde{A}}(x) = trapezoid(x; a, b, c, d) = \begin{cases} 0 & for \quad x < a \\ (x-a)/(b-a) & for \quad a \leq x \leq b \\ 1 & for \quad b \leq x \leq c \\ (d-x)/(d-c) & for \quad c \leq x \leq d \\ 0 & for \quad d < x \end{cases} \tag{3}$$

2.3. Algebraic Operations

Under the assumption that $\tilde{A}$ and $\tilde{B}$ are fuzzy numbers; if the lower and upper bounds of these numbers are respectively $a_l^\alpha$and b_l^α, a_u^α and b_u^α for α -cut. α -cuts of these two fuzzy numbers are denoted $\tilde{A}^\alpha = [a_l^\alpha, a_u^\alpha]$ and $\tilde{B}^\alpha = [b_l^\alpha, b_u^\alpha]$. Basic operations using fuzzy numbers are shown in Equations (4), (5), and (6) (Chen et al., 2006).

$$(\tilde{A}(+)\tilde{B})^\alpha = [a_l^\alpha + b_l^\alpha, a_u^\alpha + b_u^\alpha] \tag{4}$$

$$(\tilde{A}(-)\tilde{B})^\alpha = [a_l^\alpha - b_u^\alpha, a_u^\alpha - b_l^\alpha] \tag{5}$$

$$(\tilde{A}(\times)\tilde{B})^\alpha = [a_l^\alpha \times b_l^\alpha, a_u^\alpha \times b_u^\alpha] \tag{6}$$

2.4. Fuzzy Inference System

A fuzzy inference system is defined as the nonlinear mapping of an input data set to a scalar output data. This system consists of basically four components called fuzzifier, rule base, inference engine, and defuzzifier (Mendel,1995). An exemplary fuzzy inference system is shown in Fig. 1.

Fuzzy inference system has become one of the most famous applications of fuzzy logic due to the ability of fuzzy systems to integrate experts' opinions in its system and to state the behavior of the system in an interpretable way for humans. While historically, the first kind of fuzzy inference system, Mamdani, is based on the ability of fuzzy logic to model natural language, the second kind, Takagi-Sugeno, focused on automatic learning from data (Mamdani and Assilian, 1975; Takagi and Sugeno, 1985; Guillaume and Charnomordic, 2012). Today, the most commonly used fuzzy inference systems are Mamdani and Takagi-Sugeno.

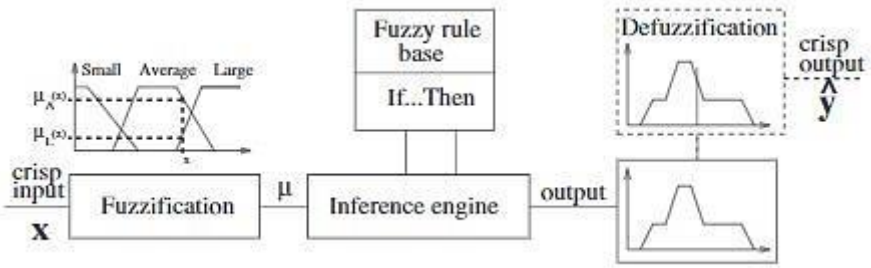

Figure 1. A Fuzzy Inference System (Guillaume and Charnomordic, 2012)

In the fuzzification phase, input data, which has a crisp numerical value, is converted into linguistic expressions by membership functions in the knowledge base. Besides, the membership degree indicating a support rate of this linguistic expression is assigned to input data (Hayajneh et al., 2006). The inference engine is based on a rule base. In this phase, it is determined which fuzzy control action is to be taken for input information received (Guillaume, 2001). Lastly, in the defuzzification phase, the fuzzy output is mapped to a crisp output via the membership functions (Madera et al., 2017).

3. Marketing Strategy Criteria

The criteria that companies must analyze before selecting their strategies have determined through literature research and expert opinions. The criteria used as input to the proposed fuzzy inference system are described in this section.

3.1. Analysis of Rival Company

Firms that want to survive in intense competitive conditions on the market need to analyze rival firms before identifying marketing strategies. This analysis provides an opportunity to move without staying behind the rival firms and to compete with rival firms. The growth strategy that rival firm is implementing is one of the most important factors that will affect the marketing strategy that a business chooses. Growth strategies are generally examined under four headings as market penetration, market expansion, product expansion, and diversification.

Market penetration is a growth strategy aimed at making more sales in the current market without making any changes in the current products. Market penetration strategy is defined as a "strategy of penetrating and deepening into existing markets with existing products". In this strategy, there is a desire to dominate the market with an effort to increase sales without making any changes to the product and market (Mucuk, 2010; Rodrigues et al., 2012).

In the market expansion strategy, firms search for new markets for the growth of sales. Market expansion strategy aims to spread existing products to new target markets. In this strategy, firms enter new markets with the existing product for going beyond existing market opportunities (Bang and Joshi, 2010; Kotler and Armstrong, 2010).

Product expansion refers to the presentation of the same product with different specifications. In other words, the growth strategy is aimed at increasing efficiency by making some changes to current products and making them privileged from competitors' products (Mishina et al., 2004). Product development strategy usually allows both the prolongation of the life of existing products and the use of a brand name.

Diversification states an effort by businesses to enter new markets entirely, either by producing new products or by making changes in existing products. The diversification strategy is different from other growth strategies. While in the other three strategies the use of available technology, financial and sales development resources for original product lines are in question, diversification strategy generally requires new skills, new technology, and new facilities (Helfat and Lieberman; Durmaz and Ilhan, 2015).

3.2. Operating Assets

There are three important points of opportunity for businesses to gain a competitive advantage. These are high quality, low cost, and high productivity. Even if businesses produce quality products at low cost, in case they do not choose an appropriate market strategy, they lose the competitive advantage. So, businesses need to analyze their available operating assets (finance, production, human resources, distribution, promotion, etc.), before selecting a marketing strategy.

3.3. Product Lifecycle

Products have a certain lifetime like all living things. They are born and after following a certain lifeline they disappear. Marketers define the concept of the life cycle as a process passed from the market-entry of a product to the disappearance of it. Products within this life cycle experience different competitive environments at different times. The life cycle of the products consists of four phases as introduction, growth, maturity, and decline (Yavuz et al., 2005). This study focuses on the introduction and maturity stages. The reasons for this are explained below.

In the introduction phase, the business presents a new product to the target market which it considers to enter (Wong and Ellis, 2007). The product may be entirely new, or it may be a product

with a new character. In this phase which is the riskiest and the over costing one, the firms' sales are low and distributions are limited. Often, they work at a loss due to large investment costs. At this stage, the goal of businesses is to create consumer awareness about the product and to direct customers for making them try the product. For this reason, in this phase, the marketing strategy should be selected by considering different market and competitor criteria.

In the growth phase, sales volume shows a rapid rise. As a result of this, profit also begins to rise. As sales volume increases, unit costs decrease and profit margin reaches the highest level. Since it is a risky situation to choose a different strategy when the profitable stage, the growth phase is not used in this study.

Stage in which product becomes well-known on market and sales continue to increase is the maturity phase. However, in this phase, marked decline occurs in the rate of sales growth of products. For this reason, the profits of both producers and retailers begin to fall. Price competition gets difficult and the share obtained from the market is tried to be preserved with more emphasis on promotional activity. In this phase, businesses strive to produce new types of products by concentrate on research and development (Chen, 2017). In such a case, because it may be possible to provide new receivers and to increase the use of the product through the renewal of properties of these products, it can be useful to choose a new strategy.

In the decline phase, the decline in sales is accelerated, a decline in profit is further increased and the product begins to lose its profitability. The reason for the products to enter this stage can be not only selecting the wrong strategies but also to the environmental changes. Moreover, new technologies might destroy products made with old technology, new products can emerge that will replace the products in the market.

3.4. Product Type

Convenience products are consumer goods that consumers often buy. They don’t spend much time and effort to compare and buy (Nilsson et al., 2015). Brand, packaging, and labeling play an important role in the sale of such goods. Manufacturers of convenience goods have to advertise goods in a way that it creates brand loyalty.

Shopping products are goods that are purchased taking account of price, quality, color, form, and modality. To ensure comparability, the manufacturer must offer the product at the point of sale near the competitor.

Specialty product, because of their unique qualities or brands, they are the goods for which consumers are willing to make a special effort to buy (Jacques and Hollander, 2017).

Unsought product is a product bought by the consumers to meet their sudden emerging needs that they are not aware of or are not willing to buy. Promotional activity is necessary for the marketing of such goods. Particularly the personal sales efforts are the most applied sales promotion technique.

3.5. Types of Marketing Strategy

The undifferentiated marketing strategy aims to reach a wide market by targeting the common desires and needs of the customers. In this strategy, known as the entire market strategy, enterprise considers the market as a whole without regard for differences between market segments (Firat et al., 2004). For this reason, the business tries to improve its product and marketing programs that attract as many buyers as possible. Thus, it tries to obtain the largest possible market sharing with the lowest cost.

In the differentiated marketing strategy, the nonhomogeneous market is divided into small homogeneous market segments and different marketing mix is applied to each market segment (Ray, 2015). Thus, this strategy provides the opportunity to serve pricing, distribution and communication strategies for several market segments. The marketing mix is created according to the sensitivity of the consumers in each segment.

Concentrated marketing strategy is the strategy that businesses choose one of the market segments and then direct all marketing efforts with a single marketing mix to this segment (Racz-Akacosi, 2017). This strategy, which is particularly useful in situations where resources are restricted, follows the path to address a large part of a small market, rather than addressing a small part of a large market. The strategy is aimed at effectively controlling costs, addressing a small portion of the market, and being in a strong position in the market.

4. Design Process of Fuzzy Inference System

When designing a fuzzy inference system, the inputs and outputs variables of the system were first determined. As a result of the literature survey and interviews with academicians in the business department, it was decided to use four input variables to select the marketing strategy.

While in the literature subsets and membership functions are generally formed to identify the degree of variables, in this study subsets and membership functions are formed to determine the

degree of variables' subset (alternatives). Inputs and output variables with their alternatives are presented in Table 1 and Table 2.

Table 1. Input variable

Input Variable	Abbreviation	Subset
Growth Strategy of Rival Company	GSRC	Market Penetration
		Market Expansion
		Product Expansion
		Diversification
Product Life Cycle	PLC	Introduction
		Maturity
Product Type	PT	Convenience Product
		Shopping Product
		Specialty Product
		Unsought Product
Operating Assets	OA	Restricted
		Sufficient

Table 2. Output variable

Output Variable	Abbreviation	Subset
Market Strategy	MS	Undifferentiated Concentrated Differentiated

4.1. Fuzzification

The degrees of variables are often expressed as based on personal value judgments rather than numerical magnitudes. Therefore, in order to define verbally expressed variables in the fuzzy system, they must be represented by fuzzy subsets and membership functions. Fuzzy subset intervals and membership functions were determined by expert opinions and membership functions of subsets were designed via the Fuzzy Inference System interface in Matlab 2018b (Figure 2). The fuzzy subset ranges and membership degrees used were presented in Figure 3.

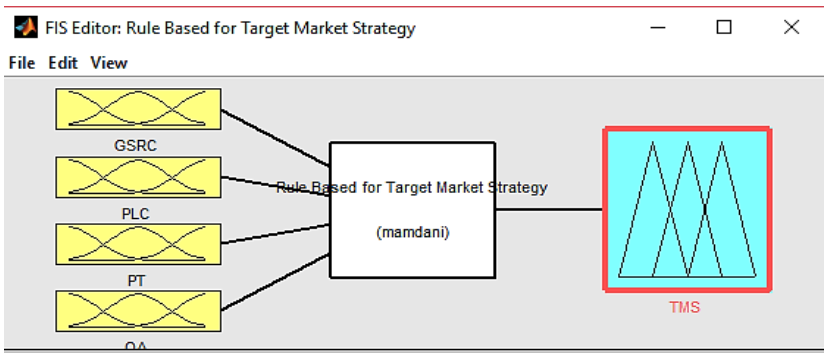

Figure 2. Fuzzy inference system editor

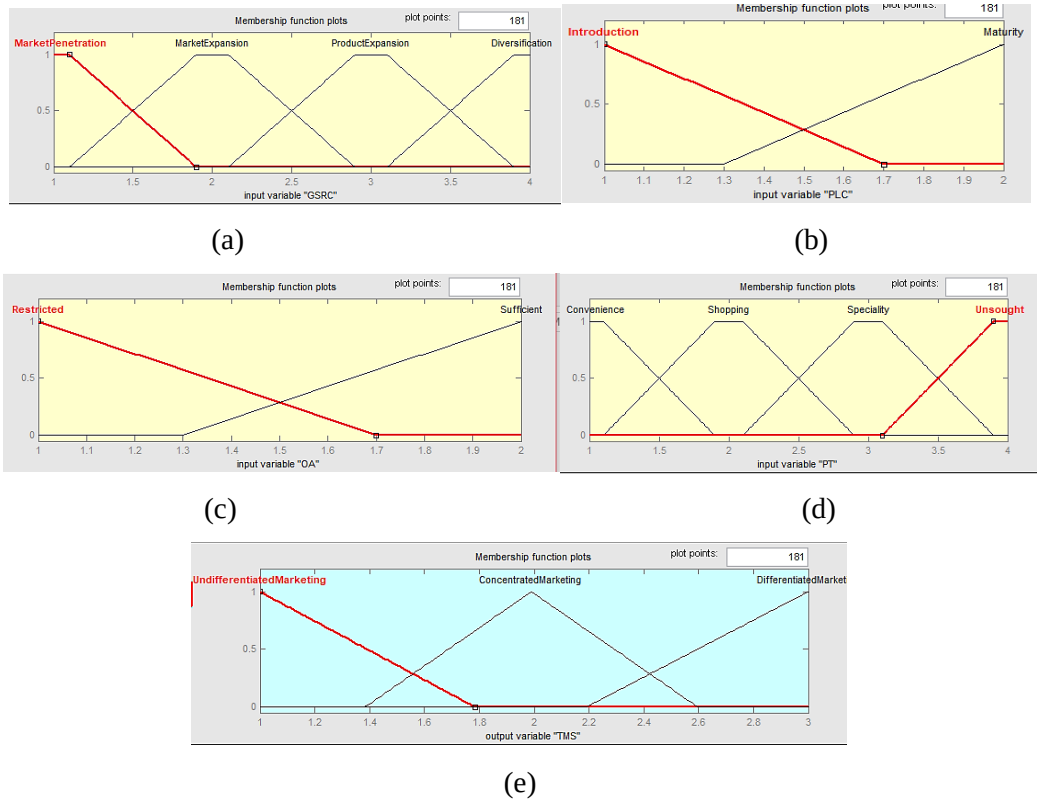

Figure 3. Membership functions of inputs and output **(**a) Growth strategy of rival firm, (b) Product life cycle, (c) Operating assets, (d) Product type, (e) Target market strategy Product

4.2. Mamdani Inference Engine

In this study, the Mamdani inference system was used. The Mamdani is a type of fuzzy relational model. In this model, rules logically creating the input-output relationship system control. Rules consist of two parts as antecedent and consequent like "If (condition 1) or/and (condition 2) or/and ... or/and (condition n) then (result)". Due to the fact that in the Mamdani model both the antecedent and the consequent are stated as fuzzy propositions, it is also called a linguistic model (Keshwani et al., 2008; Kadaifci et al., 2019). The output of a Mamdani model is a fuzzy membership function based on the rule base created with experts' opinions.

The rule base of the Mamdani model designed for marketing strategy selection was created by five experts. The experts were one from the Department of Business, two from the Department of Industrial Engineering. Moreover, it was asked for advice from two business managers related to rules. In all fuzzy rules, the operator ‘‘AND’’ was used, interpreting Zadeh (1965)’s intersection of fuzzy sets. The fuzzy propositions concerning the marketing strategy selection were exemplified in Table 3.

Table 3. Fuzzy propositions for evaluating marketing strategy

Rule No	Rule
1	If (GSRC is Market Penetration) and (PLC is Introduction) and (PT is Convenience) and (OA is Restricted) then (MS is Undifferentiated)
2	If (GSRC is Market Penetration) and (PLC is Introduction) and (PT is Convenience) and (OA is Sufficient) then (MS is Concentrated)
.	…
30	If (GSRC is Market Expansion) and (PLC is Maturity) and (PT is Unsought) and (OA is Restricted) then (MS is Concentrated)
31	If (GSRC is Market Expansion) and (PLC is Maturity) and (PT is Specialty) and (OA is Sufficient) then (MS is Differentiated)
.	…
63	If (GSRC is Diversification) and (PLC is Maturity) and (PT is Unsought) and (OA is Restricted) then (MS is Concentrated)
64	If (GSRC is Diversification) and (PLC is Maturity) and (PT is Unsought) and (OA is Sufficient) then (MS is Differentiated)

4.3. Defuzzification

Every solution, every fuzzy region, produced by the system turns into an expected crisp value, in the defuzzification stage. In the Mamdani model, the center of gravity technique is used to obtain the defuzzified value (Papadopoulos et al., 2011; Mesran et al., 2018). Let A is fuzzy number, x is the domain point of i, and μ(x) is the membership value for that point. Expected crisp value (Ecv) is calculated by using Equation (7).

$$Ecv = \frac{\sum_{i=0}^{n} x_i \mu_A(x_i)}{\sum_{i=0}^{n} \mu_A(x_i)} \tag{7}$$

In this study as a result of the evaluations made with the rule base, the membership functions of all consequences have combined into a single fuzzy set. Then, the Mamdani inference system has aggregated fuzzy sets of each rule via Equation (7) and has presented crisp value for market strategy (Figure 4). The subset that corresponds to the crisp value in the marketing strategy membership function is the alternative strategy presented by the inference system.

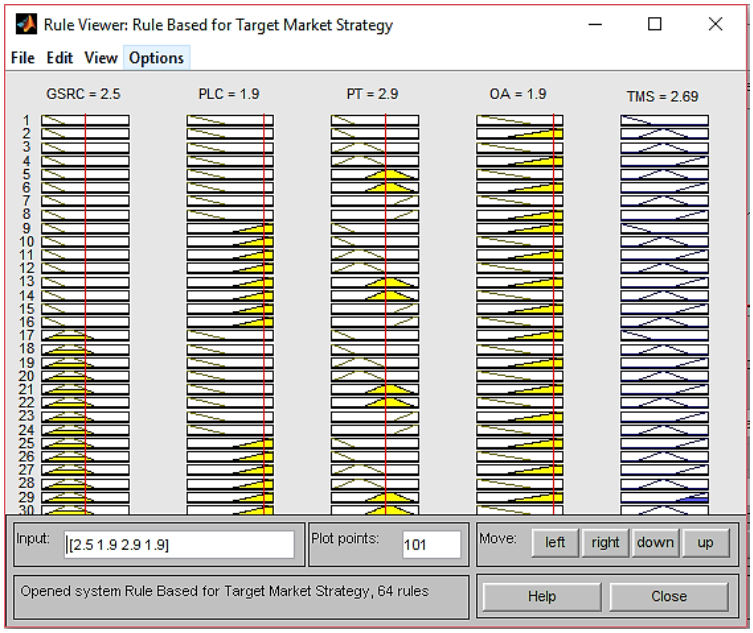

Figure 4. Rule Viewer

5. An Application with Proposed Fuzzy Inference System

In order to evaluate the proposed system, the input data of the system were requested from two companies which are large and small scale (Table 4). When selecting firms, it was the attention that characteristics of the firms (product type, operating assets, product life cycle, the growth strategy of rival company) to be different.

Table 4. Input variables data of firms

Large Scale Firm	Small Scale Firm
GSRC = 4 (diversity)	GSRC = 2 (market expansion)
PLC = 1.6 (near maturity)	PLC = 1.3 (near introduction)
PT =2 (shopping product)	PT =1 (convenience product)
OA =1.8 (near sufficient)	OA =1.2 (near restricted)

First, the test was performed using the input data of the large-scale firm. The test started by writing the data received from the companies into the rule viewer interface. The rule viewer created a solution area in all rules according to the input values presented, and then these solutions were integrated. After integrating and defuzzification processes, the crisp value of the marketing strategy offered by the system was obtained as 2.68 (Figure 5). When this value matched up to the membership functions of MS, it was seen that the point where the crisp value of output and membership function intersect was above the differentiated strategy subset (Figure 6).

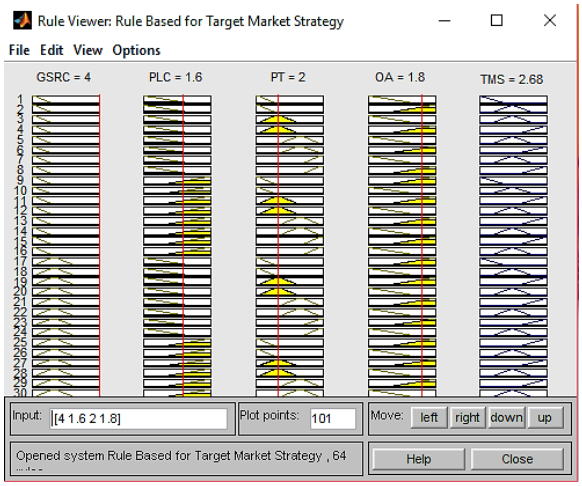

Figure 5. Rule viewer for first test

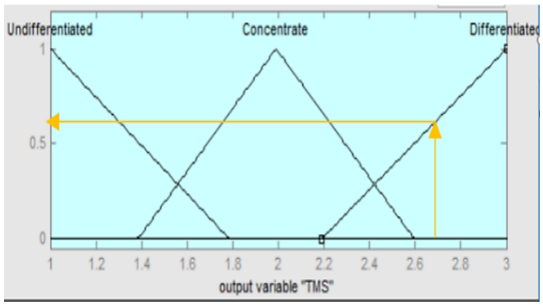

Figure 6. Intersection crisp value and membership function

The second test was performed using the input data of the small-scale firm. When the test data received from the companies integrated into the rule viewer interface, the crisp value of the marketing strategy offered by the system was obtained as 1.99 (Figure 7). When this value matched up to the membership functions of MS, it was seen that the point where the crisp value of output and membership function intersect was above the concentrated strategy subset (Figure 8).

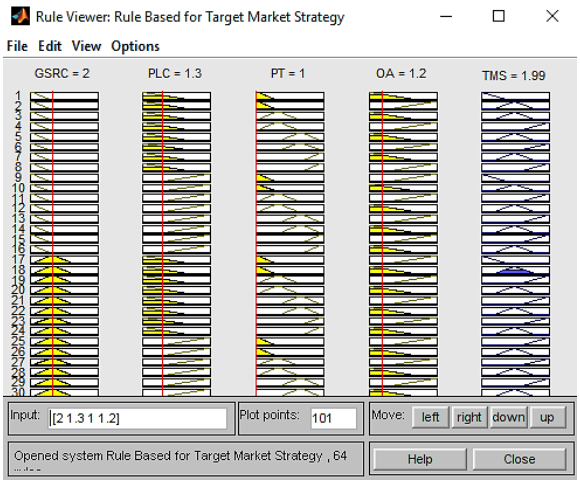

Figure 7. Rule viewer for the second test

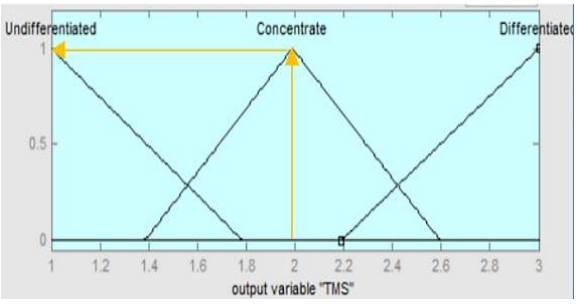

Figure 8. Intersection crisp value and membership function

5.1. Risk of Strategy

It is also possible to calculate the risk value of the strategy suggested by the system. For this calculation, the output variable's membership functions of subsets are used. Membership functions designed for each subset considering expert opinions were converted to formulas in order to

calculate risk value. Membership functions of fuzzy numbers shown in MS graph are shown in Equations (8), (9) and (10). Here $\widetilde{U}$ is fuzzy number and $\mu_{\widetilde{U}}(x)\ is$ membership function for undifferentiated strategy, $\tilde{C}$ is fuzzy number and $\mu_{\tilde{C}}(x)$ is membership function for concentrated strategy, $\widetilde{D}$ is fuzzy number and $\mu_{\widetilde{D}}(x)$ is membership function for differentiated strategy.

$$\mu_{\tilde{U}}(x)=\begin{cases}0 & ,x\le 0\\ x & ,0\le x\le 1\\ \dfrac{(1.785-x)}{0.785} & ,1\le x\le 1.785\\ 0 & ,x\ge 1.785\end{cases} \tag{8}$$

$$\mu_{\tilde{C}}(x)=\begin{cases}0 & ,x\le 1.384\\ \dfrac{(x-1.384)}{0.606} & ,1.384\le x\le 1.99\\ \dfrac{(2.596-x)}{0.606} & ,1.99\le x\le 2.596\\ 0 & ,x\ge 2.596\end{cases} \tag{9}$$

$$\mu_{\tilde{D}}(x)=\begin{cases}0 & ,x\le 2.19\\ \dfrac{(x-2.19)}{0.81} & ,2.19\le x\le 3\\ \dfrac{(2.596-x)}{1.01} & ,3\le x\le 4.01\\ 0 & ,x\ge 4.01\end{cases} \tag{10}$$

When it is desired to limit the area of membership degrees of fuzzy numbers, the α-cut is used. So, to determine the risk of strategy, fuzzy numbers should be expressed in terms of α-cut. Because α-cut cuts the membership function at two points, two crisp values corresponding to an α-cut are obtained. An example of obtaining α -cut values from membership functions is presented below.

Let the membership function of the undifferentiated strategy subset get cut with an α-cut. In this case, the right and left α-cut values are obtained via Equation (8). After the calculation is done, the value of the left side of undifferentiated fuzzy number is obtained as $\alpha_l = x_1^{\alpha}$ and value of the

right side is calculated as $\alpha_r = 1.785 - x_2^a / 0.785$ (Equation (11)). When calculations are carried out in the same way for concentrated and differentiated strategies, Equations (12) and (13) are obtained.

$$\widetilde{U}_\alpha = [\alpha, 1.785 - 0.785\alpha] \quad (11)$$

$$\tilde{C}_\alpha = [0.606\alpha + 1.384, 2.596 - 0.606\alpha] \quad (12)$$

$$\widetilde{D}_\alpha = [0.81\alpha + 2.19, 4.01 - 1.01\alpha] \quad (13)$$

In order to decide whether or not the strategy is implemented according to the calculated risk level, the value range has been established by considering expert opinions (Table 5).

Table 5. Range of risk

Range	Decision
$0.70 < \alpha - cut\ value \leq 1.00$	Strategy can be applied
$0.50 < \alpha - cut\ value \leq 0.70$	Strategy has a certain risk
$0.00 \leq \alpha - cut\ value \leq 0.50$	Strategy mustn't be applied

The risk values were calculated for the large and small scale companies considering the crisp values calculated in the previous section. It is seen that the crisp value obtained for the large-scale firm cuts the membership function of the undifferentiated strategy from the left (Figure 6). Therefore, when calculating the α-cut value, the cutting formula of the left part of the membership function ($\alpha_l = 0.81\alpha + 2.19$) is used. So, as calculated by Equation (14), the a-cut value was obtained as 0.60. This value indicates that the differentiated strategy application has a certain risk. In other words, all marketing mixes should not be invested in this area, and the current situation must be analyzed and then decided.

$$0.81\alpha + 2.19 = 2.68 \quad (14)$$

When the crisp value of the small-scale firm is analyzed, it is seen that this value cuts the membership function of the concentrated strategy from the centerline (Figure 8). In such a case, the formulas created for the right and left a-cut both produce the same result, that is, a value of 1 is obtained (Equation (15) and (16)).

$$0.606\alpha + 1.384 = 1.99 \quad (15)$$

$$2.596 - 0.606\alpha = 1.99 \quad (16)$$

This value indicates that strategy should be implemented at a high rate. In this example, the company, whose rival firm implements the market expansion strategy, has limited resources and

offers a new product to the market. In this case, while selecting differentiated strategy creates a risk of incurring a loss, selecting of undifferentiated strategy may lead to that business drop behind than rival firm. So, when the strategy proposed by the system was analyzed, it was seen that a logical decision gave by proposing the concentrated strategy.

6. Conclusions

The main goal of this study is to develop a system to help firm managers in selecting marketing strategies. This system is designed to recommend the most appropriate marketing strategy by evaluating the different conditions of the firms in accordance with the criteria determined by the experts. In addition, the prominent property of this study is that the system can determine the risk level for the proposed strategy. Thus, the managers have the opportunity to see the level of risk that the strategy they choose.

Inputs of the proposed system are competitor's growth strategy, product lifecycle, product type, and operating assets. The output of this system is the target market strategy proposed for the firm. Moreover, the rule base of this system is generated taking into consideration decision rules created by the evaluation of 5 different specialists. In order to test the proposed system, input data taken from two different companies were used and the output obtained was evaluated by the experts. As a result of the analysis and evaluation of the experts, it was concluded that the proposed strategies are reasonable for the firms and this decision support system can be used in real-life problems.

This study, which proposes a marketing strategy considering the criteria of firms' existing conditions and using the fuzzy logic approach, gives a new perspective to the literature. This study provides the basis for a more comprehensive system to be designed in the future to assist managers in choosing the marketing strategy.

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