

Fuzzy logic marketing models for sustainable development

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Abstract: *Fuzzy logic offers a different approach to describe economic and marketing phenomena. By providing a replacement for crisp values the fuzzy sets proved to be efficient alternatives for customer behaviour analysis. These advantages can provide a new way to address sustainable development issues. The present paper aims at presenting the main characteristics of fuzzy models and their main advantages. Evidence on how to implement a fuzzy model and what are its strong points are provided based on previous research and published scientific papers. It is concluded that fuzzy logic gives a different view on a wide range of topics.*

Key-words: *fuzzy logic, marketing models, sustainable development.*

1. Introduction

Fuzzy logic gained an important role in the scientific field of marketing as soon as the advantages of working with membership functions instead of crisp values became obvious. The best ways to use fuzzy logic and fuzzy reasoning proved to be in relation with marketing models. Marketing models are the final step in a marketing research initiative (Lilien et al., 1992). The models can be used to better understand marketing variables like customer behaviour and customer satisfaction, to model response for price or product policies or to provide useful information regarding marketing strategies.

The synergy between fuzzy logic and marketing models can deliver powerful tools for marketers. The advantages of not needing crisp values, of using if-the rules and the ability to plot results in a relevant manner led to a new kind of market analysis – fuzzy logic marketing models. These new models are able to provide reliable and sustainable tools for business development.

By using marketing models in business development the institutions can strengthen their capacity to respond to market fluctuations and they can increase their flexibility in relation to market changes. Combining fuzzy logic with marketing models can further improve these advantages.

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2. Literature review

Since Zadeh presented the fuzzy sets for the first time (Zadeh, 1965) the fuzzy theory proved to be an extension of the classical crisp theory and provided a background for changing a bivalent, boolean view on systems to a better, multivalent perspective. The main advantage of the fuzzy sets is the ability to use linguistic formulations. The basis of this ability is the use of the if-then rules (Jantzen, 2007).

The if-then rules are using fuzzified variables, membership functions. The membership function can have different shapes, the most common ones being triangular, trapezoidal, gaussian and singleton (Enache, 2012). An example of gaussian membership functions is presented in figure 1. The membership functions are being processed by the if-then rules in a new fuzzy set that describes the obtained result. The result can be achieved by using different methods like Mamdani (Mamdani, 1977, Mamdani 1976) or Takagi-Sugeno (Sugeno, 1985). For an educational marketing research, the if-then rules and their result is presented in figure 2.

In the field of marketing, fuzzy logic applications were deployed in various research situations. A strong contribution was made in customer behaviour and customer satisfaction where it has been proven that a fuzzy system can model customer behaviour (Martinez-Lopez, Casillas, 2009; Casillas, Martinez-Lopez, 2009) and the interactions with on-line shops (Casillas, Martinez-Lopez, 2004). In relation with customer satisfaction the fuzzy logic offered different perspectives on the correlation between needs and product and service attributes (Ertay, Kahraman, 1999), on the SERVQUAL analysis (Abdolvand, Taghipouryan, 2011) and its applications (Afkham et al., 2012), and on the evaluation (Deng, 2008) and improvement of the quality system (Temponi et al., 1999). By offering a method to deal with natural language statements the fuzzy logic had several important contributions to product and service evaluation (Chen et al., 2011; Maruvada, Bellamkonda, 2010) and group analysis (Cheng et al., 2011). Other important contribution to marketing field were made in customer segmentation (Ou et al., 2009), decision planning (Weber, Sun, 2000; Li, Li, 2010), strategy design (Li et al., 2002), product policy (Susanto et al., 2006; Vasant, 2004), price policy (Xiong, 2010; Sadjadi, 2010) or marketing mix (Aly, Vrana, 2005).

Sustainable development became an economic topic as soon as the academia realized the importance of providing efficient ways to promote and sustain growth (Hopwood et al., 2005). It is argued that the change should happen on different levels and sustain a shift in behaviour and attitudes (Dobson, 2007). Sustainable development marketing approach elicits a great emphasis on imperfect knowledge attached to marketing decisions (van Dam, Apeldorn, 1996) and new topics, like sustainable marketing orientation (Mitchell et al., 2010) or sustainable competitive

advantage (Vorhies, Morgan, 2005), are expanding this new field. In relation with these new demands, the use of fuzzy logic can provide a better way to increase the information gathered from a marketing analysis.

3. Methodology

In order to provide a better outlook of the advantages provided by the fuzzy logic application on marketing analysis two fuzzy logic marketing models are going to be analysed. First one uses the fuzzy applications in the educational marketing field (Enache, 2012). The second one is developing a framework to understand the customer perception on a restaurant (Enache, Gruia, 2015). Both papers used a combination of descriptive and inference statistic to set a basis for the fuzzy model and both reported relevant information gathered by this type of modelling.

4. Discussion and conclusions

First step in creating a fuzzy logic model is to transform the linguistic variables in membership functions able to grasp the meaning of the variable in a fuzzy way. Each membership function represents a linguistic variable, and defines a fuzzy set associated with a certain parameter. The membership function can have different shapes according to the research needs. In figure 1 five gaussian membership functions are describing the students' perception on tuition fees (Enache, 2012).

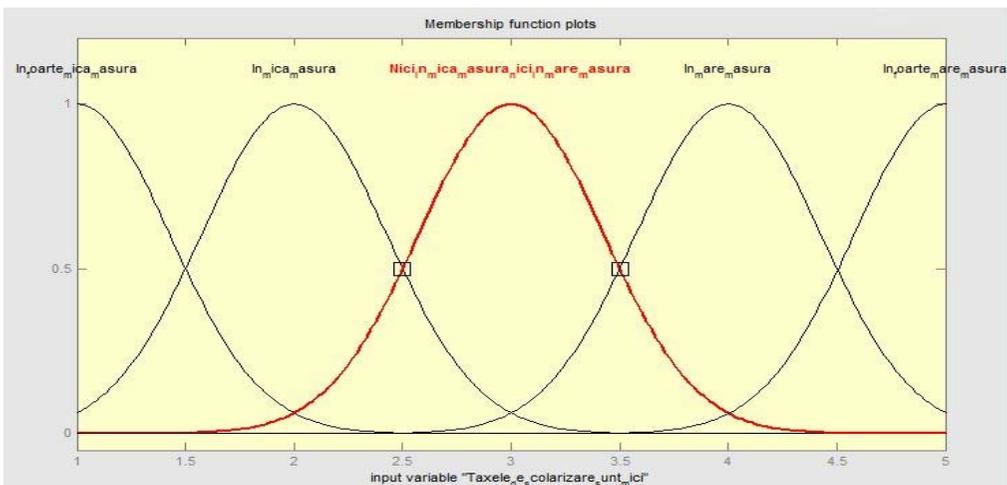


Fig. 1. *Membership functions (Enache, 2012)*

Having defined the fuzzy sets it becomes necessary to define the if-then rules that describe the interaction between the fuzzy sets. If the antecedent proposition has more than one part, a fuzzy operator is used to create the connection. Several solutions can be deployed at this point; the most common ones are max for “and” operator and min for “or” operator.

The antecedent proposition will shape the consequent using rules like maxmin or maxprod. Finally, all the consequent propositions are aggregated in a final fuzzy set. The final step of this process is to transform this fuzzy number in a crisp value, using different techniques like centroid, bisector, middle of the maximum, smallest of the maximum or largest of the maximum. In figure 2 a fifteen rules fuzzy model is presented. The aggregation method is max and min, and the defuzzification technique is centroid.



Fig. 2. If-then rules plot (Enache, 2012)

All the data obtained with a fuzzy model can be plotted in a three dimensional space that covers all the possibilities for two input variables and one output variable. The plot is describing all the possible situations and all the interactions that occur between these three variables. The dependent variable uses the z axis, while the other two are represented on x and y axes. All the axes are defined based on the membership functions describing the phenomena. The shape of the plot is given by

the interactions modelled by the fuzzy operators. In figure 3 and figure 4 several interactions can be observed. Figure 3 plots the connection between quality and tuition fees perceptions, as independent variables, on student satisfaction, as dependent variable. In figure 4 it is represented an interaction between perception on food taste and food presentation and their impact on restaurant perception.

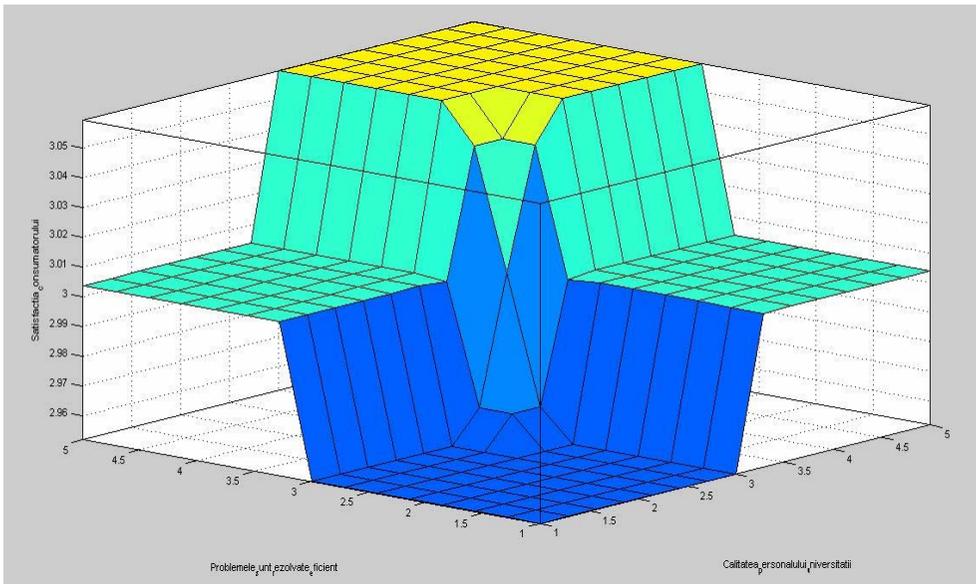


Fig. 3. *Interaction between quality and tuition fees perceptions and student satisfaction (Enache, 2012)*

By comparing the two fuzzy models representations it becomes obvious that the outcomes are different. The first model is describing a situation where the maximum for the dependent variable has more chances to be obtained. This first model is describing a situation where it is advantageous to use a step-by-step strategy designed to move the institution from a lower to a higher plateau. The main drawback in this situation is that the results are detectable only when a critical point is reached. The second model is describing a phenomenon that is best to tackle in a continuous manner. The effort invested in improving the independent variables has an immediate result. The main drawback of this situation is the difficulty of reaching the peak.

But there are several similarities also. Both models have obvious plateaux that need to be overcome. These plateaux are generated by a lack of correlation between the perceptions. The figure 3 is presenting an extreme example of the impact of the correlation lag. Another common characteristic is that the models are reaching a peak that is not the maximum as described by the fuzzy set. This situation should imply that business decisions are going to help improve the business situation only to a certain point.

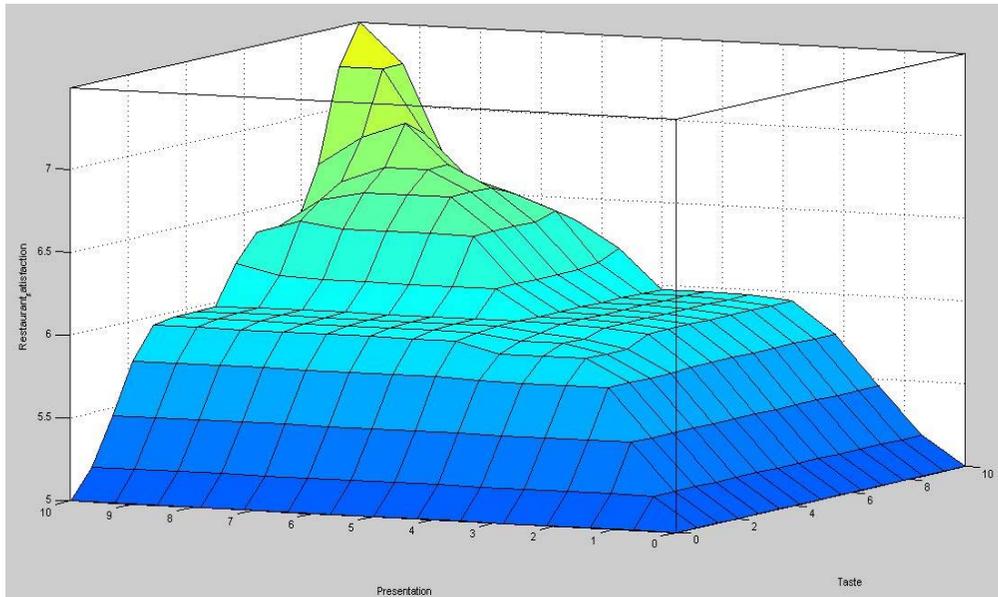


Fig. 4. *Fuzzy correlation between food taste, food presentation and restaurant perception (Enache, Gruia, 2015)*

For a sustainable development approach the fuzzy logic marketing models offers a different perspective. This model category has several advantages. One of the most important is that it offers a clear, step by step method to deal with linguistic variables. For business intelligence this is an advantage that can dramatically improve the data analysis. By using flexible operators the fuzzy logic models are able to adapt to various market or customer situations. But probably the main advantage is the ability to plot the interactions and the results in a relevant manner. The fuzzy logic marketing models are a powerful tool for a sustainable development of companies and institutions because it encapsulates strong marketing model conceptualisation in a linguistic and reliable presentation.

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