Special issue of the 3rd International Conference on Computational and Experimental Science and Engineering (ICCESEN 2016)

Determination of Customer Loyalty Levels by Using Fuzzy MCDM Approaches

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Customer loyalty is an important issue for business enterprises to improve their market performance. It can be defined as the outcome of a customer's belief in a particular company and customer satisfaction with the company's products or/and services. Business enterprises can make strategic marketing decisions by using customer loyalty levels and manage customer relations. This research will mainly focus on determination of loyalty criteria. The second objective of the research is to prioritize the criteria set. In the proposed model, fuzzy multi-criteria decision making approaches consisting of fuzzy analytic network process and fuzzy decision making trial and evaluation laboratory methods were used to determine the customer loyalty level. A case study has been conducted in a small-medium enterprise to improve the understanding of how companies establish a customer selection strategy with customer loyalty degree. The results from this study indicate that "resistance to change", "purchase frequency" and "switching cost" are the most important criteria to determine customer loyalty.

DOI: 10.12693/APhysPolA.132.650
PACS/topics: 89.65.Gh, 07.05.Mh

1. Introduction

Customers are critical elements of an enterprise to gain competitive advantage in the market. Therefore enterprises overemphasize the importance of customer relationship management (CRM). Customer behaviour affects strategic decisions. For instance customer behaviour plays a key role in decision making, regarding product design and marketing for manufacturers [1]. Customer loyalty (CL) is the significant issue of the CRM concept. In relation to this, the primary target of the enterprises is to achieve profitability. There is a positive relationship between CL and profitability [2]. Moreover, CL is directly proportional to customer satisfaction (CS). Determination of the CL degree becomes more of an issue to prioritize the customer orders and to meet the customer demands. Companies can classify the customers by measuring loyalty levels. In this way they can manage customer relations and give priority to customer orders.

In this study CL levels were determined using multi-criteria decision making (MCDM) methods. The proposed model is summarized in Fig. 1. Firstly, CL criteria set is determined from literature and a practitioner. In this step each enterprise can add their own special criteria or they can reduce the criteria set. Second step is examining the interactions among main criteria by using fuzzy decision making trial and evaluation laboratory (F-DEMATEL) method. Third step is prioritizing sub-criteria using fuzzy analytic network process (F-ANP).

There are many studies related to CL, CS and CRM in the related literature. Some studies involve relationship

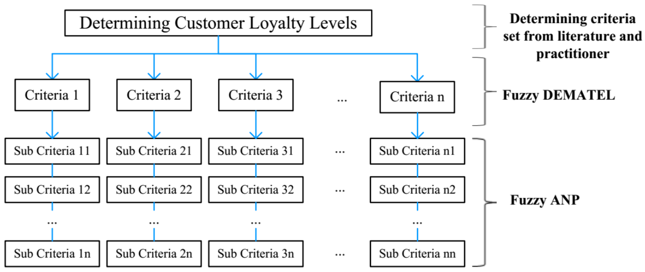

Fig. 1. Proposed model for determining customer loyalty levels.

between CL and CS [3–5]. Moreover, Aydın and Özer [6] aimed to examine the relationships between CL and corporate image, perceived service quality, trust and customer switching costs. Zu et al. [7] evaluated CL degree by using fuzzy neural networks in a part of their study. Jeng and Bailey [8] investigated the customer retention framework with DEMATEL and ANP methods. Pan and Nguyen [9] aimed to determine the key performance criteria of CS by using MCDM approaches. Ansari and Riasi [10] proposed a model for CL in startup insurance companies by using artificial neural networks. Picón-Berjoyo et al. [11] validated a model for relationships between loyalty and perceived value, satisfaction, and perceived switching costs. Öztayşi et al. [12] compared the CRM performances of e-commerce firms using ANP method. In addition to these, MCDM methods have been used in different problems that require selection, sorting and classification in literature [13–18].

However, to the best of our knowledge, not enough studies have been conducted on the subject of evaluation CL degree with fuzzy MCDM approaches. This research is believed to contribute to the literature in this sense.

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2. Methodology

The cognitive information over alternatives provided by decision makers are usually uncertain and hesitant because of complexity and uncertainty of socioeconomic environments and cognitive diversity of the decision makers. Therefore, the decision makers have to use fuzzy variables to express their cognitions [19, 20]. This study includes fuzzy DEMATEL and fuzzy ANP methods that are mentioned briefly in this section.

2.1. Fuzzy DEMATEL method

F-DEMATEL method is developed by Lin and Wu [21]. Steps of F-DEMATEL method are described below. In the F-DEMATEL method five linguistic terms are used. The linguistic terms and their corresponding triangular fuzzy numbers are shown in Table I.

TABLE I

The linguistic terms and corresponding triangular fuzzy numbers.

Linguistic terms	Triangular fuzzy numbers
No influence	(0, 0, 0.25)
Very low influence	(0, 0.25, 0.50)
Low influence	(0.25, 0.50, 0.75)
High influence	(0.50, 0.75, 1.0)
Very high influence	(0.75, 1.0, 1.0)

Obtaining the assessments of all decision-makers

$$\tilde{Z} = \frac{\tilde{Z}_1 + \tilde{Z}_2 + \ldots + \tilde{Z}_p}{p}, \quad (1)$$

$\tilde{Z}$(initial direct relation fuzzy matrix) =

$$\begin{bmatrix} 0 & \tilde{z}_{12} & \cdots & \tilde{z}_{1n} \\ \tilde{z}_{21} & 0 & \cdots & \tilde{z}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{z}_{n1} & \tilde{z}_{n2} & \cdots & 0 \end{bmatrix}$$

Normalized direct-relation fuzzy matrix:

$$\tilde{X} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{x}_{n1} & \tilde{x}_{n2} & \cdots & \tilde{x}_{nn} \end{bmatrix}, \quad (2)$$

where

$$\tilde{x}_{ij} = \frac{\tilde{z}_{ij}}{r} = \left(\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r}\right),$$

$$r = \left(\sum_{j=1}^{n} u_{ij}\right). \quad (3)$$

Total-relation fuzzy matrix ($\tilde{T}$):

$$X_l = \begin{bmatrix} 0 & l'_{12} & \cdots & l'_{1n} \\ l'_{21} & 0 & \cdots & l'_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ l'_{n1} & l'_{n2} & \cdots & 0 \end{bmatrix},$$

$$X_m = \begin{bmatrix} 0 & m'_{12} & \cdots & m'_{1n} \\ m'_{21} & 0 & \cdots & m'_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ m'_{n1} & m'_{n2} & \cdots & 0 \end{bmatrix},$$

$$X_u = \begin{bmatrix} 0 & u'_{12} & \cdots & u'_{1n} \\ u'_{21} & 0 & \cdots & u'_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ u'_{n1} & u'_{n2} & \cdots & 0 \end{bmatrix},$$

$$\tilde{T} = \begin{bmatrix} \tilde{t}_{11} & \tilde{t}_{12} & \cdots & \tilde{t}_{1n} \\ \tilde{t}_{21} & \tilde{t}_{22} & \cdots & \tilde{t}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{t}_{n1} & \tilde{t}_{n2} & \cdots & \tilde{t}_{nn} \end{bmatrix},$$

where

$$\tilde{t}_{ij} = \left(l''_{ij}, m''_{ij}, u''_{ij}\right),$$

$$\left[l''_{ij}\right] = X_l \times (I - X_l)^{-1}, \quad (4)$$

$$\left[m''_{ij}\right] = X_m \times (I - X_m)^{-1}, \quad (5)$$

$$\left[u''_{ij}\right] = X_u \times (I - X_u)^{-1}, \quad (6)$$

$$\tilde{T}^{\text{def}} = \begin{bmatrix} \tilde{t}^{\text{def}}_{11} & \tilde{t}^{\text{def}}_{12} & \cdots & \tilde{t}^{\text{def}}_{1n} \\ \tilde{t}^{\text{def}}_{21} & \tilde{t}^{\text{def}}_{22} & \cdots & \tilde{t}^{\text{def}}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{t}^{\text{def}}_{n1} & \tilde{t}^{\text{def}}_{n2} & \cdots & \tilde{t}^{\text{def}}_{nn} \end{bmatrix}$$

where

$$\tilde{t}^{\text{def}}_{ij} = \left(l''_{ij}, m''_{ij}, u''_{ij}\right)^{\text{def}}.$$

Total-relation fuzzy matrix includes fuzzy values. However, crisp value is needed to examine the interactions among main criteria. For this reason converting fuzzy data into crisp scores method, proposed by Opricovic and Tzeng [22], is used in defuzzification process.

2.2. Fuzzy ANP method

ANP method, developed by Saaty [23], is a general form of the analytic hierarchy process. There are several F-ANP methods in the literature. However, in this study Chang's extent analysis method [24] is selected due the fact that this approach has a relatively simple calculation compared to the others. Chang's method is described below. Linguistic terms and corresponding triangular fuzzy numbers for pairwise comparisons are given in Table II.

TABLE II

Linguistic terms and triangular fuzzy numbers.

Linguistic terms	Triangular fuzzy numbers	Triangular fuzzy reciprocal numbers
Equally important	(1, 1, 1)	(1, 1, 1)
Weakly important	(1, 3, 5)	(1/5, 1/3, 1)
Strongly important	(3, 5, 7)	(1/7, 1/5, 1/3)
Very important	(5, 7, 9)	(1/9, 1/7, 1/5)
Absolutely important	(7, 9, 9)	(1/9, 1/9, 1/7)

Let $X = \{x_1, x_2, \ldots, x_n\}$ be an object set, and $G = \{g_1, g_2, \ldots, g_m\}$ be a goal set.

$M^1_{g_i}, M^2_{g_i}, \ldots, M^m_{g_i}, \; i = 1, 2, \ldots, n$ are triangular fuzzy numbers.

$$S_i = \sum_j^m M^j_{g_i} \otimes \left[\sum_{i=1}^n \sum_{j=1}^m M^j_{g_i} \right]^{-1}, \tag{7}$$

$$\sum_j^m M^j_{g_i} = \left(\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j \right), \tag{8}$$

$$\sum_{i=1}^n \sum_{j=1}^m M^j_{g_i} = \left(\sum_{i=1}^n l_i, \sum_{i=1}^n m_i, \sum_{i=1}^n u_i \right), \tag{9}$$

$$\left[\sum_{i=1}^n \sum_{j=1}^m M^j_{g_i} \right]^{-1} = \left(\frac{1}{\sum_{i=1}^n u_i}, \frac{1}{\sum_{i=1}^n m_i}, \frac{1}{\sum_{i=1}^n l_i} \right). \tag{10}$$

$$M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$$

is defined as

$$V(M_2 \geq M_1) = \sup \left[\min \left(\mu_{M_1}(x), \mu_{M_2}(y) \right) \right]$$

and can be equivalently expressed as follows:

$$V(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = \mu_{M_2}(d) = \begin{cases} 1, & \text{if } m_2 \geq m_1, \\ 0, & \text{if } l_1 \geq u_2, \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & \text{otherwise,} \end{cases} \tag{11}$$

where d is the ordinate of the highest intersection point between μ_{M_1} and μ_{M_2}. Both values of $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$ are required in order to compare M_1 and M_2.

$$V(M \geq M_1, M_2, \ldots, M_k) = V[(M \geq M_1) \wedge (M \geq M_2) \wedge \ldots \wedge (M \geq M_k)] = \min V(M \geq M_i), \; i = 1, 2, \ldots, k. \tag{12}$$

Assume that

$$d'(A_i) = \min V(S_i \geq S_k), \tag{13}$$

for $k = 1, 2, \ldots, n$; $k \neq i$.

$$W' = \left(d'(A_1), d'(A_2), \ldots, d'(A_n) \right)^T, \tag{14}$$

where A_i $(i = 1, 2, \ldots, n)$ are n elements.

$$W = \left(d(A_1), d(A_2), \ldots, d(A_n) \right)^T, \tag{15}$$

where W is a non-fuzzy number.

3. Case study for empirical evidence

In the proposed model, the first step is determination of the criteria set. There are five main criteria that are identified as "Purchase activity", "Emotion factor", "Switching barrier", "Customer attitude" and "Customer satisfaction". Each main criterion has its own sub-criteria and there are 19 sub-criteria in total. These criteria are obtained from the literature and empirical study. The criteria and the sub-criteria are listed in Table III.

TABLE III

Criteria and the sub-criteria of customer loyalty.

Criteria	Sub-Criteria	Ref.
C1: Purchase activity	C11: Purchase frequency	[7, 25]
	C12: Total quantity of purchases	[25]
	C13: Number of different product categories a customer has purchased	[7, 25]
	C14: Purchase amount share compared to strongest competitors	[7]
C2: Emotion factor	C21: Price sensitivity	[4, 7]
	C22: Trust	[6, 26]
	C23: The interpersonal relationship and customer care	[5]
C3: Switching barrier	C31: Resistance to change	[26]
	C32: Switching costs	[5]
	C33: Loss of time	
	C34: Brand equity and corporate image	[6, 26]
C4: Customer attitude	C41: Not seeking alternatives to replace	
	C42: Recommend products/services to others	[27]
	C43: Providing the company with opportunities to correct problems	
	C44: Share experiences about the products/services	
C5: Customer satisfaction	C51: Customer relationship management	
	C52: Bidirectional communication	
	C53: Easy access to needed information	[3]
	C54: Feel close to ideal point scale	[4]

The second step is to examine the interactions among main criteria with F-DEMATEL method. The threshold value (0.680) was determined according to the opinions of the decision makers from the case company. Values which are above the predefined threshold value are shown in Table IV. For instance, Criterion 1 affects Criterion 3 (0.701), likewise, Criterion 2 affects Criterion 1 (0.711), Criterion 3 (0.809) and Criterion 4 (0.799).

After determining the interactions among the identified criteria, their importance weights are calculated according to the decision makers' opinions with F-ANP method, by using pairwise comparisons. Just one comparison matrix is given, as an illustration, in Table V.

TABLE IV

Defuzzified total relation matrix.

def	C1	C2	C3	C4	C5	D	R	D+R	D−R
C1	0.492	0.473	0.701	0.606	0.540	2.813	3.445	6.258	−0.632
C2	0.711	0.489	0.809	0.799	0.639	3.447	2.811	6.258	0.637
C3	0.691	0.551	0.576	0.693	0.530	3.042	3.736	6.778	−0.695
C4	0.722	0.617	0.811	0.594	0.723	3.467	3.432	6.900	0.035
C5	0.828	0.680	0.839	0.740	0.536	3.623	2.968	6.592	0.655

* Threshold value: 0.680.

4. Conclusions

Numerical study is performed according to the proposed model. As it can be seen from Fig. 2a, the three most important criteria are determined as "resistance to change", "purchase frequency" and "switching costs". The three least important criteria are "trust", "share experiences about the products/services" and "loss of time". Least important criteria are not insignificant for entire business environment. These criteria weights are specific to the companies and their strategies.

TABLE V

Pairwise comparisons of a decision maker in terms of C11, C12, C13 and C14.

		Fuzzy numbers				Triangular fuzzy numbers			
		C31	C32	C33	C34	C31	C32	C33	C34
C11	C31	1	5	5	3	(1;1;1)	(3;5;7)	(3;5;7)	(1;3;5)
	C32	1/5	1	3	3	(1/7;1/5;1/3)	(1;1;1)	(1;3;5)	(1;3;5)
	C33	1/5	1/3	1	1/3	(1/7;1/5;1/3)	(1/5;1/3;1)	(1;1;1)	(1/5;1/3;1)
	C34	1/3	1/3	3	1	(1/5;1/3;1)	(1/5;1/3;1)	(1;3;5)	(1;1;1)
C12	C31	1	5	7	5	(1;1;1)	(3;5;7)	(5;7;9)	(3;5;7)
	C32	1/5	1	3	5	(1/7;1/5;1/3)	(1;1;1)	(1;3;5)	(3;5;7)
	C33	1/7	1/3	1	1/3	(1/9;1/7;1/5)	(1/5;1/3;1)	(1;1;1)	(1/5;1/3;1)
	C34	1/5	1/5	3	1	(1/7;1/5;1/3)	(1/7;1/5;1/3)	(1;3;5)	(1;1;1)
C13	C31	1	5	7	5	(1;1;1)	(3;5;7)	(5;7;9)	(3;5;7)
	C32	1/5	1	3	3	(1/7;1/5;1/3)	(1;1;1)	(1;3;5)	(1;3;5)
	C33	1/7	1/3	1	1/3	(1/9;1/7;1/5)	(1/5;1/3;1)	(1;1;1)	(1/5;1/3;1)
	C34	1/5	1/3	3	1	(1/7;1/5;1/3)	(1/5;1/3;1)	(1;3;5)	(1;1;1)
C14	C31	1	5	7	3	(1;1;1)	(3;5;7)	(5;7;9)	(1;3;5)
	C32	1/5	1	3	3	(1/7;1/5;1/3)	(1;1;1)	(1;3;5)	(1;3;5)
	C33	1/7	1/3	1	1/3	(1/9;1/7;1/5)	(1/5;1/3;1)	(1;1;1)	(1/5;1/3;1)
	C34	1/3	1/3	3	1	(1/5;1/3;1)	(1/5;1/3;1)	(1;3;5)	(1;1;1)

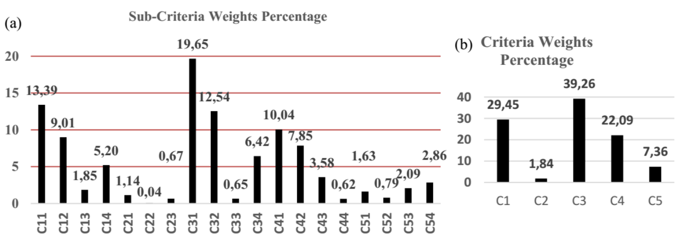

Fig. 2. (a) Sub-criteria weights percentage, (b) main criteria weights percentage.

Main criteria weights percentages, which are based on cumulative of relevant criteria, are shown in Fig. 2b. In the case study "switching barrier" is determined as the most important criterion and "emotion factor" is determined as the least important criterion for the company. Business enterprises can improve customer relationship management performance by giving priority to improvement activities, based on the importance of the performance criteria. As a future work, all loyalty criteria for each customer should be evaluated and multiplied by the coefficient of the priority. In this way loyalty indicator for each customer can be obtained and business enterprises can manage customer relationship in the light of the customer priorities.

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