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Measuring Customer Satisfaction Using Multi-Criteria Analysis Model of Customer Satisfaction to Evaluate Product Lines (Case Study: Kaveh Glass Industrial Group)

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Abstract

Today, customer retention and growth is the first goal. Companies have taken a heavy toll on each customer, and competitors are constantly seeking to steal them. Satisfied customers have many benefits for the company, they are less sensitive to prices, will be a customer for a long period of time, and give a favorable view of the company and its products and services to others. Paying attention to the factors that are less important from the customer's point of view and evaluating these factors leads to spending resources in areas that have less impact on customer behavior, so understanding the factors that have the greatest impact on customer satisfaction to the organization to move in this will help. In this study, we intend to use the operational data of the lines and customer satisfaction scales to evaluate the relative efficiency of product lines using the network data envelopment analysis method. In order to achieve this goal and quantify the data obtained from the questionnaire, another linear programming method called multi-criteria satisfaction analysis will be used. Another innovation of this research is the application of customer expectations in the data envelopment analysis mole because most researchers that focus on quality do not consider this component in their evaluation model. The results indicate that the distribution system is the most effective factor and resources and supply is the most effective factor affecting customer satisfaction.

Keywords: Customer Satisfaction, Multi-Criteria Satisfaction Analysis, Manufactured Products

1. Introduction

Currently, customer retention and growth are the first objectives. Companies have endured a heavy exaction to achieve each customer, and competitors are continuously attempting to steal them. Missing a customer does not mean losing next sales, but missing every customer provides a loss for the purchase of his/her whole life, and we also should regard the cost of obtaining a replacement customer [1], [2]. Customers experience various degrees of satisfaction and dissatisfaction after each experience based on the level of realizing their expectations or receiving services and goods that are beyond their expectations. Satisfaction is an emotional state, reactions after the purchase can include anger, dissatisfaction, excitement, impartiality, happiness, or passion [3], [4]. Considering the factors that are less important in terms of the customer and paying attention to these factors cause to spend resources in fields that insignificantly affect customer behavior, therefore, understanding properly the factors that significantly affect customer satisfaction will help the organization to move in this direction [5]. Findings explain that higher than 90% of a company's dissatisfied customers do not attempt to communicate with the company to provide a comment or criticism. These customers refer to competitors in order to satisfy their requirements and express their dissatisfaction with interest to other potential customers [6], [7]. Masters et al conducted several studies on 124 large American companies and the achieved results explained that 75% of these companies have explicitly stated the word customer satisfaction in their organization's mission statement. Customer satisfaction and the quality of an organization's product or service imply concepts that are truly related to each other, almost 65% of these statements utilized customer satisfaction more than the word quality of product or service. More than half of the mission statements (56%) have paid attention to customer service and approximately 46% of the statements have stressed the principle of customer orientation [8]. Studies conducted by Juran Institute in 1994 showed that about 90 percent of top executives in more than 200 large US companies accept that "improving customer satisfaction will increase our profitability and develop our market share in the competitive market." Approximately 90% of these companies have designated high capital and taken organized measures in order to follow up and improve customer satisfaction and have presented objective evidence for this claim [9], [10].

If paying attention to the satisfaction is increased and the methods of attracting and retaining them are identified and increased, in fact, we could take useful and beneficial steps in terms of the prosperity and dynamism of the company. Customer satisfaction results in repeated purchases or increases the visits for the purchase, and this customer loyalty increases the market share and profitability of the organization. Increasing customer loyalty will increase sales and will result in better financial performance [11], [12]. Currently, customer satisfaction has become a significant issue for organizations. The organization's success or failure is determined by the percentage of customers who the organization has retained [13]. Customer satisfaction is essential in shaping customers' future purchasing wishes. It is also possible that satisfied customers share their experiences with others, which is particularly important when social life has been designed in such a way to improve social interactions with

others in the population [14]. It is more beneficial to retain good customers in the long term compared to constantly attracting new customers in order to replace customers who have missed their relationship with the company. Customers who are extremely satisfied with the organization communicate their positive experiences to others and consequently, advertise for the organization. Consequently, it reduces the cost of attracting new customers. This is particularly valuable for professional service providers because others explain self-awareness and reputation and its advantages and positive points that can be a key source of information for new customers [15]. In fact, organizations and institutions' most significant task is customer satisfaction because it has a direct relationship with customer retention, market share, and the interests of the organization ([16]. Kadic et al. (2017) believe that customer satisfaction is one of the main columns in any business, particularly in the marketing division. Customer satisfaction is the best indicator of understanding the issue of the customer's future purchase and makes the company expected that it can count on satisfied customer's purchases in the future. A similar study conducted by Chang (2016) showed that loyal customers make 2.6 times more profits than customers with relative loyalty. Satisfaction plays a significant role in purchasing more and investing more customers in the product and declares that successful businesses are able to recognize the significance of the customer's life value. It has also been confirmed that obtaining a new customer costs 6 to 7 times higher than retaining a current customer. Consequently, all companies first attempt to make their current customers loyal in order to reduce their marketing costs, then think of new customers [17]. Although every successful marketer requires to provide a service that satisfies customers, this is not his/her only purpose. Companies are required to consider other main objectives of the businesses, such as producing a competitive profit or creating profits. Customer satisfaction provides many advantages to the company and higher levels of customer satisfaction make customers more loyal. Subsequently, it is more beneficial to retain good customers compared to constantly attracting new customers in order to replace a customer who has not purchased from the company anymore. Highly satisfied customers publish positive verbal advertisements and accordingly, become a moving spoken advertisement for the company, therefore, reduce the cost of attracting new customers. This is particularly significant for specialized service providers such as dentists, lawyers, and engineers because reputation and word of mouth are considered as the main sources of information for new customers [18].

Customer satisfaction extends the length of the customer survival period. Also, the spread of negative messages by dissatisfied customers of the organization will be minimized by concentrating on the principle of customer satisfaction. The disadvantage of missing a customer or the loss of a dissatisfied customer is much more serious because a dissatisfied customer can talk to many people and explain his/her dissatisfaction in a bad way. Also, as studies conducted by Melinda Goddard explain, expanding mass communication instruments and particularly, developing the World Wide Web communicate the negative verbal message of dissatisfied customers to everyone much faster than previously and with great exaggeration. Customers frequently choose suppliers to satisfy their requirements, consciously or unconsciously, who create the most customer satisfaction for the amount of money

paid for the product. Organizations will take a significant step in order to establish a customer-oriented business by spending the time and cost to evaluate current customer satisfaction [16]. Feedback is one of the essential factors in any process. Feedback can enable a process to adapt to environmental requirements and adjust its structure, production, and services. Accordingly, the organization to be able to guarantee the customers' satisfaction and apply their opinions and demands in the competition field to proceed with high self-confidence. It is possible that customer feedback directs us to optimal performance, therefore, it is required to establish a notable feedback mechanism in the first stage in order to identify the positive and effective points of the organization and also the negative and destructive points. Consequently, successful organizations are mainly required to establish feedback as one of their most basic necessities [15], [18].

There are limited resources of firms, hence, it is highly significant to apply these resources. Also, the way to spend these resources in order to satisfy customers' needs to identify the factors that have an effect on their satisfaction. Profitability is the ultimate objective of all companies and also there is a clear and substantial relationship between product quality, service, customer satisfaction, and profitability. Consequently, it is possible for the organization to meet its objective by considering the product and its customers and it is also highly significant for most companies to identify factors affecting customer satisfaction and the survival of organizations depends on identifying these factors and strengthening them [16].

The following table shows the summary of the research conducted in the fields of applying data envelopment analysis (DEA), fuzzy data envelopment analysis (FDEA), MUSA multi-criteria analysis, and satisfaction.

Satisfaction of Client	MUSA	FDEA	DEA	Year	Topic of Study	Reference
✓				2019	Determining the impact of employees' social identity on customer satisfaction in the hotel industry applying structural equation modeling	Rajabi
✓				2019	Surveying the classification of insurance customers in terms of satisfaction with insurance services applying data mining	Pooyan Far
✓				2018	Evaluating the status of communication skills of administrative staff and its relationship with customer satisfaction (teachers) Education and upbringing District 1 of Ardabil	Hosseini Nasab and Azimi Kohan
✓				2018	Surveying and determining the difference among the attitudes of regular customers and unstable customers to accurately determine satisfied and loyal customers	Fakhr Hosseini et al
			✓	2017	Evaluation of production lines of Iran Khodro Press Factory with data envelopment analysis technique	Maghsoud Amiri et al
			✓	2017	Evaluating the efficiency of Golbarg Baharan Company products with product development approach applying DEA data envelopment analysis	Reza Habibollah Garmabaki et al

			✓	2017	"Measuring the relative efficiency of forestry plans applying various hybrid scenarios in DEA data envelopment analysis	Majid Zad Mirzaei Soleimanda rabi
			✓	2017	Measuring the efficiency of bank branch management applying three-stage data envelopment analysis (Case study: Bank Melli Iran(	Roghayeh Mozaffari et al
		✓		2017	Evaluation of chosen performance of Iranian sports federations applying data envelopment analysis with approach to fuzzy systems	Simin Eskandari Dastgiri et al
		✓		2017	New model of fuzzy two-stage data envelopment analysis with variable-scale returns	Mohammad Javad Glij
✓				2020	Surveying the reasons for turning away from customers and finally canceling the insurance policy by customers	Parastoon et al
✓				2019	Development, analysis and applications of quantitative methods for evaluating customer satisfaction utilizing evolutionary optimization	Bandura et al
✓				2019	Time 1: Strategic utilization of the formal conscious half to improve customer satisfaction	Ford
✓				2018	The objective of determining customer satisfaction for the organization	Omayan et al
✓				2016	The field of business to increase customer satisfaction in academic libraries	Jayasandra
	✓			2015	Title of applying national component satisfaction analysis in the health care sector	Demitrus Doruy
	✓			2015	Multivariate customer satisfaction analysis with interaction metrics	Silvia
	✓			2013	Job Satisfaction of University Teachers: Multi-Criteria Satisfaction Analysis (MUSA) Method	Avadin
			✓	2011	Integration of data envelopment analysis, artificial neural network and anomalous set algorithm to measure the efficiency of bank staff	Alizadeh et al
✓	✓	✓	✓	2021	Present Study	

Table 1. Summary of research background studies

The studies conducted in papers related to the research subject explain that customer expectation components are applied as one of the inputs in the data envelopment analysis model. The multi-criteria customer satisfaction analysis model of evaluation is a hierarchical Analytical Hierarchy process in studies. In this analysis, the evaluation will be performed based on the combined model of Fuzzy DEMATEL Analytical Network Process networks. Because Analytical Network Process considers the complex relationships between decision elements by replacing the hierarchical structure and the network structure. Fuzzy sets are additionally utilized to cover uncertain decision-making states. The innovation of this research is to apply customer expectations in the data envelopment analysis model because most studies that concentrate on quality do not consider this component in their evaluation model.

Consequently, this study mainly aims to measure customer satisfaction employing a multi-criteria analysis model of customer satisfaction of Kaveh Industrial Group.

2. Research methodology

This study is applied in terms of the objective and is a kind of descriptive-analytical survey in terms of the type of research and data collection. Descriptive research describes and interprets everything and considers current circumstances, various approaches, current processes, tangible effects, or developing trends. It focuses fundamentally on the present, although it additionally examines past events and effects relate to the current circumstances. Descriptive research includes collecting information for the test by responding to questions related to the current studied circumstances. The survey research is conducted based on the generalization of information. The research method is a definite survey because it has been collected in a certain period of time. The spatial scope of this research is Kaveh Industrial Group in Iran. The time scope of this research is 25 months from 2019 to April 2020. The following four methods were applied in order to collect information and data:

1. This study is field research, consequently, the library method has been applied in order to collect information.

2. We also used interviews with academic and industry experts and also examined the content validity of the factors.

3. Three questionnaires were applied in order to collect research data using a field method.

A. The first questionnaire is to select the effective factors in the customer survey in which experts responded to the significance of each factor based on the 5-point Likert scale and the fuzzy Delphi method was applied to screen them.

B. The second questionnaire was employed to determine the relationships between the effective factors to solve the fuzzy dimethyl.

C. The third questionnaire was employed to determine each index in which customers responded based on a 5-option scale and the method of multi-criteria satisfaction analysis was applied in order to solve it.

4. Data related to the past year and also customer surveys were employed in order to evaluate the product lines and data envelopment analysis technique was used to solve.

2.1. Validity and reliability of data collection instruments

Experts examined the validity of the questionnaire. To this end, the identified indices were referred to 10 university professors and 11 industry managers as a questionnaire. At this stage, some of the factors identified by experts were mixed, modified, removed, and added.A self-control mechanism was employed in order to examine the reliability of the fuzzy Delphi screening questionnaire with the difference in responses at 0.2 based on the experts' opinions. Two methods have been used to examine the reliability of the DEMATEL questionnaire. (Wang, 2012) with the response error less than 5% and it is possible to confirm it:

$$\frac{1}{n(n-1)}\sum_{i=1}^{n}\sum_{j=1}^{n}\frac{\left|t_{ij}^{p}-t_{ij}^{p-1}\right|}{t_{ij}^{p}}\times 100\% = 4.97\% < 5\%$$

Where, n is the number of sub-factors and tpijis the aggregation of 21 expert's opinions.

The questionnaires were sent to customers in the form of 1000 questionnaires compared to the customers in the country after extracting the criteria and indices and organizing the questionnaire. 500 questionnaires were analyzed and other questionnaires that could not be analyzed were collected and deleted.

Data analysis method: Four fuzzy Delphi approaches, fuzzy DEMATEL approach, Fuzzy Analytical Network Process, and multi-criteria analysis of multi-criteria customer satisfaction analysis satisfaction is used in this study. In general, Figure 1 shows the process of the DANP hybrid method:

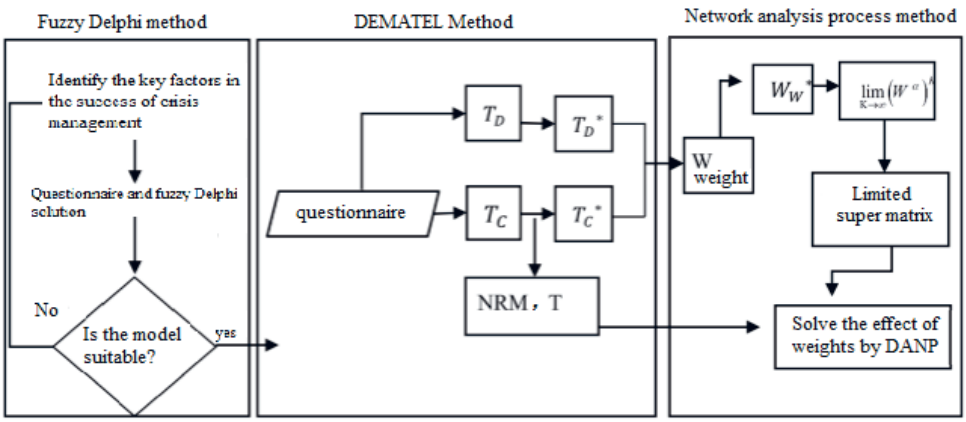

Figure 1. DANP hybrid problem-solving process

2.2. Multi-criteria analysis model of customer satisfaction

The multi-criteria satisfaction analysis model mainly aims to aggregate individual decisions in a set of value performances. Assuming that the customer satisfaction based on a set of criteria or variables indicates the dimensions of service features, each customer is invited to explain his/her opinion on the overall satisfaction with the services provided based on this model and also explain his/her opinion based on a set of separately defined criteria in order to measure satisfaction (Haghighi Nasab, 2008).

The main objective of the MUSA method (multi-criteria customer satisfaction analysis) is to combine customer judgment into a collective value function assuming that overall customer satisfaction is based on a set of n criteria that create customer satisfaction criteria. The set of criteria is presented with $X = (x_1.x_2.\ldots.x_n)$. Six criteria have been utilized in this research to measure customer satisfaction of Kaveh Glass Industrial Group as follows:

x_1	x_2	x_3	x_4	x_5	x_6
Customer Communication	Price	Customer complaint	Loyalty	Product quality	The quality of service

Table 2. Customer Satisfaction Criteria

Accordingly, customers reveal their judgment about the general satisfaction of Kaveh Glass Industrial Group and also a set of satisfaction criteria (x_i) in the form of a questionnaire with distance scales. The multi-criteria customer satisfaction analysis method that observes the rules of sequential regression analysis tries to create the maximum agreement between general customer satisfaction and satisfaction criteria by inferring the collective value function of total satisfaction (Y^*) and the set of functions of satisfaction criteria (X_i^*) (Mehregan et al. 2013). The multi-criteria customer satisfaction analysis sequential regression analysis equation has the following model:

$$Y^* = \sum_{i=1}^{n} b_i X_i^* \quad (1)$$
$$st: \sum_{i=1}^{n} b_i = 1 \quad (2)$$

Where, the values of the functions Y^* and X_i^*have been normalized in the range [0-100] and b_i is the ith standard weight.

According to the presented model and introducing a pair of error variables, the sequential regression equation will be as follows:

$$Y^{\sim *} = \sum_{i=1}^{n} b_i x_i^* - \sigma^+ + \sigma^- \quad (3)$$

Where, $Y^{\sim *}$ are the estimations of some general functions of Y^*, σ^+, and $\sigma^-$are high estimation error and low estimation error, respectively. Formula (3) is considered for each customer and explains a set of satisfaction judgments. Accordingly, it is required that a pair of error variables be assessed separately for each customer (Grigoroudis & Siskos 2010).

y	General customer satisfaction
α	Number of levels (response options) General customer satisfaction
y^m	Level (option) of mth in general satisfaction (m = 1, 2…, α)
z_m	Distance between m and m + 1 levels in total satisfaction
n	Number of satisfaction criteria (dimensions)
x_i	Partial customer satisfaction in the ith criterion (i = 1,2, ..., n)
α_i	Number of levels (response options) of satisfaction in the ith criterion
x_i^k	Level (option) of kth in the ith criterion (k=1, 2…,α_i)
w_{ik}	The distance between the levels k and k + 1 in the i-th criterion
y^*	The value of the function y
y^{*m}	value of y^m (level mth in total satisfaction)
x_i^*	The value of the x_i function

x_i^{*k}	Value x_i^k (kth level in ith standard)
M	Number of customers
y^j	Selection option of customer jth in total satisfaction (j = 1, 2…, M)
x_i^j	Selection option of customer jth in the ith criterion (j = 1, 2…, M)
σ^+	High estimation error
σ^-	Low estimation error

Table 3. Variables used in the multi-criteria customer satisfaction analysis method

The model of multi-criteria satisfaction analysis in the form of ideal linear programming is ultimately presented as follows, in which the variables of deviation from the ideal determine the degree of deviation of the combination of satisfaction criteria of total satisfaction per jth customer. (Mehregan et al., 2013)

$$MinF = \sum_{j=1}^{M} \sigma_j^+ + \sigma_j^- \quad (4)$$

$$S \cdot t \cdot$$

$$\sum_{i=1}^{n} \sum_{k=1}^{x_j^i - 1} w_{ik} - \sum_{m=1}^{y^j - 1} z_m - \sigma_j^+ + \sigma_j^- = 0 \qquad forj = 1.2. \ldots . M \quad (5)$$

$$\sum_{m=1}^{\alpha - 1} z_m = 100 \quad (6)$$

$$\sum_{i=1}^{n} \sum_{k=1}^{\alpha_j - 1} w_{ik} = 100 \quad (7)$$

$$z_m \geq 0. w_{ik} \geq 0 \ . \forall m. i. k \quad (8)$$

$$\delta_j^+ \geq 0. \delta_j^- \geq 0 \quad forj = 1.2. \ldots . M \quad (9)$$

This model uses the distances between the response options instead of using the response values of the questions due to the rank of the scale of the data obtained from the questionnaire. Consequently, the first response option of each question has a value of zero and from the second option, the distance variable (w_{ik}) between the ith standard options (k + 1) indicates the w_{ik} distance variable. It is considered that the sum of all distance variables in the ith criterion is 100%. The measuring scale is normalized at a distance of 0 to 100 for the ith satisfaction criterion and also total satisfaction.

$$x_i^1 = 0 \ w_{i1} \quad x_i^2 \quad w_{i2} \quad x_i^3 \quad \ldots \quad x_i^k$$
$$w_{ik} x_i^{k+1} = 100$$

According to the results, if the respondent prefers an option in the range completely disagree to completely agree for the ith criterion, w_{ik}will be considered relevant to his/her option. For example, if the option of the somewhat agree is selected for the ith criterion, the intervals $w_{i1} + w_{i2}$ will be considered. In this model, a constraint is generated for each customer, in which, jth customer's response has been considered to all n criteria in the form of a linear combination and its deviation from the value of the intervals of the criterion of total satisfaction (z_m)that has been exactly developed like w_{ik}, is recognized by the deviation of the ideal variables ($\sigma_j^+ . \sigma_j^-$). The

model aims to minimize deviations from the ideal of total customers by specifying proper values to the intervals of the scale. In this model, M denotes the number of customers. The variable y^j describes the option that the customer jth has been selected in the criterion of total satisfaction and x_i^j describes the option that the customer jth has been selected for the criterion ith. For example, if the fifth customer (j = 5) adopts the option of somewhat agree for the first criterion (i = 1), the value model $x_{i=1}^{j=5}$ will be equal three, which describes the sum of the first two distance variables of criterion 1 that means $w_{11} + w_{12}$. The model has been solved optimally solving and the optimal values of the distance variables have been determined and a distance measurement scale has been then obtained in which the final value of all levels of satisfaction and total satisfaction criteria have been determined in the optimal state with the least deviation in terms of all customers. The value of the value per kth level in the ith criterion is calculated through the Equation $x_i^{*k} = 100 \sum_{t=1}^{k-1} w_{it} / \sum_{t=1}^{\alpha_j - 1} w_{it}$ and is calculated through the Equation $Y^{*m} = \sum_{t=1}^{m-1} z_t$ to measure the total satisfaction (Grigoroudis & Siskos, 2010).

This M + 2 linear programming model is a variable constraint of $2m + (\alpha - 1) + \sum_{i=1}^{n}(\alpha_i - 1)$. Accordingly, the multi-criteria customer satisfaction analysis method creates a value system between satisfaction and total customer satisfaction criteria and estimates the distances of the scale and the weight values of satisfaction criteria using the equation $b_i = \sum_{t=1}^{\alpha_i - 1} w_{it} / 100$. (Mehregan et al., 2013)
The initial variables of the model are calculated based on the optimal solution of the previous LP (Grigoroudis & Siskos, 2010).

$$b_i = \frac{1}{100} \sum_{t=1}^{\alpha_t - 1} w_{it} \; for i = 1.2. \ldots . n \tag{10}$$

$$y^{*m} = \sum_{t=1}^{m-1} z_t \; form = 2.3. \ldots . \alpha \tag{11}$$

$$x_i^{*k} = 100 \frac{\sum_{t=1}^{k-1} w_{it}}{\sum_{t=1}^{\alpha_t - 1} w_{it}} for i = 1.2. \ldots . n and k = 2.3. \ldots . \alpha_i \tag{12}$$

3. Results

3.1. Evaluating and selecting the factors

Customer satisfaction indices were extracted by examining the theoretical literature and various papers and holding meetings with experts in order to identify the effective factors. To this end, a questionnaire with 41 questions (each question represents a variable) was designed and 21 questionnaires were provided to the respondents that all questionnaires were collected comprehensive and complete. These questionnaires have been designed qualitatively based on 5 Likert scales from extremely high to extremely low. Currently, the fuzzy Delphi method is applied after distributing and collecting the questionnaire in order to determine the most significant factors that we have explained its steps in the following part.

Accordingly, experts selected 6 main factors with 24 effective indices in customer polling, and we drew a model with a network structure in three rounds of polling, which Figure 2 shows it.

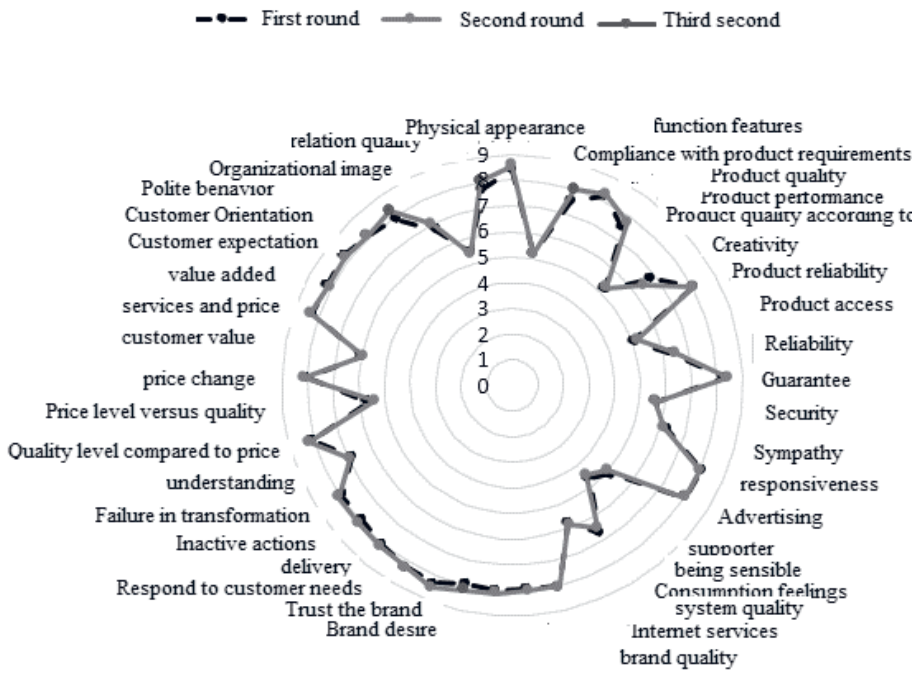

Figure 2. Average of expert opinions using fuzzy Delphi for screening customer satisfaction indices

Also, Table 4 shows the effective factors and sub-factors in improving customer satisfaction performance in order to evaluate product lines.

Sign	Subscribers	Main factors
C11	Physical appearance	C1
C12	Product quality produced	Product quality
C13	Compliance with product requirements	
C14	Product reliability	
C21	Guarantee	C2
C22	Security	Services quality
C23	responsiveness	
C24	Internet services	
C31	Brand quality	C3
C32	Brand loyalty	loyalty
C33	Willingness to repurchase	
C34	the trust	
C41	Lack of response to customer needs	C4

C42	Timely delivery	Client complaint
C43	Delivery failure	
C44	Passive and irresponsible action	
C51	Price versus quality	C5
C52	Price change	price
C53	Price	
C54	Value Added	
C61	Customer expectation	C6
C62	Customer Orientation	Relation with client
C63	Polite behavior	
C64	Quality of relationships	

Table 4. Factors affecting the performance of customer satisfaction in order to evaluate product lines

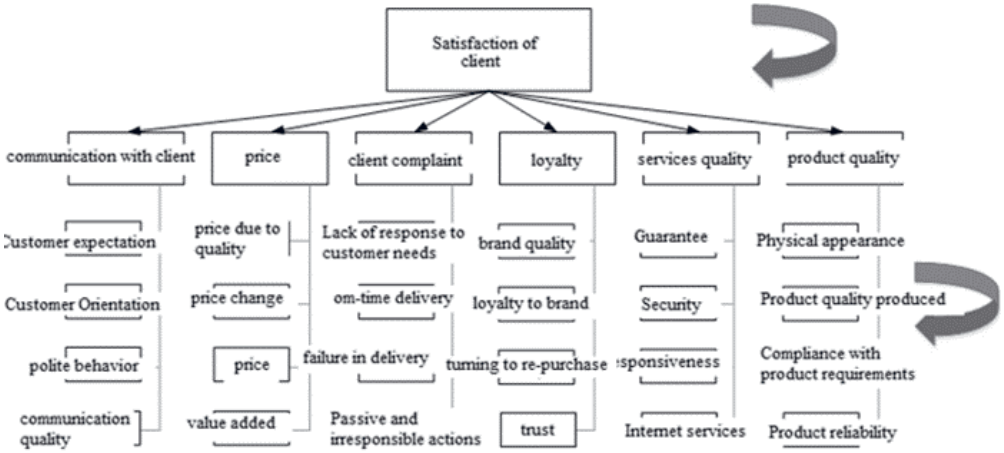

Figure 3. Network structure model

3.2. Results of fuzzy DEMATEL

5 verbal expressions have been used to compare factors with each other that Table 5 shows the names of these expressions and their equivalent fuzzy values.

Triangular fuzzy numbers	Definitive numbers	Language options
(0/75 ،1 ،1)	4	Too much impact
(0/5 ،0/75 ،1)	3	high impact
(0/25 ،0/5 ،0/75)	2	Low impact

(0 ،0/25 ،0/5)	1	Very little impact
(،0 ،0 ،0/25)	0	No effect

Table 5. Language options and fuzzy numbers in order to measure the intensity of effects

9 experts' opinions have been used in order to investigate the factors. In these matrices, $\tilde{x}_{ij} = (l_{ij}, m_{ij}, u_{ij})$are triangular fuzzy numbers and $\tilde{x}_{ii} = (i = 1,2,3, \dots, n)$are considered as Fuzzy numbers (0,0,0). We take an arithmetic average to consider the opinion of all experts according to the formula 1-4.

$$\tilde{Z} = \frac{\tilde{x}^1 \oplus \tilde{x}^2 \oplus \tilde{x}^3 \oplus \dots \oplus x^p}{p} \quad (1\text{-}4)$$

In this formula, p is the number of experts and $\tilde{x}^1$ ، $\tilde{x}^2$، $\tilde{x}^p$ are the matrix comparison pairs of expert 1, expert 2 and expert p, respectively, and $\tilde{z}$ is a triangular fuzzy number in the form of $\tilde{z}_{ij} = (l'_{ij}, m'_{ij}, u'_{ij})$. Table 7 presents the average pairwise comparisons for the main factors and Table 8 for the following factors:
We use formulas 2-4 and 3-4 in order to normalize the achieved matrix.

$$\widetilde{H}_{ij} = \frac{\tilde{z}_{ij}}{r} = \left(\frac{l'_{ij}}{r}, \frac{m'_{ij}}{r}, \frac{u'_{ij}}{r}\right) = (l''_{ij}, m''_{ij}, u''_{ij}) \quad (2\text{-}4)$$

Where r is obtained using the following equation:

$$r = max_{1 \le i \le n}\left(\sum_{j=1}^{n} u_{ij}\right) \quad (3\text{-}4)$$

After calculating the above matrices, the matrix of fuzzy total equations is obtained using formulas 4-4 to 7-4.

$$T = \lim_{k \to +\infty}\left(\widetilde{H}^1 \oplus \widetilde{H}^2 \oplus \dots \oplus \widetilde{H}^k\right) \quad (4\text{-}4)$$

A fuzzy number is as $\tilde{t}_{ij} = (l^t_{ij}, m^t_{ij}, u^t_{ij})$ in each element and is calculated as follows:

$$[l^t_{ij}] = H_l \times (I - H_l)^{-1} \quad (5\text{-}4)$$
$$[m^t_{ij}] = H_m \times (I - H_m)^{-1} \quad (6\text{-}4)$$
$$[u^t_{ij}] = H_u \times (I - H_u)^{-1} \quad (7\text{-}4)$$

In these formulas, I is a single matrix, and H_l ،$H_m$and H_u are n × n matrices whose elements are the lower number, middle number, and an upper number of the triangular

fuzzy numbers of the H matrix, respectively. Table 10 presents the t-matrix for the principal factors and for the sub-factors.

The next step is to calculate the sum of the rows and columns of the matrix $\tilde{T}$. The sum of rows and columns is calculated according to formulas 8-4 and 9-4.

$$\tilde{D} = (\tilde{D}_i)_{n\times 1} = [\sum_{j=1}^{n} \tilde{T}_{ij}]_{n\times 1} \quad (8\text{-}4)$$

$$\tilde{R} = (\tilde{R}_i)_{1\times n} = [\sum_{i=1}^{n} \tilde{T}_{ij}]_{1\times n} \quad (9\text{-}4)$$

Where $\tilde{D}$ and $\tilde{R}$ are the matrices n × 1 and 1 × n, respectively.

The next step is to determine the significance of the indices $(\tilde{D}_i + \tilde{R}_i)$ and the relationship between the criteria $(\tilde{D}_i - \tilde{R}_i)$. If $\tilde{D}_i - \tilde{R}_i > 0$, the relevant criterion will be effective, and if $\tilde{D}_i - \tilde{R}_i < 0$, the relevant criterion will be effective. In the next step, we will perform the deffuzification of the fuzzy numbers $\tilde{D}_i + \tilde{R}_i$ and $\tilde{D}_i - \tilde{R}_i$ achieved by the previous step according to the formula 10-4.

$$B = \frac{(a_1 + a_3 + a_2)}{3} \quad (10\text{-}4)$$

B is diffused form of the number $\tilde{A} = (a_1, a_2, a_3)$. Table 10 shows the diffused numbers of values of effect $(\tilde{D})$, effectiveness $(\tilde{R})$, significance $(\tilde{D} + \tilde{R})$ and net effect and effectiveness $(\tilde{D} - \tilde{R})$ for the main factors and for the sub-factors.

Result	$\tilde{D} - \tilde{R}$	$\tilde{D} + \tilde{R}$	$\tilde{R}$	$\tilde{D}$	Main factors
Effective	0.167	5.436	2.635	2.802	Communicational
Effective	0.222	5.018	2.398	2.62	Manpower
The most effective	-0.81	5.312	3.063	2.25	Distribution system
Influential	-0.12	5.961	3.043	2.918	Production system
The most effective	0.369	4.072	1.851	2.221	Resources and supplies
Effective	0.18	5.447	2.634	2.813	Environmental

Table 6. Significance and effectiveness of the main injury

As Table 6 shows, if the value of $\tilde{R}$-$\tilde{D}$ is positive for an index, that index will be effective, and if the value of $\tilde{R}$-$\tilde{D}$ is negative, that index will have affectability; consequently, "price" with an effective value of 0.369 is the most effective among the main factors and "loyalty" with a net effect value of -0.81 has the most affectability. In general, positive $\tilde{R}$-$\tilde{D}$is considered the causal factor and negative $\tilde{R}$-$\tilde{D}$is considered the effected factor. Accordingly, the factors of "price", "service quality", "customer relationship", "and product quality" are the cause and which direct more and are less dependent. The factors of "customer complaint" and "loyalty" are affected factors, which are affected by causal factors. These factors are highly dependent and direct in less value. Table 7 also shows the value $\tilde{R}$-$\tilde{D}$ for the sub-factors.

Main factors	Sub-factors	Abbreviation	0.094	0.069	0.164	0.0253	Result
Product quality	Physical appearance	C11	0.094	0.069	0.164	0.0253	effective
	Product quality produced	C12	0.201	0.193	0.393	0.0078	effective
	Compliance with product requirements	C13	0.19	0.218	0.409	-0.028	influential
	Product reliability	C14	0.176	0.181	0.357	-0.0051	influential
the quality of service	Guarantee	C21	0.119	0.152	0.271	-0.0328	influential
	Security	C22	0.125	0.115	0.24	0.0107	effective
	responsiveness	C23	0.1	0.081	0.181	0.0196	effective
	Internet services	C24	0.039	0.037	0.076	0.0025	effective
Loyalty	Brand quality	C31	0.214	0.189	0.403	0.0248	effective
	Brand loyalty	C32	0.203	0.223	0.427	-0.0201	influential
	Willingness to repurchase	C33	0.249	0.289	0.539	-0.0404	influential
	trust	C34	0.244	0.208	0.452	0.0358	effective
Customer complaint	Lack of response to customer needs	C41	0.172	0.243	0.415	-0.0714	influential
	On-time delivery	C42	0.208	0.194	0.403	0.0142	effective
	Delivery failure	C43	0.247	0.216	0.462	0.031	effective
	Inactive and irresponsible actions	C44	0.263	0.236	0.499	0.0262	effective
Price	Price versus quality	C51	0.173	0.155	0.328	0.0179	effective
	Price change	C52	0.164	0.174	0.338	-0.0104	influential
	price	C53	0.163	0.175	0.338	-0.012	influential
	Value added	C54	0.042	0.037	0.079	0.0045	effective
Communication with client	Customer expectation	C61	0.236	0.248	0.484	-0.0115	influential
	Customer Orientation	C62	0.226	0.235	0.462	-0.0091	influential
	Polite behavior	C63	0.186	0.179	0.365	0.0074	effective
	Quality of relationships	C64	0.186	0.173	0.359	0.0132	effective

Table 7. Significance and effectiveness of sub-injuries

Figure 4 also shows the significance and effectiveness between factors. The horizontal axis of the diagram shows the significance of the factors and the vertical axis shows the effectiveness or affectability of the factors. In this figure, the diagram shows the center of relationships and the way to interact between the main factors that the way

of the interactions between their sub-factors have been also determined. As this figure shows, price affects other factors and affects "service quality", "customer relationship", "product quality", "customer complaint" and "loyalty", respectively.

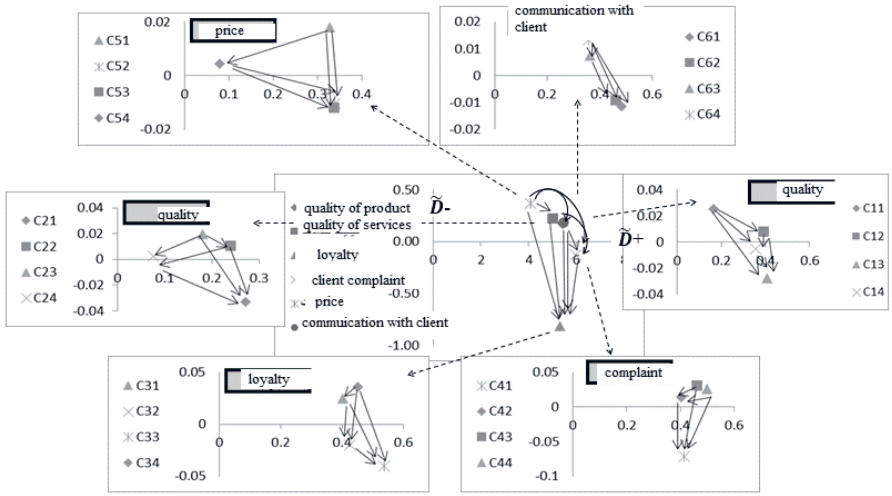

Figure 4. cause-and-effect-relationships diagrams and relationships among the following factors

3.3. Results of the fuzzy network analysis process

Finally, we calculated the weight of factors and sub-factors by obtaining the limit supermatrix, which is shown in Table 8.

Weight and priority of the main factors	Sub-factors	Code	Weight and relative priority under the factors		Weight and final priority under the factors	
Product quality 0.156 (4)	Physical appearance	C11	0.0682	4	0.0116	22
	Product quality produced	C12	0.3094	2	0.0528	8
	Compliance with product requirements	C13	0.3397	1	0.0579	6
	Product reliability	C14	0.2828	3	0.0482	10
Services quality 0.172 (5)	Guarantee	C21	0.3965	1	0.0598	5
	Security	C22	0.2645	3	0.0399	14
	responsiveness	C23	0.2961	2	0.0447	12
	Internet services	C24	0.0429	4	0.0065	23
Loyalty 0.182 (2)	Brand quality	C31	0.1817	4	0.0361	15
	Brand loyalty	C32	0.2048	3	0.0406	13
	Willingness to repurchase	C33	0.3823	1	0.0759	2

	trust	C34	0.2312	2	0.0459	11
Client complaint 0.2 (1)	Lack of response to customer needs	C41	0.2409	3	0.0495	9
	On-time delivery	C42	0.172	4	0.0354	16
	Failure in delivery	C43	0.3263	1	0.0671	3
	Inactive and irresponsible actions	C44	0.2608	2	0.0536	7
Price 0.177 (6)	Price versus quality	C51	0.2907	3	0.0288	19
	Price change	C52	0.3271	2	0.0324	18
	price	C53	0.3324	1	0.0329	17
	Value added	C54	0.0498	4	0.0049	24
Communication with client 0.112 (3)	Customer expectation	C61	0.4731	1	0.083	1
	Customer Orientation	C62	0.3491	2	0.0612	4
	Polite behavior	C63	0.0898	3	0.0158	20
	Quality of relationships	C64	0.088	4	0.0154	21

Table 8. The weight and significance of improving the factors affecting the performance of customer satisfaction in order to evaluate product lines

As Table 8 shows, the factor of "customer complaint" with a weight of 0.206 has the most weight and significance among the main factors. Furthermore, the highest weight is related to the "customer expectation" factor among the sub-factors, which has the first priority. The factor of "willingness to repurchase" has the second priority, "failure to deliver" has the third priority, "customer orientation" has the fourth priority and guarantee has the "fifth priority" and eventually, "conformity with product requirements" has the sixth priority among 24 sub-factors that approximately allocated 40.49% of the total weight of the sub-factors and this issue explains the high significance of these sub-factors.

3.4. Results of the modified multi-criteria customer satisfaction analysis method

One of the main assumptions of the multi-criteria customer satisfaction analysis method is that the satisfaction sub-criteria have no interfering effects on each other and are completely independent and while in fact, the satisfaction sub-criteria have interfering effects on each other and are not independent of each other and influence each other. Consequently, it is required to determine these interference effects in the model and it is possible to determine these interference effects in two ways. A) by asking customers and b) by asking experts in the field of satisfaction.

It is possible that customers have no information about the way of the interaction and effects of sub-criteria in a multi-criteria decision problem and it is also possible that customers do not consider attractive completing separate questionnaires in order to determine the interaction effects between criteria, hence, we use method b in this

study that is, questioning experts in order to determine the interactions of the satisfaction sub-criteria.

Consequently, DEMATEL and FANP techniques are applied in order to calculate relative weights of the satisfaction sub-criteria. Presently, we experience a problem including that if we use the standard multi-criteria customer satisfaction analysis method to calculate the sub-criteria weights of satisfaction, we will only consider the customers' opinion (which is correct and reasonable) and if we employ the mixed method of DEMATEL and FANP, we will only consider the experts' opinion.

We plan to modify the MUSA method in such a way in this section that it can consider the opinion of experts and also the experts' opinions. In fact, we enable it to achieve information from customers outside the organization as input, and also from the interference effects of these sub-criteria hidden in the output of DEMATEL and FANP and displayed in Wi, i = 1,…, n values in order to determine the weights of satisfaction criteria. To this end, we should maintain all the previous definitions for the parameters and we are also required to consider the decision variables of the modified MUSA mixed model as follows.

$$Min \quad F = \sum_{j=1}^{M} (\sigma_j^+ + \sigma_j^-) + \sum_{i=1}^{n} (d_i^+ + d_i^-)$$

$$s.t.$$

$$Y_j^* = \sum_{i=1}^{n} b_i X_{ij}^* - \sigma_j^+ + \sigma_j^-, \quad j = 1,...,M$$

$$a_{i't} \times b_i - d_i^+ + d_i^- = 0, \quad i',i = 1,...,n, i' \neq i$$

$$\frac{w_{i'}}{w_i} = a_{i't}, \quad i',i = 1,...,n, i' \neq i$$

$$\sum_{i=1}^{n} b_i = 1$$

$$\sigma_j^+ \geq 0, \quad j = 1,...,M$$

$$\sigma_j^- \geq 0, \quad j = 1,...,M$$

$$b_i \geq 0, \quad i = 1,...,n$$

The parameters and symbols are introduced as follows in the above model.

Indices and sets:

j: is the customer counter

M: Number of customers who have completed the satisfaction questionnaire.

i: The satisfaction counter

n: Number of satisfaction sub-criteria

Parameters: Y_j^* : The level of overall satisfaction of customer jth about the product or service (quality values that are obtained through a questionnaire and quantified with a range between 0 and 100).

X_{ij}^{*} :The level of overall satisfaction of customer jth in I sub-criterion about the product or service (quality values that are obtained through a questionnaire and quantified with a range between 0 and 100).

w_i : The weight of criterion ith that has been obtained using FANP method.

$a_{i'i}$: : The weight ratio of criterion ith and criterion i that have been obtained using FANP.

Decision variables:

b_i : Decision variables indicate the weight or relative significance of the i-th sub-criterion of satisfaction

σ_j^+ : The decision variable is the amount of positive deviation in terms of the customer's opinion jth about the sub-criteria of satisfaction (overestimation)

σ_j^- :: The decision variable is the amount of negative deviation in terms of the customer's opinion jth about the sub-satisfaction criteria (underestimation)

d_i^+ :: The decision variable is the amount of positive deviation from the weight obtained from the ith criterion of FANP output (overestimation)

d_i^- : : The decision variable is the amount of negative deviation from the weight obtained from the ith criterion of FANP output (overestimation)

The weights achieved by the above-modified model consider both opinions explained by goods and services customers who are the final consumers of goods and services and their opinions on the significance of satisfaction sub-criteria are important and also consider the opinions explained by satisfaction experts that examined the network structure between satisfaction sub-criteria and try to minimize the total deviation in terms of the different opinions explained by customers and the judgments explained by experts.

The optimal value of decision variables $b^*_i, i = 1,...,n$ is calculated after solving the above model. This value really shows the weight of the satisfaction sub-criteria in such a way that the target variance is calculated at its lowest value. This means, the amount of positive and negative deviations in terms of the jth customer's opinions and the amount of positive and negative deviations according to the outputs of the weights obtained from FANP in the case of satisfaction sub-criteria is the minimum possible value and in fact, the weights of the satisfaction sub-criteria have been determined in such a way that a collective decision has been made according to the opinion of all customers and experts and paying attention to the network structure and interaction between the sub-criteria. Using the optimal amount $b^*_i, i = 1,...,n$ and using the formula $Y_j = \sum_{i=1}^{n} b_i X_{ij}, \quad j = 1,...,M$, it is possible to calculate the

total satisfaction of each customer according to the mentioned conditions, and also calculate the amount of overall satisfaction using the formula:

$$Y = \frac{\sum_{j=1}^{M} Y_j}{M}$$

3.5. Measuring customer satisfaction

After gathering data due to the questionnaire completed by 500 customers in 4 kinds of products of Kaveh Industrial Group, the modified MUSA model was implemented applying LINGO 11 software and the average findings of customer satisfaction were separately presented. In the figure below, the numbers on the right are due to the weight of criteria and the numbers on the left are due to the average (geometric) scores of the customers of criteria.

Customer satisfaction	Evaluation period	Customer satisfaction	Evaluation period	Customer satisfaction	Evaluation period
0.88	19	0.90	10	0.90	1
0.90	20	0.88	11	0.88	2
0.85	21	0.85	12	0.86	3
0.88	22	0.89	13	0.89	4
0.90	23	0.87	14	0.88	5
0.89	24	85.	15	0.84	6
0.88	25	0.88	16	0.87	7
Total satisfaction 0.88		0.90	17	0.89	8
		0.84	18	0.87	9

Table 9. Results of Method

4. Conclusion

Nowadays, customer survey is so significant in evaluating product lines. The objective of this research was to identify the appropriate hybrid model of DEA/MCDM to identify the relationship between customer satisfaction, employee assessment and financial performance in Kaveh Industrial Group. First, reviewing the theoretical literature of study, the dimensions of customer satisfaction were determined and dimensions were determined. Then, the dimensions were screened by university and industry experts applying fuzzy Delphi method and finally 6 indicators and 24 criteria were chosen. These indicators are as follows:

- Product quality (physical appearance, product quality, compliance with product requirements, product reliability)
- Quality of service (guarantee, security, accountability, internet service)
- Customer loyalty (brand quality, brand loyalty, willingness to repurchase, trust)

- Customer complaint (lack of response to customer needs, timely delivery, failure to deliver, irresponsible and irresponsible actions)
- Price (price against quality, price change, price, value added)
- Customer relationship (customer expectation, customer orientation, polite behavior, quality of relationships)

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