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Full Length Research Paper

A fuzzy conjoint analysis approach for evaluating credit card services: A case study of Iranian bank

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Nowadays, the objective of all organizations is to achieve higher market share by recognizing the customer requirements and try to offer the products or services according to these requirements. Financial and credit institutes like banks try to follow these objectives as well. Conjoint analysis (CA) method is one of the statistical methods which widely used in the marketing problems like prediction of customer behaviors and evaluation of customers' utility of a special service or product. In spite of other methods directly evaluating product preferences, CA helps the organizations to measure the degree of importance of each product or service from general assessment of that product or service by an analytical approach. One of the services of banks is presenting the credit cards to their customers. In Iran, credit cards have been introduced to customers in the recent years. Regarding to improving market of credit cards in Iran, research on identification of Iranian customers' expectations and preferences in use of credit cards is so necessary. The aim of this research is using fuzzy CA method for specification and selection of the best combination of attributes and levels of credit cards in an actual case "Eghtesad-Novin Bank" in Iran according to customers' opinions.

Key words: Conjoint analysis, Fuzzy sets, credit cards.

INTRODUCTION

All banks, despite its size, should be flexible enough to react to environmental changes which effect on their goal market like change in customers interests or need to a new service from customers (Kara et al., 1996). On the other hand, development of novel technologies in electronic commerce (e-commerce) and telecommunication has triggered customers' needs and invention of new tools and banking services.

Adoption is defined as acceptance or keeping use of a product, goods, or an idea. Several studies have been carried out on the selection process of a product or service by customers. One of the most important studies in this area is Rogers' (1995) research. Based on Rogers' (1995) study, before acceptance of differentiation in a product or service, customers will experience the following processes:

1. Awareness: creative individuals have the extensive social relations and consequently they have more information and knowledge or awareness than others. Creativity is a measure that a person acts faster than others in accepting a product or an idea.
2. Motivation: in this step, potential interest is created. By predicting the satisfaction and risk, the person would have a negative or positive interest toward the differentiation that can play an important role in final acceptance.
3. Decision: in this step, a person contributes in decision making activities which will lead to admission or rejection of a differentiation.
4. Action: in this step, decision making process is finished and behavioral changes will form.
5. Confirmation: after accepting a differentiation, a person evaluates the decisions results. If high level satisfaction is achieved, use of this product or service will be continued.

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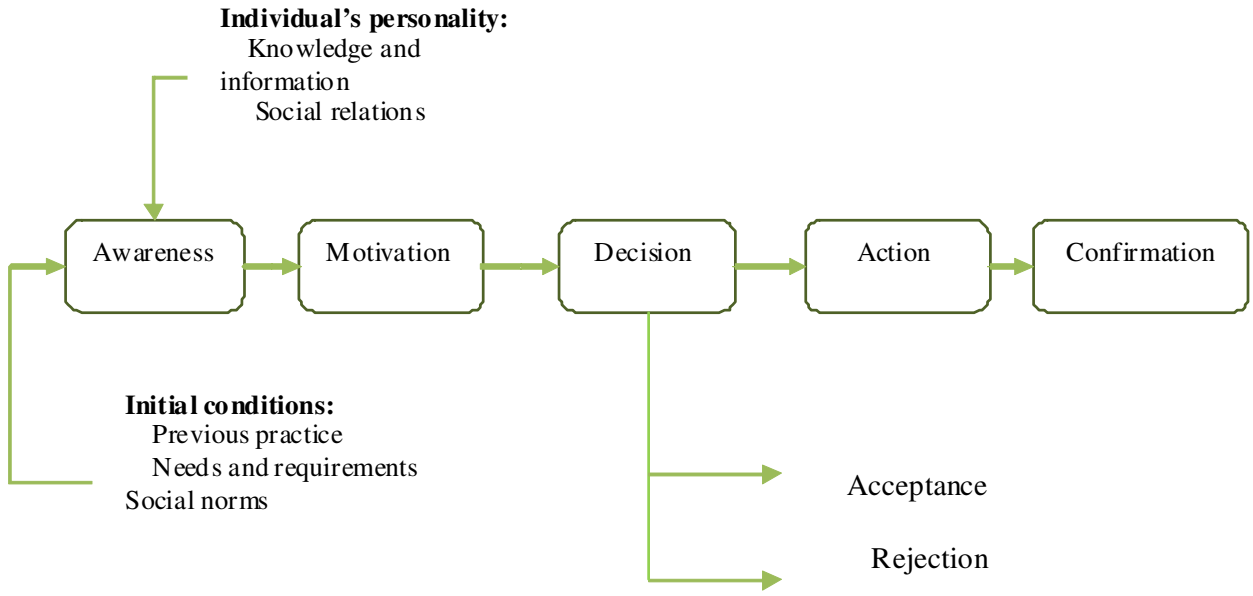

Figure 1. Steps of acceptance of a new product or a service (Rogers, 1995).

In spite of high satisfaction, use of this product or service may be rejected. Figure1 shows the steps of acceptance of a new product or a service.

The time to accept/reject a specific product or a service could be short or relatively long. For example, awareness from a differentiation about a specific product or services could lead to acceptance in some years (Rogers, 1995). One of banking services is credit cards service. Credit cards have different specifications like credit ceiling, interest rate, statement period and so on. Design and selection of the best specifications for the credit cards are not simple. Although credit cards are common in the developed countries, instruction of credit cards issue from the Iranian central bank to banks has been ordered in 2008. Thus, credit cards service is a new phenomenon. Regarding to growing market of credit cards in Iran, an appropriate research which can identify Iranian customers' expectation and preferences is highly demanded. With identification of customers' expectation and preferences, the best specifications of credit cards which are of customers' concern can be extracted. There are numerous methods for identification of these preferences. Most of these methods are based on economic parameter studies like consumption pattern for demand prediction or studies on behavior science for providing profile of demographic specification of consumers (Kara et al., 1996). These studies can be performed by examining the people's perception related to preference of each type of credit cards. The method widely used in the literature for the problem of "identifying people's preferences from different specifications of a typical product or service" is the Conjoint Analysis.

Conjoint analysis was introduced to marketing as a mean to understand the importance of product and service attributes and levels as predictors of consumer preferences (Green and Rao, 1971; Green and Wind, 1973; Luce and Tukey, 1964). Since conjoint analysis introduction it has received many attentions from both theoretical and applied fields (Vadali et al., 2009; Ding et al., 2009; Pieterse et al., 2010).

The full-profile method is one of the methods for designing product different states for evaluation, by establishing all possible combinations of attribute levels in conjoint analysis. Full-profile method is the most popular method in conjoint analysis because it provides more reasonable descriptions through defining levels of each attribute in a product profile, and is recommended when the number of attributes is six or less (Novotorova and Mazzocco, 2008). As an example of full profile method if a problem has 3 attributes and 4 levels, the number of total states equals to $4\times3=12$. Then, the customers are requested to sort them from the worst to the best (ranking method) or to assign a value between 0 and 100 as their preference to each of those attributes (rating data method). Finally, using statistical methods, most favorable product is determined based the reported data from customers.

This full profile method was used for obtaining the customer's preferences for a long time until Johnson (1974) confronted with a problem with 28 attributes and 5 levels which was so difficult to be solved by full-profile method. In 1974, Johnson (1974) suggested the trade-off matrix method for solving that problem. Following that, other CA-based methods were developed rapidly. Wittink and Cattin (1982) presented a novel application for CA method in the trade market. Generally, CA is applied in many different applications. As an example in the credit

cards design, Kara et al. (1994) used CA for determining the strategies related to design and development of credit cards. They applied full-profile method in 3 steps of design, analysis, and simulation. Schaupp and Bélanger (2005) use conjoint analysis to evaluate online consumer satisfaction based on data collected from 188 consumers. Their results indicate that the three most important attributes to consumers are privacy, merchandising, and convenience. Lee et al. (2000) suggest a methodology of benefit segmentation for electronic shopping malls using conjoint analysis. In their proposed methodology, to get market segmentation information for preference elicitation, automatically generated surfing or buying data is captured and analyzed.

Data analysis methods in Conjoint Analysis

In the CA method, the most important step is the data analysis. In this section different methods of the data analysis in the CA will be briefly reviewed with looking at their history. At the early of 1980, Tanaka et al. (1980) presented a linear programming-based (LP-based) method on regression model equipped with fuzzy linear model with symmetric triangular fuzzy numbers. This method was used by Heshmati and Kanded (1985) for predicting in uncertain environments. Nazaki et al. (1997) extracted a new method from the interval linear method to solve fuzzy models. In 1973, the Linear Programming Techniques for Multidimensional Analysis of Preference (LINMAP) method was introduced which is one of the most important methods in calculating attributes weights for solving multiple attribute decision-making problems (Srinivasan and Shocker, 1973). Hwang and Yoon (1981) showed that LINMAP can't provide all possible pairwise comparisons. LINMAP method proposed by Sarinivasan and Shaker (1973) was only applied for solving CA problems in the crisp environment. Sadi-Nezhad (2002) presented two methods to solve fuzzy LINMAP while crisp decision matrix and pairwise comparisons vectors are accompanied by a preference function. He used the integer programming in the first method and fuzzy goal programming in the second with the Werner membership function (Sadi-Nezhad, (2002).

DeSarbo et al. (1992) developed a latent class methodology for conjoint analysis which simultaneously estimates market segment membership and part-worth utilities for each derived market segment. Li and Yang (2004) developed the LINMAP method for solving the grouped decision making problems with fuzzy decision matrix. Sadi-Nezhad and Akhtari (2008) introduced a fuzzy LINMAP method with decision matrix and fuzzy pairwise comparisons vector for group decision making methods. This method was developed by combining Yang and Li's method (2004) and Sadi-Nezhad's (2002).

Fuzzy preference models were extensively applied in product designing, marketing management, and market segmentation (Green and Sirinivasan, 1990; Wittink and Cattin, 1989). In these models, a fuzzy membership function is defined for each linguistic variable. Turksen and Willson (1994) combined the conjoint analysis method with fuzzy set concept.

The fundamental philosophy of model proposed by Turksen and Willson (1994) is that the overall preference can be decomposed as a combination of preferences of forming attributes (such as price, quality, end etc.). The combination of these attributes creates combination function as the "model vector". In fact, the general preferences are a vector of preferences of specifications.

Among different mentioned methods in this research, the fuzzy regression method has not been applied because of its statistical and computational complexities. The fuzzy LINMAP method has not been used as well because we want to involve both experts' and customers' opinions in the modeling while LINMAP method only permits involvement of either customers' or experts' opinions. Thus, for information analysis, the fuzzy preference method has been applied in this paper. It should be noted that other studies on CA with using linguistic variables have been done which we can refer to Biswas (1995), and Wang (1997). Difference between these methods is in calculation of similarity degree of two fuzzy sets.

METHODOLOGY

Fuzzy set theory

Fuzzy set theory was first developed in 1965 by Zadeh (1965). Fuzzy set theory has more advantages in describing set concepts in human language than traditional set theory. It shows unspecific and fuzzy properties of language by evaluation and uses the membership function concept to represent the fuzzy terms like "incompletely belonging to" and "incompletely not belonging to".

Definition of fuzzy number

Fuzzy set of $\tilde{N}$ in R is called a real fuzzy number (Ross, 2004), If:

1. It is convex. A fuzzy set is convex when each α-cut of that is convex.
2. It is normal and single-valued. It means that just there is one $x \in R$ which $\tilde{N}(x)=1$.
3. $\tilde{N}(x)$ is segmentally continuous.

Definition of Triangular Fuzzy Number

The triangular fuzzy number $d(\tilde{m},\tilde{n})=0$ defined as

$$L(x)=R(x)=\begin{cases}1-x & 0\le x\le 1\\ 0 & 0\omega\end{cases} \Rightarrow \mu_{\tilde{M}}(x)=\begin{cases}L(\frac{m-x}{\alpha}) & 0\le\frac{m-x}{\alpha}\le 1\\ R(\frac{x-m}{\beta}) & 0\le\frac{x-m}{\beta}\le 1\end{cases} \quad (1)$$

Where m, α, and β represent the center of fuzzy number, the distance from the left of the center, and distance from the right of

the center, respectively.

Definition of linguistic variable

Zadeh (1965) introduced the application of linguistic variables. The fuzzy linguistic variable is a variable that reflects the different levels of human language with a range from natural to artificial languages. A linguistic variable is presented by a quintuplet of (X, T(x), U, G, M). *X* represents the name of variable, T(x) represents a set various terms or linguistic values of *X* which are produced by grammatical rules of *G*; *U* indicates the reference set, and *M* is a semantic structure which relates a meaning to each term of $Max \sum \phi_{k,l} . \mu(k,l)$. Linguistic variables can also be shown with triangular fuzzy numbers. In addition, variables related to a human word or statement can be categorized into numerous linguistic criteria such as equally important, moderately important, strongly important, very strongly important, and extremely important.

Distance between two triangular fuzzy numbers

Let $\tilde{m}=(m_1,m_2,m_3)$ and $\tilde{n}=(n_1,n_2,n_3)$ be two triangular fuzzy numbers. Then, a simple and effective method, the vertex method, is used to calculate the distance between them as follows (Li and Yang 2004):

$$Wj \geq 0 \quad Vj\ unrestricted\ in\ Sign \quad j=1,...m$$

In this regard, two triangular fuzzy numbers $\tilde{m}$, $\tilde{n}$ are identical if and only if the distance measurement $d(\tilde{m},\tilde{n})=0$

Fuzzy sets theory has been applied to many areas such as social science (Ragins, 2000), business, finance, management, economics and marketing (Bojadziev and Bojadziev, 2007). Also, as an example of its application in assessment of education, we can mention the research done by Weon and Kim (2001).

As stated, a conjoint analysis is an overall preferences rating for a state which can be de-composed into a combination of preferences for it component. The fuzzy conjoint model is developed by integrating fuzzy measurement of evaluations into the vector preference model. The fuzzy conjoint analysis used in this study is a method originally designed by Turksen and Willson's CA model (Turksen and Willson, 1994) and is used to rank different states in the product design or marketing management by means of similarity degree criterion of two fuzzy sets *R* and *L*. Fuzzy set *L* includes linguistic variables which have subjective nature and its membership function can be defined according to experts' opinions as triangular, trapezoidal fuzzy, and etc. Fuzzy set *R* includes all states which are going to be ranked.

It is clear that experts' opinions related to the importance and priority of each state on others are reflected by the membership function. Similarity degree of *R* and *L* indicates how much experts' opinions correspond on customers' needs. There are few formulas to determine the similarity degree between two fuzzy sets. This study uses the dot product based on Euclidean inner formulated by Biswas (1995) as follows:

$$SD(\tilde{R},\tilde{L})=\frac{\tilde{R}.\tilde{L}}{\max(\tilde{R}.\tilde{R},\ \tilde{L}.\tilde{L})}$$

Where $\tilde{R}$ and $\tilde{L}$ are fuzzy sets in the reference set X and defined as follows:

$$\tilde{R}=\langle \mu_R(x_1),\mu_R(x_2),...\rangle,\ \tilde{L}=\langle \mu_L(x_1),\mu_L(x_2),...\rangle$$

$\tilde{R}$ and $\tilde{L}$ are vectors and $X=\{x_1,x_2,x_3,...\}$ represents the respected product(s). Finally, sets or products are grouped based on their similarity degree values. Thus, it is possible one or more states are grouped in the same class or rank. Similarity degree values are between zero and one.

Case study

In recent years in Iran many banks have tried to expand their financial services especially in providing credit cards services as one of the most significant financial services. Credit cards service is one of effective motivating marketing tools for attraction of new customers. Although expansion of credit cards services has been started through some years, but an academic research on these services presented in Iran has not been performed. Therefore, in this paper, we are looking for the best combination of attributes and levels of credit cards from the point of view of customers of one of private banks in Iran. The results of this research can help banks in better design of credit cards and increase of their market share.

Attributes and levels for credit cards

To apply conjoint analysis firstly we should define attributes as well as levels of attributes. Attributes should be those unique properties of products which are considered in the ranking process by customers. Therefore, defining attribute categories need so many considerations. These attributes which are considered in CA should be the same as those which are of great importance for the potential customers in the competitive market. After investigation and determination of the attributes, another important point is the precise definition of the range of definable levels for each attributes. The defined levels of each attribute should be large enough to consumers can distinguish them. On the other hand, these attributes should be small enough to be believable (Green and Srinivasan, 1978). According to the research done by Quester and Smart (1998), to CA results to be reliable, the precise and real definition of the attributes is absolutely necessary. Defining up to 5 attributes with 3 levels for each of them can be an appropriate design (Kucher and Hilleke, 1993). In the literature, to evaluate the desirability of utility of credit cards and select the best combination of levels, the following attributes have been chosen as the main ones: credit card brand, credit ceiling, annual expenditure, annual percentage rate credit use and fees (Allenby et al., 1995; Kara et al., 1994; Orme and King, 1998). Therefore, regarding to the literature, the opinions of the bank experts, and also the existing legal regulation on credit cards, attributes and their definable levels for the credit cards are defined as follows:

1. Credit ceiling: this is defined as the maximum amount which is determined by the bank through a process of credit validation. Cardholders are only allowed to buy and be in debt up to the credit ceiling. Banks usually consider the amount of deposits as an important factor to set the credit ceiling. Thus, definable levels for this attribute are 80, 60 and 40% of total amount of deposit.
2. Period of purchase: this is the regular time interval from the issue date of card. The definable levels for this attribute are 30, 45, and 60 days.
3. Penalty rate: If customers refuse to pay the debt through the statement period, bank would charge for each day of delay in paying off. Definable levels for this attribute are 6 and 10%. It should be noted that these levels are not the same in different banks.

Table 1. Attributes and their respected levels for the credit cards case study based on experts' opinions.

Attribute Levels	Credit ceiling (% deposit)	Period of purchase (Days)	Penalty rate (%)
1	80	30	6
2	60	45	10
3	40	60	

Table 2. All possible states

States Name	Credit ceiling (% deposit)	Period of purchase(Days)	Penalty rate (%)
R1	80	30	6
R2	60	60	10
R3	40	30	6
R4	80	30	10
R5	60	60	6
R6	40	30	10
R7	80	60	6
R8	60	30	10
R9	40	60	6
R10	80	60	10
R11	60	30	6
R12	40	60	10

In this research, according to opinions of experts in the Eghtesad-Novin bank (including some staffs in the marketing service management department and customer relation management department), following attributes and levels for more studies are selected. These attributes and levels are presented in Table 1.

As can be observed in Table 1, the number of all possible states for designing the credit cards with determined attributes and levels in Table 1 is 3×3×2=12 are shown in Table 2.

Data gathering tool

The data gathering tool in this research is full-profile based questionnaire. Customers are questioned about all possible 12 states. A sample questionnaire has been provided in the Appendix. The questionnaire includes four general questions and 12 states which are designed in one page. The first three questions focus on gathering the demographic data about answerers. The forth question includes 12 states. Each of these states consists of 7 linguistic variables 'very strongly agree', 'strongly agree', 'agree', 'indifferent', 'strongly disagree', 'very strongly disagree' that answerers have to select one of these variables in each choice.

Sample size

Based on literature review of different applications of CA (Griffin and Hauser, 1993), for understanding 90 to 95 percent of customer requirements related to the product, 20 to 30 questionnaires or direct interviews with customers are required. Most studies are limited to 5 to 17 interviews (Pullman et al., 2002). For example, in a paper entitled "Conjoint analysis as a new methodology for Korean typography guideline in Web environment", 12 people's opinions were used (Myung, 2003). The statistical population of current research is set of customers of Eghtesad-Novin Bank in Tehran, capital of Iran. Also, 40 branches of this bank are selected as sample and required information is collected by customers of these branches.

Evaluating validity of research tools

Before distributing the questionnaires and gathering customers' opinions, the validity of questionnaires was confirmed by a group of experts at managing banking efforts department of Eghtesad-Novin Bank. As mentioned, this group is a combination of staffs in management of banking service, marketing department and bank's customer relationship management department.

RESULTS

Gathering customers and experts' opinion

The purpose of this phase is to rank different states of presenting credit card services to Bank customers and valuation of levels and degree of importance of each attribute. Among 40 distributed questionnaires, 16 customers refused to answer and remaining 24 customers answered the questionnaires. Biswas (1995) used 23 questionnaires to rank and evaluate students' performance by means of fuzzy CA approach. Also, recently, Song et al. (2009) used 15 questionnaires to classify internet protocol television (IPTV) services in Korea by

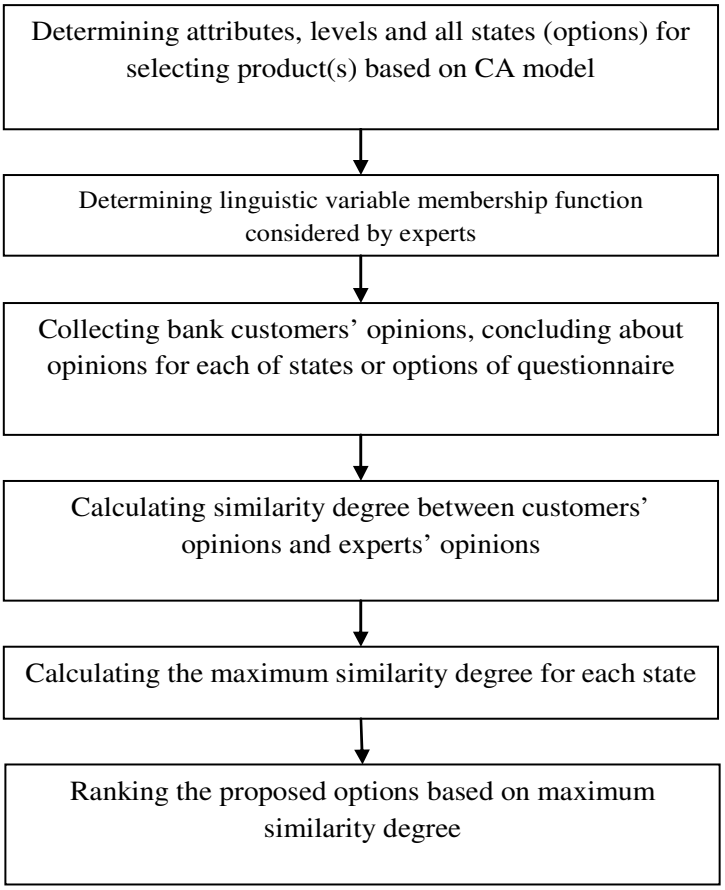

Figure 2. Procedure of ranking the proposed states.

using CA model. Thus, 26 questionnaires seem to enough for information analysis and ranking.

Applying fuzzy conjoint analysis

The proposed steps of applying fuzzy CA method are depicted in Figure 2 and their explanations are briefly as follows:

Step 1: *Determining attributes, levels and all states to select a product or individual products based on CA model.* Tables 1 and 2 show the results of Determining attributes, levels and all states respectively.

Step 2: *Determining the membership function for linguistic variables considered by experts:* Most of previous research related to this step includes 5 to 7 linguistic variables that vary based on nature of problem and experts' opinions. In this study, 7 linguistic variables are defined as L_k = {very strongly agree, strongly agree, agree, indifferent, disagree, strongly disagree, and very strongly disagree}. The fuzzy sets represented for each linguistic value, L_k (k= 1, 2, 3, 4, 5, 6, 7) are defined as follow according to opinions of chief experts in the Eghtesad-Novin Bank.

The membership functions for linguistic variables are as follows:

L1: the first linguistic variable, very strongly agree.

$$L_1 = \left\{\frac{1}{1}, \frac{0.8}{2}, \frac{0.5}{3}, \frac{0.2}{4}, \frac{0}{5}, \frac{0}{6}, \frac{0}{7}\right\}$$

L2: the second linguistic variable, strongly agree.

$$L_2 = \left\{\frac{0.7}{1}, \frac{1}{2}, \frac{0.6}{3}, \frac{0.4}{4}, \frac{0}{5}, \frac{0}{6}, \frac{0}{7}\right\}$$

L3: the third linguistic variable, agree.

$$L_3 = \left\{\frac{0.4}{1}, \frac{0.6}{2}, \frac{1}{3}, \frac{0.6}{4}, \frac{0.4}{5}, \frac{0}{6}, \frac{0}{7}\right\}$$

L4: the forth linguistic variable, indifferent

$$L_4 = \left\{\frac{0}{1}, \frac{0.3}{2}, \frac{0.7}{3}, \frac{1}{4}, \frac{0.7}{5}, \frac{0.3}{6}, \frac{0}{7}\right\}$$

Table 3. The customers' opinions related to proposed states.

	L1	L2	L3	L4	L5	L6	L7	$\sum_{i=1}^{7} L_i$
R1	5	6	12	3	0	0	0	26
R2	0	5	8	7	3	2	0	25
R3	0	0	5	5	5	6	3	24
R4	0	1	4	17	4	0	0	26
R5	6	5	6	7	1	1	0	26
R6	0	1	2	1	7	6	8	25
R7	17	6	3	0	0	0	0	26
R8	0	2	1	10	8	4	0	25
R9	1	2	7	6	3	6	1	26
R10	2	9	10	4	1	0	0	26
R11	1	2	9	8	3	2	0	25
R12	0	0	1	11	3	7	4	26

L5: the fifth linguistic variable, disagree.

$$L_5 = \left\{\frac{0}{1}, \frac{0.2}{2}, \frac{0.4}{3}, \frac{0.6}{4}, \frac{1}{5}, \frac{0.6}{6}, \frac{0.4}{7}\right\}$$

L6: the sixth linguistic variable: very disagree.

$$L_6 = \left\{\frac{0}{1}, \frac{0}{2}, \frac{0}{3}, \frac{0.4}{4}, \frac{0.6}{5}, \frac{1}{6}, \frac{0.7}{7}\right\}$$

L7: the seventh linguistic variable, very strongly disagree.

$$L_6 = \left\{\frac{0}{1}, \frac{0}{2}, \frac{0}{3}, \frac{0.2}{4}, \frac{0.5}{5}, \frac{0.8}{6}, \frac{1}{7}\right\}$$

Step 3: *Collecting bank customer's opinions, concluding about combination of attributes for each of states in the questionnaire:* In this step, all collected questionnaires are analyzed and bank customer's opinions related to each of proposed states existed in questionnaires are mentioned regarding to the selected linguistic variable. For instance, in 26 collected questionnaires, for the first option (R1), 5 customers had chosen very strongly agree (L1), 6 had chosen strongly agree (L2), 12 had selected agree (L3), and finally 3 customers had chosen indifferent (L4).

According to Table 3, related to the first state, none of customers had chosen disagree (L5), very disagree (L6) or very strongly disagree (L7). This also, can be observed for other states.

The fuzzy weighted vectors for 2 states out of 12 states can be calculated by following equations:

$$R_1 = (\frac{5}{26}, \frac{6}{26}, \frac{12}{26}, \frac{3}{26}, 0, 0, 0) \quad ; \quad R_2 = (0, \frac{5}{25}, \frac{8}{25}, \frac{7}{25}, \frac{3}{25}, \frac{2}{25}, 0)$$

The same computing procedure is done for other states. Summary of computational results are shown in Table 4.

Step 4: *calculating the similarity degree values between customers' opinions and bank experts' opinions:* In this step, values of similarity degree between fuzzy sets *R* and *L* are computed by CA model of Turksen and Willson (1994). Similarity degree values among all possible pair wise comparisons of *R* and *L* are calculated by following equation:

$$SD(\tilde{R}_i, \tilde{L}_j) = \frac{1}{1 + \sqrt{\sum_{j=1}^{N} (\mu_{R_i} - \mu_{L_j})^2}}; j = 1,...,N, \forall i = 1,..,M$$

μ_{R_i} : Membership function of fuzzy set *R*, μ_{L_j} : Membership function of fuzzy set *L*, *N*: Number of members in linguistic variable vector and *M*: Number of members in state.

Values of similarity degree for all pairwise comparisons are reflected in Table 5.

Step 5: *Computation of maximum amount of similarity degree for each states:* With having the values of similarity degree between fuzzy sets *L* and *R*, maximum similarity degree (MSD) value can be obtained which represents the maximum closeness of experts and customer's opinions to each other. The similarity degree values are mentioned in Table 6.

Step 6: *Ranking proposed states based on maximum similarity degree values calculated in step5*: Ranking can be presented by considering the maximum similarity degree among all states. The results of ranking of proposed states in this case study are shown in Table 7.

Table 4. Output fuzzy vectors of different proposed states.

	L1	L2	L3	L4	L5	L6	L7
R1	0.192308	0.230769	0.461538	0.115385	0	0	0
R2	0	0.2	0.32	0.28	0.12	0.08	0
R3	0	0	0.208333	0.208333	0.208333	0.25	0.125
R4	0	0.038462	0.153846	0.653846	0.153846	0	0
R5	0.230769	0.192308	0.230769	0.269231	0.038462	0.038462	0
R6	0	0.04	0.08	0.04	0.28	0.24	0.32
R7	0.653846	0.230769	0.115385	0	0	0	0
R8	0	0.08	0.04	0.4	0.32	0.16	0
R9	0.038462	0.076923	0.269231	0.230769	0.115385	0.230769	0.038462
R10	0.076923	0.346154	0.384615	0.153846	0.038462	0	0
R11	0.04	0.08	0.36	0.32	0.12	0.08	0
R12	0	0	0.038462	0.423077	0.115385	0.269231	0.153846

Table 5. Values of similarity degree between states R and linguistic variables L.

	L1	L2	L3	L4	L5	L6	L7
R1	0.501383	0.50628	0.518409	0.453432	0.427664	0.401126	0.402864
R2	0.456315	0.472776	0.503859	0.493	0.465956	0.432365	0.426265
R3	0.423854	0.426935	0.457007	0.47581	0.494176	0.485871	0.478511
R4	0.418852	0.434123	0.471034	0.515252	0.464123	0.42848	0.414877
R5	0.494379	0.495821	0.496305	0.465163	0.442602	0.421481	0.418165
R6	0.413127	0.411221	0.426509	0.437281	0.488544	0.504842	0.519135
R7	0.557147	0.501788	0.450002	0.395109	0.393189	0.387435	0.379142
R8	0.420578	0.428556	0.455931	0.499004	0.5	0.468987	0.450317
R9	0.444429	0.450426	0.476945	0.48031	0.476118	0.460848	0.375199
R10	0.491847	0.510503	0.515775	0.461695	0.435996	0.406064	0.374524
R11	0.449919	0.46102	0.503447	0.49841	0.467175	0.43328	0.426049
R12	0.413621	0.419568	0.437892	0.47498	0.482776	0.491801	0.477454

Table 6. Maximum similarity degree based on Turksen and Willson's (1994) method.

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
MSD	0.5184	0.5039	0.4942	0.5153	0.4963	0.5191	0.5571	0.5000	0.4803	0.5158	0.5034	0.4918
L	Agree	Disagree	Disagree	Indifferent	Agree	Very strongly disagree	Very strongly agree	Disagree	Indifferent	Agree	Agree	Very disagree

Table 7. Ranking of proposed states based on Turksen and Willson's (1994) method.

R		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
Ranking	Turksen and Willson (1994)	2	2	9	7	2	12	1	9	7	2	2	11

As can be seen in Table 7, the seventh state (credit ceiling up to 80% of total deposits; time of pay off: 60 days; penalty rate: 6%) has the best rank. Also, states 1, 2, 5, 10, and 11 are ranked as the second. The worst state is the sixth state (credit ceiling: up to 40% of total deposit; time of pay off: 30 days, penalty rate: 10%) in this ranking. It can be observed that some states are placed in one class due to fuzzy nature of the proposed model. Since input parameters of model are fuzzy variables, output of proposed model (rankings) would be fuzzy

Table 8. Similarity degree values between states (R) and linguistics variables (L).

	L1	L2	L3	L4	L5	L6	L7
R1	0.325389	0.341791	0.365686	0.236574	0.145192	0.023881	0.012435
R2	0.194819	0.250746	0.321569	0.311111	0.242308	0.131343	0.093264
R3	0.076166	0.104478	0.205882	0.268056	0.299038	0.274129	0.24715
R4	0.122798	0.19403	0.305882	0.403704	0.292308	0.174129	0.106218
R5	0.285492	0.297015	0.30098	0.244444	0.171154	0.085572	0.054922
R6	0.041451	0.051741	0.117647	0.174074	0.296154	0.322388	0.341969
R7	0.463212	0.376617	0.253922	0.070833	0.045192	0	0
R8	0.084974	0.131343	0.223529	0.335185	0.330769	0.254726	0.190674
R9	0.147668	0.1801	0.254902	0.275926	0.257692	0.20995	0.170984
R10	0.300518	0.345274	0.356863	0.254167	0.169231	0.041791	0.025907
R11	0.180311	0.224876	0.32549	0.325926	0.25	0.139303	0.097409
R12	0.053886	0.095522	0.166667	0.283796	0.293269	0.30597	0.264249

in nature.

Validation

Validation and verification of a solving method needs the comparison of its results with results of well-known approaches in the literature. In the case study, the fuzzy CA developed by Turksen and Willson (1994) method was used to rank different sort of credit card services of Eghtesad-Novin Bank. But, there are different methods in the literature related to ranking which here, two of them, Biswas's (1995) approach and Wang's (1997) approach, are selected for validation of proposed model. As Turksen and Willson (1994) method, Similarity degree values between two fuzzy sets are the basis of Biswas's (1995) and Wang's (1997) approaches.

Biswas's approach

Based on Biswas's Approach and equation 3, values of similarity degree of pairwise comparisons are calculated, and are represented in Table 8.

Also, values of maximum similarity degree in Biswas's (1995) method are mentioned in Table 9.

Results of ranking of proposed states in this case study are mentioned in Table 10. Based on Table 10, the seventh state (credit: up to 80% of total deposit, time of pay offs: 60 days, penalty rate: 6%) has the best rank. Also, states 1, 2, 5, and 10 are of the second rank. The worst state is the sixth one (credit: up to 40% of total deposit, time of pay off: 30 days, penalty rate: 10%)

Wang's approach

Similarity degree values between fuzzy sets *R* and *L* based on Wang's (1997) method are calculated by following equation:

$$SD(\tilde{R}_i, \tilde{L}_j) = \frac{\sum_{j=1}^{7} (1 - \left| \mu_{R_i} - \mu_{L_j} \right|)}{N}; j = 1,...,N, \forall i = 1,..,M$$

Where, μ_{R_i} and μ_{L_j} represent the membership function of fuzzy sets R and L, respectively. Also, *N* and *M* are the number of members in the vector of linguistic variables and the number of members in the vector of state.

Similarity degree values of pairwise comparisons based on above equation for this case study are presented in Table 11. Maximum values of similarity degree are stated in Table 12.

Results of proposed ranking of this study are mentioned in Table 13. Based on this Table 13, the first state (credit ceiling: up to 80% of total deposits; time of pay off: 30 days; penalty rate: 6%), the fifth state (credit ceiling: up to 60% of total deposit; time of pay off: 60 days; penalty rate: 6%), the seventh one (credit ceiling: up to 80% of total deposits; time of pay off: 30 days; penalty rate: 6%) and the tenth one (credit ceiling: up to 80% of total deposits; time of pay off: 60 days; penalty rate: 10%) have the best ranks.

The worst states are the third (credit ceiling: up to 40% of total deposits; time of pay off: 30 days; penalty rate: 6%) and the sixth state (Credit ceiling: up to 40% of total deposits; time of pay off: 30 days; penalty rate: 10%).

Comparison of 3 ranking approaches of different states is shown in Figure 3.

Examination of ranking correlation obtained by Turksen and Willson (1994), Biswas (1995), and Wang (1997) methods

For comparing results and to check the accuracy of the Turksen and Willson's (1994) method, a non-parametric inference method such as Spearman rank correlation test is used. To be more specific for each state, the statistical

Table 9. Maximum similarity degree based on Biswas's (1995) method.

R	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
MSD	0.3657	0.3216	0.2990	0.4037	0.3010	0.3420	0.4632	0.3352	0.2759	0.3569	0.3259	0.3060
L	Agree	Agree	Disagree	Indifferent	Agree	Very strongly disagree	Very strongly agree	Indifferent	Indifferent	Agree	Indifferent	Very disagree

Table 10. Ranking of proposed states based on Biswas's (1995) method.

R		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
Ranking	Biswas (1995)	2	2	10	6	2	12	1	6	6	2	6	11

Table 11. Similarity degree between states (R) and linguistic variables (L) based on Wang's (1997) method.

	L1	L2	L3	L4	L5	L6	L7
R1	0.785714	0.757143	0.714286	0.66	0.605714	0.505714	0.534286
R2	0.705714	0.7	0.691429	0.714286	0.685714	0.608571	0.614286
R3	0.615714	0.59	0.607143	0.678571	0.687143	0.698571	0.724286
R4	0.612857	0.641429	0.698571	0.712857	0.67	0.63	0.601429
R5	0.742857	0.734286	0.702857	0.648571	0.62	0.571429	0.58
R6	0.545714	0.517143	0.554286	0.622857	0.685714	0.722857	0.751429
R7	0.785714	0.757143	0.642857	0.528571	0.491429	0.471429	0.5
R8	0.591429	0.62	0.668571	0.714286	0.685714	0.722857	0.694286
R9	0.667143	0.647143	0.638571	0.692857	0.675714	0.647143	0.667143
R10	0.774286	0.745714	0.714286	0.677143	0.62	0.525714	0.554286
R11	0.694286	0.7	0.691429	0.702857	0.674286	0.62	0.614286
R12	0.568571	0.597143	0.594286	0.671429	0.685714	0.74	0.711429

significance of the difference between the ranking obtained by Turksen and Willson's (1994) and each of two other ranks obtained by Biswas (1995) and Wang (1997) methods is determined using Spearman's rank correlation test. Spearman test evaluates the similarity of the rankings of the different states. In the Spearman test, to examine the null hypothesis a test statistic, Z, is calculated using Equations (6) and (7) and compared with a pre-determined level of significance, α value. The null hypothesis is "The rankings are not similar". By considering level of significance α equal to 0.05, critical Z value will be 1.645. If the test statistic computed by Equation (7) exceeds 1.645, the null hypothesis is rejected and we can conclude that alternate hypothesis which is "The two rankings are similar" is true (IC and Yurdakul, 2010).

$$r_s = 1 - \left[\frac{6.\sum_{j=1}^{k}(d_j)^2}{K.(K^2-1)}\right] \quad (6)$$

$$Z = r_s\sqrt{(K-1)} \quad (7)$$

In Equation (6) and (7), d_j is the ranking difference of states j in different methods and K is the number of states. r_s represents the Spearman rank correlation coefficient in Equations (6) and (7). The rankings obtained by the Turksen and Willson's (1994) and two other methods (Biswas (1995) and Wang (1997) methods) are provided in Table 14.

The calculated Z-values, 2.992 and 2.876, are higher than 1.645, which indicates that the difference in ranking results is statistically insignificant. Based on the test results, it can be concluded that the ranking of credit cards states, obtained by Turksen and Willson's (1994) method are reliable and results can be used by the bank in their credit card design process.

Conclusion

There are various methods for measurement and evaluation of customers' utility value about a typical product or service. One of the most common methods is CA. This paper examines the customers' satisfaction on different levels of credit cards of one of private banks in Iran. The applied approach for data collection and analysis is fuzzy preference. Fuzzy numbers have been used because

Table 12. Maximum similarity degree based on Wang's (1997) method.

R	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
MSD	0.7857	0.7143	0.7243	0.7129	0.7429	0.7514	0.7857	0.7229	0.6929	0.7743	0.7029	0.7400
L	Very strongly agree	Indifferent	Very strongly disagree	Indifferent	Very strongly agree	Very strongly disagree	Very strongly agree	Very disagree	Indifferent	Very strongly agree	Indifferent	Very disagree

Table 13. Ranking of proposed states based on Wang's (1997) method.

R		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
Ranking	Wang (1997)	1	5	11	5	1	11	1	9	5	1	5	9

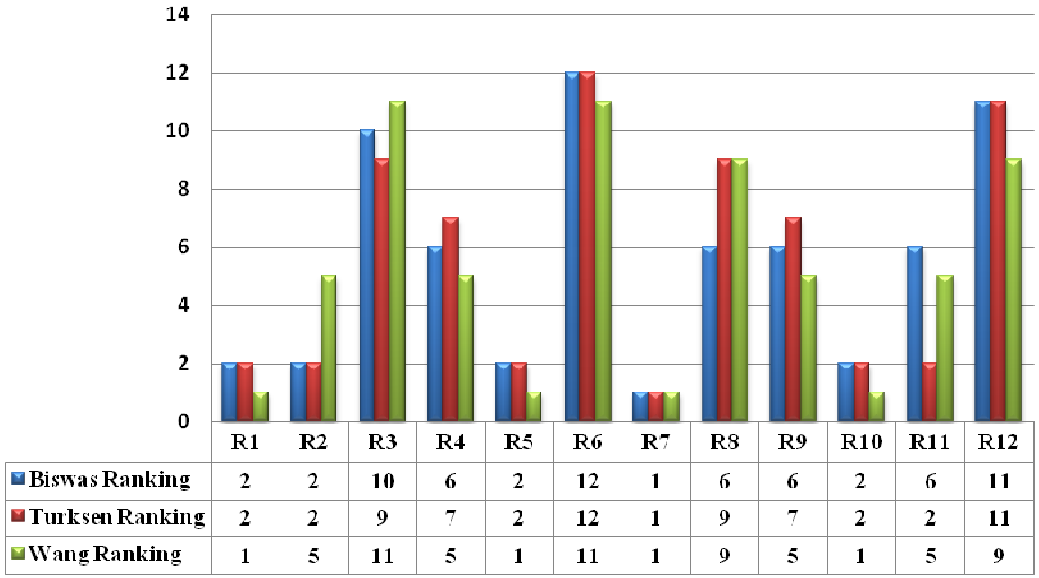

Figure 3. Comparison of three proposed ranking approaches.

with this type of numbers, customers and experts can state their opinions about each combination of attribute levels (states). The method estimated the structure of consumers' preferences, given their overall evaluations of a set of options that are prespecified in terms of levels of different attributes.

The result of this paper based on Turksen and Willson (1994) method showed that the credit cards with credit ceiling up to 80% of total deposits; time of pay off: 60 days; penalty rate: 6% has the best rank. Also, states 1, 2, 5, 10, and 11 are ranked as the second.

To validate results of this study, results are compared to other similar method in literature,

Table 14. Determination of the significance of the difference between the Turksen and Willson's (1994) method and Biswas (1995) and Wang (1997) methods.

States	Turksen and Willson's (1994) method	Biswas's (1995) method	Wang's (1997) method	d_j	d_j
	method 1	method 2	method 3	method 1,2	method 1,3
R1	2	2	1	0	1
R2	2	2	5	0	-3
R3	9	10	11	-1	-2
R4	7	6	5	1	2
R5	2	2	1	0	1
R6	12	12	11	0	1
R7	1	1	1	0	0
R8	9	6	9	3	0
R9	7	6	5	1	2
R10	2	2	1	0	1
R11	2	6	5	-4	-3
R12	11	11	9	0	2
			r_s	0.902	0.867
			Z	2.992	2.876

Biswas (1995) and Wang (1997) method. Based on Biswas's (1995) method the best state is similar to Turksen and Willson (1994) method and states 1, 2, 5, and 10 are of the second rank but based on Wang's (1997) method, the first state (credit ceiling: up to 80% of total deposits; time of pay off: 30 days; penalty rate: 6%), the fifth state (credit ceiling: up to 60% of total deposit; time of pay off: 60 days; penalty rate: 6%), the seventh one (credit ceiling: up to 80% of total deposits; time of pay off: 30 days; penalty rate: 6%) and the tenth one (credit ceiling: up to 80% of total deposits; time of pay off: 60 days; penalty rate: 10%) have the best ranks.

The validation showed that results based on Turksen and Willson (1994) in compare to Biswas's (1995) and Wang's (1997) methods are not statistically significant in $\alpha = 0.05$ and results are reliable. For the future research reconsidering the assumption in this research and formulate and prepare problem to apply other different methods like the fuzzy regression or the fuzzy LINMAP method and compare the results with current result could be useful.

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