

# Developing a model to measure customers' desire to use electronic insurance services by Fuzzy inference system

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**Abstract**— Using information technology to provide insurance services is considered as electronic insurance services. Since the quality of electronic services is one of the most important factors which lead to customer interest, and also one of the most important changes which happened in the field of quality improvement attitudes is the measurement of customer desire, in the present research we have considered the customer desire to use electronic insurance services by study the quality of electronic services. Because of lack of comprehensive factors to measure various aspects of electronic insurance services we identified these factors by designing questionnaire. After identification and classification of the factors which include quality of provided electronic services, reliability and ease of services usage, accessibility to information, accountability, they are placed as fuzzy sets in fuzzy inference system. After determining the membership functions by Matlab software and 25 fuzzy sets written by four experts in insurance information technology, fuzzy inference system is designed for Iran insurances as a general mode which has the capability to measure desire of all electronic insurance companies. For validation, one other branches of electronic services was studied by the aid of questionnaire.

**Index Terms**— electronic insurance, electronic services, fuzzy inference system, fuzzy logic.

## I. INTRODUCTION

Many industries and businesses have significant progress in using new technologies such as electronic phenomenon. From among them we could refer to service activities such as tourism and banking. Insurance Global Industry is one of the industries which has potential power in using new technologies and phenomenon and has had a good progress in this regard. Electronic trade is the main result of using information and communication technology in economic fields. One of the applications of electronic trade in insurance industry is electronic insurance. From benefits of using electronic insurance for customers we could refer to their access to related, inter-organizational information [1]. Other benefits of electronic insurance which encourage the insurance companies to use them are: ease of making change in insurance conditions, decreased barriers in entering the market, improve insurance relations between companies and their agencies, ability to provide better and faster services

with lower costs, increased market share because of low costs, improving services by liquidating the losses on time, continuous services (24hours), expanding existed information

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about prices' comparison and information about goods, decreased boundary limitations and shortening accountability time. Therefore, research regarding electronic insurance services is necessary and vital. One of most important changes which happened in the field of quality improvement insights is the subject of measuring customer desire as one of the main requirements of quality management regimes in all institutes and business agencies. The abundant attempt which has done for improving quality management tools and expanding customer oriented culture by organizations' researchers, managers and experts are all indicate that now customer desire, in general view, is the most important factor in determining organizations' success and improving the profitability [2]. Style of service providing, services' qualities and properties which could be considered regarding electronic insurance from one hand have direct relation with rate of customers' desires and tendency to use these services, and on the other hand affect rate of electronic insurance customers' satisfaction and royalty [3]. Because in the present research desire index is considered and electronic services quality is one of the important factors which lead to customer desire, so first we identify the effective indices on electronic insurance services quality based on study of past researches and articles and using experts point of views. Then we propose a Fuzzy inference system for evaluating and measuring the rate of customers' desires to use electronic insurance services. By now there are many researches about identification of electronic services qualities. In most researches which have done in the recent years, efficiency, web site design, information quality, reliability, privacy, system access, personalization, accountability, and trust are selected as the aspects of electronic services quality. But we could pay attention to the point that the importance of electronic services quality based on the type of industry which uses this could be changed. There are several methods and models for identifying quality aspects of electronic services which are: Shanon entropy, web-qual model, site-qual model, and E-qual model. In contrast to several articles about selection of electronic services in big industries such as banks and agency companies, there was no research in the field of selection of electronic insurance services by now. The reason of using Fuzzy inference system among various types of fuzzy methods is its intelligence. Intelligence is means that it has a similar behavior such human beings and also it considers defined rules simultaneously and this is the act which human perform in everyday activities. Entrance of fuzzy inference system is the score of each factors of electronic services quality measurement which obtained by averaging. This system catches the inputs and after some actions on them and written rules, it delivers the output (which is customers' desire to use electronic insurance services). This article has been organized in four main parts. In the second part (research literature) we discuss about history of electronic services

selection provided in this regard. In the third part we have provided the recommended model and in the fourth part we have provided case study.

### 1. Research literature

Today with increasing growth of global development of electronic trade, businesses more and more try to interact with customers with providing electronic services and obtain their competitive benefits [4], In order to maintain their situation and improve it by customer satisfaction. Such pressures forced the companies to invest in providing better electronic services. Insurance industry is one of the industries which have progressed using new technologies and phenomenon. Regarding to the fact that criterion has used in electronic services selection and used method is very important, research history was studied from two used criteria view and applied method.

#### 1.1. Criterion selection

This section includes some researches which handled effective aspects on electronic services quality: Luie Kono et.al in 2002 [5] divided the aspects of electronic services to 12 aspects and provided a tool called Web qual. They paid more attention to user media quality more than other aspects. Aspects of Web-qual are as the follow: worthy of duty, worthy of communications, trust, reaction time, ease of perception, witnessed operational, visual attraction, being innovative, emotional attraction, compatible image, being complete on line, relative benefit. Yoo and Donthu in 2001[6] explained the site-Qual scale for evaluating electronic services quality. They introduced four aspects for evaluation of electronic services quality: ease of usage, design beauty (site creativity by using colored and multimedia graphics), time of process completion (completion of in line processes without interruption and interactional answer to customers' request), and security of personal and financial information. Zeithaml and Parasurman in 2002 [7] were introduced the E-SERV QUAL scale as a parameter which includes seven aspects of efficiency, reliability, implementation, personal privacy, accountability, compensation and contact which formed a main scale and a services recovery scale. They pointed that four aspects of efficiency, reliability, implementation and personal privacy were formed the main scale of E-SERV-QUAL. The main scale is related to the time that users encounter with no problem in using the site. Three other aspects, accountability, compensation and contact create recovery scale for E SERV QUAL. Recovery scale is related to the time when users have some problems in using the site. Wolfenbarger and Gilly in 2002 [8] decreased the electronic services quality scale into four aspects by means of interview using the focused group method and field researches: web site design, reliability, keeping personal secrets/security, give service to customers which are the base of on line services quality and web site design and they include applicability in time saving, easy transaction, suitable choice, deep information and personalizing suitable level. Madu and Mhdu in 2002 [9] introduced fifteen aspects of performance, properties, structure, beauty, reliability, saving capability, service capability, system security and integrity, trust, accountability, service, diversity and personalization, web saving politics, reputation and honor, guarantee and consensus for electronic service selection. Lee and Lin in

2005 [4] introduced the aspects of web site design, reliability, accountability, trust and personalization based on traditional model of SERV QUAL for transparency of comparative factors of online services quality. They studied the relation between electronic services quality, services' general quality and customers' satisfaction. With regard to their researches, trust is the most important factor for service quality and customer satisfaction and after that is reliability and accountability. Web site design was placed after them. Finally this subject wondered them that personalization was placed in the last position as the least effective factor. Ahmad Afkhami [10] in a research named web site effect on customer satisfaction in electronic insurance found that quality of electronic services such as ease of use, information quality, reaction time, visual image, accountability, and trust have positive effect on customers' satisfaction

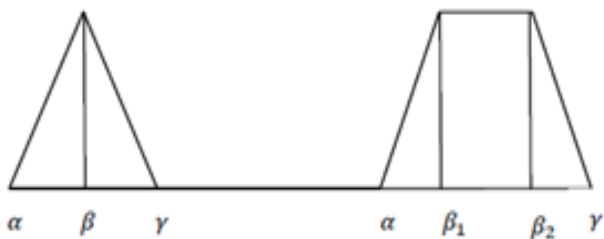
#### 1.2. Methods

Amiri [11] proposed some alternatives for improving banks' electronic services using BSC, Fuzzy ANP and Fuzzy TOPSIS strategies. The aim of this research is to study the quality of provided electronic services in governmental banks of Fars Province, and to provide service improvement solutions. For these purpose electronic services evaluation indices were identified based on research literature and Fuzzy ANP was used for measuring the importance of indices. For improving banks' performance twenty solutions have suggested which the most important is measurement of task progress rate and continuous supervision. Mohammadi (2012) [12] evaluated the effective factors on electronic royalty in the organization which provide electronic services using Fuzzy AHP. This research identifies the effective factors on customers' royalty in electronic services for the organization provided electronic services which are as the follow: customer satisfaction, trust, mental image, brand reputation, online communication, switching cost, quality of received service, value of received service, and service properties. Sajedi Far [13] identified the most important aspects of electronic services quality in agency companies. By means of questionnaire they received the opinions of 22 experts of financial and university services industry about importance of each identified aspects and then the Shanon entropy was used. Akhter in 2014 [14] provided the usage of Fuzzy inference for people reasoning about electronic trade transaction. Also he proposed some hidden relations between critical factors such as security, familiarity, designing, and competition. He expressed that in this research effect of mentioned factors on people decision making process and effect of people on the result of customer-institute electronic trade were analyzed. One study is performed a research named rating electronic banking challenges from customers' and banking regime managers' point of view using process of Fuzzy hierarchical analysis. Results of this research showed that from banking regime managers' point of view, the most important challenges of electronic banking are keeping personal information and customers' privacy, internet security, and customers' trust. While from customers' point of view the most challenges of future electronic banking are bank reputation, access to rules and provisions of moment electronic banking, providing easier, more diverse and faster services, and bank's trustfulness. Mamadani and Asilian in 1975 [15] have used Fuzzy inference to control a steam motor

and boiler using human configuration of language control rules in experiments of operators of system existence. A system that formulates a map from input to output using Fuzzy inference named Fuzzy inference system, it also called as a system based on If- Then rules.

• Fuzzification

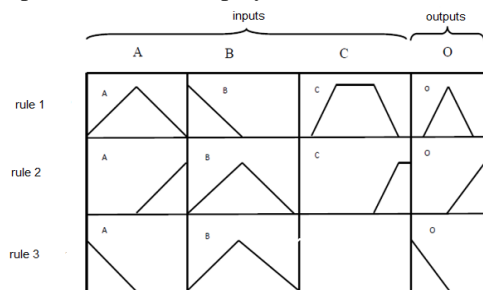
In this stage we consider membership functions for each input variable in order to convert definite inputs into Fuzzy ones and being placed in Fuzzy inference system. Membership functions have different types, such as triangular, trapezoidal, aural, and ..., that in this research we have used triangular type.



Shape 2: trapezoidal and triangular membership functions

• Rules base

Rules base referred to a set of Fuzzy “If – Then” which form the heart of Fuzzy inference system. There are two main methods to determine Fuzzy rules: one is suing expert’s knowledge and the other is using trainings such as new algorithm and neural network, that in this research we have used the first method to determine Fuzzy rules. A rule of If-Then was defined as “If x equals to A, then Y equals to B; that x and Y are input and output variables and A and B are language values (membership function) written for these variables. It is noteworthy that in Mamadani approach, the output was defined as Fuzzy form. Section of “If x equals to A”, is prior section or assumption and section of “Then Y equals to B” is result or consequent section. Figure 2 shows several rules. As it has been shown in figure 3, rules 1 and 2 have three priorities, but rule 3 has two priorities. Number of priorities and results are determined regarding expert’s opinion. Table 1 displays the written form of rules base.



Shape 2: three fuzzy rules

Table 1: description of shape 3

			operator		operator			
rule 1	if	A is A2	and	B is B1	and	C is C2	then	O is O2
rule 2	if	A is A3	and	B is B2	and	C is C3	then	O is O3
rule 3	if	A is A1	and	B is B2			then	O is O1

• Fuzzy inference motor

Performance of fuzzified inference motor is the process of human reasoning, so that with applying it on inputs and rules we could determine the output and his is the same humans apply in many of their judgments [16]. In fact task of Fuzzy inference motor is that place the output of indication process, which as a list of sets, as input in society process. In this process the resulted output is a unit Fuzzy set. This Fuzzy set enters defuzzify process and out desired output was obtained which is an absolute number.

• Defuzzification

Defuzzification is a process which converts a Fuzzy set to an absolute number. So the input of a defuzzification process is a fuzzy set (sum of output fuzzy sets) and its output is a number. Since fuzzification helps to valuation in middle stages, final desired output for each variable is just a number. There are different methods for defuzzification such as gravity center, half-maximum, the biggest maximum, and the least maximum; but the most common method is gravity center (Roychowdhury, K. and Pedrycz, 2007) [17]. In the present research we have use gravity center method for defuzzification.

2. Recommended model

Recommended model in this research include two stages and five steps.

• First stage

First step) identification of indices and sub-indices to evaluate electronic insurance services:

In this step 38 indices were extracted to measure electronic insurance services using wide range of articles and research resources and also using experts’ opinions. These are shown in table 2.

Table 2: indices of electronic insurance services measurement

Measurement factor	Measurement index
Information content	.ease of understanding sentences and insurance terms . access to sufficient information about insurance . sufficiency and completion of information contents . common questions’ pages
Customizing/personalizing	. providing information based on customer need . providing personalized insurance services for each customer and based on her/his preferences
Accuracy and ease of services usage	. rate of accuracy and ease of access to provided information

	<ul style="list-style-type: none"> <li>. accuracy and integrity of provided insurance services</li> <li>. ease of insurance operations and access to information</li> <li>. ease of required steps for request and receive insurance services</li> </ul>
Privacy	Keeping personal information of customer Keeping related information to customer received services (customer purchase behavior)
Quality of service	Accuracy and integrity of insurance exchanges Speed of receiving electronic services

	Possibility of complaints record and announce and critique by the customer Rate of insurance interest in receiving feedback from customer (complaints or critiques)
Trust	Rate of honesty of provided insurance information

Second step) evaluation of identified indices in measuring electronic insurance services capabilities using experts' opinions.

To evaluate and determine the provided indices in table 1 from external and conceptual view and consequently extraction of research native model, we asked some questions from insurance experts and specialists. After collecting questionnaires and for studying data distribution status, we have used Kolmogrov – Smirnov test which is one of the accurate tests in SPSS software. Data distribution doesn't follow normal distribution in some indices and in the others it follows the normal distribution. In result we have used bi-sentence test to analyze the results of indices doesn't follow normal distribution and to delete or confirm the indices which are follow normal distribution we have used T test. Regarding bi-sentence test and T test it was confirmed that among 38 identified indices seven items have not capabilities of measuring electronic insurance because tests' meaningfulness level is higher than 0.5 for these indices.

1. Rate of usability of these provided insurance information
  2. Access to sufficient information
  3. Existence of common questions
  4. Providing personalized insurance services for each customer
  5. Recreation or entertainment
  6. Possibility of receiving support services by telephone and email communication
  7. Rate of insurance interest in feedback from customers (either complaint and critique)
- Second stage

Third step) indices classification by means of exploratory factorial analysis

Factorial analysis originally used for decrease or identify the structure. Factorial analysis is a general name for some of multi-variable methods which its main goal is data summarization. This method studies the internal correlation of many variables and finally classifies them in general factors frames. To use 31 confirmed indices by experts in designing research Fuzzy inference system it is needed that confirmed indices being classify by some factors and for ease of research operation indices representatives should be used. First we study the data suitability for factorial analysis. There are different methods for doing that include KMO test. When KMO is less than 0.5, data are not suitable for factorial analysis and if it is between 0.5 - 0.69 we could do factorial analysis with more care but if it is higher than 0.70, existed correlation between data is suitable for factorial analysis In this research KMO is 0.71. Table 3 shows the extracted final factors from factorial analysis along with related indices.

Measurement factor	Measurement index
Website performance	Usability of search operation (rate of search motor capability) Speed of displaying website pages Applicability of existed links in the site
Trust and guarantee	Insurance guarantee in providing electronic insurance services
Availability	Correct and without technical error performance Providing electronic insurance services in 24 hours and without interval
Security	Rate of security sense for insurance operations implementation Rate of following required security properties for doing insurance operation by insurance company
Website design	Rate of user- friendly of website Providing on time information and services related to customers' requests Appropriate organizing and suitable structure of website Rate of accuracy of introduced services and their capabilities High ease of contents search
Recreation and entertainment	Existence of recreation or entertainment more than providing electronic insurance services
System efficiency	Appropriate organization of provided insurance information
Communication	Possibility of receiving support services by online communication Possibility of receiving support services by telephone and e-mail communication
Accountability	Fast and effective answer to complaints



Table 3. The extracted final factors from factorial analysis

Factor name	Index
1. Rate of services' supplier accountability	<ul style="list-style-type: none"> <li>- Fast and effective answer to complaint</li> <li>- Possibility of complaints' record and announce and critique by the customer</li> <li>- Providing information based on customer need</li> <li>- Speed of websites' pages display</li> <li>- Applicability and usability of links in the site</li> <li>- High ease of site contents search</li> <li>- Reliability of financial exchanges</li> <li>- Possibility of receiving support service by online communication</li> </ul>
2. Rate of access to information	<ul style="list-style-type: none"> <li>- Appropriate organization of provided insurance information</li> <li>- Rate of access accuracy to provided information</li> <li>- Capabilities and abilities of search motor</li> <li>- Correct and without technical error performance</li> </ul>
3. Quality of provided services	<ul style="list-style-type: none"> <li>- Speed of receiving electronic services</li> <li>- Accuracy of insurance exchange operations</li> <li>- Providing electronic insurance services without interval</li> <li>- Providing on time information and services</li> <li>- Rate of accuracy of site introduced services</li> </ul>
4. Trust and ease of services usage	<ul style="list-style-type: none"> <li>- Rate of honesty of provided information in website</li> <li>- Ease of sentences' understanding</li> <li>- Insurance guarantee in providing electronic insurance services</li> <li>- Rate of following required security properties for insurance operations by the company</li> <li>- Rate of security sense in doing insurance operations</li> <li>- Keeping customer personal information</li> <li>- Rate of site structure suitability</li> <li>- Exterior and graphic form of website</li> <li>- Keeping related information to customer receive services</li> <li>- Ease of doing insurance</li> </ul>

<ul style="list-style-type: none"> <li>operations and access to information</li> <li>- Rate of ease of required steps for insurance services request and receive</li> <li>- Rate of sufficiency and completion of information contents</li> <li>- Accuracy of provided insurance services</li> <li>- Rate of user – friendly website</li> </ul>
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Fourth step) designing Fuzzy sets and membership functions of selecting electronic insurance services based on data results of second step questionnaire

Fuzzy sets related with research goal were introduced to design research fuzzy inference system. In this section we use factorial analysis results. So that the factors classified by factorial analysis were introduced as fuzzy sets which are inputs of fuzzy inference system. We have used common triangular function to define membership functions of fuzzy inference system because of simplicity and easiness. There considered three verbal terms of "low", "middle" and high for each membership function. Fuzzy sets which are considered as fuzzy inference system inputs are shown in table 4.

Table 4: Fuzzy inference system inputs

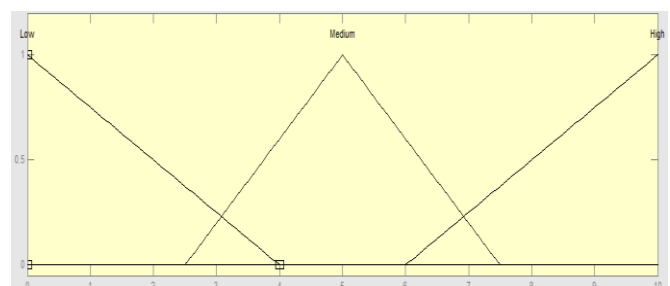
Row	Inputs of fuzzy inference system
1	Quality of provided services
2	Ease of services usage
3	Accessibility to information
4	Rate of services provider accountability

For input fuzzification three verbal words are defined as it is shown in table 5.

Table 5: Verbal words and fuzzy numbers to fuzzification of system inputs.

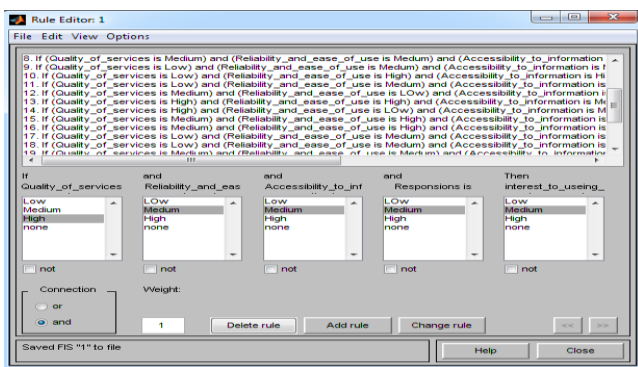
Triangular fuzzy numbers	Verbal words
(0 0 4)	Low
(2.5 5 2.5)	Medium
(6 10 10)	High

C By considering the fuzzy sets as inputs and the fuzzy numbers for system input fuzzification in Matlab software shape 3 is resulted.



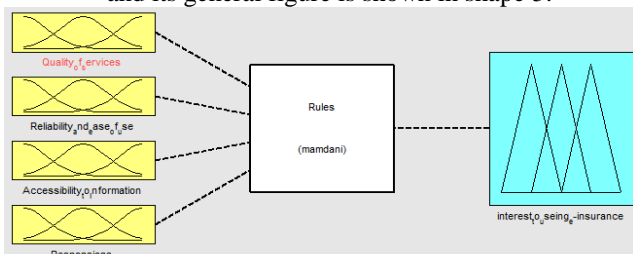
Shape 3: Fuzzy sets of the study (system inputs).  
Fifth step) writing related rules using experts' opinions

To complete research fuzzy inference system it is needed to define fuzzy logic rules which are the heart of fuzzy system. These rules indeed define the style of defined fuzzy sets communication in the fuzzy inference system with each other and their effectiveness on customer desire to use electronic services. In the other words, entering related data to assumption part of fuzzy rules of If-Then to system which are obtained by questionnaire, output value was calculated as an unfuzzy and definite number. Twenty five rules were designed by four experts of insurance information technology. After designing fuzzy rules by four experts, these are added to the system and formed the system knowledge base. In figure 4 we could see that rules' editor allow us to delete, add or change each of them



Shape 4: Editing rules in Matlab software.

In this step fuzzy inference system of this study is designed and its general figure is shown in shape 5.



Shape 5: General shape of fuzzy inference system.

5. Case study

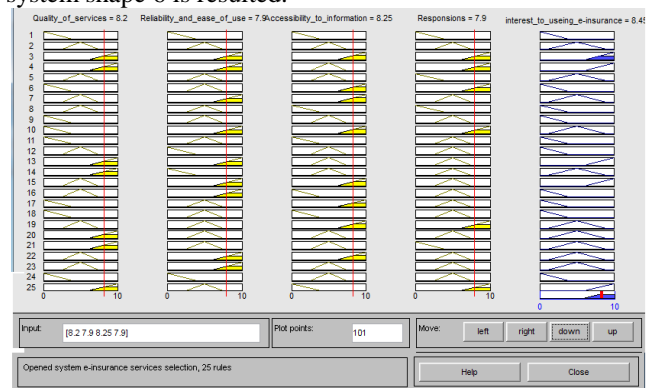
Provided model in figure 4 is a general model which could be used for all insurances. To make applicable this model an insurance company was selected. This company is the first electronic insurance and the biggest private insurance with reliable and famous stockholders along with best thoughts and capabilities, which provide complete services to governmental sectors, banks, capital market, various industries, service companies, and private sector. For the first time in insurance industry, purchase credit card of insurance company was awarded to all real and legal persons in the form of credit insurance. In this section we study the customers' desire to use electronic insurance services. A questionnaire was designed which include confirmed indices by experts in the questionnaire of second step. That is regarding view of the selected insurance company customers about these indices we have measured their desire to use electronic services. In questionnaire analysis we have used 0-10 range for scoring. This questionnaire was distributed among twenty customers.

Questionnaire's data were entered fuzzy inference system to determine the rate of usage desire for electronic insurance services. Method of data entering to this system is such that the average of subsets indices scores of each four factors was calculated, then factor average regarding obtained indices' averages, obtained averages of each factor (quality of provided services, trust and ease of services usage, accessibility to information and rate of services provider accountability) were entered the system as inputs of Fuzzy inference system. Resulted average for each factor could be seen in table 6.

Table 6: average for each factor.

Factor name	average
Quality of provided services	8.2
Ease of services usage	7.9
Accessibility to information	8.25
Rate of services provider accountability	7.9

By entering the resulted number of step 6 to fuzzy inference system shape 6 is resulted.



Shape 6: the display of the amount of each input and active rules and final outputs.

Each left column was displayed in relation to four factors of quality of provided services, trust and ease of services usage, accessibility to information, rate of services provider accountability and number of each rule was shown on the left side of charts. Four columns in left side of chart indicate the membership functions of rules' assumption (IF section). Fifth column indicates the membership function related to rules results (THEN section).

Result of implementation of each Fuzzy rule on each defined fuzzy set accorded with obtained score for each factor. In the end defuzzified output (rate of customer desire to use electronic insurance services) was shown as a bold vertical line on the terminal chart of right column which same as 8.4. Number 8.4 with membership rate of 1 is a member of high membership function from fuzzy set of customer desire to use electronic insurance services. In the other words we could say that based on results of twenty customers' opinions of one branch of an electronic insurance company, rate of

satisfaction from electronic services of this company is high. Designed system has the capability to measure desire of electronic insurance companies.

## II. CONCLUSIONS

In this study we have tried to design for the first time a fuzzy inference system so that we can measure customer interest in using electronic insurance services. The factors are classified in to these four categories: Quality of provided services, ease of services usage, accessibility to information, rate of services provider accountability. According to the four factors which was mentioned earlier fuzzy sets and the membership function of each fuzzy sets and at the end fuzzy inference system which measures customer interest in using electronic insurance services are designed. Fuzzy inference system which measures customer interest in using electronic insurance services was filled by 20 customers in one of the branches of insurance industry in Iran. According to the result of these 20 customer opinions and entering the numbers to the fuzzy inference system, the number, 8.4 was resulted. This number has the membership rate 1, as a result it is a member of high membership function of fuzzy set of customer interest in electronic insurance services. In other words according to the results of 20 customers in one of the branches of insurance services in Iran the amount of interest in electronic services of this insurance is "high".

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