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An application of Fuzzy DEMATEL electronic life-insurance development

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A B S T R A C T

For years, e-commerce has generated competitive advantage for many industries especially in insurance industry where people could apply for any sort of insurance, very easily. In fact, insurance industry has become one of the most important sectors in the world. E-commerce, on the other hand, has absorbed various people in insurance industry to develop economic growth. However, applying e-commerce for insurance firms may encounter serious obstacles and it is important to know them properly and setup appropriate actions to remove them. In this paper, we present a multi-criteria decision making (MCDM) technique based on DEMATEL with an adaptation of fuzzy logic to find important factors impacting implementation of e-commerce for life insurance industry. The proposed study of this paper designs a questionnaire and distributes it among some insurance experts and then we analyze them using fuzzy DEMATEL technique. Findings indicate that "lack of designing death table based on the existing statistics of population death in Iran", "lack of variety in protections of life insurance in proportionate to society individual's requirements by means of low level income of society individuals" and "lack of extensive advertisements for developing the culture of life insurance in country" are the most important factors influencing insurance industry for enhancing e-business.

1. Introduction

For years, e-commerce has generated competitive advantage for many industries especially in insurance industry where people could apply for any sort of insurance very easily. In fact, insurance industry has become one of the most important sectors in the world. E-commerce, on the other hand, has absorbed various people in insurance industry to develop economic growth. However, applying e-commerce for insurance firms may encounter serious obstacles and it is important to know them properly and setup appropriate actions to remove them (Skipper, 2001).

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There are literally various types of activities associated with insurance industry to increase their efficiencies, significantly. In fact, it can be stated that internet services and e-commerce can be considered as the key success of today's organizations (Ahmadi & Salami, 2010). However, some insurance firms prefer not to implement electronic commerce since they are under the impression that they are unable to have good infrastructure to operationalize it. Others may be unwilling to implement e-commerce since they do not have experience in this area (Truong & Jitpaiboon, 2008).

These days, service industry is an active segment because of globalization rate and information technology revolution and there are some changes in customer needs and expectations in the field of giving high quality services (Barkur, 2007). To detect the traits of organizations to retain customers, business consulters try to obtain necessary instruments for investigating customer satisfaction and create permanent quality improvement systems (CSSP, 2007).

Quick access to insurance services is one of the most prominent factors considered for customer satisfaction in insurance industry. In other words, people look for insurance services as soon as an incident occurs. Internet facilities have provided some opportunities for buying and selling various goods and services over the cyber space. This has also created an opportunity for insurance companies to present their products and services more easily. In Iran, the first attempt on providing insurance over the internet was started in 2001 in auto industry and it has experienced growing trend during the past few years.

Zhou et al. (2011) determined critical success factors in emergency management based on fuzzy DEMATEL method. Tzeng et al. (2007) implemented a hybrid MCDM technique to investigate the independent relationships of evaluation criteria with the help of factor analysis and the dependent relationships of evaluation criteria using DEMATEL technique. The results generated effective evaluation of e-learning programs with good criteria, which fit with respondent's perception patterns, especially when the evaluation criteria were different.

Tsai and Chou (2009) used a hybrid model based on DEMATEL, ANP, and ZOGP to choose management systems for sustainable development in SMEs. Lin and Tzeng (2009) presented a value-created system of science (technology) park by using DEMATEL. Lin et al. (2010) made an assessment vehicle telematics system by implementing a novel MCDM technique with dependence and feedback.

DEMATEL was first initially presented at Battelle Memorial Institute of Geneva Research Center and it has been used for different complicated problems in the world such as famine, energy, environmental protection, etc. (Fontela & Gabus, 1976). DEMATEL is one the MCDM techniques and maintains the capability to convert the qualitative designs for quantitative analysis (Lee et al., 2011). The objective of DEMATEL is to convert the relationships among different criteria, causal dimensions from a complex system into an understandable structural framework of that system (Dalalah et al., 2011). All criteria of a system, directly or indirectly, are mutually related to each other in a general reciprocal system.

In this paper, we present fuzzy DEMATEL technique to prioritize important factors adaptation of e-commerce in insurance industry.

2. The proposed study

We first present details of the fuzzy logic needed in this paper.

2.1. Fuzzy-logic

Many organizations adopted group decisions to determine a solution, group decision means to reach an agreement through dialogue among many experts, and in this case, an acceptable decision needs to be adopted. Of course, in such decision associated with complex systems, assessment by experts or

decision-makers about a qualitative criteria object will be presented, always couched in language. The theory of fuzzy collection can be implemented to measure vague concepts based on unreal (personal) judgments. Table 1 demonstrates change the vague judge to fuzzy triangle numbers.

Table 1
The correspondence of linguistic terms and values

Linguistic values	Linguistic terms
[0.75,1,1]	Very high influence(VH)
[0.5,0.75,1]	High influence(H)
[0.25,0.5,0.75]	Low influence (L)
[0,0.25,0.5]	Very low influence (VL)
[0,0,0.25]	No influence (NO)

Fuzzy triangle number can be a regular triplets of the form of (l, m, n) or $1 \leq m \leq n$. For both fuzzy triangle numbers $A_1 = \{l_1, m_1, r_1\}$ $A_1 = \{l_2, m_2, r_2\}$, the arithmetic operations are performed as follows,

$$A_1 + A_2 = (l_1 + l_2, m_1 + m_2, r_1 + r_2)$$
$$A_1 - A_2 = (l_1 - l_2, m_1 - m_2, r_1 - r_2)$$
$$A_1 \otimes A_2 = (l_1 l_2, m_1 m_2, r_1 r_2)$$
$$\lambda A_1 = (\lambda l_1, \lambda m_1, \lambda r_1), (\lambda > 0)$$

In recent years, various types of defuzzy techniques have been used (Opricovic & Tzeng, 2003). In the meantime, the especial unknown and instable environment where fuzzy numbers are applied by considering suitable defuzzy technique. This study implements changing the fuzzy data into determined values (CFCS) proposed by Opricovic and Tezeng (2003) to de-fuzzy. Based on the process of CFCS method, first, right and left values are determined with a minimum and maximum fuzzy based on the fuzzy numbers based on the group evaluating and then the final definite number are measured in the form of average weight based on membership subject.

2.2 The Fuzzy DEMATEL steps:

1.Specify evaluation factors according to expert committee's opinion and research background,

2.Determine each factor influences on whole system, according to expert's opinion. To do so, we use discussed wordy expressions in Table 2 and Fig. 1. Then, we used CFC method (Eqs. 1-9) to convert the fuzzy results into crisp values.

Table 2
The correspondence of linguistic terms and values

Linguistic values	[0.75,1,1]	[0.5,0.75,1]	[0.25,0.5,0.75]	[0,0.25,0.5]	[0,0,0.25]
Linguistic terms	Very high influence(VH)	High influence(H)	(L) Low influence	)VL (Very low influence	)NO (No influence

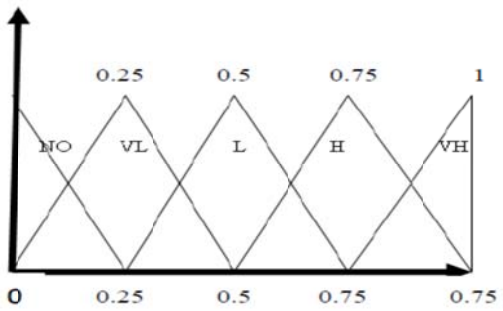

Fig. 1. Fuzzy triangle numbers

$$XL_{ij}^{k} = (L_{ij}^{k} - \underset{1 \le k \le k}{minL_{ij}^{k}})/\Delta_{min}^{max} \quad (1)$$

$$XM_{ij}^{k} = (M_{ij}^{k} - \underset{1 \le k \le k}{minL_{ij}^{k}})/\Delta_{min}^{max} \quad (2)$$

$$Xr_{ij}^{k} = (r_{ij}^{k} - \underset{1 \le k \le k}{minL_{ij}^{k}})/\Delta_{min}^{max} \quad (3)$$

$$\Delta_{min}^{max} = maxr_{ij}^{k} - minL_{ij}^{k} \quad (4)$$

$$Xls_{ij}^{k} = \frac{Xm_{ij}^{k}}{(1 + Xm_{ij}^{k} - Xl_{ij}^{k})} \quad (5)$$

$$Xrs_{ij}^{k} = \frac{Xr_{ij}^{k}}{1 + Xr_{ij}^{k} - Xm_{ij}^{k}} \quad (6)$$

$$X_{ij}^{k} = \left[Xls_{ij}^{k}\left(1 - Xls_{ij}^{k}\right) + Xrs_{ij}^{k} \,.\, Xrs_{ij}^{k}\right]/(1 + Xrs_{ij}^{k} - Xls_{ij}^{k}) \quad (7)$$

$$BNP_{ij}^{k} = minL_{ij}^{k} + X_{ij}^{k}\,\Delta_{min}^{max} \quad (8)$$

$$a_{ij} = \frac{1}{k}\sum_{k}^{1 \le k \le k} BNP_{ij}^{k} \quad (9)$$

A= [a_{ij}] is direct relations matrix of experts opinions.

3. Calculate total relations matrix T- I where I is an identity matrix $n \times n$ and $T = \left[t_{ij}\right]$ representing the elements indicating the direct and indirect impacts of factor i on factor j. Now, matrix T is the indicator of general relationships between each pair factor in the system. Matrix D is the normalized matrix $D = \left[d_{ij}\right], 0 \le d_{ij} \le 1$.

$$D = \frac{1}{\underset{1 \le i \le n}{max} \sum_{j=1}^{n} a_{ij}} A \quad (10)$$

$$T = D(I - D)^{-1} \quad (11)$$

4. Calculate row summation and column summation of T matrix – i row summation is indicator of all direct and indirect effects of i factor on all other factors and so can call r_i as the impacting degree. C_j is similarly, the column summation and we can call it as influenced degree of j factor.

$$r_i = \sum_{1 \le i \le n} t_{ij} \quad (12)$$

$$C_j = \sum_{1 \le i \le n} t_{ij} \quad (13)$$

Therefore, when $i = j, r_i + C_i$ shows both the influence of which i factor can have on other factors of system and also the impacts of other factors of system on i factor. So, $r_i + C_i$ show the significant degree of i factor in whole system, and $r_i - C_i$ indeed shows the influence of i on system. If $r_i - C_i$ is positive, i factor belong to the cause group and if $r_i - C_i$ is negative, i factor belong to the effect group.

5. Demonstrate the diagram of factors influencing on $r_i - C_i$ and $r_i + C_i$ bases. This diagram is drawn by ($r_i + C_i$, $r_i - C_i$) coordinate (Huang, 2009).

2.3 Fuzzy DEMATEL

The proposed model of this paper uses the following nine factors as important barriers for implementation of Fuzzy DEMATEL.

S_1- Lack of designing death table based on the existing statistics of population death in Iran,

S_2- Lack of appropriate mechanism and planning for the use of capital stores during contract time within insurance industry,

S_3- Existence of legal barriers for investment of state insurance firms,

S_4- Lack of variety in protections of life insurance in proportionate to society individual's requirements by means of low level income of society individuals,

S_5- Limited monitoring of insurance firms in accurate awareness of the kinds of life insurance,
S_6- Weak system of instructing and equipping specialist marketers of life insurance,
S_7- Severe shortage of specialists for accurate investigating the risk of life insured health,
S_8- Limiting tax and performance rules of agents in life insurance sale,
S_9- Lack of extensive advertisements for developing the culture of life insurance in country.

3. The results

In this section, we present details of our proposed model. We first present direct relations matrix A associated with structural factors, which are summarized in Table 3 and Table 4 as follows,

Table 3
Direct relations matrix A associated with structural factors

Factors	S1	S2	S3	S4	S5	S6	S7	S8	S9
S1	0.004	0.336	0.298	0.499	0.448	0.411	0.499	0.25	0.499
S2	0.68	0.004	0.004	0.624	0.784	0.004	0.004	0.004	0.25
S3	0.957	0.004	0.004	0.624	0.004	0.004	0.411	0.749	0.11
S4	0.784	0.499	0.004	0.004	0.004	0.004	0.004	0.004	0.749
S5	0.749	0.448	0.004	0.004	0.004	0.25	0.004	0.004	0.957
S6	0.624	0.004	0.004	0.004	0.957	0.004	0.004	0.004	0.499
S7	0.624	0.004	0.004	0.68	0.004	0.004	0.004	0.004	0.004
S8	0.819	0.888	0.499	0.499	0.004	0.004	0.004	0.004	0.004
S9	0.749	0.004	0.004	0.004	0.923	0.004	0.004	0.004	0.004

Table 4

Total relations matrix T related to structural factors

Factors	S1	S2	S3	S4	S5	S6	S7	S8	S9
S1	0.659	0.369	0.182	0.449	0.567	0.257	0.282	0.173	0.602
S2	0.693	0.235	0.079	0.398	0.574	0.135	0.120	0.075	0.487
S3	0.892	0.321	0.137	0.531	0.377	0.146	0.284	0.334	0.458
S4	0.649	0.323	0.074	0.213	0.354	0.112	0.112	0.070	0.530
S5	0.705	0.327	0.080	0.227	0.420	0.201	0.122	0.077	0.640
S6	0.623	0.199	0.071	0.184	0.614	0.129	0.108	0.068	0.512
S7	0.461	0.142	0.053	0.344	0.188	0.075	0.080	0.050	0.232
S8	0.849	0.532	0.255	0.492	0.417	0.144	0.167	0.128	0.441
S9	0.589	0.182	0.067	0.172	0.539	0.119	0.102	0.064	0.326

Finally, Table 5 demonstrates details of influences of structural factors and Fig. 2 shows details of our findings.

Table 5

The sum of given and taken influences of structural factors

Factors	r_i	C_i	$r_i + C_i$	$r_i - C_i$
S1	-2.581	9.660	6.120	3.539
S2	0.168	5.427	2.630	2.798
S3	2.483	4.480	0.998	3.481
S4	-0.572	5.449	3.011	2.438
S5	-1.252	6.849	4.051	2.798
S6	1.189	3.825	1.318	2.507
S7	0.247	3.005	1.379	1.626
S8	2.385	4.466	1.040	3.425
S9	-2.067	6.387	4.227	2.160

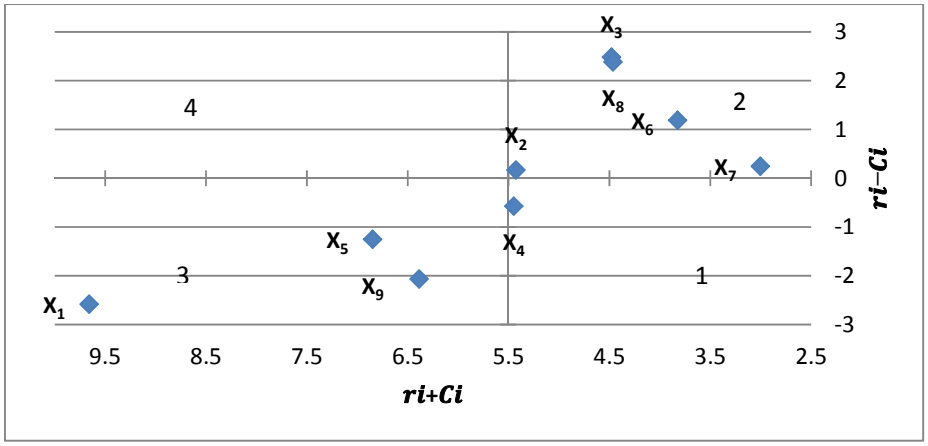

Fig. 2. The casual diagram of structural barriers

In order to compete in today's modern world, it is necessary to proceed along with modernization. Electronic life insurance industry requires investigating cultural-environmental factors and software-administrative infrastructures to be accepted by insurance industry staffs and people as the customers.

In order to perform detailed investigation on important barriers, it is required to determine the influences of factors and barriers and relationships among variables and the extent of their influences. There are constantly fundamental problems in experimental studies, which should be promoted:

1. Do users have enough perception and experience in using electronic insurance?

2. Are internal and external variables independent or dependent?

3. Are there any required software-hardware infrastructures for protection of whole network in country?

We have applied Fuzzy DEMATEL to dominate the discussed problems as well as removing any ambiguities in some of judgments. This method has the potential to clarify the cause and effect relation among developmental barriers of electronic life insurance and the influence extent of each of these barriers on the whole network of barriers. To do so and after required calculations, diagram of factor influences has been obtained (Fig. 2) and the average of horizontal and vertical quantities of diagram, which are respectively 5.505 and 0.00 are indicated for simpler analysis of diagram. The left factors of average line 5.505 are of more importance. The factors located in upper side of line 0.00 have the most impacts on the network of relationships, they are located in cause or influencing group, and the factors in lower side are in effect or influenced group. In fact, to accurately analyze the influences of the factors, this diagram can be divided to four areas: the first area of factors have the least relationships or in other words are independent factors, S_4.

The second area indicates the causal factors but their influence on factor network is low, S_2, S_3, S_6, S_7 and S_8. The third area is indicator of factors, which are of high importance but are in effect group. In fact, these factors are the main problems of network and their solving should be the management priorities, S_1, S_4 and S_9. The fourth area indicates the factors, which have both high importance and are located in causal group and are actually the most important factors. These factors are called key success factors and management can promote the problems and limitations by focusing on them. Unfortunately, none of barriers is placed in this area. In fact, it should be tried to place close variables such as S_2 or S_4 to this area and reinforce the whole network by their strengthening. Off coarse focusing on barriers S_3 and S_8, which are determined as the most influencing barriers promoting the others. DEMATEL can contribute the management by identifying the factors and dividing resources and organization energy on factors and more focus on key factors by simplifying the complex relation in network of interrelated factors.

4. Conclusion

In this paper, we have presented an empirical study to determine important obstacles for implementation of e-business in insurance industry. The proposed study of this paper designed and distributed a questionnaire among some experts from industry and using fuzzy DEMATEL determined important barriers. Based on findings from implementation of Fuzzy DEMATEL technique, we found that lack of designing death table based on the existing statistics of population death in Iran, lack of variety in protections of life insurance in proportionate to society individual's requirements by means of low level income of society individuals and lack of extensive advertisements for developing the culture of life insurance in country are the most important factors influencing insurance industry for enhancing e-business.

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