A New Model for Insurance Fraud Detection in Car Accidents Using a Combined Fuzzy DEMATEL and ELECTRE-TRI Approach

Ehsan Taghiloo, M.Sc
Department of Industrial Engineering, Arak Branch
Islamic Azad University
Arak, Iran

Adel Azar, PhD
Department of Management
Faculty of Management and Economic
University of Tarbiat Modares
Tehran, Iran

Ebrahim Nasiri
Emen hamrah-e vista company
Qom, Iran

Hossein Ghaedrahmati, M.Sc
Young researchers Club, Arak Branch
Islamic Azad University
Arak, Iran.

Abstract

Insurance Industry, as one of the most important instruments of the financial development triangle in advanced and developing countries, has continually attracted the attention of economical theorists, since the Insurance Influence Coefficient is counted as an important index for indicating economic development .Fraud and cheating are serious enemies of Insurance Industry. Also paying for counterfeit forged damages, as well as customer dissatisfaction are considered as main factors of Insurance Industry in Motor Insurance. This investigation tries to introduce an instrument to determine the amount of fraud in an accident. through considering the criteria of an accident, the importance of these criteria and using DEMATEL[1] and ELECTRE-TRI[2] decision-making techniques. The new introduced instrument is hoped to help companies discovers fraud and gain satisfaction from the honest customers by compensation them for their loss of the accidents.

Key Words: Fuzzy DEMATEL, ELECTRE TRI, Fraud detection, Intelligent fraud detection

1-Introduction

Insurance fraud is not an unfamiliar issue for insurance companies but the concern of insurance companies about the occurrence of this phenomenon can be seen in the text of the insurance policies terms. Considering that, from a sharing point, the third person insurance has the first place in the received insurance fee portfolio of the insurance companies in many countries among them Iran, and also this field is prejudicial in our country and many other countries, so confronting to the cases of insurance fraud that causes to decrease payable damages and consequently causes to decrease operational loss in third person insurance and most important of them, causes to draw the honest customers satisfaction, has been emphasized.

----

1. Decision Making Trial Evaluation Laboratory

2. Elimination et Choice Translating Reality

Since customer is the main capital of a customer-oriented organization and considering that the market of insurance industry has been inclined to be competitive during recent years, it is said that insurance companies also force to have such an approach toward customers, and it is also said that customer has the most important role in these companies, and because of this, the customer's satisfaction takes a special emphasis and priority. Decision-making about the existence of fraud in one accident will enjoy a very high sensitivity. So making incorrect decisions about the validity of an accident, will lead to the irreparable loss like lapse of confidence of the customer from the insurance company.

Recently, in order to make a suitable decision, the multi-criterion decision-making methods have had a high application in different scientific areas that the most important of them can be the consideration of a counterfeit accidents. So this research tries to separate the affected and effective criteria by using of DEMATEL technique so that we can determine the cases of occurrence of the counterfeit accident, then we can also determine the amount of the fraudulence of the fraud occurrence cases and consequently a case of accidents by using ELECTRE-TRI multi-criterion classification technique.

2-Fuzzy systems

They are systems whose input data can be inaccurate. It means that their input data will be as Fuzzy sets or Fuzzy numbers (Shavandi, 2006).

2-1- Triangular fuzzy numbers

Triangle fuzzy number $\tilde{A}$ or in simple word, triangle number with the membership function of $\mu_{\tilde{A}}(x)$ on X is defined as follows:

$$\mu_{\tilde{A}}(x)\begin{cases}\dfrac{(x-L)}{(M-L)} & , \quad L \le x \le M, \\ \dfrac{(U-x)}{(U-M)} & , \quad M \le x \le U, \\ 0 & , \quad \text{otherwise}\end{cases}$$

In above mentioned relation, [L,U] is the supporting interval, and the point (M,1) is the head. Figure (1) shows a triangle fuzzy number.

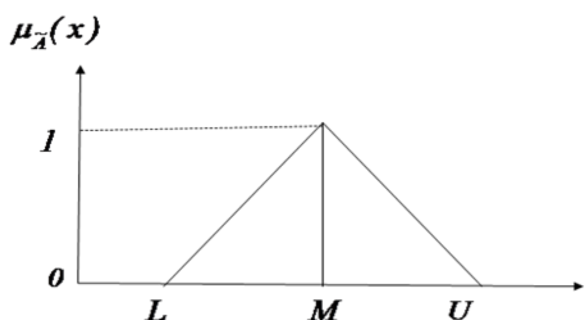

Figure 1- triangle fuzzy number

Suppose that $\tilde{A}_1, \tilde{A}_2, ..., \tilde{A}_n$ are n fuzzy number, then their mean is calculated as follows:

$$\tilde{A}_{ave} = \frac{\tilde{A}_1, \tilde{A}_2, ..., \tilde{A}_n}{n} = \frac{(L_1, M_1, U_1) + (L_2, M_2, U_2) + ... + (L_U, M_U, U_U)}{n}$$

$$= \left(\frac{1}{n}\sum_{i=1}^{n} L_i, \frac{1}{n}\sum_{i=1}^{n} M_i, \frac{1}{n}\sum_{i=1}^{n} U_i\right) \qquad (1)$$

And, in order to turn the fuzzy number (A= (L,M,U)) into the certain number, the following formula is used:

$$d = \frac{L + 2M + U}{4} \qquad (2)$$

2-2- Intuitionistic Fuzzy sets

Intuitionistic fuzzy set was introduced by Atannasov in 1986, that is, in fact a development of classical fuzzy theory. Intuitionistic fuzzy set A in a limited set of X is written as $\mathrm{A} = \{(x, \mu_A(x), \nu_A(x)) \mid x \in \mathrm{X}\}$. In a way that $\mu_A(x), \nu_A(x) : \rightarrow [0,1]$ is membership function and non membership function respectively:

$$0 \le \mu_A(x) + \nu_A(x) \le 1 \qquad (3)$$

It's third member is $\prod_A (X)$ that is known as the index of intuitionistic fuzzy number or ambiguity degree whether X is belonged to set A or not.

$$\prod_A (X) = 1 - \mu_A(x) - \nu_A(x) \qquad (4)$$

The smaller the amount of $\prod_A (X)$ is the more certain the information about X is. It is clear that if $\mu_A(x) = 1 - \nu_A(x)$ is continuing for all elements of the source set, the meaning of triangle fuzzy numbers set will be covered. It is clear that the importance of decision makers toward each other is not equal.

Suppose that $D_K = [\mu_K(x), \nu_K(x), \prod_K]$ is the intuitionistic fuzzy number for ranking the i_{th} decision maker, so the weight of the i_{th} decision maker is calculated as follows [6]:

$$\lambda_k = \frac{\left(\mu_k + \pi_k \left(\frac{\mu_k}{\mu_k + \nu_k}\right)\right)}{\sum_{k=1}^{l} \left(\mu_k + \pi_k \left(\frac{\mu_k}{\mu_k + \nu_k}\right)\right)} \qquad (5)$$

And, in order to determine the importance of decision maker, the linguistic variables which are shown in table (1) are used.

Intuitionistic fuzzy number - IFN	Linguistic variables
(0.9 و0.1)	VI) very important
(0.75,0.2)	(I) Important
(0.50,0.45)	(MI) Middle important
(0.35,0.60)	(LI) Low important
(0.1,0.9)	(UI) Unimportant

Table 1- linguistic variables and intuitionistic fuzzy number alike to it.

3- Group Fuzzy DEMATEL Technique

This technique is mainly generated for considering very complicated global issues, and some experts in different fields are used for judging and polling.

In order to access to the judgment of experts, interviews and the questionnaire are used repeatedly. The steps of DEMATEL Model as flow chart in figure (2) is shown.

In fuzzy DEMATEL, the fuzzy theory is connected to DEMATEL Technique. On this basis, in this research, the linguistic variables which are shown in table (2) are used for evaluation.

Linguistic variables	Triangular fuzzy number
Very high influence (VH)	**(0.75,1,1)**
High influence (H)	**(0.5,0.75,1)**
Low influence(L)	**(0.25,0.5,0.75)**
Very Low influence(VL)	**(0,0.25,0.5)**
No influence(NO)	**(0,0,0.25)**

Table 2- linguistic variables & triangular fuzzy numbers related to them

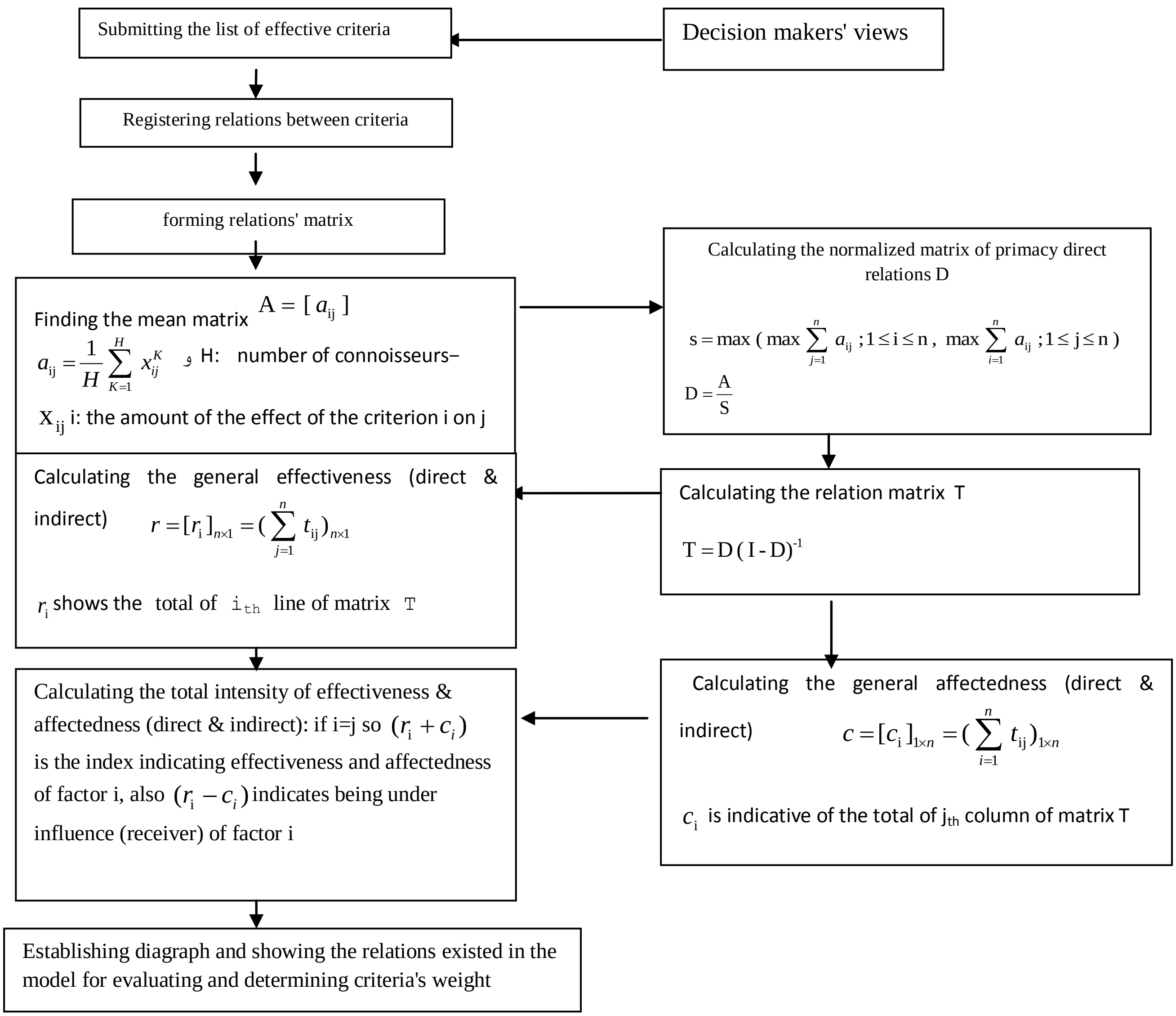

Figure 2- DEMATEL flow chart

4- Introducing the ELECTRE-TRI model

ELECTRE-TIR model is a kind of ELECTRE multi-criterion methods. For the first time, ELECTRE model was introduced by Benayoun & colleagues in 1966 and then it was developed by Roy in 1968, Nijkamp in 19999977 and Roy & Skalka in 1984. For the first time ELECTRE method was submitted by Yu in 1992 (Kontant 2007) and also for the first time as well.

This method is a way of multi-criterion decision making classification and it classifies the alternatives based on predetermined intervals. This classification is obtained from the result of comparing each alternative with the profiles that are indicative of the limit of classes (Mooso & Osloonski 2006).

If according to figure (3), the profiles $b_1, b_2, \ldots, b_p$ (set B) are taken into consideration for the criteria g_1‘$g_2, \ldots, g_m$ (set F), and b_h is the upper limit of the group C_h and the lower limit of the group C_{h+1} - {h= (1,2,… , p)} – so we'll have p+1 group. In this method the preference relation (S) is established among alternatives and profiles. This relation – that is shown with $\mathbf{b_hSa}$ or $\mathbf{aSb_h}$ – means that alternative **a** is at least better than profile b_h or vice-versa. The limit of indifference thresholds (q) and the priority (p) form the inner preference data of each criterion. In fact these amounts show the accuracy of evaluation of the alternative for the criterion (L.Berger, 2002).

$q_j(b_h)$ specifies the greatest difference of $g_j(a)$-$g_j(b_h)$, that is indicative of the level of indifference between alternative **a** and profile b_h for the criterion g_j.

$p_j(b_h)$ specifies the minimum difference of $g_j(a)$-$g_j(b_h)$ that is indicative of the level of desirability of alternative **a** and profile b_h for the criterion g_j. The schematic presentation of groups and profiles in ELECTRE-TRI method is shown in figure (3).

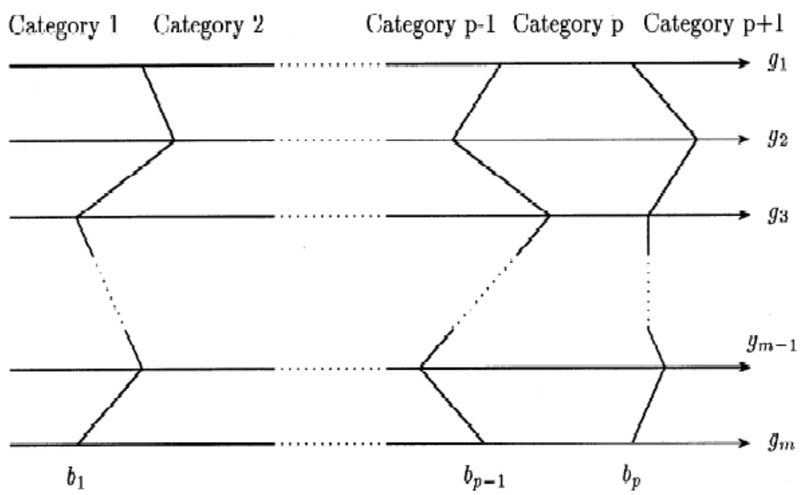

Figure 3- the way of defining groups using the limitation of profiles in ELECTRE-TRI model (Mooso & Osloonski, 1999)

In order to classify alternatives, it is necessary to calculate the similarity and non-similarity indexes for each pair of alternatives, each criterion and each profile for each criterion (Mooso & Osloonski 1998).

A set of coefficients of the important weights ($k_1, k_2, \ldots, k_m$) and a set of non-acceptance thresholds ($v_1(b_h)$, $v_2(b_h), \ldots, v_m(b_h)$) are the parameters that have an important role for making preference relations. $V_j(b_h)$ is indicative of the minimum difference of $g_j(b_h)$-$g_j(a)$ that is incompatible with aSb_h equation. In this method the index of $\sigma(a,b) \in [0,1]$ is indicative of the degree of validity of aSb_h equation. If the relation of $\lambda \leq \sigma(a,b)$ is continuing, so aSb_h equation will be true. It is required to explain that λ is a cutting level ($\lambda \in [0.1]$)
There are two optimistic and pessimistic viewpoints for performing this classification. In pessimistic view, alternative **a** is consecutively compared with profiles b_i, and b_h is the first profile that connects alternative **a** to the group of C_{h+1} in aSb_h equation.

In optimistic viewpoint, alternative **a** is consecutively compared with profile b_i, and b_h is the first profile that connects alternative **a** to the group of c_h in $a<b_h$ equation.

Finally as mentioned before, in ELECTRE-TRI model, the alternatives are placed according to predetermined criteria. This is performed as a result of comparing the alternative with the profiles that in fact are indicative of the limit of classes (Mooso & Osloonski 2006).

5– Methodology presentation

Different stages of performing the model submitted in this paper are shown in figure (4):

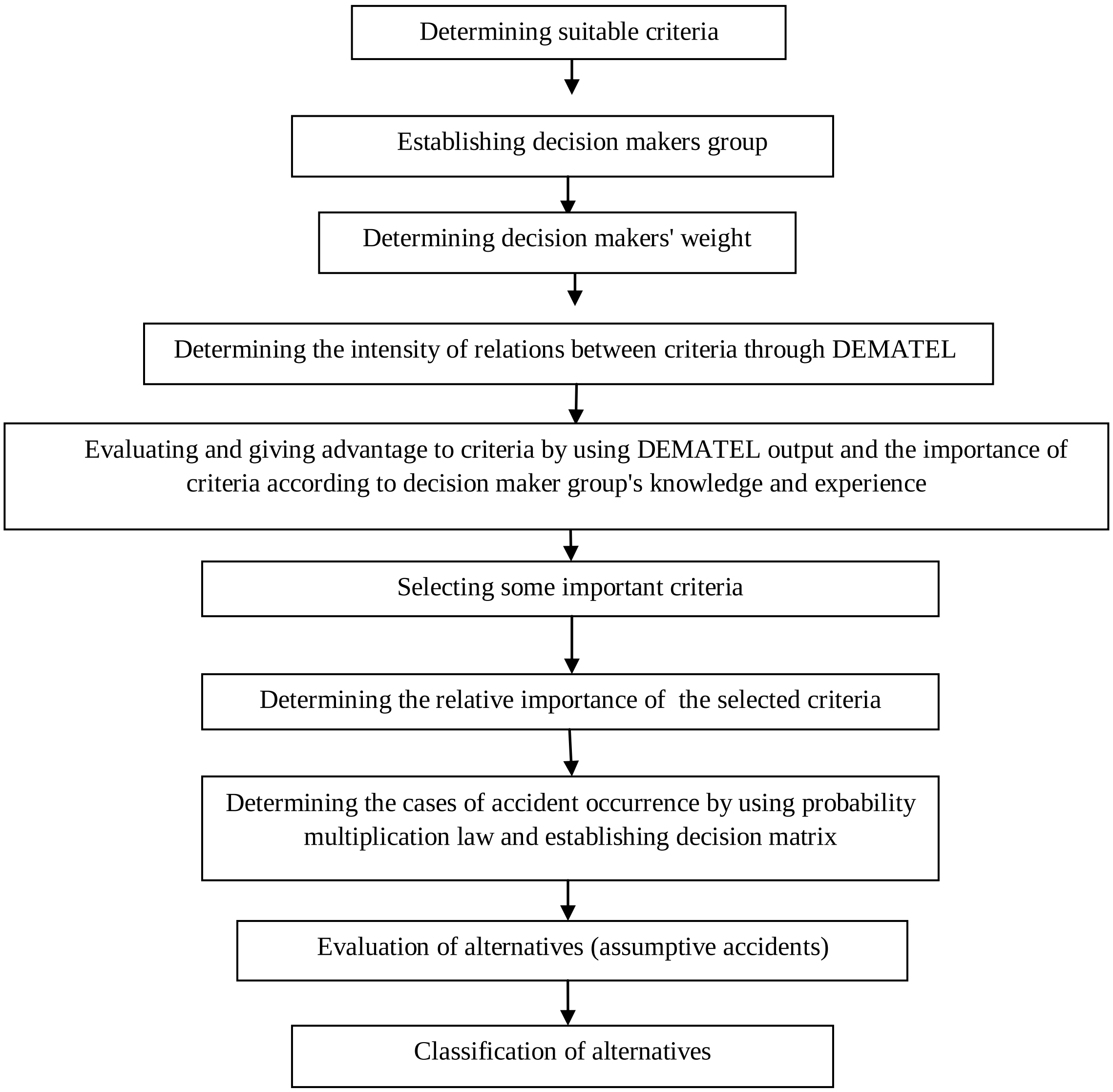

Figure 4- decision making model

5-1- Definition of indexes

In order to define the indexes for making a correct and reasonable decision about the amount of fraud in a wounding accident, the specialists of some science related to this issue are used. Finally, according to these specialists, 15 criteria are selected as effective and useful criteria, that they are introduced in table (3):

criteria	
Have the wounds had reasonable bleeding or not	C1
Have the injured person's cloth a reasonable tear or not.	C2
Is there any necessity for urgent washing of the wounds or not.	C3
Is the accident containing a reasonable brake line or not (according to the type of land or asphalt of the place of accident).	C4
Do the parties of accident insist on the presence of disciplinary officer or not.	C5
Does the driver know himself as guilty or not.	C6
The amount familiarity of the accident parties with blood money and accident law.	C7
The amount of income of the accident parties.	C8
Education level of the accident parties.	C9
Relation of the injured person/persons to the driver.	C10
Is the accident in a way that the driver has insurance policy and he/she is guilty in certain?	C11
The type of the vehicle (organizational or personal)	C12
The price of the vehicle	C13
Place of the accident (Is it isolated, busy, inside the city, outside the city or entrance of the city)	C14
Time of the accident (not crowded time or busy time).	C15

Table 3- The criteria used for determining the fraud in wounding accident

5 -2 Establishment of decision making group

We have formed a committee composed of seven decision makers including connoisseurs and specialists of this issue for evaluating and giving advantage to the criteria, that they are introduced in table (4).

Members of decision maker group	
DM1	Physician of legal medicine
DM2	Senior expert of Insurance
DM3	Senior expert of Traffic
DM4	Senior expert of Law
DM5	Senior expert of Intelligence
DM6	Expert of Emergency
DM7	Senior expert of Disciplinary Force

Table 4 – decision maker group

5-3- Determining the weight of decision makers

As mentioned before, the amount of the importance of the view of all experts in a decision making group is not equal, and the linguistic variables are used for this important issue. The linguistic variables used for ranking decision makers are introduced in table (1).

We determine the linguistic variable related to each decision maker of the formed decision makers group as shown in table (5):

Table 5 – linguistic importance of decision makers

Decision maker	DM1	DM2	DM3	DM4	DM5	DM6	DM7
Linguistic variable	VI	VI	I	MI	I	MI	MI

Now we specify the weight of decision makers by using of formulas 3, 4 and 5 as follows:

$\pi_4 = 1-0.75-0.2 = 0.05$ $\pi_1 = 1-0.9-0.1 = 0$

$\pi_2 = 1-0.9-0.1 = 0$ $\pi_5 = 1-0.5-0.45 = 0.05$

$\pi_3 = 1-0.5-0.45 = 0.05$ $\pi_6 = 1-0.75-0.2 = 0.05$

$$\pi_7 = 1-0.75-0.2 = 0.05$$

$$\lambda_1 = \frac{\left(0.9 + 0 \times \left(\frac{0.9}{0.9+0.1}\right)\right)}{2 \times 0.9 + 3 \times \left(0.5 + 0.05\left(\frac{0.5}{0.5+0.45}\right)\right) + 2 \times \left(0.75 + 0.05\left(\frac{0.75}{0.75+0.2}\right)\right)} = \frac{0.9}{4.956} = 0.182$$

$$\lambda_2 = \frac{0.9}{4.956} = 0.182 \qquad \lambda_5 = \frac{0.789}{4.956} = 0.159$$

$$\lambda_3 = \frac{0.789}{4.956} = 0.159 \qquad \lambda_6 = \frac{0.526}{4.956} = 0.106$$

$$\lambda_4 = \frac{0.526}{4.956} = 0.106 \qquad \lambda_7 = \frac{0.526}{4.956} = 0.106$$

You see the obtained results in table (6):

Decision maker	DM1	DM2	DM3	DM4	DM5	DM6	DM7
Linguistic variable	VI	VI	I	MI	I	MI	MI
Weight	0.182	0.182	0.159	0.1	0.159	0.11	0.106

Table 6- the amount of the importance of decision makers

5-4- Determining the intensity of relations among criteria through group fuzzy DEMATEL model

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
C1	0	VL	H	NO	H	L	NO	NO	NO	NO	VL	NO	NO	NO	NO
C2	H	0	VH	NO	H	L	NO	NO	NO	NO	VL	NO	NO	NO	NO
C3	VL	VL	0	NO	VH	H	VL	NO	NO	NO	NO	NO	NO	NO	NO
C4	VH	H	VH	0	L	VL	NO	NO	NO	NO	NO	NO	NO	NO	NO
C5	L	L	VL	VL	0	L	L	NO	NO	NO	NO	NO	VL	L	L
C6	L	L	L	L	VH	0	L	NO	NO	VL	VL	NO	NO	VL	VL
C7	VH	VH	VH	H	VH	VH	0	L	NO	VH	VH	VH	H	VH	VH
C8	L	L	VL	M	L	L	L	0	H	NO	L	H	VH	NO	NO
C9	L	VL	VL	VL	H	H	H	H	0	VL	VL	H	H	VL	VL
C10	VL	VL	VL	L	VH	VH	VH	NO	VL	0	L	NO	NO	L	L
C11	L	L	L	L	VH	VH	VH	VL	NO	VL	0	VL	VL	VL	VL
C12	VL	VL	VL	VL	VH	H	VL	L	L	VL	VL	0	L	H	H
C13	VH	VH	VH	VH	NO	VH	NO	L	NO	NO	VL	VL	0	NO	NO
C14	VH	VH	VH	VH	L	L	NO	NO	NO	VL	L	VL	NO	0	VL
C15	VH	VH	VH	H	L	L	NO	NO	NO	NO	L	VL	NO	H	0

Table 7 – The estimated data of legal medicine

Then the direct-relation matrix A is calculated with a view to the experts' views. We use of formula 1 for calculating the mean of experts' views. After calculating the mean of views, we diffuse it by formula 2 to obtain the data of table (8).

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
C1	0	0.2054	0.8036	0.1786	0.8036	0.5625	0.2411	0.1875	0.1518	0.125	0.3214	0.1786	0.1518	0.1518	0.179
C2	0.75	0	0.9107	0.1875	0.75	0.3929	0.125	0.2143	0.125	0.1875	0.3482	0.1518	0.2054	0.1518	0.205
C3	0.2679	0.2946	0	0.1518	0.8839	0.7679	0.2946	0.0625	0.125	0.1518	0.1875	0.1518	0.1518	0.1518	0.179
C4	0.8214	0.7143	0.8482	0	0.5	0.2857	0.1875	0.125	0.125	0.1875	0.1607	0.1786	0.2054	0.2143	0.152
C5	0.5	0.5	0.2857	0.2857	0	0.5357	0.5268	0.1518	0.1518	0.2143	0.2411	0.1518	0.25	0.5	0.464
C6	0.5625	0.5	0.5	0.5	0.8839	0	0.5625	0.1875	0.125	0.3214	0.3482	0.1518	0.125	0.3571	0.321
C7	0.8839	0.875	0.9107	0.7679	0.9107	0.9107	0	0.5	0.125	0.8839	0.9107	0.8214	0.7143	0.9107	0.884
C8	0.4732	0.5	0.2589	0.5	0.4643	0.5714	0.5	0	0.7679	0.1607	0.5714	0.7768	0.8482	0.125	0.152
C9	0.4732	0.3214	0.2857	0.2857	0.7411	0.7411	0.7679	0.7946	0	0.3214	0.3214	0.7054	0.6786	0.2321	0.295
C10	0.3214	0.2857	0.3214	0.5	0.8482	0.9107	0.875	0.125	0.2857	0	0.5982	0.125	0.125	0.5625	0.5
C11	0.5625	0.5	0.5357	0.5	0.9107	0.9375	0.9375	0.3214	0.125	0.3482	0	0.2857	0.2857	0.3214	0.268
C12	0.2857	0.2857	0.2589	0.2857	0.8482	0.7143	0.3214	0.5357	0.5	0.2857	0.2857	0	0.5	0.7143	0.741
C13	0.7321	0.8214	0.8214	0.8214	0.125	0.8482	0.125	0.5714	0.1786	0.1518	0.2857	0.2589	0	0.125	0.152
C14	0.8571	0.8214	0.8214	0.8214	0.5357	0.5	0.1875	0.125	0.1518	0.3214	0.5714	0.2946	0.1518	0	0.295
C15	0.8036	0.8214	0.8571	0.6786	0.5625	0.5714	0.1607	0.1518	0.1518	0.2411	0.5714	0.5	0.125	0.8036	0

Table 8- Direct relation matrix A

Now, using the stages mentioned in figure(2), we normalize the direct-relation matrix, so matrix D is obtained. You can see matrix D in table (9):

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
C1	0	0.019	0.073	0.016	0.073	0.051	0.022	0.017	0.014	0.011	0.029	0.016	0.014	0.014	0.02
C2	0.068	0	0.083	0.017	0.068	0.036	0.011	0.019	0.011	0.017	0.032	0.014	0.019	0.014	0.02
C3	0.024	0.027	0	0.014	0.08	0.07	0.027	0.006	0.011	0.014	0.017	0.014	0.014	0.014	0.02
C4	0.075	0.065	0.077	0	0.045	0.026	0.017	0.011	0.011	0.017	0.015	0.016	0.019	0.019	0.01
C5	0.045	0.045	0.026	0.026	0	0.049	0.048	0.014	0.014	0.019	0.022	0.014	0.023	0.045	0.04
C6	0.051	0.045	0.045	0.045	0.08	0	0.051	0.017	0.011	0.029	0.032	0.014	0.011	0.032	0.03
C7	0.08	0.079	0.083	0.07	0.083	0.083	0	0.045	0.011	0.08	0.083	0.075	0.065	0.083	0.08
C8	0.043	0.045	0.024	0.045	0.042	0.052	0.045	0	0.07	0.015	0.052	0.071	0.077	0.011	0.01
C9	0.043	0.029	0.026	0.026	0.067	0.067	0.07	0.072	0	0.029	0.029	0.064	0.062	0.021	0.03
C10	0.029	0.026	0.029	0.045	0.077	0.083	0.079	0.011	0.026	0	0.054	0.011	0.011	0.051	0.05
C11	0.051	0.045	0.049	0.045	0.083	0.085	0.085	0.029	0.011	0.032	0	0.026	0.026	0.029	0.02
C12	0.026	0.026	0.024	0.026	0.077	0.065	0.029	0.049	0.045	0.026	0.026	0	0.045	0.065	0.07
C13	0.067	0.075	0.075	0.075	0.011	0.077	0.011	0.052	0.016	0.014	0.026	0.024	0	0.011	0.01
C14	0.078	0.075	0.075	0.075	0.049	0.045	0.017	0.011	0.014	0.029	0.052	0.027	0.014	0	0.03
C15	0.073	0.075	0.078	0.062	0.051	0.052	0.015	0.014	0.014	0.022	0.052	0.045	0.011	0.073	0

Table 9- The normalized direct-relation matrix D

Also we calculate the total relation matrix T by using of the mentioned stages in figure (2). Matrix T is introduced in table (10).

We can calculate the total effectiveness and affectedness of each criterion by using of matrix T. as mentioned before, $r_i + c_i$ is indicative of total intensity of an element from the viewpoint of both being influential or being under influence, and if $c_i - r_i$ is positive, the criterion will certainly be influential, and if it is negative then the criterion will be under influence or receiver.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
C1	0.04	0.054	0.11	0.045	0.119	0.093	0.051	0.034	0.027	0.031	0.055	0.036	0.033	0.04	0.04
C2	0.107	0.037	0.123	0.047	0.119	0.082	0.042	0.037	0.026	0.036	0.058	0.035	0.039	0.04	0.04
C3	0.061	0.06	0.038	0.041	0.122	0.106	0.053	0.022	0.023	0.032	0.042	0.032	0.031	0.039	0.04
C4	0.113	0.098	0.12	0.029	0.097	0.072	0.045	0.029	0.025	0.036	0.042	0.036	0.038	0.045	0.04
C5	0.094	0.088	0.078	0.062	0.058	0.098	0.077	0.035	0.029	0.043	0.055	0.039	0.045	0.075	0.07
C6	0.103	0.092	0.1	0.083	0.141	0.057	0.086	0.039	0.029	0.054	0.067	0.041	0.037	0.067	0.06
C7	0.181	0.169	0.188	0.146	0.204	0.192	0.072	0.088	0.048	0.125	0.149	0.123	0.112	0.147	0.14
C8	0.108	0.103	0.091	0.094	0.12	0.124	0.091	0.035	0.091	0.047	0.094	0.104	0.111	0.054	0.05
C9	0.112	0.092	0.097	0.08	0.148	0.142	0.116	0.104	0.027	0.063	0.078	0.102	0.099	0.068	0.07
C10	0.096	0.086	0.097	0.095	0.153	0.149	0.122	0.04	0.046	0.034	0.098	0.046	0.044	0.094	0.08
C11	0.118	0.105	0.118	0.095	0.161	0.154	0.128	0.058	0.034	0.065	0.047	0.061	0.06	0.074	0.07
C12	0.092	0.086	0.09	0.077	0.149	0.132	0.074	0.077	0.067	0.056	0.07	0.036	0.077	0.105	0.1
C13	0.119	0.119	0.13	0.11	0.08	0.131	0.048	0.074	0.036	0.038	0.06	0.05	0.027	0.042	0.04
C14	0.134	0.122	0.135	0.112	0.121	0.107	0.057	0.036	0.033	0.055	0.088	0.054	0.041	0.036	0.06
C15	0.135	0.128	0.144	0.105	0.129	0.119	0.058	0.04	0.035	0.051	0.092	0.074	0.041	0.11	0.04

Table 10 – total relation matrix T

The real place of each element is characterized by the columns (c_i+r_i) and (r_i-c_i) in final hierarchy, so that (r_i-c_i) is indicative of the position of an element along the width axis and (c_i+r_i) is indicative of total intensity of an element along the length axis. In figure (5), you see the final hierarchy of direct and indirect relations with a view to the values of c_i+r_i and r_i-c_i introduced in table (11) is shown.

Ri-Ci	Ri+Ci	criterion
-0.8051	2.4195	Have the wounds had reasonable bleeding or not C1
-0.5695	2.3077	Have the injured person's cloth had a reasonable tear or not. C2
-0.9177	2.4005	Is there any necessity for urgent washing of the wounds or not C3
-0.3599	2.0837	Is the accident containing a reasonable brake line or not (considering the type of land or asphalt of the place of accident). C4
-0.9756	2.8648	Do the parties of accident persist on the presence of disciplinary officer or not. C5
-0.7023	2.8139	Does the driver know himself as guilty or not C6
0.9607	3.2025	The amount familiarity of the accident parties with blood money and accident law. C7
0.5728	2.0666	The amount of income of the accident parties C8
0.8209	1.9725	Education level of the accident parties.C9
0.517	2.0504	Relation of the injured person/persons to the driver C10
0.2533	2.4389	Is the accident so that the driver has insurance policy and he/she is guilty in certain? C11
0.4226	2.1614	The type of the vehicle (organizational or personal) C12
0.2701	1.9419	The price of the vehicle C13
0.154	2.2244	Place of the accident (Is it isolated, busy, inside the city, outside the city or entrance of the city) C14
0.3587	2.2361	Time of the accident (not crowded time or busy time). C15

TABLE 11- The amount of the effect of elements on each

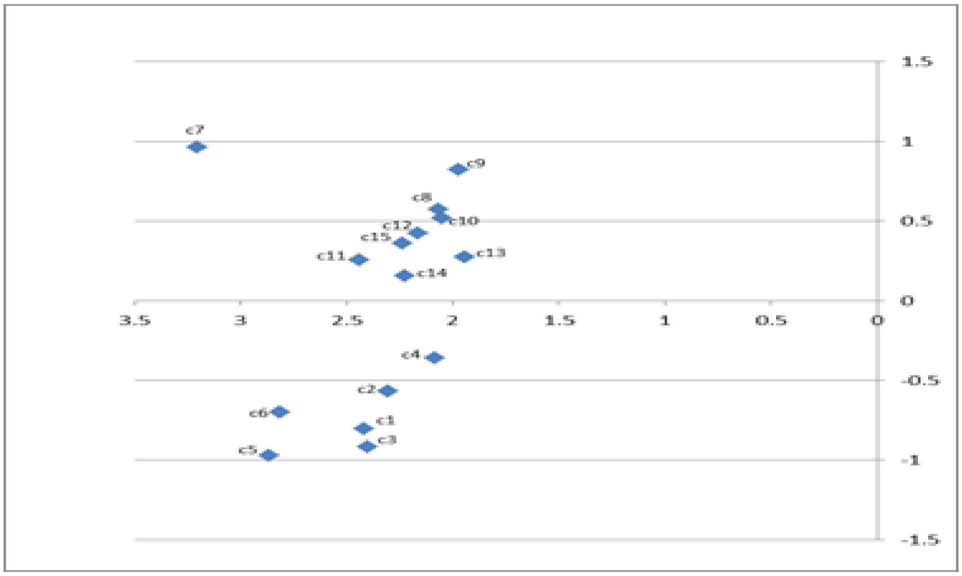

Figure 5 – Position of the elements in possible hierarchy

As it can be seen in diagram obtained from group fuzzy DEMATEL, among the criteria, C5 (Do the parties of accident persist on the presence of disciplinary officer or not) has the least amount of r_i-c_i and its amount is negative. It means that C5 is the most affected criteria and it should have the lowest position in ranking and it has the least priority, but factor C7 (The amount familiarity of the accident parties with blood money and accident law) has the most positive amount of r_i-c_i. It means that C7 is the most effective criteria.

5-5- Selecting some preferred criteria

It showed be mentioned that the model presented in this research is in a way that we will encounter with the limitation of decision matrix submission if all the defined criteria are applied, so we are forced to screen criteria in theoretical phase of this research. Therefore the output of DEMATEL and connoisseurs' experience are used for evaluating and giving advantage to the 15 criteria introduced in table (13). It can be said that, with a view to inequality of the importance of connoisseurs' views, the amount of the importance of each expert's view is taken into account in experts' views table. Also linguistic variables introduced in table (12) are used for showing the partial view of experts.

Linguistic variable	Triangular fuzzy number
Very high(VH)	**(0.75,1,1)**
High(H)	**(0.5,0.75,1)**
Medium(M)	**(0.25,0.5,0.75)**
Low(L)	**(0,0.25,0.5)**
Very Low(VL)	**(0,0,0.25)**

Table 12 – linguistic variables related to the importance of each one of criteria

DM1	DM2	DM3	DM4	DM5	DM6	DM7	
H	M	M	M	L	H	M	C1
M	M	M	M	M	H	M	C2
H	M	M	M	M	H	M	C3
L	M	VH	M	H	L	H	C4
L	VL	VL	L	VL	VL	VL	C5
VL	L	VL	L	VL	M	VL	C6
H	H	H	M	H	H	H	C7
H	VH	VH	M	VH	H	VH	C8
H	H	VH	VH	H	H	VH	C9
M	M	L	M	VL	L	M	C10
M	M	L	M	VL	M	VL	C11
H	VH	M	H	VH	H	M	C12
VH	H	H	H	VH	H	VH	C13
M	H	H	H	H	M	H	C14
M	H	H	H	H	M	H	C15
0.182	0.182	0.159	0.106	0.159	0.106	0.106	**Connoisseurs' weight**

Table 13 – The advantage of criteria from the viewpoint of decision makers

Since the expert's views are as linguistic variable , at first the fuzzy numbers equal to the linguistic amount in table of views. Then through applying the amount of each expert's importance for his view are inserted, the fuzzy mean of these 7 experts' views by using of formula (1) is calculated, and after diffusing the mean of views, we calculate the amount of the importance of 15 criteria is calculated. The amounts of this importance are shown in table (14):

Table 14- Total weight of criteria

criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
weight	0.0629	0.062	0.07	0.07	0.014	0.02	0.085	0.099	0.1	0.043	0.041	0.088	0.098	0.08	0.08

As it is mentioned before, regarding to the existing limitations, 4 more important criteria is selected for entering to ELECTRE-TRI phase, then a Pair Comparison Matrix related to each one of decision makers is used for calculating the relative weight of these 4 criteria toward each other. In this case, with a view of Pair Comparison Matrix, a weight is given to each expert, and then we calculate the total mean of weights as the final weight through applying the amount of each expert's importance. It should be mentioned that we use the numerical range of 0 to 10 for relative evaluation of criteria.

DM3	C1,8	C2,13	C3,9	C4,12
C1,8	1	0.33333333	5	7
C2,13	3	1	3	9
C3,9	0.2	0.33333333	1	9
C4,12	0.14285714	0.11111111	0.111111	1

Table 15- Pair Comparison Matrix of the senior expert of Traffic

The Pair Comparison Matrix for the senior expert of Traffic (as sample) and the final weight of the 4 selected criteria are shown in tables (15) and (16).

Criteria	weight
Income of the accident parties C1,8	0.385333951
Price of the vehicle C2,13	0.296336888
Education level of the accident parties C3,9	0.282415617
Type of the vehicle (organizational or personal) C4,12	0.035913544

Table 16 – Final weight of the selected criteria

5-6- Determining the cases of accident occurrence and establishing decision matrix

Considering that we have 4 criteria in this matrix and also each criterion can appear in matrix at 3 cases introduced in table (17), according to the Possibilities Multiplication Law, the number of cases of accidents' occurrence – that will be the alternatives of matrix – is equal to 81 cases. Decision matrix and numerical amounts alike to it, are shown in table (19):

Diffusion of fuzzy numbers	Fuzzy equivalent of the linguistic variable	Linguistic variable
0.25	(0,0,1)	Weak (W)
1	(0,1,2)	Middle (M)
1.75	(1,2,2)	High (H)

Table 17 – the cases of the appearance of criteria in decision

5-7 Definition of classes (groups)

According to connoisseurs and senior experts of Insurance and decision matrix data, we classify the alternatives from a fraud viewpoint into three groups namely high, middle and weak.

5-7-1- Limits of groups (B= h1, h2…), preference and indifference thresholds

In order to calculate the amount of b_h allocated to each group, we can experientially determine the amounts, based on the investigations of Mooso & Osloonski and with a view to regularity of data. Also in order to define the preference and indifference indexes, formula 6 can be used:

$$\begin{cases} q_j(b_h) = 0.05 g_j(b_h) \\ p_j(b_h) = 0.1 g_j(b_h) \end{cases} \qquad (6)$$

The obtained results are shown in table (18):

g_j	g1	g2	g3	g4
b1	0.5	0.5	0.5	0.5
b2	1.25	1.25	1.25	1.25
$q_j(b_1)$	0.025	0.025	0.025	0.025
$p_j(b_1)$	0.05	0.05	0.05	0.05
$q_j(b_2)$	0.0625	0.0625	0.0625	0.0625
$p_j(b_2)$	0.125	0.125	0.125	0.125

Table 18- The amounts of group's limits, preference threshold and indifference threshold

	C1,8	C2,13	C3,9	C4,12		C1,8	C2,13	C3,9	C4,12
A1	0.25	0.25	0.25	0.25	A42	1	1	1	1.75
A2	0.25	0.25	0.25	1	A43	1	1	1.75	0.25
A3	0.25	0.25	0.25	1.75	A44	1	1	1.75	1
A4	0.25	0.25	1	0.25	A45	1	1	1.75	1.75
A5	0.25	0.25	1	1	A46	1	1.75	0.25	0.25
A6	0.25	0.25	1	1.75	A47	1	1.75	0.25	1
A7	0.25	0.25	1.75	0.25	A48	1	1.75	0.25	1.75
A8	0.25	0.25	1.75	1	A49	1	1.75	1	0.25
A9	0.25	0.25	1.75	1.75	A50	1	1.75	1	1
A10	0.25	1	0.25	0.25	A51	1	1.75	1	1.75
A11	0.25	1	0.25	1	A52	1	1.75	1.75	0.25
A12	0.25	1	0.25	1.75	A53	1	1.75	1.75	1
A13	0.25	1	1	0.25	A54	1	1.75	1.75	1.75
A14	0.25	1	1	1	A55	1.75	0.25	0.25	0.25
A15	0.25	1	1	1.75	A56	1.75	0.25	0.25	1
A16	0.25	1	1.75	0.25	A57	1.75	0.25	0.25	1.75
A17	0.25	1	1.75	1	A58	1.75	0.25	1	0.25
A18	0.25	1	1.75	1.75	A59	1.75	0.25	1	1
A19	0.25	1.75	0.25	0.25	A60	1.75	0.25	1	1.75
A20	0.25	1.75	0.25	1	A61	1.75	0.25	1.75	0.25
A21	0.25	1.75	0.25	1.75	A62	1.75	0.25	1.75	1
A22	0.25	1.75	1	0.25	A63	1.75	0.25	1.75	1.75
A23	0.25	1.75	1	1	A64	1.75	1	0.25	0.25
A24	0.25	1.75	1	1.75	A65	1.75	1	0.25	1
A25	0.25	1.75	1.75	0.25	A66	1.75	1	0.25	1.75
A26	0.25	1.75	1.75	1	A67	1.75	1	1	0.25
A27	0.25	1.75	1.75	1.75	A68	1.75	1	1	1
A28	1	0.25	0.25	0.25	A69	1.75	1	1	1.75
A29	1	0.25	0.25	1	A70	1.75	1	1.75	0.25
A30	1	0.25	0.25	1.75	A71	1.75	1	1.75	1
A31	1	0.25	1	0.25	A72	1.75	1	1.75	1.75
A32	1	0.25	1	1	A73	1.75	1.75	0.25	0.25
A33	1	0.25	1	1.75	A74	1.75	1.75	0.25	1
A34	1	0.25	1.75	0.25	A75	1.75	1.75	0.25	1.75
A35	1	0.25	1.75	1	A76	1.75	1.75	1	0.25
A36	1	0.25	1.75	1.75	A77	1.75	1.75	1	1
A37	1	1	0.25	0.25	A78	1.75	1.75	1	1.75
A38	1	1	0.25	1	A79	1.75	1.75	1.75	0.25
A39	1	1	0.25	1.75	A80	1.75	1.75	1.75	1
A40	1	1	1	0.25	A81	1.75	1.75	1.75	1.75
A41	1	1	1	1					

Table 19- Decision matrix with the parallel numerical amount

In order to classify the optimistic and pessimistic cases as equal, the amount of λ has been considered as 0.50 (λ=0.50) in this research.

Finally, through analyzing the obtained information and by using of ELECTRE-TRI 2a software, all alternatives (cases of accidents occurrence) are classified into three categories, namely, high, middle and weak, that the results of this classification are shown in table (20).

Row	group	Classification of the cases of occurrence	
1	weak	A_{25},A_{26}, A_{27}, A_{52}, A_{53}, A_{54}, A_{61}, A_{62}, A_{63},(A_{70}, A_{71},…, A_{81})	
2	middle	(A_{13}, A_{14},…, A_{18}), A_{22},A_{23}, A_{24},(A_{31}, A_{32},…, A_{51}), A_{58},A_{59}, A_{60}, (A_{64}, A_{65},…, A_{69})	
3	high	(A_1, A_2,…, A_{12}), A_{19},A_{20}, A_{21}, A_{28},A_{29}, A_{30}, A_{55},A_{56}, A_{57}	

Table 20- The results classified by ELECTRE-TRI 2a software

6- Implications of the study

- Since, in this research, a special type of fraud in insurance industry has been considered, it is recommended to use this model in other fields as well.
- Since the insurance companies haven't had enough data for using data-searching model, and we used this model in this research, so that through performing this model, the mentioned companies can use a smart software for recognizing fraudulent persons. So it is also recommended to use data-searching model to discover fraud in insurance industry after executing this model and collecting data through insurance companies.

7- Conclusion

To conclude, the rate of fraud is low in a car accident whenever, for example, three yardsticks are met simultaneously as a: a high level of education (higher than M. A.), b: a suitable financial condition, c: an expensive car. In general, the alternatives which take a higher amount in criterion with a higher weight, are located in the low category (in other words, the possibility of fraud is low in these accidents) and vice versa.

Acknowledgement

The authors are truly thankful to Dr. Akbar Alam Tabriz for his instructive suggestions.

References

Ju-Kuei , I – Shuo Chen. (2009) Using a novel conjunction MCDM approach based on DEMATEL , fuzzy ANP and TOPSIS as an innovation support system for Taiwanese higher education . Expert systems with Application 2009.

Fatith Emare Boran , Mustafa Kurt , Diyor Akay .(2009). A multi criteria intuitionistic fuzzy group decision making for selection of supplier with TOPSIS method. Expert systems with Application.2009.

Dais, L., and Mousseu, V. (2006). Inferring electre's veto-related parameters from outranking examples. European J. of Operational Research, 170 (1), 476-482

Berger, L. (2002). Transport infrastructure regional study (TIRS) in the Balkans, Final Report, Appendix 8,ELECTRE TRI, Balkan.

Mousseau, V., Slowinski, R., and Zielniewicz, P. (1999). Electre_TRI 2.0a methodological guide and user's manual, LAMSADE Pub., Paris University.

Mousseau, V., and Slowinski, R. (1998). Inferring an Electre_TRI model from assignment examples. Journal of Global Optimization, 12, 157-174.

Nijkamp, P. (1977). Stochastic quantitative and qualitative multi criteria analysis for environmental design. Journal of Pap. Reg. Sci. Assoc., 39 (1), 175-199.

Dais, L., and Climaco, J. (2006). Electre-TRI for groups with imprecise information on parameter values. Jurnal of Group Desision and Negotiation, 9 (5), 355-377.

Contant, O., Macnoamara, P., Lafortune, S., and Tenekezi, D. (2007). A hierarchical framework for classifying and accessing internet traffic anomalies, Tech. Report, Dept. of Electrical Eng., University of ,gkg Michigan.