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The Performance Analysis of Fuzzy Topsis and Fuzzy Dematel Methods Into Insurance Companies

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Abstract

Choices of businesses and humans during life may bring positive or negative results and people need to make decisions with optimal benefits. Decision-making is to choose an alternative with the maximum benefits among alternatives. So, using the most appropriate decision-making method is becoming an important issue in decision-making process. In this study, By using the financial charts of seven insurance companies, Trade on Turkey-Istanbul Stock Exchange and financial performance of companies are analyzed with two integrated Multi-Criteria Decision Making (MCDM) methods. In this study, firstly the weights of performance ratios are determined by Fuzzy Decision Making Trial and Evaluation Laboratory (Fuzzy DEMATEL) method. Secondly, while applying Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (Fuzzy TOPSIS) together with Fuzzy DEMATEL, two different integrated methods are applied to MCDM process. Performance order scores from both methods are used for the rates of companies by 2008 - 2014 and for a comparison of two different methods. In conclusion, it was observed that the results obtained are consistent with Topsis and DEMATEL methods. For example preference ranking for 2014 with TOPSIS and DEMATEL methods has been found as AVIVA > AKGRT > ANHYT > ANSGR > YKSGR > RAYSG > GUSGR.

Keywords: Fuzzy DEMATEL-TOPSIS, MCDM, Performance Analysis, Insurance Industry.
JEL Classification Codes: C44, G22, M10.

Bulanık Topsis ve Bulanık Dematel ile Sigorta Firmaları Performans Analizi

Öz

Yaşam süresi boyunca insanların ve işletmelerin yaptığı seçimler olumlu veya olumsuz sonuçlar doğurabilmektedir ve bireyler maksimum fayda sağlayacak kararları vermeye ihtiyaç duymaktadırlar. Karar verme, alternatifler arasından maksimum faydayı sağlayacak alternatifi seçmektir. Böylece Karar verme sürecindeki konuya ilişkin en uygun karar verme yöntemini kullanmak önemli bir konu haline gelmektedir. Bu çalışmada İstanbul Menkul Kıymetler Borsası'nda işlem görmekte olan yedi sigorta şirketinin mali tabloları kullanılarak, şirketlerin mali performansları iki tane bütünleşik çok kriterli karar verme yöntemi ile analiz edilmiştir. Çalışmada ilk olarak performans oranlarına ait ağırlıklar Bulanık DEMATEL yöntemi ile belirlenmiştir. Daha sonra TOPSIS ve Bulanık TOPSIS yöntemleri Bulanık DEMATEL yöntemi ile birlikte uygulanarak, farklı iki bütünleşik yöntem çok kriterli karar verme sürecine uygulanmıştır. Her iki yöntem sonucu elde edilen performans sıralama puanları 2008 – 2014 yılları arasında şirketlerin derecelendirilmesinde ve iki farklı yöntemin karşılaştırılmasında kullanılmıştır. Çalışmanın sonucunda TOPSIS ve DEMATEL yöntemi ile elde edilen sonuçların tutarlı olduğu gözlemlenmiştir. Örneğin; TOPSIS ve DEMATEL metodu ile 2014 yılı için tercih sıralaması AVIVA>AKGRT>ANHYT>ANSGR>YKSGR>RAYSG>GUSGR şeklinde bulunmuştur.

Anahtar Kelimeler: Bulanık DEMATEL - TOPSIS, ÇKKV, Performans Analizi, Sigorta Sektörü.
Jel Sınıflandırma Kodları: C44, G22, M10.

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1. Introduction

Today, for many reasons such as the difficulty of living conditions and a large number of alternatives, it’s important to make the right decisions particularly in business life and to be succesful in the light of these right decisions. The kinds of decisions affect the success of the business directly. Comparisons among businesses are important guides to invest and tor identify performance measurement. These comparisons provides the opportunities for businesses operating in the same business line while comparing the strong and the weak sides of each other. Determining whether or not firms use their resources efficiently is obtained by comparing to the others using similar inputs and outputs (Başkaya & Akar, 2005, 37).

In parallel with the development of science and technology, it’s a well-known fact that one dimensional or multivariate analysis isn’t enough to the solve complex structured problems. Thus, events and objects must be defined by not only one variable but also by a large number of variables (Ertuğrul & Aytaç, 2012, 80).

Economic, political, and cultural differences influence the strategic and operational possibilities of firms and therefore might influence profitability (Wagner et al., 2013, 343). Although the insurance industry is one of the least developed financial sectors, it is developing continuously in terms of both the amount of premium per capita and its share in Gross National Product, and so its contribution is increasing the country’s economy day by day (Nomer, 1999, 3). The insurance industry is included in this study because of being an investment area in order to emphasize its increasing importance every year.

Multi-criteria decision-making analysis has got a structure that brings together many evaluation criteria with value levels and that can solve simultaneously. In this way, it’s an important method that provides the most reasonable choice for especially business strategic and critical decisions in the complex structured problems. By this way, the financial values of ISE companies operating in the insurance sector are analyzed particularly for business interest groups including investors to make the right choices and to compare different analysis methods. In this study, the Fuzzy DEMATEL method is used to show the relationships among selection criteria in decision-making process of insurance companies. However, The Fuzzy TOPSIS and TOPSIS methods are used for grading insurance companies and suggesting the alternative proposal to ensure optimum benefit during the decision making process. Decision making group of five is occured for comparisons in the scope of work to be more accurate and more consistent.

The insurance sector is handled in the first section. In this section, the development of insurance sector and its position today are mentioned and its importance is stressed. In the second section, the concept of fuzzy logic is emphasized, its history and application areas are mentioned. Also the use of fuzzy logic and multi-criteria decision making method are explained. However, methods used in application part are discussed and literature scanning is mentioned. In the third part, performance analysis of companies operating in Istanbul Stock Exchange is presented. Data used for comparisons are obtained by companies in these year end balance sheets. Then, fuzzy weights of criteria are calculated according to the comparison results obtained by the decision maker DEMATEL method and five decision makers. Then, Fuzzy TOPSIS and TOPSIS methods are applied as two different integrated methods together with weights obtained by DEMATEL method. In conclusion and recommendation parts, there is a comparison of two integrated methods. However, an evaluation of companies' performance analysis is presented according to both two methods during the years 2008-2014.

2. Insurance Industry

Generally ''Insurance means bringing together many similar units threatened by risks that can be determined probability of occurance with statistical methods and whose economic results can be measurable with money if it happens in order to meet these results by creating a fund.'' Aim of insurance doesn't cover losses on individual basis, its aim is to overcome the loss with statistical methods as bringing together more than one person exposed to the same loss. It aims to minimize risk existing individually by sharing it. Insurancy fulfills not only some operational functions in terms of economic and initiatives, but also compensates losses or risk sharing. It has an economic function at macro level and in terms of initiatives, it operates at micro level and enables them to be involved in economy (Genç, 2002, 3-5).

When examining the development of *Turkish Insurance Sector* related to premium production excluding crisis years, the sector is seen as growing. Sector increases premium production with succesful performance parallel to economic growth in 2012. Total premium production of Turkish insurance sector rises by 15,5 percent last year to 19.826 million. Adjusted for inflation with 6,16 in 2012, premium production rises in real terms by 8%. From this perspective, sector records a growth above general economic growth. According to Turkey Insurance Association, in 2012, premiums of life branch reach 2,7 million Turkish Liras (TL) by an increase of 1% while total premium production in non-life branches reaches 19.826 million TL by an increase of 15,5%. The ones having the most premium production among non-life branches are 1.742 million TL general losses, 4.533 million TL motor vehicles, 3.937 million TL motor vehicles, 2.645 million TL fire and natural disasters, 2.237 million TL sickness/health. There has been an important increase of global reinsurance capacity in 2012, but the capacity to supply Turkish Insurance Sector hasn't got an increase correspondingly (Sigortacılık Sektörüne Bakış, 2013).

In the insurance industry premium production in 2013 increased by 22 per cent compared with the previous year to 24 billion 182 million pounds was reached. At the end of 2013, considering the annual inflation rate (CPI: 7.40, PPI: 6.97) insurance sector in real terms grew by 14,57. (2013 Sigortacılığa Dönüş Yılı Oldu, 2014)

In 2013 the insurance industry has made a very good start. Insurance sector grew by 25% in the first quarter. In particular, *IPS, TCIP and casco* state contribution and support in the areas of recent growth has been behind the success factors (Yıl 2023, Türkiye "Sigorta" ile Zirvede, 2013).

One of the most important developments in Turkish Insurance Sector in 2012 is seen in Individual Pension System (IPS). The new Turkish Commercial Law which gets into force in 2012 with numbered 6102 and Individual Pension Savings and Investment System Law with number 6327 is accepted as an important improvement in terms of not staying behind the changing needs. The Regulation on Government Contribution is published in the Official Newspaper with numbered 28512 and dated 29.12.2012 and gets into force in the new year. Thus, the system pension policy owners have begun to get the state contribution about 25% of total. But the state contribution can’t exceed 222 Liras a month, 2264 Liras a year. This amount is planned to increase according to the extent of the minimum wage. Based on the data of Pension Monitoring Centre (PMC), from the date 5 April 2013, Individual Retirement participant number has reached 3.457.582. The fund size directed from Individual Pension Fund into investment is at the level of 17 billion 275 million, collected contribution share is at the level of 17 billion 719 million liras (Sigortacılık Sektörüne Bakış, 2013). That insurance has such a global structure makes it a key sector in financial system and the real economy. With this feature, the share of insurance sector has been increasing more and more depending on the regional and global developments (Tatlıgül and İçen, 2013, 21). According to the World Economic Forum’s Financial Development Report in 2012, Turkey has the rank of 35 in the world in terms of Insurance Sector. As compared to the previous year, our country taking a further rank has a great potential and an insurance sector that is open to development.

3. Fuzzy Multi Criteria Decision Making

In 1965, L. A. Zadeh develops ‘Fuzzy Sets’ as a tool for the presentation of uncertainty (Zadeh, 1965, 338-353). In the past, general and specific terms and concepts with uncertainty are included in a random distinction and they are identified by two-valued set theory. Fuzzy sets theory leads to many definitions for the terms and concepts of uncertainty without getting them into a random distinction, but by giving certainty degree to the uncertainties within the scope of a very valuable sets theory (Çitli, 2006, 3).

Fuzzy set is a group that aims at undivided membership degree (Zadeh, 1965, 338). Fuzzy numbers can be defined as a function that matches each real number with closed interval of [0,1]. Like in the non-fuzzy sets, non-fuzzy numbers are defined at a single point and their membership values are 0 or 1. A fuzzy number is defined by at least one interval and its membership degree takes any value in the covered interval of [0,1]. Namely, a fuzzy number does not have a certain value, but it can be known with its available values and the membership degrees of these values.

Triangular membership functions are defined as the function whose elements are A = (m, n, u). Here, if it is accepted as the most probable value of n, the minimum value of m, or its lower limit is u, u represents the maximum value or the upper limit. Triangular membership function chart shown in Fig. 1; (Chen, 2000, 3)

$$\boldsymbol{\mu_{\tilde{A}}(x)} = \begin{cases} \mathbf{0}\ , & \boldsymbol{x} < m \\ \frac{\boldsymbol{x-m}}{\boldsymbol{n-m}}\ , & \boldsymbol{m \leq x \leq n} \\ \frac{\boldsymbol{u-x}}{\boldsymbol{u-n}}\ , & \boldsymbol{n \leq x \leq u} \\ \mathbf{0}\ , & \boldsymbol{x} > u \end{cases}$$

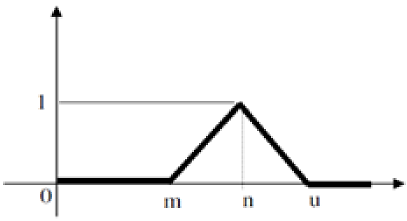

Figure 1: Triangular Fuzzy Number
Source: Chen (2000, 3)

In the multi-criteria decision making (MCDM) with group decision problems generally there arise situations of conflict and agreement among the experts as each expert has his own opinion or estimated rating under each criterion for each alternative (Hsu & Chen, 1996, 279). Multi-criteria decision making is included in models, methods, approaches and concepts that help decision makers to identify the choises according to various criteria. Literature on multi-criteria decision-making is highly developed in the recent past. Fuzzy set theory contributes to both multi purpose decision making and highly qualified decision making (Çitli, 2006, 50). Kickert has discussed the eld of fuzzy multicriteria decision making. Zimmermann illustrated a fuzzy set approach to multiobjective decision making. Yager presented a fuzzy multiattribute decision-making method, using crisp weights and he introduced an ordered weighted aggregation operator and investigated the properties of the operator. Laarhoven et al. presented a method for multiattribute decision making, using fuzzy numbers as weights. Zimmermann has compared some approaches to solve multiattribute decision problems based on fuzzy set theory (Hong & Choi, 2000, 103).

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The reason to use multi criteria decision making methods is to keep under control decision making mechanism in the situations of multiple and general conflicting criteria with each other and to reach the decision as possible as quickly and easily (Ertuğrul & Karakaşoğlu, 2010, 24).

3.1. Fuzzy DEMATEL

Between the years 1972 - 1976, developed by Geneva Battelle Memorial Institute Of Science and Human Affairs Program, DEMATEL method is used to research the nested problem groups and to solve them (Tzeng et al., 2007, 1031). The original DEMATEL Method aims the fragmented and uncompromising events of the the world communities and integrated solutions for them. DEMATEL pragmatic method for especially visualization structure of complex causal relationships has become so popular in Japan (Wu & Lee, 2007, 501).

DEMATEL is a comprehensive method to create a structural model including the relationships among complex factors and to analyze. Criteria are divided into two groups in DEMATEL method; cause group and effect group. Finding which factors are the affecting and which ones are the affected is an key stage in the solution of complex problems handled. So, DEMATEL is a method used to determine the affecting and the affected factors having a complex structure for the events. It basically aims meaningful results by visualizing the complex cause and effect relationships. But it is diffucult to determine the extent of the interaction betweeen the factors. Its reason is that it's difficult to express the interaction between the factors as quantitatively. So Lin and Wu expand DEMATEL method into fuzzy context (Lin & Wu, 2008, 205-213). The reason to suggest such this model is that the criteria for each hierarchy level are included in the hierarchy between criteria with fuzzy pairwase comparisons (Baykasoğlu et al., 2013, 902). Fuzzy DEMATEL method mainly aims to get meaningful results by visualizing the complex cause and effect relationships (Öztürk, 2009, 78). DEMATEL is built on the basis of graph theory, enabling analyzes and solves problems by visualization method. This structural modeling approach adopts the form of a directed graph, a causal-effect diagram, to present the interdependence relationships and the values of influential effect between factors. Through analysis of visual relationship of levels among system factors, all elements are divided into causal group and effected group. And this can help researchers better understand the structural relationship between system elements, and find ways to solve complicate system problems (Quan et al., 2011, 246). Suggested by Lin and Wu, Fuzzy DEMATEL Method covers the steps given below (Lin & Wu, 2008, 208-210).

Step 1: Determining factors and the creation of fuzzy scale.

In this step, the factors should be determined for an evaluation. To determine the affecting and affected factors, meaningful correlations between the factors should be obtained by the experts. After creating these correlations, bilateral comparisons between the functions should be obtained by the experts. After creating these correlations, bilateral comparisons between the functions should be made. But during the comparison, it's difficult to determine to what extent one factor effects the other one. So, proposed by Chen, fuzzy scale is used. According to this scale, it is thought as a linguistic variable that a factor affects the other and it's explained by seven linguistic terms of 'Very High' (VH), 'High' (H), 'Medium High' (MH), 'Medium' (M), 'Medium Low' (MD), 'Low' (L), 'Very Low' (VL) as shown in the Table 1.

Table 1: Fuzzy Scale

	Linguistic Terms	Abbreviation	For Fuzzy Numbers
1	Very Low	VL	(0,0,0.1)
2	Low	L	(0,0.1,0.3)
3	Medium Low	MD	(0.1,0.3,0.5)
4	Medium	M	(0.3,0.5,0.7)
5	Medium High	MH	(0.5,0.7,0.9)
6	High	H	(0.7,0.9,1.0)
7	Very High	VH	(9.0,1.0,1.0)

Source: Chen (2000, 5)

Step 2: The creation of the direct relation matrix. Assessment of bilateral correlations between the factors of decision-makers.

To measure the correlation levels between criteria {C1, C2, ..., Cn}, pairwise comparison matrix is created by an expert with linguistic expressions. Suppossed the decision group with the experts number 'p', decision matrix with P number $\tilde{Z}^{(1)}$, $\tilde{Z}^{(2)}$, ... , $\tilde{Z}^{(p)}$ is obtained. $\tilde{Z}$ fuzzy matrix is called the direct relation matrix.

$$\tilde{Z} = \begin{matrix} 0 & \cdots & \tilde{Z}_{1n} \\ \vdots & \ddots & \vdots \\ \tilde{Z}_{n1} & \cdots & 0 \end{matrix} \tag{1}$$

(i=1,2,...,n) is given as (0,0,0)

Step 3: The creation of the normalized direct correlation matrix.

The normalized direct correlation matrix is calculated with a direct relation matrix and the numbers equation (2) and (3). $\widetilde{x}$ matrix is called as 'the normalized direct relation matrix'.

$$\widetilde{x} = \begin{bmatrix} \widetilde{x}_{11} & \cdots & \widetilde{x}_{1n} \\ \vdots & \ddots & \vdots \\ \widetilde{x}_{m1} & \cdots & \widetilde{x}_{mn} \end{bmatrix} \qquad \tilde{x}_{ij} = \frac{\tilde{z}_{ij}}{r_{l,n,u}} = \left(\frac{l_{ij}}{r_l}, \frac{n_{ij}}{r_n}, \frac{u_{ij}}{r_u}\right) \qquad \tilde{x} = r^{-1} \times \tilde{z} \tag{2}$$

$$r_s^{(k)} = max\left(\sum\nolimits^{n}_{\substack{j=1 \\ 1\le i\le n}} z^{k}_{ij,s}\right) \qquad s \in \{l,n,u\} \qquad i,j \in \{1,2,3,\dots,n\} \tag{3}$$

Step 4: The creation of total correlation matrix.

Total correlation matrix (T) is calculated with the help of normalized direct correlation matrix and Equation (4).

$$S = M + M^2 + M^3 + \cdots = \sum\nolimits^{\infty} M^i = M(1-M)^{-1}\ \tilde{T} = \begin{bmatrix} \tilde{t}_{11} & \cdots & \tilde{t}_{1n} \\ \vdots & \ddots & \vdots \\ \tilde{t}_{m1} & \cdots & \tilde{t}_{mn} \end{bmatrix} \tag{4}$$

Step 5: The calculation of the sender and the receiver group.

After obtaining $\tilde{T}$ matrix, $\widetilde{D}_i + \tilde{R}_i$ and $\widetilde{D}_i - \tilde{R}_i$ values are calculated as the sum of the column elements $\tilde{R}_i$, $\tilde{T}$ matrix and the raw elements in $\widetilde{D}_i$, $\tilde{T}$ matrix (Baykasoğlu et al.. 2013, 902; Öztürk, 2009, 78; Baykasoğlu et al., 2011, 171; Yao and Wu, 2000, 283).

Defuzzification of the number of $\widetilde{D}_i + \tilde{R}_i$ and $\widetilde{D}_i - \tilde{R}_i$:

$$\widetilde{D}_i^{Def} + \tilde{R}_i^{Def} = \frac{1}{4}(l + 2n + u) \tag{5}$$

$$\widetilde{D}_i^{Def} - \tilde{R}_i^{Def} = \frac{1}{4}(l + 2n + u) \tag{6}$$

Step 6: The calculation of weights.

The defuzzificated values of criteria, their weight coefficients values are calculatedwith the help of the following formulas below.

$$\omega_i = \left\{\left(\widetilde{D}_i^{def} + \tilde{R}_i^{def}\right)^2 + \left(\widetilde{D}_i^{def} - \tilde{R}_i^{def}\right)^2\right\}^{1/2} \tag{7}$$

$$W_i = \frac{\omega_i}{\sum_{i=1}^{n} \omega_i} \tag{8}$$

3.2. TOPSIS - Fuzzy TOPSIS

One of many famous multi criteria decision making methods, TOPSIS is a useful and a practical method for the evaluation and selection thanks to Euclidean distance measurement (Wang & Lee, 2009, 8981).

TOPSIS method is introduced by Hwang and Yoon (1981). TOPSIS method is one of the multi criteria decision making methods. Using this method, alternative options should be compared according to certain criteria and ideal positions including the possible maximum and minimum values of criteria. As the number 'N' is for its alternatives and as the number 'M' is for its criteria, multi criteria decision making problem may be shown with N the points in three dimensional space. Hwang & Yoon (1981). They create TOPSIS method according to the assumption that solution alternative has the minimum distance to positive ideal point and maximum distance to the negative ideal solution point (Demireli, 2010, 104). While positive ideal solution is described as a solution that maximizes the benefit criteria and minimize the damage criteria, negative ideal solution is described as a solution that maximizes the damage criteria and minimizes the benefit criteria. Certain numbers are used for performance evaluation and the importance degree of criteria. In many cases, certain numbers are inadequate to model real life situations. A more realistic approach may be using the linguistic values instead of numerical values. In Fuzzy TOPSIS method, caring the uncertain atmosphere in the real life, while making group decisions, the evaluations of alternatives are obtained by linguistic variables according to the criteria and the importance weights of criteria. Fuzzy TOPSIS method is a developed multi criteria decision making method to solve the problems requiring making the group decision and the problems including linguistic uncertainty based on human judgements during decision making process (Demir, 2010, 55).

In fuzzy multi criteria decision making, performance ratings and its weights are usually represented by fuzzy numbers. An alternative is calculated by collecting its all criteria weights and its alternative ratings and preferring the higher useful alternative (Wang & Lee, 2009, 8981).

Fuzzy TOPSIS method is a decision tool that is used in decision making in fuzzy environments, that gives the membership function to the evaluations with linguistic variables and makes them numerical and that presents the candidates an evaluation opportunity thanks to its algorithym. In Fuzzy TOPSIS method, the affinity coefficients of candidates are ranged by calculating the promixity coefficiencies take a value between 0 and 1. The closer the conclusion is to 1, the greater the chance of candidate selection is. The base of Fuzzy TOPSIS method is a manner in which the selected alternative is the closest to the Fuzzy Positive

Ideal Solution (FPIS) and is at the maximum distance to the Fuzzy Negative Ideal Solution (FNIS). The most distinctive feature is that it enables the decision criteria to have different importance weights. The algorithm of Fuzzy TOPSIS method is like that: Decision makers evaluate the importance level of decision criteria and the candidates according to these criteria. The linguistic variables used for the evaluation and the provisions of these variables in triangular fuzzy numbers are given in Table 1 (Ecer, 2006, 83).

The application differences of TOPSIS and Fuzzy TOPSIS multi criteria decision making methods are explained in Fuzzy TOPSIS method. During the application of Fuzzy TOPSIS, the following steps below are followed (Chen, 2000, 5):

Step 1: The identification of fuzzy scale and the creation of Fuzzy Decision Matrix

In this period, including the correlations between alternatives and criteria, Matrix is firstly created by linguistic expressions (Table 1). Then, they are shown with fuzzy numbers on the matrix and a direct correlation matrix comes out.

Decision matrix lines are with decision points of superiorities to be demonstrated and its colums are with the evaluation factors to be used in the decision making. The matrix A is an initial matrix created by the decision maker. The decision matrix is shown as follows:

$$A_{mn} = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{bmatrix}$$

In A_{mn} matrix, m represents the number of decision point, n gives the number of assessment factor (Chen, 2000, 5).

Step 2: Creating the normalized decision matrix.

The next step after the creation of decision matrix is the normalization of decision matrix. The normalized fuzzy decision matrix is shown as $\tilde{R}$.

$$\tilde{R} = \left[\tilde{r}_{ij}\right]_{m\times n}$$

While the matrix is being normalizated, B and C, the benefit (B) and cost (C) criteria are calculated using the formulas with the numbers 9 (Öztürk et al., 2008, 796).

$$\tilde{r}_{ij} = \left(\frac{l_{ij}}{u_j^*}, \frac{m_{ij}}{u_j^*}, \frac{u_{ij}}{u_j^*}\right) \quad \begin{matrix} j \in B \\ u_j^* = \max\limits_i u_{ij} \end{matrix} \quad \tilde{r}_{ij} = \left(\frac{l_j^-}{u_{ij}}, \frac{l_j^-}{m_{ij}}, \frac{l_j^-}{l_{ij}}\right) \quad \begin{matrix} j \in C \\ l_j^- = \min\limits_i l_{ij} \end{matrix} \tag{9}$$

In TOPSIS method, the Standart Decision Matrix is calculated by using the elements of the matrix A and the equation numbered as (10). Matrix R is obtained as below (Chen, 2000, 5):

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}} \qquad R_{ij} = \begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{bmatrix} \tag{10}$$

Step 3: Creating weighted standard decision matrix.

Firstly, all weight values (w_i) are determined on the evaluation factors. The standart weighted decision matrix is indicated by $''\tilde{V}''$. The calculation way is shown in the formul with the number (11) (Baykasoğlu et al., 2013, 902).

$$V_{ij} = \begin{bmatrix} w_1 r_{11} & \cdots & w_n r_{1n} \\ \vdots & \ddots & \vdots \\ w_1 r_{m1} & \cdots & w_n r_{mn} \end{bmatrix} \qquad \tilde{v}_{ij} = \tilde{r}_{ij} \times \tilde{\omega}_j \qquad \sum_{i=1}^{n} w_i = 1 \tag{11}$$

Step 4: Determination of negative and positive ideal solutions.

In order to establish a set of ideal solution, the weighted evaluation factors of V matrix, namely the biggest in the column values is selected (The smallest is selected if the related evaluation is of the minimization way). Finding the ideal solution set is shown in the formula below (Yoon and Hwang, 1995, 23).

$$A^* = \left\{ \left(\max_i v_{ij} \middle| j \in J \right), \left(\min_i v_{ij} \middle| j \in J' \right) \right\} \tag{12}$$

The set A^* to be calculated by the formula with number (12) can be shown like that:

$$A^* = \left\{ v_1^*, v_2^*, \ldots, v_n^* \right\}$$

The negative ideal solution set is obtained by selecting the smallest in the column values or in the weighted evaluation factors of V matrix (The biggest is selected if the related evaluation factor is of the maximization way).

The negative ideal solution set is shown in the formula below:

$$A^- = \left\{ \left(\min_i v_{ij} \middle| j \in J \right), \left(\max_i v_{ij} \middle| j \in J' \right) \right\} \tag{13}$$

The set to be calculated from the formula (13) can be shown like that:

$$A^- = \{v_1^-, v_2^-, ..., v_n^-\}$$

Both of formulas, J' represents the benefit value (maximization) and J represents the cost value (minimization).

Both ideal and negative solution set consist of evaluation factor number (m).

Step 5: Calculation of positive and negative distances.

Each alternative's distances to positive ideal solution A^+ and negative ideal solution A^- are calculated by the formulas 14 and 15 respectively.

$$d_i^+ = \sqrt{\frac{1}{3}\sum_{j=1}^{n} d_v\left(\tilde{v}_{ij}, v_j^+\right)} \qquad j = 1,2,\dots,n \tag{14}$$

$$d_i^- = \sqrt{\frac{1}{3}\sum_{j=1}^{n} d_v\left(\tilde{v}_{ij}, v_j^*\right)} \qquad i = 1,2,\dots,n \tag{15}$$

Here d_v shows the distance between two fuzzy numbers and it is calculated using the vertex method (Demir, 2010, 67).

$$d(\widetilde{m}, \tilde{n}) = \sqrt{\frac{1}{3}[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2]} \tag{16}$$

Here, to measure the distance between two triangular fuzzy numbers, it is suggested Vertex method which is effective and simple, and we extend fuzzy environment into TOPSIS procedure. In fact, the vertex method can easily be applied to calculate the distance between two fuzzy numbers whose their membership function is linear. During the group decision making process, in the suggested method, it is not difficult to use the other collection functions to combine the degrees of other decision makers (Chen, 2000, 7-8).

In TOPSIS method, Euclidian Distance Approach is used for finding the deviations of evaluation factor value on each decision point from positive ideal and negative ideal solution set. The deviation values on decision points are called as Ideal Distinction (S_i^*) and negative ideal distinction (S_i^-) measurement. The calculation of ideal distinction measure (S_i^*) is shown in the formula (17), and the calculation of negative ideal solution measure (S_i^-) is shown in the formula (18).

$$S_i^* = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^*\right)^2} \quad j = 1,2,\dots,n \tag{17}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^-\right)^2} \quad i = 1,2,\dots,m \tag{18}$$

Step 6: The calculation of the proximity coefficients.

For the calculation of the relative proximity of each decision point, the ideal and the negative ideal dinstriction measurements are used. The criteria used here is the share of the negative ideal distinction measure in the total distinction measure. In order to determine the ranking of the alternatives, the proximity coefficients for each a alternative (C_i) is calculated. The proximity coefficient cares simultaneously fuzzy positive ideal solution A^+ and fuzzy negative ideal solution A^- distances. Each alternative proximity is calculated by the Formula (19) (Çınar, 2010, 41).

$$CC_i = \frac{d_i^-}{d_i^* + d_i^-} \quad i = 1,2,\dots,m \tag{19}$$

Here, the value C_i^* takes place in the range of $C_i^* = 1$ and $0 \le C_i^* \le 1$ indicates the absolute proximity of related decision point to the ideal solution, $C_i^* = 0$ indicates the absolute proximity of related decision point to the negative ideal solution (Yaralıoğlu, 2004, 26).

4. Application

4.1. Defining The Problem

In the performance analysis problem, the application of Fuzzy DEMATEL, Fuzzy TOPSIS and TOPSIS method is obtained by the financial structure rates of insurance companies operating in Turkey-Istanbul Stock Exchange (IMKB). The application enables some information about financial structures of insurance companies and it is presented the differences between two methods compared. In the study, it is used financial structure rates of insurance companies between the years 2008-2014. The data are obtained from the official web site called 'Public Information Platform' (www.kap.gov.tr). The criteria are determined and evaluated by a group of decision makers. In the study, it is presented the ranking of insurance companies by years.

4.2. Determining The Criteria And Creating Decision Makers Group

As the evaluation criteria for analysis through similar studies; nine criteria are defined as Current Ratio, Liquidity Ratio, Cash Ratio, Leverage Ratio, Financial Ratio, Asset Turnover Ratio, Equity Capital Rate, Net Profit Margin, Return On Equity (Uygurtürk and Korkmaz, 2012, 103) in the Table 2.

Table 2: Comparison Criteria

Code	Ratio	Formula
CR	Current Ratio	= Current Assets / Current Liabilities
LR	Liquidity Ratio	=(Current Assets-Stock-Prepaid Expenses) / Short-Term Debt
CAR	Cash Ratio	= (Cash Equivalents + Marketable Securities) / Current Liabilities
LR	Leverage Ratio	= Total Debt / Total Assets
FR	Financial Ratio	= Total Liabilities / Shareholders' equity
AT	Asset Turnover	= Net Sales / Total Assets
ECR	Equity Capital Rate	= Net Sales / Shareholders' equity
NPM	Net Profit Margin	= Net Income / Net Sales
ROE	Return On Equity	= Net Income / Shareholders' equity

Source: Uygurtürk & Korkmaz (2012, 103)

To evaluate the correlation between these criteria, five different decision makers who want to invest are interviewed and the comparisons are evaluated.

4.3. The Application Of Fuzzy DEMATEL Method

Step 1: Identification of evaluation criteria and determination of the fuzzy linguistic scale.

The evaluation criteria; Current Ratio, Liquidity Ratio, Cash Ratio Leverage Ratio, Financial Ratio, Asset Turnover, Equity Capital Rate, Net Profit Margin, Return On Equity (Uygurtürk & Korkmaz, 2012, 103; Dumanoğlu, 2010, 329).

A fuzzy scale used for creating matrix is given in Table 1.

Step 2: Establishment of direct correlation matrix.

Firstly, direct correlation matrix is generated for the criteria by five decision makers.

Table 3: Direct Correlation Matrix of First Decision Maker

	CR	**LR**	**CAR**	**LR**	**FR**	**AT**	**ECR**	**NPM**	**ROE**
CR	-	MH	M	H	VL	MD	MD	VL	L
LR	H	-	VH	M	MD	MD	L	VL	L
CAR	MH	VH	-	MD	MD	L	L	VL	L
LR	MH	M	M	-	MH	MH	MD	VL	MD
FR	MD	L	L	VH	-	M	H	L	M
AT	M	L	L	MH	MD	-	H	MH	MD
ECR	MD	MD	MD	MD	MH	MH	-	H	H
NPM	L	VL	VL	VL	MD	MH	MH	-	H
ROE	L	L	VL	L	M	MD	MH	H	-

The direct correlation matrix of the first decision maker presented by linguistic expressions shown in the Table 3 is given with fuzzy numbers in the Table 4.

Table 4: First Decision Maker's Direct Correlation Matrix with Fuzzy Numbers

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
CR	-	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.7,0.9,1.0)	(0,0,0.1)	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0,0,0.1)	(0,0.1,0.3)
LR	(0.7,0.9,1.0)	-	(9.0,1.0,1.0)	(0.3,0.5,0.7)	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0,0.1,0.3)	(0,0,0.1)	(0,0.1,0.3)
CAR	(0.5,0.7,0.9)	(9.0,1.0,1.0)	-	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0,0.1,0.3)	(0,0.1,0.3)	(0,0,0.1)	(0,0.1,0.3)
LR	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.3,0.5,0.7)	-	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.1,0.3,0.5)	(0,0,0.1)	(0.1,0.3,0.5)
FR	(0.1,0.3,0.5)	(0,0.1,0.3)	(0,0.1,0.3)	(9.0,1.0,1.0)	-	(0.3,0.5,0.7)	(0.7,0.9,1.0)	(0,0.1,0.3)	(0.3,0.5,0.7)
AT	(0.3,0.5,0.7)	(0,0.1,0.3)	(0,0.1,0.3)	(0.5,0.7,0.9)	(0.1,0.3,0.5)	-	(0.7,0.9,1.0)	(0.5,0.7,0.9)	(0.1,0.3,0.5)
ECR	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	-	(0.7,0.9,1.0)	(0.7,0.9,1.0)
NPM	(0,0.1,0.3)	(0,0,0.1)	(0,0,0.1)	(0,0,0.1)	(0.1,0.3,0.5)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	-	(0.7,0.9,1.0)
ROE	(0,0.1,0.3)	(0,0.1,0.3)	(0,0,0.1)	(0,0.1,0.3)	(0.3,0.5,0.7)	(0.1,0.3,0.5)	(0.5,0.7,0.9)	(0.7,0.9,1.0)	-

Direct correlation matrixes obtained by decision-makers are used to calculate the initial direct correlation matrix shown in the Table 5.

Table 5: **Initial Direct Correlation Matrix**

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
CR	(0,0,0)	(0.62,0.82,0.96)	(0.42,0.62,0,82)	(0.62,0.80,0.94)	(0.04,0.14,0,30)	(0.22,0.42,0,62)	(0.12,0.30,0,50)	(0,0,0.10)	(0,0.08,0.26)
LR	(0.66,0.86,0.98)	(0,0,0)	(0.90,1.00,1.00)	(0.30,0.50,0.70)	(0.10,0.26,0.46)	(0.12,0.26,0.50)	(0.02,0.12,0.03)	(0,0.02,0.14)	(0.02,0.12,0.30)
CAR	(0.54,0.74,0.92)	(9.0,1.0,1.0)	(0,0,0)	(0.28,0.42,0.62)	(0.14,0.34,0.54)	(0.02,0.12,0.30)	(0.02,0.12,0.30)	(0,0.02,0.14)	(0,0.10,0.30)
LR	(0.50,0.70,0.88)	(0.30,0.50,0.70)	(0.30,0.50,0.70)	(0,0,0)	(0.50,0.70,0.90)	(0.50,0.70,0.88)	(0.08,0.26,0.46)	(0,0.02,0.14)	(0.08,0.26,0.46)
FR	(0.14,0.34,0.54)	(0.02,0.12,0.30)	(0.06,0.20,0.38)	(0.70,0.86,0.96)	(0,0,0)	(0.22,0.42,0.62)	(0.70,0.88,0.98)	(0,0.08,0.26)	(0.30,0.50,0.70)
AT	(0.30,0.50,0.70)	(0.04,0.18,0.38)	(0.02,0.12,0.30)	(0.46,0.66,0.86)	(0.12,0.30,0.50)	(0,0,0)	(0.66,0.86,0.98)	(0.46,0.66,0.86)	(0.12,0.30,0.50)
ECR	(0.08,0.26,0.46)	(0.08,0.22,0.42)	(0.10,0.28,0.46)	(0.14,0.34,0.54)	(0.54,0.74,0.92)	(0.54,0.74,0.90)	(0,0,0)	(0.70,0.88,0.98)	(0.66,0.86,0.98)
NPM	(0,0.06,0.22)	(0,0,0.10)	(0,0.02,0.14)	(0,0.02,0.14)	(0.04,0.18,0.38)	(0.54,0.72,0.92)	(0.62,0.82,0.96)	(0,0,0)	(0.70,0.88,0.98)
ROE	(0,0.10,0.30)	(0.02,0.12,0.30)	(0,0.02,0.14)	(0.06,0.20,0.38)	(0.30,0.50,0.70)	(0.12,0.30,0.50)	(0.50,0.70,0.90)	(0.70,0.88,0.98)	(0,0,0)

Step 3: Establishment of normalized direct correlation matrix

Matrixes are normalized by equation (2) and (3). Decision maker's normalized matrix is given in the Table 6.

Table 6: Normalized Direct Correlation Matrix

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
CR	(0,0,0)	(0.22,0.19,0.17)	(0.15,0.14,0.15)	(0.22,0.19,0.17)	(0.01,0.03,0.05)	(0.08,0.10,0.11)	(0.04,0.07,0.09)	(0,0,0.02)	(0,0.02,0.05)
LR	(0.23,0.20,0.17)	(0,0,0)	(0.32,0.23,0.18)	(0.11,0.12,0.12)	(0.04,0.06,0.08)	(0.04,0.06,0.09)	(0.01,0.03,0.05)	(0,0,0.02)	(0.01,0.03,0.05)
CAR	(0.19,0.17,0.16)	(0.32,0.23,0.18)	(0,0,0)	(0.10,0.10,0.11)	(0.05,0.08,0.10)	(0.01,0.03,0.05)	(0.01,0.03,0.05)	(0,0,0.02)	(0,0.02,0.05)
LR	(0.18,0.16,0.16)	(0.11,0.12,0.12)	(0.11,0.12,0.12)	(0,0,0)	(0.18,0.16,0.16)	(0.18,0.16,0.16)	(0.03,0.06,0.08)	(0,0,0.02)	(0.03,0.06,0.08)
FR	(0.05,0.08,0.10)	(0.01,0.03,0.05)	(0.02,0.05,0.07)	(0.25,0.20,0.17)	(0,0,0)	(0.08,0.10,0.11)	(0.25,0.20,0.17)	(0,0.02,0.05)	(0.11,0.12,0.12)
AT	(0.11,0.12,0.12)	(0.01,0.04,0.07)	(0.01,0.03,0.05)	(0.16,0.15,0.15)	(0.04,0.07,0.09)	(0,0,0)	(0.23,0.20,0.17)	(0.16,0.15,0.15)	(0.04,0.07,0.09)
ECR	(0.03,0.06,0.08)	(0.03,0.05,0.07)	(0.04,0.06,0.08)	(0.05,0.08,0.10)	(0.19,0.17,0.16)	(0.19,0.17,0.16)	(0,0,0)	(0.25,0.20,0.17)	(0.23,0.20,0.17)
NPM	(0,0.01,0.04)	(0,0,0.02)	(0,0,0.02)	(0,0,0.02)	(0.01,0.04,0.07)	(0.19,0.17,0.16)	(0.22,0.19,0.17)	(0,0,0)	(0.25,0.20,0.17)
ROE	(0,0.02,0.05)	(0.01,0.03,0.05)	(0,0,0.02)	(0.02,0.05,0.07)	(0.11,0.12,0.12)	(0.04,0.07,0.09)	(0.18,0.16,0.16)	(0.25,0.20,0.17)	(0,0,0)

Step 4: Total correlation matrix

After obtaining the normalized correlation matrix, total correlation matrix is obtained by using equation (4). The obtained total correlation matrix is given in the Table 7.

Table 7: Total Correlation Matrix

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
CR	(0.36,0.35,0.48)	(0.52,0.46,0.55)	(0.45,0.41,0.52)	(0.53,0.52,0.64)	(0.24,0.31,0.49)	(0.34,0.40,0.57)	(0.29,0.37,0.55)	(0.17,0.19,0.34)	(0.17,0.26,0.44)
LR	(0.57,0.51,0.59)	(0.38,0.31,0.38)	(0.59,0.47,0.52)	(0.46,0.46,0.57)	(0.25,0.32,0.48)	(0.29,0.35,0.52)	(0.25,0.32,0.48)	(0.15,0.17,0.32)	(0.16,0.25,0.41)
CAR	(0.51,0.46,0.56)	(0.60,0.47,0.52)	(0.33,0.27,0.35)	(0.43,0.41,0.54)	(0.24,0.31,0.47)	(0.25,0.30,0.47)	(0.22,0.30,0.46)	(0.13,0.16,0.30)	(0.14,0.22,0.39)
LR	(0.51,0.51,0.65)	(0.41,0.42,0.54)	(0.39,0.40,0.52)	(0.40,0.41,0.54)	(0.41,0.46,0.62)	(0.47,0.50,0.67)	(0.38,0.44,0.60)	(0.24,0.24,0.39)	(0.26,0.34,0.51)
FR	(0.34,0.41,0.57)	(0.26,0.32,0.45)	(0.25,0.31,0.45)	(0.56,0.55,0.65)	(0.31,0.34,0.47)	(0.44,0.47,0.61)	(0.61,0.56,0.66)	(0.32,0.29,0.41)	(0.40,0.42,0.54)
AT	(0.37,0.44,0.60)	(0.24,0.32,0.48)	(0.23,0.29,0.45)	(0.46,0.50,0.65)	(0.31,0.40,0.57)	(0.36,0.39,0.54)	(0.59,0.58,0.68)	(0.45,0.41,0.51)	(0.36,0.40,0.54)
ECR	(0.32,0.42,0.60)	(0.26,0.34,0.51)	(0.26,0.33,0.49)	(0.43,0.49,0.65)	(0.49,0.52,0.66)	(0.59,0.58,0.72)	(0.54,0.48,0.59)	(0.63,0.50,0.56)	(0.61,0.55,0.64)
NPM	(0.19,0.24,0.41)	(0.14,0.18,0.33)	(0.14,0.17,0.31)	(0.25,0.27,0.42)	(0.26,0.30,0.44)	(0.48,0.44,0.56)	(0.59,0.50,0.58)	(0.36,0.26,0.32)	(0.53,0.45,0.51)
ROE	(0.17,0.26,0.45)	(0.14,0.22,0.38)	(0.13,0.19,0.34)	(0.25,0.33,0.49)	(0.32,0.37,0.51)	(0.34,0.38,0.53)	(0.52,0.48,0.60)	(0.51,0.42,0.48)	(0.31,0.29,0.39)

Step 5: The determination of the sender and reciver groups for basic criteria.

The sum of lines and columns are shown with the vectors D and R seperately. In total correlation matrix, the sum of lines give D_s , the sum of columns give R_s ; namely the sum of lines i give D_i , the sum of columns give R_i . The sender and the receiver groups are given for the key criteria.

Step 6: Defuzzication

Triangular fuzzy numbers are defuzzified using the vertex method given equation (5) and (6) and they are returned to only one value. In the table 8, defuzzified values are given.

Table 8: The Sender And Receiver Groups, Defuzzified Values And Criteria Weights

	Fuzzy Values		Defuzzified Values		Weights	
	D+R	D-R	D+R	D-R	w	W
Current Ratio	(6.39,6.89,9.49)	(-0.27,-0.31,-0.35)	7.415	-0.31	7.4215	**0.11**
Liquidity Ratio	(6.06,6.21,8.42)	(0.14,0.11,0.12)	6.725	0.12	6.7261	**0.10**
Cash Ratio	(5.61,5.74,8.03)	(0.09,0.08,0.11)	6.28	0.09	6.2806	**0.10**
Leverage Ratio	(7.26,7.65,10.21)	(-0.32,-0.23,-0.11)	8.1925	-0.2225	8.1955	**0.13**
Financial Ratio	(6.33,6.99,9.53)	(0.63,0.35,0.11)	7.46	0.36	7.4687	**0.12**
Asset Turnover	(6.95,7.53,10.20)	(-0.19,-0.09,-0.18)	8.0525	-0.1375	8.0537	**0.12**
Equity Capital Rate	(8.13,8.26,10.63)	(0.15,0.18,0.23)	8.82	0,185	8.8220	**0.13**
Net Profit Margin	(5.90,5.46,7.52)	(-0.02,0.16,0.26)	6.085	0.14	6.0866	**0.09**
Return On Equity	(5.64,6.11,8.55)	(-0.22,-0.25,-0.21)	6.6025	-0.2325	6.6066	**0.10**

Step 7: The calculation of weights.

The importance weights of criteria are calculated with the help of equation (6) and are normalized with the help of equation (7). These values are shown in the Table 8.

4.4. The Application of Fuzzy TOPSIS Method

Step 1: Identification of fuzzy scale and creation of fuzzy decision matrix

Fuzzy decision matrix formed for the year 2008 is given in the Table 9.

Table 9: Comparison Matrix With Fuzzy Linguistic Terms

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
AKGRT	VH	VH	VH	ML	VL	L	VL	MH	L
ANSGR	M	M	M	M	L	MH	M	H	VH
ANHYT	L	L	ML	MH	VH	L	MH	M	MH
AVİVA	M	M	M	M	ML	M	ML	VH	H
GUSGR	L	L	L	M	ML	M	ML	ML	L
RAYSG	L	L	L	MH	MH	H	VH	VL	VL
YKSGR	ML	ML	ML	M	L	H	MH	MH	H

The comparison matrix for 2008 is expressed fuzzy numbers. This matrix is given in the Table 10.

Table 10: Comparison Matrix with Fuzzy Numbers

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
AKGRT	(0.9,1.0,1.0)	(0.9,1.0,1.0)	(0.9,1.0,1.0)	(0.1,0.3,0.5)	(0,0,0.1)	(0,0.1,0.3)	(0,0,0.1)	(0.5,0.7,0.9)	(0,0.1,0.3)
ANSGR	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0,0.1,0.3)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.7,0.9,1.0)	(0.9,1.0,1.0)
ANHYT	(0,0.1,0.3)	(0,0.1,0.3)	(0.1,0.3,0.5)	(0.5,0.7,0.9)	(0.9,1.0,1.0)	(0,0.1,0.3)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.5,0.7,0.9)
AVİVA	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.1,0.3,0.5)	(0.3,0.5,0.7)	(0.1,0.3,0.5)	(0.9,1.0,1.0)	(0.7,0.9,1.0)
GUSGR	(0,0.1,0.3)	(0,0.1,0.3)	(0,0.1,0.3)	(0.3,0.5,0.7)	(0.1,0.3,0.5)	(0.3,0.5,0.7)	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0,0.1,0.3)
RAYSG	(0,0.1,0.3)	(0,0.1,0.3)	(0,0.1,0.3)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.7,0.9,1.0)	(0.9,1.0,1.0)	(0,0,0.1)	(0,0,0.1)
YKSGR	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0.3,0.5,0.7)	(0,0.1,0.3)	(0.7,0.9,1.0)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.7,0.9,1.0)

Step 2: The creation of normalized decision matrix

Fuzzy decision matrix is normalized with the help of equation (8). The normalized decision matrix for the year 2008 is given in the Table 11.

Table 11: Normalized Decision Matrix

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
AKGRT	(0.9,1.0,1.0)	(0.9,1.0,1.0)	(0.9,1.0,1.0)	(0.11,0.33,0.56)	(0,0,0.1)	(0,0.1,0.3)	(0,0,0.1)	(0.5,0.7,0.9)	(0,0.1,0.3)
ANSGR	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.33,0.56,0.78)	(0,0.1,0.3)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.7,0.9,1.0)	(0.9,1.0,1.0)
ANHYT	(0,0.1,0.3)	(0,0.1,0.3)	(0.1,0.3,0.5)	(0.56,0.78,1.0)	(0.9,1.0,1.0)	(0,0.1,0.3)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.5,0.7,0.9)
AVİVA	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.33,0.56,0.78)	(0.1,0.3,0.5)	(0.3,0.5,0.7)	(0.1,0.3,0.5)	(0.9,1.0,1.0)	(0.7,0.9,1.0)
GUSGR	(0,0.1,0.3)	(0,0.1,0.3)	(0,0.1,0.3)	(0.33,0.56,0.78)	(0.1,0.3,0.5)	(0.3,0.5,0.7)	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0,0.1,0.3)
RAYSG	(0,0.1,0.3)	(0,0.1,0.3)	(0,0.1,0.3)	(0.56,0.78,1.0)	(0.5,0.7,0.9)	(0.7,0.9,1.0)	(0.9,1.0,1.0)	(0,0,0.1)	(0,0,0.1)
YKSGR	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0.33,0.56,0.78)	(0,0.1,0.3)	(0.7,0.9,1.0)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.7,0.9,1.0)

Step 3: Establishment of weighted standart decision matrix.

The weighted standard decision matrix is created with the help of equation (10) and is given in the Table 12.

Table 12: Weighted Standard Decision Matrix

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
AKGRT	(0.099,0.110,0.110)	(0.09,0.10,0.10)	(0.09,0.10,0.10)	(0.014,0.043,0.073)	(0,0,0.012)	(0,0.012,0.037)	(0,0,0.013)	(0.045,0.056,0.081)	(0,0.01,0.03)
ANSGR	(0.033,0.056,0.078)	(0.03,0.05,0.07)	(0.03,0.05,0.07)	(0.043,0.073,0.101)	(0,0.012,0.036)	(0.06,0.084,0.108)	(0.039,0.065,0.091)	(0.056,0.081,0.09)	(0.09,0.1,0.1)
ANHYT	(0,0.011,0.033)	(0,0.01,0.03)	(0.01,0.03,0.05)	(0.073,0.101,0.130)	(0.108,0.12,0.12)	(0,0.012,0.037)	(0.065,0.091,0.117)	(0.027,0.045,0.063)	(0.05,0.07,0.09)
AVIVA	(0.033,0.056,0.078)	(0.03,0.05,0.07)	(0.03,0.05,0.07)	(0.043,0.073,0.101)	(0.012,0.036,0.060)	(0.037,0.06,0.084)	(0.013,0.039,0.065)	(0.081,0.09,0.09)	(0.07,0.09,0.1)
GUSGR	(0,0.011,0.033)	(0,0.01,0.03)	(0,0.01,0.03)	(0.043,0.073,0.101)	(0.012,0.036,0.060)	(0.037,0.06,0.084)	(0.013,0.039,0.065)	(0.009,0.027,0.045)	(0,0.01,0.03)
RAYSG	(0,0.011,0.033)	(0,0.01,0.03)	(0,0.01,0.03)	(0.073,0.101,0.130)	(0.060,0.084,0.108)	(0.084,0.108,0.12)	(0.117,0.13,0.13)	(0,0,0.009)	(0,0,0.01)
YKSGR	(0.011,0.033,0.056)	(0.01,0.03,0.05)	(0.01,0.03,0.05)	(0.043,0.073,0.101)	(0,0.012,0.036)	(0.084,0.108,0.12)	(0.065,0.091,0.117)	(0.045,0.056,0.081)	(0.07,0.09,0.1)

Step 4: Identification of positive and negative ideal solution.

The positive and negative ideal solution based on formula 12;

$$A^{*}=\left\{\begin{matrix}(0.11,0.11,0.11),(0.108,0.108,0.108),(0.13,0.13,0.13),\\(0.101,0.101,0.101),(0.101,0.101,0.101),(0.13,0.13,0.13),\\(0.12,0.12,0.12)\end{matrix}\right\}$$

$$A^{-}=\left\{\begin{matrix}(0,0,0),(0,0,0),(0,0,0),(0.002,0.012,0.012),\\(0,0,0),(0,0,0)\end{matrix}\right\}$$

Step 5: The calculation of positive and negative distances.

Each alternative distances from positive ideal solution A^+ and negative ideal solution A^- is calculated with the help of equation (14) and (15) respectively. These calculations are given in the Table 13.

Step 6: The calculation of the proximity coeffients

The proximity coefficients are calculated with the help of positive and negative distances through equation (17). For this, firstly it's necessary to determine total positive and negative distances for alternatives. The values are shown in the Table 13.

Table 13: Proximity Coefficients

	Positive Distances	Negative Distances	Proximity Coefficients
AKGRT	0,5615	0,4673	0,4542
ANSGR	0,4386	0,5903	0,5737
ANHYT	0,6944	0,5278	0,4318
AVİVA	0,4052	0,4631	0,5333
GUSGR	0,6441	0,3304	0,3390
RAYSG	0,7291	0,4887	0,4013
YKSGR	0,5845	0,553	0,4862

Step 7: The creation of preferences ranking of alternatives.

When we evaluate the alternatives according to their proximity coefficients between the years 2008 – 2014, the preference rankings resulting from the calculations are given in the Table 14.

Table 14: Proximity Coefficients For 2008-2014 Years

	Proximity Coefficients						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
AKGRT	0,4542	0,4142	0,5027	0,5774	0,5672	0.5383	0.5383
ANSGR	0,5737	0,5976	0,5287	0,5371	0,4560	0.4492	0.4492
ANHYT	0,4318	0,4738	0,4341	0,4478	0,4880	0.3818	0.3818
AVİVA	0,5333	0,4480	0,4820	0,4405	0,4781	0.4344	0.4344
GUSGR	0,3390	0,3998	0,3800	0,4141	0,3503	0.3387	0.3387
RAYSG	0,4013	0,4396	0,4490	0,4910	0,4728	0.5063	0.5063
YKSGR	0,4862	0,5054	0,5863	0,5518	0,5440	0.5417	0.5417

After calculating the proximity coefficients, preference rankings established by Fuzzy TOPSIS method are presented in the Table 15.

Table 15: Preference Ranking Over The Years

Year	Preference ranking
2008	ANSGR > AVİVA > YKSGR > AKGRT > ANHYT > RAYSG > GUSGR
2009	ANSGR > YKSGR > ANHYT > AVİVA > RAYSG > AKGRT > GUSGR
2010	YKSGR > ANSGR > AKGRT > AVİVA > RAYSG > ANHYT > GUSGR
2011	AKGRT > YKSGR > ANSGR > RAYSG > ANHYT > AVİVA > GUSGR
2012	AKGRT > YKSGR > ANHYT > AVİVA > RAYSG > ANSGR > GUSGR
2013	YKSGR > AKGRT > RAYSG > ANSGR > AVİVA > ANHYT > GUSGR
2014	YKSGR > AKGRT > RAYSG > ANSGR > AVİVA > ANHYT > GUSGR

4.5. The Application of TOPSIS Method

Following the implementation of Fuzzy TOPSIS method, the differences between both two methods are presented. Like in the Fuzzy TOPSIS method, the weights obtained by the Fuzzy DEMATEL method are used as weight matrix.

Step 1: The creation of decision matrix.

Criteria comparison matrix of insurance companies for the year 2008 is given in the Table 16.

Table 16: Comparison Matrix for Criteria - Company

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
AKGRT	3,282	3,172	2,758	0,248	0,330	0,248	0,330	0,088	0,029
ANSGR	1,595	1,497	1,011	0,604	1,524	0,722	1,822	0,106	0,194
ANHYT	1,106	1,102	0,664	0,897	8,716	0,214	2,082	0,073	0,151
AVİVA	1,564	1,438	1,015	0,652	1,874	0,522	1,499	0,115	0,172
GUSGR	1,086	0,969	0,469	0,681	2,132	0,502	1,571	0,033	0,052
RAYSG	1,178	1,079	0,462	0,77	3,353	0,816	3,55	0,003	0,010
YKSGR	1,333	1,244	0,809	0,583	1,398	0,869	2,083	0,085	0,177

Step 2: The creation of standard decision matrix

The standard decision matrix is calculated with the help of A matrix's elements and by using the formula 14 shown in the Table 17.

Table 17: Standard Decision Matrix

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
AKGRT	0,711	0,723	0,825	0,142	0,033	0,155	0,061	0,411	0,082
ANSGR	0,345	0,341	0,302	0,346	0,153	0,45	0,336	0,495	0,549
ANHYT	0,239	0,251	0,199	0,513	0,873	0,133	0,384	0,341	0,427
AVİVA	0,339	0,328	0,303	0,373	0,188	0,325	0,276	0,537	0,486
GUSGR	0,235	0,221	0,14	0,39	0,214	0,313	0,29	0,154	0,147
RAYSG	0,255	0,246	0,138	0,441	0,336	0,509	0,654	0,014	0,028
YKSGR	0,289	0,284	0,242	0,334	0,14	0,542	0,384	0,397	0,501

Step 3: The creation of weighted standard decision matrix.

First of all, related to evaluation factors, all weight values obtained by Fuzzy DEMATEL method are cared. Then V matrix is created by multiplying the elements in each column with the related the value w_i shown in the Table 18.

Table 18: Weighted Standard Decision Matrix

	CR	LR	CAR	LR	FR	AT	ECR	NPM	ROE
AKGRT	0,078	0,072	0,083	0,018	0,004	0,019	0,008	0,037	0,008
ANSGR	0,038	0,034	0,03	0,045	0,018	0,054	0,044	0,045	0,055
ANHYT	0,026	0,025	0,02	0,067	0,105	0,016	0,05	0,031	0,043
AVİVA	0,037	0,033	0,03	0,048	0,023	0,039	0,036	0,048	0,049
GUSGR	0,026	0,022	0,014	0,051	0,026	0,038	0,038	0,014	0,015
RAYSG	0,028	0,025	0,014	0,057	0,04	0,061	0,085	0,001	0,003
YKSGR	0,032	0,028	0,024	0,043	0,017	0,065	0,05	0,036	0,05

Step 4: The creation of positive and negative ideal solution

The positive and negative ideal solution sets are shown below.

$$A^{-} = \{0.004, 0.018, 0.016, 0.023, 0.014, 0.001, 0.017\}$$
$$A^{*} = \{0.083, 0.055, 0.105, 0.049, 0.051, 0.085, 0.065\}$$

Both positive and negative ideal solution set consists of seven elements that is the number of evaluation factor.

Step 5: The calculation of seperation measures.

The calculation of positive ideal seperation measure is calculated by the help of the formula 17 and the calculation of negative ideal seperation measure is calculated by the help of the formula 18.

Step 6: Calculation of the relative proximity to the ideal solution.

The calculation of each alternative's proximity to the ideal solution is used formula 19 and shown in the Table 19.

Table 19: The Relative Proximity To The Ideal Solution

	Positive Distances	Negative Distances	Proximity Coefficients
AKGRT	0,166	0,134	0,446
ANSGR	0,055	0,074	0,573
ANHYT	0,203	0,113	0,357
AVİVA	0,041	0,053	0,568
GUSGR	0,08	0,053	0,4
RAYSG	0,171	0,129	0,431
YKSGR	0,091	0,078	0,461

The calculation made for the year 2008 is also made for other years. In the Table 20, the proximity coefficients of companies are given.

Table 20: Proximity Coefficients for 2008-2014

	Proximity Coefficients						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
AKGRT	0,446	0,377	0,634	0,672	0,655	0,606	0.533
ANSGR	0,573	0,566	0,652	0,61	0,546	0,529	0.495
ANHYT	0,357	0,401	0,425	0,403	0,425	0,39	0.512
AVİVA	0,568	0,455	0,616	0,572	0,546	0,553	0.534
GUSGR	0,4	0,433	0,448	0,458	0,451	0,469	0.422
RAYSG	0,431	0,413	0,457	0,589	0,59	0,549	0.472
YKSGR	0,461	0,491	0,649	0,662	0,641	0,59	0.482

As well as in the proximity coefficients presented, the necessary preference ranking is given in the Table 21.

Table 21: Preference Ranking for 2008-2014

Year	Preference ranking
2008	ANSGR > AVİVA > YKSGR > AKGRT > RAYSG > GUSGR > ANHYT
2009	ANSGR > YKSGR > AVİVA > GUSGR > RAYSG > ANHYT > AKGRT
2010	ANSGR > YKSGR > AKGRT > AVİVA > RAYSG > GUSGR > ANHYT
2011	AKGRT > YKSGR > ANSGR > RAYSG > AVİVA > GUSGR > ANHYT
2012	AKGRT > YKSGR > RAYSG > ANSGR > AVİVA > GUSGR > ANHYT
2013	AKGRT > YKSGR > AVİVA > RAYSG > ANSGR > ANHYT > GUSGR
2014	AVİVA > AKGRT > ANHYT > ANSGR > YKSGR > RAYSG > GUSGR

5. Conclusion

The insurance industry continuously is lets the financial services sector develop and has a feature to be followed. Natural disasters in recent years as well as the regulations have proven once again the need for continuous monitoring of the industry data. Performance evaluation for the sector provides us to have an idea about following years. It also suggested an appropriate multi-criteria decision model for the sector.

In this study, a multi-criteria decision-making models like DEMATEL, TOPSIS and Fuzzy TOPSIS methods are used. Weighting coefficients of the determined comparison criteria are calculated between 2008-2014 years by the DEMATEL method, and then Fuzzy TOPSIS and TOPSIS methods are evaluated comparatively. As a result of the weight calculation, criterias related to the stability and profitability are found to be higher weights in terms of finance. In the end of the study, both two methods have been found to have different results from each other. While the values of firms with fuzzy TOPSIS method are comparative and sequenced, the values of firms with TOPSIS are obtained by numerical superiority. In TOPSIS method, although there are positive distances between companies, the negative values are processed as positive values thanks to constant increasing amount.

In the end of TOPSIS study, it is found that Ak Insurance has recently had a growing financial structure and has the best financial structure in the between 2010 – 2012 years and has the lowest financial structure in the year 2009. Yapı Kredi Insurance has a more stable and more positive financial structure compared to other companies. Aviva Insurance is seen to have a declining financial structure in the sector for the first three years and just last two years started to rise. Anadolu Insurance has the best financial structure for the first three years, but showed a continuous decline in the past three years. Ray Insurance stands as a company that has a steady rise except last two years and has exhibited a decline in the last two years. At last, Güneş Insurance and Anadolu Hayat Insurance has attracted attention in the sector every year as the lowest financial structured company except the years 2009 and 2014.

As a result of the study, it is concluded that to evaluate the performances of the company financial structure, TOPSIS and DEMATEL integrated multiple criteria decision making method is more appropriate compared to Fuzzy TOPSIS and DEMATEL integrated multiple criteria decision making method so The fuzzy TOPSIS results shown in Table 15 haven't been interpreted and only the TOPSIS method results shown in Table 21 are presented.

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