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ABSTRACT
The aim of this study is to propose a fuzzy multi-criteria model that will facilitate the assessment of insurance companies' efficiency. This study includes all companies operating within the insurance sector in Serbia in the period from 2007 to 2014 and the data were used from the published financial statements of insurance companies. Five key indicators were identified for the assessment and rating of insurance companies. Fuzzy Analytic Hierarchy Process (FAHP) and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) were used for building the proposed model. In the first stage, priority weights of criteria were defined by using the FAHP, while in the second phase the insurance companies were ranked using the TOPSIS method.

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1. Introduction

The impact of the economic crisis on the insurance industry was less prominent than it was on the banking industry. However, the financial crisis and subsequent recession imposed substantial changes to the institutional and business landscape in which insurance industry operates (Marović, Njegomir, & Maksimović, 2010). Management has an important role in successfully managing an insurance company and has responsibility for the preparation and objective presentation of financial statements so that various interest groups could make appropriate economic decisions. The quality of financial statements is a complex category which is primarily influenced by the opinions of users of financial statements, i.e. its understanding is primarily dependent on human (subjective) factors. The quality of financial statements of insurance companies is affected by several factors, among which are the following: the role of management in the fair presentation of the financial statements, the role of an actuary in the calculation of the financial category, developed system of internal control and risk management and the role of auditors in terms of accountability for the quality of information disclosed in the financial statements.

The insurance market in Serbia is still developing compared to other countries in the region given the amount of earned premiums per capita and the ratio of premium to gross domestic product (GDP). The development of the insurance market in the Republic of Serbia

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measured by premium growth shows a positive but relatively slow trend. In the total financial sector (banks, leasing, insurance and voluntary pension funds) the insurance according to the capital and the number of employees is in second place. The share of non-life insurance in total premium of market is still dominant.

The aim of this paper is to propose a model for evaluating the financial parameters of the insurance companies operating in Serbia. In the period from 2007 to 2014, 28 insurance companies were considered; the analysed criteria in this paper were chosen based on the data available within the financial statements. The National Bank of Serbia has the most important role in the presentation of financial statements of insurance companies. Also, when selecting the relevant criteria for the analysis, other related papers were viewed in order to make the best possible decision.

The specificity of the balance sheet and income statement of the insurance company is reflected in several segments. There is a significant share of investment in the structure of assets (investments in stocks, bonds, mortgages and loans, equipment and intangible assets), which is not unusual given the fact that insurance companies are the most important investors on the financial market. The obligations of the insurance company to the insured persons are mainly related to unearned premiums and paid claims. The importance of investment results is specially emphasised in the case of life insurers who provide unit-linked policies, life insurance products associated with investments into funds, as the key incentive for buyers of such products is profit making (Marović, Njegomir, & Maksimović, 2010). The investments represent the core of efficiency.

Over the last few years, fierce competition has meant that insurance companies attempted to strengthen their positions in the market in which they operate and to operate in the most efficient manner. Thus in the financial services sector, particularly in insurance companies, the need for performance measurement was increased. This paper proposes a multiple criteria decision approach in a fuzzy environment for ranking insurance companies in Serbia. In a decision-making process, the use of linguistic variables is highly beneficial when criteria values cannot be expressed by means of numerical values. Therefore, the concept of linguistic variables is very useful in dealing with situations, which are too complex or not well defined to be reasonably described in conventional quantitative expressions (Zimmermann, 1991). Conventional multi-criteria decision-making methods cannot effectively handle problems with such imprecise information. For these reasons, the fuzzy set theory is introduced by Zadeh (1965). The paper proposes a model for evaluating insurance companies, based on combination of two multi-criteria decision-making methods, Fuzzy Analytic Hierarchy Process (FAHP) and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS). FAHP method determines the weights of criteria, and these calculated weight values are used as TOPSIS inputs. Then, after TOPSIS calculations, evaluation of the insurance companies and selection of the most appropriate one is realised. The main objective of this study is to provide decision-making support, in a manner that enables the decision-makers to measure the efficiency of insurance companies business by using multi-criteria decision-making models.

The paper is organised as follows: Section 2 is a brief literature review. Section 3 shows the initial basis of the theory of fuzzy sets and extended fuzzy AHP analysis, while in Section 4 the TOPSIS method is presented. Section 5 contains a constructed integrated fuzzy AHP-TOPSIS model for evaluating the financial parameters of the Serbian insurance sector. The paper ends with concluding remarks in Section 6.

2. Literature review

Economic experts frequently conduct an assessment of insurance companies according to various parameters and in these cases use different methods. In the literature we can find studies using multi-criteria decision-making methods (MCDM) to evaluate the effectiveness of insurance companies. The method that is recognised in numerous studies as a useful and systematic way to measure efficiency in the insurance sector is AHP (Saaty, 1980). Also, TOPSIS has been recognised as a typical comprehensive evaluation method for ranking insurance companies by similarity to ideal solution. The TOPSIS (Hwang & Yoon, 1981) method identifies solutions from a finite set of alternatives.

Many authors in their works used an MCDM method for measuring the efficiency of insurance companies. Puelz (1991) used the AHP method for the selection of life insurance, and made a model that helps people choose the best life insurance. Khodaei Valahzaghard and Ferdousnejhad (2013) applied the AHP method and factor analysis to rank the insurance companies. Azizi, Jafarzadeh Kenari, and Nasiri (2013) used the AHP method to identify factors that affect the price of insurance. Cheng-Ping (2006) analysed the Taiwanese insurance companies so they were evaluated based on five financial ratios: financing structure, profitability, repayment capacity, management and overall operational efficiency and equity. Tsai, Huang, and Wang (2008) have integrated the ANP and TOPSIS methods for the evaluation of 14 Taiwanese insurance companies. Fan and Cheng (2009) used AHP and TOPSIS to evaluate the curriculum in the departments of risk management and insurance. Also, Ilyas and Tunay (2015) and Sehhat, Teheri, and Sadeh (2015) combined AHP and TOPSIS methods for the ranking of insurance companies in Turkey and Iran. Zhengkui and Jian (2012) implemented TOPSIS to establish an evaluation model for the insurance industry to fill the gaps in the social responsibility theory. Fan, Lee, Lee, and Lu (2011) proposed TOPSIS and CA models for evaluating intentions of consumers' cross-buying insurance in banks. Daneshvar, Azar, and Zali (2006) used the DEA method for the evaluation of performances of DANA insurance branches. Jalili Sabet and Fadavi (2013) applied the DEA technique for Iranian insurance companies, and the results showed that although four companies operated efficiently, most of the others were noticeably ineffective. Houshmand Neghabi, Morshedian Rafiee, and Soleymani (2012) implemented two methods known as CAMELS and RBC for the ranking of 18 active private and public insurance companies in Iran in the period from 2009 to 2011. Navabakhsh, Nili, and Naeeni (2013) included a multi-criteria decision-making technique in order to assess the Iranian insurance companies in the province of Isfahan using BSC.

Although the AHP found widespread use for solving the problem of multi-criteria decision-making in real-world situations, that approach does not give satisfactory results in situations that can be characterised as uncertain, especially in human assessments where it is difficult to express opinions with numbers. In addition, the criteria are often subjective and qualitative in nature, which negatively affects decision-makers in terms of expressing their own preferences in numerical values and the subsequent comparison of assessments (Chan & Kumar, 2007). This is exactly what has led researchers to propose a fuzzy version of the AHP method, adapted to situations of risk and uncertainty (Bottani & Rizzi, 2005; Chan, Kumar, Tiwari, Lau, & Choy, 2008; Mikhailov, 2002). Fuzzy evaluation in the decision-making process is very useful in order to compensate for said limitation of the AHP method.

In the literature we can find studies that evaluate the effectiveness of the operations of insurance companies using the fuzzy approach. Yücenur and Demirel (2012) used an extended version of VIKOR method in the fuzzy setting for the selection of insurance companies. Also, Motameni, Fatahi, and Karimi (2012) combined FAHP and VIKOR technique for performance evaluation of insurance companies. Huang, Lin, and Lin (2008) developed an evaluation model for determining insurance using AHP and fuzzy logic. Hui and Abdullah (2012) have done a case study to rank the quality of insurance services for vehicles using fuzzy-weighted entropy. Chen and Lu (2014) used fuzzy correlation analysis and improved fuzzy modified TOPSIS for assessing the competitiveness of insurance corporations. Saeedpoor, Vafadarnikjoo, Mohammadsadegh, and Rastegari (2015) proposed a FAHP-FTOPSIS model for ranking life insurance firms.

In this paper we shall suggest a hybrid model that combines a classical MCDM method (TOPSIS) that uses data that are numerically expressed and a fuzzy MCDM method (FAHP), which enables working with linguistic variables. The aim of this paper is to apply a fuzzy MCDM method to determine the priority weight of the decision-making criteria, thereby being enabled to work with uncertain and imprecise data, while the classical MCDM method is applied for the ranking of insurance companies. The proposed integrated MCDM model will enable a more efficient determination of the best insurance company in a manner that provides work with numerical and linguistic information in uncertain situations.

3. The theory of fuzzy sets

By using classical logic, it is possible to work only with the information that is either completely true or completely false. It is not possible to control the information that is inaccurate or incomplete, although this information may provide a better solution to a problem. Human assessments are generally characterised by imprecise language, such as the terms 'equal', 'weak', 'fairly strong', 'very strong' and 'absolute'. Therefore, the application of fuzzy theory by decision-makers enables them to successfully deal with uncertainties. The theory of fuzzy sets was presented by Zadeh (1965) as an effective method for mathematical representation of uncertain and imprecise evaluations made by humans. The word 'fuzzy' is of English origin and it means a vague, imprecise concept. Thanks to the introduction of the fuzzy concept, it is possible that a value be allocated to a statement that varies between completely false and completely true.

Fuzzy set theory is based on fuzzy sets which represent a class of objects with a degree of membership (Negoita, 1985). Such sets are characterised by a function of membership which is assigned to each object of the class with a rank that moves within the interval [0,1]. The mathematical operations that are allowed on the sets are: addition, subtraction, multiplication and division (Dubois & Prade, 1979; Kaufmann & Gupta, 1991).

A thorough analysis of the theory of fuzzy sets is given by (Dubois & Prade, 1980; Zimmermann, 1991). Bellman and Zadeh (1970) were the first to include the theory of fuzzy sets in decision-making, in situations when using vague, imprecise and uncertain data to generate decisions. Yager and Basson (1975) had proposed the introduction of fuzzy sets theory into solving of the decision-making problem.

3.1. Fuzzy Analytic Hierarchy Process

The Fuzzy Analytic Hierarchy Process (FAHP) represents a systematic approach to selecting alternatives and solving problems using the concept of fuzzy sets theory (Zadeh, 1965) and the AHP method, which are implemented through the use of triangular fuzzy numbers (Chang, 1996). Triangular fuzzy numbers are applied in order to determine the priority of different decision variables. While the extended AHP method is used to determine the final priority of weights based on triangular fuzzy numbers.

The FAHP method has been suggested by various authors (Van Laarhoven & Pedrycz, 1983; Buckley, 1985; Chang, 1996; Mikhailov & Tsvetinov, 2004). The most commonly used is the FAHP methodology which was extensively analysed by Chang (1992, 1996). Let $X = \{x_1, x_2, \ldots, x_n\}$ be a set of objects, and let $G = \{g_1, g_2, \ldots, g_m\}$ be a set of goals.

According to the Cheng's methodology, an extended analysis of goal *gi* is performed for every taken object. The values of extended analysis *m* for each object can be represented as follow, by **Eq. (1):**

$$M_{gi}^1,\ M_{gi}^2,\ \ldots,\ M_{gi}^n, \quad i = 1, 2, \ldots, n, \tag{1}$$

where $M_{gi}^j (j = 1, 2, \ldots, m)$ are fuzzy triangular numbers. Chang's extended analysis consists of the following steps:

Step 1: The values of fuzzy extensions for the *i*-th object are given in **Eq. (2)**:

$$S_i = \sum_{j=1}^{m} M_{gi}^j \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j \right]^{-1}, \tag{2}$$

In order to obtain the expression $\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j \right]^{-1}$, it is necessary to perform additional fuzzy operations with *m* values of the extended analysis, which is represented by **Eq. (3), (4)**:

$$\sum_{j=1}^{m} M_{gi}^j = \left(\sum_{j=1}^{m} l_i \sum_{j=1}^{m} m_i \sum_{j=1}^{m} u_i \right), \tag{3}$$

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j = \left(\sum_{j=1}^{n} l_i \sum_{j=1}^{n} m_i \sum_{j=1}^{n} u_i \right), \tag{4}$$

In other words, it is necessary to calculate the inverse vector using **Eq. (5)**:

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i} \right), \tag{5}$$

Step 2: The degree of possibility for $M_2 = (l_2, m_2, u_2)$ and $M_1 = (l_1, m_1, u_1)$ is defined by **Eq. (6)**:

$$V\ (M2 \geq M1)\ =\ y \geq x \min(\mu_{M1}(x),\ \mu_{M2}(y)) \tag{6}$$

It can be represented in the following manner by **Eq. (7)**:

$$V\ (M2 \geq M1)\ =\ hgt\ (M_1 \cap M_2)\ =\ \mu_{M2}\ (d), \tag{7}$$

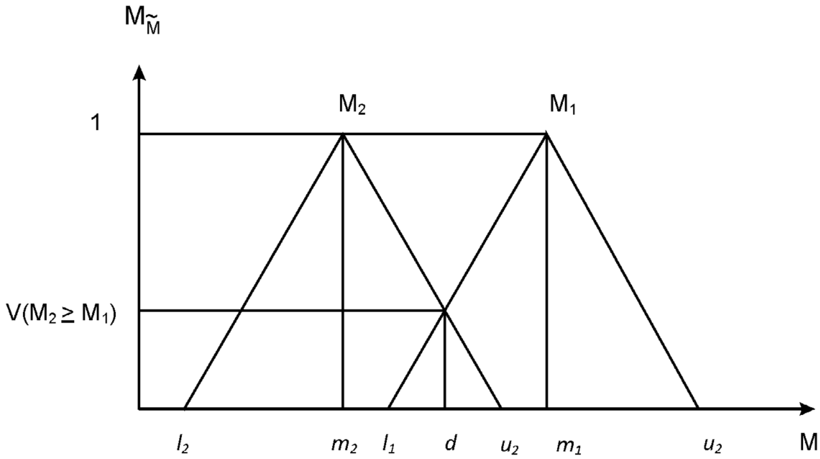

Figure 1. The intersection between $M1$and $M2$. Source: Chang (1994).

$$\begin{cases} 1, & if\ m_2 \geq m_1 \\ 0, & if\ l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & \text{otherwise,} \end{cases}$$

where d is the ordinate of the highest intersection point D between μ_{M1} and μ_{M2} (Fig. 1).

In order to compare $M1$ and $M2$, values of both $V(M1 \geq M2)$and $V(M2 \geq M1)$are needed.

Step 3: The degree of possibility for a convex fuzzy number to be greater than the k convex numbers $Mi(i = 1, 2, ..., k)$ can be defined by **Eq. (8)**:

$$\begin{aligned} V(M \geq M1, M2, ..., Mk) &= V\left[(M \geq M1)\text{ and }(M \geq M2)\text{ and } \cdots \text{ and }(M \geq Mk)\right] \\ &= minV(M \geq Mi), i = 1, 2, 3, ..., k \end{aligned} \tag{8}$$

Let us assume that **Eq. (9)** is true:

$$d^{'}(Ai) = \ min\ V\ (Si\ \geq\ Sk) \tag{9}$$

for $k = 1, 2, ...n; k \neq i$. The weight vector is obtained by **Eq. (10)**:

$$W' \ = (d'\ (A1),\ d'\ (A2), ...,\ d'\ (An))T \tag{10}$$

Step 4: Through normalisation, the weight vectors are reduced to **Eq. (11)**:

$$W \ = (d\ (A1),\ d\ (A2), ...,\ d\ (An))T \tag{11}$$

where W does not represent a fuzzy number.

4. TOPSIS method (Technique for Order Performance by Similarity to Ideal Solution)

TOPSIS ranks alternatives according to their distance from the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS). PIS represents a solution that maximises the benefit criteria and minimises the cost criteria, while NIS has the opposite logic, i.e. it maximises the cost criteria and minimises the benefit criteria (Benítez, Martín, & Román, 2007). The TOPSIS method takes into account both PIS and NIS distances, whereby the optimal alternative is the one that is in geometric terms the closest to PIS, and the farthest from (Seçme, Bayrakdaroğlu, & Kahraman, 2009). The ranking of alternatives is based on the relative similarity to the ideal solution, which avoids the situation of the alternative having the same similarity to both PIS and NIS.

PIS is defined using the best rating of the values of the alternatives for each individual criterion; conversely, the NIS represents the worst values of the alternatives' ratings. The terms 'best' and 'worst' are interpreted for each criterion separately, according to whether maximisation or minimisation of criteria is in question.

The TOPSIS methodology presented by (Hwang & Yoon, 1981) consists of the following steps:

Step 1: The decision matrix is normalised through the application of **Eq. (12)**:

$$r_{ij} = \frac{W_{ij}}{\sqrt{\sum_{j=1}^{J} W_{ij}^2}}, \; j = 1, 2, \ldots, J; i = 1, 2, \ldots n \tag{12}$$

Step 2: A weighted normalised decision matrix is obtained by multiplying the normalised matrix with the weights of the criteria, **Eq. (13)**:

$$V_{ij} = W_i^* r_{ij}, j = 1, 2, \ldots, J; i = 1, 2, \ldots, n \tag{13}$$

Step 3: PIS (maximum value) and NIS (minimum value) are determined by **Eq. (14, 15)**:

$$A^* = \left\{ V_1^*, V_2^*, \ldots, V_n^* \right\} \tag{14}$$

$$A^- = \left\{ V_1^-, V_2^-, \ldots, V_n^- \right\} \tag{15}$$

Step 4: The distance of each alternative from PIS and NIS is calculated using **Eq. (16), (17)**:

$$d_i^* = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V_j^* \right)^2}, \quad j = 1, 2, \ldots, J \tag{16}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V_j^- \right)^2}, \quad j = 1, 2, \ldots, J \tag{17}$$

Step 5: The closeness coefficient for each alternative (CC_i) is calculated by applying **Eq. (18)**:

$$CC_i = \frac{d_i^-}{d_i^* + d_i^-} \tag{18}$$

***Step* 6**: At the end of the analysis, the ranking of alternatives is made possible by comparing the CC_i values.

5. Application of FAHP and TOPSIS method for evaluating the parameters in the insurance sector

The data taken into account for the modelling include the entire insurance sector in Serbia during the period between the year 2007 and 2014. The study utilised the financial data for the 28 insurance companies that are operating in Serbia. The model was constructed by combining two methods of multi-criteria decision-making: FAHP and TOPSIS.

Authors who have measured the efficiency of insurance companies in Serbia have analysed different criteria. Backovic and Babic (2013) used AHP for selection of the best life insurance policies in Serbia, in their paper they analysed following criteria: the ratios of premium and sum insured, life insurance premiums, mathematical reserves, diversity of the offer, number of the insurance contract, length of business, the ability of agents. Stepic and Stosic (2012) proposed DEA method for measuring efficiency of insurance companies. They analysed business efficiency (inputs: insurance costs, capital and reserves, number of employees, number of insurance types, number of branches and output: total income) and financial performance (inputs: insurance costs, capital and reserves, costs of employees and outputs: incomes from insurance, other income).

The FAHP methodology was applied first in order to allow for determination of the weight vectors for each financial parameter individually. The FAHP procedure can be represented on the basis of two phases:

Stage I: defining basic criteria in relation to the target. The goal is identified, **"Evaluation of financial parameters in the insurance sector."** We analysed the five basic criteria: equity and reserves, business assets, provision and liabilities, financial incomes, cost of insurance.

Equity and business assets were considered as the two most important criteria. Equity and reserves indicate the actual state of insurance companies. Actually, the structure of insurance provisions and the structure of investments are indicators of characteristics of operations of insurance companies. In addition to these two criteria the following parameters were taken into account: provision and liabilities, financial income and insurance costs on the basis of which we can form a complete insight into the efficiency of insurance companies' business.

Five basic criteria analysed in the paper were chosen based on the data available within the financial statements. The most important role in the presentation of the financial statements of insurance companies has supervisory authority, in this case, the National Bank of Serbia. Also, when selecting the relevant criteria for the analysis, other papers were viewed in order to make the best possible decisions.

Stage II: The priority weights of each criterion are calculated by applying the FAHP method. The comparison of criteria was made easier for the experts by using a Linguistic scale of importance (Tab. 1). In Table 1 (Kilincci & Onal, 2011), the linguistic variables are converted into triangular fuzzy numbers. Table 2 shows the fuzzy comparison matrix for the five basic criteria.

Inspecting the tables we can conclude that in the process of evaluating the financial parameters of Serbian insurance companies, the criterion equity and reserves is the most important with weight vector of 0.345, followed by the criteria of business assets with a vector 0.274, financial income with 0.203, provisions and liabilities 0.148 and costs of

Table 1. Linguistic scale of importance.

Linguistic scale of importance	Triangular fuzzy numbers	Reciprocal value of triangular fuzzy numbers
Equal	(1,1,1)	(1,1,1)
Weak	(1/2,1,3/2)	(2/3,1,2)
Fairly strong	(3/2,2,5/2)	(2/5, 1/2, 2/3)
Very strong	(5/2,3,7/2)	(2/7, 1/3, 2/5)
Absolute	(7/2,4,9/2)	(2/9, 1/4, 2/7)

Table 2. Fuzzy comparison matrix of the five basic criteria and their priority vectors.

Criteria	Equity and reserves	Business assets	Provision and liabilities	Financial incomes	Cost of insurance	Priority vector (Wc)
Equity and reserves	(1,1,1)	(1/2,1,3/2)	(3/2,2,5/2)	(3/2,2,5/2)	(5/2,3,7/2)	0,345
Business assets	(2/3,1,2)	(1,1,1)	(2/3,1,2)	(3/2,2,5/2)	(3/2,2,5/2)	0,274
Provision and liabilities	(2/5,1/2,2/3)	(1/2,1,3/2)	(1,1,1)	(2/3,1,2)	(1/2,1,3/2)	0,148
Financial incomes	(2/5,1/2,2/3)	(2/5,1/2,2/3)	(1/2, 1,3/2)	(1,1,1)	(5/2,3,7/2)	0,203
Cost of insurance	(2/7,1/3,2/5)	(2/5,1/2,2/3)	(2/3,1,2)	(2/7,1/3,2/5)	(1,1,1)	0,029

Table 3. Values of the basic financial criteria of insurance companies for the year 2007.

2007 year	Equity and reserves (0,345)	Business assets (0,274)	Provision and liabilities (0,148)	Financial incomes (0,202)	Cost of insurance (0,029)
AMS	489.211,00	1.398.655,00	909.444,00	5.320,00	396.251,00
BASLER NEZIVOT	376.456,00	391.237,00	14.781,00	42.092,00	31.431,00
BASLER ZIVOT	241.766,00	247.251,00	5.485,00	27.433,00	12.386,00
CREDIT AGRICOLE	191.993,00	211.742,00	19.749,00	24.005,00	73.437,00
DDOR NOVI SAD	4.286.170,00	14.428.701,00	10.142.531,00	384.366,00	4.435.310,00
DELTA GENERALI	2.711.178,00	8.060.818,00	5.349.640,00	504.605,00	2.024.293,00
DELTA GENERALI RE	667.398,00	803.361,00	135.963,00	21.015,00	15.023,00
DUNAV OSIGURANJE	7.278.600,00	20.226.453,00	12.947.853,00	221.594,00	4.487.575,00
DUNAV-RE	856.065,00	1.799.582,00	943.517,00	62.469,00	148.025,00
ENERGOPROJEK	392.549,00	572.344,00	179.795,00	48.543,00	46.856,00
GLOBUS OSIGUR.	2.004.400,00	2.220.408,00	216.008,00	47.960,00	132.434,00
GRAWE	950.272,00	3.878.122,00	2.927.850,00	89.720,00	511.937,00
MERKUR OSIGUR.	236.048,00	259.468,00	23.420,00	14.463,00	46.456,00
MILENIJUM	469.679,00	1.087.242,00	617.563,00	3.146,00	290.196,00
SAVA	594.125,00	1.554.709,00	960.584,00	34.278,00	393.126,00
TAKOVO	655.440,00	2.239.000,00	1.583.560,00	19.127,00	660.218,00
TRIGLAV KOPAONIK	597.202,00	1.749.908,00	1.152.706,00	75.898,00	469.772,00
UNIQA ADO	431.303,00	2.594.401,00	2.163.098,00	228.693,00	557.649,00
UNIQA NEZIVOTNO	464.590,00	1.358.875,00	894.285,00	42.911,00	144.106,00
WIENER STADTIS.	777.395,00	5.541.738,00	4.764.343,00	28.192,00	1.076.843,00

insurance with 0.029. Table 3 provides a financial report with the real data for the year 2007 with calculated weight vectors for the criteria. Twenty insurance companies were taken into consideration, which constitute the entire insurance sector in Serbia for the given year.

After determining the weight vectors of the criteria using FAHP, we propose the use of the TOPSIS method which allows for the ranking of insurance companies based on financial criteria. The first step in the TOPSIS calculation is the normalisation of the decision matrix (Table 3) through the use of **Eq. (12)**. The normalised matrix is then multiplied by the FAHP weight vectors of the criteria using **Eq. (13)**, the result of which is a weighted normalised matrix.

The next step within the TOPSIS method is to determine the shortest distance from the PIS using **Eq. (16)**, and the farthest distance from the NIS using **Eq. (17)**. Following the calculation of PIS and NIS using **Eq. (18)**, it is possible to obtain the closeness coefficient (CC_i) for each alternative i.e. insurance company. Table 4 provides a complete overview of the parameters PIS, NIS, CC_i and the ranking of the insurance companies. The TOPSIS method simultaneously considers both PIS and NIS distances, so that eventually an ideal solution is obtained that is the closest to PIS and the farthest from NIS.

6. Results and discussion

An identical procedure was applied to rank the insurance companies for the years 2008, 2009, 2010, 2011, 2012, 2013 and 2014. The obtained results are shown in the summarised Table 5.

Graphic presentation of Cci data given in Table 5 is presented in Fig. 2.

By aggregation of results for the period from 2007 to 2014 in Table 5 an insight is provided into the overall ranking of insurance companies, shown in Table 6. In addition, in Table 6 variance and standard deviation were calculated for rank of insurance companies using following **Eq. (19,20)**, respectively:

$$\sigma^2 = \sum_{i=1}^{N} \frac{1}{N}\left(x_i - \mu\right)^2 \tag{19}$$

$$\sigma = \sqrt{\sigma^2} \tag{20}$$

where N represent number of insurance companies, x_i values of CCi coefficient and μ represent mean.

Inclusion of values from a Table 6 in **Eq. (19), (20)** we obtain variance of 0,028 and standard deviation of 0,17.

Table 4. PIS, NIS, Cci and the Ranking of insurance companies for the year 2007.

Insurance companies	d+	d−	Cci	**RANK**
AMS	0,355595789	0,017748397	0,047538967	**14**
BASLER NEZIVOT	0,362180761	0,012884664	0,034353111	**17**
BASLER ZIVOT	0,367923629	0,006989098	0,018641934	**19**
CREDIT AGRICOLE	0,369703945	0,005791486	0,015423587	**19**
DDOR NOVI SAD	0,130753662	0,246789468	0,653672252	**2**
DELTA GENERALI	0,21630238	0,189634353	0,467152485	**3**
DELTA GENERALI RE	0,35436395	0,019156249	0,051285711	**13**
DUNAV OSIGURANJE	0,078482416	0,350174054	0,816910693	**1**
DUNAV-RE	0,337996016	0,034286935	0,092099129	**8**
ENERGOPROJEKT	0,359770084	0,015096829	0,040272504	**15**
GLOBUS OSIGURANJE	0,310905544	0,070809327	0,185503191	**4**
GRAWE	0,317474557	0,056936665	0,152069867	**7**
MERKUR OSIGURANJE	0,369266978	0,003570724	0,009577153	**20**
MILENIJUM	0,358637221	0,014309746	0,038369386	**16**
SAVA	0,34887399	0,023062853	0,062007445	**11**
TAKOVO	0,343890473	0,029700069	0,079498985	**10**
TRIGLAV KOPAONIK	0,343156358	0,030823447	0,082420084	**9**
UNIQA ADO	0,328666307	0,069669649	0,174901734	**6**
UNIQA NEZIVOTNO	0,352612718	0,020096869	0,053920987	**12**
WIENER STADTISCHE	0,317295893	0,069265369	0,179183419	**5**

Table 5. CCi and ranking of the insurance companies for the period between the years 2007 and 2014.

Insurance companies	Cci	Rank (2007)	Cci	Rank (2008)	Cci	Rank (2009)	Cci	Rank (2010)
MET LIFE (ex ALICO)			0,020,660,653	22	0,024358585	23	0,021751111	22
AMC	0,047538967	14	0,043276355	14	0,05676027	13	0,054158878	15
AS NEZIVOT			0,042061184	15	0,02757579	21	0,032614636	20
BASLER NEZIVOT	0,034353111	17	0,048462261	13	0,03366643	22	0,043936405	18
BASLER ZIVOT	0,018641934	18	0,033895658	17	0,024380336	19	0,019968232	23
AXA ZIVOT (ex CREDIT AGRICOLE)	0,015423587	19	0,023776802	21	0,018039789	25	0,019579888	24
DDOR NOVI SAD	0,653672252	2	0,426614424	2	0,451450073	2	0,42851443	3
DDOR RE					0,07537705	11	0,044913657	17
DELTA GENERALI OSIGURANJE	0,467152485	3	0,393255272	3	0,442819523	3	0,522096595	2
DELTA GENERALI RE	0,051285711	13	0,031421944	19	0,050452914	16	0,050397568	16
DUNAV OSIGURANJE	0,816910693	1	0,90472032	1	0,868861255	1	0,710017789	1
DUNAV RE	0,092099129	8	0,107416046	8	0,153184932	8	0,132387518	8
ENERGOPROJEKT GARANT	0,040272504	15	0,051664289	12	0,058477879	12	0,057393966	12
GLOBUS OSIGURANJE	0,185503191	4	0,035807663	16	0,053527969	15	0,056735001	13
GRAWE	0,152069867	7	0,150793919	6	0,208869685	5	0,230769971	5
MERKUR OSIGURANJE	0,009577153	20	0,029830173	20	0,032076649	20	0,030484731	21
MILENIJUM	0,038369386	16	0,031660429	18	0,035654163	18	0,035888104	19
SAVA	0,062007445	11	0,082883503	10	0,056650856	14	0,060918979	11
SAVA ZIVOT			0,009817836	24	0,023307769	24	0,006598345	26
SOCIETE GENERALE					0,009571505	26	0,011600114	25
TAKOVO	0,079498985	10	0,065537514	11	0,101585997	9	0,085795253	9
TRIGLAV KOPAONIK	0,082420084	9	0,089507903	9	0,078280886	10	0,068528882	10
UNIQA NEZIVOTNO	0,053920987	12	0,129826344	7	0,157776406	6	0,134384298	7
UNIQA ZIVOTNO	0,174901734	6	0,160928889	5	0,155442823	7	0,14076509	6
WIENER RE			0,018335766	23	0,046131575	17	0,055610417	14
WIENER STADTISCHE	0,179183419	5	0,177667115	4	0,239356434	4	0,239145282	4
Insurance companies	Cci	Rank (2011)	Cci	Rank (2012)	Cci	Rank (2013)	Cci	Rank (2014)
MET LIFE (ex ALICO)	0,023569333	24	0,024036428	23	0,023987577	25	0,019087735	24
AMC	0,054203486	13	0,0455137749	13	0,068534982	11	0,067757678	11
AS NEZIVOT	0,036389635	21	0,328807384	4	0,042876244	21	0,038349335	20
BASLER NEZIVOT	0,049301565	15	0,043374808	16	0,034330887	20		
BASLER ZIVOT	0,025059725	23	0,019567847	25	0,022078646	27		
AXA ZIVOT (ex CREDIT AGRICOLE)	0,027293335	22	0,017565569	26	0,030947138	23	0,02234687	23
AXA NEZIVOT	0,037781114	20	0,038743509	18	0,43322059	19	0,06572796	12
DDOR NOVI SAD	0,378593892	3	0,349367871	3	0,436688939	3	0,335645421	3
DDOR RE	0,046706365	16	0,034324146	20	0,044043641	17	0,041989204	19
DELTA GENERALI OSIGURANJE	0,559088614	2	0,588198068	2	0,632854474	2	0,485551105	2
DELTA GENERALI RE	0,054749674	12	0,050731935	14	0,061148800	12	0,063891025	13

(*Continued*)

Table 5. (*Continued*)

Insurance companies	Cci	Rank (2011)	Cci	Rank (2012)	Cci	Rank (2013)	Cci	Rank (2014)
DUNAV OSIGURANJE	0,710427712	1	0,753507485	1	0,726663157	1	0,624292967	1
DUNAV RE	0,120877634	7	0,100218639	9	0,111373167	8	0,111519228	7
ENERGOPROJEKT GARANT	0,040351027	17	0,040972271	17	0,055275623	15	0,05450809	16
GLOBUS OSIGURANJE	0,038826824	18	0,03239384	22	0,046405364	17	0,046803467	17
GRAWE	0,221209285	5	0,259718956	6	0,302744084	4	0,299013513	4
MERKUR OSIGURANJE	0,017653208	25	0,023587879	24	0,029259477	24	0,031726142	21
MILENIJUM	0,037975789	19	0,036822663	19	0,031365744	22	0,055653059	15
SAVA	0,055565477	11	0,048805664	15	0,057375655	14	0,057266204	14
SAVA ZIVOT	0,003085500	27	0,005896658	28	0,015288407	28	0,014455119	25
SOCIETE GENERALE	0,013610129	26	0.013210907	27	0,022674736	26	0,025953699	22
TAKOVO	0,081297525	9	0,072331264	10	0,078870877	9		
TRIGLAV KOPAONIK	0,070171079	10	0,064164622	11	0,059159088	13	0,084483269	10
UNIQA NEZIVOTNO	0,091341373	8	0,110161403	8	0,118458786	7	0,132989135	6
UNIQA ZIVOTNO	0,121005348	6	0,132732757	7	0,121798587	6	0,105963963	8
WIENER RE	0,050446527	14	0,062292776	12	0,072314920	10	0,09932725	9
WIENER STADTISCHE	0,245997400	4	0,262720684	5	0,294622263	5	0,29594689	5
SOGAZ			0,033581514	21	0,049730418	16	0,045459736	18

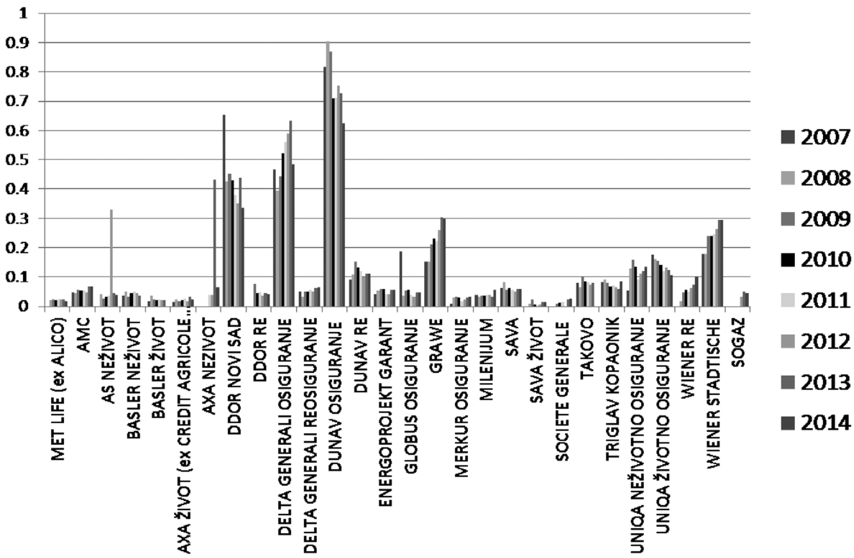

Figure 2. CCi for period from 2007 to 2014. Source: Author's Analysis.

Table 6. Total Cci, squared difference and total rank of insurance companies.

Insurance companies	Cci	$xi–\mu$	$(xi–\mu)^2$	RANK
DUNAV OSIGURANJE	0,764425172	0,636433048	0,405047	1
DELTA GENERALI OSIGURANJE	0,511377017	0,383384893	0,146984	2
DDOR NOVI SAD	0,432568413	0,304576289	0,092767	3
WIENER STADTISCHE	0,241829936	0,113837812	0,012959	4
GRAWE	0,228148660	0,100156536	0,010031	5
AXA NEZIVOT	0,14386290	0,015870776	0,000252	6
UNIQA ZIVOTNO OSIGURANJE	0,139192399	0,011200275	0,000125	7
DUNAV RE	0,116134537	−0,011857587	0,000141	8
UNIQA NEZIVOTNO OSIGURANJE	0,116107342	−0,011884782	0,000141	9
TAKOVO	0,080702488	−0,047289636	0,002236	10
AS NEZIVOT	0,07838203	−0,049610094	0,002461	11
TRIGLAV KOPAONIK	0,074589477	−0,053402647	0,002852	12
GLOBUS OSIGURANJE	0,062000415	−0,065991709	0,004355	13
SAVA	0,060184223	−0,067807901	0,004598	14
WIENER RE	0,05777989	−0,070212234	0,00493	15
AMC	0,05471804	−0,073274084	0,005369	16
DELTA GENERALI RE	0,051759946	−0,076232178	0,005811	17
ENERGOPROJEKT GARANT	0,049864456	−0,078127668	0,006104	18
DDOR RE	0,04789234	−0,080099784	0,006416	19
SOGAZ	0,042923889	−0,085068235	0,007237	20
BASLER NEZIVOT	0,041060781	−0,086931343	0,007557	21
MILENIJUM	0,037923667	−0,090068457	0,008112	22
MERKUR OSIGURANJE	0,037923667	−0,090068457	0,008112	23
SOCIETE GENERALE	0,035919876	−0,092072248	0,008477	24
MET LIFE (ex ALICO)	0,02249306	−0,105499064	0,01113	25
BASLER ZIVOT	0,022337034	−0,10565509	0,011163	26
AXA ZIVOT (ex CREDIT AGRICOLE LIFE)	0,021871622	−0,106120502	0,011262	27
SAVA ZIVOT	0,009806204	−0,11818592	0,013968	28

The study has designed a model which combines two methods of multi-criteria decision-making: fuzzy AHP and TOPSIS. In the first stage, certain priority weights of criteria by using the fuzzy AHP were established. After conducting research on the basis of selected financial categories of the financial statements of insurance companies operating in Serbia, in the process of evaluating the financial parameters, criteria such as equity and reserves and business assets have proven to be the most important vectors of weights of 0.345 and 0.274, followed by the criteria financial income of 0.202, provisions and liabilities with 0.148 and costs of insurance with 0.029. In the second phase the insurance companies were ranked using the TOPSIS method. On the basis of selected financial indicators, the insurance companies were tested and it has been observed that Dunav insurance has the best rating in comparison to other insurance companies. From Table 6 and in Fig. 2 we see that for the period from 2007 to 2014 insurance company Dunav Osiguranje (Dunav Insurance) has the highest ranking, taking into account all criteria considered. Followed by DDOR Novi Sad, Delta Generali Insurance, Wiener Städtische, Grawe, etc.

6. Conclusion

Qualitative analysis of financial and other reports of insurance companies involves a proper application of accounting, auditing and actuarial standards. Financial information is of particular importance for identifying the business risks of insurance companies. Of particular importance is the control of the management of funds of technical reserves and guarantee reserve assets of insurance companies in order to protect against risk. The primary role of financial statements that are used in this study, and which is recognised by professional institutions, as well as all the countries that develop an economic model based on the free market, is to provide potential users with information and support in making rational decisions.

Measuring the performance of insurance companies is critical to the economy. The uncertainty and complexity of the global market, as well as increase in the flow of information are major obstacles for accurate performance measurement. In such circumstances, the traditional performance measurement does not give satisfactory results. However, the fuzzy multi-criteria approach has been successfully used to overcome this problem.

Disclosure statement

No potential conflict of interest was reported by the authors.

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