PERFORMANCE EVALUATION OF NON-LIFE INSURANCE COMPANIES WITH BEST-WORST METHOD AND TOPSIS

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ABSTRACT

Like in any other field, performance of a company in the insurance industry is the key factor of gaining competitive advantage and market share. In this study, insurance companies are ranked according to their 2016 performance indicators using a two-step hybrid MCDM method including BWM and TOPSIS. Only the non-life insurance companies are used in the study. BWM is one of the relatively new MCDM methods, which has an advantage of using less comparison, measuring the consistency between the pair-wise comparisons and giving interval analysis for multi-optimal situations. In the proposed methodology, BWM is used to calculate the criterion weights and TOPSIS to rank the alternatives. The solutions found are consistent with the real life market shares of the insurance companies.

Keywords: *Best-Worst Method, Performance Order, Non-Life Insurance, TOPSIS, Multi-Criteria Decision Making.*

HAYAT-DIŞI SİGORTA ŞİRKETLERİNİN BEST-WORST YÖNTEMİ VE TOPSIS İLE PERFORMANSLARININ DEĞERLENDİRİLMESİ

ÖZET

Şirketlerin diğer herhangi bir alanda olduğu gibi, sigorta endüstrisinde de sergileyeceği performansı, rekabet avantajı ve pazar payı kazanmada anahtar faktördür. Bu çalışmada, sigorta şirketleri 2016 yılına ait performans göstergeleri doğrultusunda BWM (Best and Worst Method) ve TOPSIS yöntemlerini içeren iki aşamalı hibrit Çok Kriterli Karar Verme Yöntemi kullanılarak sıralanmaktadır. BWM, daha az karşılaştırma kullanan, çift yönlü karşılaştırmalar arasındaki tutarlılığı ölçme ve en uygun durumlar için aralık analizi yapma avantajına sahip olan nispeten yeni çok kriterli karar verme yöntemlerinden birisidir. Önerilen yöntemde BWM, kriterlerin ağırlıklarının hesaplanmasında TOPSIS ise alternatiflerin sıralanmasında kullanılmaktadır. Elde edilen sonuçlar, şirketlerin gerçek hayattaki sektör pazar payları ile tutarlılık göstermektedir.

Anahtar Kelimeler: *Best-Worst Yöntemi, Performans Sıralama, Hayat Dışı Sigortacılık, TOPSIS, Çok Kriterli Karar Verme.*

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1. Introduction

Insurance can be seen as a financial guarantee between the customer and an insurance company providing a security against unseen risks. It's a based on a contract between these two sides, in which each side has a specific role. With this contract, customer can obtain diversity and protection; insurance company can use customer's loans to improve its financial performance and competitive advantage (Bawa & Chatta, 2013). Insurance can improve an individual's peace and prosperity by establishing one's safety. It's seen from the given definitions, insurance industry plays a crucial role as the basic financial industry by sharing the risks of manufacturing or service industry (Cummins & Weiss, 2014). Insurance companies help economic development of a country by collecting insurance premium. Some of these premium can be hold back for compensation against customers' accidents, whereas most of them are invested into mutual bonds (Turgutlu et al., 2007).

Developed countries, in comparison with developing countries, using the insurance industry effectively as a financial intermediation besides banking. Thanks to the insurance sector, on one side economic risks and uncertainties are reduced while on the other side funds are provided for economic development (Vadlamannati, 2008). From customer perspective, it can be seen that in developing countries, insurance is not liked in developed countries and customers do not see insurance as a requirement for their financial security (Özcan, 2011).

Sustainability of a company's competitiveness is based on decreasing costs and increasing the profitability and service quality (Klumpes, 2004). An efficient performance measurement system is required to achieve the same profitability with lesser inputs or to produce more outputs with the same amount of inputs. It's necessary for a company to see its position between the competitors and benchmarking the efficient ones to sustain its presence (Altan, 2010).

Comparison of insurance companies has two main benefits. The first benefit is to help companies develop their own organizations. Unsuccessful companies in the sector want to improve their performance by benchmarking the activities of successful companies. However, the determination of successful enterprises in terms of one criterion creates a comparison weakness. The successfully ranking resulting from the evaluation of many criteria is a reference for the company's managers. The second benefit is to support customers' insurance company choices. Customers want to choose the companies which offer best services for their insurance need. Therefore, it is thought that analyzing more than one criterion together will improve the quality of the customer's choice.

Discriminate analysis (Altman, 1968), data envelopment analysis (DEA) (Cummins et al., 2010; Eling & Luhnen, 2010; Wu et al., 2007) and multi-criteria decision making (MCDM) methods are widely used in different fields such as media selection problem (Chang et al., 2012), reflow soldering process (Tsai & Tsai, 2014) and sustainable assessment (Taha et al., 2015) can measure and compare the financial efficiency of the insurance companies. Due to its uncertain nature, demand oriented and complex structure, MCDM methods can be preferred to analyze and measure the performance.

Some of MCDM methods such as AHP, ANP, Critic etc. are used to assign weights to criteria. Importance degree of criteria are asked to expert decision makers by using paired comparison matrices. The weight value for each criterion results from the comparisons provided by decision makers. Criterion weights have a decisive role in ranking alternatives. Each alternative is then ranked from the best to the worst according to criteria. Thanks to these ranking features, MCDM methods provide the best alternative solution for problems such as location selection, technology selection, performance ranking and efficiency ranking problems.

In the literature, financial criteria are widely used in the performance comparison of insurance companies. However, the difficulty of the issue lies on the selection of the related evaluation criteria, which must represent the general performance of the company and the measurement method using those criteria. Based on the complex structure of the insurance industry, generally two-step hybrid MCDM evaluation methods are proposed. Shen et al., (2017) used DEMATEL-Based Analytic Network Process (DANP), Rough Set Theory and Multi-Attribute Utility Theory methods, Tuş Işık, (2016) used QUALIFLEX (Qualitative Flexible) and ORESTE (Organization, Rangement Et Synthese De Donnes Relationnelles) methods performance comparison of insurance companies. Venkateswarlu & Rao, (2016) used Grey Relational Analysis and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to evaluate the profitability of the non-life insurance companies in India. Saeedpoor et al., (2015) measured Iranian insurance companies based on five service quality criteria using first fuzzy analytic hierarchy method (FAHP) to determine the criteria weights and then used TOPSIS to rank the alternatives. In a similar approach, Akhisar & Tunay (2015) used TOPSIS to compare insurance company's performance based on the criteria weights determined by AHP.

In this study, performances of non-life insurance companies' in Turkey are ranked using a hybrid MCDM method. Importance level of the selected criteria are determined with Best – Worst Method (BWM) and companies are ranked using TOPSIS. BWM is a relatively new method proposed by Rezaei (2015). BWM is given in the next section, whereas TOPSIS is explained in Section 3. In Section 4, application of the study is given with a step by step approach, following this section is the results and future studies section.

2. BEST-WORST Method

BWM is a MCDM method using two vectors based on the pair-wise comparisons to calculate the criteria weights. In the method, decision maker first determine the best (most preferred, most important) and the worst (least preferred, least important) criteria. In the next step, the best criterion is compared against other criteria and other criteria are compared against the worst criterion. To calculate the criteria weights, a non-linear minimax model is used to minimize the maximum absolute difference between weight ratios and pair-wise comparisons (Rezaei, 2016).

In BWM, less pair-wise comparisons are needed from other MCDM methods and also the consistency of the pair-wise comparison are also calculated. When there is an inconsistency, different solution approaches are proposed for alternative comparisons (Gupta & Barua, 2016). For the multi-optimization situations, BWM suggest different solutions based

on different weight sets of the criteria. This feature can sometimes be advantageous for the decision makers. Especially in a controversial decision making (like a political one), multi-optimal solutions can provide the independence of higher information integration (without modelling it). Here, interval analysis is used. If there is not controversial situation and higher information is not needed, a single solution can be selected by the decision maker (Rezaei, 2016). These advantages make BWM popular in recent studies. BWM (Rezaei, 2015) is used for mobile telephone selection, supplier segmentation (Rezaei et al., 2016), determining the technological innovation capabilities of Indian small and medium enterprises (Gupta & Barua, 2016), evaluating the university-industry joint PhD projects (Salimi & Rezaei, 2016), supplier selection (Rezaei, 2016), evaluation of the sustainability of waste water purification technologies (Ren et al., 2017), selecting the best model for air-parcel transportation using key performance indicators (Rezaei et al., 2017), investigation and evaluation of key success factors in technological innovation development of remotely-piloted helicopters (Ghaffari et al., 2017), evaluating the external factors for the sustainability of oil and gas supply chain (Ahmad et al., 2017), ordering the factors preventing the energy efficiency (Gupta et al., 2017) and evaluating the risks in humanitarian supply chain (Mohaghar et al., 2017).

2.1. BWM Steps

Steps of the BWM for calculating the criteria weights are given as below (Rezaei, 2015):

- Step 1. Set of decision criteria are determined.
- Step 2. The best (most preferred or most important) and the worst (least desired or least important) criteria are determined.
- Step 3. Determine the preference of the best criterion over all the other criteria based on a number scale between 1 and 9. Create the Best to Others vector as:

$$A_B = (a_{B1}, a_{B2}, \ldots a_{Bn})$$

Here a_{Bj} is the preference value of the best criterion (B) over criterion j. Obviously $a_{BB}=1$.

- Step 4. Determine the preference of all the other criteria over the worst criterion based on a number scale between 1 and 9. Create the Others to Worst vector as:

$$A_w=(a_{1W}, a_{2W}, \ldots a_{nW})^T$$

Here a_{jW} is the preference value of the best criterion j over the worst criterion (W). Obviously $a_{WW}=1$.

- Step 5. Calculate the optimal weights ($w_1^*, w_2^*, \ldots, w_n^*$).

In this step, optimal criteria weights are determined, so that using the minimax model below the maximum absolute differences $\left|\frac{W_B}{W_j} - a_{Bj}\right|$ and $\left|\frac{W_j}{W_W} - a_{jW}\right|$ for all j are calculated:

$$\begin{aligned} &\min \max_j \left\{ \left| \frac{W_B}{W_j} - a_{Bj} \right|, \left| \frac{W_j}{W_W} - a_{jW} \right| \right\} \\ &subject\ to \\ &\sum_j W_j = 1 W_j \geq 0, for\ all\ j \end{aligned} \tag{1}$$

Model (1) is same as the following model:

$$\begin{aligned} &\left| \frac{W_B}{W_j} - a_{Bj} \right| \leq \xi, for\ all\ j \\ &\left| \frac{W_j}{W_W} - a_{jW} \right| \leq \xi, for\ all\ j \\ &\sum_j W_j = 1, W_j \geq 0, for\ all\ j \end{aligned} \tag{2}$$

By solving model (2), optimal weights of (w_1^*, w_2^*, …., w_n^*) and ξ^* can be found. In non-consistent problems having more than three criteria, there can be more than one optimal solution. In this case, center value of optimal criteria weights (Equation 5) can be used as the criteria weight. Model (3) and model (4) can be used to calculate the lower bound and upper bound weights of each criterion. But before these models, model (2) must be solved to find ξ^* (Rezaei et al., 2015).

$$\begin{aligned} &\min W_j \\ &Subject\ to \\ &\left| \frac{W_B}{W_j} - a_{Bj} \right| \leq \xi, for\ all\ j \\ &\left| \frac{W_j}{W_W} - a_{jW} \right| \leq \xi, for\ all\ j \\ &\sum_j W_j = 1, W_j \geq 0, for\ all\ j \end{aligned} \tag{3}$$

$$\begin{aligned} &\max W_j \\ &Subject\ to \\ &\left| \frac{W_B}{W_j} - a_{Bj} \right| \leq \xi, for\ all\ j \\ &\left| \frac{W_j}{W_W} - a_{jW} \right| \leq \xi, for\ all\ j \\ &\sum_j W_j = 1, W_j \geq 0, for\ all\ j \end{aligned} \tag{4}$$

$$Wj^* = (\min W_j + \max W_j)/2 \tag{5}$$

- Step 6. Consistency ratio is calculated to check the consistency of the comparisons. If $a_{Bj} \, x \, a_{jW} = a_{BW}$ for all j, comparisons are fully consistent. In some cases, full consistency cannot be achieved. Consistency index should be calculated using the values given in Table 1(Rezaei et al., 2015).

Table 1: Consistency Index (CI) Table

a_{BW}	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Consistency Index (max ξ)	0.00	0.44	1.00	1.63	2.30	3.00	3.73	4.47	5.23

Consistency ration (CR), can be calculated using ξ* and the related consistency index value as given below:

Consistency Ration (CR)=(ξ*)/(Consistency Index) (6)

Consistency ratio is between the interval of (0, 1) and values close to 0 indicates a higher consistency whereas values close to 1 means low consistency (Rezaei, 2016).

3. TOPSIS Method

Proposed by Yoon and Hwang in 1981, the basic principle of TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is to select alternative with closest to positive ideal solution but at the same time furthest to negative solution. Alternatives are ranked based on the calculated distances (Aktan & Tosun, 2013). Steps of the TOPSIS are given below (Özdemir, 2015):

• Step 1. Initial decision matrix having alternatives in rows and evaluation criteria in columns is created. There are *m* alternatives and *n* criteria in the matrix:

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}$$

• Step 2. Standard decision matrix (R_{ij}) is developed using the formula below:

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}} \quad (7)$$

R matrix is given below:

$$R_{ij} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

- Step 3. Weighted standard decision matrix (V_{ij}) is found by weighting the elements of the R_{ij} matrix with the pre-defined criteria weights:

$$V_{ij} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \cdots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \cdots & w_n r_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ w_1 r_{m1} & w_2 r_{m2} & \cdots & w_n r_{mn} \end{bmatrix}$$

- Step 4. Positive ideal (A^*) and negative ideal (A^-) solution sets are determined. Positive ideal solution set includes the maximum values in the V_{ij} matrix (minimum if it's a cost criteria) using Eq. 8, negative ideal solution set includes the minimum values in the V_{ij} matrix (maximum if it's a cost criteria) using Eq. 9.

$$A^* = \left\{ \left(\max_i v_{ij} \middle| j \in J \right), \left(\min_i v_{ij} \middle| j \in J' \right) \right\} \tag{8}$$

Positive ideal solution set is shown as $A^* = \left\{ v_1^*, v_2^*, ..., v_n^* \right\}$.

$$A^- = \left\{ \left(\min_i v_{ij} \middle| j \in J \right), \left(\max_i v_{ij} \middle| j \in J' \right) \right\} \tag{9}$$

Negative ideal solution set is shown as $A^- = \left\{ v_1^-, v_2^-, ..., v_n^- \right\}$.

In both equations, J shows the benefit (maximization), J is the cost (minimization) criteria value.

- Step 5. Positive ideal closeness (S_i^*) and negative ideal closeness (S_i^-) are calculated for each criterion.

$$S_i^* = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^*)^2} \tag{10}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2} \tag{11}$$

- Step 6. Total distance measurement which is the relative closeness to positive ideal solution (C_i^*) for each criterion is calculated using Eq. 12. Here C_i^* is between [0, 1] interval and $C_i^*=1$ shows the absolute closeness to ideal solution of the *i*. alternative, whereas $C_i^*=0$ is the absolute closeness of the *i*. alternative to negative ideal solution. Therefore, the ranking order is based on the C_i^* in descending order.

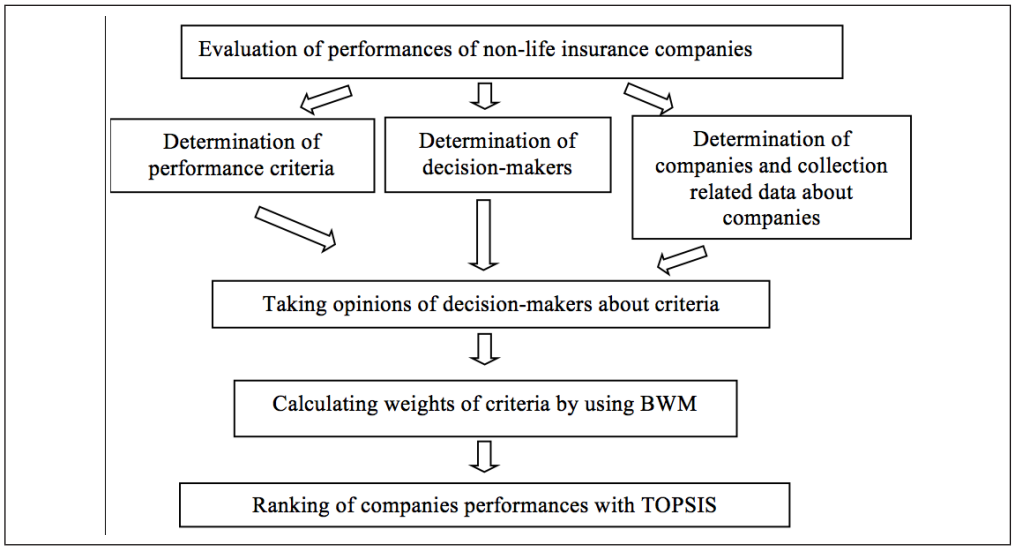
$$C_i^* = \frac{S_i^-}{S_i^- - S_i^*} \tag{12}$$

4. Application

In this study, performance of non-life insurance companies based on 2016 data will be evaluated. Non-life insurance is the kind of insurance based on covering financial loss and property damage. Here, fire insurance, vehicle insurances (automobile and traffic), transport insurance, machinery insurances, agricultural insurance and mandatory earthquake insurance can be given as example. In 2016, a total value of 35,447,988,684 TL premium production is realized. The share of the companies in these total values is given in Table 2.

Although the market share of an insurance company in premium production can be a good indicator of its performance, different indicators should also be taken into consideration at the same time for a proper analysis. Methodological steps of the study are seen in Figure 1.

Figure 1: Methodology of the Proposed Model



Step 1. In the first step, decision makers, criteria and alternatives (companies) are determined and the related data is gathered. Based on the opinions of the 5 decision makers, both from insurance companies and experts from the university, a set of criteria is identified. The decision-making group consists of three academicians who are financial experts working in the field of insurance and regional managers of two insurance companies that have a significant share in the market. In accordance with the access to the data, a total of 5 criteria are selected: C_1: Period Net Profit (TL), C_2: Equity (TL), C_3: Total Premium Generation (TL), C_4: Income and Expense Balance (TL) and C_5: Number of Marketing Channels (Number). Insurance Association of Turkey's statistics are used for collecting the data and all 38 non-life insurance company listed in Insurance Association of Turkey are used in the study.

• Step 2. With a questionnaire form, the best and the worst criterion are asked to decision makers, then asked to score the best criterion against other criteria and other criteria against the worst criteria using the scale given in Table 3. The questionnaires were answered face-to-face with academicians, and they were sent to the sector.

Table 2: Market Share of Non-Life Insurance Companies Based on Insurance Premium

No	Company Name	Market Share (%)	No	Company Name	Market Share (%)
1	Allianz	16.29	20	Unico	0.84
2	Anadolu	12.65	21	Türk Nippon	0.78
3	Axa	10.05	22	Ethica	0.59
4	Mapfre	7.88	23	Generali	0.55
5	Sompo Japan	6.31	24	Liberty	0.53
6	Aksigorta	5.35	25	Dubai Starr	0.51
7	Güneş	3.87	26	SBN	0.46
8	Ziraat	3.77	27	Işık	0.43
9	Eureko	3.48	28	Ace European Group	0.32
10	Groupama	3.25	29	SS Koru	0.29
11	Halk	2.92	30	Orient	0.26
12	Neova	2.84	31	BNP Paribas Cardif	0.20
13	HDI	2.46	32	Coface	0.18
14	Ergo	2.32	33	Euler Hermes	0.16
15	SS Doğa	2.26	34	Atradius Credit Insurance	0.10
16	Ray	1.60	35	Turkland	0.10
17	Zurich	1.36	36	Türk P&I	0.07
18	Ankara	0.89	37	Gulf	0.02
19	AIG	0.86	38	Magdeburger	0.00

Source: www.tsb.org.tr, Date: 24.03.2017

Table 3: Pair-wise Comparison Scale

Scale	**1**	**3**	**5**	**7**	**9**	**2, 4, 6, 8**
Importance Level	Equal	Medium	Strong	Very Strong	Absolute	Interval Values

Step 3. Criteria weights are calculated using BWM. Because of the independent evaluation of each decision maker, criteria weight set for each decision maker is found. Then arithmetical average of these criteria sets is used for the study. Each decision makers' best and worst criteria and pair-wise comparison of these criteria against the others are given Table 4 and Table 5.

Table 4: Pair-wise Comparison of the Best Criterion and Other Criteria

Decision Maker	**Best**	C_1	C_2	C_3	C_4	C_5
DM_1	C_4	2	3	2	1	2
DM_2	C_2	2	1	4	3	6
DM_3	C_3	2	3	1	5	7
DM_4	C_3	2	2	1	3	3
DM_5	C_1	1	3	4	2	9

Table 5: Pair-wise Comparison of the Worst Criterion and Other Criteria

	DM_1	DM_2	DM_3	DM_4	DM_5
Criteria	Worst: C_2	Worst: C_5	Worst: C_5	Worst: C_5	Worst: C_5
C_1	3	5	6	3	9
C_2	1	6	5	3	5
C_3	2	3	8	3	8
C_4	3	4	6	2	6
C_5	2	1	1	1	1

By solving Model (2) for each decision maker, criteria weights are found. For example, Model (2) for Decision Maker 1 (DM-1) using the best and worst pair-wise comparison vectors (first row in Table 4 and first column in Table 5, respectively) is given below:

$$\min \xi$$

Subject to

$$w_1+w_2+w_3+w_4+w_5 = 1$$

$$w_j \geq 0 \text{ for all}$$

Solving the above model, criteria weight set is found for DM-1 as $w_1^*=0.247$, $w_2^*=0.101$, $w_3^*=0.146$, $w_4^*=0.359$, $w_5^*=0.146$ and $\xi^*=0.551$. Consistency ration (Eq. 6) is 0.551/1.00=0.551. Same calculations are done for the other decision makers and the results are given in Table 6. Based on the average values of the criteria weights, order of criteria importance is

$w_1>w_3>w_2>w_4>w_5$ which can be also written as Net Profit (C_1) > Total Premium Generation (C_3) >Equity (C_2) > Income and Expense Balance (C_4) > Number of Marketing Channels (C_5).

Table 6: Calculated Weights and Consistency Ratios for Decision Makers' Evaluation

	w_1^*	w_2^*	w_3^*	w_4^*	w_5^*	ξ^*	*CR*
DM_1	0.247	0.101	0.146	0.359	0.146	0.551	0.551
DM_2	0.307	0.360	0.114	0.166	0.053	0.838	0.279
DM_3	0.282	0.248	0.315	0.121	0.034	2.394	0.642
DM_4	0.225	0.225	0.326	0.133	0.092	0.551	0.551
DM_5	0.449	0.117	0.238	0.157	0.040	2.113	0.404
w_i^*/n	0.302	0.210	0.228	0.187	0.073		

Step 4. Average criteria weights calculated with BWM (Table 6) is used as the criteria weights (w_1=0.302, w_2=0.210, w_3=0.228, w_4=0.187, w_5=0.073) in TOPSIS. Decision matrix of non-insurance companies (A_{ij}) using the 2016 data is created. By using Eq. (7)-(12), performance order of the companies is found as given in Table 7. In addition, the results of TOPSIS are presented in Appendix.

Table 7: Performance Order of Non-Life Insurance Companies Based on 2016 Data

No	Company Name	C_i^*	No	Company Name	C_i^*
1	Allianz	0.993	20	Işık	0.253
2	Anadolu	0.527	21	Ace European Group	0.246
3	Axa	0.526	22	Dubai Starr	0.238
4	Sompo Japan	0.498	23	BNP Paribas Cardif	0.234
5	Mapfre	0.470	24	SS Koru	0.233
6	Ziraat	0.451	25	Türk P&I	0.228
7	Eureko	0.389	26	Gulf	0.228
8	Neova	0.385	27	Coface	0.227
9	Aksigorta	0.366	28	Magdeburger	0.226
10	HDI	0.322	29	Ethica	0.223
11	Ankara	0.294	30	Euler Hermes	0.223
12	Ray	0.291	31	Orient	0.222
13	SS Doğa	0.276	32	Generali	0.215
14	AIG	0.271	33	Liberty	0.213
15	Halk	0.270	34	Güneş	0.211
16	SBN	0.266	35	Turkland	0.210
17	Zurich	0.263	36	Atradius Credit Ins.	0.192
18	Groupama	0.257	37	Unico	0.187
19	Türk Nippon	0.257	38	Ergo	0.065

Spearman rank correlation coefficient (rs) is used to analyzed the relation between the companies performance and the order of market share given in Table 2. This (rs) coefficient is used to determine the strength of association between to variables which are either ranked directly or ordered in a pre-defined rule. A meaningful relation between market share and performance rank is found with this analysis, given in Table 8.

Table 8: Spearman Rank Correlation Results

			Market Share	**Performance rank**
Spearman's rho	**Market share**	Coefficient	1,000	,704(**)
		Sig. (2-tailed)	.	,000
		N	38	38
	Performance rank	Coefficient	,704(**)	1,000
		Sig. (2-tailed)	,000	.
		N	38	38

** *Correlation is significant at the 0.01 level (2-tailed).*

There is a high and significant correlation ($rs = 0.704$, $p < 0.01$) between the performance ranking obtained through TOPSIS and the ranking of companies' market shares. This shows that the two ranking results are close to each other. The fact that an indicator from the real economy and the indicator of the results obtained in the study are close to each other shows the effectiveness of the method used. On the other hand, in order to show the effectiveness of a MCDM method, results are generally compared with the results obtained from another MCDM method. However, in this study, the comparison of the ranking obtained with TOPSIS with a real indicator reveals the innovative and objective aspect of the study.

5. Conclusion

In this study, non-life insurance companies in Turkey performances are analyzed using BWM and TOPSIS. BWM is used to calculate the criteria weights and TOPSIS is to rank the companies based on their performances. BWM is relatively a new MCDM method using pair-wise comparisons to determine the criteria weights, like AHP. The distinguishing point of the BWM is using the best and the worst criterion for pair-wise comparisons. Therefore, BWM requires less comparisons than AHP and also it can test the consistency of the comparisons. Another advantage of the BWM is finding solutions for multi-optimization cases.

Based on the results, Allianz Insurance Company, Anadolu Turkish Insurance Company and Axa Insurance Company are the first three companies based on their performances. These three are the first three company in market share order based on the total premium generation in 2016. Although Atradius Credit Insurance N.V. İstanbul is 34. Unico Insurance is 20. and Ergo Insurance Company is 14. in market share order, these are the last three companies in performance order. This is due to the differences in criteria weights. In the study, the most important criterion is Period Net Profit (C_1) and the second important one is the Total Premium Generation (C_3). With it, there is a meaningful rank correlation (0.704) between performance order and market share order.

The main limitation of the study is access to the data, therefore five quantitative criteria is used for performance order. It can be possible to increase these criteria and also using qualitative criteria (customer complaints, awareness level, etc.) using a point order. Also different MCDM methods can be used and their performances' used to compare the results. All these improvements points can be addressed in further studies.

References

Ahmad, W. N., Wan, K., Rezaei, J., Sadaghiani, S., & Tavasszy, L. A. (2017). Evaluation of the external forces affecting the sustainability of oil and gas supply chain using best worst method. *Journal of Cleaner Production,* 153, 242-252.

Akhisar, I., & Tunay, N. (2015). *Performance ranking of Turkish life insurance companies using AHP and TOPSIS*. Management International Conference. Portoroz, Slovenia.

Aktan, H. E., & Tosun, Ö. (2013). An integrated fuzzy AHP–fuzzy TOPSIS approach for AS/RS selection. *International Journal of Productivity and Quality Management,* 11(2), 228-245.

Altan, M. S. (2010). Türk sigortacılık sektöründe etkinlik: Veri zarflama analizi yöntemi ile bir uygulama. *Gazi Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* 12(1), 185-204.

Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance,* 23(4), 589-609.

Bawa, S. K., & Chattha, S. (2013). Financial performance of life insurers in Indian insurance industry. *Pacific Business Review International,* 6(5), 44-52.

Chang, S. H., Wu, T. C., Tseng, H. E., Su, Y. J., & Ko, C. C. (2012). Media mix decision support for schools based on analytic network process. *International Journal of Industrial Engineering,* 19(7), 297-304.

Cummins, J. D., Weiss, M. A., Xie, X., & Zi, H. (2010). Economies of scope in financial services: A DEA efficiency analysis of the US insurance industry. *Journal of Banking & Finance,* 34(7), 1525-1539.

Cummins, J. D., & Weiss, M. A. (2014). Systemic risk and the US insurance sector. *Journal of Risk and Insurance,* 81(3), 489-528.

Eling, M., & Luhnen, M. (2010). Efficiency in the international insurance industry: A cross-country comparison. *Journal of Banking & Finance*, 34(7), 1497-1509.

Ghaffari, S., Arab, A., Nafari, J., & Mangehti, M. (2017). Investigation and evaluation of key success factors in technological innovation development based on BWM. *Decision Science Letters,* 6, 295-306.

Gupta, H., & Barua, M. K. (2016). Identifying enablers of technological innovation for Indian MSMEs using best–worst multi criteria decision making method. *Technological Forecasting and Social Change,* 107, 69-79.

Gupta, P., Anand, S., & Gupta, H. (2017). Developing a roadmap to overcome barriers to energy efficiency in buildings using best worst method. *Sustainable Cities and Society,* 31, 244-259.

Klumpes, P. J. M. (2004). Performance benchmarking in financial services: Evidence from the UK life insurance industry. *The Journal of Business,* 77(2), 257-273.

Mohaghar, A., Sahebi, I. G., & Arab, A. (2017). Appraisal of humanitarian supply chain risks using best-worst method. *International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering,* 11(2), 259-264.

Özcan, A. İ. (2011). Türkiye'de hayat dışı sigorta sektörünün 2002-2009 dönemi itibariyle etkinlik analizi. *Celal Bayar Üniversitesi Sosyal Bilimler Dergisi,* 9(1), 61-78.

Özdemir, M. (2015). *TOPSIS i*şletmeciler, *m*ühendisler ve *y*öneticiler *için operasyonel, y*önetsel ve *stratejik problemlerin* çözümünde *çok kriterli karar verme*. B.F. Yıldırım, E. Önder (Eds.), Bursa:Dora Basım-Yayın.

Ren, J., Liang, H., & Chan, F. T. S. (2017). Urban sewage sludge, sustainability, and transition for eco-city: Multi-criteria sustainability assessment of technologies based on best-worst method. *Technological Forecasting and Social Change,* 116, 29-39.

Rezaei, J. (2015). Best-worst multi-criteria decision-making method. *Omega,* 53, 49-57.

Rezaei, J., Wang, J., & Tavasszy, L. (2015). Linking supplier development to supplier segmentation using best-worst method. *Expert Systems with Applications,* 42, 9152-9164.

Rezaei, J., Nispeling, T., Sarkis, J., & Tavasszy, L. (2016). A supplier selection life cycle approach integrating traditional and environmental criteria using the best worst method. *Journal of Cleaner Production,* 135, 577-588.

Rezaei, J., Hemmes, A., & Tavasszy, L. (2017). Multi-criteria decision-making for complex bundling configurations in surface transportation of air freight. *Journal of Air Transport Management,* 61, 91-105.

Rezaei, J. (2016). Best-worst multi-criteria decision-making method: Some properties and a linear model. *Omega,* 64, 126-130.

Saeedpoor, M., Vafadarnikjoo, A., Mobin, M., & Rastegari, A. (2015). *A servqual model approach integrated with fuzzy AHP and fuzzy TOPSIS methodologies to rank life insurance firms*. Proceedings of the International Annual Conference of the American Society for Engineering Management, American Society for Engineering Management (ASEM).

Salimi, N., & Rezaei, J. (2016). Measuring efficiency of university-industry Ph.D. projects using best worst method. *Scientometrics,* 109(3), 911-1938.

Shen, K. Y., Hu, S. K., & Tzeng, G. H. (2017). Financial modeling and improvement planning for the life insurance industry by using a rough knowledge-based hybrid MCDM model. *Information Sciences,* 375, 296-313.

Taha, Z., Salaam, H. A., Phoon, S. Y., Tuan, Ya T. M. Y. S., & Mohamad, M. R. (2015). Application of integrated sustainability assessment: Case study of a screw design. *International Journal of Industrial Engineering*, 22(1), 1-10.

Tsai, T. N., & Tsai, C. W. (2014). Development of a closed-loop diagnosis system for reflow soldering using neural networks and support vector regression. *International Journal of Industrial Engineering,* 21(1), 18-32.

Turgutlu, E., Kök, R., & Kasman, A. (2007). Türk sigortacılık şirketlerinde etkinlik: Deterministik ve şans kısıtlı veri zarflama analizi. İktisat İşletme ve Finans, 22(251), 85-102.

Tuş Işık, A. (2016). QUALIFLEX and ORESTE methods for the insurance company selection problem. *Alphanumeric Journal,* 4(2), 55-68.

Vadlamannati, K. C. (2008). Do insurance sector growth and reforms affect economic development? Empirical evidence from India. *Margin: The Journal of Applied Economic Research,* 2(1), 43-86.

Venkateswarlu, R., & Rao, B. S. S. (2016). Profitability evaluation and ranking of Indian non-life insurance firms using GRA and TOPSIS. *Journal of Insurance and Financial Management,* 2(2), 59-89.

Wu, D, Yang, Z., Vela, S., & Liang, L. (2007). Simultaneous analysis of production and investment performance of Canadian life and health insurance companies using data envelopment analysis. *Computers & Operations Research,* 34(1), 180-198.

Appendix: The Results of TOPSIS

Insurance Companies			R_{ij}		
Ace European	0.025	0.022	0.012	0.012	0.117
AIG	0.047	0.056	0.032	0.040	0.195
Aksigorta	0.096	0.153	0.195	0.193	0.195
Allianz	0.746	0.623	0.594	0.670	0.156
Anadolu	0.174	0.464	0.462	0.254	0.195
Ankara	0.076	0.040	0.032	0.080	0.156
Atradius Credit	-0.045	0.003	0.004	-0.032	0.117
Unico	-0.058	0.024	0.031	-0.035	0.195
Axa	0.204	0.365	0.367	0.337	0.195
BNP Paribas	0.010	0.011	0.007	0.002	0.078
Coface	0.002	0.010	0.007	-0.012	0.195
Turkland	-0.022	0.005	0.004	-0.018	0.156
Dubai Starr	0.009	0.017	0.019	0.014	0.195
Ergo	-0.283	0.081	0.085	-0.199	0.156
Euler Hermes	-0.001	0.008	0.006	-0.018	0.156
Eureko	0.147	0.206	0.127	0.172	0.156
Generali	-0.025	0.037	0.020	-0.002	0.195
Groupama	0.007	0.118	0.118	0.005	0.195
Güneş	-0.101	0.164	0.141	0.029	0.156
Halk	0.044	0.079	0.107	-0.020	0.195
HDI	0.081	0.126	0.090	0.123	0.156
Işık	0.029	0.031	0.016	0.024	0.195
Liberty	-0.021	0.028	0.019	-0.015	0.078
Magdeburger.	0.000	0.002	0.000	0.000	0.039
Mapfre	0.198	0.260	0.288	0.240	0.156
Neova	0.177	0.074	0.104	0.176	0.195
Orient	-0.006	0.002	0.009	-0.008	0.156
Ray	0.065	0.048	0.059	0.078	0.195
SBN	0.043	0.020	0.017	0.051	0.156
Sompo Japan	0.282	0.159	0.230	0.274	0.156
SS Doğa	0.045	0.036	0.082	0.054	0.195
SS Koru	0.007	0.000	0.011	0.007	0.156

Gulf	0.001	0.005	0.001	0.002	0.117
Türk Nippon	0.037	0.019	0.028	0.021	0.156
Türk P&I	0.002	0.002	0.003	0.001	0.156
Ziraat	0.256	0.101	0.138	0.239	0.156
Zurich	0.023	0.066	0.050	0.069	0.156
Ethica	-0.007	0.018	0.022	-0.002	0.039
Insurance Companies			V_{ij}		
Ace European	0.007	0.005	0.003	0.002	0.009
AIG	0.014	0.012	0.007	0.008	0.014
Aksigorta	0.029	0.032	0.044	0.036	0.014
Allianz	0.225	0.131	0.136	0.125	0.011
Anadolu	0.053	0.098	0.105	0.047	0.014
Ankara	0.023	0.008	0.007	0.015	0.011
Atradius Credit	-0.014	0.001	0.001	-0.006	0.009
Unico	-0.018	0.005	0.007	-0.007	0.014
Axa	0.061	0.077	0.084	0.063	0.014
BNP Paribas	0.003	0.002	0.002	0.000	0.006
Coface	0.000	0.002	0.002	-0.002	0.014
Turkland	-0.007	0.001	0.001	-0.003	0.011
Dubai Starr	0.003	0.004	0.004	0.003	0.014
Ergo	-0.086	0.017	0.019	-0.037	0.011
Euler Hermes	0.000	0.002	0.001	-0.003	0.011
Eureko	0.044	0.043	0.029	0.032	0.011
Generali	-0.008	0.008	0.005	0.000	0.014
Groupama	0.002	0.025	0.027	0.001	0.014
Güneş	-0.030	0.035	0.032	0.005	0.011
Halk	0.013	0.017	0.024	-0.004	0.014
HDI	0.024	0.027	0.020	0.023	0.011
Işık	0.009	0.006	0.004	0.005	0.014
Liberty	-0.006	0.006	0.004	-0.003	0.006
Magdeburger.	0.000	0.001	0.000	0.000	0.003
Mapfre	0.060	0.055	0.066	0.045	0.011
Neova	0.053	0.015	0.024	0.033	0.014
Orient	-0.002	0.000	0.002	-0.002	0.011

Ray	0.020	0.010	0.013	0.014	0.014
SBN	0.013	0.004	0.004	0.010	0.011
Sompo Japan	0.085	0.033	0.052	0.051	0.011
SS Doğa	0.014	0.008	0.019	0.010	0.014
SS Koru	0.002	0.000	0.002	0.001	0.011
Gulf	0.000	0.001	0.000	0.000	0.009
Türk Nippon	0.011	0.004	0.006	0.004	0.011
Türk P&I	0.001	0.000	0.001	0.000	0.011
Ziraat	0.077	0.021	0.031	0.045	0.011
Zurich	0.007	0.014	0.011	0.013	0.011
Ethica	-0.002	0.004	0.005	0.000	0.003

Insurance Companies	S_i^*	S_i^-	C_i^*
Ace European	0.310	0.101	0.246
AIG	0.299	0.111	0.271
Aksigorta	0.254	0.147	0.366
Allianz	0.003	0.398	0.993
Anadolu	0.195	0.217	0.527
Ankara	0.291	0.121	0.294
Atradius Credit	0.331	0.079	0.192
Unico	0.330	0.076	0.187
Axa	0.191	0.211	0.526
BNP Paribas	0.315	0.096	0.234
Coface	0.318	0.094	0.227
Turkland	0.325	0.086	0.210
Dubai Starr	0.313	0.098	0.238
Ergo	0.387	0.027	0.065
Euler Hermes	0.320	0.092	0.223
Eureko	0.246	0.156	0.389
Generali	0.320	0.087	0.215
Groupama	0.297	0.103	0.257
Güneş	0.316	0.085	0.211
Halk	0.295	0.109	0.270
HDI	0.274	0.130	0.322
Işık	0.307	0.104	0.253

Liberty	0.321	0.087	0.213
Magdeburger.	0.319	0.093	0.226
Mapfre	0.211	0.188	0.470
Neova	0.253	0.159	0.385
Orient	0.320	0.091	0.222
Ray	0.290	0.119	0.291
SBN	0.303	0.110	0.266
Sompo Japan	0.204	0.202	0.498
SS Doğa	0.295	0.112	0.276
SS Koru	0.316	0.096	0.233
Gulf	0.319	0.094	0.228
Türk Nippon	0.306	0.106	0.257
Türk P&I	0.319	0.094	0.228
Ziraat	0.227	0.186	0.451
Zurich	0.299	0.107	0.263
Ethica	0.318	0.091	0.223