Application of combinational approach of FAHP and PROMETHEE in the insurance branches ranking

Mostafa Kazemi and
Saeideh Farajzadeh Bardeji*

Department of Management,
Faculty of Economic and Administrative Sciences,
Ferdowsi University of Mashhad (FUM),
Azadi Square, Mashhad, Iran
Email: kazemi@um.ac.ir
Email: saeideh.farajzadeh@stu.um.ac.ir
*Corresponding author

Abstract: Nowadays, considering the importance of the insurance industry in the world of competitive economy, it seems necessary to study and determine its position among competitors. In order to study the position and situation of insurance companies, scientific methods are used. In this study, researchers have been tried to rank the branches of insurance by gathering data from 24 branches of Iran insurance. Gathered data is related to five indicators, branch manpower skill, general and administrative costs of branch, degree of branch, sales and wages. To rank these branches, the combination of fuzzy analytical hierarchy process (FAHP) and preference ranking organisation method for enrichment evaluation (PROMETHEE) methods is used; according to the results, the first and the last ranks have been obtained respectively by branches no. 23 and no. 22 among branches.

Keywords: insurance; insurances branches; fuzzy analytical hierarchy process; FAHP; preference ranking organisation method for enrichment evaluation; PROMETHEE.

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Biographical notes: Mostafa Kazemi is an Associate Professor at the Department of Management at Ferdowsi University. He has more than 20 years of experience in teaching and research. He has written several books related to his research work. His research interests include multi-criteria decision making, strategic programming, productivity and quality management, entrepreneurship, mathematical programming and mathematical modelling. He has published more than 60 research papers and guided 67 dissertation works. His work has appeared in *Journal of Mathematics and Computer Sciences, Journal of Information Systems and Telecommunication, International Journal of Fundamental Psychology and Social Sciences, International Journal of Accounting and Financial Management – IJAFM* and others.

Saeideh Farajzadeh Bardeji is a PhD student of Operational Research at Ferdowsi University. Her research interests include multi-criteria decision making, simulation, optimisation problems and inventory management.

1 Introduction

The insurance term is taken from the term fear. Elimination or protection against potential risks, i.e., vaccination against fear, is called insurance. Insurance cannot prevent the loss, but it can replace the lost resources with other resources (Valinejad, 2003).

The main benefit of insurance is to assure people to deal with possible risks. In addition to create a safe environment for economic activities, insurance creates certainty for production and investment, and generally it creates a safe and secure environment for social and economic activities.

Insurance is one of the useful tools of risk management, to provide comfort and safety of society population; it is the solution to meet the needs of societies against sudden and unpredictable accidents. Nowadays, insurance is one of the important social and economic tools, that reliance on it is inevitable in the various sectors of business, service, and economic, and as an industry, it has an important role as an industry, in growth and sustainable economic development of countries.

Over the past two decades, service sector and especially the insurance industry had experienced tremendous growth in economies of both developed and developing countries.

According to important role of this industry in national economy, it has experienced many changes; one of these major changes is the increase of number of insurance institutions and the private sector in this field of economic activity which would lead to increase of competition among insurers to attract customers and develop the insurance markets; therefore, according to the importance of the insurance industry in the today's competitive world of economy, it seems necessary to study, investigate and determine its position among competitors; so scientific methods are used to study the position and situation of insurance institutes, since scientific methods can indicate the position of insurance institutes by minimising the errors due to the subjective judgments and consequently offer appropriate strategies to strengthen the position of each institute.

Multiple-criteria decision making (MCDM) has grown as a part of operations research, concerning with designing computational and mathematical tools for supporting the subjective evaluation of performance criteria by decision makers (Banaitiene et al., 2008; Behzadian et al., 2012; Zavadskas et al., 2014b).

It refers to making preference decision (e.g., evaluation, prioritisation, and selection) over the available alternatives that are characterised by multiple, usually conflicting, criteria. As decision making requires multiple perspectives of different people, most organisational decisions are made in groups (Ma et al., 2010). Multi-criteria decision making comprises a finite set of alternatives, amongst which the decision-makers have to select, evaluate or rank according to the weights of a finite set of criteria (attributes). There are several methods for dealing with multi-criteria decision making problems, such as multiplicative exponential weighting (MEW), simple additive weighting (SAW), technique for ordering preference by similarity to ideal solution (TOPSIS), analytic and so forth. It is unrealistic to assign a crisp value for a subjective judgment, especially when the information is vague or imprecise (Chang and Wang, 2009). The multi-criteria decision making models face different kinds of uncertainty, which generally could be taken into account by using stochastic analysis or fuzzy set theory (Zarghami and Szidarovszky, 2009). Several studies have been carried out to develop MCDM (Dadelo et al., 2014; Shyur and Shih, 2006; Yazdani-Chamzini et al., 2014). In recent years several previous studies have employed MCDM tools and applications for solve areas problems such as engineering (Zavadskas et al., 2014a), science (Zavadskas et al., 2015), technology (Bagočius et al., 2014; Dadelo et al., 2014; Streimikiene et al., 2012).

In this study a combination of fuzzy analytical hierarchy process (FAHP) and preference ranking organisation method for enrichment evaluation (PROMETHEE) methods is used to rank Iran insurance branches in Tehran.

The structure of the article is organised as follows: literature review, necessity and importance of research are discussed in Sections 2 and 3. Evaluation and ranking of Indicators of insurance branches is presented in Section 4. In Section 5 which is related to the methodology of this study, FAHP and PROMETHEE methods are introduced; the steps of the methods are described then and it should be mentioned that Section 6 is devoted to the implementation of model; finally, conclusion and references are presented in Sections 7 and 8.

2 The literature review

In this regard, the literature is divided into three categories: FAHP, PROMETHEE and insurance studies using these techniques. Several papers have been published in each field. They are explained below.

2.1 FAHP

Parallel to many fuzzy extensions of other operations research methods, a fuzzy version of the AHP was developed by Van Laarhoven and Pedrycz (1983), who studied with triangular membership functions and compared underlying fuzzy ratios. Since they introduced integrated FAHP modelling in 1983, several authors contributed both with conceptual and application oriented papers. Among the conceptual papers, a researcher derived fuzzy comparison priorities from trapezoidal membership functions (Buckley, 1985), an other study proposed an approach for local priority normalisation (Boender et al., 1989), Deng (1999) presented an improved fuzzy approach to handle the multi-criteria problems in an uncomplicated manner, Leung and Cao (2000) discussed the consistency and ranking issues and contributed with a consistency definition. In view of the fact that fuzzy AHP method is applicable to many selection and evaluation type of problems, various application oriented papers appeared in the literature. The method was applied successfully for evaluating different production cycle alternatives (Weck et al., 1997), priority setting for software development process (Lee et al., 1999), evaluating military systems (Cheng et al., 1999), technology selection (Chan et al., 2000), modular product design (Lee et al., 2001), customer satisfaction measurement (Cebeci and Kahraman, 2002), location decisions (Kuo et al., 2002), supplier selection (Benyoucef and Canbolat, 2007; Kahraman et al., 2003), for facilitating the quality function deployment procedure (Kwong and Bai, 2002) and finally two researchers proposed an inventory classification system based on the fuzzy analytic hierarchy process (Cakir and Canbolat, 2008).

2.2 PROMETHEE

The PROMETHEE method is developed by Brans and Vincke (1986), it is one of the most prevalent multi-criteria decision making techniques. It consists of a family of outranking methods such as PROMETHEE I, II, III, IV, V and VI. In this study PROMETHEE I and II will be used.

The PROMETHEE methods have been successfully applied to various fields, including environment management (Briggs et al., 1990; Chou et al., 2007; Martin et al., 2003; Morais and De Almeida, 2007; Queiruga et al., 2008), hydrology and water management (Hermans et al., 2007; Pudenz et al., 2002), and energy management (Goletsis et al., 2003; Haralambopoulos and Polatidis, 2003; Hyde et al., 2003; Madlener et al., 2007; Tavana et al., 2013). Other applications of PROMETHEE are equipment selection (Yilmaz and Dağdeviren, 2011), stock trading (Albadvi et al., 2007), portfolio selection (Vetschera and Almeida, 2012), material selection (Peng and Xiao, 2013), ERP selection (Kilic et al., 2015) and so on.

2.3 Insurance studies

According to importance of the insurance in economy of each country, several studies have been done in this filed. In one study, researchers examined the effects of firm specific factors (age of company, size of company, volume of capital, leverage ratio, liquidity ratio, growth and tangibility of assets) on profitability proxied by return on assets. From the regression results; growth, leverage, volume of capital, size, and liquidity were identified as most important determinant factors of profitability hence growth, size, and volume of capita were positively related. In contrast, liquidity ratio and leverage ratio were negatively but significantly related with profitability. The age of companies and tangibility of assets were not significantly related with profitability (Sambasivam and Ayele, 2013). The relationship between volume capital and return on asset were examined in Pakistan insurance industry and found positive and statistically significant between insurance capital and profitability (Malik, 2011). Another study associated organisational factors and customers' motivation with insurance companies' performance. Research model, according to resource-based view, considered the effects of age, size, and type of products. Factor analysis and structural equation modelling methodology were the tools of analysis. Results showed that customers' necessities and confidence strongly affect organisational factors that, in turn, affect insurance companies' performance (Felício and Rodrigues, 2015).

As previously mentioned in this study a combination of FAHP and PROMETHEE methods are used to rank Iran insurance branches in Tehran. Some of the related researches are as follows:

A study was conducted to evaluate the Greek insurance companies using DEA and PROMETHEE methods, both methods met the evaluation problem in a very satisfactory way (Pardalos et al., 1997). In other research, the compilation approach of DEA and AHP was used for ranking the insurance agencies. In this study, at first data envelopment analysis model was solved for each pair of agents, and then paired comparisons matrix was formed and ranking was done by using the results of solution of data envelopment analysis models (Mohammadi and Hoseinizadeh, 2008). In addition to the above techniques, the process of fuzzy network analysis is used to identify and rank the factors affecting the utilisation of e-insurance in the insurance industry. In another study, researchers used SAW, TOPSIS and VIKOR techniques to prioritise subdirectories of life insurance portfolio (Firoozabadi et al., 2012). Elsewhere, AHP technique is used to prioritise different systems of monitoring of insurance companies opulence (Asli et al., 2014). Two researchers applied the VIKOR method to determine the priority ranking of alternative Turkish insurance companies for evaluating of suitability of their purchasable by an international investor (Yücenur and Demirel, 2012).

3 The necessity and importance of research

The importance of insurance is unquestioned in modern economy and it is necessary for business activities. Insurance beyond its role, serves the public interest in the business and support of a large part of the national wealth. This is an essential mean by which the great disasters are reduced and may be restored.

During the 1990s, the importance of international ranking agencies, among investors, credit institutions, monitoring organisations and other stakeholders who have an interest in these companies, was become more obvious to everybody. During this period, the ranking agencies had a high growth and new ranking products were developed (Cantor and Packer, 1996).

In general, evaluating the reliability of the insurance company is the basic object of ranking. In a simple definition, Ranking is a complex evaluation of the conditions and the financial situation of the insurance company, which is done by independent experts and is considered as one of the main elements of non-price competition in the market. Simply, by ranking, current and future status of various aspects of the insurance company, especially the financial aspects would become clear. Ranking operates as an event in favour of transparenting the situation of insurance company in market. So, the findings would lead to greater transparency and increase of competition in the market. Therefore, insurance companies, likely, will try to improve their ranking through the higher quality service and lower prices, because the higher the ranking, the more the customer (Mirzayi and Safari, 2009).

4 Evaluation indicators and ranking in insurance branches

In this part of the study, for evaluating and ranking insurance branches in Tehran, a series of indicators by positive and negative aspects were used, that follows:

- The branch manpower skill (C_1)#

  According to the quantity, education and experience of employees of a branch, this indicator is calculated and used in the analysis. In this way, with regard to education and work experience of each staff at the branch, the score is considered, and finally to calculate a score of the skill of manpower of each branch, scores of the staff have been added together.

- General and administrative costs of branch (C_2)#

  This indicator includes all the administrative costs within a year.

- Grade of branch (C_3)#

  Grade is an annual ranking that Iran Insurance Company allocates to insurance branches and agencies based on their performance. According to this grade, the scores that are allocated to branches and agencies throughout the year are determined. This ranking from the highest to the lowest grade level include comprehensive, excellent, grade 1, grade 2 and grade 3, which respectively have five to one degrees.

- Sale (issued premiums) (C_4)

  This indicator shows the amount of insurance sold by the branch in a year. It should be noted that the sales of insurance is done by branches related to government contracts and other companies, which is different from the sales of agencies. Insurance sale by agencies is related to the general public and amount of sale of agencies is not included in the sale of branches.

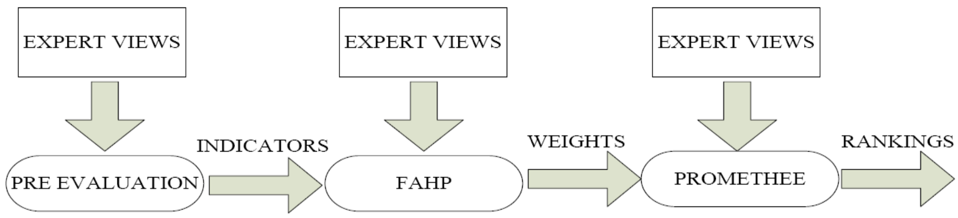
- Wage (C_5)#

  This indicator is related to the amount of employees' wages in each branch.

5 Methodology

This study is operational and descriptive/survey. To collect literature, articles, books, theses and different scientific sites have been used. For gathering data of the study, one year data of 24 insurance branches in Tehran have been used. In this study, ranking of branches is done according to the mentioned indicators. In this regard, weight of each indicator is determined first using the views of experts and fuzzy AHP; the branches are prioritised then using PROMETHEE method. For this purpose, a three stage methodology including pre-evaluation, FAHP and PROMETHEE stages is proposed as depicted in Figure 1.

Figure 1 Combined methodology based on FAHP and PROMETHEE



5.1 Analytical hierarchy process

Analytical hierarchy process (AHP) is a decision making method that provides valuable information about the problem and helps to improve rational decision-making process (Moshiri, 2002). Although this method has been criticised, it has been used more than other models for decision making because of its advantages (Ghodsipour, 2010). Detailed description of AHP is presented in Saaty (1980, 1988) and Saaty and Vargas (2001).

5.1.1 Analysis and development method of Chang

There are various methods for calculation of the fuzzy network analysis process. In this paper the analysis development method is used, that was provided by the Chinese scholar called Chang. Scale language for pair wise comparisons is shown in Figure 2.

Figure 2 Linguistic values for pair wise comparisons

Fuzzy triangular scales	*Fuzzy scales*	*Linguistic values for paired comparisons*
(1’1’1)	(1’1’1)	Uniform preference
(2’1’666/0)	(5/1’1’5/0)	Relatively preferred
(1’666/0’5/0)	(2’5/1’1)	Strong preference
(666/0’5/0’4/0)	(5/2’2’5/1)	Strongly preferred
(5/0’4/0’333/0)	(3’5/2’2)	Very strong preference
(4/0’333/0’285/0)	(5/3’3’5/2)	Inordinately strong

In analysis development method for each row of the pair wise comparisons matrix, S_k, which is a triangular fuzzy number, is calculated as follows:

$$S_k = \sum_{j=1}^{n} M_{ij} \otimes \left[\sum_{i=1}^{m} \sum_{j=1}^{n} M_{ij} \right]^{-1}$$

where k represents the number of rows, and i and j, respectively, indicate alternatives and Indicators. In this method, after calculating S_k, their largeness degree in comparison to each other should be calculated. Totally, M_1 and M_2 are two triangular fuzzy numbers and their largeness degrees are defined as follows:

$$hgt = \left(M_1 \cap M_2\right) = \frac{U_1 - L_2}{\left(U_1 - L_2\right) + \left(m_1 - m_2\right)}$$

Another triangular fuzzy number is calculated as follows:

$$V\left(M_1 \geq M_2, \ldots, M_k\right) = V\left(M_1 \geq M_2\right) \text{ and ... and } V\left(M_1 \geq M_k\right)$$

Also, the calculation of weight of Indicators in pair wise comparisons matrix is as follows:

$$w'\left(x_i\right) = \min\left\{V\left(S_i \geq S_k\right)\right\} \quad k = 1, 2, 3, .., n, \quad k \neq i$$

So, the vector of weight of Indicator will be as follows:

$$w'\left(x_i\right) = \left[w'\left(x_1\right), w'\left(x_2\right), \ldots, w'\left(x_n\right)\right]^t$$

That is the factor of abnormal vector. To obtain normal vector following procedure is performed:

$$w\left(x_k\right) = \frac{w'\left(x_k\right)}{\sum_{k=1}^{n} w'\left(x_k\right)}$$

These steps are done to obtain normal weights.

$$v(M_1 \geq M_2) = 1 \qquad m_1 \geq m_2 \text{ if}$$
$$v(M_1 < M_2) = hgt(M_1 \cap M_2) \qquad \text{otherwise}$$

5.2 Preference ranking organisation method for enrichment evaluation

This decision making method, PROMETHEE, used in this study, was introduced by two Belgian professors, Brans and Vincke (1986). The presenters of this method were looking forward to find the basic solution to improve the assessment of decision making. This method is one of the support techniques of multiple attribute decision making; it has led to the change in ranking methods (Brans et al., 1986).

In general, this technique consists of the following three steps.

5.2.1 Determining the criterion of decision

It is tried by these criteria to calculate the domain of deviation between the evaluations of alternatives. Evaluation in this method is definitive and not probable; also, understanding the parameters of this method is simple for decision-maker, because all of the defined additional parameters have economic nature. Pair wise comparisons between the possible options of set A, are shown as follows:

$$a, b \in A \Leftrightarrow f(a) > f(b) \qquad aPb$$
$$a, b \in A \Leftrightarrow f(a) = f(b) \qquad aIb$$

In this method, for calculating and evaluating deviations of alternatives toward various indicators, one decision criterion is considered for each indicator; therefore, the preference function of alternative a on alternative b toward f indicator is defined as $P(a, b)$. In most cases, it can be assumed that $P(a, b)$ is a deviation function (d):

$$d = F(a) - F(b)$$

In this case, if it is assume that the deviation function is normalised, it can be written that:

No preference or difference	$P(a,b) = 0$	if $0 \leq d$
Weak preference	$P(a,b) \approx 0$	if $d > 0$
Strong preference	$P(a,b) \approx 0$	if $d >> 0$
Very strong preference	$P(a,b) = 1$	if $d >>> 0$

Thus, the generalised correlation of $F(0)$ with other alternatives is defined by ordered pair ($F(0)$, $P(0, 0)$). It is required by PROMEHEE method that a decision criterion be linked to each indicator Fj(j = 1, 2, 3, 000, k). To facilitate this, a set of criteria, numbered from 1 to 6, is provided to the decision maker; it is shown in Figure 3.

5.2.2 Denotation of the type of preference function

a The usual preference function: indicators related to this preference often include the dramatic effects and issues related to ecology.

b The U-shape preference function: indicators related to this preference often include indicators related to discrete sources.

c The V-shape shape preference function: indicators related to this preference often include operational indicators.

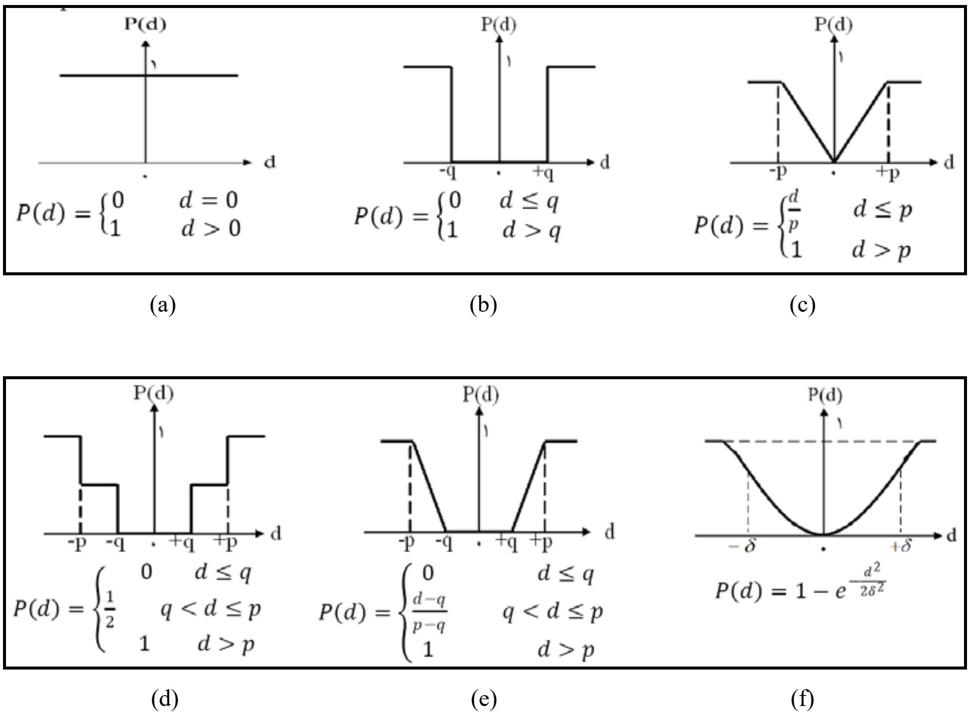
d The level preference function: indicators related to this preference often include long term profit, maintenance cost and lifetime cost.

e The linear preference function: indicators related to this preference often include exploration cost, short term profit and manufacturing cost.

f The Gaussian preference function: indicators related to this preference often include visual appeal, quality and safety.

So according to the type of indicators and supervision of decision-maker, the type of function is determined. Amount of *P* for each function is calculated using a mathematical relation, which is given in Figure 3.

Figure 3 Sextet preferred functions of Brans and et al., (a) the usual preference function (b) the U-shape preference function (c) the V-shape preference function (d) the level preference function (e) the linear preference function (f) the Gaussian preference function



5.2.3 Comparison of alternatives

In this step, pairwise comparison of alternatives is done for all indicators and for each pair of alternatives, the total amount of preference of an alternative is obtained. Hence, it can be written that:

$$\pi(a,b) = \sum W_j .P_j(a,b)$$

W_j is the weight of each indicator which is real positive number and it is not dependent to the size of the indicator. In some cases the weights are considered the same and preference indicator $\pi(a, b)$, b would be the average of all $P(a, b)$.

$$\pi(a,b) = (1/k)\sum P_j(a,b)$$

Implicitly a general weak preference of a to b is shown:

$$\pi(a,b) \approx 0$$

Implicitly a general strong preference of a to b is shown:

$$\pi(a,b) \approx 1$$

$\pi(a, b)$ shows that how and to what degree alternative a is preferred to alternative b and reciprocally $\pi(a, b)$ shows that how and to what degree alternative b is preferred to alternative a. Therefore, for each pair of alternatives $a, b \in A$, amount of $\pi(a, b)$ and $\pi(a, b)$ is calculated. Thus, the total prioritisation of possible alternatives of set A is regulated.

5.2.4 Decision making

To select the desired alternatives, it is necessary to reject other $n - 1$ alternatives belongs to the set A. So two types of prioritisations are we defined.

$$\text{Outgoing flow (positive)}: \quad \Phi^{+}(a) = 1/n-1\sum_{x \in A} \pi(a,x)$$

$$\text{Incoming flow (negative)}: \quad \Phi^{-}(a) = 1/n-1\sum_{x \in A} \pi(x,a)$$

Outgoing flow indicates the amount of prioritisation of each alternative toward other alternatives. Incoming flow also indicates the amount of prioritisation of other alternatives toward the alternative.

In this study prioritisation is done using PROMETHEE method in two partial and total manners which are called PROMETHEE I and PROMETHEEII, respectively, which are described below.

5.2.4.1 Partial prioritisation PROMETHEE I

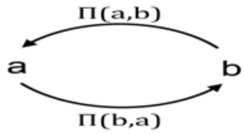
There are two types of classification, which are respectively: (P^{-}, I^{-}), (P^{+}, I^{+})

$aP^{+}b:\quad \text{if} \quad \Phi^{+}(a) > \Phi^{+}(b)$

$aI^{+}b:\quad \text{if} \quad \Phi^{+}(a) = \Phi^{+}(b)$

$aP^{-}b:\quad \text{if} \quad \Phi^{-}(b) > \Phi^{-}(a)$

$aI^{-}b:\quad \text{if} \quad \Phi^{-}(b) = \Phi^{-}(a)$



Form of relation between $\pi(a, b)$ *and* $\pi(b, a)$ (Goumas and Lygerou, 2000).

Partial prioritisation that is created in PROMETHEE I method is arisen from the participation of these two types of classification, and the result is as follows:

$$\begin{aligned} aP^{I}b \quad &\text{if} \quad aP^{+}b, aP^{-}b \\ &\qquad aP^{+}b, aI^{-}b \\ &\qquad aI^{+}b, aP^{-}b \\ aI^{I}b \quad &\text{if} \quad aI^{+}b, aI^{-}b \\ aR^{I}b \quad &\text{if} \quad \text{otherwise} \end{aligned}$$

So, the results of dual comparisons of PROMETHEE I are summarised as follows:

1. $aP^{I}b$: in this case, alternative *a* is preferred to alternative *b*.
2. $aI^{I}b$: in this case, alternative *a* and alternative *b* do not have much difference, and both the incoming flow and the outgoing flow are the same.
3. $aR^{I}b$: in this case, alternatives *a* and *b* are non-comparable. It usually occurs when alternative *a* is desirable on a set of indicators that alternative *b* is undesirable, and reciprocally, alternative *b* on another group of indicators is desirable that alternative *a* is undesirable. In this case, it is better not to make a decision on the preferred alternatives. This is one of the main weaknesses of PROMETHEE I method and this problem would be solved in the later stages of the evolution of method (Macharis et al., 2004).

5.2.4.2 Total prioritisation PROMETHEE II

To create a total prioritisation by decision maker, the net flow prioritisation can be calculated as follows:

$$\Phi(a) = \Phi^{+}(a) - \Phi^{-}(a)$$

Considering the balance between outgoing flow and incoming flow in this method, the bigger net flow represents the better alternative. So, total prioritisation is defined as follows:

$aP^{II}b:\quad \text{if} \quad \Phi(a) > \Phi(b)$

$aI^{II}b:\quad \text{if} \quad \Phi(a) = \Phi(b)$

Considering the created balance, all alternatives are comparable in this case.

6 Implementation of the model

To implement the model, prioritisation process of Iran insurance branches has been considered. After the surveys and studies and use of related experts' views, indicators were considered as effective factors in ranking of insurance branches; description of each indicator is presented. As previously mentioned, the weights of indicators were obtained using fuzzy AHP method and views of experts that are shown in Table 1.

Table 1 Matrix of comparison of branch indicators

Indicator	C_1	C_2	C_3	C_4	C_5
C_1	1	0.977167632	1.099564117	1.043400047	0.856235318
C_2	1.026782738	1	1.124449324	1.067253001	0.878492448
C_3	0.894786717	0.886671527	1	0.948335531	0.769379098
C_4	0.95026051	0.934160885	1.055557057	1	0.811454554
C_5	1.168753943	1.12079047	1.252741798	1.191628048	1

Here the final fuzzy paired comparisons matrix which is result of combination of five matrices of five experts, is shown, that, their final weights are also given in Table 2.

Table 2 Weights of branch indicators

Row	*Indicator*	*Weight*
1	Skill of branch manpower	0.197074341
2	General and administrative costs of branch	0.198878048
3	Grade of branch	0.171004565
4	Sale (issued premiums)	0.222263076
5	Wage	0.210779972

Information about the indicators is given in Table 3.

Ranking the alternatives is done using PROMETHEE method. Considering the explanations and views of experts and managers, preference function is determined for each of the indicators; these functions and threshold values are given in Table 4. Usually threshold values of p and q is determined by decision maker. In some studies (Mergias et al., 2007), 10% of variation range of each criterion is considered for q and 30% is considered for p. In this study, to determine the value of p and q, at first, outliers were removed, and then the range of the variation of each criterion is calculated. In the next step, almost 10% of the variation range was considered as the value of the indifference level of q and almost 30% of it was considered as the value of p.

After determining the preference function for each of the indicators and also threshold values, ranking of insurance branches is done using visual PROMETHEE software. The software output is shown in Table 5.

Table 3 The values of indicators

	Purpose	*Indicator*				
		C_1 *max*	C_2 *min*	C_3 *max*	C_4 *max*	C_1 *min*
Alternative	1	5.5	10,904,400	4	5,560,000	5,000,000
	2	6	31,157,570	5	54,346,000	42,800,000
	3	5.75	42,010,100	5	13,252,000	42,800,000
	4	6.25	7,034,000	4	8,250,000	10,000,000
	5	7.75	5,780,300	4	92,358,000	8,000,000
	6	7.5	27,023,250	4	16,523,000	52,400,000
	7	6.75	45,068,500	4	80,151,500	54,300,000
	8	8.25	8,795,500	5	15,657,000	6,000,000
	9	10	32,586,200	5	73,678,500	56,640,000
	10	7.25	10,245,500	4	65,678,000	6,800,000
	11	8.25	38,924,600	5	14,560,200	75,000,000
	12	7.5	24,046,500	4	60,567,500	64,000,000
	13	8.5	11,509,450	5	76,400,000	8,200,000
	14	7.75	9,503,780	4	5,240,000	8,400,000
	15	8.75	33,500,600	4	72,565,000	31,000,000
	16	8.5	38,458,670	5	6,750,500	45,200,000
	17	7.25	13,504,780	4	67,550,000	9,000,000
	18	7	10,123,600	3	108,850,000	59,500,000
	19	7.75	9,650,300	5	211,565,000	36,250,000
	20	5.5	10,153,250	4	211,565,000	12,000,000
	21	6.5	45,073,500	4	127,450,500	74,400,000
	22	8	48,238,670	5	9,924,000	68,400,000
	23	7.5	9,504,780	4	157,456,000	11,200,000
	24	7.5	37,533,600	4	91,460,000	49,200,000

Table 4 Function type and amount of the threshold values of p and q

Indicator	*Type of preference criterion*	*Parameters*	
C_1	V-shape	$P = 6$	
C_2	Level	$P = 13,317,900$	$q = 4,439,300$
C_3	Gaussian	$\delta = 3$	
C_4	V-shape	$P = 25,866,000$	
C_5	Linear	$P = 7,000,000$	$q = 21,000,000$

Table 5 Incoming flow, outgoing flow, net flow and rank of each alternative

Φ^-	Φ^+	Φ	*Alternative*	*Rank*
0.0392	0.4435	0.4043	23	1
0.0703	0.4372	0.3669	20	2
0.0572	0.4132	0.3560	5	3
0.1053	0.4084	0.3031	19	4
0.077	0.3778	0.3008	13	5
0.1128	0.33	0.2172	10	6
0.1167	0.3279	0.2112	17	7
0.1546	0.2849	0.1303	8	8
0.2153	0.2936	0.0784	18	9
0.1808	0.2443	0.0635	14	10
0.2014	0.2383	0.0369	4	11
0.2834	0.2674	–0.016	15	12
0.2382	0.2199	–0.0183	1	13
0.2587	0.2374	–0.0213	16	14
0.3102	0.2473	–0.0629	9	15
0.2975	0.217	–0.0805	24	16
0.3705	0.1879	–0.1826	2	17
0.3585	0.1748	–0.1837	12	18
0.4014	0.1975	–0.2039	21	19
0.3611	0.1534	–0.2077	7	20
0.3859	0.1146	–0.2713	6	21
0.4444	0.0766	–0.3678	3	22
0.4701	0.0669	–0.4032	11	23
0.4882	0.0387	–0.4495	22	24

A diagram of the ranking of PROMETHEE I is shown in Figure 4. As it can be seen, ranking is not performed completely using this method; for example, to determine the second rank, alternative 20 would be placed higher than alternative 5 from outgoing flow viewpoint but from incoming flow viewpoint, alternative 5 would be placed higher than alternative 20. As a result the second rank cannot be determined; to solve this problem, the total ranking PROMETHEE II is used. Net flow is used to determine the ranking in this method. Diagram of the total ranking is given in Figure 5.

Figure 6 shows the PROMETHEE network; as can be seen in this figure, the best rank belongs to alternative 23. This alternative is placed on the top of the network, and branch score from the viewpoints of indicators related to the skill of branch manpower, general and administrative costs, grade of branch, sale and wage, would be respectively 7.5, 9,504,780, 4, 15,7456,000 and 11,200,000. According to the proposed indicators, alternative 22 receives the last rank, so it would be placed in the bottom of network. Scores related to the indicators are respectively 8, 4823670, 5, 9,924,000 and 68,400,000.

Figure 4 Partial ranking PROMETHEE I (see online version for colours)

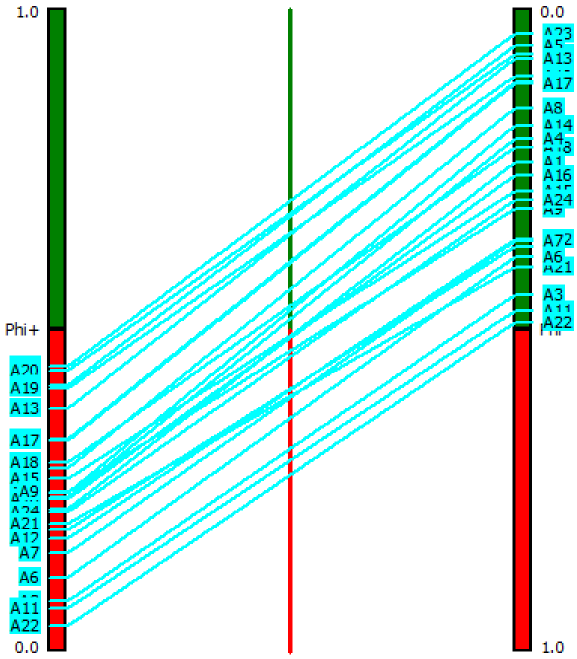


Figure 5 Total ranking PROMETHEE II (see online version for colours)

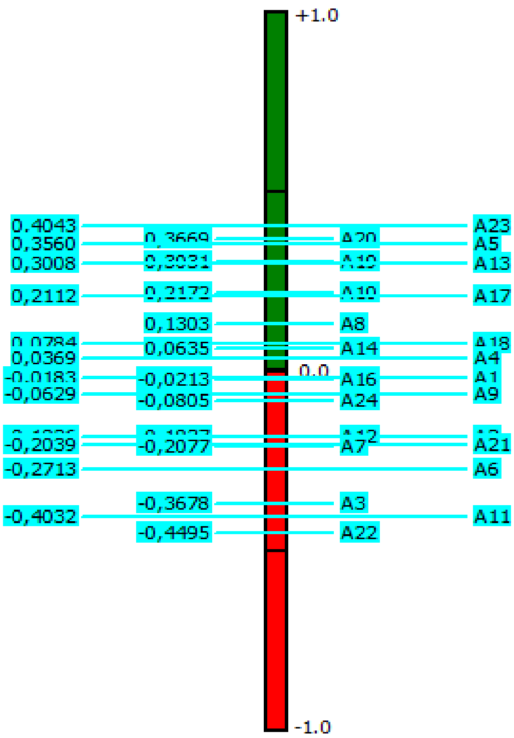
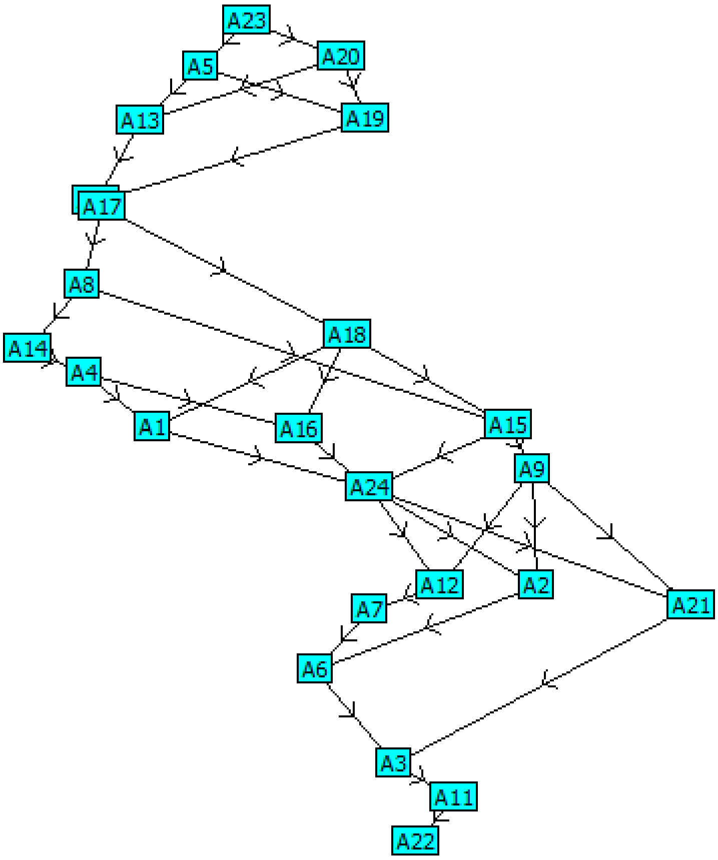
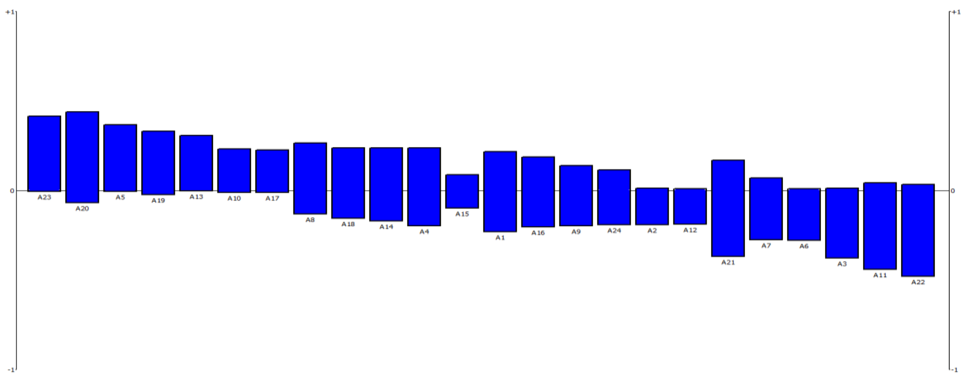


Figure 6 PROMETHEE network (see online version for colours)



Another output of software is a diagram shown in Figure 7. Another form of ranking is also shown in the PROMETHEE rainbow diagram.

Figure 7 PROMETHEE rainbow diagram (see online version for colours)



7 Conclusions

As a matter of fact, one of the most basic rights of the policyholder is, to know the rank of the insurance company that wants to buy policy from it, so insurance ranking can provide all stakeholders and decision-makers bright and clear viewpoint of the situation of relevant insurance in comparison to the organisations that have similar activities. Hence, in this study it was attempted to rank the insurance branches in Tehran using PROMETHEE ranking method by Visual PROMETHEE software. Ranking with this software had two outputs, one output was ranking with PROMETHEE I, in which a partial ranking is provided; it was not able to rank all alternatives, so the second output of software, PROMETHEE II, was used to compensate for the shortcoming. With regard to the fact that the corresponding technique is able to perform the total ranking, therefore all alternatives were ranked using this method. Using other multi-criteria methods to rank insurance companies may be important. The combination of FAHP and PROMETHEE methods were used in this study which would be interesting. Finally, comparing and ranking different insurance companies with the methods used in the current study would be also interesting.

References

Albadvi, A., Chaharsooghi, S. and Esfahanipour, A. (2007) 'Decision making in stock trading: an application of PROMETHEE', *European Journal of Operational Research*, Vol. 177, No. 2, pp.673–683.

Asli, A.D., Parizadi, I. and Tayyar, S. (2014) 'Prioritization of different monitoring systems of insurance companies opulence by using analytical hierarchy process (AHP) technique', *Insurance Journal*, Vol. 9, No. 1, pp.1–31.

Bagočius, V., Zavadskas, E. and Turskis, Z. (2014) 'Multi-person selection of the best wind turbine based on the multi-criteria integrated additive multiplicative utility function', *Journal of Civil Engineering and Management*, Vol. 20, No. 4, pp.590–599.

Banaitiene, N., Banaitis, A., Kaklauskas, A. and Zavadskas, E. (2008) 'Evaluating the life cycle of a building: a multivariant and multiple criteria approach', *Omega*, Vol. 36, No. 3, pp.429–441.

Behzadian, M., Otaghsara, S.K., Yazdani, M. and Ignatius, J. (2012) 'A state-of the-art survey of TOPSIS applications', *Expert Systems with Applications*, Vol. 39, No. 17, pp.13051–13069.

Benyoucef, M. and Canbolat, M. (2007) 'Fuzzy AHP based supplier selection in e-procurement', *International Journal of Services and Operations Management*, Vol. 3, No. 2, pp.172–192.

Boender, C., De Grann, J. and Lootsma, F. (1989) 'Multicriteria decision analysis with fuzzy pairwise comparison', *Fuzzy Sets and Systems*, Vol. 29, No. 2, pp.133–143.

Brans, J., Vincke, P. and Mareschal, B. (1986) 'How to select and how to rank projects: the PROMETHEE method', *European Journal of Operational Research*, Vol. 24, No. 2, pp.228–238.

Briggs, T., Kunsch, P. and Mareschal, B. (1990) 'Nuclear waste management: an application of the multicriteria PROMETHEE methods', *European Journal of Operational Research*, Vol. 44, No. 1, pp.1–10.

Buckley, J. (1985) 'Fuzzy hierarchical analysis', *Fuzzy Sets and Systems*, Vol. 17, No. 3, pp.233–247.

Cakir, O. and Canbolat, M. (2008) 'A web-based decision support system for multi-criteria inventory classification using fuzzy AHP methodology', *Expert Systems with Applications,* Vol. 35, No. 3, pp.1367–1378.

Cantor, A. and Packer, F. (1996) *Determinants and Impacts of Sovereign Credit Ratings*, *Economic Policy Review*, Federal Reserve Bank, New York.

Cebeci, U. and Kahraman, C. (2002) 'Measuring customer satisfaction of catering service companies using fuzzy AHP: the case of Turkey', in *Proceedings of the International Conference on Fuzzy Systems and Soft Computational Intelligence in Management and Industrial Engineering*, Istanbul, pp.315–325.

Chan, F., Chan, M. and Tang, M. (2000) 'Evaluation methodologies for technology selection', *Journal of Materials Processing Technology*, Vol. 107, Nos. 1–3, pp.330–337.

Chang, T. and Wang, T. (2009) 'Using the fuzzy multi-criteria decision making approach for measuring the possibility of successful knowledge management', *Information Sciences,* Vol. 179, No. 4, pp.355–370.

Cheng, C., Yang, K. and Hwang, C. (1999) 'Evaluating attack helicopters by AHP based on linguistic variable weight', *European Journal of Operational Research*, Vol. 116, No. 2, pp.423–435.

Chou, W., Lin, W. and Lin, C. (2007) 'Application of fuzzy theory and PROMETHEE technique to evaluate suitable ecotechnology method: a case study in Shihmen reservoir watershed, Taiwan', *Ecological Engineering Journal*, Vol. 31, No. 4, pp.269–280.

Dadelo, S., Turskis, Z., Zavadskas, E. and Dadeliene, R. (2014) 'Multi-criteria assessment and ranking system of sport team formation based on objective measured values of criteria set', *Expert Systems with Applications*, Vol. 41, No. 14, pp.6106–6113.

Deng, H. (1999) 'Multicriteria analysis with fuzzy pairwise comparison', *International Journal of Approximate Reasoning*, Vol. 21, No. 3, pp.215–231.

Felício, J. and Rodrigues, R. (2015) 'Organizational factors and customers' motivation effect on insurance companies' performance', *Journal of Business Research*, Vol. 68, No. 7, pp.1622–1629.

Firoozabadi, A.K., Mobin, M. and Abbasnejad, S. (2012) 'Prioritization of subdirectories portfolio of life insurance with multi-criteria decision-making modeling approach (case study: development insurance company)', *Insurance Journal*, Vol. 26, No. 2, pp.1–32.

Ghodsipour, H. (2010) *Analytical Hierarchy Process AHP*, Amirkabir University (Polytechnic), Tehran.

Goletsis, Y., Psarras, J. and Samouilidis, J. (2003) 'Project ranking in the Armenian energy sector using a multicriteria method for groups', *Annals of Operations Research*, Vol. 120, Nos. 1–4, pp.135–157.

Goumas, M. and Lygerou, V. (2000) 'An extension of the PROMETHEE method for decision making in fuzzy environment: ranking of alternative energy exploitation', *European Journal of Operational Research*, Vol. 123, No. 3, pp.606–613.

Haralambopoulos, D. and Polatidis, H. (2003) 'Renewable energy projects: structuring a multicriteria group decision-making framework', *Renewable Energy Journal*, Vol. 28, No. 6, pp.961–973.

Hermans, C., Erickson, J., Noordewier, T., Sheldon, A. and Kline, M. (2007) 'Collaborative environmental planning in river management: an application of multicriteria decision analysis in the white river watershed in Vermont', *Journal of Environmental Management*, Vol. 84, No. 4, pp.534–546.

Hyde, K., Maier, H. and Colby, C. (2003) 'Incorporating uncertainty in the PROMETHEE MCDA method', *Journal of Multi-Criteria Decision Analysis*, Vol. 12, Nos. 4–5, pp.245–259.

Kahraman, C., Cebeci, U. and Ulukan, Z. (2003) 'Multicriteria supplier selection using fuzzy AHP', *Logistics Information Management*, Vol. 16, No. 6, pp.382–394.

Kilic, H., Zaim, S. and Delen, D. (2015) 'Selecting "the best" ERP system for SMEs using a combination of ANP and PROMETHEE methods', *Expert Systems with Applications*, Vol. 42, No. 5, pp.2343–2352.

Kuo, R., Chi, S. and Kao, S. (2002) 'A decision support system for selecting convenience store location through integration of AHP and artificial neural network', *Computers in Industry*, Vol. 47, No. 2, pp.199–214.

Kwong, C. and Bai, H. (2002) 'A fuzzy AHP approach to the determination of importance weights of customer requirements in quality function deployment', *Journal of Intelligent Manufacturing*, Vol. 13, No. 5, pp.367–377.

Lee, M., Pham, H. and Zhang, X. (1999) 'A methodology for priority setting with application to software development process', *European Journal of Operational Research,* Vol. 118, No. 2, pp.375–389.

Lee, W., Lau, H., Liu, Z. and Tam, S. (2001) 'A fuzzy analytic hierarchy process approach in modular product design', *Expert Systems*, Vol. 18, No. 1, pp.32–42.

Leung, L. and Cao, D. (2000) 'On consistency and ranking of alternatives in fuzzy AHP', *European Journal of Operational Research*, Vol. 124, No. 1, pp.102–113.

Ma, J., Lu, J. and Zhang, G. (2010) 'Decider: a fuzzy multi-criteria group decision support system', *Knowledge-Based Systems*, Vol. 23, No. 1, pp.23–31.

Macharis, C., Springael, J., De Brucker, K. and Verbeke, A. (2004) 'PROMETHEE and AHP: the design of operational synergies in multi-criteria analysis: strengthening PROMETHEE with ideas of AHP', *European Journal of Operational research*, Vol. 153, No. 2, pp.307–317.

Madlener, R., Kowalski, K. and Stagl, S. (2007) 'New ways for the integrated appraisal of national energy scenarios: the case of renewable energy use in Austria', *Energy Policy Journal*, Vol. 35, No. 12, pp.6060–6074.

Malik, H. (2011) 'Determinants of insurance companies profitability: an analysis of insurance sector of Pakistan', *Academic Research International*, Vol. 1, No. 3, p.309.

Martin, J., Fajardo, W., Blanco, A. and Requena, I. (2003) 'Constructing linguistic versions for the multicriteria decision support systems preference ranking organization method for enrichment evaluation I and II', *International Journal of Intelligent Systems*, Vol. 18, No. 7, pp.711–731.

Mergias, I., Moustakas, K., Papadopoulos, A. and Loizidou, M. (2007) 'Multi-criteria decision aid approach for the selection of the best compromise management scheme for ELVs: the case of Cyprus', *Journal of Hazardous Materials*, Vol. 147, No. 3, pp.706–717.

Mirzayi, H. and Safari, A. (2009) 'An introduction to the ranking of insurance companies in Iran', *Journal of New Titles of Insurance World*, Vol. 20, No. 4, pp.16–29.

Mohammadi, A. and Hoseinizadeh, S. (2008) 'Application of combination approach of AHP/DEA in insurance agencies ranking', *Economic Journal*, Vol. 26, No. 3, pp.281–304.

Morais, D. and De Almeida, A. (2007) 'Group decision-making for leakage management strategy of water network, resources', *Conservation and Recycling Journal*, Vol. 52, No. 2, pp.441–459.

Moshiri, A. (2002) 'modified model of AHP for survey and group decision making', *Journal of Management Knowledge*, Vol. 52, No. 1, pp.63–92.

Pardalos, P.M., Michalopoulos, M. and Zopounidis, C. (1997) 'On the use of multicriteria method for the evaluation of insurance companies in Greece', in Zopounidis, C. (Ed.): *New Operational Approaches for Financial Modelling*, pp.271-283, Physica-Verlag HD, Heidelberg.

Peng, A. and Xiao, X. (2013) 'Material selection using PROMETHEE combined with analytic network process under hybrid environment', *Materials and Design*, Vol. 47, No. 5, pp.643–652.

Pudenz, S., Bruggemann, R., Voigt, K. and Welzl, G. (2002) 'Multi-criteria evaluation and decision-support instruments for the long-term development of management strategies', *Umweltwiss Schadst Forsch*, Vol. 14, No. 1, pp.52–57.

Queiruga, D., Walther, G., Gonzalez-Benito, J. and Spengler, T. (2008) 'Evaluation of sites the location of WEEE recycling plants in Spain', *Waste Management Journal*, Vol. 28, No. 1, pp.181– 190.

Saaty, T. (1980) *The Analytic Hierarchy Process*, McGraw Hill, New York.

Saaty, T. (1988) *Multicriteria Decision Making: The Analytic Hierarchy Process*, RWS Publications, Pittsburgh PA.

Saaty, T. and Vargas, L. (2001) *Models*, *Methods*, *Concepts and Applications of the Analytic Hierarchy Process*, Kluwer Academic Publishers, Dordrecht, The Netherlands.

Sambasivam, Y. and Ayele, A.G. (2013) 'A study on the performance of insurance companies in Ethiopia', *International Journal of Marketing*, *Financial Services and Management Research*, Vol. 2, No. 7, pp.138–150.

Shyur, H. and Shih, H. (2006) 'A hybrid MCDM model for strategic vendor selection', *Mathematical and Computer Modelling*, Vol. 44, Nos. 7–8, pp.749–761.

Streimikiene, D., Balezentis, T., Krisciukaitienė, I. and Balezentis, A. (2012) 'Prioritizing sustainable electricity production technologies: MCDM approach', *Renewable and Sustainable Energy Reviews*, Vol. 16, No. 5, pp.3302–3311.

Tavana, M., Behzadian, M., Pirdashti, M. and Pirdashti, H. (2013) 'A PROMETHEEGDSS for oil and gas pipeline planning in the Caspian Sea basin', *Energy Economics*, Vol. 36, No. 2, pp.716–728.

Valinejad, M. (2003) 'An introduction to the insurance and its history in Iran', *Journal of Bank and Economy*, Vol. 28, No. 6, pp.58–63.

Van Laarhoven, P. and Pedrycz, W. (1983) 'A fuzzy extension of Saaty's priority theory', *Fuzzy Sets and Systems*, Vol. 11, No. 1, pp.199–227.

Vetschera, R. and Almeida, A. (2012) 'A PROMETHEE-based approach to portfolio selection problems', *Computers and Operations Research*, Vol. 39, No. 5, pp.1010–1020.

Weck, M., Klocke, F., Shell, H. and Ruenauver, E. (1997) 'Evaluating alternative production cycles using the extended fuzzy AHP method', *European Journal of Operational Research*, Vol. 100, No. 2, pp.351–366.

Yazdani-Chamzini, A., Shariati, S., Yakhchali, S.H. and Zavadskas, E. (2014) 'Proposing a new methodology for prioritising the investment strategies in the private sector of Iran', *Economic Research-Ekonomska Istraživanja*, Vol. 27, No. 1, pp.320–345.

Yilmaz, B. and Dağdeviren, M. (2011) 'A combined approach for equipment selection: FPROMETHEE method and zero-one goal programming', *Expert Systems with Applications*, Vol. 38, No. 9, pp.11641–11650.

Yücenur, G. and Demirel, N. (2012) 'Group decision making process for insurance company selection problem with extended VIKOR method under fuzzy environment', *Expert Systems with Applications*, Vol. 39, No. 3, pp.3702–3707.

Zarghami, M. and Szidarovszky, F. (2009) 'Revising the OWA operator for multi criteria decision making problems under uncertainty', *European Journal of Operational Research,* Vol. 198, No. 1, pp.259–265.

Zavadskas, E.K., Antucheviciene, J., Hajiagha, S. and Hashemi, S. (2014a) 'Extension of weighted aggregated sum product assessment with interval valued intuitionistic fuzzy numbers (WASPAS-IVIF)', *Applied Soft Computing*, Vol. 24, No. 13, pp.1013–1021.

Zavadskas, E.K., Skibniewski, M. and Antucheviciene, J. (2014b) 'Performance analysis of civil engineering journals based on the web of science® database', *Archives of Civil and Mechanical Engineering*, Vol. 14, No. 4, pp.519–527.

Zavadskas, E.K., Turskis, Z. and Bagočius, V. (2015) 'Multi-criteria selection of a construction site for a deep-water port in the Eastern Baltic Sea', *Applied Soft Computing*, Vol. 26, No. 1, pp.180–192.