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One Integrated Approach in Determination of Impact of Weather Factors on the Public Health

Dragan Randjelovic,
Department of Informatics and Computing,
Criminalistic and Police University, Serbia.
E-mail: **dragan.randjelovic@kpa.edu.rs**

Kristijan Kuk,
Department of Informatics and Computing,
Criminalistic and Police University, Serbia.
E-mail: kristijan.kuk@kpa.edu.rs

Milan Randjelovic,
Local Economic Development Office,
Mayors Office City of Nis, Serbia.
E-mail: milan.randjelovic@gu.ni.rs

Abstract

A number of methods for weight coefficient determination have been developed. Therefore, the need which rises is how one can conclude which method is the best one. This paper provides, for the case of quantitative nature of criteria, comparative analysis of weight coefficients obtained with different approaches of multiple criteria analysis. The importance of this paper is that the weighting of certain criteria necessary for the application of multi-criteria analysis method which, in turn spread to almost all areas of human life, for example economy, health, education, security, etc. Case study given in this paper analyzes data about the influence of most significant weather factors on public health of citizens related to the city of Nis, Serbia, Europe. Using the results of the analysis conducted with two groups of methods available, subjective and objective nature from the operational research scientific field and regression method from the statistic scientific field, authors concluded that is necessary aggregation more possible applied methods to obtain results better characteristics, independent from the nature of applied methods.

Key words: *Decision Making; Decision Support Techniques; Statistics Methods; Public Health*
JEL Classification: *C 44, C 80, I 10*

1. Introduction

Decision-making is a complex process with a multitude of interconnected and mutually dependent factors. A number of authors and the real decision makers too, indicating that the decision-making on the basis of personal intuition or deliberation is almost impossible. In the decision-making process there is often uncertainty, vagueness and imprecision of input data necessary to make informed decisions. The complexity and diversity of decision-making process indicates the need for evaluation of the measures taken. The evaluation is based on a combination of qualitative and quantitative evaluation criteria which should improve the quality of decisions.

The quality of decisions is directly influenced by the quality of relative weights assigned to the criteria relevant for particular decision. That's why weight coefficients determination represents an important issue in the decision making models. There is no generally accepted methodology for weight coefficients determination. In literature and in the practice of multiple criteria theory, however, there are many approaches in their determination:

I. Operational research-multiple - multiple criteria decision making (MCDM)

II. Classical statistics

III. Data mining (DM)

I. Most of MCDM group of methods can generally be classified into two main categories: objective and subjective approach i.e. nature (Ma, Fan and Huang 1999). Each of the methods for the weight of criteria determination has advantages and disadvantages in terms of emphasizing some and marginalization of other factors that influence the expression of decision makers' preferences. For this reason there is a need for a combination of several methods of determining the weights. That's why the Spearman`s rank correlation coefficient as an objective method for weight coefficients determination and the Analytic Hierarchy Process (AHP) as a subjective approach in relative weights calculation were used in this paper.

II. From the other hand, in the case of quantitative evaluation of criteria, for decision making using weights determination of criteria are available in some classic statistical methods and between these regression and factor analysis which are also described and used in this paper.

III. Practically we can explain DM technics as the application of statistical methods in the form of exploratory data analysis also predictive models to reveal patterns in very large data sets. We have not such set of data in considered case and because of that this approach is excluded from later application end consideration in this paper.

Comparative analysis of application first two mentioned groups of MCDM and regression analysis from classic statistical theory is the subject of this paper.

Results of this comparative analysis was obtained using daily non-accidental mortality data between 1992 and 2009 for the city Nis in Republic of Serbia and weather factors data for the same period in this city.

2. Literature Review

As is known, it is important to notice that the taxonomy of MCDM approaches for weight determination is not uniform so some authors include the method of regression analysis in objective approach, see (Randjelovic et al. 2013; Savic et al. 2013; Weber and Borcherding 1993; Zeleny 1982; Diakoulaki, Mavrotas and Papayannakis 1995; Srđević 2005) but the methods based on data mining theory are clear separated from the other two mentioned groups.

Authors consider in this paper application of correlation analysis as one of most important objective approach in weights determination which is based on objective information. Pearson`s correlation coefficient indicates the presence of a linear stacking of variation between two variables and Spearman's rank correlation coefficient indicates whether there is monotonic connection between the two variables Cohen (Cohen 1988). Application of correlation analysis in determination of weather and climate effects on human disease incidenceauthors find, for example, in Babin, S., 2003, Kalkstein,L., and Valimont, K.,1987.

Because Analytic Hierarchy Process (AHP) is the one of the most popular subjective methods of multi-criteria analysis authors used it as a tool for decision making on the selection of optimal alternative(s), especially in cases where there is a possibility of a hierarchical structuring of relevant criteria. Problems in the field of multi-criteria analysis are focused on determining the optimal alternative in situations where it is necessary to satisfy several different and often conflicting criteria. The complexity of this type of problem is first of all in the fact that they included both quantitative and qualitative criteria, different scales of measurement (i.e. interval scales, ratio scales, ordinal scales, Likert scales, etc.), and they require multiple comparisons. Thereby as the need imposes itself as not only determination of an alternative rank, but also the application of the method that is simple enough (Saaty 1986). AHP is a scientific method appropriate for solving this kind of problem (Harker and Vargas 1987) which has been used since 1980s to solve multi-criteria problems regardless of whether decision maker is an individual or a group (Wind and Saaty 1980; Saaty and Vargas 1994). Possibly application of the AHP method as a quantitative tool are many and related to almost all multi-criteria problems - according to literature there are more than 150 different problems (Omkarprasad and Sushil 2006).

Using MCDM in determination of wheather condition influence on public health we can find in many references, for example, Youngkong, S., et al., 2015 and Aenishaenslin, C., et al.,2013.

Regression analysis is used oft for weighting determination of factors in solving different problems with multi factor dependence. When these factors are weather conditions which make influence on citizens mortality we can find application different forms of general linear model of regression in Analitis et al. 2008, Michelozzi et al. 2007, Chiogna and Gaetan 2005, Vardoulakis et al. 2008, Berko et al. 2014, Eggen and McMichael 2014 which deals with influence of weather factors on citizens mortality in suitable case studies of 15 European cities then next other 12 European cities, 20 US largest cities then 9 cities and all United States and on the end cities in United Kingdom and Australia, respectively.

3. Methodology

3.1 Research Questions

As indicated in introduction, we have two major research questions:

- Is it possible to determine the significance of weather factors on human health,
- Which type of approach to choose for determination influence and if we have more subtypes in choose approach -which subtypes of methods is most applicable.

  In this paper authors try to give answer on the last of them:

  - which types of methods is the best for solving such problems,
  - or maybe one aggregation of these methods is the best?

3.2 Objective MCDM methods

An objective approach in weights determination is based on objective information and includes the use of mathematical or statistical methods, as well as:

- Correlation analysis,
- Principal component method,
- Data envelopment analysis,
- Entropy etc.

Some of them, such as correlation analysis, will be applied in this research.

Correlation between variables included in the decision making process is possible to examine by adequate coefficient. There are several correlation coefficients, such as Pearson`s, Kendall`s and Spearman's rank correlation coefficient. The Spearman's rank correlation coefficient, calculated in this paper, can be applied regardless of the numerical expression of one or the other variables, and regardless of their normality. This coefficient is nonparametric indicator of quantitative agreement between variables. Like other nonparametric indicators this coefficient is somewhat less effective than the parametric correlation coefficient. Rank correlation deals with the ranks instead of original values, which is the main reason for exactness, otherwise loses power. It can be said that Spearman`s rank correlation coefficient has a broader meaning than the simple linear correlation coefficient.

While Pearson`s correlation coefficient indicates the presence of a linear stacking of variation between two variables, Spearman's rank correlation coefficient indicates whether there is monotonic connection between the two variables. Monotonic relationship means any permanent growing or declining correlation between the variations of the two variables.

Spearman's rank correlation coefficient can take value from -1 (perfect negative correlation) to 1 (perfect direct or positive correlation). If the value of this coefficient is closer to the extreme values, the greater degree of correlation exists between observed variables, and vice versa. Various authors give different interpretations of the correlation values between 0 and 1. Cohen (Cohen 1988) gives the following guidelines for the strength of correlation: Weak: rs = 0.10 - 0.29; Medium: rs = 0.30 - 0.49; Strong: rs = 0.50 - 1.0.

3.3 Subjective MCDM methods

The subjective approach in determining the weights is based on the preferences of decision makers (experts) and within this approach it is possible to extract the following methods:

- Analytic hierarchy process,
- Weighted least squares method,
- Delphi method,
- Conjoint analysis etc.

AHP is much used among the aforementioned subjective methods and because of that it is presented in the paper. AHP is a method for structuring and resolving problems to making decisions. AHP can be used to evaluate the impact of relevant factors to the possible outcomes of decisions taken, as well as for forecasting and determination of relative probability distribution of these outcomes. Consequently, all application of AHP method can be classified into two basic groups (Saaty 2010):

1) Problems of selection or problems of choice, where is necessary to rank current, available set of alternatives and

2) Problems of prediction, where is necessary to rank future outcomes of alternatives in accordance with the decisions taken.

The problems of choice are considering the evaluation and rang determination of available alternatives according to fulfillment of relevant criteria (Savic et al. 2013). On the other hand, the prediction problem deals with the topic of determining the probability of future outcomes that are results of decision-making process. In addition to these very important application of AHP method applies to determination of weights for multi-criteria analysis problems.

The original algorithm of AHP method, developed by Saaty(Saaty & Vargas 1994), as well as all its subsequent modifications, rely on the three fundamental principles:

- decomposition of the problem into hierarchic levels of objective(s), criteria, sub-criteria and alternatives, where the number of levels depends on problem characteristics;
- pairwise comparisons of elements on each level of hierarchy trough comparative judgments of the criteria (or alternatives) with respect to an upper hierarchic level; and
- linear-based synthesis of priority vectors that express weights on criteria level, or alternative rank on the hierarchy level of alternatives.

3.4 Regression analysis

Regression analysis is a statistical method that examines the relationship between variables. The observed variables in regression analysis are divided into two categories: dependent and independent or explanatory variables. The simple regression model helps to measure the relationship between a dependent variable and a single explanatory variable. It is relatively simple to extend this model to allow the dependent variable to be a function of several explanatory variables. This is accomplished by using a multiple regression model, which can be written as a follows (Render, Stair and Hanna 2009):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \varepsilon$$

Where:

Y – dependent variable, Xi – ith independent variable, β0 – intercept, βi – coefficient of the i-th independent variable, k – number of independent variables, ε – random error.

The parameters next to the independent variable, named regression coefficients, show its impact on the dependent variable. This impact can be positive or negative. So, we can conclude about direct or inverse relation between the dependent variable and independent variables. Estimated values of parameters of the independent variables in this analysis will serve as the basis for weights calculation. Besides them, for the weight coefficients determination parameter F, as well as standardized coefficients can also be used.

3.5 Data

The weight coefficients determination, applied in this study is based on the medical and the weather factor data related to the Nis, Serbia. The data covers the period from 1992 up to 2009. It was accessible data for 27 variables but in this paper we choose known 10 basic variables:

Total non-accidental mortality (number), Mean daily air pressure (mbar) – WF1,Daily temperature amplitude (°C) – WF2, Mean daily temperature (°C) – WF3, Mean daily relative humidity (%) – WF4,

Mean daily water vapor saturation (mbar) – WF5, Mean daily wind speed (m/sec) - WF6, Insolation (h) – WF7, Mean daily cloudiness (in tenths of the sky) – WF8, Snowfall (cm) – WF9,Rainfall (mm) – WF10.

Variables WF1 – WF10 are considered as weather factors (WF). Data used in this study were derived from several sources. Meteorological data were obtained from the Republic Hydro-meteorological Institute for the 1992-2009. Mortality database for the same period was supplied by the Statistical Office of the Republic of Serbia. All of this data are organized in the table in which are presented values of each considered variables i.e. criteria like average value for each year from considered period.

Figure1: Weather factors and total non-accidental mortality in city Nis, Serbia 1992.-2009.

Year	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992
Number of non-accidental mortality	8.67	8.31	8.56	8.01	8.53	7.64	7.83	7.90	7.44	7.76	7.50	7.33	6.85	6.86	6.28	6.61	6.52	5.98
Mean daily air pressure (mbar)	991.27	993.09	992.77	994.62	993.93	993.76	994.56	993.65	992.90	993.92	992.83	993.87	994.42	992.50	993.12	993.84	995.00	995.01
Mean daily temperature (°C)	12.74	13.19	13.51	11.87	11.24	11.97	12.36	12.64	12.35	13.06	12.08	12.00	11.08	11.36	11.68	13.16	11.66	11.91
Mean daily relative humidity (%)	72.24	69.03	65.69	71.11	72.76	72.24	67.32	69.77	69.57	63.68	72.43	68.01	70.59	69.53	69.99	67.41	65.23	67.42
Mean daily water vapour saturation (mbar)	11.34	10.95	10.35	10.67	10.65	10.80	10.27	10.89	10.61	9.75	11.04	10.14	9.95	9.97	10.21	10.56	9.29	9.87
Mean daily wind speed (m/sec)	1.07	1.13	1.04	0.89	0.90	1.25	1.49	1.39	1.36	1.31	1.29	1.34	1.33	1.46	1.32	1.35	1.48	1.50
Mean daily cloudiness (in tenths of the sky)	5.62	5.11	5.11	5.33	5.70	5.93	5.24	5.93	5.57	4.75	5.76	5.42	5.64	6.19	5.80	5.36	4.92	5.17
Snowfall (cm)	0.19	0.09	0.05	0.23	0.34	0.28	0.16	0.13	0.25	0.20	0.25	0.20	0.04	0.28	0.20	0.03	0.22	0.11
Rainfall (mm)	1.81	1.61	1.61	1.55	1.66	1.89	1.36	1.70	1.64	0.87	1.51	1.36	1.57	1.55	1.51	1.15	1.06	1.24

4. Results and Discussion

The first method applied for the weight coefficient determination is the Spearman`s rank correlation coefficient. The obtained values of this coefficient are presented in the Table 1. According to the results from the Table 1, the Total non-accidental mortality is highly correlated with Mean daily wind speed and Mean daily water vapour saturation.

Table 1: Spearman`s rank correlation coefficient between weather factors and mortality

Weather factors	r_s	p-value
Mean daily air pressure (mbar)	-0.350	0.155
Daily temperature amplitude (°C)	0.053	0.836
Mean daily temperature (°C)	0.453	0.159
Mean daily relative humidity (%)	0.247	0.324
Mean daily water vapour saturation (mbar)	0.645	0.004
Mean daily wind speed (m/sec) - WF6	0.682	0.002

Insolation (h)	-0.294	0.236
Mean daily cloudiness (in tenths of the sky)	-0.069	0.785
Snowfall (cm)	0.074	0.769
Rainfall (mm)	0.595	0.009

The next step in this analysis involves application of AHP, as a subjective method in the weight coefficients determination. By AHP model, i.e. by pairwise comparisons of weather factors according to the Total non-traumatic mortality, the following importance of the weather factors are obtained, as it is shown in Table 2:

Table 2: Summarized results of AHP method

	WF1	WF2	WF3	WF4	WF5	WF6	WF7	WF8	WF9	WF10	∑
WF1	0.037	0.125	0.017	0.115	0.041	0.037	0.082	0.136	0.139	0.028	0.757
WF2	0.004	0.014	0.007	0.003	0.032	0.033	0.003	0.004	0.004	0.019	0.122
WF3	0.149	0.125	0.067	0.162	0.072	0.059	0.136	0.136	0.139	0.042	1.087
WF4	0.007	0.125	0.010	0.023	0.032	0.033	0.009	0.136	0.139	0.019	0.533
WF5	0.261	0.125	0.268	0.208	0.290	0.296	0.245	0.136	0.139	0.335	2.302
WF6	0.298	0.125	0.335	0.208	0.290	0.296	0.245	0.136	0.139	0.335	2.406
WF7	0.012	0.125	0.013	0.069	0.032	0.033	0.027	0.136	0.139	0.019	0.606
WF8	0.004	0.056	0.007	0.003	0.032	0.033	0.003	0.015	0.008	0.019	0.179
WF9	0.004	0.056	0.007	0.003	0.032	0.033	0.003	0.030	0.015	0.019	0.202
WF10	0.223	0.125	0.268	0.208	0.145	0.148	0.245	0.136	0.139	0.167	1.805

By simple calculation procedure values of weight coefficients were obtained. These values are shown in the Table 3.

Table 3: Normalized values of weight coefficients obtained by Spearman`s rank correlation/AHP

	WF1	WF2	WF3	WF4	WF5	WF6	WF7	WF8	WF9	WF10
W_{rs}	0.101	0.015	0.131	0.071	0.186	0.197	0.085	0.020	0.021	0.172
W_{AHP}	0.076	0.012	0.109	0.053	0.230	0.241	0.061	0.018	0.020	0.180

According to the Table 3 it can be concluded that values of weight coefficients obtained by Spearman`s rank correlation coefficient range from 0.015 up to 0.197. The highest value of weight (0.197) has variable Mean daily wind speed (m/sec) - WF6, while the smallest value has the variable Daily temperature amplitude - WF2. Weight coefficients obtained by AHP method range from 0.012 up to 0.241. It is very important to stress that minimum and maximum values of the weight coefficients belong to the same variables as in Spearman`s rank correlation. These results lead to conclusion that these two methods confirm each other. According to that conclusion, as most simplify aggregation methodology for upgrade obtained results arithmetic mean of results, obtained by both methods, were calculated and shown in Table 4.

Table 4: Mean values of both, Spearman`s rank correlation and AHP weight coefficients

Weather factors	w_j
Mean daily air pressure (mbar)	0.089
Daily temperature amplitude (°C)	0.014
Mean daily temperature (°C)	0.120
Mean daily relative humidity (%)	0.062
Mean daily water vapour saturation (mbar)	0.208
Mean daily wind speed (m/sec) - WF6	0.219
Insolation (h)	0.073
Mean daily cloudiness (in tenths of the sky)	0.019
Snowfall (cm)	0.021
Rainfall (mm)	0.176

Application of regression analysis on the same data as in the case where we have still applied methods of multi criteria methods shows that classic statistical methods are not usable because the considered sample, with average values of independent variables for each year, is too small.

Results obtained with classic statistical methods of regression analysis, applied on data in which is sample enough, with values of all independent variables for each day in year of considered period, are given in Table 5.

Table 5: Weight coefficients obtained respectively with GLM Poisson regression

	GLM of regression analysis
WF1	0.0177
WF2	0.0130
WF3	0.0544
WF4	0.0139
WF5	0.1019
WF6	0.0084
WF7	0.0237
WF8	0.0060
WF9	0.0151
WF10	0.0123

According to the Table 5 it can be concluded that values of weight coefficients have range from 0.060 up to 0.1019 in the case of GLM of regression analysis and range from 0.037 to 0.0589 in the case of factor analysis. To assess the relations between daily mortality and weather variables Generalised linear model (GLM) extending Poisson regression was applied. We used mortality counts as the response variable, and the natural cubic splines of the weather factors as predictor variable. The regression models fitting was based on Akaike Information Criteria (AIC). To construct the univariate model for each weather factor, the appropriate degree of freedom for natural spline exposure-response functions that gave the smallest AIC value were selected, and 3 to 8 degrees of freedom were tested. Then we calculated F statistic values for model to estimate level of each weather variable significance.

It is very important to stress that the results obtained with the classic statistical methods of regression also confirm results which we obtain using multiple criteria methods but only in the case when we used enough sample what was expected.

5. Conclusions and Recommendations

The problem of weight coefficients determination exists since formulation of the first multi-criteria analysis methods but that the problem occurred in the regression analysis where on the size of the regression coefficients can conclude what is the relative impact or importance of each independent variable. Today are methodologies from data mining best solution under the condition that the observed data set just as in the case of regression analysis is sufficient. In the literature and in the practice also there is no generally accepted best methodology for weight coefficients determination. In order to find the most appropriate method, the several methods as well as their combination are presented in this paper. The information basis for their comparation was the medical and weather factors data obtained from different sources because the medical problems are very complicated with many factors i.e. criteria which take influence on dependent variable and from this reason in such problems the determination of weight criteria is important.

From one hand results presented in this paper lead to conclusion that the MCDM (objective and subjective) are in accordance against classic statistical methods of regression and factor analysis because they can be applicable in the case when we have and small sample. From other hand the big data as necessary condition for application of classic statistical methods enables higher objectivity. Both of noticed facts lead us to necessary aggregation more of applied methods to improve obtained results what is showed in this paper on discussed case study with using calculation of simple arithmetic means of applied methods for each of considered group of methods i.e. MCDM and classic statistical methods.

These different aggregation above methods originating from various scientific disciplines are evidently a good thing the research interests of the author in future work.

References

Aenishaenslin, C., et al.,2013, Multi-criteria decision analysis as an innovative approach to managing zoonoses:results from a study on Lyme disease in Canada.*BMC Public Health* 13:897.

Analitis, A., et al., 2008, Effects of cold weather on mortality: results from 15 European cities within the PHEWE project. *Am J Epidemiol* 168,1397–1408.

Babin, S., 2003, Weather and Climate Effects on Disease Background Levels

Berko, J., Ingram, D., Saha, S., and Parker, J., 2014, *Deaths Attributed to Heat, Cold, and Other Weather Events in the United States, 2006–2010National* Health Statistics Reports n Number 76

Chiogna, M., and Gaetan, C.G., 2005, Mining epidemiological time series: an approach based on dynamic regression. *Statistical Modelling* 5,309-325.

Cohen, J., 1988, *Statistical power analysis for the behavioral sciences. 2nd ed.* Lawrence Erlbaum, New Jersey, USA.

Diakoulaki, D., Mavrotas, G., and Papayannakis, L.,1995, Determining objective weights in multiple criteria problems: the CRITIC method. *Computers and Operations Research* 22(7),763-770.

Harker, P.T., and Vargas, L.G., 1987, The Theory of Ratio Scale Estimation: Saaty's Analytic Hierarchy Process. *Management Science* 33,1383-1403.

Kalkstein,L., and Valimont, K.,1987, *Climate effects on human health. In Potential effects of future climate changes on forests and vegetation, agriculture, water resources, and human health*. EPA Science and Advisory Committee Monograph no. 25389, 12252.Washington, D.C., U.S. Environmental Protection Agency.

Kurnoga-Živadinović, N., 2004, Utvrđivanje osnovnih karakteristika proizvoda primjenom faktorske analize. *Ekonomski pregled* 55, 952-966.

Loehlin, J.C., 2005, *Latent Variable Models: An Introduction to Factor, Path, and Structural Equation Analysis*. Lawrwnce Erlbaum Associates Inc, New Jersey, USA.

Ma, J., Fan, Z., and Huang, L., 1999, A Subjective and Objective Integrated Approach to Determine Attribute Weights. *European Journal of Operational Research* 112, 397-404.

Michelozzi, P., et al.,2007, Assessment and prevention of acute health effects of weather

conditions in Europe, the PHEWE project: background, objectives, design. *Environmental Health* 2007, 6:12 doi:10.1186/1476-069X-6-12

Omkarprasad, S.V., and Sushil, K., 2006, Analytic hierarchy process: An overview of applications. *European Journal of Operational Research* 169, 1–29.

Randjelović, D., Stanković, J., Janković-Milić, V., and Stanković, J.,2013, Weight Coefficients Determination Based on Parameters in Factor Analysis. *Metalurgia International* 18(3),128-132.

Render, B.,Stair, R.M., and Hanna, M., 2009, *Quantitative Analysis for Management*. Prentice Hall, New Jersey, USA.

Saaty, T.L.,1986, How to make a decision: The analytic hierarchy process. *Interfaces* 24,19–43.

Saaty, T.L.,2010, Economic Forecasting with Tangible and Intagible Criteria: The Analytic Hierarchy Process of Measurement and its Validation. *Economic Horizons* 1, 5–45.

Saaty, T.L., and Vargas, L.,1994, *Decision Making in Economic, Political, Social and Technological Environments with The Analytic Hierarchy Process*. RWS Publications, Pittsburgh, USA.

Savić, G., Makajić-Nikolić, D., Ranđelović, D., and Ranđelović, M., 2013, Study program selection by aggregated DEA-AHP measure. *Metalurgia International* 18(1), 169-174.

Srđević, B., 2005, Nepristrasna ocena značaja kriterijuma u višekriterijumskoj optimizaciji. *Vodoprivreda* 37, 53-58.

Vardoulakis, S., Dear, K., Hajat, S., Heaviside, C., Eggen, B., and McMichael, A.J., 2014, Comparative assessment of the effects of climate change on heat- and cold-related mortality in the United Kingdom and Australia. *Environ Health Perspect 122:1285–1292*

Weber, M., and Borcherding, K.,1993, Behavioral influences on weight judgments in multiattribute decision making. *European Journal of Operational Research* 67, 1-12.

Wind, Y., and Saaty T.L.,1980, Marketing applications of the analytic hierarchy process. *Management Sciences* 26, 641–658.

Youngkong, S., et al., 2015,Multicriteria Decision Analysis for Including Health Interventions in the Universal Health Coverage Benefit Package in Thailand.*Value in health* 15(6), 961–970.

Zanobetti, A., and Schwartz, J., 2008, Temperature and mortality in nine US cities. *Epidemiology* 1(4),563–570.

Zeleny, M., 1982, *Multiple Criteria Decision Making*. McGraw-Hill, New York, USA.