AIR CONDITIONER SELECTION PROBLEM WITH COPRAS AND ARAS METHODS

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Abstract
Installing the most suitable heating and cooling systems to the offices for the firms is one of the important decisions to be made because of the energy efficiency and working conditions. This decision requires the selection of the proper air conditioner considering several conflicting factors. So it can be handled with the Multiple Criteria Decision Making (MCDM) methods. In this paper COPRAS (**CO**mplex **PR**oportional **AS**sessment) and ARAS (**A**dditive **R**atio **AS**sessment) methods are used to reach a solution for the air conditioner selection problem in the literature. Air conditioner alternatives are ranked by using these two methods and also the results are compared.
Keywords: air conditioner selection, COPRAS method, ARAS method
Jel Codes: C02, C30, C600, M100

1. Introduction

Today air conditioning is widely recognized as an essential to live and work in comfort although it was accepted as a luxury nearly twenty years ago. An air conditioner transfers heat and humidity from the home to outside while cooling and circulating the inside air to provide a comfortable environment. From this point of view selecting and purchasing an air conditioner require efforts for the firms in terms of considering factors such as capacity, efficiency, reliability, comfort, cost and aesthetic that will improve the air quality in their office. At the same time there are a lot of brands in the market for the air conditioners. So selecting the right air conditioner becomes a difficult problem for the firms. This problem can be solved with the Multiple Criteria Decision Making (MCDM) methods. For solving the problem with these methods it is necessary to define the problem and to identify alternatives and criteria. In this paper COPRAS and ARAS methods are used for the air conditioner selection problem in the literature which was solved with MOORA (Multi-Objective Optimization on basis of Ratio Analysis) by Kundakcı et al. (2015).

The rest of this study is organized as follows. Section 2 and Section 3 shortly provides the methodological background for COPRAS and ARAS methods respectively. In Section 4 the applications of COPRAS and ARAS methods are demonstrated with a case derived from the literature. Lastly in Section 5 results of the application are presented and recommendations for future studies are discussed.

2. COPRAS Method

The COPRAS (***CO****mplex* ***PR****oportional* ***AS****sessment*) was firstly introduced by Zavadskas, Kaklauskas and Sarka in 1994. This method compares the alternatives and determines their priorities under the conflicting criteria by taking into account the criteria weights (Zavadskas et al., 2009). It assumes direct and proportional dependences of the significance and utility degree (priority) of the alternatives (Chatterjee and Chakraborty, 2014).

In the literature there are many applications of COPRAS method. Zavadskas et al. (2001) proposed COPRAS method for assessing building life cycles to select the best alternative. Vilutienė and Zavadskas (2003) determined the effective variant of a dwelling maintenance work and performance with this method. Zavadskas et al. (2004) used COPRAS method for developing a housing credit access model. Zavadskas and Vilutiene (2004) determined the appropriate maintenance contractors for apartment blocks. Kaklauskas et al. (2005) proposed COPRAS method for designing and refurbishment of building. Andruškevicius (2005) used this method for selecting the best contractor for the construction of a trade and entertainment center. Kaklauskas et al. (2006) evaluated contractors for the replacement of windows in Vilnius Gediminas Technical University main building. Kaklauskas et al. (2007a) selected the best construction alternative with COPRAS method. Kaklauskas et al. (2007b) determined the market value of real estate with help of COPRAS method. Zavadskas et al. (2007) proposed to use COPRAS method for evaluating road design alternatives. Viteikienė and Zavadskas (2007) used COPRAS method for evaluating the sustainability of residential areas in Vilnius City. Zagorskas et al. (2007) determined sustainable city compactness by using COPRAS method. Banaitiene et al. (2008) used COPRAS method to select a building’s life cycle. Kaklauskas et al. (2010) evaluated intelligent built environment alternatives in industrialized countries. Kanapeckiene et al. (2010) proposed Knowledge Based Decision Support System for Construction Projects Management (KDSS-CPM) to select a land parcel from the alternatives. Das et al. (2012)

applied COPRAS method to measure relative performance of Indian technical institutions. Mulliner et al. (2013) evaluated the affordability of different housing locations by considering economic, environmental and social criteria. Chatterjee and Chakraborty (2014) used COPRAS method to select the most appropriate Flexible Manufacturing System (FMS) for a manufacturing firm. Also COPRAS-G method was used for the selection of investment project (Popovic et al., 2012), the effective dwelling house walls (Zavadskas et al., 2008a), construction project manager (Zavadskas et al., 2008b), contractor (Zavadskas et al., 2008c), best web site (Bindu Madhuri et al., 2010) and material (Chatterjee and Chakraborty (2012); Maity et al. (2012))

The following steps are applied for the COPRAS method. Firstly it is assumed that there are *m* alternatives and *n* criteria in the problem (Chatterjee and Chakraborty, 2014):

Step 1: The normalized decision matrix is acquired with linear normalization procedure using Eq. (1) (Kaklauskas et al., 2006):

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \qquad (i = 1,2,\ldots,m;\ j = 1,2,\ldots,n) \tag{1}$$

where x_{ij} and r_{ij} are the performance of the i^{th} alternative with respect to the j^{th} criterion and its normalized value respectively. The values of the criteria with having different units of measurement should be normalized in order to compare them (Zavadskas et al., 2009).

Step 2*:* Normalized decision making matrix (*D*) is weighted as:

$$D = [d_{ij}]_{mxn} = r_{ij}\, w_j \tag{2}$$

where w_j is the importance weight of *j*th criterion. Importance weights of criteria may be derived from different weighting methods. In this paper the AHP (Analytic Hierarchy Process) method is used because of its simplicity. It was developed by Saaty (1980) and it depends on pairwise comparison of criteria. More detailed information about the procedure of the AHP method is to be found in the paper of Saaty (1980).

Step 3: The weighted normalized values are summed for both beneficial and non-beneficial criteria.

$$S_{+i} = \sum_{j=1}^{n} d_{+ij} \tag{3}$$

$$S_{-i} = \sum_{j=1}^{n} d_{-ij} \tag{4}$$

d_{+ij} and d_{-ij} are the weighted normalized values for the beneficial and non-beneficial criteria respectively. The greater the value of S_{+i} , the better is the alternative and the lower the value of S_{-i} , the better is the alternative. The S_{+i} and S_{-i} values express the degree of goals attained by each alternative. In any case the sums of S_{+i} and the sums of S_{-i} are equal to the weighted sums for the beneficial and non-beneficial criteria as expressed by the following equations:

$$\sum_{i=1}^{m} S_{+i} = \sum_{i=1}^{m}\sum_{j=1}^{n} d_{+ij} \tag{5}$$

$$\sum_{i=1}^{m} S_{-i} = \sum_{i=1}^{m}\sum_{j=1}^{n} d_{-ij} \tag{6}$$

***Step 4*:** The relative significances or priorities of each alternative (Q_i) are determined using the following formula:

$$Q_i = S_{+i} + \frac{S_{-\min} \sum_{i=1}^{m} S_{-i}}{S_{-i} \sum_{i=1}^{m} (S_{-\min} / S_{-i})} = S_{+i} + \frac{\sum_{i=1}^{m} S_{-i}}{S_{-i} \sum_{i=1}^{m} (1 / S_{-i})} \tag{7}$$

where S_{-min} is the minimum value of S_{-i}. The relative significance value of an alternative shows the degree of satisfaction attained by that alternative. The greater the value of Q_i, the higher is the priority of the alternative. The alternative with the highest relative significance value (Q_{max}) is the best choice among the alternatives.

Step 5: The quantitative utility for each alternative (U_i) is calculated. The degree of an alternative's utility which leads to a complete ranking of the alternatives is determined by comparing the priorities of all the alternatives with the most efficient one and can be denoted as below:

$$U_i = \left[\frac{Q_i}{Q_{max}} \right] .100\ \% \tag{8}$$

where Q_{max} is the maximum relative significance value. These utility values of the alternatives range from 0 % to 100 %.

3. ARAS Method

The ARAS (***A****dditive* ***R****atio* ***AS****sessment*) method was firstly introduced by Zavadskas and Turksis (2010). This method both determines the performance of alternatives and compares scores of alternatives with the ideal alternative. It is argued that the ratio of the sum of weighted normalized values of an alternative to the sum of the values of weighted normalized of the optimal alternative considering all criteria is the degree of optimality of an alternative under comparison (Turskis and Zavadskas, 2010). In the literature there are many succesfull implementations of ARAS method. Zavadskas and Turskis (2010) firstly introduced ARAS method and evaluated microclimate in office rooms to illustrate this method. Zavadskas et al. (2010) selected the foundation instalment alternative in redeveloping building with ARAS method. Tupenaite (2010) evaluated the cultural heritage renovation projects in Bulgaria by using SAW, TOPSIS, COPRAS and ARAS Methods. Bakshi and Sarkar (2011) selected projects of optical fibre expansion for telecommunication sector with ARAS method. Balezentiene and Kusta (2012) used ARAS method for reducing greenhouse gas emissions in grassland ecosystems of the central Lithuania. Stanujkic and Jovanovic (2012) applied ARAS method to evaluate the quality of faculty website. Kaklauskas et al. (2013) selected the best renovation project for standard five-story panel house built in Vilnius. Chatterjee (2013) considered the eight preference ranking-based methods (EVAMIX, COPRAS, COPRAS-G, EXPROM2, ORESTE, OCRA, ARAS and PSI) for decision making in some discrete manufacturing applications. Chatterjee and Chakraborty (2013) solved a gear material selection problem in a given manufacturing environment with COPRAS and ARAS methods. Štreimikienė and Baležentis (2013) applied ARAS and TOPSIS methods for sustainability assessment in Lithuania. Dadelo et al. (2013) used ARAS method for the personnel selection. Sliogeriene et al. (2013) choosed the Lithuania's energy generation tecnology. Reza and Majid (2013) ranked the financial institutions with ARAS method on the basis of proposed criteria affecting customers' trust in e-banking. Stanujkic et al. (2013) used various MCDM methods (SAW, ARAS, COPRAS, MOORA, GRA, CP, VIKOR and

TOPSIS) for ranking Serbian banks. Kutut et al. (2013) assesed priority options for preservation of historic city centre buildings. Kutut et al. (2014) selected the best cultural heritage building in Vilnius for restoration or maintenance of cultural properties. Darji and Rao (2014) used extended TODIM, ARAS, OCRA and EVAMIX methods for material selection of pipes in sugar industry. Chatterjee and Chakraborty (2014) made a comparative study including ARAS and the other preference ranking methods for the selection of FMS (Flexible Manufacturing System). Madić et al. (2014) applied ARAS method to evaluate the different non-conventional machining processes and they compared the ranking results with TOPSIS method. Stanujkic et al. (2015) used SWARA (Step-wise Weight Assessment Ratio Analysis) method to determine weights of evaluation criteria and the ARAS method for ranking alternatives in the personnel selection process in hospital industry. Yıldırım (2015) used ARAS method for purchase decision housing problem. Lazauskas et al. (2015) assessed the unfinished construction projects in Vilnius with ARAS, MOORA and MULTIMOORA methods. Medineckiene et al. (2015) used ARAS method for sustainable building assessment/certification.

This method was extended into fuzzy environment (ARAS-F) and grey criteria scores (ARAS-G). Turskis and Zavadskas (2010) used ARAS-G to select the most appropriate stakeholders. Balzentis et al. (2012) used fuzzy TOPSIS, fuzzy VIKOR and fuzzy ARAS methods together for evaluation of economic sector. Turskis et al. (2013) assessed the alternatives of the cultural heritage renovation projects in Vilnius city with ARAS-G method. Esbouei and Ghadikolaei (2013) integrated FAHP (Fuzzy Analytic Hierarchy Process) and ARAS methods for financial performance evaluation. Ghadikolaei et al. (2014) evaluated the financial performance of companies with FAHP to determine the weights of criteria and fuzzy VIKOR, fuzzy ARAS and fuzzy COPRAS to select best alternative among six Iranian companies. Chatterjee and Bose (2013) selected and ranked the vendors for a wind farm with ARAS and COPRAS based on fuzzy set theory. Barak et al. (2014) applied fuzzy ARAS method to a well selection for hydraulic fracturing treatment and used fuzzy TOPSIS method to compare the results. Keršulienė and Turskis (2014) used ARAS-F for the selection of chief accountant. Shariati et al. (2014) proposed the fuzzy GARAS (Group ARAS) method to select the best waste dump site in Ayerma phosphate mine located in Yasouj, Iran. Ghadikolaei and Esbouei (2014) evaluated the financial performance of the companies in automotive and parts manufacturing industry that traded on Tehran Stock Exchange (TSE) in 2002-2011. They used fuzzy ARAS method to rank the companies according their financial performance. Zavadskas et al. (2015) combined AHP and ARAS-F methods for the selection of a deep-water port in the Eastern Baltic Sea.

ARAS method consists of the steps as below:

Step 1: The decision matrix *X* is formed. Alternatives and criteria are listed in the row and column of the decision matrix respectively. The decision matrix shows the performance of different alternatives with respect to various criteria.

$$X = [x_{ij}]_{mxn} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (i = 1,2\ldots,m;\ j = 1,2,\ldots,n) \tag{9}$$

x_{ij} presents the performance value of *i*th alternative on *j*th criterion, *m* and *n* are the numbers of alternatives and criteria respectively. Then the optimal performance rating of *j*th criterion (x_{0j}) is determined. If x_{0j} is unknown, then it is assummed as the maximum values of beneficial criteria or minimum values of non-beneficial criteria (Zavadskas and Turskis, 2010).

Step 2: The decision matrix is normalized. Beneficial criteria are normalized with linear normalization procedure as follows:

$$x_{ij}^{*} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \tag{10}$$

where x_{ij}^{*} is the normalized value.

Non-beneficial criteria are normalized with two-stage procedure. In the first stage the reciprocal of each criterion with respect to all the alternatives is taken as follows:

$$x_{ij}^{*} = \frac{1}{x_{ij}} \tag{11}$$

In the second stage, the normalized values are calculated as follows:

$$R = [r_{ij}]_{mxn} = \frac{x_{ij}^{*}}{\sum_{i=1}^{m} x_{ij}^{*}} \tag{12}$$

Step 3: The normalized decision matrix is weighted as follows:

$$D = [d_{ij}]_{mxn} = r_{ij}.w_j \quad (13)$$

where w_j is the weight (importance) of *j*th criterion.

Step 4: The optimality function (S_i) is determined for each alternative as follows:

$$S_i = \sum_{j=1}^{n} d_{ij} \qquad (i = 0,1,2\ldots,m;\ j = 1,2,\ldots,n) \quad (14)$$

The highest and lowest S_i values are the best and the worst respectively. The optimality function S_i has a direct and proportional relationship with the values in the decision matrix and criteria weights. S_0 is the optimality function of the optimal alternative.

Step 5: The degree of the utility (U_i) is determined for each alternative. It is calculated as follows:

$$U_i = \frac{S_i}{S_0} \quad (15)$$

In this method, a utility function value determines the relative efficiency of an alternative over the best alternative (Chatterjee and Chakraborty, 2014). The U_i values of alternatives range from 0 % to 100 % and they are placed in ascending order. The alternative with the highest utility value is the best choice among the alternatives (Turskis and Zavadskas, 2010).

4. Application

In this section the air conditioner selection problem taken from Kundakcı et al. (2015) is solved with COPRAS and ARAS methods. The textile company operated in Denizli decides to purchase inverter air conditioners with 12000 BTU for their offices. In the problem there are eight criteria as Energy Efficiency Ratio, EER (C_1), Coefficient of Performance, COP (C_2), presence of ionizer (C_3), cost (C_4), maximum sound level (indoor) (C_5), maximum sound level (outdoor) (C_6), watts consumption for heating (C_7) and watts consumption for cooling (C_8). The first three criteria are beneficial where higher values are desirable whereas the last six criteria are non-beneficial where smaller values are desirable. The company determines six air conditioner alternatives (A_1, A_2,..., A_6). Table 1 shows the decision matrix of the problem which summarizes the performance of each alternative with respect to each criterion. Weights of criteria derived from AHP method and criteria type are also shown in the same table.

Table 1. Decision matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	4,60	5,00	1	2750	38	45	800	760
A_2	3,30	3,71	1	2267	39	65	880	900
A_3	3,61	3,84	1	1584	38	50	990	970
A_4	3,37	3,62	1	1650	35	53	1010	1050
A_5	4,09	4,40	0	2650	40	55	870	860
A_6	3,24	3,88	0	3340	57	52	1080	1030
Criteria type	max	max	max	min	min	min	min	min
w_j	0,2817	0,1387	0,0413	0,0413	0,0215	0,0215	0,0215	0,2817

4.1. Application of COPRAS Method

For the COPRAS method firstly the decision matrix is normalized using Eq. (1) as seen in Table 2. Then the corresponding weighted normalized decision matrix is developed using Eq. (2) as given in Table 3.

Table 2. Normalized decision matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	0,2071	0,2045	0,25	0,1931	0,1538	0,1406	0,1421	0,1364
A_2	0,1486	0,1517	0,25	0,1592	0,1579	0,2031	0,1563	0,1616
A_3	0,1625	0,1571	0,25	0,1112	0,1538	0,1563	0,1758	0,1741
A_4	0,1517	0,1481	0,25	0,1159	0,1417	0,1656	0,1794	0,1885
A_5	0,1842	0,1800	0,00	0,1861	0,1619	0,1719	0,1545	0,1544
A_6	0,1459	0,1587	0,00	0,2345	0,2308	0,1625	0,1918	0,1849

Table 3. Weighted normalized decision matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	0,0583	0,0284	0,0103	0,0144	0,0033	0,0030	0,0197	0,0384
A_2	0,0419	0,0210	0,0103	0,0119	0,0034	0,0044	0,0217	0,0455
A_3	0,0458	0,0218	0,0103	0,0083	0,0033	0,0034	0,0244	0,0491
A_4	0,0427	0,0205	0,0103	0,0087	0,0030	0,0036	0,0249	0,0531

A₅	0,0519	0,0250	0,0000	0,0139	0,0035	0,0037	0,0214	0,0435
A₆	0,0411	0,0220	0,0000	0,0175	0,0050	0,0035	0,0266	0,0521

Based on Eq. (3) and Eq. (4), the sums of the weighted normalized values are calculated for both the beneficial criteria (S_{+i}) and non-beneficial criteria (S_{-i}). Then, applying Eq. (7) and Eq. (8), the relative significance or priority value (Q_i) and the quantitative utility (U_i) for each alternative are computed, as given in Table 4.

Table 4. Q_i and U_i values

	Q_i	U_i	*Rank*
A_1	0,1982	100,0000	1
A_2	0,1652	83,3211	4
A_3	0,1682	84,8544	3
A_4	0,1592	80,3317	5
A_5	0,1697	85,5961	2
A_6	0,1394	70,3159	6

According to the calculation results, the complete ranking of the alternatives is obtained as $A_1>A_5>A_3>A_2>A_4>A_6$. A_1 is the best alternative with 100 % utility degree and A_6 is the worst alternative with 70,3159 % utility degree.

4.2. Application of ARAS Method

ARAS method requires the decision matrix shown in Table 1. Before normalizing the decision matrix the optimal performance ratings for each criterion are determined as the maximum values of beneficial criteria and minimum values of non-beneficial criteria. Optimal performance ratings for each criterion are placed as A_0 in bold and italic in Table 5.

Table 5. Decision matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_0	***4,60***	***5,00***	***1***	***1584***	***35***	***45***	***800***	***760***
A_1	4,60	5,00	1	2750	38	45	800	760
A_2	3,30	3,71	1	2267	39	65	880	900
A_3	3,61	3,84	1	1584	38	50	990	970

A$_4$	3,37	3,62	1	1650	35	53	1010	1050
A$_5$	4,09	4,40	0	2650	40	55	870	860
A$_6$	3,24	3,88	0	3340	57	52	1080	1030
Criteria type	max	max	max	min	min	min	min	min

The decion matrix is normalized by using Eq.(10)-(12) and shown in Table 6. Then normalized decision matrix is weighted by considering criteria weights derived from AHP and shown in Table 7.

Table 6. Normalized decision matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_0	0,1716	0,1698	0,2000	0,1884	0,1605	0,1633	0,1623	0,1666
A_1	0,1716	0,1698	0,2000	0,1085	0,1478	0,1633	0,1623	0,1666
A_2	0,1231	0,1260	0,2000	0,1317	0,1441	0,1130	0,1476	0,1406
A_3	0,1347	0,1304	0,2000	0,1884	0,1478	0,1470	0,1312	0,1305
A_4	0,1257	0,1229	0,2000	0,1809	0,1605	0,1386	0,1286	0,1206
A_5	0,1526	0,1494	0,0000	0,1126	0,1404	0,1336	0,1493	0,1472
A_6	0,1209	0,1317	0,0000	0,0894	0,0986	0,1413	0,1203	0,1229

Table 7. Weighted normalized decision matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_0	0,0483	0,0235	0,0083	0,0139	0,0035	0,0035	0,0225	0,0469
A_1	0,0483	0,0235	0,0083	0,0080	0,0032	0,0035	0,0225	0,0469
A_2	0,0347	0,0175	0,0083	0,0097	0,0031	0,0024	0,0205	0,0396
A_3	0,0379	0,0181	0,0083	0,0139	0,0032	0,0032	0,0182	0,0368
A_4	0,0354	0,0170	0,0083	0,0133	0,0035	0,0030	0,0178	0,0340
A_5	0,0430	0,0207	0,0000	0,0083	0,0030	0,0029	0,0207	0,0415
A_6	***0,0340***	***0,0183***	***0,0000***	***0,0067***	***0,0021***	***0,0030***	***0,0167***	***0,0348***

The optimality function (S_i) and the utility degree (U_i) of each alternative is calculated using Eq.(14) and Eq.(15) respectively. S_i and U_i values and the ranking of the alternatives are presented in Table 8.

Table 8. S_i and U_i values

	S_i	U_i	*Rank*
A_0	0,1704	1,0000	-
A_1	0,1643	0,9640	1
A_2	0,1357	0,7965	4
A_3	0,1395	0,8184	3
A_4	0,1323	0,7763	5
A_5	0,1401	0,8219	2
A_6	0,1154	0,6770	6

It is revealed from Table 8 that the priority order of the air conditioners can be represented as $A_1 > A_5 > A_3 > A_2 > A_4 > A_6$. It means that the best air conditioner is A_1 with 96,40 % utility degree and the worst air conditioner is A_6 with 67,70 % utility degree.

5. Conclusion

In this paper COPRAS and ARAS methods are applied on the air conditioner selection problem. These methods are chosen for analysis due to their effectiveness and suitability for compromise selection. COPRAS method is based on the utility degree of the alternatives which is determined by comparing the priorities of all the alternatives with the most efficient one whereas ARAS method is based on ratio sums of alternatives and selects alternative as the best which is closest to the optimal alternative (Tupenaite, 2010). The ranking performance of COPRAS and ARAS methods are same for air conditioner alternatives. This paper shows that there are some similarities between these two methods. Computational procedures of two methods are straightforward and simple in terms of understanding and applying these methods for evaluating the alternatives and selecting the best air conditioner. They consider simultaneously both quantitative and qualitative criteria and there is no limit on the number of criteria. Decision makers' preferences are put into decision process as criteria weights and then a simple weighted summation technique is adopted separately for the normalized beneficial and non-beneficial criteria. An overall significance or utility of the alternatives is taken into account while ranking the alternatives.

The main difference between computational procedures of COPRAS and ARAS methods is the normalization of the decision matrix. A straightforward linear normalization is executed in COPRAS method whereas a two stage linear normalization technique is adopted in ARAS method (Chatterjee and Chakraborty, 2013). Also introduction of the optimal alternative (A_0) is the main characteristic of ARAS method (Stanujkic et al., 2013). In COPRAS method the best alternative is selected from the existing set of alternatives in comparison with the best alternative from this set. So the utility degree of certain alternative can change if the new alternatives are added to the set. Accordingly, the best alternative can not be the best in all the cases. In order to avoid this disadvantage it is more convenient to compare the alternatives with the "optimal" alternative. For this purpose the ARAS method is recommended (Tupenaite, 2010).

From the illustrative example it can be concluded that applied MCDM analysis based on COPRAS and ARAS methods may be successfully adopted to the air conditioner selection problem. In future studies these methods can be used for other selection problems. Other MCDM methods may be used to solve similar problems and the results may be compared. The number of criteria and alternatives may be changed. Fuzzy set or grey relation theories may be used in order to deal with uncertainty of decision process.

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