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Comparing ARAS and COPRAS Methods to Evaluate Firms by Using Fundamental Analysis

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Abstract:

The decision-making process is a tough process not only for the management decisions but also for daily choices. Multicriteria decision-making methods were developed to make this process easier. There are many multicriteria decision-making methods used in the past and the present in many different areas. In this study, two of these methods are used, namely ARAS (Additive Ratio Assessment) and COPRAS (Complex Proportional Assessment), in fundamental analysis for investment decisions. This study aims to implement and compare methods on fundamental analysis to make an investment decision. In the study, financial ratios of 20 firms from 5 different sectors and 4 different countries, sectoral data and country indicators are used. ARAS and COPRAS methods are implemented for these data. Although the same results are not found, similar results are obtained. The best and the worst companies are the same for both methods, even though other rankings differ slightly. Also, the same sector selected as the best sector to invest in, according to both methods.

Key Words:

ARAS, COPRAS, Multi-criteria
Decision-Making Methods,
Fundamental Analysis

1. Introduction

Multicriteria decision making methods are widely used in different fields of studies, including management and finance. We have focused on fundamental analysis in this study. We have used two of these multicriteria decision-making methods, which are COPRAS and ARAS methods, in the process of fundamental analysis. The main point is, if multicriteria decision-making methods are implemented for fundamental analysis, whether different alternatives can be chosen as the best. For this purpose, these two methods are compared and assessed. COPRAS and ARAS methods have been described and reviewed literature in the next section.

2. Literature

ARAS (Additive Ratio Assessment) is one of the multicriteria decision making technics. The method was firstly proposed by Zavadskas and Turksis in 2010. They used the method in construction technologies and building materials and tested newly proposed method for evaluation of microclimate in office rooms (Zavadskas et. al., 2010). After that, ARAS method was used in many areas for multicriteria decision-making problems. Although it is used in almost all areas, in the literature review, construction and material problems are seen as the mostly used areas. Since it was proposed in Lithuania, it is intensely used by academicians in North Europe (Yıldırım, 2015). Besides, there are some studies in the literature which use Fuzzy ARAS.

To mention some studies, Zavadskas (2015) used Fuzzy ARAS and AHP together to select the place of port. Kutut et. al. (2013) ordered historical places for preservation with ARAS. Then in the further work Kutut et. al. (2014) used ARAS method with AHP together on the same subject. Medineckienevd et. al. (2015) used the method in sustainability of buildings. Stanujkic et. al. (2013) compared some of multicriteria decision making methods, including ARAS and COPRAS to order Serbian banks. Chatterjee and Chakraborty (2013) used ARAS and COPRAS comparatively in material selection problem. Sliogeriene et. al. (2016) used ARAS in choice of energy generation technologies within a case study of Lithuania. Shariati et. al. (2014) used the method in selecting a place for a waste disposal facility. Kersulienė and Turskis (2014) used Fuzzy ARAS for personnel selection for a firm. Balezentiene and Kusta (2012) studied about fuel selection with ARAS. Yıldırım (2015) used ARAS in selection of house to buy. Streimikienė and Balezentis (2013) used ARAS and TOPSIS in the case study of Lithuania about integrated sustainability index. Darji and Rao (2014) used 5 different multicriteria decision making methods including ARAS for material selection in sugar industry between 5 alternative materials. Balezentis and Streimikiene (2017) used ARAS method for their study on

energy generation ranking with Monte Carlo simulation. Dahooie et. al. (2018) used Fuzzy ARAS for oil and gas well drilling project choice. Ecer (2018) used ARAS to evaluate mobile banking services.

COPRAS (Complex Proportional Assessment) is a multicriteria decision making method like ARAS. It was firstly proposed by Zavadskas, Kaklauskas and Sarka in 1994. After that, COPRAS method and its fuzzy version have been used in many studies. In the literature, it is seen that the method is mainly used in construction area. Also, material selection problems are frequently seen in the literature. COPRAS method was used in Chatterjee et. al. (2011) study in material selection for a product. Kaklauskas et. al. (2006) used COPRAS method in contractor selection. They used 14 criteria to select the best contractor out of 5 contractors. Chatterjee and Chakraborty (2012) used COPRAS again in material selection problem. Kaklauskas et. al. (2010) used the method for selecting the robot to do the cleaning. Özdağoğlu (2013) used COPRAS for comparison of eccentric press alternatives for manufacturing companies. Maity et. al. (2012) used grey COPRAS method in the process of selection of material for cutting tool. Maharaja and Saravanakumar (2016) compared five banks for investment decision with fundamental analysis. Chatterjee (2018) used COPRAS method in supplier selection and Peng and Dai (2017) used COPRAS in hesitant fuzzy soft decision-making process.

In this study, we use ARAS and COPRAS methods together and compare the results of these two methods. In the literature, some studies that compare these two methods too. Chatterjee and Chakraborty (2013) used ARAS and COPRAS in a power transmission gear material selection problem. Three main criteria were used in the study and selection was done among nine alternatives. Another comparative study was done by Stanujkic, Dordevic and Dordevic in 2013 to compare Serbian banks. Five banks were the alternatives in the study and 12 criteria were used for selection. For this selection some of mostly used multicriteria decision making methods including ARAS and COPRAS used and results of these methods are evaluated comparatively. These methods are used more together in recent years. Ömürbek (2017) used ARAS and COPRAS together to evaluate banks' sustainability performances and Kaplanoğlu (2018) used these methods for performance measurement based on cash flow.

These two multicriteria decision-making methods were used in many different areas as seen above. Although they were used in financial problems, different country data were not compared by these methods. Also, different sector data are included in this study.

3. Multi Criteria Decision Making Methods

In this part, the methods, used in the study will be presented.

3.1 Aras Method

ARAS (Additive Ratio Assessment) is one of the multicriteria decision making technics. This technic classically deals with ranking the alternatives is developed by Zavadskas and Turskis. (Zavadskas and Turskis, 2010). Most of multicriteria decision making methods compare the alternatives and focus on the selecting the best results. As one of these methods, in ARAS method, ranks the efficiency of an alternative over the others by a utility function value. (Chatterjee and Chakraborty, 2013). To give an example, if an optimal score of a criterion is 100 points, but none of the alternatives have 100 points and one of them has a score of 80 while the other alternatives are less than 80, optimality level of this criterion is 0,8 instead of 1,0 (Sliogene et. al. 2013). ARAS method differentiates from other methods in this way.

To implement ARAS method, there are 4 main steps (Zavadskas et. al., 2010).

Step 1. Forming the decision-making matrix (DMM)

Assume that there are m feasible alternatives and n criteria for selection. Alternatives should be put in rows while the criteria should be put in columns. Thus, decision making matrix (DMM) takes this form;

$$X = \begin{bmatrix} x_{01} & \dots & \ddots & x_{0j} & \dots & x_{0n} & \ddots & x_{i1} & \dots & x_{m1} & \ddots & \dots & x_{ij} & \dots & x_{in} & \ddots \\ x_{mj} & \ddots & \dots & x_{mn} & \end{bmatrix}; \quad i=0,1,2,\dots,m; \quad j=1,2,3,\dots,n \quad (1)$$

Here x_{ij} represents the value of the i'th alternative for the j criterion. Besides, there are m+1 rows in the matrix, whereas there are number of m alternatives. This is because in the first row, optimal values of each criterion takes place. In other words, x_{0j} represents optimal value of the j'th criterion.

If optimal value of a criterion is unknown, then if max x_{ij} is preferable $x_{0j}=\max_i (x_{ij})$, if min x_{ij} is preferable, $x_{0j}=\min_i (x_{ij})$.

Step 2. Normalizing the criteria values.

In this step, DMM values are normalized and \underline{X} matrix is defined. Normalization process is different for the criterion in which maxima is preferable from the criterion in which minima is preferable. If maxima are preferable for any criterion, normalization is done as below;

$$\underline{x}_{ij} = \frac{x_{ij}}{\sum_{i=0}^m x_{ij}} \quad (2)$$

If minima are preferable for a criterion, then normalization is done as below;

$$x_{ij} = \frac{1}{x_{ij}^*}; \underline{x}_{ij} = \frac{x_{ij}}{\sum_{i=0}^m x_{ij}} \quad (3)$$

Then the normalized matrix is formed as follows;

$$\underline{X} = \begin{bmatrix} \underline{x}_{01} & \dots & \dots & \underline{x}_{0j} & \dots & \underline{x}_{0n} & \dots & \dots & \underline{x}_{i1} & \dots & \dots & \underline{x}_{m1} & \dots & \dots & \underline{x}_{ij} & \dots & \underline{x}_{in} & \dots & \underline{x}_{mj} & \dots \\ \dots & \dots & \dots & \underline{x}_{mn} & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \end{bmatrix}; \quad i=0,1,2,\dots,m; \quad j=1,2,3,\dots,n \quad (4)$$

Step 3. Defining Normalized-weighted matrix.

In this step, criteria are evaluated with weights. These weights should be between 0 and 1. ($0 < w_j < 1$). Weights should be chosen carefully. Since weights are subjective, they can influence the results easily. Another important point in defining weights is sum of weights w_j should be equal to 1. Normalized-weights values should be calculated as below;

$$\hat{x}_{ij} = \underline{x}_{ij} w_j; \quad i=0,1,\dots,m. \quad (5)$$

Here w_j is the weight of the j 'th criterion and \underline{x}_{ij} is normalized value which is used in step 2.

Then normalized-weighted matrix is formed as follows;

$$\hat{X} = \begin{bmatrix} \hat{x}_{01} & \dots & \dots & \hat{x}_{0j} & \dots & \hat{x}_{0n} & \dots & \dots & \hat{x}_{i1} & \dots & \dots & \hat{x}_{m1} & \dots & \dots & \hat{x}_{ij} & \dots & \hat{x}_{in} & \dots & \hat{x}_{mj} & \dots \\ \dots & \dots & \dots & \hat{x}_{mn} & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \end{bmatrix}; \quad i=0,1,2,\dots,m; \quad j=1,2,3,\dots,n \quad (6)$$

Step 4. Calculating values of optimality function.

Value of optimality function is calculated as follows;

$$S_i = \sum_{j=1}^n \hat{x}_{ij}; \quad i = 0,1, \dots m. \quad (7)$$

S_i is the value of optimality function for the i 'th alternative. Here, the biggest S_i is the best for criterion. By using this calculation, utility degrees can be calculated. To find utility degrees optimality criterion values which obtained above should be used.

$$K_i = \frac{S_i}{S_0}, i=0,1,\dots,m. \quad (8)$$

Value of K_i is between 0 and 1. Finally, biggest value of K_i is the alternative which we are looking for. In other words, alternatives can be ordered with their K_i values descending order.

3.2 Copras Method

COPRAS (Complex PROportional ASsesment) is an MCDM technique, which is proposed by Zavadskas et al. in 1994. (Zavadskas et. al, 1994). Dependences, direct and proportional, of significance and utility degree of alternatives are assumed by the method. (Chatterjee, Athawale, Chakraborty, 2011). Aim of method is to select the best among alternatives available. The method determines also the ideal-worst solution as well as the best solution. To implement COPRAS method the steps are below:

Step 1. Forming the decision making matrix.

Assume that number of available alternatives is m and the number of criteria is n . So the decision matrix X is formed as follows;

$$X = \begin{bmatrix} x_{11} & \dots & x_{1j} & \dots & x_{1n} & \dots & x_{i1} & \dots & x_{m1} & \dots & x_{ij} & \dots & x_{in} & \dots & x_{mj} & \dots \\ \dots & \dots & x_{mn} & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \end{bmatrix}; \quad i=1,2,\dots,m; j=1,2,3,\dots,n \quad (9)$$

Here, x_{ij} is the value of the i^{th} alternative for the j^{th} criterion.

Step 2. Normalizing the decision making matrix.

After forming the decision making matrix (DMM), the values of DMM should be normalized following way;

$$\underline{x}_{ij} = \frac{x_{ij}}{\sum_{i=0}^m x_{ij}} ; i=1,2,\dots,m; j=1,2,\dots,n. \quad (10)$$

Thus, we have the normalized matrix as below;

$$\underline{X} = \begin{bmatrix} \underline{x}_{01} & \dots & \underline{x}_{0j} & \dots & \underline{x}_{0n} & \dots & \underline{x}_{i1} & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \underline{x}_{mj} & \dots & \underline{x}_{in} & \dots & \underline{x}_{mj} & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \end{bmatrix} \quad (11)$$

Step 3. Defining weighted normalized decision-making matrix.

After normalizing the decision matrix, it should be weighted. Weights are the subjective side of the method. Since the weights influence the results significantly, they can be determined carefully. Weighting the normalized values can be done as follows;

$$d_{ij} = x_{ij} * w_j; \quad i=1,\dots,m; j=1,\dots,n \quad (12)$$

Weighted normalized matrix D can be shown as such;

$$D = \begin{bmatrix} d_{11} & \dots & \dots & d_{1j} & \dots & d_{1n} & \dots & d_{i1} & \dots & d_{m1} & \dots & d_{ij} & \dots & d_{in} & \dots \\ d_{mj} & \dots & \dots & d_{mn} & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \end{bmatrix}; \quad i=1,2,\dots,m; j=1,2,3,\dots,n \quad (13)$$

Step 4. Computing the summations.

In this step, summations are calculated in terms of criteria whether it is to be maximized or minimized. Calculations are as follows;

$$S_{+i} = \sum_{j=1}^{L_{max}} d_{+ij} \quad (14)$$

$$S_{-i} = \sum_{j=1}^{L_{min}} d_{-ij} \quad (15)$$

Here, d_{+ij} represents the values to be maximized whereas d_{-ij} represents the values to be minimized.

Step 5. Determining relative significance of alternatives.

In this step priorities of alternatives are calculated and it is shown as Q_i . Calculation is as follows:

$$Q_i = S_{+i} + \frac{S_{-min} \sum_{i=1}^m S_{-i}}{S_{-i} \sum_{i=1}^m (S_{-min} / S_{-i})} \quad i=1,2,\dots, m. \quad (16)$$

Here S_{-min} shows the minimum value of S_{-i} and Q_i shows the priority of i^{th} alternative. The greater value of Q_i , the higher is the priority of the alternative. (Chatterjee, Chakraborty, 2012)

Step 6. Calculating the quantitative utility

After finding the Q_i values, quantitative utilities of alternatives should be calculated. It can be denoted as below;

$$U_i = \left[\frac{Q_i}{Q_{max}} \right] \times 100 \quad (17)$$

Here Q_{max} is the biggest value calculated in the previous step. Finally, the alternative which has the biggest U_i value is the best selection for the method and the other alternatives can be ordered descendingly according to their U_i values.

4. Practice

We used fundamental analysis for investment decision process in this study. Fundamental analysis uses basic financial information of companies. This information can be used for especially forecasting process for profits, supply and demand, and similar subjects that affect the market value of a stock and growth potential of company (Thomsett, 1998). In fundamental analysis, analyst focuses on financial statements of firms. The most basic and the popular way of analyzing financial statements is done with financial ratios. Thus, chosen financial ratios are used for the company part of this fundamental analysis. Maharaja and Saravanakumar (2015) argues that the best method for evaluating companies' results properly is fundamental analysis. Also, a company's performance can be measured by fundamental analysis. Thomsett (1998) impresses fundamental analysis as the best method of choice since providing dependable, consistent information.

Fundamental analysis consists of 3 steps; macroeconomic analysis, sectoral analysis and company analysis (Uyar, 2001). In the first step, the country in which the company is located is evaluated. For this evaluation macroeconomic indicators of the country are used. To give an example, GDP, GNP, inflation rate, unemployment rate, interest rates or debts etc. can be used as macroeconomic indicators. GDP, inflation rate and external debt ratios are selected for macroeconomic analysis in this study, since they are the mostly used indicators by the economists. The companies, used in the study, are located in USA, Japan, Turkey and England, so these countries' values are taken. In the second step, sectors which companies are included are evaluated. For this step, price to equity, long term debt to equity and net profit margin ratios of sectors are used in analysis. Companies used in our study are selected from five different sectors namely, textile, medicine, communication, food and information technology (IT). Finally, in the third step of fundamental analysis financial performances of companies are measured. Financial ratios can be used in this step easily. We selected profit margin, debt ratio and current ratio for the company analysis. 20 different firms from 5 countries are evaluated with fundamental analysis in this way.

We determined two dimensions in the study. First is ranking firms, selected from different countries and different sectors randomly. Second, ranking sectors due to preference of investing.

Values used in practice are taken from several places. While macroeconomic data are taken from World Bank website; sectoral and company data are taken from finance websites concerned with the stock market data of Dow Jones (USA), LSE (London Stock Exchange), Nikkei (Japan) and BIST (Turkey).

Names of companies were not used in the study, instead of their names, coded are used.

Company list according to their sectors is as below;

Textile: Companies A, F, K, P

Medicine: Companies B, G, L, Q

Communication: Companies C, H, M, R

Food: Companies D, I, N, S

Information Technology: Companies E, J, O, T.

Company list according to their stock market traded in is as below;

Dow Jones: Companies A, B, C, D, E

LSE: Companies F, G, H, I, J

Nikkei: Companies K, L, M, N, O

BIST: Companies P, Q, R, S, T.

Initial table used for ARAS is as follows;

	Company			Sectoral			Macroeconomic		
	Max	Min	Max	Max	Min	Max	Max	Min	Min
Companies	Profit	Debt to equity	Current Ratio	P/E	Long Term Debt to Equity	Net Profit Margin	GDP	Inflation	External Debt
Weights	0,183	0,217	0,117	0,093	0,083	0,124	0,067	0,063	0,053
OPTIMUM	0,22	0,27	3,16	62,80	0,14	21,40	17946996	0,1	392812
Company A	0,11	1,53	1,33	23,50	0,17	-2,60	718221	7,7	392812
Company B	0,06	14,36	1,45	41,30	54,59	6,40	2848755	0,1	8638047
Company C	0,12	3,18	2,77	24,10	1008,09	10,50	2848755	0,1	8638047
Company D	0,22	45,05	3,16	24,80	43,01	7,60	17946996	0,1	17437745
Company E	0,03	2,21	1,57	25,20	0,45	1,30	718221	7,7	392812
Company F	0,09	9,16	1,85	13,10	0,86	5,00	718221	7,7	392812
Company G	0,00	463,39	0,93	20,20	118,77	21,40	2848755	0,1	8638047
Company H	0,10	55,17	1,35	22,20	0,65	4,40	718221	7,7	392812
Company I	0,19	4064,06	1,89	38,60	1170,17	7,50	17946996	0,1	17437745
Company J	0,05	0,27	1,65	30,44	0,19	5,34	4123258	0,8	2833852
Company K	0,12	17,13	2,80	25,90	36,96	9,60	17946996	0,1	17437745
Company L	0,00	0,90	1,02	20,03	0,45	6,93	4123258	0,8	2833852
Company M	0,13	4,16	2,51	18,30	111,91	6,00	4123258	0,8	2833852
Company N	0,13	70,06	1,37	20,20	118,77	21,40	17946996	0,1	17437745
Company O	0,12	68,35	0,75	62,80	46,78	8,50	2848755	0,1	8638047
Company P	0,09	51,06	1,79	31,56	0,14	10,89	4123258	0,8	2833852
Company Q	0,04	97,44	1,96	6,33	0,26	5,72	4123258	0,8	2833852
Company R	0,17	47,79	1,63	11,60	0,15	-6,40	718221	7,7	392812
Company S	0,11	481,87	0,61	24,90	256,98	6,40	17946996	0,1	17437745
Company T	-0,10	67,36	0,84	24,90	256,98	6,40	2848755	0,1	8638047

Table 1. ARAS Decision Making Matrix

Here weights are determined by expert comment over market conditions and investment priorities. According to these comments, weights are for company level, sectoral level and macroeconomic level are 0,517; 0,300 and 0,183 respectively. Similarly, these weights are divided into three categories according to experts' comments. These weights can be seen at

Table 1. After implementing the steps of ARAS, final table is formed as;

K_i

Company J	0,6500
Company D	0,3234
Company N	0,2994
Company I	0,2929
Company A	0,2893
Company K	0,2752
Company C	0,2718
Company P	0,2678
Company L	0,2545
Company R	0,2326
Company O	0,2236
Company M	0,2143
Company S	0,2080
Company E	0,2034
Company F	0,1952
Company H	0,1915
Company B	0,1798
Company G	0,1768
Company Q	0,1588
Company T	0,0593

Table 2. Ranking for ARAS

Table 2 shows the ranking of companies for ARAS method. Companies are ordered according to their utility degree optimality values.

As being second method; initial table used for COPRAS is as follows;

	Company			Sectoral			Macroeconomic		
	Max	Min	Max	Max	Min	Max	Max	Min	Min
Companies	Profit	Debt to equity	Current Ratio	P/E	Long Term Debt to Equity	Net Profit Margin	GDP	Inflation	External Debt
Weights	0,183	0,217	0,117	0,093	0,083	0,123	0,067	0,063	0,053
Company A	0,11	1,53	1,33	23,50	0,17	-2,60	718221	7,7	392812
Company B	0,06	14,36	1,45	41,30	54,59	6,40	2848755	0,1	8638047
Company C	0,12	3,18	2,77	24,10	1008,09	10,50	2848755	0,1	8638047

Company D	0,22	45,05	3,16	24,80	43,01	7,60	17946996	0,1	17437745
Company E	0,03	2,21	1,57	25,20	0,45	1,30	718221	7,7	392812
Company F	0,09	9,16	1,85	13,10	0,86	5,00	718221	7,7	392812
Company G	0,00	463,39	0,93	20,20	118,77	21,40	2848755	0,1	8638047
Company H	0,10	55,17	1,35	22,20	0,65	4,40	718221	7,7	392812
Company I	0,19	4064,06	1,89	38,60	1170,17	7,50	17946996	0,1	17437745
Company J	0,05	0,27	1,65	30,44	0,19	5,34	4123258	0,8	2833852
Company K	0,12	17,13	2,80	25,90	36,96	9,60	17946996	0,1	17437745
Company L	0,00	0,90	1,02	20,03	0,45	6,93	4123258	0,8	2833852
Company M	0,13	4,16	2,51	18,30	111,91	6,00	4123258	0,8	2833852
Company N	0,13	70,06	1,37	20,20	118,77	21,40	17946996	0,1	17437745
Company O	0,12	68,35	0,75	62,80	46,78	8,50	2848755	0,1	8638047
Company P	0,09	51,06	1,79	31,56	0,14	10,89	4123258	0,8	2833852
Company Q	0,04	97,44	1,96	6,33	0,26	5,72	4123258	0,8	2833852
Company R	0,17	47,79	1,63	11,60	0,15	-6,40	718221	7,7	392812
Company S	0,11	481,87	0,61	24,90	256,98	6,40	17946996	0,1	17437745
Company T	-0,10	67,36	0,84	24,90	256,98	6,40	2848755	0,1	8638047

Table 3. COPRAS Decision Making Matrix

Since we are trying to compare COPRAS and ARAS methods, same weights were used for COPRAS with ARAS. As you see in the table, the basic difference of COPRAS decision making matrix from ARAS decision matrix is the absence of the column that shows the optimal values.

After implementing the steps of COPRAS, presented already, final table is as follows;

U_i

Company J	1,000
Company L	0,903
Company D	0,760
Company P	0,745
Company K	0,681
Company N	0,676
Company M	0,668
Company O	0,612
Company B	0,591
Company I	0,538
Company Q	0,483
Company C	0,460
Company S	0,409
Company F	0,390
Company H	0,378
Company G	0,361
Company R	0,341
Company A	0,338
Company E	0,299
Company T	0,179

Table 4. Ranking for COPRAS

Table 4 shows the ranking of companies for COPRAS method. Companies are ordered according to their quantitative utilities.

5. Results and Conclusion

According to the calculations done for ARAS method, top three companies are Company J, Company D, Company N respectively. On the other hand, the worst three companies are Company T, Company Q and Company G.

Results of COPRAS method shows that top three companies are Company J, Company L, Company D respectively. And the worst three companies are Company T, Company E and Company A respectively.

As seen above, the best (Company J) and the worst (Company T) companies are same for both methods. Although, they have different values in different methods, their ranking does not change. When we think that these methods are used for choosing the best within the alternatives, taking same result from different methods is important. Also, when we apply Pearson correlation to results of ARAS and COPRAS methods, there is a strong relationship between results. ($r = 0,70$)

If we evaluate these results in sector level instead of company level, information technology sector is the best among all alternatives for both methods.

To sum up, when we compare the results of ARAS and COPRAS methods similar results are found. Although this does not mean that methods are interchangeable, results after evaluating same data does not differ significantly. These two methods give similar results even though they have different steps. These results correspond to other studies which compares methods in different areas like Chatterjee and Chakraborty's (2013) study.

Furthermore, fundamental analysis with these methods can be done by taking different ratios and different weight. For further research, it can be proposed to use different multi criteria decision making methods or criteria.

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