Research article Available online www.ijsrr.org ISSN: 2279–0543

International Journal of Scientific Research and Reviews

Financial Performance Evaluation of Selected Steel Companies in India by using Multi Criteria Decision Technique of ARAS, SAW and TOPSIS with DVA based Weight Determination.

Raikar Avinash V*.

Department of Economics, CES College of Arts & Commerce, Cuncolim- 403703 Goa, India

ABSTRACT

Blessed with 5^{th} largest reserves of the iron ore, the iron and steel industry occupies an important place in the development process of the country. The steel sector has strong forward linkages with sector like construction, automobile, manufacturing etc., and hence for the development of these sectors the development of the iron and steel industry is a prerequisite. The industry has made rapid strides since independence, production of iron and steel has increased from merely 1.0 MTPA in 1951 to 106.5 MTPA in 2018, making it a second largest producer of steel in the world. In this study attempt is made to analyse financial performance of the selected 24 steel manufacturing firms in India over a period 2014 to 2018. The study uses 17 ratios that broadly cover profitability, solvency, stability, managerial efficiency and liquidity. These ratios are the criteria on which alternatives or steel companies are evaluated by using three well known MCDM techniques, namely, ARAS, SAW and TOPSIS. The weights or relative priority of the criteria is assigned by SDV method. The study ranks the alternatives on the basis of their performance and identifies that Tata Metalik, Tata Sponge, Tata Steel, JSW Steel, Kalyani Steel are the five best companies among the set of companies evaluated in the study.

KEY WORDS: Mcdm, Steel Sector, Aras, Saw, Topsis.

***Corresponding author**

Dr Avinash V. Raikar

Associate Professor,

Department of Economics,

CES College of Arts & Commerce,

Cuncolim, Salcete, Goa, India Pin 403703

Email: avraikar@rediffmail.com Mobile No: 9860868326

INTRODUCTION

In the development initiative of any country the steel sector has to play a crucial role. Blessed with 5th largest reserves of the iron ore, the iron and steel industry occupies an important place in the development process of the country. The steel sector has strong forward linkages with sectors like construction, automobile, manufacturing etc., and hence for the development of such sectors the development of iron and steel industry is a prerequisite.

Iron and iron made products are known to the Indians from very early times. The famous iron pillar built around 402 CE (date under dispute and the exact date is just speculation) which still today is non-rusting is a mystery that science still today struggling to answer. It displays the mastery that our iron smith had achieved in those times. However, modern steel industry started in India in 1907 when TISCO was set up by the Dorabji Tata in Bihar, this was followed by Indian Iron and Steel Company in 1918 in West Bengal. In Mysore state, the Mysore Iron and Steel Work which later renamed as the Vesvesvaraya Iron and Steel Limited were set up in 1923. After independence, Government of India invested heavily in iron and steel sector under the Nehru-Mahalnobis strategy of growth that emphasized on initial development of basic and heavy industry like iron and steel for future rapid growth of the economy. The number of steel plants were set up in the public sector at various locations in India, which latter on were consolidated under the aegis of the Steel Authority of India (SAIL). Today, SAIL is the third largest steel company in terms of market valuation after Jindal Steel Work (JSW) and Tata Steel (TISCO).

The production of steel has increased significantly over the years from merely 1.0 MTPA in 1951 to 106.5 MTPA in 2018 and with this it has overtaken the Japan the second largest producer of the steel in the world. However, if one compares the steel production of India with that of the largest producer of steel in the world than it is insignificant. The largest producer of steel in the world i.e. China produces around 52 percent of world steel output, whereas the Indian share is miniscule about 10 percent. The steel sector in India contributes around 2 percent of the GDP and provides employment to about 0.6 million workers. In this article an attempt is made to evaluate the performance of 24 steel manufacturing sector companies listed on the National Stock Exchange of India by using ratios that cover the parameters of investment valuation, profitability, liquidity, solvency, debt coverage, and managerial efficiency. In all seventeen ratios are used in the study, the brief description of these ratios that are used as a criteria in the multi-criteria evaluation are given in the section below. The use of the seventeen ratios in performance evaluation gives us a confusing picture as different ratios show us a different set of companies to be efficient. This problem is resolved in the literature by using various types of multi criteria decision making (MCDM) techniques. This article proposes to use the relatively new MCDM method of the Additive Ratio

Assessment Method (ARAS) developed by Zadvaskas and Turskis[1] and match the rank generated from it by another widely used method of the MCDM called TOPSIS developed by Hwang & Yoon[2] and by Simple Additive Weighted (SAW) Method.

MATERIALS AND METHODS

In literature various types of multi-criteria decision making techniques are used to assess the performance of manufacturing companies by using ratios derived from the information contained in the balance sheet and profit and loss statement. The ratios that measure investment valuation, profitability, liquidity, solvency, debt coverage, managerial efficiency in conversion of inputs into output are widely used. With such an approach, one of the widely used MCDM methods for evaluation and ranking of alternative is TOPSIS. This method is used by number of researchers[3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22] in the performance evaluation of various types of business entities and their ranking. Another widely used MCDM method is the VIKOR[17,23,24,25,26]. The other MCDM methods like the PROMETHEE [13,22,27], ELECTREE[28,29], MOORA[25,30,31], SAW[25,26] GRA [10,25] are often used by the researchers. The ARAS is relatively new methods, though widely used in the MCDM evaluation problems with different facets; it is relatively less used in the multi-criteria based financial evaluation. The ARAS method is used by Zavadskas and Turskis[1] for determining inside climate of the premises and to define measures required to be initiated for improving their environment. Bakir and Atalik[32]uses ARAS to evaluate the quality of air transport services of 11 major airline operators in the world. Debapriya, P. et. al[33] used ARAS to rank the Indian states on the basis of its police performance. Karabasevic et al.[34]used ARAS method for personnel section. The relative importance of the criteria or weights of the criteria used in personnel section was determined by the MCDM method called as Stepwise Weight Assessment Ratio Analysis (SWARA). Karabasevic et al.[35]used ARAS and SWARA method for personnel selection under uncertainty. Chatterjee and Bose[36]used ARAS method for selecting and ranking of the vendors for a wind farm. The fuzzy set theory is used to determine the weights of the criteria. Ecer, F[37]evaluates mobile banking services by using FAHP and ARAS method. FAHP is used to evaluate relative priorities of the criteria and ARAS sorting and ranking of the mobile banking services. Karabasevic, et al[38]identifies the indicators of corporate social responsibility and ranks companies, according to the indicators by using ARAS technique. The weights of the criteria are determined by SWARA technique in the study. Stanujkic, D and Javanovic, R[39]used ARAS for the evaluation of a faculty website. Kutut, V. et. al.[40]outlines the status of the some buildings located in the historic city centre of Vilnius and analyses the indicators on the basis of which such buildings could be assessed or identified for reconstruction by using the MCDM technique of ARAS. Kersuliene and Turskis[41] uses

ARAS method for selection or promotion of chief accountant. The relative priorities or weights of the criteria are determined in the study by FAHP. Zavadskas, E.K. et. al[42] uses ARAS for selection of construction project manager assessment. Saparauskas, J et. al[43] used ARAS method to compare different design of a building or structure and to select the best alternative using criteria of optimality. Thus, the ARAS technique is widely used for resolving multi-criteria decision problems in diverse fields. Apart from above, this method is also used in the financial performance evaluation of the companies operating under the diverse sector. For instance, Ozbek and Erol[44] use ARAS for ranking of 7 factoring companies listed on Istanbul Stock Exchange using financial data for the period 2013 to 2016.

Table 1: List of the Companies Used in Financial Analysis

Number of DMU	Name of the Steel Company
DMU-1	JSW Steel
DMU-2	Tata Steel
DMU-3	Steel Authority of India Limited
DMU-4	Jindal Stainless (Hisar)
DMU-5	Visa Steel Limted
DMU-6	Steel Exchange India Limited
DMU-7	Manaksia Steel
DMU-8	Sunflag Iron and Steel Company
DMU-9	Kalyani Steels
DMU-10	MSP Steel & Power
DMU-11	Godawari Power & Ispat
DMU-12	Sarda Energy and Minerals
DMU-13	Jindal Steel and Power
DMU-14	Mukand Ltd
DMU-15	Technocraft Industries (India)
DMU-16	Usha Martin
DMU-17	Jindal Stainless
DMU-18	Tata Sponge
DMU-19	Tata Metalik
DMU-20	Pennar Industries
DMU-21	Tata Steel BSL
DMU-22	Uttam Galva Steel
DMU-23	Jai Corporation
DMU-24	Kirloskar Ferrous

As stated above, 24 companies listed on NSE are used as alternatives or Decision Making Units (DMUs) that includes large and small manufacturers, flat and long product manufacturers, crude steel and alloy steel manufacturers operating in steel sector in India. The requisite data of the DMU are compiled from the ratios displayed by investor portal moneycontrol.com for the period 2014 to 2018. In final analysis data averages for the period and the average is used in the analysis. The list of Manufacturers of steel considered in the analysis is given in the table 1 along with DMU number. The criteria on which these DMUs are assessed are given in the table 2 below. The requisite data compiled and used in the analysis for performance evaluation and ranking/sorting is given in the table 4.

Table 2: Ratios or Criterion Used in the Analysis along with the Type & Weights of Criterion

Sr. No	Criteria/Ratio	Abbreviation	Weights by SDV approach	Type of Criterion
1.	Operating Profit per share	OPMS	0.0612	+
2.	Net Operating Profit per share	NOPS	0.0678	+
3.	Operating Profit Margin (%)	OPM	0.0630	+
4.	Gross Profit Margin (%)	GPM	0.0545	+
5.	Net Profit Margin (%)	NPM	0.0597	+
6.	Return on Capital Employed (%)	RCEM	0.0583	+
7.	Return on Net Worth (%)	RNW	0.0412	+
8.	Return on Long term Fund (%)	RLF	0.0514	+
9.	Current Ratio	C-Ratio	0.0488	+
10.	Quick Ratio	Q-Ratio	0.0517	+
11.	Debt Equity Ratio	D-E Ratio	0.0604	-
12.	Inventory Turnover Ratio	INVTR	0.0672	+
13.	Debtor Turnover Ratio	DTR	0.0701	+
14.	Investment Turnover Ratio	INTR	0.0553	+
15.	Total Asset Turnover Ratio	ATR	0.0701	+
16.	Number of Days in Working Capital	NDIWC	0.0612	-
17.	Material Cost Composition	MCC	0.0579	-
+ indicates Benefit and - Cost Criteria				

Additive Ratio Assessment (ARAS) Method: is relatively new multi criteria decision technique developed by Zavadskas and Turkis[1]**.** Its algorithm is as follows:

Construct the decision matrix with m alternative and n criteria as follows:

$$X=\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \text{---} \quad (1)$$

Where x_{ij} represents performance of i[th] alternative on the jth criteria; $i = 1,2, \ldots \ldots m \; and \; j = 1,2, \ldots . . n$.

The first step in the ARAS method is to determine the optimal preference rating of the criteria if decision makers have, if any, otherwise determine preference rating as indicated below:

$$x_{0j} = \begin{cases} \max_j x_{ij} \text{ ; } if\ J \in\ Benefit\ criterion \\ \min_j x_{ij} \text{ ; } if\ J \in Cost\ Criterion \end{cases}$$

The x_{0j} is the optimal rating of the j[th] criterion. It is maximum if criteria are positive, i.e. higher is better and minimum if the criteria are cost or less is better.

Second step is to calculate normalized decision matrix $R = r_{ij}$ in such that:

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}};\ if\ \ j = bennefit\ criteria$$

$$r_{ij} = \frac{{}^{1}/_{x_{ij}}}{\sum_{i=1}^{m} {}^{1}/_{x_{ij}}}; if\ j = cost\ criteria \text{ --- } (2)$$

Where r_{ij} is the normalized performance rating of the i[th] alternative on the j[th] criteria.

Step 3 is to weight the matrix with appropriate weights of the criteria to derive a weighted normalized decision matrix v_{ij} as:

$$v_{ij} = w_j r_{ij} \text{ -- } (3)$$

Where v_{ij} the weighted is normalized performance rating of i[th] alternatives in relation to the J[th] criterion.

As step 4 calculate the overall performance index of the alternative as a sum of the weighted normalized performance as:

$$s_i = \sum_{j=1}^{n} v_{ij}\ ; i = 0,1,2, \ldots \ldots . m \text{ ---------------------------- } (4)$$

From s_i calculate the degree of utility for each alternative as:

$$Q_i = \frac{s_i}{s_0} \text{ --- } (5)$$

Where Q_i is the degree of i[th] alternative and s_0 overall performance index of optimal alternative and it is normally 1.

Based on the Q_i rank the alternatives as:

$$A^* = \{A_i | \max_i Q_i\}; i = 1,2, \ldots \ldots . m \text{ ------------------------------- } (6)$$

Simple Additive Weighting Method: is one of the earliest known methods of the multi criteria evaluation technique and it still continues to be used. The method involves three steps:

Step 1: Generation of data matrix as shown in the equation 1 above.

Step 2: Normalization of data matrix normally by a linear sum method which can be expressed as:

$$r_{ij} = \frac{x_{ij}}{\sum_{j=1}^{n} x_{ij}} : if\ J \in Benefit\ Criteria$$

$$r_{ij} = \frac{\sum_{j=1}^{n} x_{ij}}{x_{ij}}; if\ J \in Cost\ Criteria$$

In this study construction normalized decision matrix is done as:

$r_{ij} = \frac{x_{ij}}{x_{0j}}; \; j \in benefit\ criteria$

$r_{ij} = \frac{x_{0j}}{x_{ij}} \; ; j \in Cost\ criterion$ -- (8)

Where x_{0j} is the maximum value of the criterion if it is a benefit criterion and the minimum value if it is cost criterion. r_{ij} represents the normalized performance rating of the ith alternative on the jth criterion.

Step 3: Calculate relative importance of the ith alternative based on Simple Additive Weighting Method as shown in the equation (9) .

$p_i = \sum_{j=1}^{n} w_j r_{ij}$ -- (9)

TOPSIS Method: Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method developed by Hwang and Yoon[2]. However, it is not free from the drawbacks sighted above, according to Opricovic and Tzeng[45] though the TOPSIS is supposed to identify the best alternative that has the shortest distance from a positive ideal solution and longest distance from negative ideal solution, it fails to do so. Also, the rank reversal problem is observed in TOPSIS when alternatives are close. To Olson[46] TOPSIS algorithm involves six steps as follows:

Step 1: Compilation of data into data matrix.

$X = |x_{ij}|$ -- (10)

where, $i = 1,2, \ldots \ldots m$ alternatives; $j = 1,2, \ldots \ldots n$ criteria's and x_{ij} indicates the performance of the ith alternative on the jth criteria.

Step 2: Normalization of the decision matrix. Classical TOPSIS uses vector normalization technique.

$N = |x_{ij}^*| = \frac{x_{ij}}{\left[\sum_{i=1}^{m} (x_{ij})^2\right]^{\frac{1}{2}}} \; ; if\ j \in BC$ -------------------------------------- (11a)

This makes criteria values commensurate and lie between {0,1}. Many of the studies convert cost criteria into benefit criteria by using vector transformation of the type

$= |x_{ij}^*| = \frac{\left[\sum_{i=1}^{m} (x_{ij})^2\right]^{\frac{1}{2}}}{x_{ij}} \; ; if\ j \in CC$

In recent years other normalization techniques are also used by the researchers. In this study we use max-min method to normalize data and to convert negative criteria into positive ones. Linear max-min normalisation method can be expressed as:

$n_{ij} = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} \; ; If\ J \in BC$

;

$n_{ij} = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}}; If\ J \in CC$ ---------------------------------- (11b)

Step 3: Develop a weighted, normalized decision matrix by multiplying normalized matrix (N) by weights of the criteria.

$WN = |v_{ij}| = |w_j x_{ij}^*|$ -- (8)

Step 4: Determine the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS) from weighted normalized decision matrix.

$PIS = (v_1^+, v_2^+, \ldots \ldots .. v_n^+)\ if\ (\max_j v_{ij},\ if\ j \in BC;\ \min_j v_{ij}, if\ j \in CC)$

$NIS = (v_1^-, v_2^-, \ldots \ldots .. v_n^-)\ if\ (\min_j v_{ij},\ if\ j \in BC;\ \max_j v_{ij}, if\ j \in CC)$ --------- (9)

Here, since we have already converted the cost criteria into benefit criteria by using normalization techniques shown in the equation (11b), therefore all criteria have to be treated as benefit criteria while determining PIS and NIS.

Step 5: Calculate n-dimensional Euclidian distance of separation of each alternative from PIS and NIS as:

$d_i^+ = \left[\sum_{j=1}^n \left(v_{ij} - v_j^+\right)^2\right]^{1/2}, i = 1,2, \ldots \ldots .. m$; and

$d_i^- = \left[\sum_{j=1}^n \left(v_{ij} - v_j^-\right)^2\right]^{1/2}, i = 1,2, \ldots \ldots \ldots m.$ --- (10)

Step 6: Relative closeness to ideal solution (R) is calculated as:

$R_i = \frac{d_i^-}{d_i^+ + d_i^-}$ -- (11).

Rank the alternatives on R_i in descending order.

In MCDM techniques the relative priority attached to the criteria plays an important part in the determination of the final outcome. The relative priorities of criteria or weights of the criteria in MCDM techniques are given subjectively by judgment of the decision maker or by objectively by using various methods available in the MCDM literature like linear programming technique[5], Entropy [6,14,32] , CRITIC[20,26,31] concordance matrix[29] and SDV (standard deviation approach)[47]. The objective methods of weight determination are generally used when the decision maker finds it rather difficult to allot relative priorities to the criteria due to inexperience or lack of sufficient knowledge. The best methods of weight determination are subjective methods were in the experience of the decision maker play an important role in the final outcome. There are a large number of subjective weight determination methods used in the MCDM literature, however, one of the widely used technique is the Analytic Hierarchic Process (AHP) and its fuzzy variant which is used by number of researchers[1,3,24,30,36,37,48]. A large number of studies also use SWARA[34,35,38] which is also one of the subjective method of weight determination. Another way out when the decision maker lack necessary experience is to assign relative priorities to the criteria or weights to criteria is to assign equal weights to all the criteria. Such approach is taken by[3,4,8,9,11,16,19] etc. In this study SDV approach is used for determination of the relative importance or weights of the criteria. Under this method standard deviation of the each criterion is measured and then, the sum of standard deviation of all the criteria is calculated, Finally, by dividing Standard Deviation of each of the criteria by the sum of standard deviation of all the criteria the relative priority of the criteria or weights of the criteria are determined. The weights derived by using SDV approach are given in the table 2.

DATA ANALYSIS:

Sorting and ranking of the DMUs on the basis of their relative financial performance assumes importance from the fact that in business world various groups of the stakeholders like competitors, financial analyst, government, workers and others, including common man on the street wants to know which firms is doing better and which are not. However, yardsticks or indicators of performance measurement vary from stakeholder to stakeholder. For instance, workers might be interested in profit and bonus declared by the management. Whereas, the government will be interested in indirect and direct taxes paid on sales and profit. Owners may be interested in stability and profitability of business, the managers involved in day to day administration of business may be interested in stability and sales growth. The investors on the other hand might be interested in profitability, dividend yield, sales growth, debt-capital composition, etc. Thus, when one looks at the performance of the business unit we look at it from multiple criteria to be fulfilled at the same time. Hence, this gives rise to the multiple criteria optimization problem. The unit-criteria decisions are simple to make but a multi-criteria decision entails the use of procedures or method to convert multi-criteria into unit-criteria. The various methodologies are developed in the MCDM literature, the brief review of which is given in the review of literature. Herein, as stated above ARAS method is used. The algorithm of the ARAS method in final step gives us the ranking as shown in table 3 below. From the table it can be seen that the five best DMUs are DMU19, DMU18, DMU2, DMU1 and DMU9 whereas the five worst of the lot are DMU5, DMU21, DMU10, DMU22 and DMU3. The SAW method is one of the simplest of all the MCDM method, when used on the data matrix yields us preference index p_i that when arranged in descending order to rank the alternatives yield us ranks shown in table 3. From the table, it is observed that DMU19, DMU4, DMU1, DMU13 and DMU2 are the best, whereas DMU24, DMU11, DMU17, DMU10 and DMU6 are the worst five on the SAW method. It can be seen that the listing/ranking of DMUs generated by ARAS and SAW is different. This is the most common problem in MCDM literature. The rank tends to vary with the methodology used and weight assigned to the criteria. Therefore, most of the researchers use two or more methods simultaneously to derive better understanding of the problem. Here in, to sort out the confusion caused by the different results thrown in by the ARAS and SAW we use the third MCDM method called TOPSIS. This is widely used method for performance evaluation of companies by using financial data.

Table 3 : Ranking Generated by SAW, ARAS and TOPSIS Method

	SAW Method		ARAS method		TOPSIS Method	
	p_i	Rank	Q_i	Rank	R_i	Rank
DMU1	1.599	3	0.478	4	0.735	4
DMU2	0.811	5	0.517	3	0.753	2
DMU3	0.701	6	0.105	20	0.574	19
DMU4	2.551	2	0.430	6	0.693	6
DMU5	-0.001	19	-0.099	24	0.552	22
DMU6	-0.099	20	0.152	18	0.560	20
DMU7	0.193	12	0.334	11	0.656	12
DMU8	0.013	17	0.280	13	0.639	14
DMU9	0.051	15	0.456	5	0.720	5
DMU10	-0.108	21	0.067	22	0.515	24
DMU11	-0.163	23	0.319	12	0.660	11
DMU12	0.119	14	0.388	8	0.680	8
DMU13	0.963	4	0.251	15	0.649	13
DMU14	0.028	16	0.190	16	0.575	18
DMU15	0.225	9	0.397	7	0.669	10
DMU16	0.385	8	0.120	19	0.584	17
DMU17	-0.137	22	0.154	17	0.534	23
DMU18	0.420	7	0.566	2	0.738	3
DMU19	3.434	1	0.657	1	0.754	1
DMU20	0.012	18	0.276	14	0.628	15
DMU21	0.170	13	0.009	23	0.609	16
DMU22	0.204	10	0.084	21	0.558	21
DMU23	0.199	11	0.387	9	0.676	9
DMU24	-0.572	24	0.348	10	0.683	7
$Spearman's\ rank\ corelation\ co-efficent\ r_s\ between$: SAW_ARAS is 0.455; p (two tailed) = 0.0256; SAW_TOPSIS:r_s =0.514, p (two tailed)=0.0102; ARAS_TOPSIS r_s = $0.942\ p(two-tailed) = 0.$						

It should be noted here that in the most of the MCDM techniques the confusion is caused by the larger than normal negative and positive data that creates bias towards particular alternative and it gets reflected in the final performance benchmarking. The $d_i^+ and\ d_i^-$ calculated by using TOPSIS algorithm is shown in the table 3. The table indicates that the DMU19 is the best performing unit among the lot considered in the analysis followed DMU2, DMU18, DMU1 and DMU9. The five worst of the DMUs ranked by this method are DMU10, DMU17, DMU5, DMU22 and DMU6. Casual look at the ranks indicates there are variation in the ranking generated by the TOPSIS, ARAS and SAW. To verify, if these three ranking generated by the three different methods vary significantly or not, the study uses spearman's rank co-relation technique. The list generated by SAW and ARAS is not statistically significant as Spearman's rank co-relation R_s= 0.0455 with p (2-tailed)=0.0256 similarly lists or ranks generated by SAW and TOPSIS is also not highly co-related as R_s= 0.514 with p (2 tailed)=0.0102. On the other hand ARAS and TOPSIS gives us a list that is highly co-related with R_s=0.94174 with p(2 tailed)=0. Thus, the ranking generated by the ARAS and TOPSIS is almost identical, whereas, a list generated by the SAW differs. Thus, ARAS ranks Tata Metalik, Tata Sponge, Tata Steel, JSW Steel, Kalyani Steel as the five best, whereas TOPSIS ranks Tata Metalik as number one, followed by Tata Steel, Tata Sponge, JSW Steel and Kalyani Steel. Thus to conclude, both the methods give the list of the same firms as five best performing companies. The only difference between the listing/ranking by ARAS and TOPSIS method is that in the ARAS method the Tata Sponge is ranked as the second whereas in TOPSIS its rank is third. On the other hand, Tata Steel which is ranked as second by TOPSIS method is ranked third by ARAS method. The rest of the DMUs are identically listed. Thus, these five are the best performing DMU where investors should focus from medium to long term perspective

Table 4Data of the Steel Manufacturing Companies on Various Parameters (criteria) Used in the Multi criteria Evaluation

	OPMS	NOPS	OPM	GPM	NPM	RCEM	RNW	RLF	C-RATIO	Q-RATIO	INVTR	DTR	INTR	ATR	NDIWC	MCC	D_E RATIO
DMU1	172.36	884.01	19.84	13.78	2.40	13.31	5.65	14.03	0.86	0.61	6.52	18.26	6.52	0.90	-19.16	61.69	1.25
DMU2	112.52	448.48	24.95	19.33	11.55	11.40	8.16	11.61	0.58	0.31	6.04	50.89	6.04	0.52	-70.56	33.67	0.46
DMU3	5.31	113.48	4.09	-1.02	-1.46	0.64	-1.57	-2.22	0.68	0.48	3.11	12.73	3.11	0.65	-38.70	49.61	0.86
DMU4	30.26	322.25	11.95	8.13	1.95	23.65	15.31	24.88	1.85	1.76	6.05	8.12	6.05	2.96	-10.31	70.60	2.58
DMU5	1.02	97.77	1.05	-6.65	-35.15	-2.76	-14.41	-5.34	0.18	0.21	8.35	13.89	8.35	0.52	-368.47	75.89	14.46
DMU6	17.31	210.31	7.01	5.04	-5.14	11.29	-7.60	10.41	0.74	0.56	2.15	5.65	2.15	1.57	88.72	85.02	5.45
DMU7	78.05	894.19	6.80	4.90	3.05	8.12	6.35	12.38	1.13	2.72	4.89	4.12	4.89	1.46	192.94	79.36	0.50
DMU8	10.06	97.33	10.28	7.54	3.34	14.49	8.40	18.02	1.01	1.00	5.11	8.01	5.11	1.80	86.41	57.82	0.49
DMU9	46.77	280.32	16.61	13.24	8.53	21.85	17.68	24.88	1.15	1.08	10.53	3.50	10.53	1.62	59.63	54.92	0.34
DMU10	5.79	97.71	6.30	0.70	-8.72	1.40	-30.44	1.87	0.90	1.59	3.61	8.02	3.61	0.65	118.65	82.04	4.38
DMU11	72.41	521.48	13.45	9.13	1.25	8.98	3.23	10.11	0.92	1.06	5.86	18.89	5.86	0.90	48.19	70.79	1.60
DMU12	62.06	343.95	17.62	13.11	7.82	13.97	8.26	15.97	0.93	1.07	5.12	25.63	5.12	0.85	91.85	63.48	0.33
DMU13	36.21	154.35	23.39	10.47	-2.77	4.09	-0.97	5.17	0.49	0.77	5.59	13.99	5.59	0.34	-31.32	48.04	1.38
DMU14	17.88	195.57	9.29	6.78	-0.30	10.75	-2.24	15.64	1.01	1.13	2.32	3.10	2.32	1.00	137.01	65.60	4.64
DMU15	48.09	309.73	15.55	12.87	10.54	17.01	15.27	22.87	1.20	3.32	5.02	3.91	5.02	1.05	153.48	59.52	0.39
DMU16	15.33	116.50	13.16	4.67	-7.74	5.57	-63.66	6.84	0.48	0.36	3.63	8.26	3.63	0.84	-91.21	46.77	7.47
DMU17	26.29	307.59	9.11	4.61	-2.03	6.49	-155.25	8.04	0.71	0.89	4.44	8.20	4.44	1.04	75.43	69.37	20.71
DMU18	66.40	454.93	13.78	11.79	11.61	15.55	10.08	15.55	3.24	2.90	12.49	28.57	12.49	0.85	183.80	69.75	0.00
DMU19	67.88	505.31	13.09	11.23	6.71	31.87	182.50	45.64	0.72	0.75	12.47	6.79	12.47	2.85	-7.82	67.50	12.13
DMU20	6.68	77.30	8.52	7.07	2.94	13.72	8.15	16.93	1.13	1.36	6.21	4.14	6.21	1.90	89.70	76.89	0.47
DMU21	106.44	554.87	20.00	8.75	-42.15	1.22	42.73	3.47	0.32	0.43	3.72	7.50	3.72	-0.09	-169.34	58.40	9.81
DMU22	16.37	368.31	3.90	-1.68	-11.79	0.35	-90.11	2.41	0.53	0.51	6.55	5.09	6.55	1.27	-202.46	82.02	12.63
DMU23	5.08	36.35	14.07	11.29	6.56	5.71	2.18	5.71	8.68	7.71	9.04	7.32	9.04	0.39	140.32	68.27	0.44
DMU24	9.98	97.77	10.53	7.16	4.22	15.72	10.68	18.50	0.75	0.72	10.71	7.17	10.71	2.21	24.86	70.41	0.21

REFERENCES:

1. Zavadskas, E. K., & Turskis, Z. A new additive ratio assessment (ARAS) method in multicriteria decision-making. *Technological and Economic Development of Economy*, 2010; 16(2): 159–172.
2. Hwang, C. L., & Yoon, K. S. *Multiple attribute decision making: Methods and applications*. Springer-Verlag. New York, 1981.
3. Islamoglu, M., Apan, M., and Oztel, A. An evaluation of financial performance of REIT in Borsa Istanbul: A case study using the Entropy based TOPSIS method, *International Journal of Financial Research*, 2015;6(2):124-138.
4. Farrokh, M., Heydari, H., and Junani, H. Two comparative MCDM Approach for Evaluating the financial performance of Iranian basic metal companies", *Iranian Journal of Management Studies*, 2016; 9(2): 359-382.
5. Moradi, M. and Janatifar, H. Performance evaluation of automobile companies based on multi criteria decision making technique, *Global Journal of Management Studies and Researches*, 2014;1(2):77-84.
6. Raikar, A.V. Cementing the cement stock: Use of MCDM technique of TOPSIS for identifying cement stock for stock investment with Entropy based weight determination, *International Journal of Development Studies*, January-June, 2018; 10(1): 12-19.
7. Kandsar, M.Y.F., and Esmi, S. Presenting a consolidated approach for fuzzy financial assessment accepted by the companies on the stock exchange by using the fuzzy established techniques, *International Journal of Humanities and Cultural Studies*, Special June, 2015;1268-1283.
8. Siew, L. W., Liew, K. F. and Hoe, L.W. Evaluation on the financial performance of the Malaysian banks with TOPSIS Model", *American Journal of Service Science and Management*. 2017;4(2): 11-16.
9. Isserveroglu, G. & Sezer, O. Financial performance of pension companies operating in Turkey with TOPSIS analysis Method, *International Journal of Academic Research in Accounting, Finance and Management Sciences*, January 2015;5(1): 137–147.
10. Sakinc, O.S. Comparison of Turkish state banks' performance via Multi-criteria performance measurement method, *International Journal of Scientific Research and Management*, 2016;4(11): 4857-4871.

11. Gundogdu, A. Measurement of financial performance Using TOPSIS method for Foreign Banks of established in Turkey between 2003-2013 Years, *International Journal of Business and Social Science,* January, 2015; 6(1): 139-151.
12. Basdar, C. & Alper, D. A comparison of TOPSIS and ELECTRE methods: An application on the Factoring Industry", *Business and Economics Research Journal*, 2017;8(3): 627-646.
13. 13 Sharma, A., Kaur, J., and Bansal, J. *A comparative analysis of PROMETHEE, AHP AND TOPSIS aiding in financial analysis of firm performance*, Proceedings of the First International Conference on Information Technology and Knowledge Management, ACSIS, 2017; 14:145–150.
14. Aras, Guler., Tezcan, M., and Ozlem, K. F. Comprehensive evaluation of the financial performance for intermediary institutions based on Multi-criteria decision making method, *Journal of Capital Markets Studies*, 2018; 2(1): 37-49,
15. Inani, S.K & Gupta, R. Evaluating financial performance of Indian IT firms: an application of a multi-criteria decision making technique, *International Journal of Behavioral Accounting and Finance*, 2017, Vol.6, No.2, 126 – 139.
16. 16 Fai, L.K., Siew, L.W., Hoe, L.W. Financial analysis on the company performance in Malaysia with Multi-criteria decision making model, *Systems Science and Applied Mathematics*, 2016; 1(1): 1-7.
17. Yalcin, N., Bayrakdaroglu, A., and Kahraman, C. Application of fuzzy multi-criteria decision making methods for financial performance evaluation of Turkish manufacturing industries, *Expert Systems with Applications*, 2012; 39: 350–364.
18. Cetin, M.K. & Cetin, E.I. Multi-criteria analysis of bank's performances, *International Journal of Economic and Finance Studies*, 2010; 2(2): 73-78.
19. Ucuncu, T., Akyuz, K.C., Akyuz, I., Bayram, B.C. and Ersen, N. Evaluation of financial performance of paper companies traded at BIST with TOPSIS method, *Kastamonu Univ., Journal of Forestry Faculty,* 2018; 18(1): 92-98.
20. Kazan, H., and Ozdemir, O. Financial performance assessment of large scale conglomerates via TOPSIS and CRITIC method, *International Journal of Management and Sustainability,* 2014; 3(4)
21. Önder, Emrah and Hepsen, Ali, Combining Time Series Analysis and Multi Criteria Decision Making Techniques for Forecasting Financial Performance of Banks in Turkey (September 27, 2013). *International Journal of Latest Trends in Finance and Economic Sciences*, 2013; 3(3): 530-555. Available at SSRN: https://ssrn.com/abstract=2332207

22. 22 Esfahanipour, A and Ardakani, H.D. A Hybrid multi criteria approach for performance evaluation: The case of holding company, International Journal of Industrial Engineering & Production Research, 2015; 26(4): 287-309.
23. 23 Hajihassani, V. Using VIKOR method in performance evaluation of cement industry, *Cumhuriyet University Faculty of Science Journal*, 2015; 36(3): 420-430.
24. 24 Raikar, A.V. An analytical study of the cement sector and selected cement companies in India by using Multi criteria decision making (MCDM) technique of Analytic Hierarchy Process (AHP) and VIKOR, *International Journal of Research in Management, Economics and Commerce*, May 2018; 08(05): 1-11.
25. Stanujkic, D., Dordevic, B., Dordevic, M. Comparative analysis of some prominent MCDM methods: A case study of ranking Serbian banks, *Serbian Journal of Management*, 2013: 8(2): 213-241.
26. Dedania, H.V., Shah, V.R., Sanghi, R.C. Portfolio management: Stock ranking by multiple attribute decision making methods, *Technology and Investment*, 2015; 6:141-150.
27. Alenjagh, R.S. "Performance evaluation and ranking of insurance companies in Tehran Stock Exchange by financial ratios using ANP and PROMETHEE", *European Online Journal of Natural and Social Sciences*, 2013;2(3): 3478-3486.
28. Sorayaei, A., Hassanpour, N., Maryam, S., Armaki, K., Zahra A. The assessing of financial performance of accepted banks in stock exchange market by means of ELETERE Technique, *American Journal of Engineering Research* (AJER), 2014; 03(7): 01-06.
29. Alper, D and Basdar, C. Comparison of TOPSIS and ELECTRE method: An application on factoring Industry, Business and Economic Research Journal, 2017;8(3) 627-646.
30. Dincer, H. Profit-based selection approach in banking sector using fuzzy AHP and MOORA method. *Global Business and Economics Research Journal*, 2015; 4(2): 1-26.
31. Raikar, A.V. An assessment of financial performance of selected steel manufactures in India with MCDM Technique of MOORA and TOPSIS with CRITIC Based Weight Determination, *International Journal of Current Advanced Research*, 2019; 08(03): 17836-17843.
32. Bakir, M & Atalik, O. Evaluation of Service Quality in Airlines by Entropy and ARAS Method, *Journal of Business Research Turk*, 2018; 10(1): 617-638.
33. Debpriya, P., Agarwal, P.K. & Chakraborty, S. Performance Appraisal of Indian State Police Force using ARAS Method, *Management Science Letters*, 2016; 6: 361-372.
34. Karabasevic,D., Stanujkic, D & Urosevic, S. The MCDM model for personal selection based on SWARA and ARAS Method, *Management*, 2015; 20(27): 43-77.

35. Karabasevic, D., Zavadskas, E.K., Turskis, Z. & Stanujkic, D. The framework for the selection of personnel based on SWARA and ARAS method under uncertainties, *Informatica*, 2016; 27(1): 49-65.
36. Chatterjee, N.C & Bose, G.K. Selection of vendor for wind farm under Fuzzy MCDM environment, *International Journal of Industrial Engineering Computation*, 2013;4(4): 535-546.
37. Ecer, F. An integrated fuzzy AHP and ARAS model to evaluate mobile banking services, *Technological and Economic Development of Economy*, 2018; 24(2): 670-695
38. Karabasevic, D., Paunkovic, J., & Stanujkic, D. Ranking of companies according to the indicators of corporate social responsibilities based on SWARA and ARAS Method", *Serbian Journal of Management*, 2016;11(1): 43-53
39. Stanujkic, D. & Javanovic, R. Measuring a quality of faculty website using ARAS method, *Contemporary Issues in Business, Management and Education*, Seminar Paper, (online), 2012, DOI: 10.3846/cibme.2012.45
40. Kutut, V., Zavadskas, E.K. and Lazauskas, M. Assessment of priority option for preservation of historic city center buildings using MCDM (ARAS), *Procedia Engineering*, 2013; 57: 657-661
41. Kersuliene, V. and Turskis, Z. An integrated Multi-criteria group decision making process: Selection of chief accountant, Contemporary Issues in Business, Management and Education-2013, *Procedia Social and Behavioral Sciences*, 2013; 110: 897-904.
42. Zavadskas, E.K., Vainiunas, p., Turskis, Z., & Tamosaitiene, J. Multi-criteria decision support system for assessment of project managers in construction, *International Journal of Information Technology and Decision Making*, 2012; 11(2): 501-520.
43. Saparauskas, J., Zavadskas, E.K. and Turskis, Z. Selection of façade's alternatives of commercial and public building based on multiple criteria, *International Journal of Strategic Property Management*, 2011; 15(2): 189-203.
44. Ozbek, A. & Erol, E. Ranking of factoring companies in accordance with ARAS and COPRAS method, *International Journal of Academic Research in Accounting, Finance and Management Studies*, April 2017; 7(2): 105-116.
45. Opricovic S., Tzeng, G. H. Compromise solution by MCDM methods: a comparative analysis of VIKOR and TOPSIS, *European Journal of Operational Research*, 2004; 156(2): 445-455.
46. Olson, D.L. Comparison of weights in TOPSIS model", *Mathematical and Computer Modelling*, 2004; 40(7): 721-727.

47. El-Santanwy, M.F. and Ahmed, A.N. Analysis of project selection by using SDV-MOORA approach, *Life Science Journal*, 2012; 9(2): 129-131.
48. Ghadikoloei, A.S. & Esbouei, S.K. "Integrating FAHP and Fuzzy ARAS for Evaluating Financial Performance", *Bulletin de Sociedade Paranaense de Matematics*, 2014; 32(2): 163-174