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An Assessment of Performance of Steel Companies in India using PROMETHEE method of Multi Criteria Decision Technique

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ABSTRACT

PROMETHEE has emerged as a one of the important multi-criteria based decision technique due to the simplicity in its use as well as a deep analytical aid it provides to the decision maker. The PROMETHEE apart from financial based performance assessment is also used in various multi-criteria decisions making. In this paper the method is used for assessment of 24 steel companies operating in India by considering 15 financial ratio indicators that measure profitability, liquidity, stability, managerial efficiency. The results indicate that Tata Sponge, Kalyani Steel, Jindal Stainless, JSW Steel and Sarda Energy and Minerals are the five best performers among the lot of companies evaluated by using this method.

Keywords: MCDM, PROMETHEE, Steel Companies.

INTRODUCTION:

Steel sector plays an important role in the development process of the country and in most of the developed countries one often finds the existence strong steel sector. Steel sector has strong forward linkages with transport, construction, manufacturing, shipbuilding, railways, etc. One cannot think of the development of any sector without the adequate availability of steel. Realising this in the planned development process, the steel sector was accorded a high priority by the planners. Huge investments were made in the public sector by setting up steel plants in different parts of the country that were latter on consolidated under common management by creating a holding company called SAIL or Steel Authority of India Limited. The SAIL, today, is the third largest producer of steel in the country.

The steel industry has a long history in India and steel making was known to the Indian's from very early times. In fact, the famous Iron Pillar built around 300 AD stands as a testimony of the standard of perfection achieved by our precursor. Its non-rusting character displays the mastery that the craftsman of that time had achieved. However, modern steel industry emerged in India in 18th and 19th century when British civil servant after leaving his service with East India Company set up a steel plant consisting of furnaces, forges and rolling mill at Porto Novo on Madras Cost in 1833. The venture eventually failed due to shortages of fuel, inexperience labour, scarcity of funds, lack of equipments, etc. Another effort was made almost after 40 years, by setting up a modern factory at Kutli in Culcutta in year 1875. This enterprise saw many up and down and ultimately passed in the hands of the Bengal Iron and Steel Company. The steel industry was set on the firm footing when Jamshetji Nusserwanji Tata set up Tata Iron & Steel Company popularly known as TISCO in 1930. The success of TISCO gave boost the iron and steel industry in India as many small big steel manufacturing plants emerged in different parts of the country. For instance, Indian Iron & Steel Company (IISCO) was set up at Hirapur in 1918 acquired Bengal Iron & Steel Company in 1936. The Mysore Iron Steel Work that was set up to produce pig iron by the Government of Mysore added small steel plant in 1936. Apart from the above, a number of small steel plants with electric furnaces', foundries and rolling mills emerged in the different parts of the

country in 1930s and 1940s. Along with it various enterprises supplying inputs needed in the steel manufacturing and the industries that used steel as a raw material to manufacture customised steel product also emerged. Steel production in India increased from merely 1.0 million tonnes finished steel in 1950-51 to 9.6 million tonnes in 1990-91 but, thereafter in post liberalisation period production of steel increased significantly to 30.3 million tonnes by 2000-01. However, post 2001 there was a significant growth in steel production in India which touched all time high of 106.5 MT in 2018 and with that India became a second largest producer of steel in the world, surpassing Japan. However, China which is the largest producer of the steel that produces close to about 50 percent of the total steel produced in the world.

However, in recent years steel industry is in doldrums due to overcapacity built up in steel production and subdued national and international demand. The growth in demand has not kept a pace with capacity expansion and as a result many steel companies that went in for expansion through huge borrowings found it difficult to service their debt due to lower prices realisation and underutilisation of the capacity. Those who were strong had to wait for the steel cycle to turn upward and continued to sustain with lower margin. In these market upheavals, many of the key steel producers like Bushan Steel, ESSAR steel, etc are facing bankruptcy proceeding in NCLT. Thus, analysis of companies on various parameters of performance evaluation assumes significance from the point of view of understanding growth dynamics of steel companies and sorting them among best and worst categories from investor point of view. In this paper, we use standard ratios of performance evaluation that measures Managerial efficiency, liquidity, stability, profitability of the enterprise. These multiple ratios results in multiple situation and identification of best of the Decision Making Unit (DMU) or Company become difficult. To overcome the situation in literature number of methods that converts multi-criteria problems into a uni - criteria problem for decision making are widely used.

REVIEW OF LITERATURE:

The MCDM technique of PROMETHEE is widely used by the researcher for solving, sorting and ranking of alternatives or actions. In this section we take a brief review of the studies done by the researchers using this technique. For instance, Zopounidis, C., Shiniotakis, N. & Baourakis, G (2006) uses Promethee for evaluating performance of co-operative union in Crete by using 11 financial ratios, namely, Gross Profit to Sales, Net Profit before Tax to Sales, Net Profit before taxes to Total Assets, Net Profit before taxes to Equity Capital, Sales to equity capital, sales to fixed assets, Sales to short term obligations, Current assets to Short-term obligations, Total obligations to Total assets, Sales to Current assets minus short term obligations. The study identifies that the Central Union of Chania as the best among the 12 co-operative unions examined by the study. The study concludes that despite of ineffective exploitation of assets the efficiency of the agricultural union has improved in relation to the previous 3 years. The higher loan burden, low liquidity, ineffective operations are some of the problems grappling these institutions. Gavurova, B. et.al (2017) evaluates the performance of Czech and Slovak banks by using PROMETHEE. The study uses CAMEL ratios that measure Capital Adequacy, Asset Quality, Management efficiency, Earning ability and Liquidity as a criteria on which 22 banks operating in the region are evaluated. Alenjagh, R.S. (2013) uses PROMETHEE in combination with the Analytic Network Process (ANP) to assess the performance of insurance firms listed on the Tehran Stock Exchange by using 17 financial ratios as criteria, selected by using expert opinion method and five insurance firms as an alternative. The relative priority of the criteria is determined by the ANP method and the PROMETHEE is used for performance evaluation and ranking of the alternative. The study finds that the Persian Insurance Company is the best among the lot assessed by the study. Gokalp, F. (2015) uses PROMETHEE to compare performance of different banking groups operating in Turkey for the period 2006 to 2012. The timeline is divided into two distinct periods: 2006-2008 a pre crisis period and 2009-12 post crisis period. The study uses 17 financial ratios that broadly cover CAMEL framework as criteria and banking groups as an alternative. The study finds that the State owned banks were the best alternative in 2006-08 period, but the post crisis period 2009-12 State owned banks went down and foreign banks emerged as a better performing group. Uzar, C. (2013) evaluates financial performance of three public banks in Turkey by using data for the period 2002to 2012, bifurcating it into two time lines 2002 to 2007 (pre Global crisis) and 2008 to 2012 (post global crisis period). The study uses 10 financial ratios as criteria and assumes the Gaussian preference function for all the criteria on the basis of which the performance of the public banks is assessed. The study uses a different set of weights in two different time periods to reflect the turbulence caused by the global crisis. The study finds that bank C is the best performer among the lot for both the period. The study, therefore, concludes that since the ranking order generated by PROMETHEE method has not been affected in two time period and hence the global financial crisis has not affected the Turkish public banks significantly this may be due to strong liquidity position and capital adequacy. Kalogeras, N. et. al. (2005) used PROMETHEE

method to analyse the performance of 8 agro-food firms in Greece by using eleven ratios that broadly measured profitability, Solvency, and Managerial Performance. The study used the Gaussian Preference function to evaluate criteria whose weight are determined by prioritization of ratio or criterion. The study finds that the MC of Koutsouras is the best firm throughout the years and for all the scenarios. Akkaya & Uzar (2013) uses PROMETHEE for evaluation of tourism companies operating in Turkey and listed on the Bursa, Istanbul by using ratios that measure profitability and efficiency. The study uses following ratios as a criteria: Profit/Sales, Net Profit/Equity, Net Profit/Assets, Sales, Current Ratio, Acid Test Ratio, Total debt/ Assets and Stock turnover. The weights of the criteria are determined depending upon the importance of criteria and the Gaussian preference function is used to evaluate the performance of 8 tourism companies on 8 criteria. The study finds that the Tekart is the best among the lot followed by Maalt and Nettur.

Apart from financial analysis and sorting of DMUs on financial performance the PROMETHEE has been put to other innovative uses as well. For instance, Butowski, L. (2018) uses PROMETHEE in combination with AHP to evaluate best destination on European coast for the development of sailing tourism. He uses six criteria and covers all the cost of the Europe. The weights of the criteria are determined by AHP and PROMETHEE for ranking of destinations. The study finds that Central Mediterranean to be the most suitable destination for the development of sailing tourism followed by West Mediterranean and Baltic Sea. Similarly, Lopes, A.P.F., Munoz, M.M., Alercon-Urbitondo, P (2018) uses PROMETHEE for evaluating the competitiveness of eight tourist destinations located in the Northern Region of Portugal. The study uses 5 tourism dimensions and six environment dimension to assess tourism destination competitiveness. In the study weights of the criteria are determined by the expert and each criteria is evaluated by assuming the linear preference function with indifference (q) at 20 percent and preference (p) at 80 percent. The study finds that the Porto Metropolitan Area is ranked first and holds clear edge on tourism criteria i.e., on basic offer, a number of museums, a number of arts facilities, whereas it shows weakness on criteria of environmental expenditure, the proportion of the municipalities included in the UNESCO list of heritage sites and crime rate. Ranjan, R. & Chakraborty, S. (2015) uses this method to rank to evaluate performance of 20 National Institute of Technology (NITs) in India on the basis of nine criteria. The criteria used are: Faculty strength, Teacher-student ratio, Number of conferences held in last five years, Number of papers published in last five years, Research Grants, Campus area, Placement of UG and PG students, Number of Books and online journals available in library and course fee. Except the last one all are the benefit criteria, which needs to be maximised and the last one is to be minimised. The weight of criteria is determined by the Shannon Entropy method. The usual preference function is assumed for all criteria for evaluation of alternatives. The study finds that the NIT-Tiruchirapalli and NIT-Warangal are two best performing NITs and the NIT-Patna is the worst performers among the lot of 20 NITs evaluated by the study. Murat, S. et. al., (2015) uses PROMETHEE to assess the performance of five secondary and two high schools from town of Keles in Turkey. The study uses four criteria, namely, achievements, non-attendance, social activities and project criteria. Assuming equal weight of the criteria and linear preference function in case of the first three criteria and V-shaped preference function for the last criterion, the study finds that the secondary schools performed better than the high schools and schools from towns show better performance than the village schools. Ertugrul & Oztas (2016) used PROMETHEE and MACBETH for analysing the performance of the online bookstores. The study uses an AHP method for determination of the weight of the criteria and PROMETHEE for ranking or sorting of alternatives. The criteria used to evaluate online bookstores are: price, security, lead time, product range and customer care. The study finds that both the method generates same ranking of alternatives. Ginevicius, R et.al (2010) evaluates and ranks Luthuanian banks based on their reliability to the customers on the basis of 15 criteria that includes, among the others the quality and costs of services provided including time customer has to spend in waiting for his turn. The study compares the results obtained by other MCDM methods like sum of ranks (SR), SAW, TOPSIS, COPRAS and argued that rank given by a different method differs. Venkatesan, P.S and Kumanan, S (2012) uses hybrid AHP and PROMETHEE to prioritize supply chain risk. Such a risk prioritization, according to the study is essential in order to build an appropriate supply chain that will add financial value to the firm and also enhance customer support services. Sakthivel, G et al. (2013) uses PROMETHEE in combination with Fuzzy AHP to evaluate the best car model for a purchase decision. Peterkova, J & Franek, J (2018) uses PROMETHEE method to prioritize the ten defined innovation ideas. Each of the idea is ultimately evaluated on the basis of five broad criteria whose weight or relative priority is determined by using the AHP method. The study finds that the idea I_4 is the best, followed by the I_2 and I_6.

Ozturk, A. et al (2013) uses PROMETHEE technique for selection of candidates for front desk personnel who had applied for a hotel job in Kutahya, Turkey. The 15 criteria are used for evaluation of candidate that among the others includes knowledge of foreign language, educational background, communication skills and paying

attention to personnel appearances. These four are considered as important criteria and its preference function is assumed to be linear whereas for rest all other criteria v-shaped preference function is assumed. In all 7 candidates are evaluated on 15 criteria by using PROMETHEE method. The result indicates that the candidate 7 is the best followed by the Candidate 6 and Candidate 5, whereas, the Candidate 3 is the worst among the lot. Firouzabadi, A.K. and Ghazimatin, E (2013) uses interval PROMETHEE to determine the best renewable energy alternative for Sistan and Baluchestan in Iran. To identify the best renewable energy resource for the region the study analyses 14 alternatives before it on the basis of seven criteria which includes, Capital cost of engineering, Annual operation and maintenance costs, Efficiency, Capacity factor, Lifetime, Internal consumption, Resource Potential. The finds that for the region under consideration fuel cells are best alternatives followed by Landfill gas and Sewage (biosolid).

DATA & METHODOLOGY:

Let the multi-criteria problem be expressed as: $\max\{f_1(a), f_2(a), \dots\dots\dots f_j(a) \dots\dots\dots f_k(a) | \ a \in A\}$ --------- (1)
Here, A is finite set of possible alternatives and $\{f_1(.), f_2(.), \dots\dots\dots f_j(.) \dots\dots\dots f_k(.)\}$ is the set evaluation criteria which may be benefit or cost criteria. Benefit criteria are to be maximised and cost criteria need to be minimised. The decision makers have to identify the best possible alternative that optimises all the criteria. This above expressed problem takes the shape of following data matrix.

$$\boldsymbol{A} = \begin{vmatrix} f_1(a_1) & f_2(a_1) & \cdots & f_j(a_1) & \cdots & f_k(a_1) \\ f_1(a_2) & f_2(a_2) & \cdots & f_j(a_2) & \cdots & f_k(a_2) \\ \vdots & \vdots & \ddots & \vdots & \cdots & \vdots \\ f_1(a_i) & f_2(a_i) & \cdots & f_j(a_i) & \cdots & f_k(a_i) \\ \vdots & \vdots & \vdots & \vdots & & \\ f_1(a_n) & f_2(a_n) & \cdots & f_j(a_n) & \cdots & f_k(a_n) \end{vmatrix} \text{ ---------- (1)}$$

The PROMETHEE is based on the outranking relation concept developed by Roy (1968). The action (alternative) 'a' over action (alternative) 'b' for a criteria j is expressed as $P_j(a,b)$which is a function $d_j(a,b) = f_j(a) - f_j(b)$. The value of $P_j(a,b)$ lies between $(0\ ,1)$.
If: $P_j(a,b) \approx 0 \leftrightarrow$ then weak preference of alternative (action) a over alternative (action) b.
$P_j(a,b) \approx 1 \leftrightarrow$ then strong preference of alternative (action) a over alternative (action) b.
If the weights of the criteria $(w_j)$are known or decided by the decision maker then by using weights and the positive and negative pairwise comparison flows can be aggregated as defined in the following equation :
$\emptyset^+(a) = \frac{1}{n-1}\sum_{x\in A}\sum_{j=1}^{k} w_j P_j(a,x)$
where w_j is weight of the criteria of j.
$P_j(a,x\ )$ is the preference of a over x on criteria j.
k is number of criteria and n the number of alternative.
The score represents the global strength of alternative 'a' in comparison with other alternatives in the decision matrix. This score needs to be maximised. Similarly, negative flow is measured as:
$\emptyset^- = \frac{1}{n-1}\sum_{x\in A}\sum_{j=1}^{k} w_j P_j(x,a)$
Where w_j is weight of the criteria of j.
$P_j(\ x,a\ )$ is the preference of x over a on criteria j.
k is number of criteria and n the number of alternative.
This indicates the global weakness of alternative 'a' as compared to other alternatives. This score needs to be minimised. The PROMETHEE I which is a partial ranking method uses this positive and negative flows to define Preference (P), Indifference (I) and Incomparability (R) as follows:
$aP^I b \ \ iff \ \emptyset^+(a) > \emptyset^-(b) \ and \ \emptyset^-(a) < \emptyset^+(a)$
$or \ \ \emptyset^+(a) = \emptyset^+(b) and \ \emptyset^-(a) < \emptyset^-(b)$
$or \ \emptyset^+(a) > \emptyset^+(b) \ and \ \emptyset^-(a) = \emptyset^-(b)$
$aI^I b \ \ iff \ \emptyset^+(a) = \emptyset^+(b) \ and \ \emptyset^-(a) = \emptyset^-(b)$
$aRb \ \ iff \ \emptyset^+(a) > \emptyset^+(b) \ and \ \emptyset^-(a) > \emptyset^-(b)$
$or \ \emptyset^+(a) < \emptyset^+(b) \ and \ \emptyset^-(a) < \emptyset^-(b)$
PROMETHEE I is a partial ranking method that fails to generate complete ranking of alternatives. However,

PROMETHEE II generates complete ranking by measuring outranking flow from positive$(\emptyset^+)$ and negative $(\emptyset^-)$ ranking flows as:

$\emptyset(a) = \emptyset^+(a) - \emptyset^-(a)$

The higher the net flow better is the alternative and vice versa. Thus, in PROMETHEE II all alternatives are comparable as no incomparability remains. Here in:

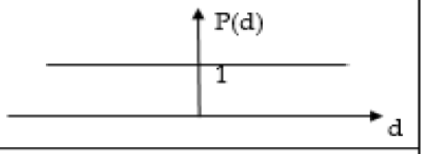
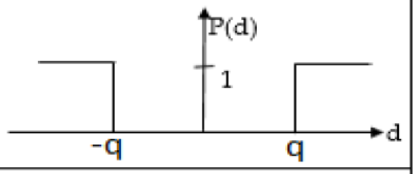
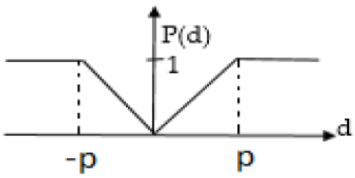
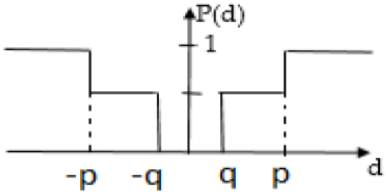
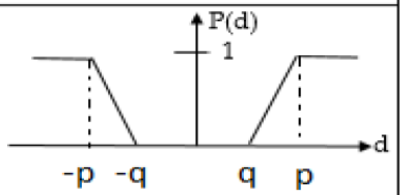
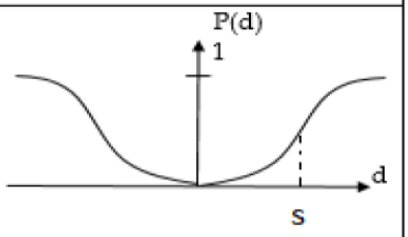
$aP^{II}b \;\; iff \; \emptyset(a) > \emptyset(b)$

$aI^{II}b \;\; iff \; \emptyset(a) = \emptyset(b)$

However, the information obtained by PROMETHEE II is more disputable because more information gets lost when only the difference between two flows is considered.

The preference function of PROMETHEE is based on the pairwise comparison and hence, the deviation between the alternatives on particular criteria has to be considered by assuming a specific preference function. This implies that the decision maker has to define a specific preference function while evaluating alternatives pair-wise on particular criteria. The results obtained are largely determined by the preference function of criteria that is assumed. (Podvezko, V. & Podviezko, A. 2010) In PROMETHEE literature six types of preference functions are proposed as shown in the table below.

Figure 1: Various Types of Preference Functions Assumed in PROMETHEE

Function Type	Preference Function
Type 1: Usual Criterion $P(d)=\begin{cases}0 & d=0\\1 & \lvert d\rvert=1\end{cases}$	
Type 2: U-shape Criterion $P(d)=\begin{cases}0 & \lvert d\rvert \le q\\1 & \lvert d\rvert > q\end{cases}$	
Type 3: V-shape Criterion $P(d)=\begin{cases}\frac{\lvert d\rvert}{p} & \lvert d\rvert \le p\\1 & \lvert d\rvert > p\end{cases}$	
Type 4: Level Criterion $P(d)=\begin{cases}0 & \lvert d\le q\rvert\\\frac{1}{2} & q<\lvert d\rvert\le p\\1 & \lvert d\rvert > p\end{cases}$	
Type 5: Linear preference and indifference area $P(d)=\begin{cases}0 & \lvert d\rvert \le q\\\frac{\lvert d\rvert-q}{p-q} & q<\lvert d\rvert\le p\\1 & \lvert d\rvert > p\end{cases}$	
Type 6: Gaussian Criterion $P(d)= 1- e^{(-d^2/2\sigma^2)}$	

Source: Brans et al., 1986: 231

In each case 0, 1 and other parameters needed to be defined. Here q is a threshold or indifference, p threshold or strict preference and s is an intermediate value between q and p.

In this paper, an assessment of the performance of selected steel companies listed on the National Stock Exchange (NSE) is done by using 15 financial ratios as criteria on which 24 alternatives or steel companies are evaluated. The required data are compiled from the balance-sheet and profit and loss account information available on business website moneycontrol.com. The detail information on the criteria and alternative used in the analysis is specified in the table 2 & 3 below. The data matrix used in PROMETHEE analysis is shown in the table 4. While evaluating alternatives on criteria usual criterion is assumed as a preference function with equal weights to all the criteria. The equal weights are assumed because PROMETHEE fails to provide guidelines for determining the weights of the criteria (Macharis et. al. 2004).This happens to be the main drawback of this method. However, many researchers use other methods for determination of weights and use them in conjunction with PROMETHEE.

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

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

Sr. No	Criteria/Ratio	Abbreviation	Type of Criterion
1.	Net Operating Profit per share	NOPS	+
2.	Operating Profit Margin (%)	OPM	+
3.	Gross Profit Margin (%)	GPM	+
4.	Net Profit Margin (%)	NPM	+
5.	Return on Capital Employed (%)	RCEM	+
6.	Return on Net Worth (%)	RNW	+
7.	Return on Long term Fund (%)	RLF	+
8.	Current Ratio	C-Ratio	+
9.	Quick Ratio	Q-Ratio	+
10.	Inventory Turnover Ratio	INVTR	+
11.	Debtor Turnover Ratio	DTR	+
12.	Total Asset Turnover Ratio	ATR	+
13.	Number of Days in Working Capital	NDIWC	-
14.	Material Cost Composition	MCC	-
15	Debt Equity Ratio	D-E Ratio	-
+ indicates Benefit and - Cost Criteria			

DATA ANALYSIS:

When PROMETHEE method is applied on the decision matrix given in the table 4 it yield the following outranking flow as shown in the table 5. The result indicates that (table 5) DMU18, DMU9, DMU4, DMU1 and DMU12 are the five best alternatives with a net positive flow or outranking of 0.2928, 0.2754, 0.2435, 0.2145 and 0.1884 respectively. On the other hand five worst performers are DMU 22, DMU3, DMU6, DMU10, and DMU5 with the net outranking flow of minus 0.2029, 0.2087, 0.2870, 0.3101 and 0.3188 respectively. The similar observation can be drawn from visual PROMETHEE diamond shown in figure 1. Further graphical analysis indicates, as shown in figure 2, that the DMU18 performs better on criteria such as INVTR, D-E Ratio, C-ratio, DTR, Q-Ratio, NOPS, OPM, RLF, GPM, NPM, RCEM and RNW; whereas negative performance is displayed by MCC, ATR and NDIWC. Hence, to further improve its performance this DMU has to focus on these criteria. Similarly, DMU9 which is ranked second by the PROMETHEE shows the positive influence on the performance of the criteria RLF, INVTR, DE Ratio, C-Ratio, MCC, OPM, ATR, Q-Ratio, GPM, NPM, RCEM, RNW, NOIWC whereas NOPS and DTR has negative impact its performance. As far as third best DMU is concerned, which is the DMU4, the positive impact is seen of the following criteria – ATR, RLF, C-Ratio, NDIWC, NOPS, INVTR, DTR, GPM, NPM, RCEM, RNW. On the other hand negative impact is exerted by OPM, DE Ratio and MCC. The DMU1, which stand forth on the list of best performing DMUs shows a positive performance on NOPS, OPM, DTR, NDIWC, INVSTR, MCC, RLF, D-E Ratio, GPM, NPM, RCEM, RNW whereas it performs poorly on C-Ratio, ATR, and Q-Ratio. The fifth DMU on the list of best performers is DMU12, its performance is positive on DTR, D-E Ratio, OPM, RLF, NOPS, C-Ratio, Q-Ratio, MCC, GPM, NPM, RCEM, RNW whereas criteria INVTR,

Table 4: Data of the Steel Manufacturing Companies on Various criteria Used in the PROMETHEE Analysis

	NOPS	OPM	GPM	NPM	RCEM	RNW	RLF	C-RATIO	Q-RATIO	INVTR	DTR	ATR	NDIWC	MCC	D_E RATIO
DMU1	884.01	19.84	13.78	2.40	13.31	5.65	14.03	0.86	0.61	6.52	18.26	0.90	-19.16	61.69	1.25
DMU2	448.48	24.95	19.33	11.55	11.40	8.16	11.61	0.58	0.31	6.04	50.89	0.52	-70.56	33.67	0.46

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

ATR and NDIWC impacts it negatively. Thus, PROMETHEE with its visual presentation can also provide a decision maker an idea about the criteria on which the DMU is performing well and on which it performs badly. This can aid him in decision making. For instance, DMU18 which ranked the best is showing negative or poor performance on three indicators, namely, MCC, ATR, and NDIWC. So this DMU should focus on improving these ratios. The graphical presentation in PROMETHEE gives a hierarchical presentation of criteria and this can used efficiently in the analysis to understand how different criteria's impact their performances and hence, corrective action need to be directed towards improving these ratios.

Table 5: PROMETHEE Flow Table

Action	Phi	Phi+	Phi-	Rank
DMU 18	0.2928	0.5101	0.2174	1
DMU9	0.2754	0.5014	0.2261	2
DMU4	0.2435	0.4899	0.2464	3
DMU1	0.2145	0.4783	0.2638	4
DMU12	0.1884	0.458	0.2696	5
DMU2	0.1652	0.4551	0.2899	6
DMU15	0.1565	0.4435	0.287	7
DMU19	0.1391	0.4348	0.2957	8
DMU 24	0.0957	0.3797	0.2841	9
DMU11	0.0783	0.4029	0.3246	10
DMU8	0.0667	0.3971	0.3304	11

Action	Phi	Phi+	Phi-	Rank
DMU 23	0.0232	0.3768	0.3536	12
DMU 20	-0.0058	0.3594	0.3652	13
DMU13	-0.0058	0.3623	0.3681	13
DMU7	-0.0377	0.3449	0.3826	15
DMU21	-0.1159	0.3072	0.4232	16
DMU 16	-0.1362	0.2957	0.4319	17
DMU 14	-0.1478	0.2899	0.4377	18
DMU17	-0.1623	0.2841	0.4464	19
DMU 22	-0.2029	0.2638	0.4667	20
DMU3	-0.2087	0.2638	0.4725	21
DMU6	-0.287	0.2203	0.5072	22
DMU10	-0.3101	0.2087	0.5188	23
DMU5	-0.3188	0.2029	0.5217	24

Fig.1: PROMETHEE Diamond

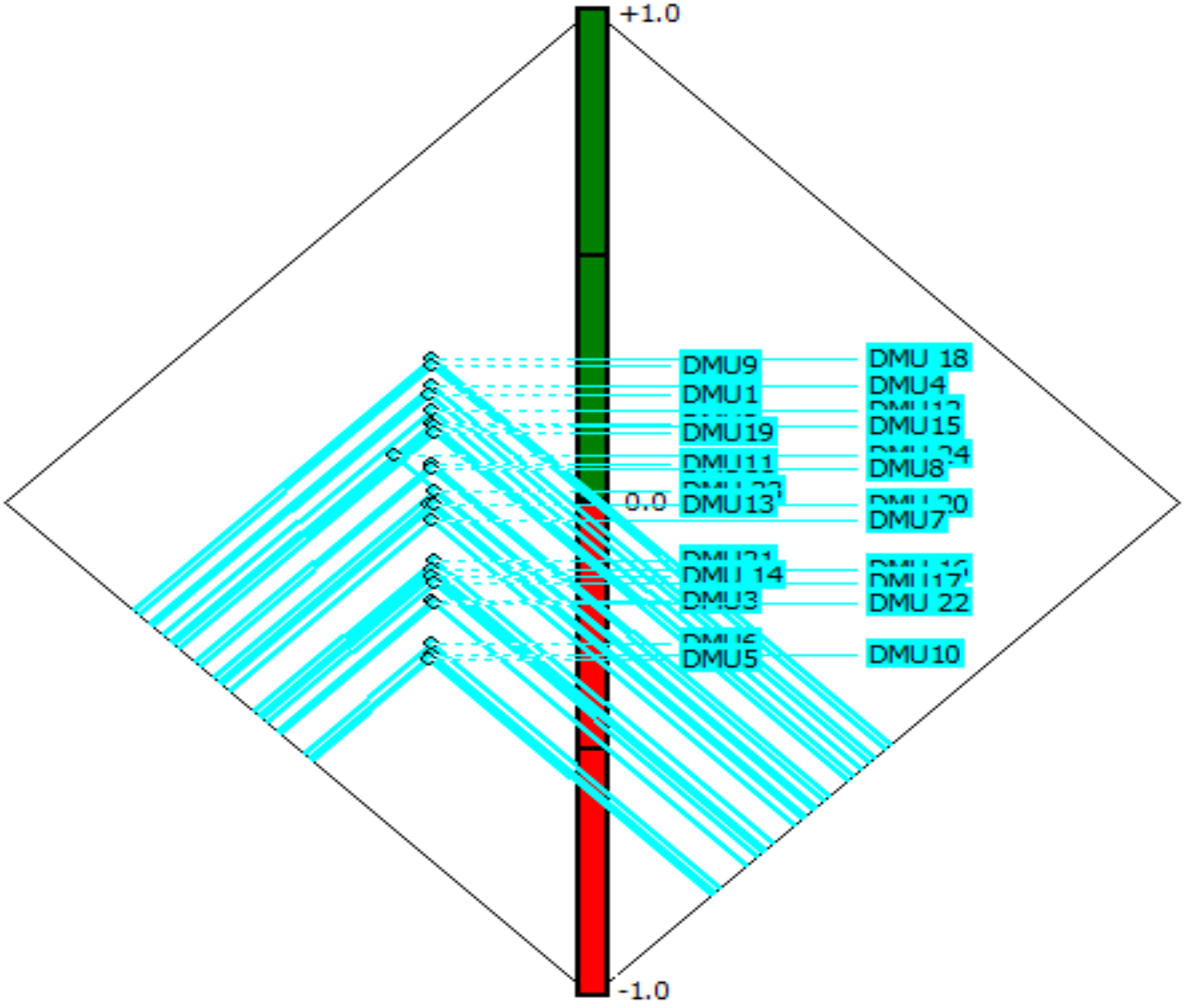
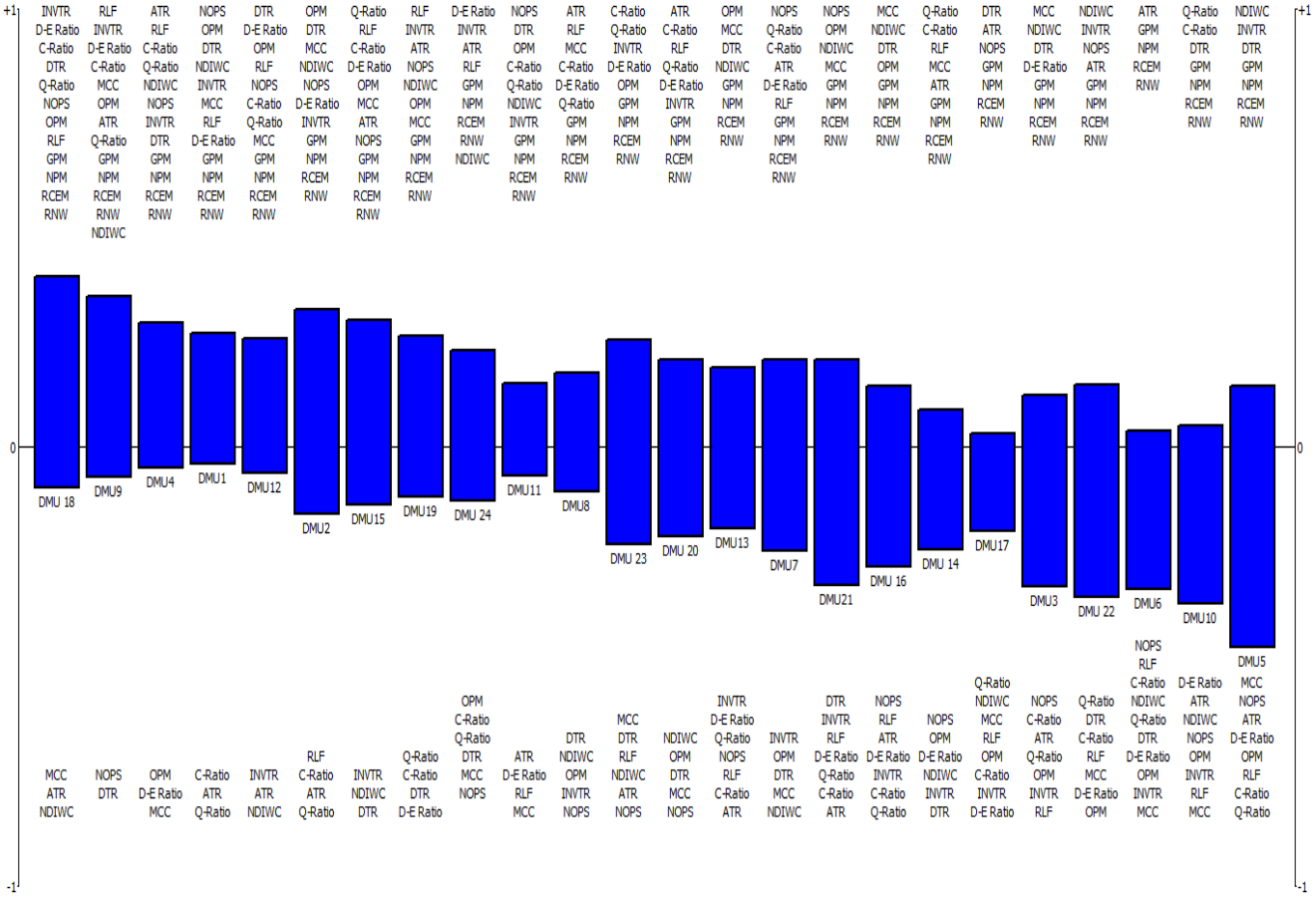


Fig. 2: Visual Presentation of Criteria Performance of DMUs



CONCLUSION:

To conclude, the PROMETHEE generates a rank based list of DMUs that helps us to identify the best and worst performers. It also helps us to identify the DMUs operating with net positive outflow and net negative outflow. This can help use to classify DMUs in two groups positive performers and negative performers. Such an analysis can help long term investor in deciding his investment options. Further Visual PROMETHEE help us to generate a visual criteria based performance of DMU which can aid the decision maker (one within the firm) to take corrective action on the criteria which exhibit its weakness. The study finds that the Tata Sponge is the best among the lot followed by kalyani Steel, Jindal Stainless, JSW Steel and Sarda Energy & Minerals.

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