I J A B E R, Vol. 14, No. 6, (2016): 4463-4473

FINANCIAL PERFORMANCE RANKING OF OIL AND GAS COMPANIES IN INDIA USING TOPSIS METHOD

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Abstract: *This paper analyzes the financial performances of oil and gas companiesusing Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method. Financial ratios of the oil and gas companies were calculated for each and every company separately. The computed ratio was transformed to show the performance rankings of oil and gas companies by using entropy and TOPSIS method. Ranking of the companies was done by arranging according to their performance. The time period for assessment of oil and gas companies was from 2011 to 2015 and results show each year's company performance ranking. The result showed that Hindustan Ltd. has the highest ranking in the year 2011, BPCL for the year 2012, Gail Ltd. for the year 2013, and in the last two yearsPetronet had the highest ranking. Every year different companies had the lowest ranking.*

Keywords: *Performance Measurement, Financial Ratios, TOPSIS Method, Oil and Gas companies, India.*

JEL Classification: M10, M21, M49.

1. INTRODUCTION

The oil and gas sector comes under top six industries and is the backbone of the society and economy in Indian context. It is the source of power for other parts of the economy. This sector has over 15% contribution to the Indian GDP. As the economies are growing the demand for oil and gas in increasing. Government of India has come up with various plans and policies in order to supply the oil and gas to the needed sections of the economy.

One of the policies named as New Exploration Licensing Policy (NELP) was designed to minimize the gap between supply and demand during 1997-98.

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According to recent report, Indian oil and gas industry had worth of USD 139.8 bn by 2015 (IBEF). As India's economic growthis directly dependent on the oil and gas; soits demand isbound to increase in time to come.

The Government of India (GOI) has designed and implemented various initiatives to meet the rising energy demand by different sectors. One of the initiatives is 100% FDI in various segments, for example petroleum products/ services, refineries, natural gas, etc. Recentpolicies draw attention in domestic as well as foreign investment, as evident by the existence of Cairn India and Reliance Industries Ltd (RIL) (http://www.ibef.org/industry/oil-gas-india.aspx)

Cormier and Magnan (2002) presented that performance reporting by managers of oil and gas firms basically relies on three key measures: first, earnings (financial measure); second, cash flow from operations (financial measure) and last, oil and gas discoveries, extensions and acquisitions (non-financial measure). The performance analysis using the TOPSIS technique of the Indian oil and gas sector is still not researched well.

So this paper is an attempt to analyze the performance of Indian oil and gas sector and come up with recommendations for improving the sector performance. Performance of the oil and gas companies which is based on the Bombay stock exchange were analyzed by Technique for Order preference by similarity to ideal solution (TOPSIS).

The rest part of this paper has been organized in various sections.First section is literature review of the TOPSIS and oil and gas sector research with respect to performance analysis. In second section, information was given about entropy weight method. TOPSIS method is described in third section. Last section deal with data analysis, results, recommendations and gives scope for future research.

2. LITERATURE REVIEW

Generally, decision makers always encounter problems with many criteria. For example, if a person wants to make a holiday plan then which alternative has is the best option on the basis of different criteria, like entertainment, accommodation, traveling cost etc. Now days, decision makers want to take immediate decisions so in this regard multi criteria decision making method is helpful to take decision. One of the most important methods to take decision under multi-criteria decision making is TOPSIS.

Many authors have done research on financial performance of the differentcompanies because it is easy to take at certain point. Barnes (1987) defined financial ratio can be used for all kind of purposes and can help in business firm performance.

Bulguru (2013) studied the financial performance of ten automotive firms which is based on Istanbul Stock Exchange Market (ISEM) between 2009-2013. The ten financial ratios used the entropy method to determine the objective weight of each criteria and applied TOPSIS method for evaluation of financial performance of the automotive firms. The results showed that F-M Izmit Piston firm financial performance ranking was consistent for all four years.

Arab, Mosoumi and Barati (2015) in their study, examined the financial performance of steel industry in India which is based on the stock exchange market in India. They chose five steel companies and used the ANOVA method on sixteen financial ratios. The results show that all null hypotheses were rejected and showed significant difference in the financial performance of units in the steel industry.

Gündoðdu (2015) studied financial performance of foreign banks in turkey between 2003 to 2013. Ten banks and sixteen criteria were used for evaluation by the TOPSIS method. Results showed that Deutsche bank had the highest performance rank while Burgan bank and Turkland bank had the lowest financial performance rank from 2003 to 2013.

Wang (2008) studied and evaluated financial performance ranking of domestic airlines in Taiwan with fuzzy TOPSIS method.

Ertugrul and Karakasoglu (2009) found that Technique for Order preference by similarity to ideal solution (TOPSIS) and Fuzzy Analytical hierarchy process (FAHP) methods can be used to evaluate the performance of cement firms and also proposed methods that can be applied for evaluating the firms in other sectors.

Ozden (2009) used multiple criteria decision-making method, such as ELECTRE, PROMETHEE, VIKOR and TOPSIS, in the financial performance ranking of banks in financial analysis, and found that this method was very useful for classification of banks according to their financial statements.

Sun andLin (2009) investigated the competitive advantages of shopping websites by using TOPSIS method. Ergul (2010) based on the Istanbul energy firms data concluded that TOPSIS is one of the best technique to analyze the financial health of the company. Also Feng and Wang (2000) were of the same opinion and found out the similar results for TOPSIS technique for Taiwanese airline industry.

Deng *et al.* (2000) haveinvestigated performance score for seven textile companies.They evaluated each company's financial ratio by four financial ratios of efficiency, profitableness, debtand market position. They used entropy method to get value of objective weight and TOPSIS method to provide ranking of alternatives.

Financial ratios also provide a direction for predicting future performance of companies. TOPSIS method is widely used in literature and has covered many

areas like banking, cement industry, supplier selection, textile companies, tourism, food sector, pension, airlines etc.

3. DATACOLLECTION AND RESEARCH METHODOLOGY

3.1 Data Collection

Our goal is to identify the rank among the alternatives. The initial step was to collect financial ratios of oil and gas companies under the Bombay stock exchange from 2011 to 2015. Some of the companies had significant missing financial ratio values so we dropped three companies. In this situation, we have taken six companies for 2011, 2012 and 2013, and seven companies for 2014 and 2015. Financial ratios are given in table 1 for this study.

Table 1
List of Financial Ratios Used

Financial Ratio	*Formula*
Net Profit Margin (L1)	Net Revenue/Net Sales
Return on Capital Employed (L2)	Net Income/Total Capital Employed
Return on Assets Including Revaluations (L3)	Net Profit/Total Assets
Current Ratio (L4)	Current Assets/Current Liabilities
Quick Ratio (L5)	(Current Assets-Inventories)/Current Liabilities
Debt Equity Ratio (L6)	Total Debt/Shareholder's Equity
Total Debt to Owners Fund (L7)	Debt/(Shareholder's equity + Debt)
Fixed Assets Turnover Ratio (L8)	Net Sales/Fixed Assets
Dividend Payout Ratio (L9)	Dividend per Equity Share/Earning per Share
Total Assets Turnover Ratio (L10)	Net Sales/Total Assets

Source: Compiled by authors

3.2 Research Methodology

3.2.1 Entropy weight method

The term entropy was proposed by Shannon (1948) which is based on estimate the data quantity and calculates objective weight of the information. The main use of informational entropy is to measure message uncertainty. Ifthe entropy value is high, then uncertainty will be greater. It is also called entropy weight method. It is an average amount of information (Ding and Shi, 2005). Liu *et al.* (2010) used the entropy method to determine the weight of criteria's in water quality assessment. Zou *et al.* (2006) in their studyused entropy method to calculate the weight of evaluating criteria's or attributes in water quality assessment of the three reservoir areas. This study used the entropy weight method to calculate the weights of each criterion.The decision matrix can be defined as follows:

$$\begin{pmatrix} x_{11} & x_{12} & \ldots\ldots & x_{1n} \\ x_{12} & x_{22} & \ldots\ldots & x_{2n} \\ \ldots\ldots & \ldots\ldots & \ldots\ldots & \ldots\ldots \\ x_{m1} & x_{m2} & \ldots\ldots & x_{mn} \end{pmatrix}$$

The steps for the determining entropy weight of each criterion are as follows.

Step 1: Calculate the closeness to the point

In this step, define closeness between x_{ij} and its ideal value (p_{ij})·$p_{ij} \in [0, 1]$, $i = 1, 2,....m, j = 1, 2, ..., n$)

$$p_{ij} = x_{ij} / \max x_{ij}, \text{ positive indicator}$$

$$p_{ij} = \min x_{ij} / x_{ij}, \text{ negative indicator}$$

Step 2: Construct the standardized index matrix (D) *i.e.* $D = P_{ij} = [r_{ij}]_{m \times n}$

Step 3: Determine the entropy value of each criteria

$$E_j = -k \sum_{j=1}^{n} P_{ij} \ln P_{ij} \qquad (k = 1 / \ln n, 1 \le j \le n)$$

Step 4: Variation coefficient of the j^{th} factor

$$d_j = I - E_j \qquad (1 \le j \le n)$$

Step 5: Calculate the entropy weight value

$$w_j = d_j / \sum_{j=1}^{n} d_j \left(1 \le j \le n\right) 0 \le w_j \le 1, \sum_{j=1}^{n} w_j = 1$$

3.2.2 Technique for Order Preference by Similarity to Ideal Solution Method (TOPSIS)

TOPSIS method was developed by Hwang and Yoon (1981). According to TOPSIS method, a positive ideal solution maximizes the benefit criteria and minimizes the cost criteria, whereas a negative ideal solution maximizes the cost criteria and minimizes the benefit criteria.The TOPSIS method has six steps which are given below:

Step 1: Construct the Decision Matrix (A)

$$A = (a_{ij})_{m \times n} = \begin{bmatrix} a_{11} & a_{12} & \cdots a_{1n} \\ a_{21} & a_{22} & \cdots a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & \cdots a_{mn} \end{bmatrix}$$

Step 2: Calculate the normalized decision matrix. The normalized value P_{ij} is calculated asfollows: $P_{ij} = a_{ij} / \sqrt{\sum_{i-1}^{m} a_{ij}^2}$ $i = 1, 2, ..., m$ and $j = 1, 2, ..., n$.

Step 3: Calculate the weighted normalized decision matrix. The weighted normalized value v_{ij} is calculated as follows: $v_{ij} = p_{ij} \times w_{ji} = 1, 2, ..., m$ and $j = 1, 2, ..., n$.

where w_j is the weight of the j^{th} criterion or attribute and $\sum_{j=1}^{n} w_j = 1$.

Step 4: Determine the ideal (A^*) and negative ideal (A^-) solutions.

$$A^* = \{(\max_i v_{ij} \mid j \in C_b), (\min_i v_{ij} \mid j \in C_c)\} = \{v_j^* \mid j = 1,2,...,m\}$$

$$A^- = \{(\min_i v_{ij} \mid j \in C_b), (\max_i v_{ij} \mid j \in C_c)\} = \{v_j^- \mid j = 1,2,...,m\}$$

Step 5: Calculate the separation measures: The separation measures of each alternative from the positive ideal solution and the negative ideal solution, respectively, are as follows:

$$S_i^* = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^*)^2}, j = 1,2,...,m \quad S_i^- = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^-)^2}, j = 1,2,...,m$$

Step 6: Calculate the relative closeness to the ideal solution. The relative closeness of the alternative A_i with respect to A^* is defined as follows:

$$RC_i^* = \frac{S_i^-}{S_i^* + S_i^-}, i = 1,2,...,m$$

Step 7: Rank the preference order.

4. DATA ANALYSIS

In this study, the financial data of seven oil and gas companies used for the period between 2011 to 2015. First, all the ratio data collected for all seven oil and gas companies and constructed decision matrix for the years of 2011, 2012, 2013, 2014 and 2015. These ratio data calculated based on ten financial ratios such as Net Profit Margin, Return on Capital Employed, Return on Assets Including Revaluations, Current Ratio, Quick Ratio, Debt equity ratio, Total debt *t* owners fund, Fixed Assets Turnover Ratio, Dividend Payout Ratio and finally,Total Assets Turnover Ratio. The financial ratio is represented by criteria L1, L2, L3, L4, L5, L6,

L7, L8, L9 and L10 respectively. Next, entropy weight method used to collect the value of each criteria weight and sum of all weight should be equal to one. Next, TOPSIS method applied to get rank of each oil and gas companies on the basis of their performance. The original data matrix is given for the year 2011 in table 2.

Table 2
The collected data of financial ratio of oil and gas companies for 2011a

	L1	*L2*	*L3*	*L4*	*L5*	*L6*	*L7*	*L8*	*L9*	*L10*
BPCL	1.01	11.50	388.82	0.65	0.45	1.17	1.17	5.19	32.72	4.98
Gail	10.94	25.07	151.78	1.04	0.96	0.10	0.10	1.49	26.71	1.55
Hindustan	1.15	7.93	370.49	0.77	0.44	1.99	1.10	4.53	30.80	3.57
IOC	2.24	10.32	227.83	0.80	0.51	0.95	0.38	3.61	30.97	3.09
Petronet	4.69	18.4	35.74	0.80	0.73	1.20	1.13	3.72	24.20	2.24
Reliance	8.17	13.15	462.95	1.12	0.89	0.43	0.35	1.61	11.75	1.55

Source: Compiled by authors.

Next, calculated maximum and minimum criteria values from the original data matrix from the step 1 of entropy method in table 3 and get the standardized matrix in table 4.

Table 3
Maximum and minimum value of each criteria for 2011

	L1	*L2*	*L3*	*L4*	*L5*	*L6*	*L7*	*L8*	*L9*	*L10*
MAX	10.94	25.07	462.95	1.12	0.96	1.99	1.17	5.19	32.72	4.98
MIN	1.01	7.93	35.74	0.65	0.44	0.1	0.1	1.49	11.75	1.55

Source: Compiled by authors.

Table 4
Standardised index matrix for 2011

	L1	*L2*	*L3*	*L4*	*L5*	*L6*	*L7*	*L8*	*L9*	*L10*
BPCL	0.0923	0.4587	0.8398	0.5803	0.4687	0.5879	0.0855	1	1	1
Gail	1	1	0.3278	0.9285	1	0.0502	1	0.287	0.8163	0.3112
Hindustan	0.1051	0.3163	0.8002	0.6875	0.4583	1	0.0909	0.8728	0.9413	0.7168
IOC	0.2047	0.4116	0.4921	0.7142	0.5312	0.4773	0.2632	0.6955	0.9465	0.6204
Petronet	0.4287	0.7339	0.0772	0.7142	0.7604	0.603	0.0885	0.7167	0.7396	0.4497
Reliance	0.7468	0.5245	1	1	0.927	0.216	0.2857	0.3102	0.3591	0.3112

Source: Compiled by authors

In this step, the value of output entropy E_j is calculated from step 3, variation coefficient of the j^{th} factor from step 4 and last entropy weight value from the step 5 of entropy weight method. The result is given in table 5.

Table 5
The value of output entropy, intrinsic information and weight for 2011

	L1	*L2*	*L3*	*L4*	*L5*	*L6*	*L7*	*L8*	*L9*	*L10*
E_j	0.7604	0.9222	0.6905	0.6268	0.7408	0.8101	0.7546	0.743	0.483	0.9045
$d_j = 1 - E_j$	0.2396	0.0778	0.3095	0.3732	0.2592	0.1899	0.2454	0.257	0.517	0.0955
Weight	0.0934	0.0303	0.1207	0.1456	0.1011	0.0741	0.0957	0.1002	0.2016	0.0372

Source: Compiled by authors

Now calculated entropy weight value used in the TOPSIS method to get the financial ranking of each company. For the TOPSIS method we need to normalize the original data matrix by using the formula in the second step of the TOPSIS method as table 6 shows.

Table 6
The normalized decision matrix for 2011

	L1	*L2*	*L3*	*L4*	*L5*	*L6*	*L7*	*L8*	*L9*	*L10*
BPCL	0.0687	0.3029	0.5109	0.302	0.2641	0.4171	0.5755	0.5834	0.4924	0.6601
Gail	0.7447	0.6603	0.1994	0.4832	0.5634	0.0356	0.0491	0.1675	0.1019	0.2054
Hindustan	0.0783	0.2088	0.4869	0.3578	0.2582	0.7095	0.5411	0.5092	0.4635	0.4732
IOC	0.1524	0.2718	0.2994	0.3717	0.2993	0.3387	0.1869	0.4058	0.4661	0.4095
Petronet	0.3193	0.4846	0.0469	0.3717	0.4284	0.4278	0.5558	0.4182	0.3642	0.2969
Reliance	0.5562	0.3463	0.6084	0.5204	0.5224	0.1533	0.1722	0.1809	0.1768	0.2054

Source: Compiled by authors

Then, the weighted normalized matrix is calculated by multiplying each normalized matrix value with their entropy weight. The calculated entropy weight value for the year 2011 is given below from the table 5. Table 6 represents the entropy weight normalized matrix from the third step of TOPSIS method.

Table 7
The entropy weight normalized decision matrix for 2011

	L1	*L2*	*L3*	*L4*	*L5*	*L6*	*L7*	*L8*	*L9*	*L10*
BPCL	0.0064	0.0092	0.0617	0.0439	0.0267	0.0309	0.0551	0.0585	0.0993	0.0246
Gail	0.0696	0.0200	0.0241	0.0703	0.0569	0.0026	0.0047	0.0168	0.0810	0.0076
Hindustan	0.0073	0.0063	0.0588	0.0521	0.0261	0.0525	0.0518	0.0510	0.0934	0.0176
IOC	0.0142	0.0082	0.0361	0.0541	0.0303	0.0251	0.0179	0.0406	0.0939	0.0152
Petronet	0.0298	0.0147	0.0057	0.0541	0.0433	0.0317	0.0532	0.0419	0.0734	0.0110
Reliance	0.0519	0.0105	0.0734	0.0758	0.0528	0.0113	0.0165	0.0181	0.0356	0.0076

Source: Compiled by authors

Next, positive ideal solution (PIS) and negative ideal solution (NIS) are calculated by taking maximum and minimum values for each ratio or criteria using step 4 and determined the separation measure from the step 5 of TOPSIS method. The separation measure value is given in table 7.

Table 8
Positive and negative ideal solution for 2011

S*	0.081476906	0.099248727	0.077068644	0.091333616	0.091764431	0.097806949
S_i^-	0.112048083	0.090676713	0.110482743	0.076290158	0.079254428	0.092869446

Source: Compiled by authors

After getting the value of separation measure, we have given the rank for each company on the basis of their performance value. The rank of the each company result shown in the table 9 from 2011 to 2015.

Table 9
The final ranking of oil and gas companies from 2011-2012-2013-2014-2015

	2011		*2012*		*2013*		*2014*		*2015*	
Companies	C_i	*Rank*	C_i	*Rank*	C_i	*Rank*	C_i	*Rank*	C_i	*Rank*
BPCL	0.57899	2	0.54517	1	0.49958	2	0.34627	2	0.3977	2
Gail Ltd.	0.47743	4	0.51076	2	0.56003	1	0.32676	3	0.17198	7
Hindustan	0.58908	1	0.46496	3	0.4687	3	0.277	5	0.36619	3
Indian Oil	0.45513	6	0.39345	6	0.40091	6	0.18334	7	0.24886	5
Petronet	0.46343	5	0.4558	4	0.41	5	0.69029	1	0.60547	1
Reliance	0.48705	3	0.44201	5	0.41798	4	0.28984	4	0.31766	4
Oil India							0.26048	6	0.21112	6

Source: Compiled by authors

5. RESULTS AND CONCLUSIONS

In this study, Technique for order preference by positive ideal solution method was used to evaluate the financial performance of oil and gas companies for five years from 2011 to 2015. Entropy weight method was used to calculate each criteria weight value.

As a result of the study on financial performance of oil and gas companies from period 2011-2015, Hindustan Corporationhad the first rank in the year 2011. Bharat Petroleum Corporation limited had second rank, Reliancegot third rank, Gail ltd. fourth rank,Petronet fifth rank and Indian oil had the last rank for the year 2011. We applied same process for the year 2012, 2013, 2014 and 2015 and got results. In 2012, BPCL had the highest ranking, Gail ltd. second, Hindustan, third and Indian oil has last rank. Gail ltd. had the first rank in the year 2013, Bharat Petroleum Corporation limited had second rank, Hindustan got third rank; Reliance fourth rank and Indian oil had the last rank for the year 2013. In 2014, Petronethad the highest ranking, BPCL second, Gail ltd. third and Oil India had last rank. In 2015, Petronet had the highest ranking, BPCL second, Hindustan third and Gail ltd. has last rank. Another important result is that Indian oil had consistent sixth rank from the year 2011 to 2013.

We have taken only oil and gas companies in India. Further, researchers can use more criteria in different field. Performance evaluation is required for the different companies and entropy based TOPSIS method performs to provide better ranking among the companies.

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