Management Science Letters 2 (2012) 2341–2346

Contents lists available at GrowingScience

Management Science Letters

homepage: www.GrowingScience.com/msl

An application of multiple criteria decision-making techniques for ranking different national Iranian oil refining and distribution companies

Ibrahim Nazari[a], Younos Vakil Alroaia[b*] and Samaneh Bahraminasab[c]

[a]*National Iranian Oil Refining & Distribution Company*
[b]*Assistant Professor, Department of Management, Semnan Branch, Islamic Azad University , Semnan , Iran*
[c]*Master Student of Industrial Management, Aliabad Branch, Islamic Azad University, Aliabad, Iran*

A R T I C L E I N F O

Article history:
Received May 14, 2012
Received in Revised form June, 26, 2012
Accepted 2 August 2012
Available online August 9 2012

Keywords:
National Iranian oil Refining and Distribution Companies
TOPSIS
AHP
Ranking

A B S T R A C T

Performance measurement plays an essential role on management of governmental agencies especially when profitability is not the primary concern and we need to consider other important factors than profitability such as customer satisfaction, etc. In this paper, we propose a multi-criteria decision making method to rank different national Iranian oil refining and distribution companies. The proposed study of this paper uses six factors including per capita supply, energy cost, physical productivity of labor, staff participation, quality control inspection of stations and education per capita. The proposed study uses Entropy to find the relative importance of each criterion and TOPSIS to rank 37 alternatives based on cities and three regions. The results of the implementation of our method indicate that central regions close to capital city of the country maintains the highest ranking (0.9122) while southern regions maintains the lowest comes in the lowest priority (0.0569) and the northern region is in the middle (0.7635).

1. Introduction

During the past few years, there have been tremendous efforts on having efficient methods for ranking different alternatives such as data envelopment analysis (DEA) (Charnes et al., 1978, 1994; Andersen et al., 1993), analytical hierarchy process (AHP) (Saaty, 1992), Entropy and **T**echnique for **O**rder **P**reference by **S**imilarity to **I**deal **S**olution (TOPSIS). Some of the techniques ask decision maker (DM) to give his/her opinions for ranking preference, for instance AHP, while the others do not, e.g. DEA. In the event we wish to avoid direct communication with DM, we may choose other techniques to rank various alternatives. In fact, there are growing interests among practitioners for

* Corresponding author. Tel.: +989122316247
E-mail addresses: younos.vakil@gmail.com (Y. Vakil Alroaia)

doi: 10.5267/j.msl.2012.08.009

adapting methods for decision making processes, which rely on both financial and non-financial figures (Kaplan & Norton, 1992; Kaplan, & Norton, 1996).

TOPSIS, originally developed by Hwang and Yoon in 1981, is a simple but sophisticated ranking methodology used in many real-world applications of science and engineering (Chang et al., 2010). The standard TOPSIS method chooses alternatives, which simultaneously have the shortest distance from the positive ideal solutions and the longest distance from the negative-ideal solutions. The positive ideal solution maximizes the desirable criteria and minimizes the undesirable criteria, whereas the negative ideal solution maximizes the undesirable criteria and minimizes the desirable criteria. TOPSIS makes full implementation of attribute information, provides a cardinal ranking of alternatives, and does not need attribute preferences to be independent. To apply this technique, attribute values must be numeric, monotonically increasing or decreasing, and have commensurable units (Chen and Hwang, 1992; Yoon & Hwang, 1995).

There are literally different applications of TOPSIS used in many areas of scientific societies and there are various extensions of TOPSIS such as fuzzy TOPSIS. In Fuzzy TOPSIS, we consider uncertainty with input parameters. This extension makes the implementation more realistic since in today's world, uncertainty is an unavoidable part of events and incidents. Aiello et al. (2009), for instance, used fuzzy TOPSIS for clean agent selection. Amiri (2010) presented project selection for oil-fields development by using the AHP and fuzzy TOPSIS methods. Athanasopoulos et al. (2009) proposed a decision support system for coating selection based on fuzzy logic and multi-criteria decision making. Awasthi et al. (2011a) used an application of fuzzy TOPSIS in evaluating sustainable transportation systems. Awasthi et al. (2011b), in an another assignment, proposed a hybrid approach based on SERVQUAL and fuzzy TOPSIS for evaluating transportation service quality. Performance measurement is another area of implementation of TOPSIS and its extentions such as fuzzy TOPSIS. Aydogan (2011), for instance, presented an empirical study for performance measurement model for Turkish aviation firms using the rough-AHP and TOPSIS methods under fuzzy environment. Chamodrakas et al. (2009) performed another empirical investigation for customer evaluation for order acceptance using a novel class of fuzzy methods based on TOPSIS. Kelemenis et al. (2011) presented a method for support managers' selection using an extension of fuzzy TOPSIS. Sun and Lin (2009) used fuzzy TOPSIS method for evaluating the competitive advantages of shopping websites. Krohling and Campanharo (2011) implemented fuzzy TOPSIS for group decision making in a case study for accidents with oil spill in the sea. Thomaidis et al. (2008) used the implementation of TOPSIS for the wholesale natural gas market prospects in the energy community treaty countries.

In this paper, we propose the implementation of TOPSIS for ranking different national Iranian oil refining and distribution companies. The organization of this paper first presents details of the implementation in section 2 and section 3 presents the results of our survey. Finally, concluding remarks are given in the last to summarize the contribution of the paper.

2. The proposed model

In this section, we first present details of our implementation of TOPSIS method. Let x_{ij} be the inputs for matrix of priorities where there are $i = 1, \cdots, m$ alternatives and $j = 1, \cdots, n$ criteria. There are six steps associated with the implementation of TOPSIS as follows, Step 1. Construct normalized decision matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n} x_{ij}^2}} \tag{1}$$

Step 2. Construct the weight normalized matrix

$$v_{ij} = w_i r_{ij}, i = 1, \cdots, m \quad j = 1, \cdots, n \tag{2}$$

Step 3. Determin the positive and negative ideal solutions

$$\begin{aligned} A^+ &= \left\{v_1^+, \cdots, v_n^+\right\}, \text{ where } v_j^+ = \left\{\max(v_{ij}) \text{ if } j \in J; \min(v_{ij}) \text{ if } j \in J'\right\} \\ A^- &= \left\{v_1^-, \cdots, v_n^-\right\}, \text{ where } v_j^* = \left\{\min(v_{ij}) \text{ if } j \in J; \max(v_{ij}) \text{ if } j \in J'\right\} \end{aligned} \tag{3}$$

Step 4. Calculate seperation (positive and negative) measures for each alternative

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_j^+ - v_{ij})^2}, S_i^- = \sqrt{\sum_{j=1}^{n} (v_j^- - v_{ij})^2}, i = 1, \cdots, m \tag{4}$$

Step 5. Calculate the relative closness to the ideal solution

$$C_i^+ = \frac{S_i^-}{S_i^- + S_i^+}, 0 < C_i^+ < 1, i = 1, \cdots, m \tag{5}$$

3. Case study

The proposed of this paper has been implemented for a real world application of oil product refinary and distribution in Iran. Since the proposed case of this paper is more active as a governmental service provider, it is important to have a comprehensive method for ranking different units and assign budget based on their performances. The proposed study of this paper uses six factors including per capita supply, energy cost, physical productivity of labor, staff participation, quality control inspection of stations and education per capita. The proposed study uses Entropy to find the relative importance of each criterion and TOPSIS to rank 37 oil distribution units based on cities and three regions of north, center and south. Table 1 shows details of six criteria for three regions.

Table 1
Input parameters for three regions of North, South and Center

	Criteria					
Region	per capita supply cubic meters	quality control inspection of stations	energy cost Rials/cubic meter	education per capita: hour/person	physical productivity of labor : cubic meter per person	staff participation
North	16,180	1.9	591	68.0	5,306	2.1
South	17,722	1.8	426	65.6	4,909	2.0
Center	18,806	2.4	858	48.2	4,032	1.0

We have used the TOPSIS for ranking different regions and implemented Entropy method for ranking criteria. The results of the implementation indicates that the center region, which is close to the capital city of country comes first with relative ranking value of 0.9122 followed for north region with relative ranking of 0.7635 and south region comes in the last position and with relative ranking number of 0.0569.

We have repeated the same methodology for rankin different oil distribution compnaies located in 37 various cities and Table 2 shows details of the inputs along with the relative rankings.

Table 2

Input parameters for 37 cities of the country along with the result of TOPSIS method

	Criteria						
City	per capita supply m^3	quality control inspection of stations	energy cost Rials/m^3	education per capita: hour/person	physical productivity of labor : m^3 per person	staff participation	Rank
1	13,956	2.5	321	103.8	5,157	0.5	0.2660
2	14,435	0.7	387	23.3	4,808	0.3	0.2054
3	30,526	2.9	511	51.4	4,205	2.3	0.3181
4	17,111	0.4	485	150.7	3,888	8.1	0.6534
5	11,316	1.6	384	59.0	4,852	2.4	0.3166
6	21,790	2.6	670	39.5	3,196	0.3	0.2053
7	10,090	0.7	430	95.0	4,922	0.6	0.2367
8	10,596	0.8	370	128.0	4,493	2.5	0.3427
9	21,842	3.8	574	10.9	4,728	9.4	0.7285
10	15,670	4.7	1,773	79.2	3,400	1.1	0.2430
11	12,246	2.8	1,993	60.7	3,265	0.3	0.1421
12	21,435	1.0	337	143.2	6,433	0.8	0.2817
13	12,219	1.5	372	19.8	8,463	0.9	0.2322
14	13,156	1.4	380	84.0	5,302	3.0	0.3566
15	19,183	2.6	222	15.9	7,386	0.8	0.2554
16	13,316	0.8	252	23.8	10,400	0.9	0.2373
17	17,111	0.4	540	113.8	3,888	1.4	0.2648
18	14,040	1.7	445	111.6	4,374	1.1	0.2698
19	18,541	3.2	558	33.6	2,980	0.1	0.2218
20	13,252	0.9	196	20.7	5,126	1.2	0.2512
21	8,943	1.9	361	93.4	4,816	5.7	0.5662
22	13,799	1.5	255	23.1	6,298	3.0	0.3465
23	32,803	4.4	366	9.6	4,125	0.8	0.2780
24	23,966	1.5	346	42.4	4,713	3.3	0.3660
25	15,699	1.9	780	70.9	3,980	0.9	0.2178
26	20,043	1.3	517	17.0	4,693	0.8	0.2095
27	20,480	2.6	412	148.7	7,368	2.9	0.3978
28	13,988	0.8	335	102.4	6,542	2.6	0.3363
29	23,079	1.0	254	73.1	6,828	0.9	0.2521
30	20,630	2.3	528	46.8	4,776	1.1	0.2402
31	17,618	9.0	1,331	24.4	3,163	0.1	0.3293
32	17,666	1.9	512	33.5	4,138	0.6	0.2151
33	21,981	2.9	1,993	9.9	1,694	0.7	0.1456
34	14,062	1.3	584	16.3	4,079	4.3	0.4150
35	26,159	2.1	551	29.7	3,655	0.2	0.2035
36	12,626	0.2	1,497	62.2	3,914	0.9	0.3978
37	15,429	0.9	473	137.8	4,044	0.1	0.2503

As we can observe from the results of Table 2, the ranking numbers vary from 0.1421 to 0.7285. The mean and standard deviation of the ranking are 0.3026 and 0.1250, respectively. One obvious observation is that there is a big gap between the most efficient and the least efficient units, which means there is a serious need to focus on inefficient units and try to improve their efficiencies.

4. Conclusion

In this paper, we have presented a multi-criteria decision making method to rank different national Iranian oil refining and distribution companies. The proposed study of this paper used six factors including per capita supply, energy cost, physical productivity of labor, staff participation, quality control inspection of stations and education per capita. The proposed study uses Entropy to find the relative importance of each criterion and TOPSIS to rank 37 alternatives based on cities and three regions. The results of the implementation of our method indicate that central regions close to capital city of the country maintains the highest ranking (0.9122) while southern regions maintains the lowest comes in the lowest priority (0.0569) and the northern region is in the middle (0.7635). The results of the implementation of TOPSIS method for ranking 37 cities yields various numbers vary from 0.1421 to 0.7285. The mean and standard deviation of the ranking were 0.3026 and 0.1250, respectively.

Acknowledgment

The auhthors would like to thank National Iranian oil Refining and Distribution Companies for supporting this project. We are also grateful to auhtors' insights on earlier version of this paper, which made it more comprehensive.

References

Aiello, G., Enea, M., Galante, G., & La Scalia, G. (2009). Clean agent selection approached by fuzzy TOPSIS decision-making method. *Fire Technology*, 45, 405–418.

Amiri, M. P. (2010). Project selection for oil-fields development by using the AHP and fuzzy TOPSIS methods. *Expert Systems with Applications*, 37, 6218–6224.

Andersen, P., & Petersen, N. C. (1993). A procedure for ranking efficient units in data envelopment analysis, *Management Science*, 39, 1261-1264.

Athanasopoulos, G., Riba, C. R., & Athanasopoulou, C. (2009). A decision support system for coating selection based on fuzzy logic and multi-criteria decision making. *Expert Systems with Applications*, 36, 10848–10853.

Awasthi, A., Chauhan, S. S., & Omrani, H. (2011a). Application of fuzzy TOPSIS in evaluating sustainable transportation systems. *Expert Systems with Applications*, 38, 12270–12280.

Awasthi, A., Chauhan, S. S., Omrani, H., & Panahi, A. (2011b). A hybrid approach based on SERVQUAL and fuzzy TOPSIS for evaluating transportation service quality. *Computers & Industrial Engineering*, 61, 637–646.

Aydogan, E. K. (2011). Performance measurement model for Turkish aviation firms using the rough-AHP and TOPSIS methods under fuzzy environment. *Expert Systems with Applications*, 38, 3992–3998.

Charnes A, Cooper, W. W., Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of the Operational Research*, 2, 429–44.

Charnes A, Cooper W. W., Lewin, A., Seiford, L. M. (1994). *Data envelopment analysis: theory, methodology and applications*. Massachusetts: Kluwer Academic Publishers.

Chen, S. J., & Hwang, C. L. (1992). *Fuzzy multiple attribute decision making: Methods and applications*. Berlin: Springer-Verlag.

Chang, C. H., Lin, J. J., Lin, J. H., & Chiang, M. C. (2010). Domestic open-end equity mutual fund performance evaluation using extended TOPSIS method with different distance approaches. *Expert Systems with Applications*, 37, 4642–4649.

Chamodrakas, I., Alexopoulou, N., & Martakos, D. (2009). Customer evaluation for order acceptance using a novel class of fuzzy methods based on TOPSIS. *Expert Systems with Applications*, 36, 7409–7415.

Kaplan, R. S. & Norton, D. P. (1992). The balanced scorecard – measures that drive performance, *Harvard Business Review*, 70(1), 71-79.

Kaplan, R.S. & Norton, D.P. (1996). The balanced scorecard: translating strategy into action, *Harvard Business School Press*, Boston, MA.

Kelemenis, A., Ergazakis, K., & Askounis, D. (2011). Support managers' selection using an extension of fuzzy TOPSIS. *Expert Systems with Applications*, 38, 2774–2782.

Krohling, R. A., & Campanharo, V. C. (2011). Fuzzy TOPSIS for group decision making: A case study for accidents with oil spill in the sea. *Expert Systems with Applications*, 38, 4190–4197.

Saaty, T. L. (1992). How to make a decision: the analytic hierarchy process. *European Journal of Operational Research*, 48, 9–26.

Sun, C. C., & Lin, G. T. R. (2009). Using fuzzy TOPSIS method for evaluating the competitive advantages of shopping websites. *Expert Systems with Applications*, 36, 11764–11771.

Thomaidis, F., Konidari, P., & Mavrakis, D. (2008). The wholesale natural gas market prospects in the energy community treaty countries. *Operational Research International Journal*, 8, 63–75.

Yoon, K. P., & Hwang, C. L. (1995). *Multiple attribute decision making*. Thousand Oaks, CA: Sage Publication.