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Evaluating Performance of the 37 Areas of N.I.O.P.D.C Using a Mathematical Model

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Abstract. In the present paper, which is conducted in N.I.O.P.D.C for the first time, efficiency of 37 areas of this company has been studied all over the country by data envelopment analysis model. In this model, the variables "number of human resources" and "technology", are considered as input and "percent of beneficiaries' satisfaction"," tankers operation" and "sold products income" are considered as output. These variables are selected according to the experts and regional managers using various tools and techniques of decision making such as entropy and analytical hierarchy process (AHP).

Keywords: Performance Evaluation, Efficiency, Data Envelopment Analysis (DEA), Ranking, National Iranian Refinement and Oil Products Distribution Company (N.I.O.P.D.C)

1. Introduction

Productivity is a comprehensive concept and means efficient use of production resources to obtain the most and the best possible output (product).[1] However, organizations have played various roles during the time, at present they developed their operations efficiently and they are continuously expected increasingly. On the other hand, in today competitive world, organizations, in any environment they act, need to evaluate their operations and improve continuously to obtain the organizational objectives.

Having established an efficient managing framework, performance evaluation systems allow managers to compare their own performance with their competitors' and the associates' and identify the gap between the organizations objectives and actual processes.[2]

2. Definition

Productivity is discussed in all economical and social systems and has been used in different ways. First definitions of productivity are mainly involved minor productivity concept of production factors. From the systematic point of view, productivity consists of the ratio of total system outputs to the total of its inputs, which its outputs consists of volume and amount of the product or produced service and inputs are production factors.[4]

Efficiency means not to waste the sources and is obtained from the ratio of total inputs to the total outputs. During past years, some different models are created to measure the efficiency, which can be divided into two categories of hard and soft models. Hard models rely on the quantitative and objective data

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Operation Research Model, Multi Attribute Decision Making, Data Envelopment Analysis)) and soft models emphasize qualitative and subjective data like analytical hierarchy process and Delphi.[6]

This study tends to evaluate performance of the 37 areas of N.I.O.P.D.C using the most appropriate tools and represents a complete ranking due to the areas efficiency scores.

Some of the major tools and patterns to evaluate performance of organizations are as follow: EFQM, 360 degree feedback model, performance charter model, balanced scorecards model, patterning model and data envelopment analysis model and etc. that each of which has its definition, advantage and disadvantage separately. Since the data envelopment analysis model specifies the productivity components, has been used more than the others. Its capabilities causes to be used as an appropriate tool to appraise in most of the economical parts. Also this model is the best one for the organizations with multiple input and output and decision making units with similar functions.[5]

3. Literature Review

Heretofore, many useful studies have been conducted using data envelopment analysis model and this is modelling in the most of the industries as an applied technique and finally has presented comprehensive reports to the organizations and industries about efficiency and their unit ranking.

No research has been studied in this field in N.I.O.P.D.C yet, and the present study is the first one about operation evaluation in this company using DEA model. So we just imply some selective researches which conducted in other industries:

1) Achieving the growth of total productivity factors by generalized data envelopment analysis is a case study of National Iranian Oil Company:

In this study, a method is introduced based upon the productivity growth indices and generalized models of DEA, as the productivity rate in the past courses is calculated at first and then the change rate in inputs and outputs is defined in order to achieve 2.5% productivity growth in the future course based on the effective factors in productivity changes. Also in a case study in National Iranian Oil Company, calculating and applying the mentioned above method is defined.

2) Representing an ideal programming model to efficiency evaluate the refineries of the country:

This study evaluates the refineries performance based on the years 80- 83, using a combined model of DEA techniques and ideal programming and ranks them and identifies the relative inefficiency and its reasons.

4. Data envelopment analysis model

The concept of efficiency is derived from physical and engineering science and indicates the relationship between inputs and outputs. Charnes et al. (1978) introduced the ratio definition of efficiency, also known as the CCR ratio definition, which generalizes the single-output to single-input ratio definition used in classical science to multiple outputs and inputs without requiring pre-assigned weights. The main strength of DEA model as it is applied in this study lies in its ability to combine multiple inputs and outputs into a single summary measure to select the most efficient unit.

Since being proposed by CharnEs et al. (1978) and Banker et al. (1984), the DEA models have been widely applied in evaluating the efficiencies of manufacturing and service industries. A recent research by Mostafa (2007) employed DEA to evaluate the relative efficiency of the top 100 Arab banks. However, the DEA models are rarely used in portfolio management. Research on evaluating performance of the 37 areas of N.I.O.P.D.C using DEA models has not been found in previous literature. Therefore, this study applies DEA models to evaluate performance of these areas.[6]

5. Inputs and outputs

The first and very crucial step in conducting a DEA is the determination of inputs and outputs. The main important point in this process is that the input-output variables should be chosen in accordance with the type of efficiency being assessed. Efficiency in DEA is not confined to a traditional sense of operating efficiency;

it can be generalized to represent relative evaluation of performance in any performance dimension if the inputs and outputs are specified according to the performance dimension considered.

It is well known that DEA is sensitive to variable selection. As the number of variables increases, the ability to discriminate between the DMUs decreases. The more variables are added the greater becomes the chance that some inefficient unit dominates in the added dimension and becomes efficient. Thus, to preserve the discriminatory power of DEA the number of inputs and outputs should be kept at a reasonable level.

At the beginning of this study, with a total of two input variables and three output variables, we were faced with about 110 variable which were obtained according to experts, and by distributing questionnaires during the three phases. Input variables obtained include "number of human resources" and "technology", and output variables obtained include "percent of beneficiaries' satisfaction"," tankers operation" and "sold products income".

6. Methodology

Statistical society of this study is N.I.O.P.D.C. this company is established as an adjunct company of N.I.R.O.P.D.C. National Iranian Refinement and Oil Products Distribution Company is one of the four subordinate companies of Oil ministry. These four subordinate companies are as follow: 1) National Iranian Oil Company. 2) National Iranian Gas Company. 3) National Iranian Petrochemical Company. 4) National Iranian Refinement and Oil Products Distribution Company.

This study is an applied type of research. This study is a descriptive- measuring plan. As it represents a picture of the present condition is descriptive and is a measuring one because is gathering information of statistical society through questionnaire.

To measure the regional efficiency, BCC model is used for the variable return to scale and this model is based on the input oriented.

Since in input oriented approach, the presented solutions with decreasing production factors level leads to increased efficiency and in output oriented approach is tried to increase outputs with the former inputs level and since all the outputs in the N.I.O.P.D.C are not controlled completely, so it essentially should use input oriented approach to solve the model. But like many other researches, we suggest CCR model for a constant yield to the scale.

However, data envelopment analysis is used in many studies, this model is very responsive to the inappropriate data and in case of entering primary inappropriate data it will represent totally different results from the actual ones. So it is very important that DMU(decision making units) of the research are comparable and well balanced.[3]

7. Finding

The following model is a BCC model. Consider that there are 37 decision making units (DMU) with 2 input and 3 output variables:

$$Min\ y_0 = \theta$$

s.t

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r_0} \qquad (r = 1,2,3,\dots,s)$$

$$\theta x_{i_0} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0 \qquad (i = 1,2,3,\dots,m)$$

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad (j = 1,2,3,\dots,n)$$

$$\lambda_j \geq 0$$

In this case and after solving the model, the efficient and inefficient units are identified and their efficiency numbers are determined. The following table represents the general information of the model situation and its solving.

No. of DMUs in Data =	37
No. of DMUs with inappropriate Data =	0
No. of evaluated DMUs =	37
Average of scores =	0.783879
No. of efficient DMUs =	7
No. of inefficient DMUs =	30
No. of over iteration DMUs =	0
Total number of simplex iterations =	557

Now, we represent the efficient numbers of decision making units and ranking them in the following table.

Table 1 Rank of DMUs with BCC

Rank	DMU	Score	Rank	DMU	Score
1	Kh.jonobi	1	20	Chabahar	0.738
1	Tehran	1	21	Charmahal e bakhtiyari	0.735
1	Abadan	1	22	Arak	0.703
1	Yazd	1	23	Torbat e Heidarieh	0.699
1	Kerman	1	24	Ahvaz	0.696
1	Fars	1	25	Tabriz	0.692
1	Qom	1	26	Kordestan	0.69
8	Kh.Shomali	0.979	27	Zahedan	0.677
9	Yasuoj	0.943	28	Esfahan	0.676
10	Golestan	0.891	29	Buoshher	0.671
11	Sabzevar	0.887	30	Kh.Razavi	0.671
12	Ielam	0.864	31	Saree	0.666
13	Ghazvin	0.855	32	Kermanshah	0.63
14	Oromieh	0.844	33	Lorestan	0.629
15	Karaj	0.84	34	Ardebil	0.624
16	Gilan	0.774	35	Shahrod	0.601
17	Miyandoab	0.774	36	Hormozgan	0.522
18	Zanjan	0.768	37	Hamadan	0.495
18	Chalos	0.768			

The following model is a CCR model framework which specifies efficient decision making units assuming the fixed return to scale with 37 DMU's and 2 input and 3 output variables.

$$Min\ y_0 = \theta$$

s.t

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r_0} \qquad (r = 1,2,3,\dots,s)$$

$$\theta x_{i_0} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0 \qquad (i = 1,2,3,\dots,m)$$

$$\lambda_j \geq 0 \qquad (j = 1,2,3,\dots,n)$$

Now, we represent the general information of the model and efficient numbers of decision making units and ranking them.

No. of DMUs in Data =	37
No. of DMUs with inappropriate Data =	0
No. of evaluated DMUs =	37
Average of scores =	0.742769
No. of efficient DMUs =	5
No. of inefficient DMUs =	32
No. of over iteration DMUs =	0
Total number of simplex iterations =	196

Table 2 Rank of DMUs with CCR

Rank	DMU	Score	Rank	DMU	Score
1	Kh.jonobi	1	20	Arak	0.702
1	Abadan	1	21	Chalos	0.702
1	Yazd	1	22	Kordestan	0.673
1	Fars	1	23	Charmahal e bakhtiyari	0.666
1	Qom	1	24	Saree	0.66
6	Kh.Shomali	0.973	25	Zahedan	0.652
7	Kerman	0.928	26	Ahvaz	0.649
8	Ielam	0.86	27	Kh.Razavi	0.642
9	Sabzevar	0.86	28	Buoshher	0.642
10	Ghazvin	0.852	29	Ardebil	0.616
11	Yasuoj	0.852	30	Lorestan	0.605
12	Oromieh	0.82	31	Kermanshah	0.6
13	Karaj	0.808	32	Torbat e Heidarieh	0.599
14	Gilan	0.77	33	Tabriz	0.567
15	Golestan	0.767	34	Sharod	0.542
16	Miyandoab	0.759	35	Esfahan	0.524
17	Zanjan	0.751	36	Hormozgan	0.501
18	Tehran	0.742	37	Hamadan	0.491
19	Chabahar	0.71			

8. Conclusions

In this study, operations of 37 regional N.I.O.P.D.C evaluated and regions were ranked according to the efficiency numbers and finally, Abadan, Tehran, South Khorasan, Fars Qom, Kerman and Yazd allocated the superior regions with 100% efficient number in BCC model from 1st to 7th ranks and Hamedan allocated the last ranking with 49% efficient number and in CCR model, 5 regions Abadan, South Khorasan, Fars, Qom and Yazd determined as superior regions.

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