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Evaluating Productive Organizations of Iran Khodro Industrial Group using DEA

Case study: Color Saloons of Mehr cam Pars Co.

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ABSTRACT

Undoubtedly, each organization thinks to evaluate its controlled units' performance to use its resources optimally that data envelopment analysis is one of the most applied method of evaluating performance. This is non-parametric method in field of research in operations measuring the attributed relationship between inputs and outputs to various units and also their performances. Since various models have been developed using data envelopment analysis in past years to be used, selecting a proper model to evaluate and measure efficiency of studied units is so important step. In this research, DEA is proposed and CCR linear planning model and LINGO software were used to analyze efficiency of coloring lines in Mehr cam Pars co. of Iran Khodro industrial group. It was tried in this research to proposed efficiency of coloring production units, advantages, and disadvantages of their ranking, and having some suggestions to increase units' efficiency which are in lower levels..

Keyword:

DEA,

efficiency,

ranking

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1. Introduction

Production units are needed to assess the criteria taken into account the fact that the input variables to produce the same unit of output is the ranking criteria and that it is possible to show measure the view the performance of units.

variables and criterions ⇨ evaluating efficiency ⇨ Ranking productive units

In recent years, due to economic sanctions and reduced foreign substances also reduce the cost of expensive resources and the obligation to remain in a competitive market for the products of manufacturing main target is to improve the efficiency In the meantime the important role in helping plays organizations.

Provide appropriate solutions to improve the performance of a production unit are one of the most important performance evaluation processes. DEA or DEA is a method based on linear programming and the Charles and colleagues first presented in 1978. The method for evaluating the relative efficiency of decision making units that perform the same tasks used. [1] Such as measurement and comparison of the relative efficiency Of organizational units such as universities [7] banks [8] Airports [9] and similar cases where units

are egalitarian decision-making. DEA efficiency analysis is an appropriate method to evaluate multifaceted similar units (DMU) is based on multiple inputs and outputs. In a manufacturing unit to determine the relationship between input and output, efficiency frontier production function is the same, but in a non-parametric method to evaluate the method DEA Used since the beginning of the production function is not defined, but directly "using observed data to determine the efficiency and effectiveness of border units it is measured. [2]

2 .Research Theoretical Literature

2-1 Data Envelopment Analysis (DEA)

Data envelopment analysis (DEA) is a mathematical programming approach is to assess the relative efficiency of decision making units. Decision-making unit consists of a corporate unit that includes a system process, the number of inputs are applied to the output can be achieved. The main objective manner, identify the most efficient organization among a group of organizations, is preparing a similar output. This model units set as a target for the inefficient units, as well as strategic and performance improvement strategies in the field suggests development units. [3] Index into three simple categories, partially divided and combined. A simple indicator of absolute value as a contributing factor in product performance reports.

Relative indicators and indicators of factors affecting the performance of the single product combines a set of factors affecting the performance of the index and percent report that can be combined [4] In this study, the extent of the relative indices. Input parameters include: human resources, both producers and overhead (staff), raw materials, machinery depreciation and maintenance machinery and output indicators include: profits from the sale, scrap and rework items and items back from customers.

Among the different models available in two basic models of DEA, the analog standard fixed and variable CCR and BCC are very versatile and easier computer programs available, most of these models are taken and modeling. In between BCC and CCR model should be noted, if constant returns to scale of CCR, if BCC method used is variable returns to scale and decreasing returns to scale if CCR-BCC method for increasing returns to scale BCC- CCR method is appropriate. [5]

RTS is a long-term concept that reflects the increase in output for the increase in inputs. This ratio can be constant, increasing, or decreasing. When the constant returns to scale is true that the increase in input as well as output increases, such as "If labor and capital is doubled, the product is also double. Increasing returns to scale beyond the proportion that the amount of output the rate of increase of input, output increased and if the rate of increase is less than the inputs are increasing, decreasing returns to scale is created. [6]

To answer research questions, the first step is finding a suitable DEA model to evaluate DMU units produced. Due to the constant returns to scale is applicable only if the firms act in optimal scale if different issues such competitive effects, limitations, and so are the firms do not act in optimal scale. In evaluating the performance of products, given that inputs per unit of output than intended constant returns to scale, input-based cover CCR model that is provided by experts in the project has been investigated.

2.2 Main CCR Model

Charles, Cooper, and Rhodes Farrell vision to develop and provide the ability to measure performance model with multiple inputs and multiple outputs, respectively. The DEA was called and the first time in 1976, in Rhodes, along with Cooper's thesis ((national schools assess student achievement America)) was used at Carnegie in 1978 in an article as measured by the efficiency of decision-making units)) were presented.

The first DEA model based on the initials of its founder CCR Was named. In this model, aimed at measuring and comparing the relative efficiency of organizational units such as schools, hospitals, banks and municipalities with multiple inputs and multiple outputs are the same .mdl of CCR Among the models are constant returns to scale. Constant returns to scale model is useful when all units act in optimal scale. In evaluating the performance of units when space and imperfect competition, impose restrictions on investments caused inactivity is optimal scale units. [6]

2.3 Advantages and Disadvantages of DEA

The advantages of DEA models focus on each of the observations in the population mean, the simultaneous use of multiple input and multiple output estimate changes in input and output units that are located in the center Kara possibility of using different inputs and outputs with scale different measurement and disadvantages of DEA is regarded as an optimization technique is possible to prevent measurement errors and other errors do not. Since the DEA is non-parametric technique, performed statistical tests to the problem, add a new unit to investigate the change in the rating performance of previous units are all units and changes in the type and number of entries may be the survey results make a difference. [6]

2.4 DEA Basical Models

Mathematical Classic Model of DEA (CCR)

$$Max\ Z^{\circ} = \sum_{R}^{S} = 1\ y_{rj^{\circ}}\,\mu_r$$

St:

$$\sum_{r}^{s} = 1\, y_{rj}\ \mu_r - \sum x_{ij}\ w_i\ \le 0$$

$$\sum_{i}^{n} = 1\, x_{ij^{\circ}}\, w_i\ = 1$$

$$\mu_r\ , w_i\ \ \ge 0$$

The model parameters are:

J= input value from unit

rj: The output value of the unit

r= Output weight

i= Input weight

n = number of units DMU

Number of model CCR restrictions on the number of units and the number of variables is equal to the total number of inputs and outputs.

DMU number of = number of restrictions

The number of outputs + number of entries = number of variables

Multiple input oriented CCR model

CCR model to convert to a linear programming model and we will deduct the equivalent of a numerator is the maximum. Thus, the deficit objective function model with respect to an objective function and linear equality constraints becomes a target.

$$Max\ z^{\circ} = \frac{\sum_{r=1}^{s} u_r\, y_{r^{\circ}}}{\sum_{i=1}^{m} v_i\, x_{i^{\circ}}}$$

Objective function model

$$Max\ z^{\circ} = \sum_{r=1}^{s} u_r\, y_{r^{\circ}}$$

$$\frac{1}{\sum_{i=1}^{m} v_i\, x_{i^{\circ}}} = 1$$

Objective function of Input CCR model

$$Max\ z^{\circ} = \sum_{r=1}^{s} u_r\, y_{r^{\circ}}$$

$$\sum_{i=1}^{m} v_i\, x_{i^{\circ}=1}$$

Objective function of input oriented CCR model

The basic model (multiple) CCR of input shaft:

$$Max\ z^{\circ} = \sum_{r=1}^{s} u_r\, y_{r^{\circ}}$$

St:

$$\sum_{i=1}^{m} v_i\, x_{i^{\circ}=1}$$

$$Max\ z^{\circ} = \sum_{r=1}^{s} u_r\, y_{rj}\ - \sum_{i=1}^{m} x_{ij}\, v_{i\ \le\ 0}$$

$$u_r\, , v_i\ _{\ge 0}$$

CCR cover model input shaft

According to multiple CCR model and the fact that a limit should be written for each unit, thus, can be obtained linear programming model that limits the number is higher than the number of variables and because simplex operation volume for the solution of planning issues are more dependent on variables, problem solving model requires a secondary operation volume will be less. [6]

Cover model called secondary model that will be as following:

St:

$$\sum_{j=1}^{n} \delta_j\, y_{rj}\ \ \ge\ \ y_{r\cdot}$$

$$\sum_{j=1}^{n} \delta_j\, x_{rj}\ \ \le\ \ \theta x_{i\cdot}$$

$$\delta_j \ge \theta$$

3. Introduction Model and Describing Research Data

3.1 Input and Output Variables

Increased efficiency depends on successful practices that could be the key factors influencing the activities of a detection system that divided the main group.

The first batch of internal factors that can be controlled by a person or manager. Including inputs, outputs and processes, and the second is the external factors such as governance, infrastructure, resources, etc. Since external factors cannot be controlled by the organization or its management, after internal factors that most manufacturing organization is to evaluate and change management attention. [2]

The model for evaluating the performance of units of paint (color lines) Mehr cam Pars co. which manufactures a variety of domestic and foreign car including the dashboard, seats and bumper implemented and evaluated in this study is a case study. The company has started since 76 colored pieces production process and now 2700 people are employed at the company's eight active color line, there are: IP 11, IP 12, IP 13, IP 15 , IP 16, IP 17, IP 18, IP 19, IP 20

In this study, each shift of the color lines are considered as a DMU and to evaluate the performance of each production units in three shifts A, B, C, and from there look at production units focus most attention on costs, have production and overhead costs, including cost of human resources and raw materials as input variables have been selected.

And profits from sales, customer satisfaction, collection of various types of bumpers and grille, frame and mirror frame score were selected as the output variable.

x1 = human resources and overhead

x2 = Raw material

y1 = profit

y2 = Customer Satisfaction

y3 = Set of bumpers

y4 = front of window frames and framed mirrors score

According to data collected through interviews indicators defined for each unit of decision-making and their values is as follows:

Input variables				
Row	Shift	Color Line	Total human resources overhead	Raw material (Billion Rial)
1	A	IP 11	3.6	11.2
2	B	IP 11	3	11
3	C	IP 11	2.2	9.9
4	A	IP 12	3.6	12
5	B	IP 12	2.8	11.2
6	C	IP 12	2.4	8.8
7	A	IP 13	4.3	25
8	B	IP 13	3.5	23
9	C	IP 13	2.7	23.5
10	A	IP 15	11.6	24.5
11	B	IP 15	10.3	23.5
12	C	IP 15	8	23
13	A	IP 16	11.7	26.5
14	B	IP 16	10.4	25
15	C	IP 16	8.9	24.2
16	A	IP 17	3.1	23.5
17	B	IP 17	2.8	22.1
18	C	IP 17	1.6	21
19	A	IP 18	4.5	22.9
20	B	IP 18	2.1	22.9
21	C	IP 18	1	22
22	A	IP 19	4	24.5
23	B	IP 19	3.4	23.9
24	C	IP 19	1.9	23.5
25	A	IP 20	6.2	16
26	B	IP 20	5.3	14
27	C	IP 20	4.4	13

Output variables						
Row	Shift	Color Line	Profits (Billion Rial)	Customer satisfaction (percent)	Set of bumpers (100)	Front of window frames and framed mirrors score (100)
1	A	IP 11	12.1	85%	10	72
2	B	IP 11	10	81%	8	50
3	C	IP 11	8.8	71%	3	29
4	A	IP 12	17.5	0.8	22	85
5	B	IP 12	13	0.78	19	93
6	C	IP 12	11	0.7	11	51
7	A	IP 13	16.5	86%	18	84
8	B	IP 13	10	78%	14	41
9	C	IP 13	8	62%	10	31
10	A	IP 15	13.2	88%	72	71
11	B	IP 15	8	79%	59	51
12	C	IP 15	4	65%	48	38
13	A	IP 16	14.5	73%	88	64
14	B	IP 16	6	63%	66	36
15	C	IP 16	4	58%	48	25
16	A	IP 17	16.2	86%	55	84
17	B	IP 17	13	76%	49	69
18	C	IP 17	10	70%	43	53
19	A	IP 18	18.8	89%	34	85
20	B	IP 18	14	74%	22	81
21	C	IP 18	12	71%	18	63
22	A	IP 19	19.2	88%	40	83
23	B	IP 19	13	73%	30	65
24	C	IP 19	8.8	65%	24	44
25	A	IP 20	2.2	90%	10	30
26	B	IP 20	1.6	85%	9	24
27	C	IP 20	1.5	84%	8	21

4. Calculation

4.1. Implementation of performance evaluation model

As mentioned above, taking into account all factors CCR model was used for the study. Given that output is intended to satisfy the authorities consent to units due to the economic situation (sanctions) they are more inclined to cut back on inputs in their production units. The model reviewed for this case is covered by CCR-INPUT. The model is solved using LINGO software. For example, to get the color line performance IP 11 must solve the following equation and the objective function.

$MIN\ Y° =$
12.1*u1+10*u2+8.8*u3+17.5*u4+13*u5+11*u6+16.5*u7+10*u8+8*u09+13.2*u10+8*u11+4*u12+14.5*u13+6*u14+4*u15+16.2*u16+13*u17+10*u18+18.8*u19+14*u20+12*u21+19.2*u22+13*u23+8.8*u24+2.2*u24+1.6*u25+1.5*u26>=12.1;
0.85*u2+0.81*u2+0.71*u3+0.8*u4+0.78*u5+0.7*u6+0.86*u7+0.78*u8+0.62*u9+0.88*u10+0.79*u11+0.65*u12+0.73*u13+0.63*u14+0.58*u15+0.86*u16+0.76*u17+0.7*u18+0.89*u19+0.74*u20+0.71*u21+0.88*u22+0.73*u23+0.65*u24+0.90*u25+0.85*u26+0.84*u27>=0.85;
10*u1+8*u2+3*u3+22*u4+19*u5+11*u6+18*u7+14*u8+10*u9+72*u10+59*u11+48*u12+88*u13+66*u14+48*u15+55*u16+49*u17+43*u18+34*u19+22*u20+18*u21+40*u22+30*u23+24*u24+10*u25+9*u26+8*u27>=10;
70*u1+50*u2+29*u3+85*u4+93*u5+51*u6+84*u7+41*u8+31*u9+71*u10+51*u11+38*u12+64*u13+36*u14+25*u15+84*u16+69*u17+53*u18+85*u19+81*u20+63*u21+83*u22+65*u23+44*u24+30*u25+24*u26+21*u27>=72;
3.6*u1+3*u2+2.2*u3+3.6*u4+2.8*u5+2.4*u6+4.3*u7+3.5*u8+2.7*u9+11.6*u10+10.3*u11+8*u12+11.7*u13+10.4*u14+8.9*u15+3.1*u16+2.8*u17+1.6*u18+4.5*u19+2.1*u20+1*u21+4*u22+3.4*u23+1.9*u24+6.2*u25+5.3*u26+4.4*u27<=3.6* θ;
11.2*u1+11*u2+9.9*u3+12*u4+11.2*u5+8.8*u6+25*u7+23*u8+23.5*u9+24.5*u10+23.5*u11+23*u12+26.5*u13+25*u14+24.2*u15+23.5*u16+22.1*u17+21*u18+22.9*u19+22.9*u20+22*u21+24.5*u22+23.9*u23+23.5*u24+16*u25+14*u26+13*u27<=11.2* θ ;
u>= θ;

With high-efficiency model (optimum) amount of 0.8623787 units IP 11 respectively. It shows that the inefficient functioning of the unit for the software call that number REDUCED COST (price reduction) to 0.4576616 for U1 shows to your use of all input variables without reducing output of 45.76 per cent.

If $\theta > 0$ resources used more virtual units of the first unit and if $\theta < 0$ is less than the first unit. Thus, if $\theta = 1$ unit under consideration is efficient and if $\theta < 1$ is the inefficient units [6]

4.2. Determine efficient and inefficient units and rank color units

Relative performance DMU 100% if and only if the value cannot be subtracted any data or output of no more we can do it, unless the data are fed another or the output of other less produced [1]

To calculate the efficiency of the operation is repeated for other data and compute efficiency and then ranked each match. Given that performance assessment coloring 9 units in three shifts based on several factors, is very complex, product manager without the use of tools able to perform multi-criteria decision will not be exact. Experience gained from the application of DEA in calculating the efficiency of color in three shifts Mehrcam Pars co. This method clearly showed that the optimal manner can be exploited in evaluating the efficiency of production units. In this case the color of the unit (IP 12 shift B) (IP 16 shift A) (IP 17 shift A,C) (IP 18 shift C) are efficient, in fact, generally has the best output from minimum input sources.

NO	IP NUM	SHIFT NO	Objective value	Reduced Cost
1	IP 12	B	1	0.2473118
2	IP 16	A	1	0.3090051
3	IP 17	A	1	0.4143028
4	IP 17	C	1	0.6364144
5	IP 18	C	1	0.688889
6	IP 12	A	0.9777175	0.5338543
7	IP 15	A	0.9622924	0.2614797
8	IP 17	B	0.9585767	0.5353517
9	IP 18	B	0.880827	0.4851257
10	IP 11	A	0.8623787	0.4576616
11	IP 12	C	0.8511138	0.7279832
12	IP 15	B	0.824993	0.3674819
13	IP 16	B	0.8248203	0.3106354
14	IP 19	A	0.755263	0.31541
15	IP 15	C	0.7261499	0.3548811
16	IP 18	A	0.7158962	0.329546
17	IP 11	B	0.6899179	0.4659828
18	IP 16	C	0.6660342	0.3323219
19	IP 19	C	0.6649662	0.6929902
20	IP 19	B	0.6327341	0.4295672
21	IP 11	C	0.6228189	0.8704896
22	IP 13	A	0.5667192	0.4130009
23	IP 20	C	0.5061214	0.6642942
24	IP 20	B	0.4921359	0.6168446
25	IP 20	A	0.4636531	0.4003907
26	IP 13	B	0.4557403	0.5023332
27	IP 13	C	0.4041914	0.5796796

4.3. Optimal values for the input variables

As mentioned in section 4.1 model input is required to get optimum levels of cost reduction number (Reduced Cost) to be deducted percent per unit of input variables.

5. Conclusion:

The results were determined pursuant C shifts each color line Mehr cam Pars compared to other shifts in the same line has lower performance, which is necessary to identify the root causes of the other of done.

According to the model used is observed that DEA is a good tool for calculating performance and rankings production units. It should also be noted that production managers can according to your desired input and output variables in the model considered appropriate factors and to assess the efficiency of their units.

Model limitations can be pointed out that the DEA method to compare the relative production units are absolute and cannot calculate their effectiveness and can be used only in comparison

One important limitation of the method DEA The number of units DMU Which are directly related to the number of input and output variables. In fact if the formula (number of outputs + number of entries) * 3 ≤ number of units do not adhere to assess the most efficient units will be equal to a model used is not reliable.

6. Suggestions:

The establishment of quality control personnel at the entrance of raw materials for better control of color is as following:

- Laboratory tests for color materials
- Review and integration of environmental factors such as temperature and humidity affecting the production process in three shifts
- Repair and maintenance of machines scheduled to perform better color lines color process and reduce waste and rework
- The actual re-allocation of human resources required for precision measurement in paint lines
- Production personnel to do their training painting
- The establishment of quality control personnel at the entrance of raw materials for better control of color

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