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DATA ENVELOPMENT ANALYSIS (DEA): CASE STUDY OF THE IRANIAN UNIVERSITIES

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ABSTRACT
Data envelope analysis (DEA) is one of the optimization approaches known and used for evaluating the relative efficiency of similar decision units. This model is indeed a modern mathematical technique in the field of quantitative management models. This study intends to briefly define DEA model and then expresses how to conduct input and output data calculations related to this model. As evaluating the performance of different sections in an organization is considered as a main issue, more, we deal with the importance of this principle in the universities as well as finding out how much efficiency may be effective in the progress and development of universities' performance. The case study here investigates and evaluates the performance of different parts among 10 national universities analyzed by DEA master software

Keywords: DEA (Data Envelopment Analysis); DMU (Decision making unit); Efficiency; Performance Management; Performance Improvement; Regression Equation.

INTRODUCTION
Efficiency is a concept has been used for long time to evaluate the performance of organizations. According to definition output to input ratio may determine the value of this indicator. Should an organization or a system have multi-input and multi-output, they could be homogenate by some coefficients; for this reason the ratio of summation of homogenized outputs to summation of homogenized inputs might be used as an indicator. This could be indicated by following equation:

$$\text{efficiency} = \frac{u_1 y_1 + u_2 y_2 + \cdots + u_r y_r}{v_1 x_1 + v_2 x_2 + \cdots + v_m x_m}$$

where $(u_1, u_2, u_3, \ldots, u_r)$ are output weights and $(v_1, v_2, v_3, \ldots, v_r)$ are input weights. According to above definition, the performance of similar departments and organizations could be comprised to each other; among them, full ranking of units from most efficient to most inefficient ones is very important. Some different universities nationally could be considered as similar units and by determining the faculties and their raking, their quality and performance could be assessed from most efficient to most inefficient one.
DEA is a mathematic programming-based approach mostly used for evaluating the performance of similar decision units. Capability of this method comparing to similar units as well as possibility of data analysis caused them to be used increasingly in different fields such that now this model has been used increasingly for assessing the efficiency of public and private institutes in a set of units or departments as is discussed as a strong and efficient tool (Mehrgan, 2004).
DEA obtains an extent of efficiency of a decision unit comparing to decision making units producing similar outputs by similar inputs. These units could be the branches of a bank, schools, universities, hospitals, refineries, branches of insurance companies, power plants, departments covered by a ministry and or similar factories.
DEA, conceptually, expresses the technical efficiency related to the input and output values of the process of producing the decision making units that physical outputs and inputs are indeed considered when calculating it.

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In this method, determining the weight for any output of similar units by solving an optimization problem, there is produced an output weighed aggregated scale (summation of weighed outputs) and an input weighed aggregated scale (summation of weighed inputs); then by dividing the aggregated output to aggregated input, the score of relative efficiency for any similar units will be obtained. Then units are ranked from the maximum efficiency score to minimum one. Therefore, the unit with maximum efficiency score is given with first rank and unit with minimum efficiency score is given with n^{th} rank (assuming the presence of n decision units) and units with their score equals with one, are considered as efficient units and units with their score less than one are considered as inefficient units.

One disadvantage of DEA model is lack of full ranking of decision unit and this occurs when it allocates the score of relative efficiency of one to many units and resulting in ranking the power of units completely from most efficient to most inefficient one.

This study that was a starting point for DEA was called as CCR. Turning the multi- inputs and outputs to a virtual input and output, CCR Model generalizes the Farl's Efficiency Measurement Approach for assessing the multi-input and multi-output units. For calculating the technical efficiency, CCR indeed uses ratio of outputs weighed summation (=virtual output) to inputs weighed summation (=virtual input) instead of ration of an output to an input.

The main objective of DEA includes comparing and evaluating some decision making units (DMU) similar to each other with different consumed inputs and produced outputs.

These units may include branches of a bank, schools, hospitals, power plants, departments covered by a ministry and or similar factories.

Now DER model is widely used for evaluating the efficiency of public and private institutes comprising from a set of similar units and are considered as a strong and efficient tool for management.

A model presented on 1978 (CCR) was developed on 19984 by Banker, Chartz and Copper (BCC) followed by special studies during two past decades as well as successful and various applications of this method reported in the international journals such that now DEA is considered as a suitable and strong tool for evaluating the performance of decision unit (Banker, 1984).

Literature Review
Performance Analysis and Introduction to DEA
One of the simplest and oldest methods for performance evaluation includes calculating the technical efficiency index, by definition is the ratio of output to input developed for the first time by Farrel (Farrel, M.J. 1957).

Farrel tried to obtain the productivity of a system with two inputs and one output based on general concept of productivity. As modern systems come with multiple inputs and outputs, the question is which output to input ratio must be used for calculating the technical efficiency index and how one must consider the weight of all outputs and inputs for calculating the technical efficiency index.

To answer above mentioned questions, the discussion for DEA was began by thesis provided by Edward Rhods supervised by Cooper. Rhods studies on evaluating the schools of USA and published his results on 1978 by cooperation of Charnes and Cooper (Charnes, A. 1978).

Concept of DEA
We consider some observations as indicated in figure (1). Analyzing the relation between output and input in such observations, there was used a regular method, i.e. parametric methods like regression. Parametric approach aims to optimize the regression equation explaining the gradual behavior changes against input. For this reason, all observations are used once to obtain this regression equation. In this approach, there is initially considered a special form of production function as default.

There are other methods called "Non-Parametric Approaches" (mathematical programming) and DEA is one of such approaches by which any observation will be optimized separately and DEA has no need to any assumption about function form. On the other hand, maximizing the efficiency index of any

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observation separately, a frontier, as indicated in figure (1) by continuous line could be determined, while any observation is located on linear piecewise Frontier is considered as efficient, otherwise it is inefficient.

Performance Assessment on 10 Faculties

Today, one of the main management objectives is efficiently using the existing sources. This requires knowing the performance of sources by which one can improve the sources state. Performance assessment process is a process aiming to increase the efficiency
of units in an organization, by which one can recognize the weaknesses and strengths of resources management in organizations.

Efficiency Measurement Model in the University

Performance evaluation in different parts of public sector in economy is one of the main issues attracted the attention of many scholars, particularly during recent years with its main discussions include decentralization and increasing the responsibility of executive managers in different departments as well as optimally allocating the existing resources among these departments. In this case, studying the performance of departments structured as a great organization with several branches has been specially attended. Branches charge for administrative tasks and produce special goods and or services by using special inputs. Organization is also responsible for supervising and controlling the branches.

As its name implies, performance measure indicators interrelated to what organization does. On the other hand, what is conducted by an organization is allocated for achieving the mission and objectives prepared for that organization. For this reason, it is necessary to have a general pattern of what is done by university to have efficiency indicators along with measurement of universities' performance. On the other hand, universities can develop their indicators based on their special objectives and an indicator provided in this complex seems to be an interface for all universities. These indicators also recommended being broken down to side indicators for accurate analysis in the universities.

This paper decided to measure the efficiency of 10 faculties nationally by using DEA; then its results are used for improving the situation of inefficient universities. Data analyzed by DEA MASTER for calculating the efficiency.

Background of DEA in the Universities

There are various studies used DEA for evaluating the efficiency of university departments and institutes. For the first time, Edwards Rhods, in his PhD thesis called "Evaluation of Academic Achievement of Students of USA" (1976) supervised by Cooper, use of DEA for this reason in Carnaki University. In another study conducted in Helsinki Economic School, Finland, a systematic approach was provided for analyzing the performance in the universities and researching institutes. This analysis was conducted based on recognizing a set of measures related to the decision.

Some of the most important works conducted in the field of performance assessment in higher education include study of Mrs. And MS. Johns. In their study, the technical efficiency of 36 economic faculties in UK was investigated. Bizli (1995), Bro et al. (1994); Alirezaei and Jahanshahloo (1994); Colbert et al. (2000)…. , dealt with evaluating the efficiency of higher education departments and universities by using DEA.

In a study conducted by Alirezaei and Jahanshahloo (1994) in TarbiateMoalem University, they evaluated the university departments of TarbiateMoalem University, Tehran. In this study, two main duties of university units, training duties and researching duties were defined with training dimension has been more described in this university.

Determining the Indicators Evaluated

As the first step for evaluation is determining the evaluated indicators, therefore, the indicators that must be assessed for performance assessment of faculties will be determined (tables (1),(2) and (3).

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Input Indicators:

1-   Number of faculties member;

2-   Number of training team or personnel;

Output Indicators:

1-   Number of students;

2-   Number of graduated students;

3-   Reversed number of probations.

Table 1: Performance Assessment of Universities with faculty and training team as indicators

DMU	Faculty				Training team
	Part time	Full time	invited	total	employees
University 1	41	27	91	159	8
University 2	8	18	17	43	6
University 3	22	32	24	78	15
University 4	33	30	136	199	14
University 5	51	39	90	180	11
University 6	24	21	69	114	29
University 7	17	28	61	106	7
University 8	17	16	74	107	7
University 9	11	17	17	45	10
University 10	14	18	48	80	5

Table 2: Performance Assessment of Universities with number of graduated students and students as indicators

DMU	Students				Graduated			
	Bachelor	*Master*	*PhD*	*Total*	*Bachelor*	*Master*	*PhD*	*Total*
University 1	472	749	339	1560	43	175	0	218
University 2	170	222	0	392	19	75	0	94
University 3	180	0	166	346	4	0	16	20
University 4	236	703	483	1422	24	68	0	92
University 5	254	655	419	1382	23	108	4	135
University 6	1721	70	0	1791	191	0	0	191
University 7	394	639	0	1033	13	90	0	103
University 8	922	273	275	1325	73	124	21	218
University 9	350	350	0	442	39	10	0	49
University 10	63	224	224	464	47	37	0	84

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Table 3: Performance Assessment of Universities with Number of Probations as indicator

			Probation
DMU	Bachelor	Mster	Total
University 1	59	83	142
University 2	0	13	13
University 3	14	0	14
University 4	13	89	102
University 5	29	35	54
University 6	177	0	177
University 7	0	35	35
University 8	67	25	92
University 9	7	0	7
University 10	4	18	22

Table 4 indicates the results of assessment as university efficiency percentage

Table 4- Universities' Efficiency

DMU	Efficiency%
University 1	100
University 2	100
University 3	30.347
University 4	58.003
University 5	65.907
University 6	100
University 7	78.629
University 8	100
University 9	64.858
University 10	53.945

According to tables for efficiency of 10 faculties, we conclude that universities 1, 2, 6 and 8 are efficient.
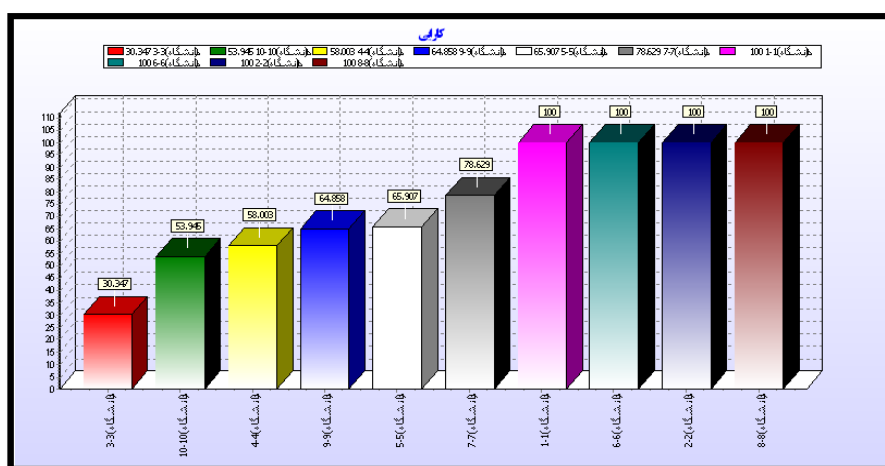
Graph 2: indicates the efficiency diagram obtained by related software

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REFERENCES

Banker, R.D, charnes, A., cooper, 1978. some models for estimating technical and scale in efficiencies in data envelopment analysis. Management science.30 (9), 1078- 1092.

Charnes A., cooper, W.W., Rhodes, E.,1978. Measuring the efficiency of decision- making units. European Journal of operational Resarch2, 429-444.

Farrell, M.j, 1957 .The measurement of productive efficiency. Journal of the Royal statistical society A 120, 253- 281

Mehrgan, Mohammadreza, 2004. quantitative models for organizational performance assessment (data envelopment analysis), Tehran University Press.