PERFORMANCE MEASUREMENT OF MANAGEMENT DEPARTMENTS OF IRAN ISLAMIC AZAD UNIVERSITIES BY USING OF DEA; (CASE STUDY: NORTHERN PROVINCES OF IRAN)

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Abstract
Performance evaluation is considered as one of the basic necessities for individuals, groups and institutions. Having the crucial responsibility of upbringing the required human forces of societies and job markets, universities, as public organizations, are not exception. Using data envelopment analysis (DEA) methodology, this study seeks to evaluate the performance of management departments of Islamic Azad universities of north of Iran in three aspects of the quality of education, quantity of education and research activities. The performance evaluation of decision units in the main model is measured considering two input indices (the number of entered students in three university degrees and full time scientific group) and three output indices (the quality of education, the quantity of education and research activities), and also sensitivity analysis is measured in 5 different scenarios. These models are analyzed using DEA-SOLVER and EMS software and after calculating the performance evaluation of each unit, ranking them is done by the use of Anderson-Peterson technic. The results of these analysis show that 10 units out of 16 units were identified as efficient and others were identified as insufficient. Then, by determining the reference units for insufficient units, an appropriate pattern is recommended.

Keywords: performance evaluation, data envelopment analysis

Introduction

University and its subsets are considered as an organization, which like any other organization has its own specific aim and purposes. To achieve these goals, it tries to precisely share its limited resources and make the best out of them. To determine how efficiently and successfully a university has acted and approached its final goals, its activities need to be specifically assessed. Since universities are some non-profit organizations with no financial aims, they can not be evaluated by typical criteria of performance assessment, which are mainly based on financial factors and wouldn't consider the growth and development of the capacities of the organization (being evaluated) and its performance improvement. Therefore, new performance assessment factors, in which financial factors as well as non-financial ones are involved, must be used.

Problem statement

Nowadays, transformations and changes in organizations are indispensible. When there are not any changes in an organization, the performance evaluation system is the first one to be noticed because the most striking feature of a dynamic organization is the evaluation and effective analysis of its activities in the course of time. Due to the importance of the performance

evaluation system in universities, an effective and efficient method, of a mathematical form, would be of much help. Nowadays, one of the prevalently used methods for performance evaluation is data envelopment analysis (DEA) methodology.

Accordingly, the present study is an attempt to evaluate the performance of management and the ranking of Azad universities of Northern provinces of Iran in order to identify their defections and inefficient parts and be able to come up with some practical solutions and suggestions to improve the performance level.

Research Methodology

The aims of the current study can be listed as follows:

1) Identification and comparative evaluation of the rate and kind of inefficiency in studied departments.

2) Declaration of performance improvement and optimization in studied departments.

3) Recognition of model departments to be served as an example for inefficient departments.

BCC output based model is used in this paper. The reason for this choice is that a given amount of resources, such as budget, students, scientific group, and etc, is allocated to each university and then they are asked to have the best output, as far as possible. (Martin,2005)

Data envelopment analysis (DEA) methodology divides the under-study departments into two groups, efficient and inefficient. The inefficient groups can be rated by their inefficiency grade although the same approach is impossible for efficient departments as their efficiency grade equals to 1.To rate the efficient departments, there exist a lot of methods among which the Anderson-Peterson (A-P) method is selected for our studies.

Input and output variable selection:

Model inputs: students and management faculty board members.

Model outputs:

Educational aspect: the number of educated students.

Investigation aspect: the number of published papers and written books by the faculty board members.

Education quality aspect: the rate of admission of the university students in higher levels.

Integration of inputs and outputs:

As the number of under-analysis units should not be fewer than three times as many as the sum of the inputs and outputs, input and output variables are combined with pre-determined weighing coefficients to lower their number to get more accurate results.

To combine the students of different levels and change them into a variable called incoming students (and also graduated students), the weighs used are:

If associate degree students are depicted as x_1, bachelor's degree students as x_2, and master's degree students as x_3, we get to:

Incoming student number = $x_1 + 2x_2 + 4x_3$

The weighs used to integrate research activities are according to the board member's promotion distinction chart, which is as follows:

Accepted papers in journals (ISI=7 points, scientific-research= 5 points, scientific-extensive=3, national seminars= 2 points, and written books= 20 points)

Statistical population in this study includes all management students of the educational year 2010-2011 from all Azad Universities of Northern provinces of Iran (including Mazandaran, Qilan, and Qolestan).

Required data were gathered by mathematical documents, evidence, and modeling and the yielded models were analyzed by functional software such as DEA-SOLVFR, EMS , and EXCEL.

Calculation and study of efficiency and inefficiency of different departments:

DEA model selected to measure efficiency and inefficiency of the departments is a BCC envelopment output-based model. The main question of the research is the determination of the efficiency of decision units. To answer this question, after entering data, all units were evaluated with the consideration of all input and output variables. The results are listed in table 1.

DMU code	DMU	efficiency	Reference group(shadow price)
16	Firuzkuh	1	1
1	Babol	1	0
15	Roudsar	1	3
13	Rasht	1	1
11	Astaara	1	5
10	Qonbad	1	1
6	Qaemshahr	1	1
7	Aliaabad	1	0
8	Qorqan	1	3
9	Qalikash	1	3
3	Tonekabon	0.970866	6(0.09),9(0.12),11(0.79)
4	Jouybar	0.954785	10(0.85),11(0.05),15(0.11)
5	Chaloos	0.864865	11(1.00)
14	Roudbar	0.846644	8(0.25),9(0.31),11(0.29),15(0.15)
12	Bandar Anzali	0.708744	8(0.30),11(0.67),13(0.02),16(0.01)
2	Behshahr	0.498337	8(0.07),9(0.19),15(0.73)

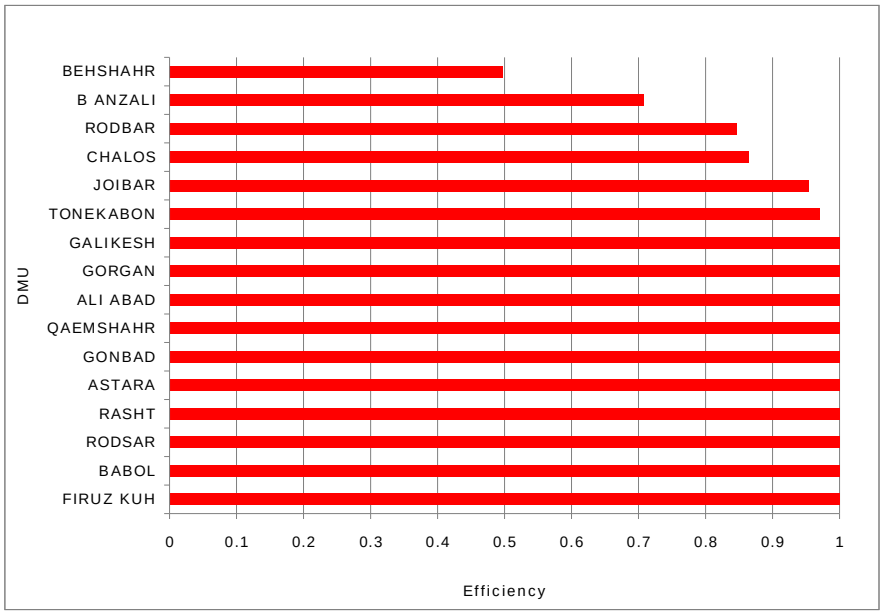
Table1: efficiency of units with all inputs and outputs

In the column of reference group, the numbers on the right side of each line indicate the number of units for which the correspondent unit has been introduced as a reference. For example, Roodsar unit has been introduced as a reference for three units, Jouybar, Roudbar, and Behshahr. In the number 6(0.09) in the reference column of Tonekabon row, number 6 is the reference DMU code and (0.09) is the shadow price.

According to the table, 10 out of the 16 units were distinguished as efficient, which is about %62 of all units. The average efficiency of all units is 0.93 with the standard deviation of 0.14. The minimum efficiency grade of 0.498337 is for Behshahr unit.

As it can be understood from the table, Tonekabon, Jouybar, Chaloos, Roudbar, Bandar Anzali, and Behshahr units are identified as inefficient units. One of the advantages of the data envelopment analysis is that it provides a practical solution for optimization through introduction of an imaginary unit resulted from the combination of the efficient units. Therefore, the imaginary unit for Tonekabon unit is resulted from the combination of Qaemshahr, Qalikash, and Astara units. This analysis depicts that Tonekabon unit can be on the border of efficiency by increasing its output.

Figure1- The figure below shows the bar figures of the efficiency rate of the units.



Since most of the units are recognized as efficient (Efficiency rate of 1), it is impossible to rank them. Therefore, for comprehensive ranking of the units, Anderson-Peterson method was used. In this method, efficient units can take efficiency rate of more than 1, so they can be ranked regarding their grades.

DMU code	DMU	Efficiency rate	A-P ranking	Final ranking
10	Qonbad	1	1.95	1
9	Qalikash	1	1.92	2
7	Aliaabad	1	1.81	3
13	Rasht	1	1.69	4
11	Astaara	1	1.58	5
16	Firuzkuh	1	1.57	6
6	Qaemshahr	1	1.52	7
15	Roudsar	1	1.48	8
1	Babol	1	1.41	9
9	Qorqan	1	1.38	10

Table 2. The comprehensive ranking of all units with all inputs and outputs.

As it can be seen from the table above, Qonbad unit is recognized as the most efficient unit and Qalikash and Aliaabad units are ranked as second and third units, respectively.

The analysis of the sensitivity of input and output parameters in unit efficiency level

The purpose of sensitivity analysis is to identify the kind of totally sensitive parameters to be able to have a more accurate estimation of them and, in the meantime, the selected answer, for all likely values of parameters, be an appropriate answer. The purpose is to study the efficiency grade changes by removing input or output factors. Accordingly, different scenarios are presented to evaluate units, which are thoroughly discussed as follows:

Scenario 1: in this scenario, the decision units are compared and evaluated in educational and investigative aspects. It includes two input variables, the number of students and faculty board members, and two output variables, the number of graduated students and published papers.

DMU code	DMU	Efficiency rate	A-P ranking	Final ranking	Reference group(shadow price)
10	Qonbad	1	1.92	1	1
9	Qalikash	1	1.91	2	2
11	Astaara	1	1.74	3	5
13	Rasht	1	1.71	4	3
1	Babol	1	1.66	5	1
16	Firuzkuh	1	1.57	6	3
6	Qaemshahr	1	1.52	7	2
15	Roudsar	1	1.48	8	3
8	Qrqan	1	1.38	9	4
3	Tonekabon	0.970866		10	6(0.09),9(0.12),11(0.79)
4	Jouybar	0.954785		11	10(0.85),11(0.05),15(0.11)
7	Aliaabad	0.893254		12	8(0.02),13(0.25),16(0.73)
12	BandarAnzali	0.675386		13	8(0.47),11(0.49),13(0.04),16(0.00)
14	Roudbar	0.662303		14	8(0.38),11(0.11),13(0.00),15(0.50)
2	Behshahr	0.498337		15	8(0.07),9(0.19),15(0.73)
5	Chaloos	0.314604		16	1(0.42),6(0.24),11(0.23),16(0.10)

Table 3. the rate of efficiency and comprehensive ranking of units in first scenario

If we compare the efficiency grade of table 1 with that of table 3, it is clear that the number of efficient units has declined. Aliaabad University considered as an efficient unit in the original model is inefficient in this model. This implies that the deleted variable, the percentage of bachelor's degree students who succeed to get admission for master's degree, is very influential in the efficiency of this university as its deletion transforms this unit from an efficient state to an inefficient one. Anderson-Peterson method is also used in this scenario to rank the efficient units; the results after solving the model are listed in the table. Among the efficient units, Qonbad is ranked as first.

Scenario 2: in this scenario, the decision units are compared and evaluated in educational and investigative aspects. It includes two input variables, the number of students and faculty board members, and two output variables, the number of graduated students who continue to be accepted in master's degree and published papers.

DMU code	DMU	Efficiency rate	A-P ranking	Final ranking	Reference group (shadow price)
10	Qonbad	1	1.95	1	0
9	Qalikash	1	1.93	2	3
7	Aliaabad	1	1.81	3	1
13	Rasht	1	1.69	4	2
16	Firuzkuh	1	1.61	5	1
11	Astaara	1	1.58	6	5
15	Roudsar	1	1.48	7	3
1	Babol	1	1.44	8	1
8	Qorqan	1	1.38	9	4
6	Qaemshahr	0.977784		10	7(0.03),11(0.97)

5	Chaloos	0.864865		11	11(1.00)
14	Roudbar	0.846644		12	8(0.25),9(0.31),11(0.29),15(0.15)
3	Tonekabon	0.797952		13	1(0.09),9(0.04),11(0.87)
12	BandarAnzali	0.708744		14	8(0.30),11(0.67),13(0.02),16(0.01)
2	Behshahr	0.498337		15	8(0.07),9(0.19),15(0.73)
4	Jouybar	0.494595		16	8(0.01),13(0.00),15(0.99)

Table 4. efficiency rate and comprehensive ranking of all units in second scenario

If we compare the efficiency grade of table 1 with that of the above table, it is noticed that the number of efficient units has decreased. Qaemshahr University, an efficient university in the original model, is now an inefficient one. This means that the deletion of the variable was so important that led to the transformation of this unit from an efficient unit into an inefficient one. After solving the model, Qonbad unit was the first among all others.

Scenario 3: in this scenario, the number of omitted papers and units were assessed by two input variables, the number of students and faculty board members, and two output variables, the number of graduated students and the percentage of bachelor's students admitted in a master's degree.

DMU code	DMU	Efficiency rate	A-P ranking	Final ranking	Reference group(shadow price)
16	Firuzkuh	1	1.94	1	0
11	Astaara	1	1.65	2	6
6	Qaemshahr	1	1.52	3	3
1	Babol	1	1.43	4	3
14	Roudbar	1	1.38	5	3
3	Tonekabon	0.991421		6	6(0.09),14(0.12),11(0.79)
5	Chaloos	0.864865		7	11(1.00)
13	Rasht	0.825286		8	6(0.65),11(0.35)
7	Aliaabad	0.823315		9	6(0.56),11(0.44)
12	Bandar Anzali	0.505806		10	1(0.13),14(0.01),11(0.86)
8	Qorqan	0.498337		11	1(0.22),14(0.78)
4	jouybar	0.405118		12	1(0.95),11(0.05)

Table 5. efficiency rate and comprehensive ranking in the third scenario

In this scenario, most of the units are introduced as inefficient. When the output variable of paper numbers is removed from the model, other variables of the four units of Behshahr, Qalikash, Qonbad, and Roudsar become zero and have no figures to be calculated and, consequently, are deleted from the model; so the remaining 12 units are later evaluated. This implies that the investigative aspect was of particular importance in the efficiency of the units. As a result, Qonbad, Qalikash, and Roudsar units which were previously distinguished as efficient units were totally omitted from the model in the third scenario. On the other hand, Roudbar unit, which was an inefficient unit in other models, is an efficient one in this model. In this scenario, Firuzkuh unit is the most efficient unit among all other efficient ones.

Scenario 4: if the input variable of the faculty board member number is deleted from the model and the units are evaluated using one input variable, student number, and three output variables, education quantity, education quality, and investigative aspect, the results will be as mentioned in the following table.

DMU code	DMU	Efficiency rate	A-P ranking	Final ranking	Reference group(shadow price)
10	Qonbad	1	1.93	1	2
7	Aliaabad	1	1.88	2	1
13	Rasht	1	1.69	3	5
16	Firuzkuh	1	1.64	4	0
11	Astaara	1	1.58	5	6
6	Qaemshahr	1	1.54	6	2
15	Roudsar	1	1.48	7	6
4	jouybar	0.954785		8	10(0.85),11(0.05),15(0.11)
3	Tonekabon	0.938535		9	6(0.05),11(0.95)
1	Babol	0.881579		10	6(0.21),7(0.10),11(0.56),13(0.13)
5	Chaloos	0.864865		11	11(1.00)
8	Qorqan	0.777088		12	13(0.21),15(0.79)
14	Roudbar	0.645772		13	11(0.34),13(0.04),15(0.62)
12	Bandar Anzali	0.633079		14	11(0.68),13(0.11),15(0.21)
2	Behshahr	0.405118		15	13(0.01),15(0.99)
9	Qalikash	0.210526		16	10(0.88),15(0.12)

Table 6. efficiency rate and comprehensive ranking of the units by fourth scenario

If the efficiency rate of the above table is compared with those of the table 1, it is understood that the number of efficient units has reduced. Babol, Qorgan, and Galikash universities were previously introduced as efficient units, whereas, in the fourth scenario, they are identified to be inefficient. This means that the deletion of the variable of faculty board member number was very important in the unit efficiency. Among the efficient units, Qonbad unit is chosen to be the most efficient one.

Scenario 5: if the input variable of student number is subtracted from the model and the units are again evaluated using one input variable, faculty board member number, and three output variables, education quantity, education quality, and investigative aspect, the result will be as listed in table(7):

DMU code	DMU	Efficiency rate	A-P ranking	Final ranking	Reference group(shadow price)
9	Qalikash	1	1.96	1	1
11	Astaara	1	1.92	2	4
7	Aliaabad	1	1.81	3	2
6	Qaemshahr	1	1.67	4	2
16	Firuzkuh	1	1.57	5	4
1	Babol	1	1.41	6	3
8	Qorqan	1	1.38	7	5
13	Rasht	0.960971		8	6(0.19),7(0.80),11(0.01)
5	Chaloos	0.864865		9	11(1.00)
3	Tonekabon	0.786246		10	1(0.21),6(0.11),11(0.68)
12	Bandar Anzali	0.529661		11	1(0.44),7(0.05).11(0.51)
14	Roudbar	0.335137		12	1(0.87),8(0.10),9(0.03)

15	Roudsar	0.320233		13	8(0.91),16(0.09)
2	Behshahr	0.162739		14	8(0.94),16(0.06)
4	jouybar	0.160116		15	8(0.91),16(0.09)
10	Qonbad	0.144658		16	8(0.94),16(0.06)

Table 7. efficiency rate and comprehensive ranking of units in the fifth scenario

If the efficiency rate of table 1 is compared to that of the table above, it is noticed that the number of efficient units has declined. Qonbad, Rasht, and Roudsar units which were efficient in the original model are now inefficient. This implies that the deleted variable was very essential in unit efficiency and its deletion can change an efficient unit into an inefficient one.

Conclusion

From the gathered information, it can be concluded that 10 out of 16 units are recognized to be efficient, which accounts for %62 of the total unit number. The average total efficiency of the units is 0.93, with the standard deviation of 0.14. The lowest efficiency rate is for Behshahr unit, which equals to 0.498337.

Tonekabon, Jouybar, Chaloos, Roudbar, Bandar Anzali, and Behshahr units are categorized as inefficient units. And, Qonband unit was the most efficient unit, followed by Qalikash and Aliaabad units, respectively ranked as the second and third.

It can be understood from the first scenario that the number of efficient units has declined. Aliaabad University considered as an efficient unit in the original model is inefficient in this model. This implies that the deleted variable, the percentage of bachelor's degree students who succeed to get admission for master's degree, is very influential in the performance of this university as its deletion transforms this unit from an efficient state to an inefficient one. Among the efficient units, Qonbad is ranked as first.

According to scenario 2, it is clear that the number of efficient units has decreased. Qaemshahr University, an efficient university in the original model, is now an inefficient one. This means that the deletion of the variable was so important that led to the transformation of this unit from an efficient unit into an inefficient one. After solving the model, Qonbad unit was the first among all others.

In the third scenario, most of the units are introduced as inefficient. When the output variable of paper numbers is removed from the model, other variables of the four units of Behshahr, Qalikash, Qonbad, and Roudsar become zero and have no figures to be calculated and, as a result, are deleted from the model; so the remaining 12 units are later evaluated. This implies that the investigative aspect was of particular importance in the efficiency of the units. As a result, Qonbad, Qalikash, and Roudsar units which were previously distinguished as efficient units were totally omitted from the model in the third scenario. On the other hand, Roudbar unit, which was an inefficient unit in other models, is an efficient one in this model. In this scenario, Firuzkuh unit is the most efficient unit among all other efficient ones.

As it is clear from the fourth scenario, the number of efficient units has reduced. Babol, Qorgan, and Galikash universities were previously introduced as efficient units, whereas, in the fourth scenario, they are identified to be inefficient. This means that the deletion of the variable of faculty board member number was very important in the unit performance. Among the efficient units, Qonbad unit is chosen to be the most efficient one.

It is noticed from scenario 5 that the number of efficient units has declined. Qonbad, Rasht, and Roudsar units which were efficient in the original model are now inefficient. This implies that

the deleted variable was very essential in unit efficiency and this unit was so successful in this area that the omission of this factor changes its efficiency status. Finally it can be concluded that:

1. Tonekabon, Jouybar, Chaloos, Bandar Anzali, and Behshahr units showed low performance in the originl model and all 5 different scenarios. Hence, to promote their efficiency, they should improve their performance.
2. Aliaabad unit was appropriately active in the fields of education quality and investigative aspect. But, it should give a rise to its education quantity.
3. Qaemshahr unit was inefficient from education and investigation quality point of view. It should increase its performance in this area.
4. Rasht and Qorqan units were quantitatively and qualitatively inefficient in education. They should put more efforts into this area.
5. Behshahr, Qalikash, Qonbad, and Roudsar units underwent no activities in the educational aspect (both quantitatively and qualitatively) as they were deleted from the model. These units can improve their performance by getting more involved in this area.

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