International Journal of Academic Research in Business and Social Sciences
November 2013, Vol. 3, No. 11
ISSN: 2222-6990

The Technical Efficiency of Departments of Shiraz Medical School in Research Arena Using Data Envelopment Analysis

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DOI: 10.6007/IJARBSS/v3-i11/318 URL: http://dx.doi.org/10.6007/IJARBSS/v3-i11/318

Abstract:
Introduction: An efficient university should have a real goal and could produce the most output with the least use of inputs. Evaluation systems are an inseparable part of each organization and university. By efficiency calculation, useful information will be created about strengths, weaknesses, opportunities, threats, and opportunities for improvement. Data envelopment analysis is a useful technique for evaluation of efficiency. This technique needs all the inputs and outputs to be measured precisely**.**
Methods and material: The present study is a descriptive, analytical, cross-sectional, and retrospective research which measures the research efficiency of educational departments of Shiraz faculty of medicine by using DEA technique from 2006 to 2011. Extracted data were analyzed by Microsoft excel and DEA master software**.**
Finding: Department of pediatric and psychiatrics were efficient from 2006 to 2011. Other departments have some inefficiency. Neurosurgery department has least average of efficiency. The average of technical efficiency for all departments was 73.873.
Conclusion: where the difference between efficiency score of the department and 100 is more, the department's needs to improve its outputs will be more. Those groups which are more inefficient waste the resources more. This method also could help the faculty of medicine to identify their weakness and try for improvement

Key word: Data Envelopment Analysis, Research, Technical Efficiency, Medical Faculty

Introduction

Universities, like other organizations, are trying to achieve their pre-determined goals [1]. An efficient university should have a real goal and could produce the most output with the least use of inputs[2].

In recent years, universities were trying to evaluate their educational, research, and executive performance. The results of these evaluations were published and for purposeful decision making[3]. But today, evaluation systems are an inseparable part of each organization and university [1]. Through an efficient evaluation system, the rate of goal achievement will be determined and also the strengths and weaknesses will be distinguished [4].

On the other hand, one of the important roles of managers is to ensure organization success and survive in long term. To play this role efficiently, the manager should be able to evaluate and monitor organizational performance. Thus, calculation of efficiency is an important and inseparable part of managerial activities [5].

Thus, universities, which have a dynamic education system, need to evaluate their activities for facing with environmental changes. In this way, efficiency calculation for educational departments is a of resource allocation process in universities [6]. Through efficiency calculation, useful information will be created about strengths, weaknesses, opportunities, threats, and opportunities for improvement [1, 7].

Insufficiency of traditional efficiency measurement criteria and change in competitive environment, launch a reengineering in measuring efficiency models in universities [6, 8, 9]. Regarding to limitations of traditional methods for measuring efficiency, higher education institutes and universities should seek a comprehensive technique for evaluation [10]. One of practical and useful techniques is Data Envelopment Analysis (DEA) which helps the organizations to achieve their strategic goals in evaluation systems implementation [6, 8, 9]. This technique needs all the inputs and outputs to be measured precisely [11].

DEA helps to identification of efficient and inefficient units and create a sense of competition which drives the university toward advancement and growth [8, 9, 12]. Thus, efficiency measurement through DEA, help the universities to train powerful students which could help the society to have better life [8, 13]. DEA could rank the decision maker units (DMUs) comprehensively [14] as well as comparison of efficiency between different departments [15]. This technique has been used widely for efficiency measurement in governmental and non-governmental universities all over the world.

Using DEA for measuring efficiency is common in whether developed countries (Sav, Cunha and Rocha) and developing countries (Abdulkareem and Oyeniran, Tochkov, et al, Wei and Ahmad)[8, 16-20]. Nearly all the researchers found DEA as an effective technique for efficiency measurement in universities and declare this method has a positive impact on country advancement, and responds to political, economical, and social needs of a country (for example Kuaha and Wonga, Abdulkareem and Oyeniran) [8, 17]. Tochkov et al found that there is no significant relationship between governmental subsidy to universities and efficiencies while

International Journal of Academic Research in Business and Social Sciences
November 2013, Vol. 3, No. 11
ISSN: 2222-6990

efficiency and monetary fund has a negative relationship[18]. As Sonha and Rosha state, inefficient universities waste resources[20].

Thus, measuring efficiency through DEA could be a basis for resource allocation by government and university officials. Despite the power of DEA in planning, in Iran, few studies use DAE to measure efficiency in universities. Since in Iran medical and non-medical universities are separate, these scarce studies were mainly done in non-medical universities. Also, in other countries more researches were devoted to non-medical universities. In addition, According to searches in databases, there was no sign of using DEA for measuring department's efficiency in a medical faculty. These are some reasons that simulate performing a study in Iran to measure and rank research efficiency of departments in medical faculty of Shiraz University of Medical Sciences. Furthermore, the study is going to find the reasons of inefficiency in each department and present solutions to improve efficiency.

Methods:

The present study is a descriptive, analytical, cross-sectional, and retrospective research which measures the research efficiency of educational departments of Shiraz faculty of medicine by using DEA technique from 2006 to 2011. For the sake of using DEA, it is necessary to identify different units (departments) of the faculty which have similar input and outputs[21]. Since medical faculty is the widest faculty in the university, it has the most number of professors and students, and wide difference of disciplines existed in the faculty of medicine, as a study population, this study could help university official and decision makers to plan and allocate resources to the faculty. The study could also be a pattern for efficiency analysis of clinical and basic sciences departments of faculty of medicine all over the world and specially Iran medical universities.

Since the study measure the efficiency of all the clinical and basic sciences departments of the faculty, there is no sampling technique or formula, thus the study doesn't have any sampling error. Thirty one departments are existed in the faculty which twelve of them are basic sciences (immunology, genetics, pharmacology, anatomy, physiology, medical physics, biochemistry, bacteriology, parasitology, biostatistics, medical ethics, and medical education) and nineteen of them are clinical sciences (pediatrics, gynecology, psychiatrics, pathology, internal medicine, otology, social medicine, general surgery, radiology, dermatology, cardiology, anesthesia, ophthalmology, radiotherapy, rehabilitation, neurology, urology, orthopedics, neurosurgery). It should be noted that medical ethics and medical education department was established in 2008 and as a result in two first years of survey (2006- 2007) twenty nine departments was surveyed.

For the purpose of the study, primary data were extracted from research documents and statistics of Shiraz University of Medical Sciences for all of departments. Since basic and clinical sciences departments have different arena of performance, research activities which are similar in both sciences could be a good criteria for comparison of these departments. For example, clinical sciences departments, have treatment performance, while basic sciences departments do not have any activity in this arena). Thus, research efficiency was selected for the study.

The second phase of using DEA is to clarify inputs and outputs of decision making units. Universities have widely different inputs and outputs and therefore, defining significant criteria for strategic decision making, and efficiency measurement is a big challenge [21]. In DEA technique selecting appropriate inputs and outputs play an important role in interpretation,

usage, and acceptability of research results by managers [13]. Accordingly, to sessions of focus groups were held with the managers of nearly all departments and four inputs and six output criteria was chosen which were important in their viewpoint.

Inputs that are selected for the study were as follow: (1) number of faculty members; (2) number of faculty members which receive sabbaticals; (3) total number of students; and (4) number of research centers which was constituted by one or more faculty members of a department. Similarly, selected outputs was (1) total number of papers published in ISI and PUBMED journals; (2) total number of papers which are published in journals which are not indexed in ISI and PUBMED; (3) total number of paper which are presented in national and international conferences; (4) total number of finished thesis in master and PhD degrees; (5) total number of approved research projects; and (6) total number of finished research projects.

In the study DEA technique was used for measuring efficiency based on output maximization with the use of cross-sectional data and with the variable return to scale (VRS). given that inputs is not under the control of departments, using DEA based on input minimization is not recommend. For the survey, the following linear programming model was used[22]:

Max $z=\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+$

st:

$$\sum_{j=1}^{n} \lambda_{jX_{ij}} + S_i^- = X_{i0} \qquad (i = 1,2,\dots,m)$$

$$\sum_{j=1}^{n} \lambda_j y_{jr} - S^+ = \theta y_{r0} \qquad (r = 1,2,\dots,s)$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

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

Where:

i: decision making units (educational departments) with that number of inputs,

r: decision making units (educational departments) with that number of outputs,

$X_j = (X_{1j}, \dots, X_{ij})$: rate of each input

j = 1, ... , n: number of decision making units (educational departments)

$Y_j = (X_{1j}, \dots, Y_{rj})$: rate of each output

θ: relative decrease in inputs of zero unit while output level is constant

S_i^+: lack of produced output for one i output

S_i^-: surplus input for decision making unit

Extracted data were analyzed by Microsoft excel and DEA master software via the aforementioned model. In the next section, results of the analysis are presented.

International Journal of Academic Research in Business and Social Sciences
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Findings:
Table 1 shows the descriptive statistics of research variable in the six years of survey (2006-2011). Table 2 shows the efficiency score of each department separately for the years under survey which are ranked from the most to the least score.

Table 1- descriptive statistics of variables

Statistics / Variable	number of observations	minimum	maximum	average	standard deviation
number of research centers which was constituted by one or more faculty members of a department	182	0	13	2.20	2.656
total number of faculty members	182	1	47	11.51	9.370
total number of students	182	0	91	19.71	15.276
total number of faculty members which receive sabbaticals	182	0	3	0.08	0.374
total number of papers published in ISI and PUBMED journals	182	0	94	21.12	21.428
total number of papers which are published in journals which are not indexed in ISI and PUBMED	182	0	46	8.31	6.919
total number of finished thesis	182	0	44	9.85	8.807
total number of approved research projects	182	0	68	13.10	12.771
total number of paper which are presented in national and international conferences	182	0	70	14.34	14.439
total number of finished research projects	182	0	71	8.03	9.971

Table 2- technical efficiency of departments in research arena

Year / Department	2006	2007	2008	2009	2010	2011	Mean
Psychiatrics	100	100	100	100	100	100	100
pediatrics	100	100	100	100	100	100	100
parasitology	100	100	100	99.88	100	100	99.98
pathology	100	91.334	100	92.467	100	100	97.3
Internal medicine	82.958	100	90.733	94.181	100	100	94.645
immunology	81.843	87.262	97.383	100	100	100	94.414
otology	93.352	100	100	100	81.464	87.258	93.679
biostatistics	100	100	67.167	96.606	100	100	92.295
Social medicine	100	100	89.422	92.311	68.844	93.044	90.603
General surgery	100	81.063	86.811	83.387	100	83.734	89.165
Medical physics	100	50	100	100	66.895	100	86.149
Medical education	-	-	100	90.387	50.641	100	85.169
radiology	100	70.684	100	76.51	57.142	100	84.056
dermatology	100	90.406	100	100	68.957	41.83	83.532
cardiology	100	100	100	64.87	54.19	59.851	79.818
gynecology	100	90.946	69.581	65.926	62.664	69.879	76.499
anesthesia	100	75.112	71.187	76.4	73.634	62.395	76.454
ophthalmology	100	77.447	89.785	80.483	65.959	44.202	76.312
bacteriology	84.956	98.793	75.173	58.991	54.233	68.032	73.263
radiotherapy	100	30.733	69.444	68.91	89.326	61.384	69.966
rehabilitation	77.586	87	71.532	58.024	54.115	61.695	68.325
Medical ethics	-	-	5.882	100	50.352	100	64.058
pharmacology	68.698	76.21	69.055	60.314	43.636	61.422	63.222
Anatomy	79.881	58.451	54.436	52.936	56.189	70.459	62.058
biochemistry	23.477	48.103	47.14	63.451	61.189	76.875	53.372
neurology	43.787	53.49	46.827	52.609	49.593	73.4	53.284
urology	31.235	38.788	58.57	72.914	69.405	34.58	50.913
genetics	100	44.444	55	40.192	27.299	34.482	50.236
orthopedic	61.621	37.334	65.32	28.766	38.873	24.255	42.694
physiology	21.521	61.469	29.053	65.4	31.523	46.864	42.638
neurosurgery	41.176	47.819	48.641	34.806	27.45	34.439	39.055

mean	82.486	75.754	75.742	76.464	67.857	73.873	75.362

As it is seen in table 2, in 2006, from twenty nine departments, sixteen departments (four basic sciences and twelve clinical sciences departments) were efficient in research arena and the average of technical efficiency for all departments was 82.486. In 2007, number of efficient department decreased from sixteen to eight departments (two basic sciences and six clinical sciences departments) and the average of technical efficiency for all departments was 75.754. In 2008, thirty one departments were surveyed and ten of them (three basic sciences and seven clinical sciences departments) were efficient and the average of technical efficiency for all departments was 75.742. In 2009, from thirty one departments, seven departments (three basic sciences and four clinical sciences departments) were efficient and the average of technical efficiency for all departments was 76.464. In 2010, eight departments (three basic sciences and five clinical sciences departments) were efficient and the average of technical efficiency for all departments was 67.857. In 2011, eleven departments (six basic sciences and four clinical sciences departments) were efficient and the average of technical efficiency for all departments was 73.873.

Discussion:

DEA is a flexible model which can answer the needs and questions of policymakers and decision makers about the efficiency of their organization [23]. Via efficiency measurement, they could monitor and control departments' performance [8]. In this survey, where the difference between efficiency score of the department and 100 is more, the department's needs to improve its outputs will be more. Those groups which are more inefficient waste the resources more [20]. Since the efficiency measurement in this study was assumed output based, thus, the lack of outputs was specified that manager of department should pay attention to them. Indeed, in this type of analysis, the optimized rate of each output was specified. As DEA is able to survey different input and output together, is a suitable technique for evaluation of efficiency in universities and faculties [20]. This method also could help the faculty of medicine to identify their weakness and try for improvement. Therefore this method could help the faculty to find the best way to achieve strategic goals [14] and create a sense of competition among groups that could be a stimulus for improving quantity and quality of research in the university[24].

Acknowledgment: This paper has been extracted from MSc thesis done by somaye delavari, MSc student of medical education. The thesis is supported by vice chancellor of research affairs of Shiraz University of Medical Sciences with grant number 6157. We would like to thank Dr Gholamreza Hatam, Dr Ali Poostforoushfard, Miss Sharare Bahadori, Mrs Fatemeh Pakravan, Miss Forogh Dehbozorgiyan, Mrs Negar Firoozi, Mr Kambiz Eskandari, Mrs Samira Sabzevari, Mrs Sima Poostforoushfard, Mrs Parvaneh Sadeghi, Miss Zahra Pandkhahi.

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