Estimation of The Efficiency of Different Academic Departments Using Data Envelopment Analysis: A Study in an Iranian Medical University.

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Abstract

Introduction: In every country, educational systems are regarded as the axes of development. Therefore, evaluating different academic departments as the main parts of educational systems is one of the most important responsibilities for university managers and authorities This study aimed at evaluating educational performance of all departments at the School of Health, a University of Medical Sciences using Data Envelopment Analysis technique in a time period of 2012-2015.

Methods: This descriptive, cross-sectional study evaluated the performance of the School of Health departments from 2012 to 2015 using Data Envelopment Analysis technique and Deap version 2.1.

Results: The study findings revealed that 57% of the academic departments were efficient and had constant returns to scale (CRS) while others (43%) had decreasing returns to scale (DRS). The Departments of Health Care Management, Nutrition, and Environmental Health were mentioned as reference groups for those inefficient ones.

Conclusion: Improving the quality of universities' performance depends greatly on competent and well-organized academic departments. Thus inefficient departments should benchmark reference groups to increase their output and promote the performance.

Keywords: Performance evaluation, DEA, Academic department, Efficiency.

Introduction

Nowadays, due to increasing acceleration of knowledge, educational systems face considerable change and complexity in their structure (1). To deal effectively with such instabilities, the evaluation technique can be helpful (2). Universities as the main body of higher education system are the significant sources of human resources supply being regarded as the development axis for socio-economic growth (3). To assure the attainment of defined objectives through maximum use of limited resources, these organizations need to be systematically assessed (2). Such evaluations reveal the deficiencies in organizational performance which act as a guidance for making necessary changes in existing processes to achieve determined goals. Thus setting a system to assess organizational performance plays an important role in improvement and excellence of training institutions (4).

Universities attract human and physical resources, money, and credit as the main inputs to follow their main mission of knowledge promotion and science production. Their performance evaluation can be done based on three dimensions of workforce, resource utilization, and organization. From the resource utilization aspect, performance analysis is defined by efficiency indicators which measure the efficacy of managerial decisions regarding

optimal use of resources (5). Data envelopment analysis (DEA) is an evaluation technique which is nowadays used in a wide range mostly to assess and compare the relative efficiency of decision making units with homogenous multiple inputs and outputs (6). Efficiency is "a measure of the extent to which input is well-used for an intended task or function" (7). DEA is a linear programming method which examines the relationship between input and output variables of a production system. One of the characteristics mentioned for DEA is its structure for returns to scale which can be either constant or variable. Constant returns to scale (CRS) means that a unit of increase in the amount of input correspondingly leads to the same proportion of increase in the output. In fact CRS models are useful when all operating units work in an optimal scale. On the other hand, variable returns to scale (VRS) means that a unit of increase in input leads to disproportionate increase in output (8). Literature has mentioned different types of efficiency in various science and technology settings. Three main types of efficiency including technical, allocative efficiency, and scale efficiency can be addressed by DEA. Technical efficiency is related to an organization's success in yielding maximum output from a determined set of inputs or the situation when it yields maximum amount of output from minimum inputs. Allocative

efficiency emphasizes on the way output measures are distributed among community members to achieve the right combination of outputs which represents consumers' preferences. Finally scale efficiency is about an optimal size of operations which its value is calculated by dividing the aggregate efficiency by the technical one (9-11).

To use DEA model, inputs and outputs for decision making units should be determined. For this purpose, Bowline in 1998 stated some general guidelines as below:

➤ There is a need for clear connection between inputs and outputs so that by increasing a unit of input, an increase in one or more outputs would be expected.

➤ Input and output values in study units should be positive.

➤ Input and output variables should be comprehensive enough to explain the performance of under review unit.

➤ The selected input and output variables should be in line with managerial attitude toward performance evaluation of study units.

➤ The values of variables should be controlled in such a way that cannot simply be manipulated.

➤ Total number of input and output variables should not be more than one-third of evaluated units (12).

In recent decades, evaluating the performance of different educational departments at micro level has received a significant importance by researchers in different disciplines of social sciences particularly economics and management. Antonio in 2008 measured the efficiency of governmental universities in Portugal using DEA technique (13). Heidari Nezhad (2005), Homburg (2002), Goksen et al. (2015) and Abd Aziz et al. (2013) used a similar method to evaluate the efficiency and productivity of university educational departments (14-17). DEA as a linear programming method measures the efficiency of multiple decision-making units (DMUs) when the production process consists of multiple inputs and outputs. Researchers concluded that DEA is a dominant and easy technique to apply an approach which compares the performance of working units in different organizations and also provides managers with a useful guide to improve their departments' efficacy. Having the ability to consider multiple inputs and outputs in the model, considering returns to scale in calculating efficiency and increasing or decreasing efficiency based on size and output levels are among the main DEA advantages which have been mentioned in several studies (18). Due to the increasing importance of efficiency measurement for different decision making units and mentioned benefits regarding DEA method, this study aimed at evaluating the efficiency of different educational departments

at a University of Medical Sciences through Data Envelopment Analysis technique in a time period of 2012-2015

Methods

This descriptive, cross-sectional study was conducted to evaluate the performance of departments of the School of Health affiliated by a University of Medical Sciences (SSUMS) using DEA technique during 2012-2015. In total there were 13 academic departments among which those with more than 5 years of activity including the Departments of Health Care Management, Nutrition, Occupational Health, Environmental Health, Statistics and Epidemiology, Health Services and Food Safety were enrolled in the research. Data regarding performance and efficiency measurement of these 7 departments were gathered through interview with key informants and reviewing relevant documents registered in research training system of YUMS. To do so a checklist was designed and Data Envelopment Analysis (DEA) method was applied to rank study departments based on their technical and scale efficiency. Each variable's data were analyzed through Excel and transferred to Deap 2.1 software for DEA analysis using variable return to scale (VRS) methodology. VRS is one of DEA models which is more suitable in realistic cases where there is no constant returns to scale and a definite change in input does not

lead to similar amount of change in output. The method determines the points with lowest unit cost for any specified output and outlines the efficiency frontier by connecting the points. Units that are not placed on the frontier line are considered inefficient. Through identifying initial, optimal and extra amounts of inputs and outputs, DEA reveals the quantity of inputs and outputs that decision making units should omit or enhance to obtain efficiency (19). Efficiency measurement can be done through using two approaches including minimizing inputs at given output level and maximizing the output at the input level (20). As inputs are not controllable in study departments we used output orientation model. We defined input and output factors conforming the university mission and objective which included number of students, professors, and department staff as input variables whilst the number of published articles, books, research projects, graduates, their average BSc or MSc score, and satisfaction level were mentioned as output variables. As units might value inputs and outputs differently and consequently assume different weights, for each unit a set of weights should be adopted which confirms its most favorableness compared to other units (21). Flexibility in the selection of units' weights might be a weakness owing to probable judicious choice of weights; therefore, in the current study all weights were extracted in an

expert panel comprised of key informants (including research team, school dean and his assistants) using data obtained from literature,

relevant documents and promotion guidelines for university faculty members.

Results

As a whole there were 13 educational departments among which those with more than 5 years of activity including the Departments of Health Care Management, Nutrition, Occupational Health, Environmental Health, Statistics and Epidemiology, Health Services, and Food Safety were enrolled in the research.

The main characteristics related to academic departments are depicted in Table 1. The order of establishment of academic departments revealed Health Services and Food Safety departments as relatively the oldest and newest

ones. Furthermore, the number of students in each department showed that the greatest relevant value belonged to Health Services with 330 students. In case of published academic documents, the most pioneer department was Statistics and Epidemiology with 337 published articles, 422 research projects, and 2 books. Findings related to students' satisfaction from educational and training process in the study departments also indicated that the highest level of satisfaction belonged to Health Care Management students (87.3%).

Academic Departments	Year of establishment	Number of Staff		Number of Student Inputs				Number of articles	Number of research	Number of books	Number of graduates	Average satisfaction of students from the group
		Faculty members	staff	Associate Degree	BS	MSc	Ph.D					
Nutrition	2008	4	3	-	-	27	5	153	41	-	24	86
Statistics and Epidemiology	2010	7	3	-	-	50	-	377	422	2	31	82.7
Environmental Health	1991	4	14	-	238	34	19	254	93	-	335	86.4
Health services	1990	6	10	-	269	37	24	248	84	-	333	84.4
Health Care Management	2003	5	5	-	96	31	-	116	54	4	98	87.3
Food safety	2011	3	6	-	-	28	-	109	18	1	18	83.5
Occupational Health	1991	3	12	-	261	31	-	190	65	-	224	86.5

Table 2 depicts the values of technical, scale and allocative efficiency in different academic departments. As it is shown, four departments including Health Care Management, Nutrition,

Environmental Health, Statistics and Epidemiology were selected as reference groups for inefficient study units. Findings revealed that the Department of Health Care

Management had decreasing returns to scale and its both allocative and scale efficiency values were below 1. Food Safety and Occupational Health departments had also decreasing returns to scale and reported to be inefficient in terms of technical, allocative, and scale aspects.

Table 2: Comparison of the types of performance of the study groups

Range	Academic Departments	Efficiency			Return to Scale	Efficiency references
		Allocative	Technical	Scale		
1	Nutrition	1	1	1	fixed	-
1	Statistics and Epidemiology	1	1	1	fixed	-
1	Environmental Health	1	1	1	fixed	-
1	Health Services	1	1	1	fixed	-
2	Health Care Management	0.783	1	0.783	decreasing	-
4	Food Safety	0.936	0.971	0.965	decreasing	Health Care Management-Nutrition
3	Occupational Health	0.969	0.999	0.969	decreasing	Health Care Management-Nutrition-Health Services

Below table discloses the optimal condition regarding each study department using DEA method and variable returns to scale assumption. Reported findings declared the amount of inputs and outputs which inefficient units should increase in order to obtain efficiency. For instance, the Department of Food Safety should have almost 18 units of increase in students' average score, 0.5 units in satisfaction, 398 units in published documents, and 21.8 units in the number of graduates.

Discussion

The current study evaluated the efficiency of academic departments at the School of Health affiliated by a University of Medical Sciences in a time period of 2012-2015. As there were multiple input and output variables in estimation process and the hypothesis for constant returns to scale had been rejected, also the departments had limitation in controlling their inputs, we applied VRS-output based model using DEA method. Study findings revealed that half of the academic departments were inefficient and needed to increase their outputs to obtain efficiency. Similarly Goodarzi in a study conducted to rank different academic groups in Kerman University of Medical Sciences found that inefficient departments should increase their outputs specially those related to the number of publications (22). Furthermore, the necessity for improvement in

the number of graduates, publications and research projects were emphasized in a study done by Poormiri and Ketabi in Isfahan (23).

In a study conducted in Malaysia to evaluate the relative efficiency of departments in a public university, DEA-VRS method was used. Findings affirmed the satisfactory level of performance in the study departments regarding producing graduates compared to total number of research projects or number of publications (24). A similar study was done in Transilvania University which applied input-oriented CCR model to rank its academic departments regarding efficiency. Results confirmed significant differences in efficiency scores of different departments emphasizing the fact that university authorities should allocate different amounts of resources to dissimilar departments (25). Agha et al (2011) also found that 12 departments out of 30 study units were efficient; among which public service activities needed the most improvement in outputs, while training resources required the most improvement in inputs (26). Another study conducted by Kuah et al. (2011) to assess the

efficiency of universities through data envelopment analysis declared that under study universities should promote their efficiency regarding both research and training activities. Relevant findings suggested 40% increase in teaching outputs and 55% increase in research achievements (27).

These findings might be useful for university authorities and those responsible for policy making to attain necessary information for managing existing resources in the most efficient manner. Distinguishing efficient departments from inefficient ones is another beneficial result that helps managers make corrective and improving decisions based on it. Furthermore, the efficient departments can be mentioned as benchmarks for others enabling them to be informed of degree to which necessary changes should occur in their inputs or outputs to obtain efficiency. Managers can also find out how efficient the departments are in utilizing their resources and subsequently provide useful suggestions for them to increase their productivity by reallocating resources.

References

1. Cardinaels E,Veen Paula M.G. *Financial Versus Non-financial Information: The Impact of Information Organization and Presentation in a Balanced Scorecard*. Accounting, Organizations and Society 2010; 35(6): 565-578.

2. Lopes, Ana Lucia &Lanzer, Edgard Augusto. *Data Envelopment Analysis DEA and Fuzzy Sets to Assess the Performance of Academic Department: A case study at Federal University of Santa Catarina-UFSC, Pesquisa Operacional* 2002; 22(20): 217-230.

3. Shahriyari SA. *Providing a DEA model to evaluate the relative performance of the human faculties of Tehran University [Master's Thesis].Tehran: Tehran University* 2004. [Persian]

4. Azar A, Khosravani F, Jalali R, Dehdashti *A. University Life Cycle Fuzzy Approach*. Quarterly Journal of Research and Planning in Higher Education 2011; 17(1): 1-25. [Persian]

5. Rahimi Gh. *Performance Appraisal and Continuous Improvement of the Organization*. Monthly Journal of Tadbir 2007; 7(173): 41-44.

6. Yuksel I, Dagdeviren M. *Using the Fuzzy Analytic Network Process (ANP) for Balanced Scorecard (BSC): A Case Study for a Manufacturing Firm. Expert Systems with Applications* 2010; 37(2): 1270-1278.

7. http://www.ldoceonline.com/dictionary/efficiency.

8. Mehrgan M (2014). *Data Envelopment Analysis (Quantitative Models in Evaluating the Performance of Organizations)*.2th ed. Iran: Academic Book, 39. [Persian].

9. Briec W, Comes C, Kerstens K. T*emporal technical and profit efficiency measurement: definitions, duality and aggregation results*, International journal of production economics, 2006; 103(1): 48-63.

10. Rodriguez-Alvarez A., Tovar B. and L*. Trujillo Firm and time varying technical And allocative efficiency: an application to port handling firms,* International journal of production economics 2007; 109(1-2): 149-161.

11. Das Abhiman. *Technical, allocative and scale efficiency of public sector banks in India. Reserve Bank of India Occasional Papers* 1997 18(2&3): 279–301.

12. Bowlin WF. *Measuring performance: An introduction to data envelopment analysis*, the Journal of Cost Analysis 1998; 15(2): 3-27.

13. Antonio A, Mariana S. *DEA Approach to the Relative Efficiency of Portuguese Public Universities.Portuguese,* Journal of Management Studies 2008; 13(1); 67-87.

14.Heydari Nezhad S, *Determining Efficiency Indicators of Physical Education and Sport Sciences Faculties of State Universities and Provide Evaluation [Ph.D. Thesis].*Tehran: Teacher Training University of Tehran, 2005. [Persian]

15. Homburg C. *Using Data Envelopment Analysis to Benchmark Activities*. International Journal of Production Economics 2001; 73(1): 51-58.

16. Goksen Y, Dogan O, Ozkarabacak B. *A Data Envelopment Analysis Application for Measuring Efficiency of University Departments,* Procedia Economics and Finance Journal 2015; 19(1): 226-237.

17. Abd Aziz N, MohdJanor R, Mahadi R*. Comparative Departmental Efficiency Analysis within a University: A DEA Approach*. Procedia Social and Behavioral Sciences 2013; 90: 540-548.

18. Berg SWater *Utility Benchmarking: Measurement, Methodology, and Performance Incentives. International Water Association* (2010).

19. Emami Meybodi A. *Measurement Principles of Efficiency and Productivity, Institute for Trade Studies and Research*, Tehran, 2005.

20. Coelli T. *A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program*. Centre for Efficiency and Productivity Analysis 1996, 1-49.

21. Charnes A, Cooper WW, Rhodes E. *Measuring The Efficiency of Decision Making Units, European* Journal of Operation Research 1978, 2(6): 429-444.

22. Goudarzi GR, Khosravi S, Askari R. *Performance Appraisal of Selected Departments in Kerman University of Medical Sciences: A Quantitative Study*. Iranian Journal of Medical Education 2012; 12(2): 193-201.

23. Pourmiri M, Ketabi S. *Evaluation of Performance in Non-Clinical Educational Departments in Isfahan University of Medical Sciences, Iran with Data Envelopment Analysis Method. Health Information Management* 2013; 10(3): 471-480.

24. Mahmudah U, Safiihlola M. *The Efficiency Measurement of Indonesian Universities Based on a Fuzzy Data Envelopment Analysis Open* Journal of Statistics 2016, 6(60): 1050-1066.

25. Duguleana L, Duguleana C. *Data envelopment analysis for the efficiency of academic departments, Bulletin of the Transylvania University of Brasov* 2015; 8(2): 453

26. Agha SR, Kuhail I, Abdelnabi N, Salem M, Ghanim A. *Assessment of Academic Departments Efficiency Using Data Envelopment Analysis* 2011; 4(2): 301-325.

27. Kuah Ch T, Yew Wong K, Behrouzi F. *A review of data envelopment analysis,* AMS 2010; 45.

ارزیابی عملکرد گروه های آموزشی دانشکده بهداشت دانشگاه علوم پزشکی شهید صدوقی یزد با استفاده از تکنیک تحلیل پوششی داده‌ها

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[2]- استادیار، مرکز تحقیقات عوامل اجتماعی موثر بر سلامت، دانشگاه علوم پزشکی و خدمات بهداشتی و درمانی قزوین، قزوین، ایران.

[3]- استادیار، مرکز تحقیقات مدیریت و سیاستگذاری سلامت، گروه مدیریت خدمات بهداشتی درمانی، دانشکده بهداشت، دانشگاه علوم پزشکی وخدمات بهداشتی درمانی شهید صدوقی یزد، یزد، ایران.

[4]- دکتری اقتصاد سلامت، گروه مدیریت خدمات بهداشتی و درمانی، دانشکده بهداشت، دانشگاه علوم پزشکی شهید صدوقی یزد، یزد، ایران.

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چکیده

مقدمه: نظام‌های آموزشی محور توسعه‌ی هر کشوری به شمار می‌آیند. از این رو، ارزیابی عملکرد گروه‌های آموزشی به عنوان بدنه‌ی اصلی نظام‌های آموزشی یکی از مسئولیت‌های مهم مدیران و مسئولان دانشگاهی برای حفظ و یا ارتقای آموزش عالی است. لذا پژوهش حاضر با هدف ارزیابی عملکرد گروه‌های آموزشی دانشکده بهداشت دانشگاه علوم پزشکی شهید صدوقی یزد با استفاده از تکنیک تحلیل پوششی داده‌ها انجام شده است.

روش کار: پژوهش حاضر از نوع توصیفی — کاربردی بوده که به صورت مقطعی عملکرد گروه‌های آموزشی دانشکده بهداشت دانشگاه علوم پزشکی شهید صدوقی یزد را در طی سال‌های ۱۳۹۱الی ۱۳۹۴ با استفاده از مدل تحلیل پوششی داده‌ها و با نرم افزار Deap نسخه ۲,۱مورد ارزیابی قرار داده است. در مدل مذکور، متغییرهای ورودی تعداد دانشجویان، تعداد اعضای هیئت علمی و کارشناسان گروه و متغییرهای ستانده تعداد مقالات چاپ شده، طرح‌های پژوهشی مصوب، تعداد کتب تالیف شده، تعداد فارغ‌التحصیلان، میزان رضایت دانشجویان، میانگین معدل فارغ‌التحصیلان به عنوان شاخص‌های اصلی عملکرد در نظر گرفته شد.

یافته ها: ۵۷٪ از گروه‌های آموزشی (۴گروه) کارا و دارای بازدهی ثابت نسبت به مقیاس ومابقی گروه‌ها (۴۳٪) دارای بازدهی کاهنده نسبت به مقیاس بودند. گروه‌های آموزشی مدیریت خدمات بهداشتی و درمانی -تغذیه- مهندسی بهداشت محیط نیز به عنوان الگوهای مرجع گروه‌های ناکارا مشخص شدند.

نتیجه گیری: ارتقای کیفیت عملکرد دانشگاه‌ها در گرو گروه‌های آموزشی توانمند و شایسته است لذا گروه‌های آموزشی ناکارا می‌بایست با الگو قراردادن گروه‌های مرجع کارا گامی موثر در راستای افزایش ستانده‌های خود و برخوردار شدن از عملکردی کارا بردارند.

واژگان کلیدی: ارزیابی عملکرد، تحلیل پوششی داده‌ها، گروه‌های آموزشی، کارایی.