

Using Data Envelopment Analysis to Measure the Efficiency of the Scientific Departments of some faculties at University Of Anbar.

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ABSTRACT:

Measuring the efficiency of educational institutions has become a necessity because the success of any institution depends on taking the suitable decision at the suitable time, and that the evaluation process contributes significantly and effectively to decision-making by building and using quantitative indicators. Our research came as an attempt to find out the level of performance of the scientific departments at the University of Anbar and the extent to which they exploit their resources to achieve the outputs by using the data envelope analysis technique (DEA) to measure the efficiency of the constant and variable volume return and volumetric efficiency of the departments and to know the efficient departments and those that did not achieve full efficiency, and the necessary reforms measures to improve their performance by identifying references Providing metrics to evaluate the efficiency of resources (inputs) to achieve goals (outputs) or how to measure efficiency.

KEYWORDS: Data Envelopment Analysis, efficiency of variable volume return efficiency of constant volume return, volumetric efficiency , Educational Efficiency.

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1-Introduction

Measuring the efficiency of educational institutions has become a necessity, as the success of any institution depends on making the right decision at the right time. Many references talked about quality but neglected the evaluation process that contributes significantly and effectively to decision-making by building or using quantitative indicators suitable for comparison and arrangement (Salah, 2011).

Educational institutions face a set of changes and challenges, which they must face by making the necessary arrangements that enable them to achieve their goals efficiently and effectively. And in light of these changes and challenges, the need to periodically measure the institutional performance of these institutions in order to improve them, because improving performance and developing the institution has become a necessity for its survival (Bowlin, 1998).

The use of the Data Envelopment Analysis (DEA) technology is effective for detecting the efficiency and effectiveness of similar institutions as a mathematical method Non-parameter based on linear programming and provides objective evaluation of a number of similar institutions .

The aim of the research is represented by using the data envelopment analysis (DEA) technique to measure the technical and volumetric efficiency of the scientific departments at Anbar University and to know the efficient departments and those that could not achieve full efficiency, and the necessary

reforms procedures to improve their performance by identifying the references represented by the departments that possess full efficiency, because the educational institutions need to make a good use of its financial, material and human resources to achieve outputs of the required quantities and quality that qualify them to be in the ranks of the corresponding educational institutions.

2-Literature Review

Several studies and research have addressed the use of the data envelope analysis (DEA) technique.

Study (Abbott & Doucouliagos, 2003) adopted (DEA) technology to measure the individual aptitude of (36) Australian universities through aggregated information about one academic year. Various measures of output and inputs are used. The results show that regardless of the output-input mix, Australian universities as a whole recorded high levels of efficiency relative to each other .Study (afonso&Santo, 2005) aims to measure the efficiency of public universities in Portuguese , and it eas applied to 52 universities and the most important finding of the study is that three universities achieved full efficiency . study (Fandel, 2007)) adopted the DEA technique to measure the efficiency of universities in Germany on 15 universities and fount 10 universities achieved full efficiency.

The study (Fahmy, 2009) adopted the DEA technique to measure the efficiency of Saudi

Arabia universities and concluded by identifying the reference universities that were able to achieve comparative efficiency even though they operate in the same competitive conditions as in efficient universities.

The study (Salah, et al,2011) found ten highly qualified units among (37) departments in nine colleges located at the university, and also the improvements required to be made to the remaining units were determined.

The study (AZline et al ,2012) explores the performance efficiency of faculties at a Malaysian university by using data envelopment and the study found four of faculties achieved full efficiency. The data envelopment analysis(DEA) technology was used in Study (Joanna,2014) on (500) A higher education institution in ten European countries and in the United States of America during the period (2000-2010). The study concluded that the university's funding structure has an important role in technical competence, and it differs between Europe and America. Study (Hayder&Nor,2018)adopted (DEA) technology to measuring the efficiency at the colleges at university of Al-Qadisiyah for the academic year 2015-2016.the results indicate the 58% at the college reached their optimum economic size according to the efficiency scale since these colleges reached full efficiency ,

3-Data Envelopment Analysis (DEA)

It is a mathematical method used to evaluate the productive efficiency of a group of homogeneous institutions, and it is considered one of the important methods used in evaluating the efficiency of a group of similar entities, and it is considered a technique that can be used in determining the best performance of a practitioner in the use of resources among a group of institutions. The Data Envelopment Analysis (DEA) has several stages of development, whereby the technology that distinguishes between two types of efficiency has been accomplished: technical and volumetric efficiency , symbolized by an abbreviation (VRS, BCC). To find efficiency in the two models is done either through the classification of the inputs, which is known as the two models of input guidance, or output or What is known as the output direction models or the combination of input and output, what is known as the assembly model.

There are several aspects of the use of DEA, some of them positive and some of them Negative, as the results of this method are applied to homogeneous units and that the measurement error causes problems in the analysis, and the results of the analysis are relative and not absolute, and that the use of (DEA) gives us an analysis of a measure

of technical efficiency, not economic efficiency, and in spite of what was mentioned above, which represents shortcomings, However, the use of (DEA) technology has many advantages, that it can be used for multiple inputs and outputs with different units of measurement, that is, it deals with heterogeneous units of measurement and does not need to develop hypotheses for the function that links the dependent (output) and independent variables (input) and that technology (DEA) combines in its measurement of efficiency between internal efficiency, both quantitative and qualitative, with external efficiency and can deal with descriptive variables. Also, it does not need to specify previous weights for the input and the outputs are determined automatically. (Joseph &Joshua,2015)

The general mathematical model for DEA technology aims to achieve an efficiency value (100%) through a set of weights:

$$\begin{aligned} \text{maximize } ho(u,v) &= \frac{\sum_{r=1}^s y_{r0}u_r}{\sum_{i=1}^m x_{i0}v_i} \\ \text{Subject to } \frac{\sum_{r=1}^s y_{rj}u_r}{\sum_{i=1}^m x_{ij}v_i} &\leq 1 \quad (j = 1, 2, \dots, n) \\ u_r &\geq 0, \quad r = 1, 2, \dots, s \\ v_i &\geq 0, \quad i = 1, 2, \dots, m \end{aligned} \quad (1)$$

Where:

u_r = the weight given to output r

v_i = the weight given to input i

y_r = amount of output r

x_i = amount of Input i

Thus, the goal of the model is to maximize efficiency by using the optimal mix of inputs and outputs, and that the institutions that obtain an efficiency (100%) fall on the borderline efficiency curve and envelop the rest of the (less efficient) institutions(Tomas,2014)The DEA model is solved by converting the modifier (1) into linear form, solving the linear programming model, and finding the values of u_r, v_i

4- Data Description

Our research included the scientific departments in the colleges of the University of Anbar, where (42) departments were chosen from

the total of the (18) colleges of Anbar University, which includes (64) scientific departments. Among them, they are of greater benefit. Data for the two years (2017-2018) and (2018-2019) were collected as normal years for the university.

As for the research inputs and outputs, they were identified as follows:

Input:

- The total number of students registered in the first phase of the morning study
- The number of teaching staff
- The number of administrative and technical staff

Outputs:

- The number of students graduating from elementary studies in the morning
- The number of researches published
- The number of scientific conferences and seminars

5- Methods and Results

For practical application purposes, the Data Envelopment Analysis Program (DEAP) Ver.2.1 was used for data envelopment, where the data was entered and the following results were obtained:

1- Measuring the relative efficiency at the departmental level.

A- Measuring the relative efficiency of each department for the year 2017-2018

It is evident from the results of Table (1), which shows the efficiency of volume return (constant Changing and scaling) none of the departments of the studied colleges were efficient according to the efficiency of the constant volume return, as the geology department was one of the best departments of the College of Science, where the efficiency of the constant volume return reached (0.699), this means that there is a surplus in the inputs by (30%) while the Department of Chemistry occupied less A value of (0.429) for the same college. In the College of Islamic Sciences, the Department of Faith and Advocacy was one of

the best departments, as the efficiency of the constant volume yield reached (0.99). In order for the department to become efficient, it had to reduce the use of inputs by 1%, and the English Language Department was the best department In the College of Education for womenas the efficiency of the constant volume return reached (0.693), and the Qur'an sciences department is one of the best departments in the College of Education for humanities and the Civil Engineering Department in the College of Engineering and the Economics Department in the College of Administration and Economics and the Field Crops Department in the College of Agriculture and the History Department of the College of Arts and the efficiency of the fixed volume yield was (0.699, 0.928, 0.589, 0.459, 0.676) respectively, While the departments of (civil engineering and the department of media) in the College of Engineering and Arts were departments of efficiency according to the technical efficiency of the variable return of volume, and the departments that were efficient and achieved the optimal size, i.e. 100%, are the department of Thoug , Aqida and advocacy and the Department of foundation of figih and its Origins in the College of Islamic Sciences, the department of Arabic Language and the department Geography and the Qur'an Sciences department in the College of Education for women and all departments of the College of Education for humanities and the Accounting department and the Economics Department in the College of Administration and Economics and the department of Arabic Language the Geography department and the History department in the College of Arts. The average efficiency of the constant volume return for all departments was (0.558) and the average of technical efficiency of the variable volume returns for all departments was (0.598) while the volumetric efficiency was (0.933), which means that the departments of the studied university colleges did not fulfill the size. The optimum is that there is a possibility to expand the size of the departments by 7%.

Table (1) shows the fixed, variable and volumetric efficiency and volume yield for the 2017-2018 academic year for the departments of the selected colleges

no	college	department	Efficiency of the Constantvolume return	Efficiency of the variable volume return	volumetric efficiency	Yields volume
1	College of Science	Department of biology	0.473	0.692	0.684	drs
		department of	0.429	0.43	0.999	-

		chemistry				
		Department of physics	0.5	0.554	0.902	drs
		Department of Geology	0.669	0.673	0.994	irs
2	College of Islamic Sciences	Department of TAFSER and Quran Sciences	0.889	0.897	0.991	drs
		Department of Though, Aqida and advocacy	0.99	0.99	1	-
		Department of Hadith and its Sciences	0.889	0.891	0.998	irs
		Department of Foundation of figih	0.964	0.964	1	--
3	College Education for women	Department of English Language	0.693	0.753	0.921	irs
		Department of Arabic language	0.639	0.639	1	--
		Department of chemistry	0.569	0.602	0.945	irs
		Department of biology	0.325	0.366	0.886	drs
		Department of Geography	0.689	0.689	1	-
		Department of History	0.489	0.492	0.994	irs
		Department of Quran Sciences	0.653	0.653	1	--
4	College Education for humanities	Department of English Language	0.673	0.673	1	--
		department of Arabic language	0.665	0.665	1	--
		Department of Educational and Psychological Sciences	0.574	0.574	1	--
		Department of Quranic Sciences	0.699	0.699	1	--
		Department of Geograhly	0.59	0.59	1	--
		Department of History	0.692	0.692	1	--

5	College Engineering of	Department of civil engineering	0.928	1	0.928	drs
		Department of Chemical petrochem	0.453	0.489	0.927	irs
		Department of Mechanical Engineering	0.319	0.359	0.888	drs
		Department of Electrical Engineering	0.369	0.39	0.946	drs
		Department of Dams and water resources	0.404	0.405	0.999	drs

6	College of Administration and Economics	Department of Economics	0.589	0.589	1	
		Department of Accounting	0.476	0.476	1	-
		Department of Business Administration	0.492	0.511	0.963	irs
7	College of Agriculture	Department of animal production	0.35	0.36	0.972	drs
		Department of Soil science and Water Resources	0.223	0.319	0.699	drs
		Department of Field Crops	0.459	0.572	0.802	drs
		Department of Agricultural Economics	0.415	0.437	0.95	irs
		Department of Horticulture and Garden Engineering	0.458	0.489	0.937	drs

		Department of Food science	0.417	0.42	0.993	drs
		Department of Plant Protection	0.353	0.435	0.811	irs
8	college of Arts	Department of English Language	0.23	0.26	0.884	irs
		department of Arabic language	0.404	0.404	1	--

		Department of Sociology	0.611	0.739	0.827	irs
		Department of Media	0.433	1	0.433	irs
		Department of geography	0.611	0.611	1	--
		Department of History	0.676	0.676	1	--
	the average		0.558	0.598	0.933	

Source :From the work authors depending on the program results DEAP Ver.2.1

Where :drs: Decreasing Irs: Increasing --: Constant

B- Measuring the departments' relative efficiency for the 2018-2019 academic year

It is clear from Table (2) which shows the efficiency of volume return (fixed, variable and volumetric) and volume yield that there are (17) department of the studied departments whose efficiency was in terms of technical efficiency of the fixed volume return (100%), which are all departments of the College of Islamic Sciences and the department of Arabic Language And the English language and the geography department in the College of Education for women and all departments of the College of Education for humanities except for the Department of Educational and Psychological Sciences and the Field Crops Departments, Agricultural Economics, Horticulture and Plant Protection in the College of Agriculture and the History Department in the College of Arts.

As for the departments that occupied the lowest value for the efficiency of the constant efficiency volume return, they are the department of Physics (0.608) in the College of Science and the Department of biology(0.435) in the College of Education for women and the department of Educational and Psychological Sciences (0.974) in the College of Education for humanities and the department of Mechanical Engineering (0.259) in the College of Engineering and the department of Accounting (0.609) in the College of Administration and Economics and the Soil department in the College of Agriculture and the Department of English language (0.448) in the College of Arts, as for the efficiency of the variable volume return, (21) of the studied departments were (100%) represented by

the department of biology in the College of Science, all departments of the College of Islamic Sciences, the department of Arabic Language and the English Language, the department of Qur'an Sciences, History and Geography in the College of Education for women and all departments of the College of Education for Humanities except for the department of Educational and Psychological Sciences and the departments of Animal Production and Field Crops, Agricultural Economics, Horticulture and Plant Protection in the College of Agriculture and the departments of Media and History in the College of Art.

As for the departments that occupied the lowest efficiency for the variable volume return, they are the department of Chemistry (0.665) in the College of Science and the department of biology (0.457) in the College of Education for women. The average efficiency of the constant volume return for all departments was (0.823) and the average efficiency returns of variable volume (0.861) and average volumetric efficiency (0.956), which means that the departments of the studied university colleges did not achieve the optimum size and that there is a possibility of expanding the size of departments by 3%.

Table (2) shows the fixed, variable and volumetric efficiency and type of yield for the 2018-2019 academic year for the departments of the selected colleges.

No	college	Department	Efficiency of the Constant volume return	Efficiency of the variable volume return	Volumetric efficiency	Yields volume
1	College of Science	Department of biology	0.625	1	0.625	drs
		Department of chemistry	0.665	0.665	1	-
		Department physics	0.608	0.714	0.851	drs
		Department of Geology	0.931	0.977	0.953	irs
2	College of Islamic Sciences	Department of Tafser and quran sciences	1	1	1	-
		Department of Thogh, Aqida and advocacy	1	1	1	-
		Department of Hadith and its Sciences	1	1	1	-

		Department of Foundation of figih	1	1	1	-
3	College of Education for women	Department of English Language	1	1	1	-
		Department of Arabic language	1	1	1	-
		Department of chemistry	0.58	0.581	0.998	irs
		Department of biology	0.435	0.457	0.951	drs
		Department of Geography	1	1	1	-
		Department of History	0.986	1	0.986	irs
		Department of Quranic Sciences	0.855	0.856	0.999	irs
4	College of Education For humanities	Department of English Language	1	1	1	-
		Department of Arabic language	1	1	1	-
		Department of Educational and Psychological Sciences	0.974	0.974	1	-

		Department of Quran Sciences	1	1	1	-
		Department of Geography	1	1	1	-
		Department of History	1	1	1	-

5	College of Engineering	Department of civil engineering	0.764	0.959	0.797	drs
		Department of Chemical Engineering	0.593	0.676	0.877	irs
		Department of Mechanical Engineering	0.259	0.346	0.751	drs
		Department of Electrical Engineering	0.459	0.504	0.911	drs
		Department of Dams and water resources	0.867	0.971	0.892	irs
6	College of Administration and Economics	Department of Economics	0.764	0.764	1	-
		Department of Accounting	0.609	0.609	1	-
		Department of Business Administration	0.632	0.657	0.961	irs
7	faculty of Agriculture	Department of animal production	0.979	1	0.979	irs
		Department of Soil and Water Resources	0.718	0.738	0.973	drs
		Department of Field Crops	1	1	1	-
		Department of Agricultural Economics	1	1	1	-
		Department of Horticulture and Garden Engineering	1	1	1	-
		Department of Food	0.871	0.879	0.991	drs

		Altitude				
		Department of Plant Protection	1	1	1	-
8	college of Arts	Department of English Language	0.448	0.51	0.878	irs
		Department of Arabic language	0.586	0.586	1	-
		Department of Sociology	0.781	0.972	0.803	irs
		Department of Media	0.784	1	0.784	irs
		Department of Geography	0.782	0.782	1	-
		Department of History	1	1	1	-
	Total		0.823	0.861	0.956	

Source :From the work authors depending on the program results DEAP Ver.2.1

Where :Drs: Decreasing Irs: Increasing --: Constant

2- Measuring the relative efficiency at the colleges level

found for all colleges studied for the academic year 2017-2018 and the academic year 2018-2019 as shown in the following tables:

The relative efficiency of volume yield (constant and variable), volumetric and volume yield were

Table. 3 Shows the fixed, variable and volumetric efficiency for the 2017-2018 academic year for the selected colleges

no	College	Efficiency of the Constant volume return	Efficiency of the variable volume return	Volumetric efficiency
1	College of Science	0,518	0,587	0,895
2	College of Islamic Sciences	0,933	0,936	0,997
3	College of Education for women	0,579	0,599	0,966
4	College of Education For humanities	0,649	0,649	1
5	College of Engineering	0,495	0,525	0,936
6	Faculty of	0,519	0,525	0,988

	Administration and Economics			
7	faculty of Agriculture	0,382	0,433	0,882
8	college of Arts	0,494	0,615	0,803
total		0,571	0,555	0,933

Source :From the work authors depending on the program results DEAP Ver.2.1

It is evident from the above table that the best college was the College of Islamic Sciences, where the efficiency of the constant volume return reached (0.933) and the efficiency of the variable volume return (0.936) for the academic year 2017-2018 and that the least efficient college is the College of Agriculture where the efficiency of the fixed and variable volume returns was (0.382 and 0.433).

The average of the efficiency of the fixed and variable volume returns of the studied colleges was (0.571 and 0.555), respectively, while the average volumetric efficiency was (0.933). This indicates that the colleges of the studied university did not reach the optimum size and that there is a possibility of expanding the studied colleges by 7%.

Table. 4 Shows the fixed, variable and volumetric efficiency for the 2018-2019 academic year for the selected colleges

No	College	Efficiency of the Constant volume return	Efficiency of the variable volume return	Volumetric efficiency
1	College of Science	0.707	0.839	0.843
2	College of Islamic Sciences	1	1	1
3	College of Education for women	0.837	0.842	0.994
4	College of Education for humanities	0.996	0.996	1
5	College of Engineering	0.588	0.991	0.851
6	College of Administration and Economics	0.668	0.677	0.987
7	faculty of Agriculture	0.938	0.945	0.992
8	college of Arts	0.730	0.808	0.903
	Total	0.808	0.850	0.946

Source :From the work authors depending on the program results DEAP Ver.2.1

It is evident from the above table that the best college is the College of Islamic Sciences, where the constant, variable and volumetric efficiency reached (1), and the college recorded a development for the year 2018/2019 than it was in the year 2017/2018. The average of the fixed and variable efficiency of the studied colleges was (0.808 and 0.850), respectively, and thus they

achieved an improvement over the last year 2017/2018 which amounted to (0.571, 0.555) and a positive change occurred with regard to the volumetric efficiency for the year 2018/2019 (0.946) after it was Last year (0.933), this means that there is a possibility of expanding the studied colleges by 5%, compared to 7% last year. We also note that almost all the colleges have improved

their efficiency and that the college with the lowest in constant efficiency is the College of Engineering (0.588), which is also improving from last year as it was (0.495), and in the variable efficiency the College of Administration and Economics (0.677) which is the other. From last year, it was (0.525). As for the volumetric efficiency, the lowest is the College of Science, as it reached (0.843) and recorded a decrease compared to the year 2017/2018, reaching (0.895).

Conclusions and Recommendations

The scientific departments and colleges have achieved a significant improvement in the year 2018/2019 compared to the year 2017/2018, so that the university is very close to achieving a complete volumetric efficiency). The inputs and outputs that were used are important for finding the desired indicators for decision makers and improving performance. The research recommends adopting DEA technology as a tool to evaluate educational institutions and compare them periodically, as it is considered an effective tool.

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