Relative Efficiency of the Scientific Departments in Al-Esraa University College by Using Data Envelopment Analysis (DEA)

Prof. Dr. Abdul Ameer A.H. Al–Ali
Department of Accounting , Al-Esraa University College, Baghdad / Iraq
abdalameer@esraa.edu.iq
Assist. Lect. Asraa M. Hamdy
Department of Accounting ,Al-Esraa University College, Baghdad / Iraq
asraa.monther@esraa.edu.iq

الكفاءة النسبية للأقسام العلمية في كلية الأسراء الجامعة بأستخدام تحليل مغلف البيانات (DEA)

أ. د. عبد الأمير عبد الحسين العلي و م. م. أسراء منذر حمدي
قسم المحاسبة / كلية الأسراء الجامعة, بغداد \ العراق

Abstract

Assessment of relative efficiency in Al-Esraa University College (2018-2021), it used the data envelopment analysis method on (11) scientific departments, and, it concluded that there is a variation in the efficiency of the scientific departments in the College during the years of the investigation, the constant returns to scale (CRS) model and the variable returns to scale (VRS) model had been used to decide the output.

This variation comes from many factors such as the number of accepted students in the scientific departments, teaching staff, the administrative staff, number of graduated student, graduation projects and published researches .

Keyword: Data Envelopment Analysis (DEA), Constant returns to scale (CRS), Variable Returns to scale (VRS), Scientific departments, Relative efficiency.

المستخلص

تقييم الكفاءة النسبية في الأقسام العلمية لكلية الاسراء الجامعة خلال الفترة (2018-2021) بأستخدام طريقة تحليل مغلف البيانات (DEA) التي تغطي العديد من المجالات العلمية، ونستنتج ان هناك تباين في الكفاءة بين الاقسام العلمية في الكلية خلال سنوات البحث .

أستخدمت الدراسة التحليل التطويقي للبيانات (DEA) بنموذجيه عوائد الحجم الثابتة (CRS) وعوائد الحجم المتغيرة (VRS) وفق التوجهين الاخراجي والادخالي .

ويرجع هذا الأختلاف لعدة عوامل أهمها، اعداد الطلبة المقبولين في الاقسام العلمية، واعداد التدريسيين، والملاك الأداري، وأعداد الطلبة الخريجين ومشارع التخرج والبحوث المنشورة .

الكلمات المفتاحية : تحليل مغلف البيانات (DEA)، عوائد الحجم الثابتة (CRS)، عوائد الحجم المتغيرة (VRS)، الأقسم العلمية، الكفاءة النسبية .

Introduction

The performance of the universities is determined by academic and administrational jobs. The academic performance is divided into two activities according to the traditional way and they both support the growth of community, the activities of scientific research give the individuals knowledge and training to do the jobs, (Ramzi & Ayadi 2016) .

The administrational performance is based on two factors, human resources (workers) and financial resources, the academic works represent an important role in determining the inputs, outputs and basic services.

There are four essential factors that evaluate and measure of the efficiency of the academic performance and these are (inputs, operations intermediate output, and the final outputs), It's necessary to measure the inputs and outputs and the correlation between them, (GökŞen & Özkarabacak, 2015) .

We can merge the inputs measurements with the output measurements to give a productivity measurements such as the number of graduate measurements for every member of academic staff.

There are many ways to measure the research performance, measurements of outputs research such as articles of study, research number of scholarship and patented . This study aims to find the level of relative efficiency for the scientific departments in Al-Esraa University College by using data envelopment analysis for the period (2018-2021) .

Method of the research

The research was guided by the descriptive method that consists of a number of procedures that relies on collecting data, classifying, processing and analyzing them to get the results regarding the phenomenon.

Therefore, the descriptive method has been used to identify the proportional efficiency in the academic education and how to use data envelopment analysis programming in measuring the efficiency of research performance for the departments of Al-Esraa University College, to improve the performance of research in the scientific department of the university, (Olariu & Bard, 2017) .

Data envelopment analysis programming is relying on the linear programming to measure the efficiency of the unit performance and aims to measure the efficiency of the department, which uses available resources to give the outputs, these departments are being evaluated by using efficiency of productivity and it is weighted output to the weighted input.

The evaluation of efficiency of some unit is measured proportionally to a better unit, which achieves a hundred percent efficiency and the inefficient units range from zero to one, (Martin, 2003) .

Data envelopment analysis

In this study we adopted the output oriented model with the variable return to the scale to estimate efficiency score,(Al-Shayea & Battal, 2013)

$$\boldsymbol{\theta}^{*} = \boldsymbol{max}_{\boldsymbol{\theta},\boldsymbol{\lambda}}\boldsymbol{\theta}$$

$$s.t\ \ \boldsymbol{\theta x_{i0}} \leq \sum_{\boldsymbol{j=1}}^{\boldsymbol{n}} \boldsymbol{\lambda_j x_{ij}} \quad \boldsymbol{i = 1, \dots, m}$$

$$y_{ro} \geq \sum_{j=1}^{n} \lambda_j y_{rj} \quad r = 1, \dots, s$$

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

$$\lambda_j \geq 0 \qquad \forall j$$

Where xij and yrj denote the levels of the ith input and rth output of the jth department, j=1,…,n. the first two constraints require that the performance of a given department o in terms of its inputs xi0 and output yro is located within a production possibility set defined by the envelopment of all data point. The last two constraints, where $\boldsymbol{\lambda}$ is an N*1 vector.

Applied study

First: Sample and data study

Data envelopment analysis programming had been applied in Al-Esraa University college (2018-2021), on (11) scientific departments because the input and output data was available during the research period (appendices (A,B,C)), the output orient model was chosen (variable return to scale), here we suppose the inputs can't be controlled because the number of the registered students is determined by ministry of higher education and scientific research according to the (rating scale and applicants). Table (1), Figure (1) they showed the criteria of descriptive statistics for input and output study.

Table (1): Descriptive statistics for input, output data of Al-Esraa University College for years (2018-2021)

Year		Variables	Minimum	Maximum	Mean	Std. Deviation
2018-2019	input	Accepted students	29	704	290	207
		Teaching staff	12	52	30	12
		Administrative staff	3	90	26	29
	output	Graduated students	70	515	219	141
		Published researches	4	22	11	5
		Graduation projects	31	212	83	58

Year		Variables	Minimum	Maximum	Mean	Std. Deviation
2019-2020	input	Accepted students	47	514	235	157
		Teaching staff	13	65	32	17
		Administrative staff	3	73	23	23
	output	Graduated students	55	603	225	163
		Published researches	2	21	11	7
		Graduation projects	22	227	85	67
2020-2021	input	Accepted students	66	767	302	236
		Teaching staff	13	66	34	19
		Administrative staff	2	76	18	22
	output	Graduated students	51	859	300	288
		Published researches	2	21	12	7
		Graduation projects	18	413	118	120

Source : Al-Esraa university college ,different yearly report for the years (2018-2021)

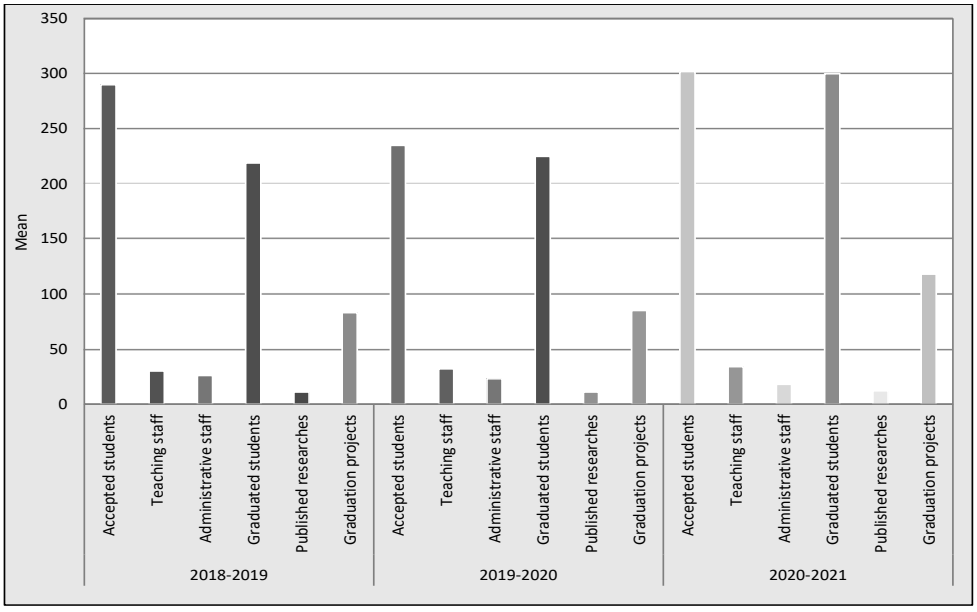

Figure (1): Arithmetical means of input, output data of Al-Esraa University College for years (2018-2021)

Source: The histogram prepared by the researcher depending on the data in Table (1)

From Table (1), Figure (1), we can notice that the minimum registered students for year (2018-2019) is (29) student in (Refrigeration and air conditioning engineering), while the maximum registered students was (704) in (law).

This shows that the disparity of student's desire to register in certain department than the others, the result of descriptive statistics show the mean number of registered students for the same year was (290), while the table shows that the mean number of graduated students for bachelor degree was (219) student, the maximum number of graduated students was (515) student, the mean number of published researches is (11) research for different scientific departments, the maximum number of published researches is (22) researches. In the same way we can determine the inputs and outputs for the other years.

Second: Results and Discussion

Table (2) shows results of constant returns to scale, variable returns to scale, and scale efficiency for of Al-Esraa University College departments (2018-2021)

Table (2): Indications of constant returns to scale, variable return to scale and scale efficiency in of Al-Esraa university college for the years (2018-2021)

Scientific Department	2018-2019			2019-2020			2020-2021			mean		
	crste	vrste	scale	crste	vrste	scale	crste	vrste	scale	crste	vrste	scale
Pharmacy	0.34	0.71	0.49	0.41	0.62	0.67	0.44	1.00	0.44	0.40	0.78	0.53
Dentistry	0.60	1.00	0.60	0.64	0.99	0.65	0.72	1.00	0.72	0.65	1.00	0.65
Medical laboratories techniques	0.76	0.88	0.86	0.70	0.85	0.82	0.94	1.00	0.94	0.80	0.91	0.87
Law	0.70	0.73	0.96	0.78	0.97	0.80	1.00	1.00	1.00	0.83	0.90	0.92
Business Administration	0.64	0.82	0.78	0.74	0.77	0.96	0.80	0.82	0.99	0.73	0.80	0.91
Accounting	0.48	0.48	0.99	0.76	0.78	0.98	0.97	0.99	0.98	0.74	0.75	0.98
Mass communication	0.85	1.00	0.85	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	0.95
English	0.56	0.57	0.97	0.58	0.59	0.99	1.00	1.00	1.00	0.71	0.72	0.99
Civil engineering	1.00	1.00	1.00	0.77	0.77	1.00	0.88	0.88	1.00	0.88	0.88	1.00
Refrigeration and air conditioning engineering	1.00	1.00	1.00	0.43	0.58	0.74	0.40	0.55	0.72	0.61	0.71	0.82
Computer technology engineering	0.60	0.81	0.75	0.56	0.57	0.97	0.45	0.84	0.53	0.54	0.74	0.75
Mean	0.68	0.82	0.84	0.67	0.77	0.87	0.78	0.92	0.85	0.71	0.84	0.85

Source: done by researcher depending on the results of (DEAP) program, second edition

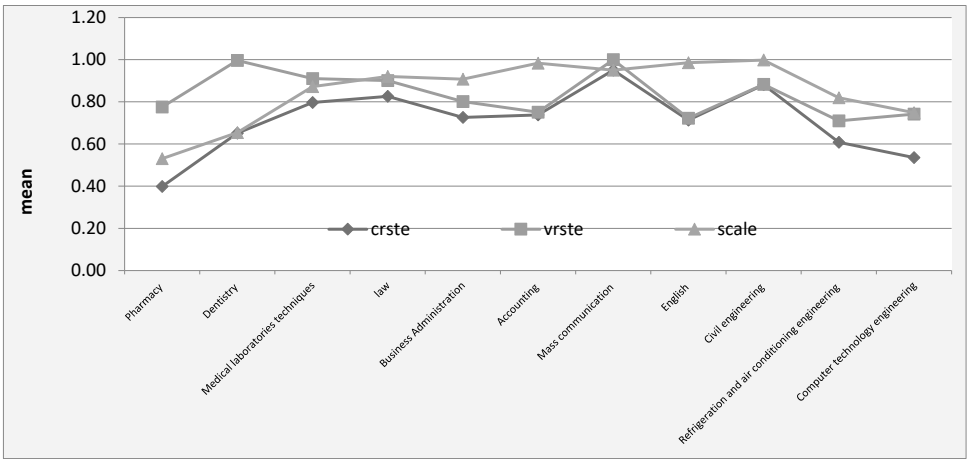

Figure (2): Means of indications of efficiency for the departments of Al-Esraa University College for years (2018-2021)

Source: done by a researcher, relying on the data represented in Table (2)

Table (2), Figure (2) show the indications of efficiency vary between scientific departments throughout the years, the results show that (mass communication) department is the best scientific department as well as the (dentistry) department, because they achieved a complete variable efficiency indication (1.0) through the years (2018-2021). Which means these departments used inputs way better to accomplish output without wasting economical resources, The lowest mean variable efficiency indication the department (refrigeration and air conditioning engineering) had was (0.71), this result indicates there is a potentiality in increasing the outputs (29%) in which the department becomes completely efficient without using new economical resources,In another point of view, the Table (3) and Figure (3) show the total means of efficiency indication for the scientific department through the years of this research, and as following

Table (3) : Total means of efficiency indications for the scientific department in Al-Esraa University College for years (2018-2021)

Years	crste	vrste	scale
2018-2019	0.68	0.82	0.84
2019-2020	0.67	0.77	0.87
2020-2021	0.78	0.92	0.85
mean	0.71	0.84	0.85

Source: Done by the researcher depending on the data represented in Table (2)

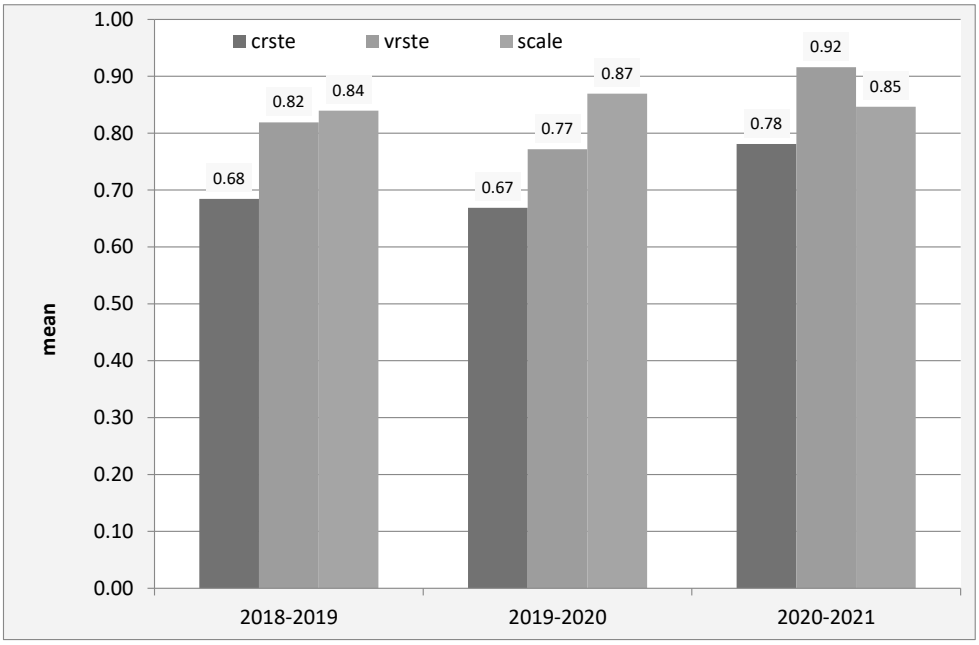

Figure (3): Total means of the efficiency indications for the scientific departments in Al-Esraa University College for years (2018-2021)

Source: Done by a researcher depending the data in Table (3)

We can find from table (3), figure (3) the academic year (2020-2021) achieved the maximum means for constant and variable returns to scale. The number of indicative means of efficiency is (0.78 and 0.92) successively, as the results show that the academic year (2019-2020) achieved the lowest indications of constant returns to scale and variable returns to scale, it got (0.67 and 0.77) successively. In a general way the results of efficiency showed that general mean for the indication of constant returns to scale is (0.71) for the scientific department in Al-Esraa University College.

This result refers to the potentiality of increasing the output by (29%) until we get to the complete constant efficiency, the general mean for indication of variable efficiency (0.84) thus we need to increase the outputs by (16%) until we get complete variables to scale efficiency without increasing the inputs.

Third: Test of hypothetical research

First hypothesis: Means of constant returns to scale differ from one scientific department to another in Al-Esraa University College

Second hypothesis: Means of variable returns to scale differ from one scientific department to another in Al-Esraa University College

To answer these hypotheses, we do analysis of variance table (ANOVA) to compare between the means of scientific department

Table (4): Analysis of variance (ANOVA) table for the first and second hypotheses

		Sum of Squares	df	Mean Square	F	Sig.
Crste	Between Groups	.751	10	.075	2.587	.030
	Within Groups	.639	22	.029		
	Total	1.389	32			
Vrste	Between Groups	.343	10	.034	1.301	.289
	Within Groups	.580	22	.026		
	Total	.922	32			

Source: outputs of statistical program SPSS ver.22

From the results of Table (4), the indications of constant returns to scale (CRSTE), it shows there is a difference between the means of constant returns to scale for scientific department through the academic year because the (P value) less than (0.05), therefore the indications of constant returns to scale differ between the scientific department, which shows the validity of hypothesis one . While the variable returns to scale (VRSTE) show no difference between the means of variable returns to scale because the (P value) more than (0.05), which rejects hypothesis two.

References

- Al-Shayea, Ali saleh, and Battal, Ahmad.H, (2013). "Evaluating the efficiency of faculties in qassim university using data envelopment analysis", Journal of Business Administration and Education , Vol.4 , No.2, 132-138 .
- GökŞen, Yılmaz, Doğan, Onur, and Özkarabacak Bilge, (2015). "A Data envelopment analysis application for measuring efficiency of university departments", Procardia Economics and Finance 19 .
- Martin, Emilio, (2003). "An application of the data envelopment analysis methodology in the performance assessment of the Zaragoza university departments", Journal of Economic and Development .

- Olariu, Gabriela vica, and Bard, Stelian, (2017)."Efficiency Assessment of university with DEA method based on public data", 8th Balkan Region Conference on Engineering and Business Education and 10th International Conference on Engineering and Business Education.
- Ramzi, Sourour & Ayadi, Mohamed, (2016). "Assessment of university efficiency using data envelopment analysis weights restrictions and super-efficiency measure", Journal of applied management and investment, Vol.5, No.1.

Appendix (A): Number of inputs and outputs of scientific departments for Al-Esraa University College, year (2018-2019)

Scientific department	Input			Output		
	Accepted students	Teaching staff	Administrative staff	Graduated students	Published researches	Graduation projects
Pharmacy	363	41	27	158	15	40
Dentistry	330	39	90	171	22	166
Medical laboratories techniques	390	52	56	515	6	82
Law	704	36	4	424	12	212
Business Administration	507	31	7	273	17	74
Accounting	334	26	5	180	9	44
Mass communication	135	12	3	71	10	71
English	246	21	4	104	4	100
Civil engineering	41	22	18	229	8	58
Refrigeration and air conditioning engineering	29	12	19	70	7	31
Computer technology engineering	106	33	56	214	9	32

Source: Al-Esraa University College, separate annually reports, academic year (2018-2019)

Appendix (B): Number of inputs and outputs of scientific departments for Al-Esraa University College, year (2019-2020)

Scientific department	Input			Output		
	Accepted students	Teaching staff	Administrative staff	Graduated students	Published researches	Graduation projects
Pharmacy	294	53	26	241	11	60
Dentistry	323	45	73	227	18	227
Medical laboratories techniques	514	65	48	603	8	86
Law	437	36	5	386	20	193
Business Administration	315	35	7	305	12	85
Accounting	242	27	5	239	6	53
Mass communication	87	13	3	104	21	62
English	152	20	4	96	2	96
Civil engineering	49	24	16	70	9	24
Refrigeration and air conditioning engineering	47	13	18	55	3	22
Computer technology engineering	121	24	48	152	7	31

Source: Al-Esraa University College, separate annually reports, academic year (2019-2020)

Appendix (C): Number of inputs and outputs of scientific departments for Al-Esraa University College, year (2020-2021)

Scientific department	Input			Output		
	Accepted students	Teaching staff	Administrative staff	Graduated students	Published researches	Graduation projects
Pharmacy	431	64	13	270	21	67
Dentistry	321	43	76	249	17	251
Medical laboratories techniques	639	66	24	859	15	72
Law	767	48	3	825	20	413
Business Administration	392	35	5	376	2	108
Accounting	231	25	3	276	4	51
Mass communication	74	13	2	108	10	65
English	155	21	4	160	11	179
Civil engineering	66	16	14	51	14	18
Refrigeration and air conditioning engineering	70	13	16	58	3	21
Computer technology engineering	180	25	40	63	18	48

Source: Al-Esraa University College, separate annually reports, academic year (2020-2021)