

## Measuring the Efficiency of Colleges at the University of Al-Qadisiyah-Iraq: A Data Envelopment Analysis Approach

(Mengukur Kecekapan Kolej-Kolej di Universiti Al-Qadisiyah-Iraq: Satu Pendekatan Analisis Data Envelopment)

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### ABSTRACT

*This study aims at measuring the efficiency of the colleges at University of Al-Qadisiyah for the academic year 2015-2016. Data Envelopment Analysis (DEA) was employed with alternative models, namely, CRS-I, CRS-O, VRS-I, and VRS-O. The number of enrolled students, lecturers, employees, and teaching assistants were used as inputs, while the number of students with bachelor's degree and published research in national and international journals were used as outputs. The results indicate that 58% of the colleges reached their optimum economic size according to the efficiency scale since these colleges reached full efficiency. The college of Nursing is a peer college for inefficient colleges. To achieve full efficiency, there must be either significant reductions in their inputs with the same amount of output (input oriented) or significant increases in output retaining the current amount of inputs (output oriented). In general, the efficiency score of University of Al-Qadisiyah indicated the possibility of reducing its available resources by 10% retaining the current amount of output to be efficient, or expanding the University's output by 1% retaining the current amount of inputs. Therefore, it is imperative that the decision makers at the University of Al-Qadisiyah and its colleges that have not achieved the required efficiency examine the factors that have contributed to this outcome in order to acquire knowledge of weaknesses and imbalances in their inputs and outputs. They could exploit the available resources efficiently by comparing their inputs and outputs with those of peer colleges.*

*Keywords: University of Al-Qadisiyah; efficiency; DEA; scale efficiency; peer colleges*

### ABSTRAK

*Kajian ini bertujuan untuk mengukur kecekapan kolej-kolej di Universiti Al-Qadisiyah bagi tahun akademik 2015-2016. Data Envelopment Analysis (DEA) telah digunakan dengan pelbagai model iaitu CRS-I, CRS-O, VRS-I, dan VRS-O. Bilangan pelajar yang mendaftar, pensyarah, pekerja, dan pembantu pengajar digunakan sebagai input manakala bilangan pelajar yang memperolehi sarjana muda dan bilangan penyelidikan yang diterbitkan dalam jurnal kebangsaan dan antarabangsa digunakan sebagai output. Hasil dapatan kajian menunjukkan bahawa 58% daripada kolej-kolej tersebut mencapai saiz ekonomi yang optima menurut skala kecekapan kerana kolej-kolej tersebut mencapai kecekapan penuh. Kolej Kejururawatan merupakan kolej rakan bagi kolej-kolej yang tidak cekap. Untuk mencapai kecekapan penuh, perlu ada penurunan yang signifikan dalam input dengan amaun output yang sama (orientasi input) atau peningkatan yang signifikan dalam output dengan amaun input yang sama (orientasi output). Secara umumnya, skor kecekapan bagi Universiti Al-Qadisiyah menunjukkan terdapat kemungkinan bagi universiti tersebut untuk mengurangkan sumber sedia ada sebanyak 10% dengan mengekalkan amaun output semasa atau menambahkan outputnya sebanyak 1% dengan mengekalkan amaun input semasa. Justeru, pembuat keputusan di Universiti Al-Qadisiyah dan kolej-kolejnya yang belum berjaya memperolehi kecekapan yang dikehendaki perlu mengkaji faktor-faktor yang telah menyumbang kepada hasil ini dan pengetahuan tentang kelemahan serta ketidakseimbangan dalam input dan output. Mereka boleh menggunakan sumber-sumber sedia ada dengan cekap dengan membandingkan input dan output mereka dengan kolej rakan.*

*Katakunci: Universiti Al-Qadisiyah; kecekapan; DEA; kecekapan skala; kolej rakan*

### INTRODUCTION

It is necessary for countries of the world, especially developing countries, to pay attention to education

and its efficiency. They must have created education enhancing limitations to meet the assigned role, which finally result in economic development. Iraq is one of the countries which had one of the best education systems



in the world, but the situation has been deteriorating as a result of wars, economic embargoes, financial crisis and the decline in crude oil prices. This has led to a significant reduction in the financial specialties of the education sector. It is therefore imperative for the Iraqi education institutions to make the optimum use of their available resources. This requires studying their efficiency and uncovering the sources of waste in their human and material resources.

Measuring the efficiency of the education sector is more difficult than measuring the efficiency of other sectors such as trade and industry due to the difficulty in evaluating the monetary values of its inputs and outputs. However, there have been several studies by economists to measure the efficiency of universities by applying the education production function, which describes the transformation of education resources (inputs) into education outputs. In addition, several studies have used different functional forms of the production function such as linear, nonlinear and logarithmic functions (Rashdan 2001). However, these methods are of limited use in measuring the efficiency of the education sector when the objective is to identify inefficient universities or colleges and the reasons behind their inefficiency. Moreover, these methods provide no information on the optimal quantities of inputs and outputs to achieve the relative efficiency of these universities or colleges. Furthermore, these methods require the researchers to write the hypothesis for the function that links the independent variables (inputs) to the dependent variables (outputs). Since the interaction between inputs and outputs in the education sector is complex, it is not possible to give specific prices for the services provided by this sector.

There are many studies which aimed to analyze the efficiency of universities by using parametric and non-parametric methods, especially in developed countries such as the United States of America (Kokkelenberg et al. 2008), Canada (McMillan & Chan 2006), the United Kingdom (Izadi et al. 2002), and Australia (Abbott & Doucouligos 2003). Other studies have examined the efficiency of the colleges in the universities (e.g. Johnes & Johnes 1993; Kao & Hung 2008). Some other studies have focused on academic programs across universities (e.g. Colbert et al. 2000).

The motivation for this research can be inferred from the lack of research in evaluating Iraqi universities (Omar & Husain 2014), especially the University of Al-Qadisiyah in terms of efficiency of using their inputs in an optimal way to get the best outputs. Research that measures the efficiency of Iraqi universities has neglected published research by lecturers in international journals. This variable has a major role in increasing the ranking of the university globally. The Iraqi Universities do not appear in any international classification except for the Universities of Baghdad and Kufa. Therefore, it is necessary to conduct a study to measure the efficiency of the University of Al-Qadisiyah. This study is one of

the early research conducted on the efficiency of this university in terms of technical and scale efficiency.

It is hoped that this research will provide a clear picture on the performance of the colleges in using human and material resources to get their outputs so that the decision makers in this university would be able to make informed decisions. This study is going to provide a scientific basis for the necessary reforms to be carried out by inefficient colleges to become efficient and provide peer colleges for each inefficient college.

The rest of this paper is organized as follows. Section 2 provides the literature review, which used Data Envelopment Analysis (DEA) to measure the efficiency of education institutions. Section 3 provides an overview of the University of Al-Qadisiyah. Section 4 provides the theoretical framework and section 5 describes the method of analysis and the data used in this study. Section 6 presents and discusses the empirical results. Finally, section 7 provides a summary of the findings and recommendations of the study.

## LITERATURE REVIEW

DEA has been employed in many areas of studies: sports, economics, operations research and others. Approximately 800 papers have been published during the period spanning from 1978 to 2002 (Cooper et al. 2000; Drebee & Nasser 2016). Studies that examined the efficiency of educational institutions differed among themselves in terms of the population and the types of inputs and outputs that are used. Table 1 shows that the literature review differ in terms of their utilization of inputs and outputs in measuring the efficiency of universities or colleges according to the country in which the study was conducted. In this respect, there is no authorized study that specified how to optimize the inputs and outputs that can reflect the performance of these units (universities, colleges or schools) in decision making, but it is possible to select inputs and outputs that must meet certain conditions (Bowlin 1998). One of these conditions is that these universities or colleges use the same inputs and outputs, which should reflect the activities of these universities or colleges, which vary from one university to another or from one country to another, which leads to the results of each study that differ from the results of other studies. Some countries provide free education, but not others. Some international universities grant scholarships to students, but not others. Therefore, some studies have used the variable grants granted to students or the revenues earned by colleges to measure their efficiency, while other studies did not use these variables. Iraqi universities differ from other universities in many aspects. They are subject to the policies of the Iraqi Ministry of Higher Education: student admission is centralized, student admission may exceed

TABLE 1. Inputs and outputs of previous studies

Authors / population	Inputs	Outputs	Results
Abbott and Doucauliagos 2003/36 Australian Universities.	A number of academic and non-academic staff and expenditure on all inputs.	A number of undergraduate and postgraduate student enrolled, and research Quantum.	The efficiency of 64% of the universities is more than 95%, while the efficiency of 6% of them is less than 80%.
Taylor and Harris 2004 10 of the South African Academic institutions.	The amount of expenditure, the amount of budget, the number of students and the number of staff.	A number of books, research papers, conferences, patents and income from research the amount of published research, the success rate and the number of doctorates granted to every 100 lecturers.	Average efficiency increased from 86% in 1994 to 91% in 1995 and then fell down to 88% in 1997.
Afonso and Santos 2005 Portuguese public Universities.	The average amount of expenditure per students and the ratio of lecturers to students.	Amount of published research, the success rate and the number of doctorates granted to every 100 lecturers.	Three universities achieved full efficiency with an efficiency score of 0.48 and the average technical efficiency is 0.45.
Johns 2006 109 universities in the United Kingdom.	A number of bachelor students, postgraduate students, lecturers and researchers, the number of expenses and revenues, and the amount of expenditure on libraries.	A number of awarded bachelor's degrees, the number of awarded certificates in postgraduate studies, and the number of funded grants from the Board of Higher Education funding in England.	262 universities achieved full efficiency and the average technical efficiency was 94.61, and the average scale efficiency was 96.45.
Fandel's 2007 15 Germany universities.	Number of students, the number of workers and extra-budgetary funding.	Alumni of Bachelor and Doctoral programs.	10 out of universities achieved full efficiency.
Salleh 2012 Malaysian public universities	Undergraduate enrolment, government research funding, and academic staffs and government research funding.	Alumni.	Malaysian public universities are relatively efficient with mean efficiency scores close to one.
Lim et al. 2016 22 Malaysian universities	Government grants, total expenditure, academic staff, administrative staff, and total assets.	Income (exclude government grants), fees income and graduate.	University Malaya, University Teknologi Mara and University Utara Malaysia are most efficient Malaysian public universities.
Arjomandi et al. 2015 Malaysia public universities	Undergraduate enrolment, postgraduate enrolment, academic staff, and government research funding.	Number of refereed articles, undergraduate and postgraduate degree awarded.	Efficiency scores among the universities are found to be similar ranging from 0.92 to 1.00.
Abdelkader 2012 Colleges of the Saida University, Algeria	A number of newly enrolled students, the number of permanent lecturers and their annual wages.	Number of success students.	College of Economic Sciences achieved full efficiency according to CRS, while the College of Law and Political Science was inefficient as compared with the other colleges according to VRS whereas five universities out of 11 were relatively efficient.
Fahmi, 2009 / Saudi Arabia government universities	Number of students and their financial allocations.	Alumni.	Number of Universities with full efficiency was 5.
Batal et al. 2008 Anbar University-Iraq	A number of students, salaries of teachers and administrative staff, and Expenses.	Alumni and the number of weekly hours for lecturers.	Four colleges at Anbar university achieved full efficiency according to CRS, while five achieved full efficiency according to VRS.

Cont. TABLE 1

Drebee and Nasser 2016 Public secondary school at Al-Qadisiyah province-Iraq	Size of schools, the number of teachers and the number of classrooms.	Number of success students.	The schools do not reach their optimum economic size since there are wastes by 21% of the inputs where their efficiency is 79%. The scale efficiency has indicated the possibility of expansion in the schools of this province by 14% until the size and economic optimum is achieved. In addition, 19% of the schools suffer from a significant increase in the number of students admitted, and 77% of those schools do not reach the optimum economic size, which reached only 5% of those schools.
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the absorptive capacity of a given university, universities receive grants from the Iraqi government, and education at all stages of the Bc, Mc, and Ph.D. is free (except for some cases such as the acceptance of some students in postgraduate studies in exchange programs).

It is worth to note that most of Arabic and Iraqi journals are not indexed by Scopus or Clarivate analytics as compared to international journals. Therefore, the advantage of this study is the use of published papers by the researchers of the University of Al-Qadisiyah in international journals that are indexed by Scopus or Clarivate analytics as one of the inputs. This variable has not been used in previous studies, especially in measuring the efficiency of Arab and Iraqi universities.

As shown in Table 1 there are differences among these studies in terms of the population of the study: some studies dealt with the efficiency of the universities, some others dealt with the efficiency of the colleges, and others dealt with both. The current study differs from the previous studies in terms of using published research in international journals are indexed by Scopus or Clarivate analytics, but the common factor is to measure the relative efficiency by using DEA.

#### AN OVERVIEW OF THE UNIVERSITY OF AL-QADISIYAH

The University of Al-Qadisiyah is one of the Iraqi universities that is located in the city of Al-Diwaniyah. It was established in 1987 and consisted of two colleges: The College of Education and the College of Administration and Economics. In the following academic year, the College of Arts was opened. Over the years, the University has expanded its colleges and developed its laboratories. Today, it includes the following colleges: Education, Management and Economics, Arts, Veterinary Medicine, Medicine, Physical Education,

Science, Computer Science and Information Technology, Agriculture, Law, Engineering, Education for Women, Dentistry, Archaeology, Biotechnology, Fine Arts, and Pharmacy and Nursing.

In terms of postgraduate studies, it started at the university in 1993 at the College of Education for master's programs and then expanded to include the Colleges of Administration and Economics, Arts, Physical Education, and Veterinary Medicine. For doctorates, the programs started in the 1998-1999 in the departments of Biology and History.

It is worth to note that the University of Al-Qadisiyah is a member of the Federation of Universities of the Arab World and Federation of Universities of the Islamic World, where many Arab students graduated from the university especially from Jordan, Palestine and Yemen.

#### THEORETICAL FRAMEWORK

Farrell (1957) argued for the need to develop better methods and models to evaluate productivity, which produced accurate measurements. The existing methods were often limited to measuring one aspect of the activities of institutions and thus failed to provide models that measure a variety of inputs. Farrell proposed a methodology for analyzing the activity of any institutions which is applicable to any productive institutions and therefore this approach extended the concept of productivity to a more general concept, namely, efficiency. His proposal went largely ignored until it was rediscovered in 1978 by Abraham Charnes, William Cooper and Edwardo Rhode in their study of the evaluation of education programs for Negroes and Spaniard's students who required appropriate analysis to compare the performance of a set of similar schools. It was difficult to compare the technical efficiency of

the schools, which included a set of inputs and outputs, and no information on their prices was available. To overcome this difficulty, they formulated a method called the Data Envelopment Analysis (DEA).

The DEA is best to measure the relative efficiency of education institutions (Koksal & Nalcaci 2006) because of its advantages over the traditional methods, including the use of multiple inputs and outputs with different units of measurement (Charnes et al. 1994), as well as the ability to identify weaknesses in the decision-making units that are evaluated, such as determining the possibility of increasing outputs in less efficient units without increasing resources. One of the most important advantages of this method is that it does not need to determine the previous weights of input and output as weights are determined automatically (Cooper et al. 2000; Joe Zhu 2000).

The DEA method will be used as the framework of analysis in this study by comparing the input of colleges at the University of Al-Qadisiyah (i.e. the number of lecturers, the number of students, etc.) to outputs (i.e. the number of graduates, the number of publications, etc.).

Through this analytical framework, colleges that have achieved full efficiency and colleges that have not will be identified and the quantity to be reduced from the inputs of inefficient colleges will be determined to achieve the required efficiency and the amount to be increased from the outputs of inefficient colleges will be determined to achieve the required efficiency.

The following is an overview of the DEA:

DATA ENVELOPMENT ANALYSIS (DEA)

The DEA is a nonlinear method that uses linear programming to evaluate the efficiency of a decision-making unit (DMU) that works in similar fields such as colleges, schools, hospitals, etc. It is done by determining the optimal mix of inputs and outputs. This approach is based on Pareto optimality, which assumes that any DMU will be inefficient if the DMU can produce the same output with less input.

The DEA is characterized by many advantages that distinguish it from other non-parametric methods, such as not having to put hypotheses about the mathematical formula that connects different inputs and outputs in different units to measure the efficiency of the DMUS without specifying the weights of those inputs and outputs.

The relative efficiency (RE) of any college  $j_0$  is calculated by finding the ratio of the weighted outputs to the weighted inputs, as follows (Charnes et al. 1978):

$$RE_j = \frac{\sum_{r=1}^t u_r y_{rj_0}}{\sum_{i=1}^m v_i x_{ij_0}}, u_r \geq 0, v_i \geq 0$$

where:

$v_j$  : the weight assigned to the input  $i$ ,  $u_r$ : the weight assigned to the output  $r$ ,  $t$ : the number of outputs,  $m$ : the number of inputs,  $x_{ij}$ : the amount of input  $i$  from college  $j_0$ , and  $y_{rj}$ : the amount of output  $r$  from college  $j_0$ .

There are several types of efficiency, one of which is known as Economic Efficiency, which refers to the ability of the DMU to obtain a certain level of production at the lowest level of costs (Farrell 1957).

Economic efficiency consists of allocative efficiency and technical efficiency. Allocative efficiency means using the production elements at the correct rates at a certain level of prices to produce a certain level of output. Technical efficiency refers to the ability of the DMU to achieve the highest level of output under its available resources. The DMU is fully efficient (inefficient) when the technical efficiency is equal to 1. There are two main approaches to measuring technical efficiency: input oriented and output oriented. While the first approach enables the DMU to determine the extent of a reduction in inputs while maintaining the current amount of output, the second approach enables the DMU to determine the extent of an increase in output while maintaining the current level of inputs.

Another related concept is scale efficiency, which refers to the efficiency that measures the degree to which the DMU can expand according to the volume of its activities. Scale efficiency is calculated by dividing the technical efficiency of Constant Return to Scale (CRS) with the technical efficiency of either Increasing or Decreasing Return to Scale (IRS or DRS). (CRS means doubling the inputs results in doubling the output, IRS means doubling the inputs results in more than doubling the output, and DRS means doubling the inputs results in less than doubling the output).

DATA ENVELOPMENT MODELS WITH INPUTS AND OUTPUTS ORIENTED

The basic model on which the subsequent models of the DEA are based is CRS, which is based on the assumption that the yield is constant and is used to evaluate the relative efficiency of the colleges and determines the source and amount of inefficiency of each college.

On the input-oriented approach (CRS-I), the model takes the following formula:

$$\begin{aligned} &Max. \phi \\ s.t. \quad &\sum_{j=1}^t \lambda_j x_{ij} - \phi x_{ij_0} \leq 0 \quad ; i = 1, 2, \dots, m; j = 1, 2, \dots, t \\ &\sum_{j=1}^t \lambda_j y_{rj} - \phi x_{ij_0} \leq 0 \quad ; r = 1, 2, \dots, s; j = 1, 2, \dots, t \\ &\lambda_j \geq 0 \quad ; j = 1, 2, \dots, t \end{aligned}$$

where:

$\phi$ : degree of college efficiency,  $m$ : number of outputs,  $n$ : number of inputs,  $t$ : number of colleges to be measured,  $\lambda_j$ : weight of input and output of the college  $j$ ,  $y_{rj}$ : amount of

output  $r$  for the college required to measure its efficiency,  $x_{ij_0}$ : amount of input  $i$  for the college  $j_0$  required to measure its efficiency.

On the output-oriented approach (CRS-O), the model takes the following formula:

$$\begin{aligned} & \text{Max. } \theta \\ \text{s.t. } & x_{ij_0} - \sum_{j=1}^t \lambda_j x_{ij} \geq 0 \quad ; i = 1, 2, \dots, m; j = 1, 2, \dots, t \\ & \theta y_{rj_0} - \sum_{j=1}^t \lambda_j y_{rj} \leq 0 \quad ; r = 1, 2, \dots, s; j = 1, 2, \dots, t \\ & \lambda_j \geq 0 \quad ; j = 1, 2, \dots, n \end{aligned}$$

where:  $1 \leq \theta \leq \alpha$ ,  $(1 - \theta)$  is the proportionate increase in the outputs that the college  $j_0$  can achieve without an increase in the amount of inputs, and the amount  $1/\theta$  represents the technical efficiency of the college  $j_0$ , which is between one and zero.

The other model of the DEA model is non-constant return to scale, which is attributed to Banker, Charnes and Cooper in the mid-1980s (abbreviated as BCC or VRS). It is distinguished from the CRS model in the sense that it gives an estimate of the technical competence under the volume of operations in the DMU when providing its services at the time of measurement. The possibility of determining a variable rate of return (constant, decreasing and increasing) in the quantity of services of inefficient DMUs results from changing the amount of inputs to reach efficiency (Cooper et al. 2000).

This model VRS-I takes the following formula from input-oriented approach (Banker et al. 1984):

$$\begin{aligned} & \text{Max. } \phi \\ \text{s.t. } & \sum_{j=1}^t \lambda_j x_{ij} - \phi x_{ij_0} \leq 0 \quad ; i = 1, 2, \dots, m; j = 1, 2, \dots, t \\ & \sum_{j=1}^t \lambda_j y_{rj} - \phi y_{rj_0} \leq 0 \quad ; r = 1, 2, \dots, s; j = 1, 2, \dots, t \\ & \sum_{j=1}^t \lambda_j = 1 \quad ; j = 1, 2, \dots, t \\ & \lambda_j \geq 0 \quad ; j = 1, 2, \dots, t \end{aligned}$$

On the output-oriented approach (VRS-O), the model takes the following formula:

$$\begin{aligned} & \text{Max. } \theta \\ \text{s.t. } & x_{ij_0} - \sum_{j=1}^t \lambda_j x_{ij} \geq 0 \quad ; i = 1, 2, \dots, m; j = 1, 2, \dots, t \\ & \theta y_{rj_0} - \sum_{j=1}^t \lambda_j y_{rj} \leq 0; r = 1, 2, \dots, s; j = 1, 2, \dots, t \\ & \sum_{j=1}^t \lambda_j = 1 \quad ; j = 1, 2, \dots, t \\ & \lambda_j \geq 0 \quad ; j = 1, 2, \dots, n \end{aligned}$$

It is worth mentioning that there are other models of importance in the DEA method including Additive Model, which explains the efficiency according to economic theory by Pareto optimality. Besides that, this model combines the objectives of the approaches of input and output orientation. The other model is Multiplicative Models, which is based on linear logarithm. This model is suitable for industrial enterprises because of the dominance of the Cobb-Douglas equation for production on this model.

## DATA AND MODEL SPECIFICATION

It should be noted that the DEA method requires that input and output variables be greater than zero. Thus, the following colleges at the University of Al-Qadisiyah (Dentistry, Pharmacy, Archaeology, Biotechnology, and Fine Arts) are excluded because they have no graduate students, and the College of Law is also excluded because there is no research published by its lecturers in international journals. This leaves us with the following colleges to be studied: Science, Veterinary of Medicine, Computer Science and Information Technology, Medicine, Education for Women, Engineering, Administration and Economics, Agriculture, Physical Education, Arts, and College of Nursing.

In this study, four models of DEA are used to estimate the efficiency score: Input-oriented Model with Constant Returns to Scale (CRS-I), Output-oriented model with Constant Returns to Scale (CRS-O), Input-oriented model with Variable Returns to Scale (VRS-I), and Output-oriented model with Variable Returns to Scale (VRS-O). This gives the decision makers a high flexibility to control the input and output of each college.

In this study, too, the number of enrolled students (Masters, Ph.D., and Board certification), the number of lecturers, employees and teaching assistants are used as inputs, while the number of students with a bachelor's degree, and the number of published research in national and international journals are used as outputs. The descriptive statistics of these variables are shown in Table 2.

As shown in Table 2, there are a lot of discrepancies among the colleges at the University of Al-Qadisiyah: the number of graduate students ranges between 37 and 994, the number of lecturers between 17 and 214, and the number of published research in international journals between 10 and 273. This indicates a lack of balance in the number of lecturers and employees among colleges, and a significant lack of research in international journals in most colleges as well.

Prior to measuring the efficiency of colleges at the University of Al-Qadisiyah, the requirement of correlation among inputs and outputs should be verified. The Pearson correlation coefficient is used to measure the strength and direction of the relationship among the variables. The results are reported in Table 3. As shown in this table, there is a positive relationship among the variables, despite the varying degrees of the correlation.

## MEASURING THE EFFICIENCY OF COLLEGES

We next proceed with the DEA. As shown in Table 4, seven of the colleges (or 58%) at the University of Al-Qadisiyah (Medicine, Education for Women, Administration and Economics, Education, Physical Education, Arts and Nursing) achieved full efficiency according to CRS-I,

TABLE 2. Descriptive statistics of the variables of study

Variables	Minimum	Maximum	Mean	Std. Deviation
No. of students with a bachelor's degree.	37	994	284	297
No. of Researches Published In International Journals.	10	273	61	73
No. of Research Published In National Journals.	31	301	106	87
No. of Students Enrolled	270	4697	1292	1340
No. of Lecturers (Masters, Ph.D. and Board certification).	17	214	68	52
No. of Employees and Teaching Assistants.	20	129	61	32

TABLE 3. The results of correlation among variables of the study

Variables	No. of students enrolled	No. of lecturers	No. of employees
No. of number of students with a bachelor's degree	0.980	0.770	0.403
No. of researches published in international Journals.	0.169	0.381	0.782
No. of researches published in national Journals	0.750	0.859	0.848

CRS-O, VRS-I and VRS-O. This means that there are no surpluses of available resources in these colleges. In other words, these colleges used all available resources from the number of enrolled students, lecturers, employees, and teaching assistants to reach the current number of students with a bachelor's degree, and published research in international and national journals. These colleges reached the optimum economic size as indicated by the efficiency scale.

The efficiency score refers to the efficiency of the College of Veterinary Medicine according to VRS-I and VRS-O, while according to CRS-I and CRS-O, this college has reached the efficiency of 80%. This means that it is able to achieve the current number of graduates, published research in national and international journals by using 80% of its resources of enrolled students, lecturers and employees. Alternatively, this college could reduce its available inputs by 20% while retaining the current amount of output.

Scale efficiency indicates that the utilization rate of the resources of the College of Veterinary Medicine is 95%. There is a possibility to expand this college by 5% according to the input and output-oriented approaches. The return of scale is increasing for both input and output-oriented approaches, indicating that an increase in the output of this college requires a lower increase in its available resources.

The efficiency score for the Colleges of Science, Computer Science and Information Technology, Engineering, and Agriculture indicates that they are inefficient. These colleges are able to achieve the current outputs by using 80%, 56%, 68% and 76%, respectively, according to CRS-I and CRS-O, and by 80%, 57%, 69% and 77%, respectively, according to VRS-I, and by 82%, 59%, 71% and 77%, respectively, from the available resources used by these colleges to be efficient according to VRS-O.

The scale efficiency indicates the possibility of expanding the College of Computer Science and Information Technology, the College of Engineering and the College of Agriculture by 1% according to input-oriented approach. Nevertheless, according to output-oriented approach, the possibility of expansion is 2% in the College of Science, 5% in the College of Computer Science and Information Technology, 3% in the College of Engineering and 1% in the College of Agriculture.

The return to scale has pointed out that increasing the output of the Colleges of Engineering and Agriculture requires a greater increase in their inputs (DRS), while increasing the output of the College of Veterinary Medicine requires a lower increase in inputs (IRS) according to the input- and output-oriented approaches. Increasing the outputs of the College of Computer Science and Information Technology requires a smaller increase in the inputs (IRS) according to the input-oriented approach and greater increase in the inputs (DRS) according to the outputs oriented. The returns to scale of the College of Science is decreasing according to the output-oriented approach, which means that the increase in the output of this college requires a greater increase of inputs (DRS).

Table 4 shows that the College of Nursing is a peer college for other inefficient colleges at the University of Al-Qadisiyah. The Colleges of Medicine and Education for Women are peer colleges for all colleges except for the College of Agriculture. The least efficient college in the University of Al-Qadisiyah is the Computer Science and Information Technology according to CRS-I, CRS-O, VRS-I and VRS-O.

In general, the average efficiency of the University of Al-Qadisiyah indicates that it is able to achieve the current number of its graduates, the number of published research in both national and international journals by using 90% of its inputs according to CRS-I, and 91% according to VRS-I. In other words, the University of

TABLE 4. Efficiency score for the colleges at University of Al-Qadisiyah according to the input and output-oriented approach

Colleges	CRS-I, CRS-I		VRS-I		VRS-O		RE. to SC		Scale Efficiency (SE)	
	TE Score	Peers	TE Score	Peers	TE Score	Peers	Input-oriented	Output-oriented	Input-oriented	Output-oriented
Science (1)	0.800	5-12	0.800	4-5-12	0.815	4-5-7	-	DRS	1.000	0.981
Veterinary Medicine (2)	0.949	4-12	1.000	2	1.000	2	IRS	IRS	0.949	0.949
Computer Science and Information Technology (3)	0.560	4-5-11-12	0.567	4-5-11-12	0.589	4-5-7-11-12	IRS	DRS	0.988	0.950
Medicine (4)	1.000	4	1.000	4	1.000	4	-	-	1.000	1.000
Education for Women (5)	1.000	5	1.000	5	1.000	5	-	-	1.000	1.000
Engineering (6)	0.682	5-7-10-12	0.685	4-5-7-10-12	0.706	12-4-5-7	DRS	DRS	0.994	0.965
Administration and Economics (7)	1.000	7	1.000	7	1.000	7	-	-	1.000	1.000
Agriculture (8)	0.766	7-12	0.769	7-12	0.774	7-12	DRS	DRS	0.991	0.987
Education (9)	1.000	9	1.000	9	1.000	9	-	-	1.000	1.000
Physical Education (10)	1.000	10	1.000	10	1.000	10	-	-	1.000	1.000
Arts (11)	1.000	11	1.000	11	1.000	11	-	-	1.000	1.000
Nursing (12)	1.000	12	1.000	12	1.000	12	-	-	1.000	1.000
Mean	0.896		0.909		0.914	-	-	-	0.994	0.986

Note: The numbers in columns 3, 5 and 7 refer to the sequence of the colleges.

Al-Qadisiyah could reduce its resources by 10% and 9% according to CRS-I and VRS-I, respectively, retaining the current amount of its outputs. In order for the University of Al-Qadisiyah to be efficient, it must increase its output by 8% assuming no change in the available resources. The scale efficiency of the University of Al-Qadisiyah is 99%, which means that there is a possibility of expanding the Colleges of the university by 1% according to the input and the output-oriented approach to achieve the optimum size.

#### FUTURE OBJECTIVES OF THE INEFFICIENT COLLEGES ACCORDING TO INPUT ORIENTED

The DEA method identifies not only inefficient colleges but also the sources and quantities of inefficiency in inefficient colleges and the proposed quantities of inputs and outputs to be efficient. Table 5 shows the required improvement in inefficient colleges according to the input-oriented approach. The column of actual values refers to the actual uses of the input and the output values, and the column of target values refers to the input and the output values that should be used or produced by inefficient colleges in order to be efficient in the input-oriented approach.

In order for the College of Science to become as fully efficient as its peer colleges (Education for Women

and Nursing in accordance with CRS and the College of Economics and Administration according to VRS), the number of enrolled students and lecturers must be reduced by 30 and 126 (i.e. by 20% and 60%), respectively, according to CRS and VRS, and the number of employees must be reduced by 27 (or 55%) according to CRS, and 26 (or 53%) according to VRS while retaining the current amount of its outputs.

In the same way for the College of Veterinary Medicine to become as fully efficient as its peer colleges (Medicine and Nursing College) according to CRS, it has to reduce the number of enrolled students, lecturers and employees from 270, 77, and 69 to 256, 30 and 45 (i.e. by 5.2%, 61% and 34.8%), respectively with an increase in the number of published research in international journals by 176.4%.

In order for the College of Computer Science and Information Technology to be as efficient as its peer colleges (Medicine, Education for Women, Arts and Nursing) according to CRS, it should significantly reduce its inputs of enrolled students, lecturers and employees from 936, 37, and 49 to 483, 21 and 27 (i.e. by 48.4%, 43.2% and 44.9%), respectively. Whereas, according to VRS, it has to reduce the number of enrolled students, lecturers and employees to 497, 21 and 28 (i.e. by 46.9%, 43.2% and 42.9%), respectively. In addition, the College of Computer Science and Information Technology needs to retain the current number of students with a



TABLE 5. The improvement required of the colleges at the University of Al-Qadisiyah according to the input-oriented approach

Colleges	Number of Graduates			Number of researches published in international Journals			Number of researches Published in national journals			Undergraduate students enrollment			Number of academic staffs			Number of employees and Teaching Assistances		
	Actual value	Target-CRS	Target-VRS	Actual value	Target-CRS	Target-VRS	Actual value	Target-CRS	Target-VRS	Actual value	Target-CRS	Target-VRS	Actual value	Target-CRS	Target-VRS	Actual value	Target-CRS	Target-VRS
Science	144	144	144	48	48	48	36	40	42	631	505	505	50	20	20	49	22	23
Veterinary Medicine	37	37	37	34	94	34	84	84	84	270	256	270	77	30	77	69	45	69
Computer Science and Information Technology	131	131	140	41	41	41	52	52	52	936	483	497	37	21	21	49	27	28
Medicine	97	97	97	273	273	273	240	240	240	711	711	711	85	85	85	129	129	129
Education for Women	152	152	152	58	58	58	37	37	37	543	543	543	21	21	21	20	20	20
Engineering	145	145	145	30	30	30	54	54	54	719	490	493	73	21	21	42	29	29
Administration and Economics	601	601	601	12	12	12	121	121	121	2041	2041	2041	78	78	78	65	65	65
Agriculture	170	170	170	10	19	17	31	61	58	728	558	560	30	23	23	63	33	32
Education	994	994	994	113	113	113	301	301	301	4696	4696	4696	214	214	214	109	109	109
Physical Education	158	158	158	28	28	28	100	100	100	713	713	713	61	61	61	39	39	39
Arts	651	651	651	69	69	69	163	163	163	3110	3110	3110	75	75	75	65	65	65
Nursing	124	124	124	18	18	18	52	52	52	402	402	402	17	17	17	28	28	28
Sum	3404	3404	3413	734	803	741	1271	1305	1304	15500	14508	14541	818	666	713	727	611	636

bachelor's degree according to CRS and increase it by nine students according to VRS in order to be as efficient as its peer colleges.

In order for the College of Engineering to reach full efficiency like its peer colleges (Education for Women, Economics, Physical Education and Nursing according to CRS and College of Medicine, Education for Women, Economics, Physical Education and Nursing in accordance with VRS), it has to reduce its input of graduate students, lecturers and employees by 229, 52 and 13 (i.e. 31.8%, 71.2%, and 31%), respectively, according to CRS, and 226, 52, and 13 (i.e. 31.4%, 71.2%, and 31%), respectively, according to VRS, retaining the current number of graduates.

As shown in Table 5 too, in order for the College of Agriculture to become fully efficiency like its peer colleges, namely, College of Administration and Economics and Nursing, it has to reduce its inputs by 20 employees (i.e. 31.7%) according to CRS and 28 employees (i.e. 44.4%) according to VRS, with an increase in the output of graduate students, published research in national and international journals, and by 30.6%, 150% and 158%, respectively, according to CRS, and by 28.8%, 70% and 113%, respectively, according to VRS.

In general, in order to achieve the full efficiency of the University of Al-Qadisiyah, it has to reduce the number of enrolled students, lecturers, and employees by 6.4%, 18.9% and 16%, respectively according to CRS, and 6.2%, 12.8% and 12.5%, respectively, according to VRS, with increased output from research published in national and international journals by 9.4% and 2.7%, respectively, according to CRS and by 1% and 2.6%, respectively according to VRS.

#### FUTURE OBJECTIVES OF THE INEFFICIENT COLLEGES ACCORDING TO OUTPUT ORIENTED

As shown in Table 6, in order for the College of Science to achieve full efficiency like its peer colleges, which are Colleges of Education for Women and Nursing, it should increase its output of graduate students and the number of research published in international and national journals by 25%, 25% and 38.9%, respectively while reducing the number of lecturers and employees by 50% and 45%, respectively according to CRS, while according to VRS, in order to achieve efficiency like its peer colleges, namely: Medicine, Education for Women, Economics and Administration and Nursing, it must increase the output of graduate students and the number of research published in national and international journals by 22.9%, 22.9% and 25%, respectively while reducing the number of lecturers and employees by 50% and 51%, respectively.

As for the College of Veterinary Medicine, in order to achieve full efficiency like its peer colleges, namely, the College of Medicine and Nursing according to CRS, it should increase the number of graduates and

research published in international and national journals by 5.4%, 191.2% and 3.6%, respectively, retaining the current number of enrolled students and reducing the number of lecturers and employees by 59.7% and 30.4%, respectively.

The College of Computer Science and Information Technology has to increase the number of students with a bachelor's degree and the number of research published in national and international journals by 78%, 74% and 78.8%, respectively, also reducing the number of enrolled students by 7.6% retaining the current lecturers and employees to achieve full efficiency like its peer colleges (Medicine, Education for Women, Arts and Nursing) according to CRS. Also to achieve full efficiency, like its peer colleges (Medicine, Education, Economics and Administration, Arts and Nursing) according to VAR, it should increase its outputs from graduate students and research published in international and national journals by 69.5%, 70.7%, and 69.2%, respectively, while also reducing the number of employees by 10.2% and retaining the current number of lecturers and enrolled students.

If the College of Engineering is to become fully efficient like its peer colleges (Education for Women, Administration and Economics, Physical Education and Nursing according to CRS and Medical, Education for Women, Administration and Economics, and Nursing according to VRS), it should increase its outputs from graduate students, publication in national and international journals by 46.9%, 46.7% and 46.3% respectively. Moreover, retaining their inputs from enrolled students and employees, and reducing the number of students by 57.5% according to CRS, whereas according to VRS the numbers of students with a bachelor's degree, published researches in national and international journals need to be increased by 41.4%, 40% and 40.7% respectively, VRS also suggests reducing the number of lecturers and employees by 54.8% and 2.4%, respectively.

Getting the College of Agriculture fully efficient as its peer colleges (Administration and Economics, and Nursing according to CRS and VRS) requires an increase in its graduates and published research in national and international journals by 30.6%, 150%, and 158%, respectively. Retaining its inputs of enrolled students and lecturers, and reducing the number of its employees by 31.7% according to CRS, and reducing the number of lecturers and the number of employees by 3.3% and 44.4% respectively, should be done, according to VRS.

In general, as shown in Table 6, in order to achieve full efficiency, the University of Al-Qadisiyah has to increase its graduates, published research in national and international journals by 7.7%, 18.8% and 10.5% respectively, and reduce the number of lecturers and employees by 13.9% and 8.7% respectively. A slight reduction in the number of students according to CRS should be done as well. Whereas, according to VRS, the University has to increase its students with a bachelor's

TABLE 6. The improvement required of the colleges at the University of Al-Qadisiyah according to the output oriented.

Colleges	Number of Graduates			Number of Researches Published in International Journals			Number of Researches Published in national journals			Undergraduate students enrolment			Number of Academic Staffs			Number of Employees and Teaching Assistances		
	Actual value	Target -CRS	Target -VRS	Actual value	Target -CRS	Target -VRS	Actual value	Target -CRS	Target -VRS	Actual value	Target -CRS	Target -VRS	Actual value	Target -CRS	Target -VRS	Actual value	Target -CRS	Target -VRS
Science	144	180	177	48	60	59	36	50	45	631	631	631	50	25	25	49	27	24
Veterinary Medicine	37	39	37	34	99	34	84	89	84	270	270	270	77	31	77	69	48	69
Computer Science and Information Technology	131	234	222	41	73	70	52	93	88	936	864	936	37	37	37	49	49	44
Medicine	97	97	97	273	273	273	240	240	240	711	711	711	85	85	85	129	129	129
Education for Women	152	152	152	58	58	58	37	37	37	543	543	543	21	21	21	20	20	20
Engineering	145	213	205	30	44	42	54	79	76	719	719	719	73	30	33	42	42	41
Administration and Economics	601	601	601	12	12	12	121	121	121	2041	2041	2041	78	78	78	65	65	65
Agriculture	170	222	219	10	25	17	31	80	66	728	728	728	30	30	29	63	43	35
Education	994	994	994	113	113	113	301	301	301	4696	4697	4697	214	214	214	109	109	109
Physical Education	158	158	158	28	28	28	100	100	100	713	713	713	61	61	61	39	39	39
Arts	651	651	651	69	69	69	163	163	163	3110	3110	3110	75	75	75	65	65	65
Nursing	124	124	124	18	18	18	52	52	52	402	402	402	17	17	17	28	28	28
Sum	3404	3665	3637	734	872	793	1271	1405	1373	15500	15429	15501	818	704	752	727	664	668

degree by 6.8% and published research in national and international journals by 8%, and reduce its input from lecturers and employees by 8% and keeping the number of enrolled students unchanged.

#### SUMMARY AND CONCLUSION

This study aims to measure the relative efficiency of the colleges at University of Al-Qadisiyah for the academic year (2015-2016) by using DEA according to several alternative models (CRS-I, CRS-O, VRS-I and VRS-O). The number of enrolled students, lecturers (Master, Ph.D. and Board certification), employees, and teaching assistants were used as inputs, while the number of students with a bachelor's degree, the number of research published in international and national journals were used as outputs.

The study has found that seven of the colleges at University of Al-Qadisiyah (Medicine, Education for Women, Administration and Economics, Education, Physical Education, Arts and Nursing) achieved their complete efficiency in all models of DEA that are used in the study.

It concluded that the CRS-I and CRS-O give the same results, but the VRS-I and VRS-O give different results, which are consistent with the findings of Stupnytsky (2002).

Furthermore, the results indicate that the inefficient colleges in the University of Al-Qadisiyah have to significantly reduce their inputs and increase their outputs to be as efficient as the reference colleges. According to the input-oriented approach, the College of Science has to reduce its inputs by 20% and 60% for enrolled students and lecturers according to CRS and VRS, and by 55% for employees according to CRS and 53% according to VRS. The College of Veterinary Medicine has to reduce the numbers of enrolled students, lecturers and employees by 5.2%, 61% and 34.8% respectively, and has to significantly increase in the number of published researches in international journals and by 176.4% according to CRS. The Colleges of Computer Science and Engineering have to make a very big reduction in their inputs and a significant increase in the number of published research in international journals and by 176.4% of graduate students. The reduction is 48.4% and 31.8% respectively according to CRS, and 46.9% and 31.4% respectively according to VRS, for lecturers the reduction is 43.2%, 71.2% respectively according to CRS, 43.2% and 71.2%, respectively, according to VRS, while for employees the reduction is 44.9% and 31%, respectively according to CRS, 44.9% and 42.9%, respectively, according to VRS. While, College of Agriculture, in order to achieve full efficiency, it should reduce the number of its employees by 31.7% according to CRS and 44.4% according to VRS and a very large increase in its outputs of researches published in international journals by 150% according to CRS and

70% according to VRS, also the researches published in national journals should be increased by 158% according to CRS and 113% according to VRS.

The highest reduction in the number of enrolled students must be done in the College of Computer Science and Information Technology, and the highest reduction in the number of lecturers should be done in the College of Engineering. In the same way, the highest reduction in the number of employees must be done in the College of Science to achieve full efficiency in these colleges according to CRS and VRS.

In terms of output-oriented approach, the Colleges of Sciences, Computer Science, Engineering, and Agriculture must increase their output of published research in international journals by 25%, 74%, 46.7% and 150% respectively according to CRS, and by 22.9%, 70.7%, 40% and 70% respectively according to VRS. They need to increase their published research in national journals by 38.9%, 78.8%, 46.3% and 158% respectively according to CRS, and by 25%, 69.2%, 40.7%, and 112.9%, respectively according to VRS. The College of Veterinary Medicine should increase the number of published research in national and international journals by 191.2% and 3.6%, respectively according to CRS.

Achieving full efficiency according to the output orientation, huge increase in the number of published research in international journals should be done in the College of Veterinary Medicine according to CRS and the College of Computer Science and Information Technology according to VRS. On the other hand, the highest increase in the number of published research in national journals should be in the College of Agriculture according to CRS and VRS.

In general, the efficiency score of the University of Al-Qadisiyah points to the possibility of reducing its inputs or available resources by 10% while retaining the current amount of output to be efficient. This is consisted with the possibility of expansion in the university by 1% to achieve the optimal economic size. Therefore, according to input-oriented approach, the University of Al-Qadisiyah has to reduce its input from the number of enrolled students, lecturers, and employees by 6.4%, 18.9% and 16% respectively according to CRS, and by 6.2%, 12.8% and 12.5%, respectively according to VRS. Nevertheless, increasing its output of published research in international and in national journals by 9.4% and 2.7% respectively need to be done according to CRS and by 1% and 2.6%, respectively according to VRS. In terms of output-oriented approach, it should increase its graduates and published research in international and national journals by 7.7%, 18.8%, and 10.5% respectively. Reduction in the number of lecturers and employees by 13.9% and 8.7% respectively needs to be done, and a slight reduction in the number of enrolled students according to CRS. On the other hand, according to VRS, the university has to increase its graduates by 6.8%, published research in international and national

journals by 8%, and reducing number of lecturers and employees by 8% and keeping the number of students.

Based on the above, the decision makers in the University of Al-Qadisiyah and its colleges that have not achieve the required efficiency score should study the reasons that have led to this outcome in order to identify the weaknesses and imbalances in their inputs and outputs. They could exploit the available resources efficiently by comparing their inputs and outputs with their peer colleges.

This study recommends comparing the Iraqi Universities among themselves, or compare the efficiency of similar colleges (e.g. the Medicine College) in Iraqi Universities with each other. It also recommends comparing the Iraqi Universities with Arab and foreign Universities to determine the efficiency of using the available resources to them. As well as, further studies using the Data Envelopment Analysis method take into consideration the time horizon to find efficiency indicators at the college level over a certain period of time. This is called the Window Analysis.

It is also necessary to have a comprehensive database of all the variables related to universities and be accessible to researchers to be discussed periodically because the main problem faced by the researchers is also facing those who wish to apply this method, which is the lack of data.

One of the main limitations of this study is the use of a limited number of inputs and outputs in measuring the relative efficiency of the colleges at University of Al-Qadisiyah, and not to use other variables such as the suitability of the graduates' specialization to the requirements of the labor market, the local and international conferences attended by the lecturers, the number of books written or translated by the lecturers in the colleges or the number of laboratories in each college. This leads to a reduction in the efficiency of those colleges that use this inputs or outputs because there are many restrictions to be considered when using DEA to ensure its accuracy. The most important of these restrictions is the balance between variables (inputs and outputs) and number of DMUs. Moreover, DEA result in inaccurate results if the number of DMUs is less than or twice the total number of inputs and outputs. Therefore, in this study, new inputs and outputs variables cannot be added.

It should be noted that there is difficulty in collecting data concerning Iraqi universities in addition to the absence of a database in each university. However, results of this study are unbiased since conditions of DEA application are achieved.

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