

Measuring the Efficiency of Colleges Using Data Envelopment Analysis

Teg Alam

College of Business Administration,
Prince Sattam Bin Abdulaziz University, Al Kharj
Kingdom of Saudi Arabia

Abstract

Universities play a significant role in the development of a community and the nations as well as being hubs for producing systematic and scientific knowledge which supports the development of quality life and economy of the nation. This paper illustrates the application of Data Envelopment Analysis (DEA) to measure the efficiency of 20 colleges of Prince Sattam bin Abdulaziz University (PSAU). The input variables used in this study are the registered students and the academic staff. The output variables are graduates and research papers. The data for this study was collected for the year 2014-2015 and the data was obtained from the University Statistics Department. In this paper, we evaluate the efficiency scores of all colleges based on the Scale Efficiency Measurement (output oriented) model. The DEA tool assists academics and administrators to identify the inefficiencies and develop the optimal strategies to eliminate them.

Keywords: Data Envelopments Analysis, Academic Colleges, Efficiency, Al Kharj

Introduction

The key task of the university is to explore and communicate knowledge and awareness. The present Prince Sattam Bin Abdulaziz University, formerly known as Al-Kharj University, was established in 1430 HC by transferring the different colleges of King Saud University, which existed in five governorates of Riyadh region (Al-Kharj, Hootah bani Tamim, Al-Aflaj, Al-sulail and Wadi Al-Dawasir) to an independent university.

The diversified approaches have been used to estimate the performance of colleges. Data Envelopment Analysis (DEA) is the most common and well-known tool for measuring the efficiencies of schools, hospitals, and universities etc.

DEA was developed by Charnes, Cooper and Rhodes (1978) to evaluate the efficiencies of nonprofit and public sector organizations. Applications of the DEA tool have been used in the context of university's colleges or courses for measuring efficiency (Abbott, 2003; Agha, Kuhail, Abdul Nabi, Salem, & Ghanim, 2011; Johnes & Johnes, 1995; Johnes, 2006; Johnes, 1996).

Also DEA techniques are used to evaluate the relative efficiencies among universities (Kao & Hung, 2008; Köksal & Nalçaci, 2006; Bougnol & Dula, 2006; Moreno & Tadepalli, 2002).

General DEA Model

Suppose that there are 'n' Decision making units (DMUs), where, m inputs and s outputs, the efficiency of DMU_r is achieved by solving the following model:

(A. Charnes, W. W. Cooper, and E. L. Rhodes ,1978).

$$\begin{aligned} \max w_r &= \frac{\sum_{k=1}^s v_k y_{kr}}{\sum_{j=1}^m u_j x_{jr}} \\ \text{s.t.} \quad &\frac{\sum_{k=1}^s v_k y_{ki}}{\sum_{j=1}^m u_j x_{ji}} \leq 1 \quad ; \forall i; \quad i = 1,2,3, \dots, n \\ &\text{and} \quad v_k, u_j \geq 0 \quad ; \text{for all } k, j \end{aligned}$$

Where

y_{ki} = quantity of output 'k' formed by DMU_i

x_{ji} = quantity of input j consumed by DMU_i

v_k = weight for output k,

u_j = weight for input j.

The aforementioned fractional program can be converted to a linear program (A. Charnes, W. W. Cooper, and E. L. Rhodes, 1978) as given below.

$$\begin{aligned} \max w_r &= \sum_{k=1}^s v_k y_{kr} \\ \text{s.t.}, \quad &\sum_{j=1}^m u_j x_{jr} = 1 \\ &\sum_{k=1}^s v_k y_{ki} - \sum_{j=1}^m u_j x_{ji} \leq 0 \quad ; \text{for all } i \\ &\text{and } v_k, u_j \geq 0 \quad ; \text{for all } k, j \end{aligned}$$

If, $w_r = 1$, then DMU_r is efficient relative to other units. If, $w_r < 1$, then the DMU is inefficient. Later, the BCC model (Banker, R.D., Charnes, A., Cooper, W.W., 1984) modified the original CCR linear programming by adding a convexity constraint.

A measure of Technical efficiency (TE) for a DMU_r defined as $\theta_r^{output} = \text{Actual output}_r / \text{Maximum possible output}_r$ in output-oriented model. The scale efficiency (SE) measurements achieved by comparing the ‘technical efficiency measurements’ formulated under the assumptions of CRS (constant returns to scale) and VRS (variable returns to scale). As aforementioned, the technical efficiency measurement associated with CRS assumption, represents overall technical efficiency (OTE). The technical efficiency measurement associated with VRS assumption represents pure technical efficiency (PTE). The term “OTE / PTE” brings a scale efficiency measurement.

Data

The sample used in this study covers twenty colleges of the university. The data for this study was collected for the year 2014-2015 and was obtained from the University Statistics Department. In this research, we used DEA Software (DEAOS) to calculate the efficiency scores of all colleges based on the Scale Efficiency Measurement (output oriented) model.

Results and Discussion

The data given in Table-1 is known as Descriptive Statistics.

	Number of Students enrolled	Number of teaching staff	Number of graduates	Number of researches
Minimum	164	12	7	1
Maximum	4177	232	525	35
Mean	1319	104	173	11
Standard Derivation	1134	57	157	10

Table: 1 Descriptive Statistics

The efficiency scores obtained by different colleges are displayed in Table 2.

DMUs	Colleges	Efficiency Scores
DMU1	College of Education, Al kharj	92%
DMU2	College of Business Administration, Al kharj	99%
DMU3	College of Science & Humanities, Al kharj	85%
DMU4	Community College, Al kharj	100%
DMU5	College of Applied Medical Science , Al kharj	92%
DMU6	College of Pharmacy	100%
DMU7	College of Engineering & Computer Science, Al kharj	100%
DMU8	College of Engineering , Al kharj	98%
DMU9	Medical College	100%
DMU10	Dental College	87%
DMU11	College of Education, Al Delam	100%
DMU12	College of Science & Humanities, Huta	100%
DMU13	College of Business Administration, Huta	84%
DMU14	College of Science & Humanities, Aflaj	95%
DMU15	Community College, Aflaj	43%
DMU16	College of Science & Humanities, Al Sulel	99%
DMU17	College of education, Wadi Al Dawasir	100%
DMU18	College of Arts and Science , Wadi Al Dawasir	87%
DMU19	College of Engineering , Wadi Al Dawasir	85%
DMU20	College of Applied Medical Science , Wadi Al Dawasir	42%

Table 2: Efficiency Score of the Colleges

Measure the Efficiency of Colleges Using Data Envelopment

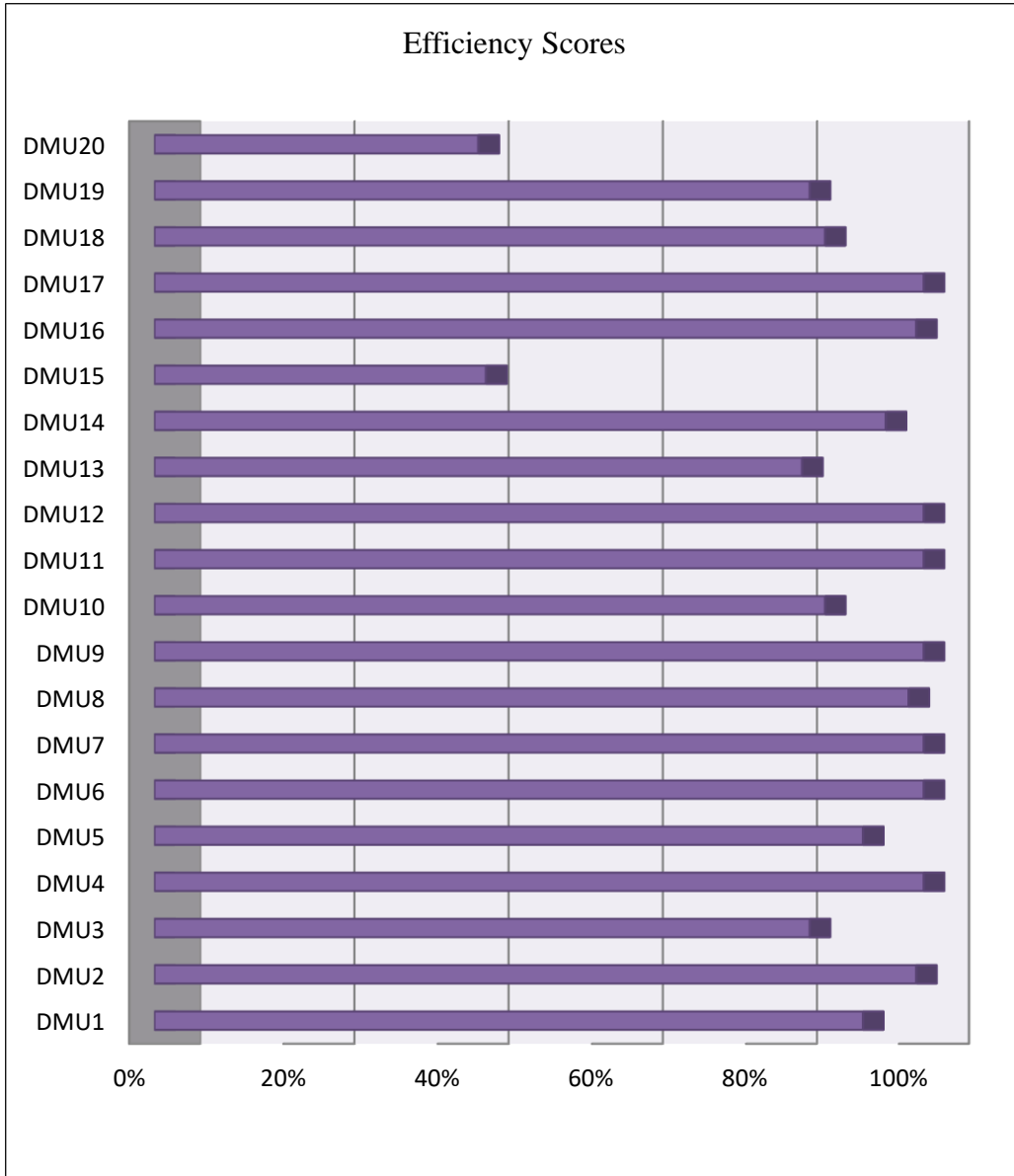


Figure 1: Efficiency Score of the Colleges

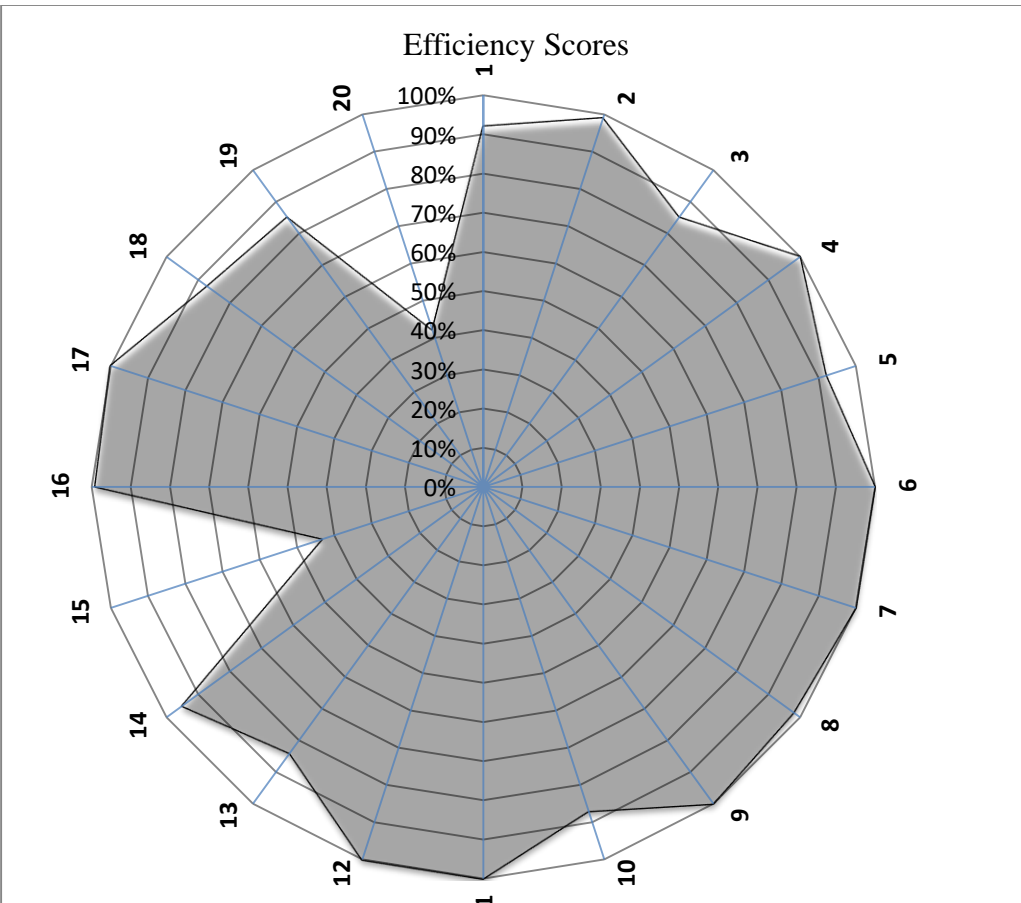


Figure 2: Efficiency Score of the Colleges

The colleges that achieved coefficient scores equal to 100%, were regarded as efficient ones. It means that they are efficient in utilizing their resources to produce all the defined outputs. Most of the colleges are nearest to 100% which shows that all the colleges will become efficient very soon. The results reveal that only two colleges achieved scores below fifty percent which requires them to focus more attention to reallocation of the resources to utilize them efficiently. This paper suggests that almost all colleges utilize their resources efficiently in producing graduates as well as research outputs. The findings of the paper are useful and important for the university administrators and policy makers which can help them in making decisions and managing their resources. The efficient colleges can be regarded as the model and benchmark for the other colleges.

Conclusion

The Ministry of Education in the Kingdom of Saudi Arabia is making all efforts towards the growth of the Nation regarding education and producing the best qualified cadres who can contribute to the development of the country and can compete successfully in this era of the competitive environment.

This study uses the DEA techniques to assess the efficiency of 20 colleges at Prince Sattam bin Abdulaziz University for the academic year 2014-2015. The results showed that approximately fifty percentage colleges are efficient in term of scale efficiency measurement (output Oriented) models. This means that the colleges are efficient in utilizing their resources to produce all the defined outputs. The efficiency scores indicate that which college needs improvement. The enhancements can be reached by either decreasing the inputs or increasing the outputs.

Most of the colleges have reached the range between 90% - 100% scores. Since some colleges are inefficient, the university administration is advised to be focused on them and develop the strategies to minimize their inadequacies. Despite the PSAU is a recently established university, it is growing and developing very fast. From the analysis, it was observed that the PSAU administrators are capable to identify the colleges that are inefficient in utilizing their resources. Also, it is recommended to reallocation of resources as it can increase the average efficiency score of the colleges.

Overall, we conclude that PSAU is growing rapidly in terms of production of graduates, teaching excellency, scientific research, efficiency of employees and infrastructure.

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