Measuring the Efficiency of Colleges Using Data Envelopment Analysis

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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).

\[
\max w_r = \frac{\sum_{k=1}^{s} v_k y_k r}{\sum_{j=1}^{m} u_j x_j r}
\]

\[
s.t. \frac{\sum_{k=1}^{s} v_k y_k i}{\sum_{j=1}^{m} u_j x_j i} \leq 1 \quad \forall \ i; \quad i = 1, 2, 3, ..., n
\]

\[
and \quad v_k, u_j \geq 0 \quad \text{for all } k, j
\]

Where

- \(y_k\) = 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.

\[
\max w_r = \sum_{k=1}^{s} v_k y_k r
\]

\[
s.t., \quad \sum_{j=1}^{m} u_j x_j r = 1
\]

\[
\sum_{k=1}^{s} v_k y_{ki} - \sum_{j=1}^{m} u_j x_{ji} \leq 0 \quad \text{for all } i
\]

\[
and \quad v_k, u_j \geq 0 \quad \text{for all } k, j
\]

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 
\[
\theta_r^{output} = \frac{Actual \ output_r}{Maximum \ possible \ output_r}
\]
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.

<table>
<thead>
<tr>
<th></th>
<th>Number of Students enrolled</th>
<th>Number of teaching staff</th>
<th>Number of graduates</th>
<th>Number of researches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>164</td>
<td>12</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Maximum</td>
<td>4177</td>
<td>232</td>
<td>525</td>
<td>35</td>
</tr>
<tr>
<td>Mean</td>
<td>1319</td>
<td>104</td>
<td>173</td>
<td>11</td>
</tr>
<tr>
<td>Standard Derivation</td>
<td>1134</td>
<td>57</td>
<td>157</td>
<td>10</td>
</tr>
</tbody>
</table>

Table: 1 Descriptive Statistics
The efficiency scores obtained by different colleges are displayed in Table 2.

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

Table 2: Efficiency Score of the Colleges
Figure 1: 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.
References