Evaluation of Efficiencies of Public Sector Universities of Quetta: An Empirical Application of Data Envelopment Analysis

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Abstract

This study examines and compares the performance efficiencies of Quetta city public sector universities from 2016 to 2021. The study has taken four output and seven input variables. Output variables were the number of graduate degrees awarded (UGDA), number of postgraduate degrees awarded (PGDA), number of unpublished research (UPR), and number of published studies (PR). At the same time, the input variables were the number of faculty staff (FS), number of undergraduate students (UGS), number of postgraduate students (PGS), number of undergraduate programs offered (NUGPO), number of doctoral programs offered (NPGPO), number of computers available for students (NCOM) and funds received from higher education institutions (FR-HEC). The data envelopment analysis (DEA) technique is used to evaluate the efficiencies of public sector universities. Three universities have been selected for performance efficiency evaluation: the University of Balochistan, Balochistan University of Information Technology Engineering and Management Sciences, and the University of Sardar Bahadur Khan Women's University. The results indicate that the University of Balochistan was the most efficient university among all DMUs in terms of graduates produced and research published. This study contributes to the literature review because it identifies rare studies that have examined the DEA among various sectors.

Keywords: Data Envelopment Analysis (DEA), Decision Making Units (DMUs), Higher Education Commission (HEC).

Introduction

Data Envelopment Analysis (DEA), henceforth the concept of efficiency measurement was introduced by (Charnes, 1978). The DEA technique is used to efficiently measure homogeneous Decision-Making Units (DMUs) in an organization and between organizations (Montoneri, 2012). DEA is a widespread technique worldwide for measuring efficiency, especially for non-profit organizations such as hospitals, schools, and universities (Talluri, 2000). As well as for many other organizations, e.g., tax offices, bank branches, agriculture, production plants, and transportation (Ehrgott, 2018). The data envelopment analysis technique is based on a nonparametric linear programming method. The advantage of this technique is that it can handle multiple inputs and outputs without making any assumptions regarding prices (Tse, 2011). Therefore, many studies have been done on different sectors for efficiency measurement, especially on public sector organizations in various countries such as the UK, USA, Finland, Mexico, Taiwan, and China. Most studies have been done on the higher education sector for efficiency measurement (Johnes, 2008).

Numerous studies have been done on the educational sector of various countries because higher educational institutions are critical elements for a Country's Economy (Singh, 2015). Education is

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vital in advancing a society because of its principal strategic mission of transmitting knowledge and enthusiastically participating in improving the social order (Boulton, 2011). Economic growth is associated with the performance of the educational department of a country; therefore, every country provides the resources (usually monetary resources) to their public and semi-public sectors schools/colleges/universities to promote their level of education in every area of the country to boost their economy (Tse, 2012). However, Pakistan is also spending its resources on its educational sector, especially on public sector universities. Those universities contribute to the development of provinces (Hussain, 2015). The role of universities depends on how efficiently universities use their resources. Therefore, for public sector universities, it is necessary to evaluate their performance efficiency and how they are performing in a given level of inputs (Vali, 2013).

In the context of Pakistani higher education in 1947, there was only one university, Punjab University, and the government of Pakistan was also spending on that. Moreover, after that, the trend of universities extended day by day (Ahmed, 2012). in 1995-1996, Pakistan had 27 public and private universities. After the formation of the Higher Education Commission (HEC) in early 2000, the government went into a complete overhaul of Pakistan's higher education system. At the end of 2011, there were 132 universities (higher degree awarding institutions) in the country; 70 were public universities, and 62 were private. After that, HEC launched the Quality Enchantment cells to assess the quality of education in the private and public sectors (Irshad, 2015). Therefore, many different methods were used, such as Pareto efficiency, self-study evaluation system, and frontier analysis, to measure the performance efficiency of public institutions. However, one of the studies has been done in Pakistan to measure the efficiency where the input variables were the number of teachers, number of classrooms, average teaching experience of teachers, and total expenditure, and the output variables were the number of students, percentage result, a weighted average of passing students' percentage marks and a score of extra-curricular activities where the efficiency measured by data envelopment analysis (Batool, 2017).

The efficiency evaluation for a knowledge-based society is critical because of the decline in resource levels for educational institutions, especially for research-based institutions (Carrington, 2005). In Pakistan, many educational institutions opened their university sub-campuses/campuses in different districts and cities, so the universities are attempting self-evaluation strategies for efficiency measurement, which need to be revised (Lindsay, 2015). However, there have been several debates regarding the efficiency of research-based institutions. Dr. Atta-ur-Rehman is among the debaters and many other authorities in higher education; according to the research, the evaluation system is not appropriate enough (Altaf, 2019). In the province of Balochistan, public-private sector universities use self-evaluation and trend ratio analysis for efficiency evaluation. However, these self-evaluation system shows biasness in their results; therefore, there is a need to attempt an authentic and accurate analysis technique like data envelopment analysis (Mcgivney, 2015). That is why the study aims to measure the efficiency of the public sector universities of Quetta through the DEA technique by using several input and output variables, which have been taken from the study (Moncayo–Martínez 2019). The objectives were to evaluate the efficiency of the public sector universities of Quetta city by using the Data Envelopment Analysis technique, to compare the efficiencies of public sector universities of Quetta city, and to highlight variables that make public sector universities of Quetta inefficient. This study is structured into five parts: Part 1 gives the introduction, part 2 provides the detailed literature review of the study, part 3 explains the methodology and technique used, part 4 indicates the results and Part 5 concludes with a discussion and conclusion.

Literature Review

The economy of a knowledge-based society is getting considerable attention daily for productivity and efficiency measurement. Several studies have been done, such as a study presented by (Rosenthal, 2017) on the efficiency measurement of research-based higher education institutions (Johnes, 2016). Some studies used self-evaluation systems for their institutions because of increased enrollments in research-based educational institutions. Due to this, public funding for research-based institutions becomes increasingly scarce; therefore, policymakers ask that these public research-based educational institutions use their resources productively and efficiently (Johnes, 2016). To answer this type of question, which is arising increasingly, much research has been done by using many different methods for efficiently measuring the knowledge-based educational sector. The methods include a Self-study approach, Pareto efficiency, frontier analysis, stochastic frontier analysis (SFA), and data envelopment analysis (DEA). According to (2015), the Self-study method is used by research-based educational institutions to emphasize the effectiveness by comparing their institution's departments' efficiency. The Pareto efficiency method states that "resources are allocated in a manner that it is impossible to make one person better off without making another person worse off" (Kosor, 2013). For example, an economy contains two persons and two commodities, such as mangoes and oranges, and person 1 likes mangoes. Then, the only Pareto efficient allocation is that person 1 has all the mangoes and person 2 has all the oranges. However, in actuality, the allocation of resources does not imply reasonable (Chappelow, 2019). Frontier Analysis is another method used for efficiency evaluation, which measures the efficiency through the ratio of output to input variable (Farrell, 1957). SFA and DEA are the most common methods required to measure efficiency; both methods have advantages and disadvantages, and the production frontier is estimated by both methods (Ramanathan, 2003). While using the stochastic frontier analysis method, the frontier is parametric, which makes assumptions regarding efficiency distribution and errors during distribution with the functional form of the production function. The advantage of using this technique is that it gives inferences from the results (Johnes, 2008).

The data envelopment analysis (DEA) technique became famous worldwide for efficiency measurement because it is based on nonparametric linear programming (Hatami, 2019). It does not require any assumptions and is accessible from technical efficiency errors. DEA is increasingly used in many organizations such as banks, hospitals, agriculture, transportation, and education (Moncayo et al., 2019). The disadvantage of not assuming the distribution is that it will not give statistical inference from the result drawn from the DEA. The DEA technique's advantage is that it measures efficiency for multiple inputs and multiple outputs for Decision-making Units (DMUs) (Khezrimotlagh, 2019). However, the main attractive advantage of using DEA is that it assigns the universal weights to each DMU input and output for subjective function while maximizing the efficiency of reference or base DMU. DEA is used in non-profit organizations like hospitals, schools, and universities. Therefore, many studies have been done on the education sector, either for the basic educational level or higher education institutions (Johnes, 2006).

Data Envelopment Analysis

DEA is a technique based on linear programming used for evaluation and performance efficiency measurement of comparable units within an organization or with different organizations (Banker, 1984). DEA application has been widely used for evaluating performance efficiency and benchmarking

universities, schools, police stations, bank branches, hospitals, tax offices, production plans, etc., where most of these DMUs are non-profit organizations (Talluri, 2000). The organizations that are compared using DEA are known as decision-making units (DMUs). DEA technique calculates the efficiency of all DMUs by getting the set of input and output variables, which is most important for businesses and organizations, and then setting the benchmark for inefficient DMUs (Ennen, 2018).

Input & Output Orientation in DEA: Appropriate orientation selection is essential to choosing input or output orientation using data envelopment analysis. Input Orientation aims to produce the same output level by minimizing available input resources. In contrast, Output Orientation aims to generate the maximum levels of output production within a given level of input resources (Cooper, 2006).

Scales and DEA: While conducting DEA analysis, organizations face two significant scales in DEA, i.e., constant returns to scale (CRS) and variable returns to scale (VRS). Constant Return to Scale occurs when a DMU increases its Input resources, which causes the same proportion increase in the output production as a constant return to scale; in Variable Returns to Scale, whether an increase or decrease in input resource of a DMU does not result in a proportional change in output production of a DMU (Ramanathan, 2003).

CCR Models: The concept of the CCR model was presented by Charnes, Cooper, and Rhodes in 1978 (Henriques, 2018). The CCR model is based on a nonparametric mathematical linear programming technique to measure performance efficiency for all DMUs, making it possible for organizational DMUs to work with multiple inputs and outputs (Charnes, 1962). That model also identifies the most efficient DMU and give guideline by setting other inefficient DMUs to work efficiently. The CCR model is called the CRS model because it is based on constant return to scale and measures relative and technical efficiency (Charnes, 1978).

BCC Model: The BCC model is the further extension of the CCR model proposed by (Banker, 1984). The BCC model deals with variable returns to scale. That is why it is also called the VRS Model. Unlike the CRS model, the BCC model measures the scale and pure technical efficiency by decomposing the scalability effect from the total efficiency of DMUs. Pure technical efficiency refers to measuring the efficiency of technical and administrative tasks of DMUs (Cooper, 2002). In this study, we aim to maximize the output within the given level of input resources. Therefore, we will use this CCR output-oriented model (Cook, 2014).

$$max \sum_{j=1}^{J} v_{jm}\ y_{jm}$$

Subject to:

$$\sum_{i=1}^{I} u_{im}\ x_{im} = 1$$

$$\sum_{j=1}^{J} v_{jm}\, y_{jn} - \sum_{i=1}^{I} u_{im}\, x_{in} \leq 0, \forall N$$

$$v_{jm}, u_{im} \geq 0, \ \forall\ i, j$$

Where:

x = input variable

y = output variable

u = weight for input variables.

v = weight for output variables.
i = particular input
j = particular output
J = no of output variables
I = no of input variables
m = particular DMU whose efficiency is to maximize
N = No of DMUs from (1…., n)

Education

Education is a significant factor in the development of a country. In developing countries, the educational sectors receive government funds to develop human resources (Chen, 2011). Therefore, many studies have been done on the efficiency measurement of education departments using the DEA technique. The efficiency is measured by the ratio of weighted output to weighted inputs (Hatami, 2019).

Education is one of the first applications of data envelopment analysis. Therefore, the literature is identified into two sections. The first section discusses the efficiency of secondary education and higher secondary education, and the second section discusses higher education institutions. The objective of the first one is to evaluate the efficiency of secondary schools and colleges. The comparative efficiency of urban schools was measured using DEA (M. Bessent, 1980). The efficiency "Follow Through" program is a large-scale social experiment of efficiency evaluation in public secondary school education presented by (1981). Another study uses output-oriented DEA to measure the performance efficiency of 40 public and private colleges of Multan. Results of the study show that private colleges perform more efficiently than public colleges (Batool, 2017). In 2015, a program was conducted for U.S. students and schools participation in PISA (Program for International Schools Assessments), whose efficiency was measured by (Aparicio, 2019). One more study has been done on Chinese colleges while considering the teaching performance of private and public college teachers by using DEA to measure efficiency (Zhu, 2018).

The second section's objective is to measure the efficiency of university departments and public sector universities and how efficiently they perform where many studies have been done (Boulton, 2011). Further, DEA is used to evaluate the relative efficiency of the top twenty-five national universities of the U.S. to rank world-reported universities (Breu, 1994). Another study has been done to evaluate the performance efficiency of university departments for comparison with the Imperial University of the U.K. (Beasley, 1990). After that, a similar study has also been done to determine the teaching and research efficiencies for university departments of the same discipline, which was proposed at the Imperial Colleges of London (Beasley, 1995). Another study used two models, DEA, which consisted of CRS and VRS models, to evaluate the productive efficiency of 35 Australian Universities because the federal government changed the policies from 1996 – 2000. Teaching, research, and community services were output variables, and capital and operating costs were input variables. The result of the study shows that the efficiency scores obtained from the VRS model are more relevant than CRS, and the efficiencies of the Australian universities were highly significant (Carrington, 2005).

Several more studies have been done on education departments, such as examining the scale and technical efficiency of public and private doctorial-granting universities in the U.S. and how effectively the universities use their resources (Ahn, 1988). A comparative analysis has been done using the DEA technique on the sustainability assessment of universities as small-scale urban

systems in Chicago (Ai, 2019). Efficiency is also measured in another study done in Malaysia, that is, efficiency assessment of universities by performing data envelopment analysis (Tse, 2011). However, if public sector institutions have to sustain their performance to become more efficient even with government policy changes, they have to utilize their resources efficiently (Vali, 2013).

DEA in Different Areas

The performance efficiency of sugarcane production systems in Thailand was measured by selecting six sugarcane production systems: lower northern, upper northeastern, etc. The efficiencies were measured and compared with all production systems and evaluated separately; the result shows that only three were efficient. Performance efficiency is also measured for Market-oriented transmission expansion planning using non-linear programming and multi-criteria data envelopment analysis in India (Yadav, 2019). Another paper measures the efficiency of 37 Brazilian banks from 2012-16 by scaling banks from small to large; the research used the CCR and BCC models for efficiency measurement; the small-scale banks had increasing return to scale while the large banks had decreasing returns to scale so the result shows that small banks are more competent than large scale banks (Henriques, 2018). One more study was done in Bangladesh for efficiency measurement for collective floodplain of aquaculture (FPAs) enterprises, which was practiced and composed of private lends by using the DEA technique while taking four input variables with one output variable with 15 FPAs as sample size. They aim to measure the technical, scale, mix, and overall efficiency, of which six were efficient (Bayazid, 2019).

In another study, DEA was used to find the exact execution assessment for the financial business like the banking sector; the study utilizes information on Taiwanese domestic banks and examines whether it is helpful to develop a coordinated presentation model to resolve the issues of productivity examination with the guide of a free part investigation (ICA) and an organization slacks-based measure (NSBM). The outcomes show that the proposed ICA-NSBM model gives adequate data to decide the principal wellsprings of shortcomings at the layered level and exhibits a fantastic huge discriminative capacity (Chiu, 2013).

Another research paper used DEA to rank the most efficient and essential networks that use measures of dominance derived from social network analysis (Blas, 2017). Performance evaluation was also measured for thermal plants while considering CO2 emission with the theory of game and data envelopment analysis (Mahmoudi, 2019). In Pakistan, many studies have also been done using DEA in various fields, e.g., the effects of input composition on technical efficiencies of Textile Industries in Pakistan (Mahmood, 2012). Efficiency differences among law enforcement units in Punjab by using DEA (Raza, 2014). Technical, allocative, and economic efficiency of public hospitals of Punjab (Ali, 2018). Another study with the components influenced by specialized productivity of small-scale apple farms in Balochistan (Murtaza, 2017) and the evaluation of Airport efficiency in Pakistan using DEA with weight restrictions (Ennen, 2018).

Methodology

The secondary type of data was used for this analysis, which was obtained from the public sector universities of Quetta city of Balochistan province, such as University of Balochistan (UoB), Sardar Bahadur Khan Women's University (SBKWU) and Balochistan University of Information Technology Engineering and Management Sciences (BUITEMS) from 2016 to 2021.

The data envelopment analysis technique is based on a non-parametric linear programming method. The advantage of this technique is that it can handle multiple inputs and outputs without making any price assumptions (Tse, 2011). Therefore, the study focuses on measuring public

sector universities' efficiencies by using the input and output variables. Thus, the data was acquired from only public sector universities of Quetta city.

For the study, we consider N = 3 DMUs; each DMU will represent the public university. The Higher Education Commission of Pakistan entirely or moderately finances all the DMUs. There are I = seven inputs (i = 1, 2, ...,7) and J = 4 outputs (j= 1, 2, …, 4) listed below. The data regarding funds received from HEC and several research were obtained from the Oric (Office of Research, Innovation & Commercialization) department of universities. Moreover, the remaining inputs and outputs were collected from the public university database without alteration or amendments.

Table 1 Number of Input & Output Variables

Input Variables	Output Variables
Faculty staff (FS)	Graduate degrees awarded (UGDA)
Undergraduate students (UGS)	Post-graduate degrees awarded (PGDA)
Postgraduate students (PGS)	Unpublished researches (UPR)
Undergraduate programs offered (NUGPO)	Published researches (PR)
Postgraduate programs offered (NPGPO)	
Computers provided for the use of Students (NCOM)	
Funds Received from HEC for Research Activities (FR-HEC)	

Orientations and Scale Selection of DEA Model

While using the DEA technique, the orientation should have identified what is to be achieved from the selected model. A study wants to measure the capacity of CEOs to create income from a business where the goal was to limit the input resources while delivering at any rate the given yield incomes, so they used an input-oriented model (Demerjian, 2012). Public sector universities are financed by the government entirely or partially. They will get less money after providing monetary resources, so the public universities must utilize their resources to increase their output within a given input. Therefore, the output orientation has been used for this study because the study aims to maximize the output within the given input resources. Moreover, the constant return to scale CRS has been used for the study to run the DEA technique for efficiency measurement of Quetta city public sector universities.

Results

While having the I = seven inputs (i = 1, 2, ...,7) and J = 4 outputs (j= 1, 2, …, 4) bellow table-4.1 describes the performance or total factor productivity of public sector universities in terms of effect “efficiency change,” teach “technical efficiency change,” pech “pure technical efficiency change” and such “scale efficiency change.”

Table 2 Decision Making Units - DMUs Performance of overall period

DMUs	Effch	Techch	Pech	Sech	Tfpch
UOB	1.000	1.133	1.000	1.000	1.133
SBK	1.000	1.002	1.000	1.000	1.002
BUITEMS	1.000	0.886	1.000	1.000	0.886
Mean	**1.000**	**1.002**	**1.000**	**1.000**	**1.002**

According to the DEA Malmquist index summary, on average, universities' performance/total factor productivity had increased by .002 in terms of research and graduates produced within the given period. As per the above table, DMU1 was efficient because the performance of the University of Balochistan increased by .133 because of an increase in technical efficiency. That means the university efficiently produced the graduates and published research with limited inputs, such as a limited number of staff, computers for students, and funds from HEC for research and development. Like DMU1, DMU2 was also efficient, as the performance of Sardar Bahadur Khan Women's University increased by .002, which means the university utilized its resources effectively to produce its maximum output. However, DMU3 was inefficient because the university faced a performance decline by .886, which means the management of Balochistan University of Information Technology Engineering and Management Sciences did not utilize their resources in a manner to produce graduates and publications. That technical efficiency change decreased mainly driven by the inefficient strategies used by BUITEMS to utilize its resources, such as the number of faculty staff, the number of computers available for students, and funds received from HEC for research and development activities in a way to produce the maximum number of qualified graduates. It increased the number of unpublished and published research. As per the above comparison, the DMU1 was more efficient than DMU2 and DMU3 regarding research published and graduates produced within the limited resources available. Let us have a look at the yearly performance of universities.

Table 3 Decision Making Units - DMUs Performance for the year of 2017

DMUs	Effch	Techch	Pech	Sech	Tfpch
UOB	1.000	0.864	1.000	1.000	0.864
SBK	1.000	0.671	1.000	1.000	0.671
BUITEMS	1.000	0.779	1.000	1.000	0.779
Mean	1.000	0.767	1.000	1.000	0.767

The result shows that while keeping the input resources constant universities on average faced efficiency decline by .767 due to change driven in technical efficiency. The performance of DMU_1 was declined by .864, the performance of DMU_2 declined by .671 and the performance of DMU_3 declined by .779. The decline occurred due to an inefficient strategical change by limiting their input resources to maintain output level.

Table 4 Decision Making Units - DMUs Performance for the year of 2018

DMUs	Effch	Techch	Pech	Sech	Tfpch
UOB	1.000	1.031	1.000	1.000	1.031
SBK	1.000	0.805	1.000	1.000	0.805
BUITEMS	1.000	0.683	1.000	1.000	0.683
Mean	1.000	0.828	1.000	1.000	0.828

The above result describes the efficiency decreased by .828 of universities performance on average in year 2018 cause of technical efficiency decreased by while keeping efficiency and scale efficiency constant which means on average all universities were inefficient to maintain their production level in terms of degrees awarded to graduates and unpublished and published researches. But if we have a look on DMUs separately then the performance of DMU_1 increased

by .031 which means the university of UOB was able to maintain its production of researches and their graduates in 2018, whereas, the DMU_2 and DMU_3 decreased their performance by .805 and .683 which means these universities were able to produced graduates and publishes researches in year 2018 with minor downfall due to technical efficiency decreased.

Table 5 Decision Making Units - DMUs Performance for the year of 2019

DMUs	Effch	Techch	Pech	Sech	Tfpch
UOB	1.000	0.947	1.000	1.000	0.947
SBK	1.000	1.719	1.000	1.000	1.719
BUITEMS	1.000	1.502	1.000	1.000	1.502
Mean	1.000	1.347	1.000	1.000	1.347

As per above results it shows that after facing decline in performances from consecutive two years, universities improved their strategies in a manner to maintain or increase their performance efficiency in 2019, in a result of technical change the table shows that on average the performance of all universities improved by .3.47 as compared to previous years. Where except DMU_1, the DMU_2 and DMU_3 improved their performance by .719 and .502 respectively. With that change the universities were able to produced more graduates and publish researches within a given resource.

Table 6 Decision Making Units - DMUs Performance for the year of 2020

DMUs	Effch	Techch	Pech	Sech	Tfpch
UOB	1.000	5.446	1.000	1.000	5.446
SBK	1.000	1.180	1.000	1.000	1.180
BUITEMS	1.000	0.710	1.000	1.000	0.710
Mean	1.000	1.659	1.000	1.000	1.659

The above table described that the universities were more efficient in 2020 as compared to 2019 because in 2020 on average the performance efficiency increased by .659 of all universities due to major change driven in technical efficiency. The performance of DMU_1 and DMU_2 increased by .446 and .180 respectively. Conversely, the efficiency of DMU_3 decreased by .710 due insufficient strategies used in terms of technical efficiency change.

Table 7 Decision Making Units - DMUs Performance for the year of 2021

DMUs	Effch	Techch	Pech	Sech	Tfpch
UOB	1.000	0.406	1.000	1.000	0.406
SBK	1.000	0.920	1.000	1.000	0.920
BUITEMS	1.000	0.961	1.000	1.000	0.961
Mean	1.000	0.711	1.000	1.000	0.711

As per the above results shown in Table A.5. the average performance of all DMUs was inefficient and decreased by .711 in 2021, causing a change in technical efficiency. The universities UOB, SBK, and BUITEMS faced performance decline by .406, .920. and .961, respectively, which show that the Balochistan University of Information Technology Engineering and Management Sciences was the most inefficient DMU in terms of producing graduates and publishing research papers within the given input resources.

Discussion

The thesis aims to provide a study to evaluate the performance efficiencies of Quetta city public sector universities. In this study, three universities have been taken for performance efficiency evaluation from 2016 to 2021. The universities are the University of Balochistan (Uob), Sardar Bahadur Khan University (SBK), and the Balochistan University of Information Technology Engineering and Management Sciences (BUITEMS). The Deap (Data Envelopment Analysis Program) software has been used to run that analysis.

The Data Envelopment Analysis (DEA) technique evaluated the efficiencies. DEA is a nonparametric technique, and the significant advantage of this method is that it considers multiple output variables and multiple input variables for the same decision-making units and does not require any parametric assumptions. Four output and seven input variables have been used to evaluate the performance efficiency among public sector universities. Output variables include the number of graduate degrees awarded, the number of postgraduate degrees awarded, the number of unpublished research, and the number of published research. Despite this, the input variables are

- the number of faculty staff,
- the number of undergraduate students,
- the number of postgraduate students,
- the number of undergraduate programs offered,
- the number of postgraduate programs offered,
- the number of computers available for students and
- funds received from the Higher Education Commission HEC for research and development activities.

The output orientation had been selected for performance evaluation of public sector universities while considering both constant and variable returns to scale. The results showed that DMU1 and DMU2 are more efficient than DMU3 because the University of Balochistan (UOB) and Sardar Bahadur Khan Women's University (SBK) know how to utilize their resources to increase their output. The performance/total factor productivity of DMU1 increased by .133, which means the university had effectively used its resources to increase its production in terms of degrees awarded to graduates and postgraduates and research published. The DMU2 increased its total factor productivity by .002 because its technical efficiency increased with the same ratio. In contrast, in this period, DMU3 faced a performance decline of .886 due to technical efficiency declined by the same proportion. From 2016 to 2021, all public sector universities were efficient except Balochistan University of Information Technology Engineering and Management Sciences (BUITEMS).

While conducting research, several limitations have been faced during the research. The study examines the performance of all Quetta city public sector universities. However, we were unable to gather the data from universities timely. Therefore, we need help finding data from UOB, SBK, and BUITEMS to complete the research. Moreover, while collecting information about funds received from HEC for research and development activities, universities refused to give the data because of the confidentiality of the nature of a variable. Other than that, due to the COVID–19 emergency all over the world, many universities were closed. Due to that, timely completion of research was not possible, and many other difficulties were faced during research, such as transportation issues and limited resources, which made it hard to collect data. However, the study has been completed successfully with the help of Allah. Moreover, with the help of my supervisors and my friends' work guide, I supported completing my research successfully.

Conclusion

The paper has given a review to evaluate public sector universities' efficiencies using the data envelopment analysis DEA technique. The study aims to evaluate and compare the performance efficiencies of the public sector universities of Quetta city.

The results from this study, about data envelopment analysis DEA application to public sector universities will propose an outline based on variables that an institute must perform. Hence, this study will contribute to the literature as, to the best of our knowledge, a study has yet to be done on the efficiency measurement of Quetta city public sector universities. Moreover, the study's findings will provide highlights to public or private universities to increase their performance efficiency.

Our future researchers should evaluate the study while taking all universities from Pakistan, or they may select the universities of Balochistan province to find the efficiencies of universities by comparing private and public sector universities. The comparison of public and private universities will give significant points to the management of where they need to improve in the future. Moreover, while selecting universities as the decision-making unit, I first did a small survey on whether the universities were interested in providing information. That survey result will be helpful in the selection of decision-making units and consider other variables as well.

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