Measuring Efficiency Of Hospitals By DEA: An Empirical Evidence From Pakistan

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Article Info	ABSTRACT
	There has been increasing focus on efficiency measurement in health sector around the world. This empirical study aims at measuring efficiency level of non-profit private organization by using Data Envelopment Analysis (DEA) in the health sector of Pakistan. DEA is non-parametric linear programming based approach for homogeneous decision making units. Layton Rehmatullah Benevolent Trust (non-profit private organization) is the subject matter for investigational analysis constituting over 16 sub-units spreading across the country. Secondary data of number of patient beds, specialists and nurses in all the 16 branches of LRBT hospitals has been used applying quantitative specification tool, both scale and technical efficiency levels in an environment where multiple of inputs and outputs are in place, has been used for final evaluation. The outcomes so expected will help policy makers to formulate effective plans and programs in order to enhance the efficiency of health measures conducted by non- profit private organizations.

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1. INTRODUCTION

There is a continual discussion in economics regarding proper extent and part of the state persists since the development of the modern economics. Current scenario of the world emphasize the importance of this basic notion of the economics, that is "efficient use of scarce resources", as population of the world growing in pace along with other complexities. Therefore, increasing emphasis has been placed on efficiency measurement of both public and private sector whether they are profit or non-profit organizations.

Organizational structure of a modern state constitutes both profit and non-profit organizations. The need for non-profit organizations is growing in pace with the increase in natural disasters and poverty. At the same time, the requirement of non-profit organization is to be able to present the results of some kind with the amount of money involved. The people who involve in contributing towards these non-profit private organizations are mostly long away then the actual project places so this thing makes efficiency measurement more important for those people. The difficulty lies in understanding the efficiency of non-profit organizations and the amount of contributions that they provide to the society.

As mentioned above that the world is facing the evils of poverty, hunger and scarce resources, specially the populated countries like Pakistan is facing these kinds of issues more severely as compare to the developed countries. So, keeping in view these glitches it is realistic that why snowballing weight is being placed on measuring the efficiency of non-profit organizations. Therefore, the focus in this study is on efficiency measurement of non-profit hospital as non-profit private organization.

Body of literature, confirms the role of allocative efficiency and optimality. Their work ranges from

corporation to individuals, covering public and private bodies including non-profit organizations. The sectoral distribution of non-profit organizations is partially non-profit and fully non-profit organizations. Health sector of Pakistan which constitutes about Rupees 42 billion that is 0.23 percent of GDP also constitutes fully funded non-profit bodies specially hospitals. Therefore the scenario requires having a detailed investigation of efficiency measurement of non-profit public organizations.

Pakistan is the one of the higher populous country in the South Asian region with 170.6 million residents. Pakistan has practiced basic health services delivery system containing of BHUs, Rural Health Centers (RHUs), Maternity and Child Health Centers (MCHs), Civil Hospitals and Dispensaries as well. This acceptable institutional mechanism for public health services delivery stand by 968 hospitals, 4,813 dispensaries, 5,345 basic health units, 572 rural health centers, 908 maternity and child health centers and 293 TB centers.

The Basic Health Unit (BHU) is termed as a health unit that provides a necessary medical cover to 5000 to10000 living within the premises of union council covering an area of 15 to 25 square miles. The Basic Health Unit (BHU) aims to provide treatment and medical facilities in rural community, basic health education, pregnancy cases and basic health of children and women, immunization, and execution of disease eradication programs such as TB, polio, etc. BHU can serve as the support by making health services within the reach for individuals, families and communities [1].

Keeping in view the importance of public sector services in the health sector, precisely of non-profit public organization as most of the population in the country is below the poverty line, this study has been conducted for efficiency analysis of the Layton Rahmatulla Benevolent Trust (LRBT) hospitals, Pakistan. The services of the hospital are extended in all four provinces of the country. So, the efficiency measurement of the non-profit organization in the form of LRBT hospitals has been taken into account.

The efficiency analysis prepared and developed by the researchers often arise the relative difficulty encountered in evaluating the performance of a firm or an organization. These organizations often have multiple inputs and outputs to be analyzed. So, for this purpose we are using Data Envelopment Analysis (DEA) methodology to measure the efficiency of non-profit public organization i.e. non-profit hospitals in our case.

This is the area which has been ignored very much in Pakistan only very little work has being done by the researchers especially in case of non-profit private organization in health sector. Organizational behavior is always important whether that is public or private sub division therefore; the tools for efficiency measurement are continuouslyimperative. In most of the real world scenarios situations are quite complex and to meet these complexities the methodology should be simple and comprehensive at the same time. In Pakistan, there exist a few non-profit private organizations in health sector, but their contribution needs to be analyzed, whether they are performing efficiently or not?

The major objectives of the study are:
a)   Evaluate and analyze the efficiency of private organization whose aim is not to seek for profit.
b)   Use of non-parametric method, DEA methodology for efficiency measure since it is compatible in using multiple inputs and outputs.

1.1. Systematic Review.

The final goal of the non-profit public organizations is not financial. Therefore, we cannot use the classical financial control in non-profit organizations. Since this is somewhat less focused area we find it important to look at the methodologies that has been used to measure efficiency in organizations which are not driven by economic results. Steingruber *et al.* (2006) discussed in his work that the need for aid organizations is growing in pace with increase in the natural disaster and poverty [2]. At the same time the need for non-profit organizations to be able to present the results that are being expected by the people who has been involved in the fulfillment of financial needs of these organizations. Henser (2001) analyzed that in recent years, much of the analytical and intellectual effort concerned with the economics of health systems in developing countries has tended to focus on aspects of what will be defined as "allocative" efficiency [3]. Hsu (2010) deduced that the relative roles of the public and private sectors in healthcare facility have and continue to evolve over time [4]. Improvements stem back to 19th century neoclassical economics that market solutions main to more efficient allocation of means, doubts over how the healthcare market would respond to these institutions and, more recently, to new public management theories and the influence of multilaterals. Charnes *et al.* (1978) discussed first time about DEA models and concluded that use of terms like DMU's (decision making unit) and programs will help to emphasize that your interest is centered on decision making by not-for profit entities rather than the more customary firms and industries [5]. Kengil *et al.* (2010) defined that Data envelopment analysis (DEA) is an empirically based methodology that excludes the need for some of the assumptions and limitations of customary efficiency measurement approaches [6]. Jacobs (2000) discussed that efficiency estimates in DEA may be subject to the same bias if

inefficient units using low levels of the endogenous resource are set tougher efficiency targets than equally inefficient units using more of the resource [7]. Kontodimopoulos and Niakas (2006) reviewed that DEA received wide acceptance by researchers and practitioners in many public and private sectors [8]. Kontodimopoulos and Niakas [8] analyzed the technical and scale efficiencies of public district hospitals in Tamil Nadu, India. Empirical analysis used the data of 29 districts hospitals for the year 2004-2005, Technical and scale efficiencies were assessed by using DEA. Output variables include number of inpatients, number of outpatient visits, number of child deliveries, number of surgeries, and number of emergency cases attended, while number of staff and number of beds were used as input variables. Death rate under five years, life expectancy at birth and good health were used as output variables and number of physicians and beds per 1000 occupants and amount of total expenditure on health were used as input variables. Zere *et al*. (2006) concluded that the technical and scale efficiencies of district hospitals of Namibia [9]. DEA was used to assess technical efficiency. Total recurrent expenditure, number of nurses and number of beds were used as input variables and total number of outpatient visits and inpatient days were used as output variables. Alvarado (2006) examined the productive efficiency of the primary health care centers of Chile [10]. Study used the cross sectional data of 24 Chilean municipalities located in the urban area for the year 2001. DEA was employed to evaluate technical and scale efficiencies. Osei *et al.* (2005) concluded that a study relying on a relative small sample of 17 hospitals in Ghana in 2000 found that they suffered from serious pure technical inefficiency together with obvious scale inefficiency [11].

2.   RESEARCH METHOD

The data for this empirical work of a non-profit private organization is taken from the annual reports, annual newsletters and personal records of LRBT hospitals and information of health department of the provincial government has also been used. Inputs and outputs data is analyze for the year 2010.

2.1. Sample Selection

The sample under study will include 16 hospitals of Layton Rahmatulla Benevolent Trust (LRBT) Pakistan. These 16 hospitals include 2 tertiary hospitals i.e. Karachi and Lahore and 14 secondary hospitals. The province-wide distribution of these hospitals is as follows.

Sindh has four hospitals, Punjab has six, Khyber Pakhtunkhwa has three and Baluchistan has two of them. It is assumed that all hospitals have homogenous decision making units.

2.2. Approaches to Study Efficiency.

Different methods to examine the efficiency are normally taken into account either parametric or non-parametric, where parametric methods are based on the assumption that a particular functional form whereas non-parametric methods do not. An alternative term can be used as that method can be statistical or non-statistical [7]. Statistical methods assume that the data is of the stochastic nature. Non-parametric methods such as DEA tend to be deterministic, whereas statistical methods due to their nature and based on frontier regression models used to be parametric and stochastic. Usually the frontier models make specific assumptions about the inefficiency term in the models which are very restrictive (Wagstaff, 1989) [12]. Stochastic Cost Frontier (SCF) usually constructs a very smooth parametric frontier. DEA has one of the advantages that it can manage miscellaneous production functions with multiple input and output technologies.

2.3. Data Envelopment Analysis (Dea) Model

The DEA, a mathematical, linear programming tool, was developed by Charnes et al. (1978) to make efficiency measurement precise and accurate discipline especially for the situations in which there are complex situations regarding to the multiplicity of different inputs and outputs [5]. It has been used all over the globe especially in the Greece [13].

Data Envelopment Analysis (DEA), as mentioned in the start is a linear programming method which helps in the measurement of efficiency. It basically comes from the theoretically based concept of production efficiency. DEA analyses the collaboration between inputs to a production process (for example, resources used in a hospital) and the outputs (for example, number of patients treated) of that process [7].

DEA has all three kinds of models that are, according to scale. There are normally two scale assumptions employed: constant returns to scale (CRS) model and variable returns to scale (VRS) model. The CRS assumption is suitable when all DMU's are working at an optimal scale.

Input-orientation method concerns when there are decreasing inputs in data to have more efficient Decision Making units (DMU's), while output-orientation method concerns of increasing quality of services provided by a health unit without changing the quality of the inputs used in that process. A variable return to

scale (VRS) model poised of three types; first, constant return to scale (CRS), which does not have to improve inputs or outputs, second, increasing return to scale (IRS) model that needs to influence the quality of provided services. Third, decreasing return to scale (DRS) model will alleviate the input volume. The software Data DEAP 2.1 version is used as the DEA software in this research.

DEA can be defined as the fraction of weighted sum of outputs to its weighted sum of inputs [11],[12]. Suppose we have Given n outputs and m inputs, efficiency ($h0$) for hospital 0 is defined as follows:

$$\text{maximise: } h_0 = \frac{\sum_{r=1}^{p} u_r \times y_{r0}}{\sum_{i=1}^{m} v_i \times x_{i0}}$$

subject to:

$$\frac{\sum_{r=1}^{p} u_r \times y_{rj}}{\sum_{i=1}^{m} v_i \times x_{ij}} \leq 1 \qquad j = 1,\ldots,n$$

where:

y_{r0} = quantity of output r for hospital 0

u_r = weight attached to output r, $u_r > 0$, $r = 1,\ldots,p$

x_{i0} = quantity of input i for hospital 0

v_i = weight attached to input i, $v_i > 0$, $i = 1,\ldots,m$

The weights are specific to each unit so that $0 \leq w \leq 1$ and a value of unity imply complete technical efficiency. DEA computes all possible sets of weights which satisfy all constraints. Hospital unit that is the highest efficiency with the given data of inputs and outputs for the specific period of time in our case it is year 2010.

Output Variables
1.   Outpatient visits, the number of outpatient visits within a year.
2.   Inpatient cases case-mix adjusted the annual number of hospitalized cases.
3.   Total number of surgery, the total number of surgeries within a year.

Input Variables
1.   Beds, the number of existing patient beds within the hospital ready for use.
2.   Specialists, the total number of specialist medical doctors employed in the hospitals.
3.   Nurses, The total number of nurses employed in the hospital.

3.   RESULTS AND DISCUSSION

This section will present the results obtained from the empirical study of non-profit public organization LRBT's 16 hospital units in the four provinces of the country by using DEA methodology. DEA differentiate the technical efficient and inefficient units across the country using specific inputs and outputs.

3.1. Descriptive statistics of inputs and outputs.

Table 1 shows the descriptive statistics of the inputs used. Average number of doctor and other inputs shows that there is on average available number of doctors in each hospital unit for the surgeries and other medical services of the patients and similarly the standard deviation shows that on average there can be variation or deviation can exist between inputs in the hospitals units of LRBT. The maximum and minimum values of the inputs show largest and lowest values of available inputs and we may say that these are the

largest or lowest number of inputs available for patients treated in a hospital whether they are out –patient visits, major surgeries or annual number of hospitalized persons during the year 2010.

Table 2 shows the descriptive statistics of the outputs used. Average number of treated persons and explains that there are on average 112237 persons visits the hospitals as out-patients, 6433 persons hospitalized in a year and 11086 persons has been admitted in hospitals for major surgeries. Standard deviation shows that on average there can be variation or deviation can exist between outputs in the hospital units of LRBT. The maximum and minimum values of the outputs show largest and lowest values of outputs and we may say that these are the largest or lowest number of patients respectively that are treated during a year in a hospital unit.

Table 1. Descriptive statistics of Input variables

Input Variables	Mean	S.D	Max	Min
Beds, the number of existing patient beds within the hospital ready for use.	43.18	22.39	95	10
Specialists, the total number of specialist medical doctors employed in the hospitals.	9.25	7	30	3
Nurses, The total number of nurses employed in the hospital.	23.43	6.44	40	15

Table 2. Descriptive statistics of output variables

Output Variables	Mean	S.D	Max	Min
Annual number of Out-patient visits	112237.5	81537.54	328500	58400
Inpatient cases case-mix adjusted the annual number of hospitalized cases.	6433.15	4304.06	18250	730
Total number of surgery, the total number of surgeries within a year.	11086.875	6240.88	29200	18250

3.2. Technical Efficiency (TE) Scores by DEA

Table 3 shows the results of technical efficiency obtained by using open-access Data Envelopment Analysis Programme (DEAP 2.1) [12]. In Table 4.3 the results are calculated with CCR constant return to scale model. A hospital unit is said to be technical efficient if its efficiency score is '1' and inefficient otherwise [13].

The degree of inefficiency then depends upon the efficiency scores of hospital units of LRBT. Therefore, according to the results shown in the table 4.3, 5 (31.25 percent) hospital units out of 16 hospitals are technical efficient with the efficiency scores of 1.000 and 11(68.75 percent) hospital units are inefficient by using available data for specific inputs and outputs that are being used in our analysis for the year 2010. The Mean TE appeared as 0.703 or 70.3 percent for all 16 units of LRBT hospitals taken in this study for the given data of considered inputs and outputs. Among those 11 technical inefficient units 5(31.25 percent) have efficiency scores ranges from 0.50 to 0.70 or we may say they are 50 percent to 70 percent technical efficient and 2 (0.125 percent) having sores more than 0.70 and remaining 4 (0.25 percent) hospital units have efficiency score 0.50 or below.

3.3. The Variable Return To Scale DEA Model And Efficiency Scores

Table 4 shows the results obtained from the extended DEA model i.e. variable return to scale (VRS), Banker, Charnes and Cooper (BCC) model the objective of the inclusion of this model in the analysis is that it stretches the efficiency scores to the scale efficiency scores of each unit along with the VRS technical efficiency scores. The TE scores obtained from a CRS DEA into two components, one due to scale inefficiency and the other one is due to "pure" technical inefficiency we can calculate these two components by conducting both a CRS and a VRS DEA upon the same data [22]. If technical efficiency scores for each hospital unit in the two efficiency scores are different then this shows that the hospital units having scale inefficiencies and these scale inefficiencies can be calculated from the difference between the VRS technical efficiency score and CRS technical efficiency scores.

Variable return to scale (VRS) normally forms a convex hull of two intersecting plans which envelop the data points more tightly as compare to the CRS DEA which makes a conical hull and thus provide technical efficiency scores which are greater than or equal to those which are obtained using CRS model [13].

In table 4 the last column shows the nature of the scales whether that is increasing return to scale (IRS) or decreasing returns to scale (DRS). The nature of scale inefficiencies (due to IRS or DRS) for a particular hospital unit can be determined by observing whether the non- increasing return to scale (NIRS) TE score is equal to the VRE TE scores, if they are equal DRS apply otherwise IRS apply.

Table 3. Technical Efficiency scores CRS DEA

S. No	Hospital unit	Technical Efficiency (TE)
1	Korangi Hospital, (Karachi) Sindh	**1.000**
2	TandoBago, Sindh	0.500
3	Rashidabad, Sindh	0.750
4	Gambat Hospital, Sindh	0.698
5	AkoraKhattak Hospital, KPK	0.591
6	Kalakalay Hospital,(Swat) KPK	0.695
7	Manshera Hospital KPK	**1.000**
8	Lar Hospital,(Multan) Punjab	0.750
9	ShahpurSaddar, Hospital (near Sargodha) Punjab	0.677
10	Mandra Hospital, Punjab	**1.000**
11	Khanewal mini Hospital, Punjab	**1.000**
12	Pasrur District Sialkot, Punjab	0.467
13	Arifwala Hospital, (near Sahiwal) Punjab	0.493
14	Lahore Hospital, Punjab	**1.000**
15	Sibi mini Hospital, Baluchistan	0.096
16	Quetta Hospital, Baluchistan	0.529
	Mean	**0.703**

Table 4. Comparison of VRS TE & CRS TE

S. No	Hospital unit	CRSTE	VRSTE	Scale	
1	Korangi Hospital, (Karachi) Sindh	**1.000**	**1.000**	**1.000**	-
2	TandoBago, Sindh	0.500	0.600	0.834	**IRS**
3	Rashidabad, Sindh	0.750	0.786	0.954	**IRS**
4	Gambat Hospital, Sindh	0.698	0.715	0.977	**IRS**
5	AkoraKhattak Hospital, KPK	0.591	0.652	0.970	**IRS**
6	Kalakalay Hospital,(Swat) KPK	0.695	0.697	0.996	**IRS**
7	Manshera Hospital KPK	**1.000**	**1.000**	**1.000**	-
8	Lar Hospital,(Multan) Punjab	0.750	**1.000**	0.750	**IRS**
9	ShahpurSaddar, Hospital (near Sargodha) Punjab	0.677	0.679	0.988	**DRS**
10	Mandra Hospital, Punjab	**1.000**	**1.000**	**1.000**	-
11	Khanewal mini Hospital, Punjab	**1.000**	**1.000**	**1.000**	-
12	Pasrur District Sialkot, Punjab	0.467	0.500	0.933	**IRS**
13	Arifwala Hospital, (near Sahiwal) Punjab	0.493	0.600	0.822	**IRS**
14	Lahore Hospital, Punjab	**1.000**	**1.000**	**1.000**	**IRS**
15	Sibi mini Hospital, Baluchistan	0.096	0.750	0.128	**IRS**
16	Quetta Hospital, Baluchistan	0.529	0.600	0.882	**IRS**
	Mean	0.703	0.786	0.866	

CRSTE = technical efficiency from CRS DEA
VRSTE = technical efficiency from VRS DEA
Scale = scale efficiency = CRSTE/VRSTE

4.   CONCLUSION

The technical efficiency of 16 hospital units of LRBT, a non-profit private organization, has been taken into account. The technical efficiency shows that among these 16 units of LRBT hospitals 5 (31.25percent) hospital units are the efficient, with the given data of inputs and outputs used in this study and the data is taken from the annual reports and personal records of LRBT hospitals. The hospital units of Korangi Karachi, Lahore, Khanewal mini, Mandra and Manshera are said to be the efficient ones and are these are the units which are providing their services with minimum level of inputs. These units are peers for the other 11 (69.75 percent) hospital units which are not on efficient frontier and said to be inefficient. Efficient units are using less inputs and larger output has been produced by them as compare to their counter partner peers, inefficient units. The average TE of all hospitals is 0.703 with the CRS DEA model using multi-stage approach. Then DEA with VRS has also been used in order to calculate the scale efficiencies of all hospital units and also to analyze the return to scales of all DMU's. the results obtained from the VRS DEA are normally high because of the intersection of the planes which form a convex hull instead of conical hull which is formulated in CRS model, the convex hull in case of VRS envelop the data points more tightly so the results with this model normally shows high results. Thus results generated by the DEA model using

DEAP in a VRS model shows on average technical efficiency scores as 0.786.

In conclusion, the study has confirmed that DEA not only helps health policymakers and managers to answer the question "How well are the hospitals performing?" but also "By how much could their performance be improved?" We indorse further analyses of the hospitals which are performing best have to make in order to enhance health facilities.

POLICY AND RECOMMENDETIONS

Concerning hospitals units with outputs falling short of the DEA targets, LRBT management and government sector policy makers could help the non-profit private organization to improve the efficiency by improving access of the funds from government sector to these kinds of non-profit organizations. Pakistan is a developing country, and as all developing countries, so the societyis facing major issues in health and education sectors therefore, government institutions are always in need of helping hands of these non-profit organizations in order to improve and enhance the living standards of the residents of the country. The utilization of health resources also needs to be improved and the management of the LRBT should also increase their performance in order to increase the efficiency of all hospital units.

Health promotion is a key issue for any country that is facing problems both at the basic and at advance level of health facilitation, like Pakistan's scenario this situation puts increasing pressure on the non-profit sector to perform competently. The present study rationally demonstrated the applicability of DEA in health sector to identify the least and most efficient health units in LRBT, Pakistan as mentioned above efficiency in health services at primary as well as at advance level can cover the way for destination

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