PalArch's Journal of Archaeology of Egypt / Egyptology

OPERATIONAL PERFORMANCE AND ECONOMIES OF SCALE IN HEALTHCARE UNITS OF PUNJAB, PAKISTAN

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Balqees Naser Almessabi : Operational Performance and Economies of Scale in Healthcare Units of Punjab, Pakistan -- Palarch's Journal of Archaeology of Egypt/Egyptology, ISSN 1567-214x

Keywords: Technical efficiency (T.E.), Scale efficiency (S.E.), Data envelopment analysis (DEA)

ABSTRACT
In order to improve the quality of healthcare services in Punjab, the health department has been applying numerous reforms such as upgrading and expansion of public healthcare facilities. To observe the performance of healthcare facilities, efficiency analysis is very important.The aim of this research is to measure the technical efficiency (TE) and scale efficiency (SE) among District Headquarters (DHQs) hospitals of Punjab. A linear programming, Data envelopment analysis (DEA), the technique is used to measure the efficiencies score of these hospitals for the period 2011 to 2015. The inputs data contained the number of doctors, nurses, other staff (paramedical and non-paramedical), and beds while outputs represented by the number of outpatients and inpatients visited in all the departments of these hospitals. The result revealed that out of 25 DHQs hospitals, 6 (24%) and 4 (16%) are fullytechnically and scale efficient respectively and lied on best practice frontier. The TE scores of the hospitals are ranged between 0.55 and 1 with the average of 0.86 while the scale efficiency scores are between 0.37 and 1. The average scale efficiency score is 0.82 which implies that, on average, these hospitals are able to reduce 18 percent of their resources while keeping the same level of output.

INTRODUCTION

Increasing healthcare cost and disparity among different part of the society are two most debatable issues for policymakers in both developed andless developed countries (Braveman, 2014). Due to financial restraint and policy concern for cost control, "efficiency" is a big challenge in many countries of the world (Weaver, et al., 2016). In Pakistan, the healthcare system acts as the main provider of public health care. After 18th constitutional amendment 2010 in Pakistan, "health" became a provincial subject and central government cannot directly interfere in health sectors of thefour provinces. Punjab is the most populous province of Pakistan with 36 districts. In spite of a wide and costly system of healthcare services, the health status of the province is lower than the desired level set by sustainable development goals (SDGs). Out of 1000 children, 77 died before their first birthday and 112 died under the age of five in

Punjab. The maternal mortality rate is172/100000while total fertility rate isfound 4.2 in the province. The malnourished children are about four million and underweight are(MICS, 2014).

In the Punjab, there is a widesetup of healthcare facilities. In primary healthcare services, there are 2461 Basic Health Units (BHUs) and 293 Rural Health Centers (RHCs). While in case of secondary health care centers, there are 114 Tehsil Headquarters Hospitals (THQs) and 25DHQs hospitals. There are 23 teaching and tertiary hospitals. As for as specialized health facilities are concerned, there are 3 cardiac facilities centers (Punjab Institute of Cardiology Lahore, Faisalabad Institute of Cardiology and Rawalpindi Institute of Cardiology, Rawalpindi), two pediatric facilities centers (Children Hospital and the Institute of Child Health Lahore and Children Hospital and the Institute of Child Health, Multan), three dental hospitals (Dental Hospital, Lahore, Dental Hospital, Multan, Dental Unit Allied Hospital, Faisalabad) and one mental health facility i.e. Punjab Institute of Mental Health, Lahore.

Total healthcare spending in Punjab has increased from 73 billion rupees in 2011 to 168 billion rupees in 2016, which is 14% of total budget.The provincial government is making strenuous efforts for a better and effective healthcare system. The major step in this courseis to identify the importance of healthcare at primary and secondary levels, and creating a separate department for it. The basic directive of this department is to emphasis on anticipatory healthcare in the primary sector along with basic facilities of diagnostics and treatment at secondary levels. The perspective is to primarily provide better healthcare services to the people of the rural area and condense the burden on tertiary healthcare services. The major challenge for secondary health department is to boost the confidence of the public in the secondary healthcare system. The reality is that most of the institutions at the secondary level are not currently providing health care services up to the desired level, owing to multiple factors including large patient incursion, scarcity of financial and human resources, and nonfunctional equipment.

Due to lack of planning, monitoring, and research, the previousstruggles did not conclude in the shape of an integrated healthcare regime, rather these have resulted in haphazard construction, poor maintenance, and lack of basic facilities. Resultantly the patients prefer to visit tertiary level and private hospitals for treatment of even very common ailments. With this in view, the health department of Punjab has decided to launch massive revamping of 40 THQs and DHQs Hospitals. However, before this, there is need to analyze the condition of utilization and capacity of resources in these hospitals. The efficiency analysisis a useful measure in this context. Therefore, technical and scale efficiency of DHQs hospitals in Punjab is measured by using input-oriented DEA model for the period 2011-15.From an administrative perspective, understanding the structure of cost in public hospitals and their efficiency in resource utilization is essential for shaping health care policies and budget making. Because fully operational efficient hospitals are expected to help in controlling the cost of medical services, and consequently to afford more reasonable cares and improved public access.

The aim of this article is to measure the technical efficiency and scale efficiency of DHQs hospitals. Because these both type of efficiency give information of utilization of resources and resource consumption capacity of health centers. Technical efficiency reflects the ability of a decision making unit to obtain maximal output from a given set of inputs or, alternatively, to obtain a given set of outputs from a minimal set of inputs

(Coelli, et al., 2005). Scale efficiency, on the other hand, refers to a possible divergence of each production unit from the optimal scale of operation (Banker et al., 1984).

Data envelopment analysis (DEA) approach, linear programming technique, is one of the methods to measure the efficiency score of a state or an organization. Unlike ratio analysis and stochastic frontier approach (SFA), the DEA allows the use of multiple inputs and outputs in the analysis (Goudarzi, 2014). There are two types of orientation uses in DEA analysis input as well as output orientation. In this article an input orientation use in measuring efficiency which is more appropriate to address questions related to resources savings and effective governance in the public sector that is becoming increasingly popular because of the adverse economic condition and the implementation of the 18th amendment. This study attempt to estimate by how much less input the health services of public hospitals could have been provided in 2011-15. This, in turn, would give a board estimate of potential health budget savings.

METHODOLOGY

Data envelopment analysis is a method that compares different decision-making units (DMUs) efficiency based on multiple inputs and outputs (Angiz, et al., 2013). The ratio of weighted inputs and outputs is calculated to produce a score which is then compared to that of the best performing DMUs (Zhang, et al., 2014). This score can also be referred to as relative efficiency. The calculated score is between 0 and 1 (the most efficient). The DMUs that have a ratio of less than 1 are less-efficient relative to the most efficient unit (Dilts, et al., 2015).

Charnes, et al. (1978) were first to introduce the DEA model that also assumes a production technology with constant returns to scales. In DEA literature this first approach is known as CCR model, named after Charnes, Cooper, and Rhodes. The CCR approach suggests that the change in output is proportionate to the change in every input use (Guddat and Stein, 2007). Later, Banker et al. (1984) have come up with another model that allows for variable returns to scale, known as the BCC (named after Banker, Charnes, and Cooper) model henceforth.

In utilizing DEA, one can use three approaches which are input, output or both input and output orientation (Cooper et al. 2007). In this study, input orientation is used as it is difficult for a hospital to control its output level. The input-oriented DEA model, which is solved for each public hospital individually, minimizes inputs while maintaining the current levels of output and environmental difficulty. For the estimation of input-oriented technical and scale efficiencies both CCR and BCC DEA model is used in this study, by which a linear programming problem is solving for each hospital for the case of outputs (yi) and inputs (xi).

Specifically, the technical efficiency is the solution of the following linear programming (Fare, Grosskopf and Lovell, 1994):

$$(1).....Min\theta$$
$$subject$$
$$\sum_{k=1}^{n} \partial_k x_{ik} \leq \theta x_{iko} \gamma_i$$
$$\sum_{k=1}^{n} \partial_k y_{rk} \leq y_{rko} \gamma_r$$
$$\sum \partial_k = 1$$
$$\partial_k \geq 0, k = 1, ...25$$

The difference between CCR and BCC model is due to the constraint of return to scale i.e. $\sum \partial_k = 1$, by removing this condition, the equation 1 will become CCR model which is used in the calculation of scale efficiency.

Scale efficiency has to do with a production unit operating at its optimal operating size given its output. An intuitive interpretation of scale efficiency is that, given its output level or external demand, there is a hypothetical scale of operations that make each hospital most productive or efficient (Masiye, 2007). The general theory is that when a firm becomes too big or too small, scale changes can lower costs and efficiency (Giancotti, 2017). Scale efficiency is healthcare industry is a consequence of market and institutional constraints which ensures that production units do not operate at an optimal size (Cincera, et al., 2011).

Inappropriate size of a hospital (too large or too small) may sometimes be a cause for technical inefficiency. This is referred to as scale inefficiency and takes two forms i.e. decreasing returns to scale and increasing returns to scale. Decreasing returns to scale (also known as diseconomies of scale) implies that a hospital is too large for the volume of activities that it conducts. Unit costs increase as outputs increases. In contrast, a hospital with increasing returns to scale (economies of scale) is too small for its scale of operation. Unit costs decrease as outputs increase. A hospital that is scale efficient is said to operate under constant returns to scale. Scale efficiency is calculated by dividing a hospital's technical efficiency score under the assumption of CRS by its technical efficiency score under VRS (Kirigia and Asbu, 2013).

$$(2).....SE_I(x_i, y_i) = TE_I(x_i, y_i / CRS) \Big/ TE_I(x_i, y_i / VRS)$$

Where

TEI (xi, yi / CRS) = TE under constant returns to scale (CRS) production technology

TEI (xi, yi / VRS) = TE under variable returns to scale (VRS) production technology

It is bounded between 0 and 1. A hospital is input scale efficient if

TEI (xi, yi / CRS) = TEI (xi, yi / VRS)

Selection of inputs and outputs

Chansky, et al. (2016) classifies hospital output into four broad categories such as inpatient treatment, outpatient treatment, teaching, and research. Measuring hospital output by such variables as inpatient days or outpatient visits does not capture the case-mix and the quality of service rendered. Even though the use of Diagnosis-related groups (DRGs) may handle the problem of hospital case-mix, the absence of data

makes its use limited in most developing countries. Within the context of developing countries, stratifying hospitals according to their level may to some degree take account of the case-mix and factors such as staffing pattern and medical technology used that are likely to affect the quality of care delivered.

Thus, in the present study, two hospital outputs are identified for the DEA model: outpatient visits and inpatient days. These are the major outputs of the district hospitals under consideration, as their involvement in teaching and research is very minimal or non-existent.

Inputs of a hospital are classified as labor and capital. The labor input can be disaggregated into the various professional groups such as physician, nurse and administrative staff. In most studies, beds are used as a proxy for capital (Aletras, et al., 2007). In this study doctors, nurses, other staff (medical & non-medical) are used as proxies for labor and beds used as a proxy for capital. The study focuses on the DHQs hospitals in Punjab (N = 25 out of 34) excluding teaching DHQs hospitals. Because for efficiency analysis, it is necessary that DMUs should be homogeneous (Mohammadi, 2016). Data for the period 2011-15 is taken from Punjab Health Department and Account General Office Punjab. The period covered includes the years 2011 to 2015.

RESULTS

The findings indicate a wide variation in the data of the DHQs hospitals as indicated by the input and output factors. Summary statistics of the key variables is given in Table 1.

The mean, median, minimum and the maximum values of output and input variables are presented in Table-1. The sample includes hospitals with significant deviations concerning the level of outputs (in-patient days and outpatient visits) and the level of inputs (beds and human resources). On average, the numbers of all inputs have increased throughout the years of study while the mean of outputs showed a mixed trend. The mixed trend for the average outputs is something to be expected here because, unlike other industries, the numbers of outputs are highly determined by the utilization of services by the community.

Table 1: Summary Statistics of Input-Output Variables (2006–2015)

Statistics		Outputs		Inputs			
		Outpatients	**Inpatients**	**Doctor**	**Nurse**	**Bed**	**Staff**
2011	Mean	63992	736	40	85	67	150
	Median	613059	104763	220	1257	467	1696
	Max	256111.04	23463.48	131.04	400.32	196.92	727.04
	Min	206837	9841	133	365	172	496
2012	Mean	72402	1497	59	100	68	131
	Median	746038	137776	250	1165	468	1029
	Max	302342	27254	153	435	198	624
	Min	264337	12047	169	408	173	640
2013	Mean	78002	422	37	192	70	131
	Median	588473	175276	211	817	470	1029
	Max	312394.44	29159.04	133.92	448.48	199.92	624.44
	Min	305069	9912	131	444	175	640
2014	Mean	68644	824	37	192	70	131
	Median	555798	167583	211	817	470	1029
	Max	312067.6	24401.24	133.92	448.48	199.92	624.44

	Min	293672	7497	131	444	175	640
2015	Mean	77918	1290	77	80	78	146
	Median	813714	157082	272	480	478	1044
	Max	362338	24400	162	209	207	635
	Min	322518	9275	170	185	183	655

Source: Authors' Calculation

Efficiency Scores

A hospital is said to be efficient if it uses all of its resources optimally and there is no scope of increasing the output without altering the number of inputs used (Boussofiane, et al., 1991). The TE score for such hospitals are going to be 1 or can be interchangeably referred to as an efficiency percentage of 100 percent. On the other hand, the hospital is said to be inefficient, if there is a scope of reducing the usage of some of the inputs without affecting the current level of output (Avkiran, 2001). The TE score of inefficient hospitals would be less than 1. It is important to note that efficiency scores range from 0 (totally inefficient) to 1 (efficient).

The constant return to scale with the score of 1 signifying that a particular hospital is scale efficient (Grosskopf, et al., 2004). A hospital that is scale inefficient might not be operating according to its real capacity. Scale inefficiency is classified into two forms i.e. increasing returns to scale (IRS) or decreasing returns to scale (DRS). In DRS, the unit cost increases as output increases and vice versa for IRS. Therefore, hospitals that facing DRS may reduce its operation and those experiencing IRS may expand its operation in order to be scale efficient (Kumar and Gulati, 2008).

In DEA models of efficiency analysis, efficient decision units are not efficient in absolute terms but only relative to less efficient units (Banker and Morey, 1986). In assessing the efficiency of a particular unit, the estimation process compares the performance of that unit with a set of other efficient units. The efficient unit with which a given unit is assessed is its reference set (Martic, et al., 2009). The performance of the efficient reference set in the various dimensions of assessment shows why an inefficient unit is regarded as inefficient.

The individual hospitals' technical and scale efficiency scores during the five years are presented in Table 2. In this table, the six district hospitals (24 percent) are technically efficient which lie on the best-practice frontier. The TE score of district hospitals ranging between 0.55 and 1 with the average of 0.86. In Table 2, the result is presented by hospital and year for the ease of interpretation. In general, there is a wide range of differences between the TE scores of the hospitals in the group ranging from the lowest to the highest implying that some hospitals are using more resources to produce output than what other hospitals are producing with a similar level of resources. The district hospitals such as Muzzafargarh, Narowal, Mundibahudin, Kasur, Chakwal, and Bhakar are efficient throughout the period, whereas there are three hospitals, Jhang, Chaniot and Okara (south), are fully effective in 4 out of 5 years. It is further observed that hospitals such as Jhang and Okara (south) which are efficient during first periods became inefficient in the last years. Chaniot is showed improvement after 2011 while Sheikhupura started performing well in last two years. All other DHQs hospitals showed mixed trend during all period. Across the years, the average TE score of the DHQs hospitals have increased from 0.78 (2011) to 0.87 (2012), 89 (2013) and after that fall, 88(2014), 86(2015).

As for as scale efficiency of districts hospitals is concerned, scale efficiency scores lies between 0.37 and 1. The average score of 25 DHQs is 0.82 which implies that, on

average, these DMUs are able to reduce 18 percent of their resources while maintaining the same number of output. In year 2011and 2012, seven of the DHQs hospitals (28 percent) have a scale efficiency of 100 percent, which implies that they have the most productive size for that particular input-output mix. However, in the year 2013 the number of scale-efficient hospitals increased to eight while in the year 2014 there are again seven scale-efficient hospitals and in 2015 eight DHQs hospitals have hundred percent scale efficiency. Across the years, the average SE score of the DHQs hospitals have increased from 0.84 (2011) to 0.78 (2012), 83(2013&2014) and after that fall, 80(2015).

On average, technical efficiency under VRS and scale efficiency are estimated at 86% and 82%, respectively, for the whole sample of DHQs hospitals. This means that hospitals could have produced the same quantity of outputs (i.e. the same amount of in-patient days and out-patient visits) with 14% fewer inputs if technical inefficiency could have been eliminated. The hospitals producing on the efficient frontier define the best practice and thus could be regarded as role models. For each inefficient hospital, the DEA model has identified efficient hospitals that could be used as comparators. Efficiency frontier is constructed on the basis of six DHQs hospitals (fully technical efficient) for the period 2011-15 and four DHQs hospitals (fully scale efficiently), which are used as a reference for inefficient DHQs hospitals.

Table 2. DHQs Hospitals' Technical Efficiency and Scale Efficiency, 2011–15

DMUs	2011			2012			2013			2014			2015		
DHQs	TE	SE	RTS	TE	SE	RTS	TE	SE	RTS	TE	SE	RTS	TE	SE	RTS
Bahawalnagar	0.64	0.95	IRS	0.63	0.87	IRS	0.59	0.91	IRS	0.47	0.96	IRS	0.55	0.94	IRS
Layyah	0.46	0.85	IRS	0.71	0.83	IRS	0.67	0.96	IRS	0.60	0.67	IRS	0.68	0.75	IRS
Muzzafargarh	1.00	1.00	CRS	1.00	1.00	CRS	1.00	1.00	CRS	1.00	1.00	CRS	1.00	1.00	CRS
Rajanpur	0.61	0.71	IRS	0.73	0.52	IRS	0.93	0.62	IRS	0.93	0.58	IRS	0.82	0.49	IRS
Jhang	1.00	1.00	CRS	1.00	1.00	CRS	1.00	1.00	CRS	0.88	0.87	DRS	1.00	1.00	CRS
T. T. Singh	0.79	0.78	IRS	1.00	0.57	IRS	1.00	0.77	IRS	1.00	0.88	IRS	0.69	0.61	IRS
Chaniot	0.80	0.93	IRS	1.00	0.82	IRS	1.00	1.00	CRS	1.00	1.00	CRS	1.00	0.98	CRS
Narowal	1.00	1.00	CRS	1.00	1.00	CRS	1.00	1.00	CRS	1.00	1.00	CRS	1.00	1.00	CRS
Hafizabad	0.51	0.95	IRS	0.81	0.78	IRS	0.73	0.99	IRS	0.76	1.00	IRS	0.84	0.92	IRS
Mndibahudin	1.00	0.82	IRS	1.00	0.57	IRS	1.00	1.00	CRS	1.00	0.95	IRS	1.00	0.62	IRS
Kasur	1.00	1.00	CRS	1.00	1.00	CRS	1.00	0.97	IRS	1.00	1.00	CRS	1.00	1.00	CRS
Okara	0.51	0.99	IRS	0.76	0.75	IRS	0.72	0.86	IRS	0.75	0.94	IRS	0.77	1.00	IRS
Okara (south)	0.49	0.42	IRS	1.00	0.38	IRS	1.00	0.38	IRS	1.00	0.31	IRS	1.00	0.34	IRS
Sheikhupura	0.65	0.98	IRS	0.67	0.95	IRS	0.92	0.94	DRS	1.00	0.89	DRS	1.00	1.00	CRS
Nankansahib	0.89	0.49	IRS	1.00	0.42	IRS	0.87	0.49	IRS	0.87	0.46	IRS	0.81	0.44	IRS
Khanewal	0.80	0.64	IRS	0.82	0.61	IRS	0.94	0.61	IRS	0.95	0.68	IRS	0.77	0.55	IRS
Lodhran	1.00	0.85	DRS	1.00	1.00	CRS	1.00	0.60	IRS	1.00	0.73	IRS	0.72	0.66	IRS
Pakpattan	0.93	0.66	IRS	1.00	0.63	IRS	1.00	0.62	IRS	0.95	0.58	IRS	0.95	0.63	IRS
Vehari	0.75	0.82	IRS	0.68	0.89	IRS	0.60	1.00	DRS	0.56	0.98	IRS	0.71	0.92	IRS
Attock	0.58	0.90	IRS	0.72	0.73	IRS	0.64	0.87	IRS	0.67	0.90	IRS	0.72	0.81	IRS
Chakwal	1.00	1.00	CRS	1.00	1.00	CRS	1.00	1.00	CRS	1.00	1.00	CRS	1.00	1.00	CRS
Jhelum	0.51	0.64	IRS	0.45	0.63	IRS	0.52	0.63	IRS	0.60	0.82	IRS	0.66	0.80	IRS

Bhakar	**1.00**	**1.00**	**CRS**	**1.00**	**1.00**	**CRS**	**1.00**	**1.00**	**CRS**	**1.00**	**1.00**	**CRS**	**1.00**	**1.00**	**CRS**
Khushab	**0.64**	**0.73**	**IRS**	**0.80**	**0.60**	**IRS**	**1.00**	**0.66**	**IRS**	**1.00**	**0.71**	**IRS**	**0.82**	**0.60**	**IRS**
Mianwali	**1.00**	**1.00**	**CRS**	**1.00**	**0.95**	**IRS**	**0.99**	**0.90**	**IRS**	**0.98**	**0.96**	**IRS**	**1.00**	**0.95**	**IRS**
D.S.	**TE**	**SE**		**TE**	**SE**		**TE**	**SE**		**TE**	**SE**		**TE**	**SE**	
Mean	**0.78**	**0.84**		**0.87**	**0.78**		**0.89**	**0.83**		**0.88**	**0.83**		**0.86**	**0.80**	
Median	**0.80**	**0.90**		**1.00**	**0.82**		**1.00**	**0.91**		**0.98**	**0.90**		**0.84**	**0.92**	
S.D.	**0.21**	**0.17**		**0.16**	**0.20**		**0.16**	**0.19**		**0.17**	**0.19**		**0.15**	**0.21**	
Max	**1**	**1.00**		**1**	**1.00**		**1**	**1.00**		**1**	**1.00**		**1**	**1.00**	
Min	**0.46**	**0.42**		**0.45**	**0.38**		**0.52**	**0.38**		**0.47**	**0.31**		**0.55**	**0.34**	
CRS=Constant Return To Scale, Irs = Increasing Return To Scale, Drs = Decreasing Return To Scale, De= Descriptive Statistics															

Source: Authors' Calculation

FREQUENCY DISTRIBUTION

Frequency distribution of technical and scale efficiency are displayed in Figures 1. It shows that the 14 (56%) hospitals exhibited technical efficiency ranging between 0.90-1.00 and 13 (52%) lies between 0.90 to 1.00 scores ofscale efficiency scores during 2011-15. while 2 (8%) hospitals technically and 1 (4%) with scale efficiency exhibited between 0.50-0.59 efficiency score. Not even single hospital lies between 0.01-0.39 efficiencies score range.The degree of the scale, as well as technical efficiency, on average, are almost similar indicating that a portion of overall inefficiency is due to misuse of resources and producing below the production frontier.

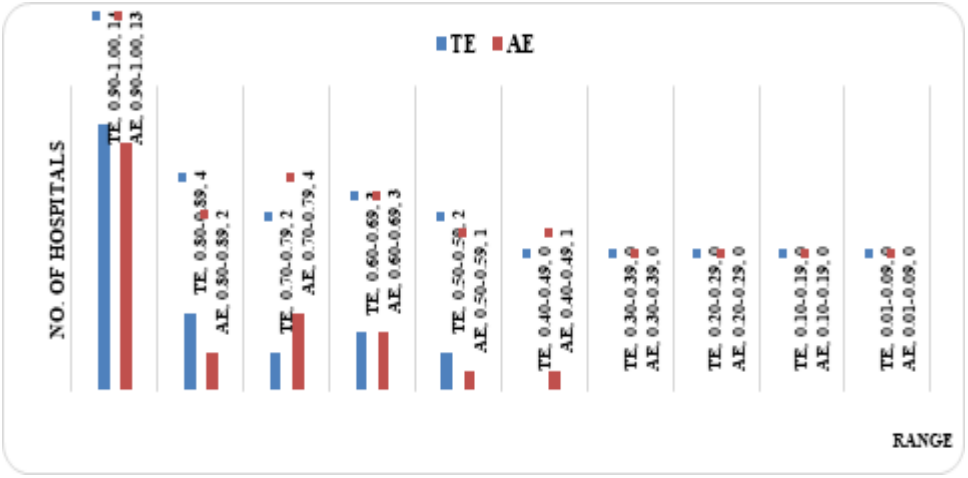

Fig No. 1

RETURN TO SCALE

Production scale of hospitals is presented in Table 3. This table represents the percentage of hospitals operated with CRS or VRS. Out of 25 hospitals, 17 hospitals exhibited IRS. Only 1 hospital of district Lodharan is working under DRS. While, 7 hospitals of districtsMuzzafargarh,Jhang, Narowal, Kasur, Chakwal, Bhakar and Mianwali are operating at optimal scale of production (CRS). Almost similar trend is found in remaining 4 years. Hospitals operated with DRS could improve their efficiency by reducing their activity scale (reducing inputs). It can be observed that hospitals with CRS achieved, on average, a higher level of technical efficiency relative to the hospitals operated under DRS or IRS. Hospitals with DRS achieved a higher level of technical efficiency and lower scale efficiency relative to hospitals with IRS. Therefore, the hospitals operated under DRS could improve their efficiency by focusing on their scale size while hospitals under IRS on the better utilization of inputs.

Table 3: Return to Scale

YEAR	IRS	MPSS	DRS
2011	17 (68%)	7 (28%)	1 (4%)
2012	18 (72%)	7 (28%)	0
2013	16 (64%)	7 (28%)	2 (8%)
2014	17 (68%)	6 (24%)	2 (8%)
2015	17 (68%)	8 (32%)	0

Source: Authors' Calculation

CONCLUSIONS

This study has estimated both technical and scale efficiency of twenty five districts hospitals in the Punjab. The non-parametric DEA approach is used to model the relationship between multiple inputs and outputs for a DHQ hospital. This approach provides the estimates of the potential improvement that can be made in inefficient hospitals that may transform 'inefficient' to 'efficient' hospitals. TE scores indicates the overall extent to which all the inputs have to be reduced in order to attain 100 per cent efficiency for the inefficient units. The inefficient hospitals could operate as efficiently as their peers either by increasing their outputs or reducing utilization of their inputs.

Out of 25 hospitals, 24 percent are technically efficient which lie on the best-practice frontier. The TE score of hospitals ranging between 0.55 and 1 with the average of 0.86 while the score of scale efficient hospitals is between 0.37 and 1. The average scale efficiency score of DMUs is 0.82 which implies that, on average, these DMUs are able to reduce 18 percent of their resources while maintaining the same number of output. It can be concluded that on average all the hospitals are technically and scale efficient. Because more than 80 percent healthcare inputs in these hospitals utilized efficiently. Furthermore, there is capacity to treat more patients in these hospitals by increasing more inputs. Because more than 65 percent hospitals are working under increasing return to production scale and those hospitals which are working under CRS, there is no need to increase or decrease of healthcare inputs.

This analysis provides interesting policy implications for developing efficient secondary healthcare delivery system in Punjab. Nevertheless, it is worth to note that these findings are critically based on the choice of attributes, thus, the policy implications should be considered accordingly. The optimal size of a hospital is also referred to as scale efficiency. In terms of decreasing return to scale it imply that a hospital has an inefficient large size. To decrease the cost and come back to optimal scale such hospitals need to cut down their size in terms of staffs and beds. It might be difficult to consider bed closures or decrease their personnel, but at least they should not keep increasing them. Policymakers could also improve efficiency through the transfer of human resources for health and beds to primary health level health facilities experiencing shortages. However, this is the only physical relationship of input-output that should not be trapped in. It is clearly understood that reducing input levels is not simply transforming one resource usage to another or merely transferring doctors and nurses somewhere else since this would entail some physiological and human factors. In contrast, hospitals that have not reached their optimal scale yet (increasing return to scale) can still expand the output.

This study gives valuable information on the efficiency of public hospitals in Punjab. Further research can also be done on this topic by finding the determinants of technical as well as scale efficiency in order to find the effect of institutional and environmental factors on the efficiencies.

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