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An Enhanced Efficiency Technique for Hospitals at Karur using Data Envelopment Analysis

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Abstract— The main purpose of this paper is to observe the technical efficiency of hospitals located in karur area using Data Envelopment Analysis. Data envelopment analysis is a non-parametric method for measuring and evaluating performance of set of entity called Decision Making Units. This method is capable to compact with multi-dimensional environment of input and output variables. A few of the local hospitals situated in karur area are measured for efficiency analysis. The several significant of inputs and outputs of these hospitals have been integrated to reveal the method. Finally, the frontiers have been identified and compared on the basis of which lagging hospitals have been given suggestion for improving their services.

Keywords— DEA, DMU, Technical efficiency, Scale efficiency and constant return to scale, variable return to scale.

1. INTRODUCTION

Health care is a sector that has to provide services related to the general public and take care of not just their needs to make them well but also to provide the same in a better manner. Health care organizations are the ones that take care of people in their illness and so they have to be hygienic, clean and provide better services. The services provided by Health Care Centres and the Quality of services provided are the main basis on which they have to be judged, even their name is spread through word of mouth if they provide with good services. The efficiency of a Health care unit depends on the quality of service provided and to measure the same we are using Data Envelopment Analysis (DEA) as a tool.

Data envelopment analysis is a method that is based on analyzing the statistical data based on a set of inputs called Decision Making Units, and mostly used for measuring and evaluating performance of the data provided. Data Envelopment Analysis has been done by taking the following inputs – Number of Doctors, Number of Nurses, Number of beds, Number of Paramedical Staff and the Number of wards. The output of the provided input are- Average number of OPD patients per day and Average number of patients admitted per day.

2. REVIEW

Benneyan et al. [1] developed DEA to identify the countries with most efficient healthcare systems were identified on clinical outcomes, health adjusted life years, access, equity, safety and resources. The results reported only few countries to be efficient and suggested improvement measures.

Cooper [2] introduced the technique DEA. It is a non-parametric technique to find the relative efficiencies of decision-making units (DMUs) incorporating multiple inputs and multiple outputs.

Jain et al. [3] described DEA for performance measurement and target setting in two manufacturing companies of discrete production systems. Various DEA models were applied and tested the factors contributing to lower efficiencies were identified in similar circumstances.

Jong Jooet al. [4] revealed DEA for benchmarking and illustrate variable selection using Return on Asset (ROA) for comparing efficiency of companies in the same industry. Moreover, a framework was suggested for selecting variables for performance measurement and benchmarking which includes general merchandisers.

Shafiee et al. [5] evaluated the efficiency of an Iranian Bank using dynamic Slack Based Model (SBM) of Data Envelopment Analysis. They measured the efficiency of bank branches for more than two periods considering net profit as a good link and loan losses as a bad link and it compared the dynamic SBM efficiency with the static efficiency.

Sherman [6] developed DEA as a managerial audit tool for resources allocation and analytic review of efficiency when applied to given set of situations. They also interpreted strengths and limitations of DEA techniques. The study was not only to evaluate the relative efficiency of non profit and public sector Decision Making Units (DMUs) but also extends to profit sector class.

Tripathy et al. [7] applied DEA to pharmaceutical firms in India for measuring the efficiency. The analysis of 90 sample firms was undertaken to measure the technical efficiency. The findings showed that performance of large number of sample firms was not optimal and the average efficiency of the R&D intensive firms is greater than that of non R&D firms.

Weber [8] published work on performance measurement of vendors. It was recognized that vendor selection is a multiple criteria decision-making problem. This work demonstrated that how DEA could be used to measure the performance of vendors on multiple criteria.

Zhou et al. [9] conducted a literature review on the importance of energy and environmental modeling techniques. The various DEA techniques have been highlighted and a large number of publications have been classified in this field. They observed that the benchmarking of electricity utilities accounts was common for the most studies.

Jat [10] conducted several studies on hospitals. Recently, a research was conducted in public district hospitals in Madhya Pradesh to measure the technical efficiency. Data from 40 district hospitals were collected and DEA was performed with return to scale assumptions. Out of all the hospitals in this study, 50% were technically efficient and the rest were inefficient according to the best practice frontiers.

3. Methodology

To measure the efficiency of hospitals, the technique used is Data Envelopment Analysis and the technique for measurement of relative efficiency of some organizations such as hospitals and schools. The linear programming technique is used in DEA to calculate the relative efficiency for each hospital. Efficiencies vary between 0 and 1. Hospitals having a score of 1 or 100% are technically efficient and hospitals having scores of less than 1 are technically inefficient.

3.1 DEA Analysis

A comparative study of input oriented CRS and VRS models is done. Firstly, the efficiencies of DMUs are measured using CRS and VRS model. The CRS model works on the concept of constant-return-to-scale. It computes the efficiency scores, which defines Technical Efficiency measures the firms success in producing maximum output from a given set of inputs. The VRS model works on the concept of variable-return-to-scale. It computes the efficiency scores, which defines Pure Technical Efficiency.

4. Analysis and Discussion

DEA model applied to all output-oriented for compute efficiency. The data for study has been collected from private hospitals at Karur region. The input measures used in this study are number of doctors, number of nurses, number of paramedical staff, number of beds, number of wards whereas the output measures are average number of OPD patients per day and average number of patients admitted per day are shown in Table 1.

Hospitals	Doctor	Nurse	Staff	Beds	Wards	OPD Patients	Patients admitted
A	4	3	6	11	6	20	1
B	9	11	7	40	7	100	7
C	10	4	2	40	4	10	2
D	4	2	4	11	3	50	2
E	3	3	0	22	7	10	2
F	3	2	5	12	2	20	7
G	5	2	8	20	7	13	3
H	3	4	7	22	2	60	15
I	1	0	10	18	6	12	1

Table.1 Input-output variables

Table.1 depicts the efficiency score of hospitals using CRS and VRS models applying DEA solver. In this section our analysis is a three-step procedure. CRS model is used to measure technical efficiency and then VRS model is used to calculate technical efficiency. This helped us to identify inefficient hospitals on account of inefficient operations. Finally scale efficiency is computed by taking the ratio of CRS and VRS. It provides information about those hospitals that are operating under disadvantageous conditions. This characteristic of each hospital can scale the input or output linearly without increasing or decreasing the efficiency.

Table.2 Efficiency of CRS model

DMU No.	DMU Name	Input-Oriented CRS Efficiency	Sum of lambdas	RTS	Optimal Lambdas with Benchmarks
1	A	0.41270	0.397	Increasing	0.381
2	B	1.00000	1.000	Constant	1.000
3	C	0.42015	0.310	Increasing	0.023
4	D	1.00000	1.000	Constant	1.000
5	E	1.00000	1.000	Constant	1.000
6	F	0.92647	0.515	Increasing	0.463
7	G	0.37736	0.358	Increasing	0.189
8	H	1.00000	1.000	Constant	1.000
9	I	1.00000	1.000	Constant	1.000

Table.3 Efficiency of VRS model

DMU No.	DMU Name	Input-Oriented VRS Efficiency	Optimal Lambdas with Benchmarks
1	A	1.00000	1.000
2	B	1.00000	1.000
3	C	1.00000	1.000
4	D	1.00000	1.000
5	E	1.00000	1.000
6	F	1.00000	1.000
7	G	0.72649	0.323
8	H	1.00000	1.000
9	I	1.00000	1.000

Table.4 Input-Oriented CRS model Slacks

DMU No.	DMU Name	Input Slacks					Output Slacks OPD patients
		Doctor	Nurse	Staff	Beds	Wards	
1	A	0.07937	0.41270	0.84127	0.00000	1.30159	0.00000
2	B	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3	C	3.13719	0.47374	0.00000	9.58628	0.00000	0.00000
4	D	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
5	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
6	F	1.33824	0.00000	0.87500	0.00000	0.61765	8.41176
7	G	1.15094	0.00000	0.00000	0.33962	1.24528	0.35849
8	H	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
9	I	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table.5 Input-Oriented VRS model Slacks

DMU No.	DMU Name	Input Slacks					Output Slacks OPDpatients
		Doctor	Nurse	Staff	Beds	Wards	
1	A	0.00000	1.00000	2.00000	0.00000	3.00000	30.00000
2	B	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3	C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4	D	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
5	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
6	F	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
7	G	0.94996	0.00000	0.00000	0.00000	1.01639	13.18809
8	H	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
9	I	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

5. CONCLUSION

In this paper, focused on measurement of the efficiency of hospitals located at karur and ranked them according to their scale efficiency. DEA models have been applied and proved to be a useful approach for efficiency measurement. Two models of DEA namely CRS and VRS were undertaken to obtain the efficiency scores of Karur hospitals. These scores have been relatively compared and scale efficiency is computed using the ratio of CRS and VRS. A comprehensive analysis of input and output variables is considered while assuming scale. This type of analysis might be useful for benchmarking consider to health care system.

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