Parametric Analysis and Performance Assessment of the Departments in a Public Hospital using Data Envelopment Analysis

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Abstract **- Improvements in health care delivery system performance are important because they can boost the well being, as well as the standard of living and the economic growth of any nation. In India, health care services are less cost and more effective compared to other developed countries. Unfortunately all hospitals cannot work efficiently due to problems like lack of good management administration, at technical and clinical levels. This shows the need to analyze the parameters involved and evaluate the performance of various departments in a public hospital and suggest remedial measures to improve its efficiency .In the present study, Data envelopment analysis is used to evaluate the performance of the departments in a public hospital. Measurement of efficiency hospitals that uses multiple inputs and generates multiple outputs is complex and comparison across units is difficult. Charnes, Cooper and Rhodes describe a non-parametric approach in such a situation to measure the efficiency score of departments or decision making units by the technique known as Data envelopment analysis. Using Data envelopment analysis the performance of departments has been evaluated, identified importance of the input parameters for each department in the hospital and suggestions are given to improve their performance.**

Keywords: : Input and output parameters, performance Assessment and Data envelopment Analysis

1. INTRODUCTION

Health care plays a vital role to improve the economic growth of any nation and increase the standard of living of people. Good health care facility mainly depends on managerial,

technical and clinical levels of respective hospitals. Throughout the world health care delivery systems are under increasing pressure to improve performance, i.e to control the health care costs while guaranteeing services and better access to care. Improvements in the health care performance are important because they can boost the well being, as well as the standard of living and economic growth of any nation. The quest for high performance in health care has been a difficult and intractable problem historically. Efforts to reduce costs and improve service quality and access to care have been only marginally successful. (Georgopoulos 1986; New house 1994; Short ell et al 2000) The public and private hospitals play a vital role to give good quality treatment to the people and give better health service facility. In general, public and private hospitals may consist of many departments like General medicine, General surgery, Cardiology, Orthopedics, Obstetric and Gynecology, Pediatrics etc. and each department performs with multiple inputs and multiple outputs. Therefore the activities of each department can be observed in terms of inputs and outputs and of each department in the hospital can be evaluated by using data envelopment analysis. Data Envelopment Analysis is basically a linear programming technique used for measuring the performance of departments and comparing the relative efficiency of each department. In the present study, different departments of a government hospital have been evaluated by using DEA and suggestions are given to improve the performance of inefficient departments.

The following terms and definitions are generally used in health care service sector. Mainly the overall hospital performance depends on the following three levels.

- Managerial performance level
- Technical performance level
- Clinical performance level

Managerial performance: Managerial performance plays a good role in any hospital for improving the overall performance of hospital. The hospital managers make good policies for improving the facilities to the patients.

Technical performance: Technical performance is mainly depends on the high quality latest equipment and highly skilled technicians. Each department in a hospital must have latest laboratory equipment that is used to improve the technical performance.

Clinical performance: Clinical performance depends on the doctors, nurses, paramedical staff and the type of patient's disease.

The overall efficiency of hospital depends on the following levels.

1. Technical efficiency
2. 2.Allocative efficiency
3. 3.Cost efficiency

Technical efficiency: It deals with the usage of labour, capital and high quality medical equipment as inputs to produce outputs relative to best practice in a given sample of decision making units or departments. In other words, same technology for all the departments with no wastage of inputs is considered in producing the given quantity of output.

Allocative efficiency: It deals with the minimization of cost of production with proper choice of inputs for a given level of output and set of out put prices, assuming that the organization being examined is expressed as a fully technical efficient.

Allocative efficiency is expressed as a percentage score, with a score of 100 percent indicating that the organization is using its inputs in the proportions which would minimize costs.

Cost efficiency: It deals with the combination of technical and allocative efficiency. Cost efficiency is calculated as the product of the technical and allocative efficiency scores (expressed as a percentage) So an organization can only achieve a hundred percent score in cost efficiency if it has achieved hundred percent in both the technical and allocative efficiency.

The health care delivery systems which are also called as hospitals consist of many departments. All departments take certain inputs and produce certain outputs providing treatment to the patients of respective departments. All departments do not perform efficiently due to lack of input parameters like equipment, medicines, doctors, nurses, administrative problems etc. So in this study, every activity of department has been observed and the performance of each department was evaluated to find out the best department in a public hospital using data envelopment analysis. The Data Envelopment Analysis has been carried out to suggest certain remedial measure for improving the performance of each department.

Data and Parameters:

For the analysis purpose of any organization, the study developed and defined several variables from the primary data collected. The variables are mainly of two types. They are

- Input parameters
- Output parameters

Input Parameters: The input parameters are broadly classified into capital, labour and technological input. Generally seven parameters are defined to measure input variables, common to all hospitals. In the present analysis input variables considered are

1. Doctors
2. Nurses
3. Expenditure on drugs and other staff etc.

Output parameters: The output parameters are generally classified into inpatients, out patients and clinical reports. In the present work output parameters considered are mainly three major services. They are 1.Outpatient's services
2. Inpatients services and
3. Laboratory services

2. LITERATURE REVIEW

Data envelopment analysis is a management science technique that is used to estimate the multi product technology functions and to assess the managerial performance of selected decision making units. Data envelopment analysis is basically a linear programming technique, first put forward by Charnes, Cooper and Rhodes in 1978. It is used for measuring the performance of any organization and comparing the relative efficiency of organizations. DEA involves identification of units, which in relative sense use the inputs for the given outputs in most optimal manner and data envelopment analysis uses this information to construct efficiency frontier over the data of available organization units. The method can successfully be applied to profit and non-profit making organizations, as well as Data envelopment analysis can handle multiple inputs and multiple outputs as opposed to other techniques such as ratio analysis or regression. The aim of this Data envelopment analysis is to quantify the distance of the efficient frontier for every decision making unit. The measure of performance is expressed in the form of efficiency score. After the evaluation of the relative efficiency of the present set of units, the analysis shows how inputs and outputs have to be changed in order to maximize the efficiency of the target decision making unit. Data envelopment analysis suggests the bench mark for each in- efficient decision making unit at the level of its individual mix of inputs and outputs.

2.1 DEA in health care applications

For health care organizations, finding a single overall measure of performance has been difficult. Goals of most health care services are multiple, conflicting, intangible, vague and complex. Virtually every study of efficiency could be criticized for failing to look at quality, clinical innovation or the changing nature of the services (New house 1994).

The first application of DEA in health care began with H.David Sherman's doctoral dissertation in 1981.(Sherman , H.D., hospital efficiency measurement and evaluation, medical care, 22, No.10,922-928) David Sherman applied DEA to evaluate the performance of medical and surgical departments in 15 hospitals in 1983.

Also using a DEA model, Castro (2004) analyzed the technical efficiency of 54 public hospitals in Chile. The estimated results showed that several hospitals were operating at lower pure technical efficiency level and scale efficiency than the best practice frontier, which was obtained on relatively more efficient hospitals. The author showed that technical efficiency ranged between 30.3 and 94.3 percentages, implying that the average hospitals consumed 30.3 to 94.3 percent more resources than needed to get the same levels of outputs (Castro 2004)

Stein Mann et al (2003) measured and compared the inefficiency of German and Swiss hospitals. Both models used- a standard DEA model and a restricted DEA model to reduce the impacts of reporting errors and get a more comparable frontier showed that the technical efficiency gap between German and Swiss hospitals winded over time. According to the authors, this gap might reflect the fact that the patients in Switzerland had a larger choice of hospitals without being exposed to cost differences (Steinmann et al 2003), and that were excessive inputs for a given output. i.e low DEA efficiency ,when inputs were valued by patients as quality indicators.

Farell (1957) defined a simple measure of firm efficiency that could account for multiple inputs, stating that technical efficiency is the ability of a firm to obtain maximal output for a given set of inputs. His definition of technical efficiency led to the development of methods for estimating technical efficiencies in the context of a firm. Data envelopment analysis is non-parametric linear programming approach formalized by Charnes, Cooper and Rhodes in 1978 and formalized by Banker, Charnes and Cooper in 1984. A more number of recent studies have employed DEA to measure hospital efficiency. Magnusson (1996), Hollingsworth and Parkin (1995), Ferrier and Valdmains (1996) estimated the technical efficiency of all hospitals in Northern Ireland from

1986 to 1992. All acute hospitals were categorized in to small, medium and large (based on total number of inpatients and outpatients). In Norway, Born, et.al. (2000) measured technical efficiency of hospitals to test the hypothesis that hospital efficiency is expected to be greater with activity based funding of hospitals than with fixed budgets. They found that there was a large improvement in efficiency in the first year after the reforms of the funding system.

2.2 DEA in Nursing homes

Sexton et al (1989) published the first two DEA studies of nursing homes. Sexton et al ran a model that relied on two measures (Medicaid and others) and six outputs that only included labour, consequently the study had some limitations. Nyman and Bricker (1989) used DEA to study 195 nursing homes for profit and not-for profit U.S nursing homes.

Another study in the United States by Nyman et al (1990) investigated the technical efficiency of 296 nursing homes producing only intermediate care, no skilled nursing care, and relying on 11 labour outputs. A study of 461 nursing homes by Rosko et al in 1995 employed five labour inputs and two outputs, ICF patients and SNF patients. Their study found that the variables associated with nursing home efficiency were managerial and environmental. Differences in efficiency were not associated with quality measures.

The nursing home studies are among the better applications of DEA. Although they encounter the same case mix problems when modeling outputs, most of these studies regress the DEA scores to identify the variables associated with inefficiency. Since the outputs are often adjusted by payment types, or patient types, many of these studies are controlled for quality, patient characteristics, while exploring effects of ownership, operating environment and strategic choice on performance. These studies have found that managerial and environmental variables (the location of the home, nurse training, size of the home, and wage rates) are strongly associated with the DEA scores, rather than quality of care or patient mix.

2.3 Importance of DEA

The Data envelopment analysis has recently the dominant approach to measure the performance of many economic sectors. One of the attractive characteristics of this approach is that it can handle easily multiple inputs and multiple outputs. Data envelopment analysis is a non-parametric approach, so it does not require any assumptions about the functional form of the production or cost frontier. Therefore, data envelopment analysis concentrates on taking in to account and classifying variables that can be inputs or outputs of the production function. From the efficiency point of view data envelopment analysis is desirable for evaluating the performance of any organization.

2.4 Data Envelopment analysis models

An organization under study is called decision making units. The following models are generally used in data envelopment analysis.

- Charnes-Cooper-Rhodes model(CCR model)
- Banker- Charnes-Cooper model (BCC model)
- Assurance Region model (AR model)
- General Returns-to-scale model(GRS model)
- Increasing Returns-to-scale model(IRS model)
- Decreasing Returns-to-scale model (DRS model)

2.4.1 Strengths of DEA

- DEA can handle multiple inputs and multiple out puts.
- It does not require an assumption of a functional form relating inputs and outputs.
- Decision making units are directly compared against a peer or combination of peers.
- Inputs and outputs can have very different units.

2.4.2 Limitations of DEA

- Data envelopment analysis results are specific.
- Since DEA is an extreme point technique, measurement error can cause significant problems.
- DEA is good at estimating relative efficiency of a decision making units but it converges very slowly to absolute efficiency.
- Since DEA is a non parametric technique, statistical hypothesis tests are difficult.
- Since the standard formulation of DEA creates a separate linear program for each decision making unit, large problems can be computationally intensive.

3. METHODOLOGY

Throughout the world, majority countries are spending more funds on health sector. Unfortunately all hospitals cannot work efficiently due to problems like lack of good management administration, at technical and clinical levels. This shows the need to evaluate the performance of various departments of a public hospital and suggest remedial measures to improve their efficiency .In the present study Data envelopment analysis is used to evaluate the overall performance of the departments in a public hospital. Measurement of efficiency of any organization (e.g. hospitals, banks etc.) that uses multiple inputs and generates multiple outputs is complex and comparison across units is difficult. Charnes, Cooper and Rhodes (1978) describe a non-parametric approach in such a situation to measure the efficiency score of departments or decision making units by the technique known as Data envelopment analysis. Present chapter discusses the CCR-Input oriented model and the pertinent data collection for analysis

3.1 Dea Ccr Model.

The most important characteristics of the DEA methodology can be presented by the CCR-I DEA model. Consider a general situation where "n" decision making units, converting the "m" inputs to the "s" outputs. The quantities of these inputs and outputs can be different for each Decision Making Unit (DMU). The following CCR model is used for finding the efficiency score of departments in the hospital.

CCR INPUT ORIENTED DEA MODEL

$$\text{Maximize } Z = \sum_{r=1}^{s} \mu_r y_{ro} \qquad (3.1)$$

Subjected to the constraints

$$\sum_{r=1}^{s} \mu_r y_r / \sum_{i=1}^{m} v_i x_{ij} \le 1 \qquad (3.2)$$

$$\mu_r \ge 0 \; ; \quad v_i \ge 0$$

For i=1, 2...m; r=1, 2,...s; j=1, 2...n

Where the

μ_r = weight given to the output r

v_i = weight given to the input i

x_{ij} = the amount of input i used by department *j*

y_{rj} = the amount of output r produced by department *j*

The virtual output is sum of the ($\sum^{s}_{r=1} \mu_r y_{ro}$) and the virtual input is sum of the ($\sum^{m}_{i=1} v_i x_{io}$). The objective function is denoted by z that is, the ratio of virtual output to virtual input. The solution is a set of optimal input and output weights. The maximum of the objective function is the DEA efficiency score assigned to DMU_0. The first set of inequality constraints guarantees that the efficiency ratios of other DMUs (compared by using the same weights u_r and v_i) are not greater than unity. The remaining inequality constraints simply require all input and output weights to be positive. Since every DMU can be DMU_0, this optimization problem is well defined for every DMU. Because the weights (u_r, v_i) and the observations of inputs and outputs (x_{ij}, y_{rj}) are all positive and the constraints must be satisfied by DMU_0, the value of z can only be a positive number less than or equal to unity. If the efficiency score z =1, DMU_0 satisfies the necessary condition to be DEA efficient; otherwise, it is DEA inefficient.

Efficiency in DEA is defined as the ratio of the weighted sum of outputs of a trust to its weighted sum of inputs (Hollingsworth & Parkin1998; Smith1998). Given "s" outputs and "m" inputs, efficiency H_O for hospital "O "is defined as follows:

Maximize $$H_O = \sum_{r=1}^{s} u_r y_{ro} / \sum_{i=1}^{m} v_i x_{io} \quad (3.3)$$

Subjected to:

$$\sum_{r=1}^{s} u_r y_{ro} / \sum_{i=1}^{m} v_i x_{io} \leq 1 \quad (3.4)$$

Where;

y_{ro}= quantity of output r for hospital

u_r= weight attached to output r, $u_r>0$, r=1....s

x_{io}= quantity of input i for hospital o

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

The weights are specific to each unit so that $0 \leq H_o \leq 1$ and a value of unity implies complete technical efficiency relative to the sample of units under scrutiny. Since the weights are not known a priory, they are calculated from the efficiency frontier by comparing a particular trust with other ones producing similar outputs and using similar inputs, known as the trust peers. Data envelopment analysis computes all possible sets of weights which satisfy all constraints and chooses those which give the most favorable view of the trust that is the highest efficiency score.

This can be stated as a mathematical linear programming problem by constraining either the numerator or the denominator of the efficiency ratio to be equal to one. The problem then becomes one of either maximizing weighted output with weighted input equal to one or minimizing weighted input with weighted output equal to one (Hollingsworth & Parkin, 1997).

3.2 Role of weights in DEA

The DEA efficiency can be computed either in a production (envelopment) or in a value (multiplier) frame work. In original formulation the assessed decision making units can freely choose the weights or values to be assigned to each input and output in a way that maximizes its efficiency, subject to this system of weights being feasible for all other DMUs. This freedom of choice shows the DMU in the best possible light, and is equivalent to assuming that no input or output is more important than any other.

Value judgments may appear in various forms, therefore requiring different treatments. Value judgments that is implicitly included in any DEA analysis is the choice of the number and type of inputs and outputs and also the number and type of DMUs used.

The number of variables and DMUs used in DEA assessment is directly linked with the discriminating power of data envelopment analysis models and also with the potential number of zero weights. Clearly if the number of variables is very high the probability of a DMU finding at least one factor on which it performs well increases, and therefore the decision making units has the chance of neglecting all other factors on which its performance is low, and eventually be rated efficient. At the same time if the number of DMUs under analysis is very small it is likely that each one specializes on a specific input/ output mix not directly compared with the mix of other DMUs.

The following step by step procedure is used for collecting the data. Data has been collected from eight major departments of the hospital. The departments are:

- General medicine (DMU-1)
- General surgery (DMU-2)
- Cardiology (DMU-3)
- Pediatrics (DMU-4)
- Obstetric and Gynecology (DMU-5)
- Orthopedics (DMU-6)
- ENT and (DMU-7)
- Skin. (DMU-8)

1. Initially, each activity of all the departments was closely observed.
2. In the next stage, the following parameters of each department of the hospital were closely observed;
   - Infrastructure and physical facilities
   - Type of services provided
   - Utilization of services, staffing
   - Management indicators
   - Expenditure on drugs
3. Finally, pertinent data was collected from the various departments under consideration.

The overall performance of the each department depends on managerial, clinical and technical levels.

Ministerial data: The ministerial staffs are used to organize the each activity of the department in a hospital. Administrative staff, labor provision staff, clerks and punes come under ministerial staff.

The average monthly data of all departments is shown as inputs and outputs in Table 3.1 and Table 3.2

3.1 Data Of Inputs Of A Public Hospital

DATA/ DEPT	DMU-1	DMU-2	DMU-3	DMU-4	DMU-5	DMU-6	DMU-7	DMU-8
NO. OF BEDS	178	172	30	60	140	60	30	15
NO. OF DOCTORS	28	30	5	8	25	11	8	6
NO. OF NURSES	40	36	24	12	40	14	10	4
NO. OF ADMI - NISTRATIVE STAFF	20	18	4	8	16	8	4	2
NO. OF PARAMEDICAL STAFF	9	8	3	6	9	6	3	3
NO.OF TECHNICIANS	15	12	35	10	25	28	6	4
EXP. ON DRUGS IN LAKHS	2.2	1.8	1.0	1.5	2.0	1.2	1.0	0.8

Clinical data: Data pertaining to Doctors, nurses and Paramedical staff come under this category. These clinical staff are used to give the better treatment to the respective departmental patients in a hospital. If excess inputs are involved compared to the outputs (patients), the overall performance of any department gets reduced.

Technical data: In the Orthopedics, Cardiology and Gynecology departments some lab tests are conducted. These tests are performed by highly skilled workers. The data pertaining to these skilled technicians is considered under this category.

Input Parameters

In any health care organization, multiple inputs are involved to produce certain outputs. The inputs collected from selected departments are as follows;

- Number of beds.
- Number of doctors.
- Number of nurses.
- Number of paramedical staff.
- Number of administrative staff
- Number of technicians.
- Expenditure on drugs.

Output Parameters

The hospital under study provides mainly three major services (outputs). They are inpatients services, outpatient's services and laboratory services. The number of cases treated or handled under each category was chosen as representative measure of the three output variables. The three output variables considered are;

- Number of inpatients
- Number of outpatients,
- Number of clinical testing reports

3.2 Data Of Outputs Of A Public Hospital

DATA/ DEPT	DMU-1	DMU-2	DMU-3	DMU-4	DMU-5	DMU-6	DMU-7	DMU-8
Inpatients	3000	4200	1500	3000	3000	4500	1200	300
outpatients old	2100	1500	400	1200	2100	2200	2100	1800
outpatients new	4800	2400	900	2100	1800	4800	4200	3600
clinical test reports	900	400	600	400	1700	500	200	300

4.CALCULATION OF EFFICIENCY OF SELECTED DEPARTMENTS USING CCR-INPUT ORIENTED MODEL

Different DEA models are used to measure the efficiency of departments in the public hospital. In this thesis, CCR-I (DEA) model is used for calculating the efficiency of departments in the public hospital. From Table 3.1 and Table 3.2, the collected input and output data are considered for calculating the performance score of selected departments in the public hospital.

The CCR-I Data Envelopment Analysis model is very useful to evaluate the performance of departments in the hospital. It can handle multiple inputs and multiple outputs cases problems. In this thesis, four outputs and seven inputs are considered. The collected input and output data of selected departments are converted into CCR-I linear programming equations. By using these equations, the efficiency and rank of all departments in the hospital are calculated and compared within the organization.

Efficiencies of hospital departments can be measured by using CCR-Input oriented Data envelopment analysis model. CCR-I model provides guidance to inefficient departments in setting new targets for improving their performance level.

5. RESULTS AND DISCUSSIONS

All the input and output weights of selected departments results are tabulated in the Table 5.1 given below
Ranks are allotted to all departments based on efficiencies are shows given in Table 5.2 By using the results of the weights obtained for each output and input, the reference departments for the inefficient departments are found out for all the departments of the hospital

TABLE-5.1. OUTPUT AND INPUT WEIGHTS OF HOSPITAL DEPARTMENTS

DMU	u_1	u_2	u_3	u_4	v_1	v_2	v_3	v_4	v_5	v_6	V_7
1	0.0079	0	0.0050	0.0439	0	0	0	0	0.0496	0.0108	0.0178
2	0.0158	0.0026	0.0001	0.0329	0.0005	0.0007	0.0018	0.0019	0.0311	0.0248	0.0136
3	0.0088	0.0040	0.0015	0.1397	0.0073	0.864	0.0003	0.0412	0.0427	0.0008	0.0020
4	0.0304	0.0011	0.001	0.0132	0.0008	0.0464	0.0127	0.0075	0.0065	0.0267	0.0039
5	0.0029	0.0007	0.0018	0.0509	0.0006	0.0025	0.0014	0.0063	0.0234	0.0075	0.0147
6	0.0157	0.0054	0.0021	0.0153	0.0030	0.0121	0.0165	0.0109	0.0149	0.0022	0.0182
7	0.0304	0.0221	0.0037	0.009	0.0029	0.0133	0.0090	0.0303	0.0625	0.0567	0.0069
8	0.0001	0.0151	0.0185	0.0210	0.0115	0.0121	0.0698	0.1041	0.0208	0.0365	0.0073

TABLE-5.2 EFFICIENCY AND RANK OF HOSPITAL DEPARTMENTS

department/dmu	*REFERENCE DEPARTMENTS*	*CCR(Z) SCORE*	*RANK*
General medicine -1	6,7	0.87	3
General surgery -2	6	0.83	4
Cardiology-3	7	0.99	2
Pediatrics -4	7	0.99	2
Obst&gynocology-5	7	0.99	2
Orthopedics -6	6	1.00	1
Ent -7	7	1.00	1
Skin-8	8	1.00	1

The inefficient departments are compared to efficient ones and the excesses in inputs are found out to realize by how much they are lagging behind the efficient departments based on the reference departments. Out of the eight departments under study of General medicine and General
surgery departments obtained efficiencies of 0.83to0.87 respectively. Remaining departments obtained efficiencies between 0.99 to 1.00. Out of the eight departments, it is observed that three departments are running efficiently when compared to other departments of the hospital. In the General medicine department, excess inputs are identified as 13 percent when compared to the reference departments. Hence, it is recommended to reduce the inputs from the General medicine department. The reduction in inputs suggested is; for number of beds-24, number of doctors-5, number of nurses-7, number of administrative staff-3, number of paramedical staff-1, number of technicians-2 and expenditure on drugs-Rs 0.286 lakhs.

In the General surgery department, excess inputs are identified as 17 percent when compared to other reference department. Hence it is recommended to reduce the inputs from the General surgery department. The reduction in inputs suggested is; for number of beds-30, number of doctors-5, number of nurses-4, number of administrative staff-3, number of paramedical staff-1, number of technicians-2 and expenditure on drugs-Rs 0.306 lakhs.

In the Obstetrics & Gynecology department, excess inputs are identified as 1 percent when compared to other reference department. Hence, it is recommended to reduce the inputs from the Obstetric and Gynecology department. The reduction in inputs suggested is; for number of beds-2, number of doctors-1, number of nurses-1, number of administrative staff-

0, number of paramedical staff-0, number of technicians-0 and expenditure on drugs-Rs 0.02 lakhs.

The reduction in manpower can be achieved by transferring the excess doctors, nurses, clinic officers, technicians and other technical staff to other health centers and dispensaries of public hospitals which are in needed of staff. This is very helpful to improve performance of the hospital under study as well as to increase the performance of other public hospitals. Efficiencies of hospital departments can be measured by using CCR-Input oriented Data envelopment analysis model. CCR-I model provides guidance to inefficient departments in setting new targets for improving their performance level.

In conclusion, DEA provides valuable information on the efficiency and inefficiency of the departments in a hospital. The DEA approach cannot provide information on how efficient departments can improve their efficiency further. This is the main limitation of the DEA analysis.

6. SCOPE FOR THE FURTHER WORK

In the present work, Data envelopment analysis is used to measure and compare the performance of different departments within the hospital only. In the further work, DEA can be used to measure and compare the performance of the same departments of different hospitals.

The Data envelopment analysis can be extended to measure and compare the individual performance of all departmental doctors, nurses, technical and administrative staff of the hospital.

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