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EFFICIENCY OF TECHNICAL INSTITUTES IN INDIA : DATA ENVELOPMENT ANALYSIS

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Abstract:

This study aims at evaluating the efficiency of top 15 Indian Technical Institutes through standard and measure-specific Data Envelopment Analysis (DEA) approaches. This purpose of this study is two-fold.

Primarily, the study shows the measuring of performance evaluation of Indian Institutes through standard DEA methodologies. Secondly, it presents the importance of each efficient institute in measuring the inefficiencies of inefficient institutes.

Data has been collected for fifteen premier technical institutes across the country from various resources. DEA uses the general-purpose linear program version of the input oriented *multi-input multi-output model* for the estimation taking state as the decision-making unit. Based on this model, eight input and two output variables are selected and analyzed.

Keywords: *Data Envelopment Analysis (DEA), Efficiency, Performance, Technical Institute.*

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1. INTRODUCTION

1.1 Scenario of the current performance evaluation:

The media is inflating the relative performance of various technical institutes in India most of the time. Biased reports available in market, which creates a false prejudice among the readers while taking critical decisions during the time of admissions, would ruin their career and also manipulate various other rating organizations.

This paper accesses the performance of 15 renowned Technical institutes in India by considering certain key factors like Infrastructure, Faculty-student ratio, Placements and Industrial links, Selection process, R&D etc., through Data Envelopment Analysis.

1.2 Data Envelopment Analysis:

Data envelopment analysis is a non-parametric method in operations research and economics for the estimation of production frontiers. It is used to empirically measure productive efficiency of decision-making units (or DMUs).

Non-parametric approaches have the benefit of not assuming a particular functional form/shape for the frontier; however they do not provide a general relationship (equation) relating output and input. It has been extensively applied in performance evaluation and benchmarking of schools, hospitals, bank branches, production plants, etc.

A typical statistical approach is characterized as a central tendency approach and it evaluates producers relative to an average producer In contrast, DEA compares each producer with only the "best" producers.

Some of the advantages of DEA are:

- No need to explicitly specify a mathematical form for the production function
- Proven to be useful in uncovering relationships that remain hidden for other methodologies

- Capable of handling multiple inputs and outputs
- Capable of being used with any input-output measurement
- The sources of inefficiency can be analyzed and quantified for every evaluated unit.

2. Literature Review:

Sherman (Sherman, 1984) indicated that ratio analysis; regression analysis and data envelopment analysis (DEA) are the most commonly used methods to assess the performance of health care organizations. Ratio analysis, the most commonly used, analyzes performance index by calculating the ratio between a single output variable and a single input variable. Regression analysis analyzes relationships between multiple input variables and a single output variable.

Data envelopment analysis calculates production frontier by analyzing information of multiple input variables and output variables and, subsequently, assesses efficiency using product frontier. The most significant difference between DEA and the other two methods is the concept of production function.

Although these assessment methods have their advantages and disadvantages, DEA model can identify units with relative inefficiency by considering multiple inputs and outputs. Avkiran (Avkiran, 2001) also indicated that DEA is an effective tool to reflect institutional performance.

The efficiency assessment in the field of healthcare involves multi-variables. The goals of the this study are to examine the most efficient way for Technical Institutes to achieve the best performance by using their current resources, as well as to provide suggestions for those that are inefficient. Because ratio analysis and regression analysis cannot meet the requirements of the above goals, this study adopts DEA model to conduct the analysis.

3. Objective:

This study aims at evaluating the efficiency of top 15 Indian Technical Institutes through standard and measure-specific Data Envelopment Analysis (DEA) approaches. This purpose of this study is two-fold.

Primarily, the study shows the measuring of performance evaluation of Indian Institutes through standard DEA methodologies. Secondly, it presents the importance of each efficient institute in measuring the inefficiencies of inefficient institutes.

4. Methodology:

4.1. Input and Output-oriented VRS DEA Model

In this part, standard output-oriented DEA model is applied to 15DMUs using the

I/O combination. Weights of all inputs and outputs are adjusted and then fed. Average efficiency score is determined as 0.898. In addition to this high average efficiency scores, only 5 institutes (DMUs) are found as inefficient. Efficiency scores are given in Table: 4.

Out of 15 DMU's, only DMU 2 and DMU 3 are considered relatively efficient with technique efficiency index of 1. Analyzing all these given Inputs and Outputs based on pure technique efficiency index, rankings were given to all the 15 DMU's based on the performance relative to DMU 2 and DMU 3

4.2. Inputs – Outputs of various institutes for evaluation:

4.2.1. Strength: Number of students in each campus and intake every year.

4.2.2. Infrastructure: Infrastructure gives a picture of the lab equipment, standards of the buildings, computer lab etc.

4.2.3. Fees/semester: The fees that a college collects form each of the student.

4.2.4 Selection Process: The procedures and standards that an institute follows and the

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criteria they look after in students.

4.2.5 Faculty-student ratio: F-S ratio denotes the no. of students associated with each faculty member.

4.2.6 Co- Extra curricular activities: This gives a detail on the student's participation in various activities.

4.2.7 Research & Development: This input shows how much the institute is investing in R&D

4.2.8 Emergency care: Placements & industrial links: It tells the industrial exposure and the packages they get during placements.

4.2.9 Academic performance: This is the relative performance of every student and the GPA of every batch in a campus.

Table 1

Inputs and Outputs flow chart:

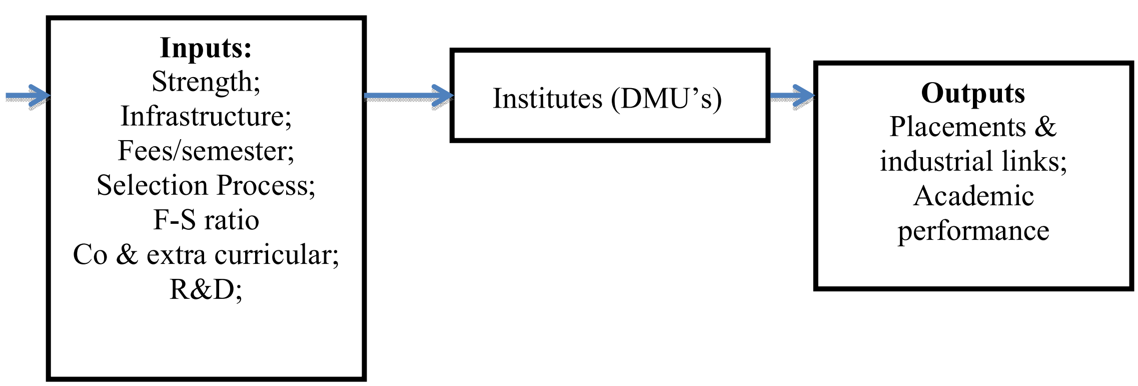

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Table 2

Inputs and Outputs of various institutes

Name of the Institute	Inputs	Outputs
DMU 1 DMU 2 DMU 3 DMU 4 DMU 5 DMU 6 DMU 7 DMU 8 DMU 9 DMU 10 DMU 11 DMU 12 DMU 13 DMU 14 DMU 15	Strength; Infrastructure; Fees/semester; Selection Process; F-S ratio Personality development; R&D;	Placements & industrial links; Academic performance

5. Analysis:

5.1. Input and Output Oriented VRS Models

The linear programming models in 5.1 and 5.2 are input and output oriented VRS models where DMU_o represents one of the n DMUs under evaluation and X_{io} and Y_{ro} are the ith input and rth output for DMU_o, respectively

$$\begin{aligned}&Min\ \theta\\&Subject\ to:\\&\sum_{j=1}^{n}\lambda_j x_{ij}\le\theta x_{io}\quad i=1,2,\dots,m\\&\sum_{j=1}^{n}\lambda_j y_{rj}\ge y_{ro}\quad r=1,2,\dots,s\\&\sum_{j=1}^{n}\lambda_j=1\\&\lambda_j\ge 0\qquad j=1,2,\dots,n\end{aligned}\tag{1}$$

$$\begin{aligned}&Max\ \phi\\&Subject\ to:\\&\sum_{j=1}^{n}\lambda_j x_{ij}\le x_{io}\quad i=1,2,\dots,m\\&\sum_{j=1}^{n}\lambda_j y_{rj}\ge\phi y_{ro}\quad r=1,2,\dots,s\\&\sum_{j=1}^{n}\lambda_j=1\\&\lambda_j\ge 0\qquad j=1,2,\dots,n\end{aligned}\tag{2}$$

5.2. Measure-Specific Models

Input or output oriented Data Envelopment Analysis models assume proportional improvements of inputs or outputs. In other words, to become efficient, a DMU must realize all the target values obtained for inputs in an input oriented model or outputs in output oriented model. In some cases, it may be impossible for a DMU to improve all of the inputs or outputs at the same time.

For these types of situations, Measure-specific data envelopment models can be used. Measure-specific models take sets of specific inputs or outputs of interest and give the target values for only those factors. The use of these models can be appropriate for the situations where only one or some of the inputs or outputs can be intervened.

Let $I\subseteq\{1,2,..,m\}$ and $O\subseteq\{1,2,..,s\}$represent the sets of specific inputs or outputs of interest, respectively. Input oriented VRS envelopment model is converted to input oriented measure-specific VRS model with the inclusion of equation (3) into equation (1).

$$\sum_{j=1}^{n}\lambda_j x_{ij}\le x_{io}\quad i\notin I \tag{3}$$

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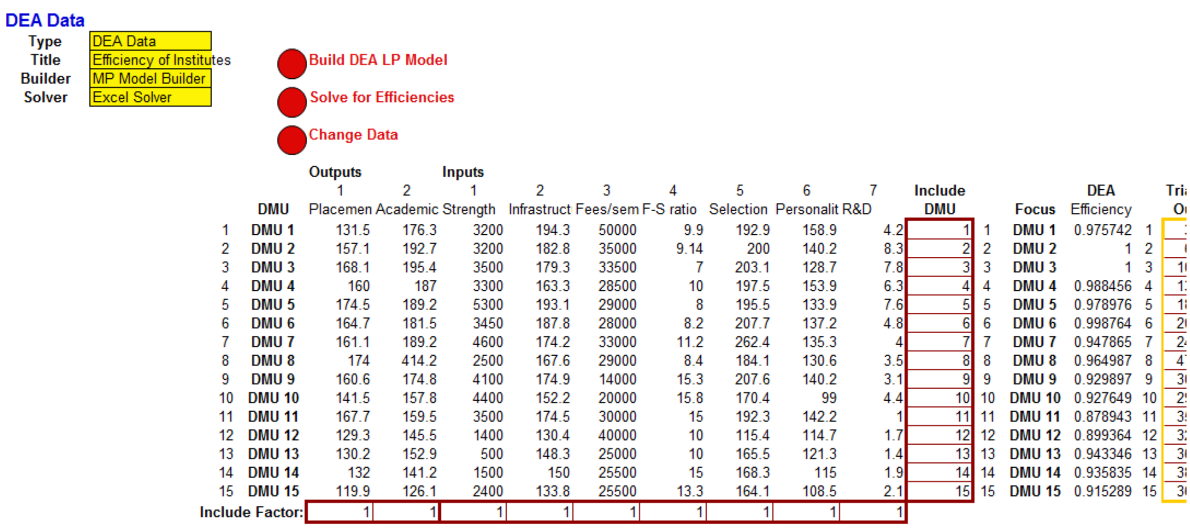
Output oriented VRS envelopment model is converted to output oriented measure-specific VRS model with the inclusion of equation (4) into equation (2).

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro} \quad r \notin O \qquad (4)$$

Fig.1 Screen shot of the result obtained using mp_model_builder.xla (MP Model Builder), Solver.xla (Excel Solver)



DEA Data

Type	DEA Data
Title	Efficiency of Institutes
Builder	MP Model Builder
Solver	Excel Solver

Build DEA LP Model

Solve for Efficiencies

Change Data

		Outputs		Inputs											
		1	2	1	2	3	4	5	6	7	Include			DEA	
	DMU	Placemen	Academic	Strength	Infrastruct	Fees/sem	F-S ratio	Selection	Personalit	R&D	DMU		Focus	Efficiency	
1	DMU 1	131.5	176.3	3200	194.3	50000	9.9	192.9	158.9	4.2	1	1	DMU 1	0.975742	1
2	DMU 2	157.1	192.7	3200	182.8	35000	9.14	200	140.2	8.3	2	2	DMU 2	1	2
3	DMU 3	168.1	195.4	3500	179.3	33500	7	203.1	128.7	7.8	3	3	DMU 3	1	3
4	DMU 4	160	187	3300	163.3	28500	10	197.5	153.9	6.3	4	4	DMU 4	0.988456	4
5	DMU 5	174.5	189.2	5300	193.1	29000	8	195.5	133.9	7.6	5	5	DMU 5	0.978976	5
6	DMU 6	164.7	181.5	3450	187.8	28000	8.2	207.7	137.2	4.8	6	6	DMU 6	0.998764	6
7	DMU 7	161.1	189.2	4600	174.2	33000	11.2	262.4	135.3	4	7	7	DMU 7	0.947865	7
8	DMU 8	174	414.2	2500	167.6	29000	8.4	184.1	130.6	3.5	8	8	DMU 8	0.964987	8
9	DMU 9	160.6	174.8	4100	174.9	14000	15.3	207.6	140.2	3.1	9	9	DMU 9	0.929897	9
10	DMU 10	141.5	157.8	4400	152.2	20000	15.8	170.4	99	4.4	10	10	DMU 10	0.927649	10
11	DMU 11	167.7	159.5	3500	174.5	30000	15	192.3	142.2	1	11	11	DMU 11	0.878943	11
12	DMU 12	129.3	145.5	1400	130.4	40000	10	115.4	114.7	1.7	12	12	DMU 12	0.899364	12
13	DMU 13	130.2	152.9	500	148.3	25000	10	165.5	121.3	1.4	13	13	DMU 13	0.943346	13
14	DMU 14	132	141.2	1500	150	25500	15	168.3	115	1.9	14	14	DMU 14	0.935835	14
15	DMU 15	119.9	126.1	2400	133.8	25500	13.3	164.1	108.5	2.1	15	15	DMU 15	0.915289	15
	Include Factor:	1	1	1	1	1	1	1	1	1					

Table 3- Overall Efficiency Scores for Indian Institutes:

DMU 1	0.975742
DMU 2	1
DMU 3	1
DMU 4	0.988456
DMU 5	0.978976
DMU 6	0.998764

DMU 7	0.947865
DMU 8	0.964987
DMU 9	0.929897
DMU 10	0.927649
DMU 11	0.878943
DMU 12	0.899364
DMU 13	0.943346
DMU 14	0.935835
DMU 15	0.915289

Table 4- Efficiency Histogram

Range of Efficiency	No. of DMU	Portion
0.8-0.85	0	0
0.851-0.899	2	13.33%
0.9-0.95	6	40.00%
0.951-0.99	4	26.66%
0.991-1.00	3	20%
Total	15	100%

6. Conclusion:

From the results we can observe that DMU 2 and DMU 3 are considered most efficient with a score of 1. Also, DMU 11 was least efficient with a score of 0.8789. No significant differences of the variable performance of inputs like emergency, strength, extra & co curricular activities etc. of various DMU's are observed in this study.

In some cases, it may be impossible for an inefficient DMU to improve all of the inputs or outputs proportionally at the same time in order to be efficient. It can be only possible to make progress in one output or input. In order to obtain targets by means of each output and input, another model is designed. In this model, measure-specific DEA methodology has to be applied to data.

Also, this study shows that institutes run and aided by government are showing better performance relatively to other private owned institutes. Several reasons are contributed to the better performance of government run institutions like infrastructure, F-S ratio, academic-performance, fee/semester. Emphasis has to be made on Research and Development by all institutes majorly private owned institutions.

7. Utility:

The students should cautiously judge the performance of institutes during the time of admissions using this article. Management should explore possible factors of their relative inefficiencies to set up strategies and goals for future improvement. Inputs and outputs should be adjusted, if necessary, to reduce costs and provide students with quality education and also to improve institution's competitive advantage.

8. Future work:

The paper was dealt with evaluating the efficiencies of various institutes in India; further work can be expanded to not only technical institutes but also to any number of institutes.

The inefficiency of the DMU's can be resolved by slack variable analysis to understand where and how to make the improvement. DEA can also be used to evaluate the performance of all institutions nation- wide. The study results can provide reference information to allocate the resources.

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