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"EVALUATION OF TECHNICAL EFFICIENCY OF STATE TRANSPORT CORPORATIONS IN TAMILNADU – DEA APPROACH"

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ABSTRACT

This study mainly focuses on estimating the Technical efficiency of Transport in public transportation among the 8 districts in Tamilnadu during the year 2014-2015. Data Envelopment Analysis(DEA) technique has been applied to evaluate the technical efficiency. For this objective CRS DEA and VRS DEA models are attempted. The analysis of the study reflects that two Transport corporations are efficient under CRS model and three are efficient under VRS model. Besides DEA provides input and output targets for the inefficient Decision Making Unit'S to improve their efficiency.

KEY WORDS:

Data Envelopment Analysis(DEA), Technical efficiency(TE), Constant Returns to Scale(CRS), Variable returns to scale(VRS)

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1.1 NTRODUCTION:

Public Transportation is very useful for the people in which transport is considered as one of the basic need in their day to day life. Under its physical performance it gives a lot of social benefits in its quality of services such as Travel concessions to the various category of persons who deserves in state transport corporation buses. TNSTC is the largest government transport corporation in India also biggest corporation in the world. It is full owned and operated by the government of Tamilnadu. In which TNSTC owns 321 depots and 5 workshops. TNSTC and SETC use custom made buses made on Ashok Leyland and TATA. State transport undertakings introduces new routes to operate and most of the villagers are benefitted.

The table given below exhibits the following facts,

NEW ROUTES INTRODUCED BY THE STATE TRANSPORT UNDERTAKINGS IN TAMILNADU 2014-2015.

State transport undertakings	**No.of new routes operated**	**No. of villages covered**	**Population benefitted(in lakhs)**
1.MetropolitanTransport corporation,chennai	-	-	-
2. State express transportcorporation,chennai	-	-	-
3.Tamilnadu state transport corporation,villupuram	1	4	0.04
4.Tamilnadu state transport corporation,salem	-	12	0.06
5.Tamilnadu state transport corporation,Coimbatore	-	21	0.07
6.Tamilnadu state transport corporation,kumbakonam	7	17	0.05
7. Tamilnadu state transport corporation, Madurai	2	2	0.04
8. Tamilnadu state transport corporation,Tirunelveli	-	-	-
State total	10	56	0.26

Thus the state transport corporation plays a vital role in the society and serving the people in various ways. So the performance evaluation of State transport corporation becomes essential and the author of this study is interested in evaluating the efficiency of State transport corporation during the year 2014-2015.

DEA is a non-parametric technique applied here to calculate the Technical efficiency of State transport corporation. For this objective the author considered the secondary data relating to State transport corporation during the year 2014-2015. The data contains 8 districts and each district is considered as decision making unit and each decision making unit has been characterised with 3 inputs and 2 outputs.

The structure of the paper is organized as follows, the Review of relevant literature is described in section 1.2.The methodology, used for analysis is discussed in detail in section 1.3. Empirical investigation based on state transport corporation data, is carried out in section 1.4. Finally the paper ends with discussion and conclusion on empirical investigation.

1.2 **REVIEW OF LITERATURE**:

Farrell's seminal work was extended by Charnes et al.(1978), which provides a relative measure of efficiency that is increasingly used in evaluating the performance of similar type of organizations. Farrell(1957) is the founder of frontiers and efficiency measure, which provided definitions and a framework for calculating the technical and allocative (in) efficiency. Banker et al(1984) introduced another basic model of DEA which admits variable returns to scale.

Banker and Morey(1986) has evaluated the relative technical and scale efficiencies of DMU'S by means of DEA. Marchand et al(1984), Ganley and Cubbins(1992), evaluates the performance of public transport services based on the concept of productive efficiency. Pastieau andTulkens(1993) has been forcefully argued that, independently of the other objectives, a first and indispensable demand for all public sector activities is to operate in a efficient manner.

Chu et al. (1992) and Viton (1998) used a DEA model to develop a unique measure of performance and concluded that the US bus system improved its productivity between 1988 and 1992. Noted also that, in general, efficiency and effectiveness are negatively correlated.

Levaggi (1994) applied a DEA model to 55 urban transport companies in Italy. As output selected the number of kilometers traveled, average speed, capital represented by a proxy, the number of vehicles, and a coefficient of capacity defined by the ratio between passengers by kilometer and disposable seats per kilometer and population density.

Nolan (1996) studied technical efficiency in 29 average size US bus systems using a DEA model. As input used the number of buses, total number of employees and gas consumed and as output vehicles per mile.

Husain et al. (2000) also estimated a DEA to evaluate the efficiency of the public transportation service of Malaysia, a sample of 46 service units. As inputs used the number of employes and total labor costs. As output selected total service and companies gross revenue. They concluded that more efficient companies achieved higher revenues.

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V. Prakash et al(2012) evaluated Technical efficiency of State road transport undertakings in India through DEA and they suggested that all the inefficient DMU'S identified in their study should reduce to input according to the radial value and slack movement to get the maximum output

Sanjay K.Singh, Amit P.Jha attempts to measure the efficiency and effectiveness of fifteen major STU's in India for the period 2003-04 to 2013-14 using DEA.

1.3 **METHODOLOGY:**

There is an increasing concern with meaning and comparing the efficiency of an organisation or Institutional units such as local authority departments, schools, hospitals, shops, bank branches and similar instances where there is a relatively homogeneous set of units. DEA approach is a

well known technique utilized to evaluate the efficiency for peer units compared to the best practice frontier.

The basic measure of efficiency is defined as,

Efficiency = Output/Input

It is often inadequate due to the existence of multiple inputs and outputs related to different resources, environmental factor's etc. A formula for relative efficiency incorporating multiple inputs and outputs is introduced and for this DEA model allows relative efficiency measures to be determined is developed.

The decision making units(DMU) is a collection or team of individuals who participates in a buyer decision process. Decision making units must be homogenous and it works in identical way transforming the same inputs into the same outputs.

Model specification:

General Input minimization and output maximization for CCR DEA model and BCC DEA model is presented here.

Let there be 'n' DMU'S and each DMU consumes i=1 2 ...p inputs and produces r=1 2 ....q outputs.

The input oriented CCR model is ,

Min θ

Subject to constraints:

$\sum x_{ik}\lambda_i \leq \theta X_{i0}$, i=1,2,….p

$\sum Y_{rk}\lambda_k \geq Y_{r0}$,r=1,2,…q

$\lambda_k \geq 0, for\ all\ k = 1,2 \dots n$

where θ represents the efficiency score of observed DMU, λ's represent the dual variables that identify the benchmarks for inefficient units.

The corresponding output oriented CCR model is,

Max φ

Subject to constraints:

$\sum X_{ik}\lambda_i \leq X_{i0}$, i=1,2,….p

$\sum Y_{rk}\lambda_k \geq \varphi Y_{r0,}$ r =1,2,…q

$\lambda_k \geq 0, for\ all\ k = 1,2 \dots n$

The above CCR model is based on constant returns to scale assumption. This is a very rigid assumption and it has been relaxed by the following model proposed by Banker Charnes Cooper(1984). They introduced a constraint called convexity constraint and it admits Variable Returns to scale assumption.

$\min \theta$

Subject to: $\sum x_{ik}\lambda_k \leq \theta X_{i0}$, i=1,2,….p

$\sum Y_{rk}k_k \geq Y_{r0,}$ r=1,2,…q

$\sum \lambda_k = 1$

$\lambda_k \geq 0, k = 1,2 \dots n$

The corresponding BCC Output oriented model is,

Max Φ

Subject to constraints:

$\sum X_{ik}\lambda_k \leq X_{i0}$

$\sum Y_{rk}\lambda_k \geq \Phi Y_{r0}$

$\lambda_k = 1$; where k = 1….n

$\lambda_k \geq 0$, k=1 2 …n

In this study the author is attempted CCR and BCC DEA model in respect of output orientation for the empirical investigation.

1.4 EMPIRICAL INVESTIGATION:

The data used in this study is secondary data which is collected from Statistical handbook of Tamilnadu 2016 published by Department of economics and statistics, Government of Tamilnadu. Eight district corporations are considered in this study. Each district corporation is termed as a DMU and each DMU with 3 inputs and 2 outputs are presented in the following table 1.

TABLE 1:Input and Output data

District road transport undertakings	Passengers carried per day(in lakhs)	Total Revenue	Fleet strength	Staff strength(exclusive reserve)	Distance operated per day(in lakhs)
MTC	49.65	1330.89	3794	22589	9.63
SETC	0.74	654.43	1099	6165	6.10
VPM	23.15	1563.58	3655	22573	16.54
SLM	15.29	907.42	2230	13562	10.17
CBE	24.70	1217.36	3283	18964	12.57
KUM	29.45	1602.57	3851	23198	16.83
MDU	17.98	1069.23	2588	15083	10.49
TNV	18.50	746.24	1974	11864	7.87

To strengthen any study the calculation of basic descriptive statistics is essential. Here the author carried out the Descriptive analysis and it is presented below,

TABLE 2:Descriptive Statistics

MEAN	22.4325	1136.465	2809.25	16749.75	11.275
MAXIMUM	49.65	1602.57	3851	23198	16.83
MINIMUM	0.74	654.43	1099	6165	6.10
STANDARD DEVIATION	13.90048	355.6968	1000.128	6133.482	3.839144
N	8	8	8	8	8

CCR output oriented model provides the following results and it is presented in Table 3.

TABLE 3:CCR Efficiency Scores

DMU'S	**Φ**	**STATUS**
MTC	1	Efficient
SETC	1	Efficient
VPM	1.1013	Inefficient
SLM	1.1235	Inefficient
CBE	1.1614	Inefficient

KUM	1.0741	Inefficient
MDU	1.1061	Inefficient
TNV	1.0822	Inefficient

The above table reveals that two Transport corporations namely SETC and MTC are identified as efficient whose efficiency score Φ = 1. Other Transport corporations included in the study are found to be inefficient i.e., these transport corporations could not give maximum output for the given level of input.

The following table provides reference set (Peers) to the inefficient DMU. The inefficient DMU could improve its efficiency through their peers.

TABLE 4:Peer Weights (CRS):

DMU	**PEER WEIGHTS(INEFFICIENCY)**
VPM	λ_1=0.4892, λ_2 = 1.63691
SLM	λ_1=0.3327, λ_2 = 0.8805
CBE	λ_1=0.5623, λ_2 = 1.0156
KUM	λ_1=0.6164, λ_2 = 1.3759
MDU	λ_1=0.3854, λ_2 = 1.0240
TNV	λ_1=0.3966, λ_2 = 0.4267

For example, the inefficient DMU VPM could improve its efficiency by comparing its input and output with DMU 1 and DMU 2.

Ranking of efficient DMU's based on peer count summary is presented in the following table:

TABLE 4.1 Ranking of DMUs:

DMU's	**PEER COUNT**	**RANK**
MTC	6	1
SETC	6	1

It is noted that there is a tie in Ranks i.e., both the efficient DMU's stood rank 1.

BCC output oriented model provides the following results and it is presented in Table 5.

TABLE 5: BCC Efficiency Scores

DMU's	**Φ**	**Status**
MTC	1	Efficient
SETC	1	Efficient

VPM	1	Efficient
SLM	1.0940	Inefficient
CBE	1.0775	Inefficient
KUM	1	Efficient
MDU	1.0362	Inefficient
TNV	1	Efficient

Here also the above table reveals that 5 Transport corporations namely SETC, MTC, VPM, KUM and TNV are identified as efficient whose efficiency score Φ=1. Other Transport corporations included in the study are found to be inefficient i.e., these transport corporations could not give maximum output for the given level of input. It may be noted that the above table indicates 5 transport corporations are efficient whereas CCR output oriented model indicates only 2 transport corporations are efficient. This is due to the fact that BCC model has convexity constraint which admits Variable Returns to Scale assumption.

TABLE 6:Peer weights(VRS)

DMU's	PEER WEIGHTS(INEFFICIENCY)
SLM	λ_1=0.2018, $\lambda_2 = 0.5848$, $\lambda_6 = 0.2133$
CBE	λ_1=0.2336, $\lambda_2 = 0.2402$, $\lambda_6 = 0.526$
MDU	λ_1=0.1801, $\lambda_2 = 0.4699$, $\lambda_6 = 0.3498$

For example, the inefficient DMU SLM could improve its efficiency by comparing its output with DMU 1 and DMU 2 and 6.

Ranking of efficient DMU's based on peer count summary is presented in the following table:

TABLE 6.1:Ranking of DMUs

DMU's	**PEER COUNT**	**RANK**
MTC	3	1
SETC	3	1
VPM	Weakly efficient	-
KUM	3	1
TNV	Weakly efficient	-

It is noted that there is a tie in Ranks i.e., MTC, SETC and KUM are efficient DMU's stood rank 1.

CONCLUSION:

Under CCR model two Transport corporations are efficient in converting all its inputs to the outputs Among all the inefficient DMU'S 5 inefficient DMU's namely, VPM,SLM,CBE,KUM,MDU, should improve their relevant outputs from 10% to 16% respectively to attain its efficiency. The other 2 inefficient DMU's namely KUM and TNV must maximize their relevant outputs from 7% to 8% respectively to reach the efficiency frontier.

BCC DEA model indicates 5 DMU's are efficient whose efficiency score is unity and 3 DMU's are inefficient whose efficiency score exceeds unity. The inefficient DMU's namely SLM, KUM and MDU could improve their efficiency by maximising their relevant output ranging from 3% to 9% respectively.

It is interesting to note that BCC model reveals the 2 DMU's namely VPM and TNV are weakly efficient DMU's.

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