Technical Efficiency of Urban Public Transport Undertakings in India: A Study with Special Reference to CSTC

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Abstract

In most of the big cities in India, buses are mainly run by publicly owned State Transport Undertakings (STUs), many of which make losses due to some social obligations to be fulfilled. In this paper, the values of certain performance indicators showed that some undertakings were in a much better position as compared to others. The Calcutta State Transport Corporation (CSTC) in the state of West Bengal, one of the oldest STUs in India, exhibited quite a dismal performance. In such a scenario, a comparison was made between the technical efficiencies of CSTC and a few other STUs of India using stochastic frontier analysis. CSTC was found to have a very low technical efficiency, corroborating the results obtained in terms of the performance indicators.

Keywords: **state transport undertakings, performance indicators, technical efficiency, stochastic frontier analysis**

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There is a demand for urban transport for carrying both passengers and goods. More of urban travel demand is, however, seen for the former, as work trips, school trips, trips for shopping, social visits, and so forth, which make up a considerable part of passenger demand in the urban areas.

Transport choices, along with the location decisions of businesses and households, influenced by economic, social, and technological factors, together constitute the spatial pattern of a city. Transport demand choices depend on a wide range of factors. Relative prices charged by different modes or different operators affect demand. Income of passengers is also an important determinant of transport demand. As income increases, the amount of travelling for both business and leisure will increase. The speed of service is another factor affecting demand. Demand will increase if passenger road vehicles can make quicker journeys. Along with these, the quality of service, comfort, reliability, and safety are other factors, which are responsible for increasing or decreasing demand for passenger transport (Gupta, 2007). Variations of transport costs have different consequences for different modes, but transport demand has a tendency to be inelastic. While commuting tends to be inelastic in terms of costs, it is elastic in terms of time (Rodrigue & Notteboom, 2013).

The basic characteristics of the urban passenger transport market are as follows :

(1) Local public transport is used quite a lot because of relatively higher density of population in urban areas than in rural areas.

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(2) Public transport has a very high demand in peak periods, that is, at the times of journeys to and from work, and

(3) Mean trip lengths are low as the urban stretch nowhere varies to a very large extent, compared to rural and suburban areas.

The increase in urban population, their activities, and the resultant rise in income as products of urbanization lead not only to an increase in demand for transport, but also an increase in vehicle ownership. In the third world cities, the coexistence of motorized and non-motorized (e.g., bicycle, rickshaw, and even pedestrians) or modern and traditional or formal and informal- all kinds of modes- is seen. This is a result of the evolution process of these cities, not of a planned management system (Gupta, 2007). The urban public transport sector in developing countries may be broadly characterized by a high growth rate, diversity, and in many cases, poor financial performance.

Urban Transport in India

Urban transport in Indian cities is heterogeneous, reflecting the heterogeneity in the socioeconomic and land-use patterns. It is dominated by walking trips, non-motorized modes such as bicycles and rickshaws, and depending on the size of the city, motorized para-transit and public transport. Given the present concerns about pollution, there is a consensus at the policy level that public transport has to be promoted to ensure sustainable mobility to all (Tiwari, n.d.). Public transport in Indian cities can be classified into two - rail and road. Out of the total passenger movement of the country, 80% are met by road transport, while the remaining 20% is carried by railways (Deb & Sundar, 2001).

Within the road transport sector, liberalization of the automobile industry along with a rapid increase in per-capita incomes has led to a shift towards personal vehicles. The share of public transport, on the other hand, has declined over time. The economy is now being constrained by the increasing number of vehicles causing congestion, and thus, slower speeds on roads. Transport infrastructure is recognized as being the critical constraint here (Ramanathan & Parikh, 1999). Efficient and optimal utilization of the available transport infrastructure would require meeting mobility needs through a greater share of public transport (Deb, 2008 ; Planning Commission, 2002).

Public Passenger Road Transport

Efficient operation of the urban bus system is central to the development of any city. There is a widespread reliance on buses for public transport, providing important mobility within urban areas throughout the world (Agarwal & Singh, 2010). Buses carry more than 90% of public transport in Indian cities. Indeed, most Indian cities have no rail transport at all, and rely instead on a combination of buses, minivans, auto rickshaws, cycle-rickshaws, and taxis. Even in most of the largest cities, rail transport carries less than a third of public transport passengers. The only exception is Mumbai, which has India's most extensive suburban rail network, carrying more than 5 million passengers a day- 58% of total public transport in the region vis-à-vis 42% by bus (Pucher, Korattyswaropam, Mittal, & Ittyerah, 2005).

Nationwide aggregate statistics on the size of the bus fleet indicate substantial growth after the 1980s, with a 313% increase from 1981 to 2002 (Ministry of Road Transport and Highways, 2003). Similarly, the fragmented statistics for individual cities suggest considerable growth. From 1990 to 2000, for example, there was a 86% increase in the size of Mumbai's bus fleet, and a 54% increase in Chennai's bus fleet. The size of Delhi's public bus fleet actually fell during the 1990s, but the number of private buses rose almost twice as much, yielding a net 28% increase (ASTRU, 2002a , 2002b ; Marwah, Sibal, & Sawant, 2001).

In general, the larger the city size, the higher the percentage of urban trips served by public transport in India: averaging 30% in cities with population between 1 and 2 million, 42% for cities with populations between 2 and 5 million, and 63% for cities with populations over 5 million (Sreedharan, 2003). Thus, the especially rapid growth of large cities suggests a further rise in future demands for public transport in India (Pucher et al., 2005).

There is substantial variation among cities of the same size category in the context of the percentage of urban trips served by public transport. Almost 80% of all trips in Kolkata are by some form of public transport, compared to about 60% in Mumbai, and 42% in both Chennai and Delhi (Pendakur, 2002; Pucher et al., 2005 ; World Bank, 2002). Research has shown that public transport, walking, and cycling meet 88% of the travel demand in Kolkata. Out of this, 54% is met by public transport.

Operation of the Urban Bus Systems

Urban bus systems in Indian cities have not been able to keep pace with the rapid and substantial increases in demand over the past few decades. The total population of India burgeoned over the last three decades of the last century rising from 109 million in 1971 to 160 million in 1981 (+47%), 217 million in 1991 (+36%), and 285 million in 2001 (+31%). The urban population had grown to 1.25 billion in 2011 (Population Census, 2011). Greater congestion and delays are widespread in Indian cities and indicate the seriousness of transport problems. A high level of pollution and accidents are the other undesirable features of the overloaded streets (Agarwal & Singh, 2010).

In most cities in India, services are mostly run by publicly owned State Transport Undertakings (STUs). In some cities with a large commuting population such as Delhi and Kolkata, though, public transit operations by private buses are prevalent. These are exceptions, and in general, public transit is usually a government-owned legal monopoly in most parts of India (Deb, 2008 ; Gowda, 1999).

At present, there are 52 STUs in the country, owning 123139 buses (CIRT, 2008-09). The organization forms of the undertakings are different for different states. The most common form is the Corporation. There are 24 corporations operating in various states. In some states, there are government departments, there being nine such departments. There are 12 organizations, which are in the form of companies. Moreover, there are seven municipal undertakings (Deb & Sundar, 2001).

Most of the STUs have, over the years, accumulated deficits and have not been able to meet the increasing transport needs of the public. The state government controls the STUs' fares, and to a large extent, the most relevant aspects of their supply. One very important form of government intervention is the granting of subsidy. Hence, the STUs have relatively few incentives to run their business efficiently (Singh & Venkatesh, 2004).

Literature Review

The measurement of economic efficiency has been intimately linked to the use of frontier functions. Modern literature in both fields begins with the same seminal paper, namely Farrel (1957). Michael J. Farrel, greatly influenced by Koopmans's (1951) formal definition and Debreu's (1951) measure of technical efficiency, introduced a method to decompose the overall efficiency of a production unit into its technical and allocative components (Murillo-Zamorana, 2004).

There are essentially four major methods to measure efficiency. They are: least square econometric production models; total factor productivity indices; data envelopment analysis (DEA); and stochastic frontier analysis (SFA). The first two methods are often applied to aggregate time-series data and provide measures of technical change. Both of these methods assume that all firms are technically efficient. Methods third and fourth are most often applied to data on a sample of firms and provide measures of relative efficiency among those firms. Hence, these latter two methods do not assume that all firms are technically efficient (Coelli, Rao, O Donnell, & Battese, 2005).

Both DEA and SFA provide information on how economic agents transform inputs into outputs, that is, they reflect different aspects of production technology. Briefly, DEA uses mathematical programming (nonparametric) methods to identify the highest output levels that can be obtained by combining different inputs. In SFA, a production function (or its dual, a cost function) is estimated using econometric (parametric) methods (Holmgren, 2012).

Both approaches have been applied to different parts of the transport sector. Recent applications of DEA to the performance of airlines can be found in Barbot, Costa, and Sochira (2008), Barros and Peypoch (2009), Bhadra (2009), and Merket and Hensher (2011). Recent applications of DEA to public transport operations include Hirschhausen and Cullman (2010), Odeck (2008), Söderberg (2009), and Holmgren (2012). De Borger, Kerstens, and Costa (2002) provided an overview of SFA applications to public transport operations. A more recent example of an application using SFA method is provided by Lin, Lan, and Chiu (2010).

Singh (2000) analyzed the level of relative efficiency of a sample of medium and large STUs of India. Singh had not considered CSTC in his analysis and he showed the STUs of Rajasthan and Punjab to be high in the efficiency rankings. However, in this study, the relative position of CSTC was of primary importance, and while the Rajasthan STU's ranking was more or less maintained, that of Punjab fell to the 16th position. Singh and Venkatesh (2004), in their paper, tried to quantify technical efficiency of 23 STUs of India for the year 2000-01 using stochastic frontier analysis. Singh and Venkatesh had not considered CSTC in their sample, and the rankings of STUs were different than those obtained in the current paper. Prakash, Rajesh, and Thilagam (2012) applied the data envelopment analysis to evaluate the relative technical efficiency of 34 STUs of India during 2011-12.

Objective of the Study

In the Indian state of West Bengal, there are five operating STUs. Out of these, CSTC is the oldest and the largest corporation. It plies buses within the city of Kolkata as well as long distance buses. It is found that there is a general discontent on the part of the consumers as far as the services provided by the corporation are concerned. Despite this, the Corporation, like many other state transport corporations, is heavily subsidized. The subsidy given to CSTC, however, cannot be economically justified (Gupta & Mukherjee, 2013). On top of that, CSTC paints a grim picture among all STUs in terms of certain performance indicators as well. Considering the above, the objective of this study is to find out the relative position of Calcutta State Transport Corporation (CSTC), in a group of a few STUs of India, in terms of technical efficiency.

Methodology

➭ **Performance Indicators :** The performance measures of an urban bus system is comprised of the capacity supplied, the quality of service produced, comparison of costs versus benefits, and environmental impact. It gives a clear indication of how well it is providing an urban service to the public (Fielding et al., 1977). Performance of the STUs under consideration can be studied with the help of different performance indicators (Agarwal & Singh, 2010). For this purpose, a few indicators describing different aspects of performance of urban bus services were considered, and the values for these indicators have been calculated for the STUs considered in the study. The indicators are as follows :

(1) Cost efficiency defined as the ratio of total operating cost to total effective kilometers covered.
(2) Energy efficiency defined as the ratio of total fuel used to total effective kilometers.

A low value for these two indicators will imply more efficiency in performance.

(3) Labour productivity is defined as the ratio of total effective kilometers to total employees.
(4) Vehicle utilization is defined as the ratio of gross kilometers covered to total number of vehicles held.

(5) Operating ratio defined as the ratio of total operating revenue to total operating cost.

For the indicators numbered 3, 4, and 5, a high value will imply higher efficiency in performance.

➥ **Stochastic Frontier Analysis :** One method for estimating a production frontier using cross- sectional data on a number of firms is to envelope the data points using an arbitrarily chosen function. This approach was used by Aigner and Chu (1968) who considered a Cobb-Douglas production frontier of the form :

$$\log q_i = x_i\beta - u_i \qquad (1)$$

where,

q_i represents the output of the ith firm, i =1,….,I, x_i is a vector of N inputs used by producer I, β is a vector of unknown parameters to be estimated, and u_i is a non-negative random variable associated with technical inefficiency. Several techniques can be used to estimate the unknown parameters in this model (Coelli et al., 2005).

Aigner, Lovell, and Schmidt (1977) and Meeusen and Broeck (1977) simultaneously introduced stochastic production frontier models. These models allow for technical inefficiency, but they also acknowledge the fact that random shocks outside the control of producers can affect output (Kumbhakar & Knox Lovell, 2003). The form of the stochastic frontier model proposed is :

$$\log q_i = x_i\beta + v_i - u_i \qquad (2)$$

which is identical to equation (1) except that a symmetric random error term v_i is added, which accounts for statistical noise. Statistical noise arises from the inadvertent omission of relevant variables from the vector x_i as well as from the measurement errors and approximation errors associated with the choice of functional form (Coelli et al., 2005).

Since the error term in (2) has two components, that is, u_i and v_i, the stochastic frontier model is often referred to as a "composite error" model (Kumbhakar & Knox Lovell, 2003). The noise components v_is are independently and identically distributed normal random variables with zero means and variances σ_v^2, and u_is are independently and identically distributed half normal random variables with scale parameter σ_u^2, that is,

$$v_i \sim \text{iid}\, N(0, \sigma_v^2)$$
$$u_i \sim \text{iid}\, N^+(0, \sigma_u^2)$$

Aigner, Lovell, and Schmidt (1977) parameterized the log likelihood function for this so called half-normal model in terms of $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\lambda^2 = \sigma_u^2/\sigma_v^2 \geq 0$. If λ= 0, there are no technical inefficiency effects and all deviations from the frontier are due to noise. Using this parameterisation, the log-likelihood function is :

$$\log L(y/\beta, \sigma, \lambda) = -I/2 \log(\pi\sigma^2/2) + \sum \log \phi(-\varepsilon_i \lambda/\sigma) - 1/2\, \sigma^2 \sum \varepsilon_i^2$$

where,

y is a vector of log-outputs; $\varepsilon_i \equiv v_i - u_i = \log q_i - x_i'\beta$ is a composite error term and $\phi(x)$ is the cumulative distribution function of the standard normal variable evaluated at x (Coelli et. al., 2005).

Maximizing a log-likelihood function usually involves taking first- derivatives with respect to the unknown parameters and setting them equal to zero. Unfortunately, for the above likelihood function, these first-order conditions are highly non linear and cannot be solved analytically for β, σ, and λ. Thus, the function must be maximized using an iterative optimization procedure. This involves selecting starting values for the unknown parameters and systematically updating them until the values that maximize the log- likelihood function are found (Coelli et. al., 2005).

The technical efficiency of the i^{th} firm is defined by $TE_i = \exp(-u_i)$. So, in order to predict technical efficiency, we clearly need information about the u_is. Once we have collected our data and observed the value of q_i, we can summarize information about u_i in the form of the truncated normal probability density function.

$$p(u_{i|}q_i) = 1/\sqrt{2}\pi\sigma_*^2 \exp\{-1/2\sigma_*^2(u_i - u_i^*)^2\} / \phi(u_i^*/\sigma_*)$$

where, $u_i^* = -(\log q_i - x_i'\beta)/\sigma^2$ and $\sigma_*^2 = \sigma_v^2\sigma_u^2/\sigma^2$

This conditional probability function gives information about likely and unlikely values of u_i after firm I has been selected in our sample and after we observed its output, q_i. Among other things, Jondrow, Lovell, Materov, and Schmidt (1982) used it to derive the following predictor of u_i^*:

$$\hat{u}_i = E(u_{i|}q_i) = u_i^* + \sigma_*[\varphi(u_i^*/\sigma_*)/\Phi(u_i^*/\sigma_*)]$$

where $\phi(x)$ is the probability density function of the standard normal random variable evaluated at x (Coelli et. al., 2005).

We are interested in the efficiency of the ith firm $TE_i = \exp(-u_i)$. A natural predictor for this quantity is $\exp(\hat{u}_i)$ where, $\hat{u}_i$ is given by the above equation. However, Battese and Coelli (1988) used $p(u_{i|}q_i)$ to derive the alternative predictor :

$$TE^*_i = E\{\exp(-u_{i|}q_i\} = [\Phi(u_i^*/\sigma_* - \sigma_*)/\Phi(u_i^*/\sigma_*)]\exp\{\sigma_*^2/2 - u_i^*)$$

This predictor can be shown to be optimal in the sense that it minimizes the mean square prediction error. So far, the estimation of technical efficiency was considered for a cross-section model. A panel contains more information than does a single cross-section. Since panel data is available for our study, we now try to see how panel data stochastic models can be solved.

Panel data versions of the Aigner, Lovell, and Schmidt (1977) model can be written in the general form :

$$\log q_{it} = x'_{it}\beta + v_{it} - u_{it}$$

which is identical to (2) except that a subscript *'t'* has been added to denote time. If we assume that u_{it}s and v_{it}s are independently distributed, we can estimate the parameters of this model using the methods described earlier (Coelli et. al., 2005).

Data

The main source of data used in this study is State Road Transport Undertakings Profile & Performance (1994-95-2008-09) published by the Central Institute of Road Transport, Pune for the Association of State Road Transport Undertakings, New Delhi. In this study, data of 22 State Transport Undertakings (STUs) were considered over a 15 year period, that is, from 1994-95 to 2008-09. Thus, panel data was used for the study. As has been mentioned earlier, there are around 52 STUs in India; however, data on all the undertakings were not available from the publications of CIRT. Data for about 30 to 35 STUs are available. Another problem is that even out of these 35 STUs, data for some are missing for a few years. Thus, around 27 STUs whose data are available consistently for the period chosen were selected for the study.

The STUs included are: Andhra Pradesh State Road Transport Corporation (APSRTC); Maharashtra State Road Transport Corporation (MSRTC); Gujarat State Road Transport Corporation (GSRTC); Uttar Pradesh State Road Transport Corporation (UPSRTC); Karnataka State Road Transport Corporation (KnSRTC); Kerala State Road Transport Corporation (KSRTC); Rajasthan State Road Transport Corporation (RSRTC); Tamil Nadu State Transport Corporation Ltd. (Madurai Division) (TNSTC(MDU)); Tamil Nadu State Transport Corporation Ltd. (Kumbakonam Division) (TNSTC(KUM)); Tamil Nadu State Transport Corporation Ltd. (Villupuram Division)

(TNSTC(VPM)); Tamil Nadu State Transport Corporation Ltd. (Coimbatore Division) (TNSTC(CBE)); Tamil Nadu State Transport Corporation Ltd. (Salem Division) (TNSTC(SLM)) ; Pepsu Road Transport Corporation (PRTC); State Transport Punjab (STPJB); Orissa State Road Transport Corporation (OSRTC); Himachal Road Transport Corporation (HRTC); Brihan Mumbai Electric Supply & Transport Undertaking (BEST); Delhi Transport Corporation (DTC); Bangalore Metropolitan Transport Corporation (BMTC) ; Calcutta State Transport Corporation (CSTC); Pune Mahanagar Parivahan Mahamandal Ltd. (PMPML); Ahmedabad Municipal Transport Service (AMTS); Meghalaya Transport Corporation (MEGTC); Nagaland State Transport (NGST); Thane Municipal Transport Undertaking (TMTU); Tripura Road Transport Corporation (TRPTC); and Mizoram State Transport (MZST). Among the STUs chosen, some are corporations, some are companies, and some are municipal undertakings. The values for the total operations of the STUs, which include both short distance and long distance buses, were used for the analysis. The paper was written during 2011 and at that time, data was available up to 2008-09. We corresponded with the Central Institute of Road Transport to obtain up to date data on the STUs for a considerable period of time and the data are still awaited.

The variables included in the model are : gross kilometers covered, traffic staff, HSD consumed, number of tyres used, number of batteries used. Gross kilometers covered in a year, measured in lakhs, is taken to be the output. The other variables are the inputs where, traffic staff includes the total number of drivers and conductors serving in a year. Fuel used is taken to be the HSD consumed in kilolitres, and the last two inputs are the number of tyres and batteries used in a year.

Table 1. Efficiency Scores of STUs

STUs	Efficiency Scores	Rank
RSRTC	0.96021063	1
KnSRTC	0.95319029	2
UPSRTC	0.95318575	3
PRTC	0.94686421	4
GSRTC	0.9271265	5
APSRTC	0.90136589	6
TN-SLM	0.86718988	7
TN-VMP	0.8298159	8
BMTC	0.8262669	9
TN-KUM	0.82514245	10
MSRTC	0.82037328	11
TN-CBE	0.75498919	12
TN-MDU	0.73213695	13
OSRTC	0.72395492	14
KSRTC	0.69535364	15
STPJB	0.69455719	16
DTC	0.67415488	17
HRTC	0.67273574	18
AMTS	0.62402219	19
PMPML	0.52581288	20
CSTC	0.51238264	21
BEST	0.45060492	22

Table 2. Performance Indicators of a few STUs

STUs	Cost Efficiency	Labour Productivity	Vehicle Utilization	Energy Efficiency	Operating Ratio
RSRTC	4.681991131	0.226333747	1.21659918	0.20579094	2.6428243
KnSRTC	5.36767092	0.217335337	1.16877056	0.200535977	2.32503735
UPSRTC	4.241991411	0.178514511	1.05575358	0.189134742	2.52226423
PRTC	4.709241318	0.214872643	1.07576462	0.213671482	2.7979645
GSRTC	4.693676447	0.190020206	1.14576962	0.192914579	2.36680888
APSRTC	4.538648188	0.180123112	1.2387149	0.18502471	2.65102719
TN(SLM)	5.102473056	0.228141957	1.56204376	0.216245616	2.23830807
TN(VMP)	5.219576542	0.23097758	1.60512286	0.220577774	2.25747431
BMTC	6.290340459	0.147240786	0.86643215	0.201368151	2.83530522
TN(KUM)	5.149659731	0.225674507	1.66084725	0.218097675	2.26230205
MSRTC	5.467234064	0.162934008	1.07488673	0.212896973	2.64483165
TN(CBE)	5.453926714	0.207322777	1.50620605	0.238623943	2.23093832
TN(MDU)	5.428742602	0.196598381	1.32466703	0.233822996	2.24817356
OSRTC	5.962105053	0.141173068	0.77475727	0.228626772	1.65003999
KSRTC	5.64906744	0.15329501	0.94123854	0.258262482	2.49706363
STPJB	4.922406901	0.137802991	0.8168968	0.221851982	2.45208365
DTC	5.384352127	0.089574454	0.67320747	0.122571358	2.7682903
HRTC	7.11073292	0.164830902	0.81488438	0.26594008	1.86322173
AMTS	5.629266423	0.099280815	0.75485606	0.215381208	2.63636244
PMPML	6.60057823	0.087395056	0.80779898	0.263677834	2.37653737
CSTC	7.395797924	0.069849831	0.52715973	0.282277885	1.34115181
BEST	7.906286609	0.066170386	0.70416497	0.297277209	3.70097917
NGST	13.68717355	0.040278051	0.22408658	29.23475114	0.86736127
TRPTC	7.162848381	0.029800843	0.2588165	32.03233166	1.51117372
MZST	14.50045161	0.020490389	0.20427387	34.62359245	0.74092664
TMTU	9.057277708	0.063655609	0.62827818	29.29964307	2.68075485
MEGTC	7.523317636	0.054283362	0.30969996	22.68631194	1.552515

To explain the various concepts of efficiency and effectiveness, that is, performance, the variables used are, total effective kilometers measured in lakhs; total number of employees or total staff employed; total number of vehicles or buses held; total number of passengers carried; total operating cost (₹ in lakhs); and total revenue (₹ in lakhs); gross kilometers covered ; and fuel used as mentioned above.

Results and Discussion

➯ **Comparison of Efficiency :** The stochastic frontier model in the study can be defined as:

$\ln Y_{it} = \beta_1 \ln X_{ait} + \beta_2 \ln X_{bit} + \beta_3 \ln X_{cit} + \beta_4 \ln X_{dit} + (v_{it} - u_{it})$, $i = 1, 2, 3\ldots 22$; $t = 1, 2, 3\ldots 15$, where Y_{it} is the gross kilometers covered, X_{ait} is labour employed or traffic staff, X_{bit} is amount of fuel used, X_{cit} is the number of tyres used, X_{dit} is the number of batteries used and v_{it} and u_{it} are as defined previously.

The efficiency scores were obtained in the process of estimation of the above model. Tim Coelli's statistical program FRONTIER version 4.1 related to the methodology described above was used for the purpose of estimation.

According to the Table 1, the efficiency scores of the 22 STUs considered in the study are shown. The STUs are ranked according to their efficiency scores. STUs such as RSTC, KnSRTC, UPSRTC, and PSRTC have high technical efficiency scores. As can be seen from this table, the position of CSTC is quite low down; it is on the 21st position out of the 22 STUs, indicating a very low level of efficiency in its performance compared to the other STUs. Hence, this result corroborates the findings regarding the performance of CSTC in terms of the efficiency and effectiveness indicators obtained earlier.

Thus, it can be seen that there is a high level of inefficiency in performance on the part of CSTC as compared to other STUs of India. To look into the causes or reasons for this, we look at the performance indicators that have been defined earlier.

➭ **Observations Based on Performance Indicators :** In Table 2, the values for the performance indicators for the selected group of STUs have been enumerated. The values are average values for the time period under calculation.

The second column of Table 2 shows the average cost efficiency of the different STUs over the time period considered. The lower the operating cost per effective kilometer, the more cost efficient an undertaking will be. From the table, it can be seen that for STUs such as APSRTC, UPSRTC, KnSRTC, RSRTC, GSRTC, and PRTC, the average cost efficiency is around 4.2 to 5.6. However, for CSTC, the average cost efficiency is quite high, around 7.4. This implies that while for the above-mentioned STUs, operating cost borne for each unit of effective kilometers covered is low, for CSTC, the cost borne is high.

Labour productivity for the different STUs is also shown in the Table 2. Labour productivity will be high if more effective kilometers are covered per unit of labour employed. If the same group of cost efficient STUs are considered, then it can be seen that for these STUs, the average labour productivity varies from 0.18 to 0.23. On the other hand, for CSTC, this figure is quite low, around 0.07. So while CSTC covers only 0.06 effective kilometers per unit of labour employed, the other efficient STUs cover more than double the distance covered by CSTC. This indicates that labour productivity is quite low for CSTC, and this may be another contributory factor towards the inefficient performance of the corporation.

As can be seen from the Table, average vehicle utilization for the efficient group of STUs ranges from 1.06 to 1.24, implying that around 1.06 to 1.24 kilometers are covered by each vehicle for these undertakings. In the case of CSTC, this value is 0.52, that is, only 0.52 kilometers are covered by each vehicle. This signifies that there is underutilization of vehicles by CSTC, which can be considered to be another factor contributing towards the low efficiency of CSTC.

As far as energy efficiency is concerned, the average value, as can be seen from the same Table, is around 0.18 to 0.25 for the efficient STUs. This implies that around 0.18 to 0.21 litres of fuel are required by these undertakings to cover a distance of one kilometer. CSTC, on the other hand, requires around 0.28 litres of fuel to cover the same distance. So, it can be said that fuel consumption is high on the part of CSTC as compared to the efficient STUs, adding to the list of factors that point towards a low efficiency on the part of CSTC.

The operating ratio for the efficient STUs average around 2.6 as can be seen from the Table 2. This means that these undertakings earn a revenue of ₹ 2.6 for every ₹ spent. For CSTC, this value is 1.3, which is half of that of the efficient STUs. This low revenue generation may be another factor leading to inefficiency on the part of CSTC.

From the Table 2, we see that for CSTC, the values of the performance indicators point towards inefficient performance on the corporation's part. The values of the indicators are for a few STUs. However, below those of CSTC, implying that these undertakings have a lower efficiency than CSTC. These STUs have not been taken into consideration while making a comparison of technical efficiency between CSTC and the other STUs of India, using stochastic frontier analysis. The STUs that have been left out include, NGST, TRPTC, MZST, TMTU, and MEGTC. BEST has been included because it is a STU operating buses in one of India's metropolitan cities. CSTC and BEST do not differ much in showing efficiency in terms of performance indicators.

Thus, the results obtained for all the indicators in the case of CSTC point towards the causes of its low efficient performance. CSTC is cost inefficient; its labour productivity is low; it does not utilize its vehicles properly; its fuel consumption per unit is high ; and its revenue generation is low. There is hence, a need to overhaul the policies of CSTC, including operational policies, labour policies, economic policies, and so forth. It is true that CSTC is a public sector undertaking like all the other STUs considered here. Hence, it has an obligation to run buses on non-profitable routes, support a large work force, and not be a profit-seeking organization. However, if the other STUs (which have shown efficient performance) can operate efficiently, then why not CSTC? There has to be a change in CSTC's outlook so that it tries to be commercial to a certain extent.

Research and Policy Implications

➷ **Research Implications :** Transport is an intermediate good which helps in both production and consumption in an economy. In most of the cities of India, public road transport meets major portion of the commuting needs of the people along with private modes. Kolkata being one of the most populous cities of India is served by both publicly owned and privately owned bus system. The study tried to see how efficient the government-owned bus system of West Bengal is as compared to the STUs of other states.

➷ **Policy Implications :** Mass public transport modes, like buses, are the most easily available and affordable modes for the common people and can mitigate problems of congestion and pollution in the cities of India. There is a need on the part of the State government to take steps to improve the working of the STUs in general, and CSTC, in particular. It has to be seen how the operations of CSTC can be made more efficient. Private buses cater to a large number of people in Kolkata. However, it is only through STU buses that the objectives of making bus rides more attractive and reducing pollution can be achieved. The government can provide clean, comfortable buses plying on both profitable as well as non-profitable routes so that a large section of the population has access to good bus services. What is needed is a proper labour recruitment policy, input purchase policy, mileage policy, and so forth in order to bring in a commercial outlook in the public sector undertakings so that there can be an efficient performance of CSTC with cross subsidization between profitable and non-profitable routes.

Conclusion

Urban transport in most developing countries is heterogeneous in nature. India is no exception. Here, trains, buses, auto rickshaws, and so forth coexist on urban roads. About 90% of the demand for urban transport is met by buses in Indian cities. In all the Indian cities, with the exception of Delhi and Kolkata, buses are run by government sector undertakings. In Kolkata, private buses coexist with government buses. CSTC is the oldest and largest corporation operating buses on Kolkata roads.

The aim of the study was to compare the technical efficiency of CSTC with a few other STUs of India and see what the relative position of CSTC is. A few performance indicators which measure both efficiency and effectiveness were calculated from the data at hand. It was found that in terms of all the indicators considered, the performance of CSTC was poor compared to the other undertakings. Then, stochastic frontier analysis was used to obtain the technical efficiency scores of the STUs under consideration. The STUs were then ranked according to the scores obtained. It was found that the position of CSTC was nearly at the bottom of the table, indicating very low technical efficiency.

Limitations of the Study and Scope for Further Research

➯ Limitations of the Study

(1) The North Eastern states of India were left out from the study on estimation of technical efficiency scores because the scores obtained were so low that they were not comparable to the other STUs.

(2) Some input variables like spare-parts were left out and the cost aspect was also not considered.

➯ Scope for Further Research

(1) Spare parts can be an important input variable that can be included in the production function.

(2) Cost efficiency can be calculated for the STUs and they can be ranked accordingly.

(3) The output variable can be taken to be number of passengers or passenger kilometers instead of gross kilometers.

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