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STUDY OF TECHNICAL EFFICIENCY OF BRIHANMUMBAI ELECTRICITY SUPPLY AND TRANSPORT UNDERTAKING (BEST) USING DEA

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Abstract : For any country, skillful utilization of its resources is an imperative to maintain progress in to the future. Developing appropriate manpower and other skills will lead to not only prosperity for the lobour force, but also significant national gains in the form of saving of scarce resources. Such improvements are however needed not only by individuals, but also organizations. In this context, this paper examines the technical efficiency of Brihanmumbai Electricity Supply and Transport undertaking (BEST) by comparing its performance with 21 other transport undertakings in the country using Data Envelopment Analysis (DEA). It emerges that the undertaking has experienced a decline of 3.1% in factor productivity over the period of study and its technical efficiency is significantly below the industry average. The study shows that a substantial reduction in inputs can be achieved without reducing service output, by adopting best practices followed by its more efficient peers in the industry.

Keywords: DEA, Technical efficiency, BEST.

1 INTRODUCTION

A growing population, rapid urbanization, fast growing economy and changing life style are leading to increased need and desire for travel in India, making transportation an area requiring massive investment. There is, therefore, unanimity on the need to promoting public transport, and by the same logic, discouraging private transport. A sustainable transport policy which promotes a public transport system affordable to all is the need of the hour. Such a public transport policy must focus on the use of minimum inputs to produce maximum output. This is especially challenging in India in view of the skill development needed to improve efficiency in operations. In this context, this paper examines the technical efficiency of Brihanmumbai Electricity Supply and Transport undertaking (BEST) by comparing its performance with 21 other transport undertakings in the country using Data Envelopment Analysis (DEA).

1.1BRIHANMUMBAI ELECTRICITY SUPPLY AND TRANSPORT UNDERTAKING (BEST)

Bombay Electric Supply and Transport Undertaking (B.E.S.&T Undertaking) came in to existence when Bombay Electric Supply & Tramways Company Limited (B.E.S.&T. Company) was taken over by the Bombay Municipal Corporation in the year 1947. The loss making tramway network was eventually terminated in the year 1964. The company was renamed Brihanmumbai Electric Supply and Transport Undertaking (B.E.S. & T Undertaking) in the year 1995.

The fleet size which stood at 242 at the time of independence witnessed steady increase over the years and stood at 4607 buses at the end of 2012 transporting nearly 3.3 million passengers daily through 335 routes and employing more than 360000 workers. The BEST bus routes are spread citywide and in to three neighboring cities of Navi Mumbai, Thane & Mira - Bhayander. It supplements suburban rails and

plays a vital role in providing affordable and convenient public transport service that helps the people reach any nook and corner in and around Mumbai and neighboring areas.

2. OBJECTIVES

It is already recognized that BEST has a great impact on Mumbai city and its growth, apart from the well being of the inhabitants of this city. Considering the size of the undertaking and the amount of resources used in its operations, it is necessary to make a serious analysis of the efficiency of its operations. Hence, this study is undertaken with the following objectives:

1.To calculate technical efficiency of BEST in relation to other firms in the industry.
2.To identify peer firms from whom BEST can adopt efficiency enhancing practices.
3.To calculate possible input reductions while maintaining the same level of output, by adopting such practices.
4.Conversely, to calculate possible output enhancements using given inputs if input reduction is not feasible- as in the case of number of workers.

3. METHOD

Urban transport service seeks the mobility of citizens within the municipal area, and constitutes a substantial component of the quality of life that is offered to citizens. For this reason, the political authorities usually impose obligations on urban public transport companies in the form of limitation of prices, minimum service levels to those users who have no alternatives or maintenance of routes and frequencies that are economically unjustifiable. The parameters that define a transport undertaking's performance compels one to examine the relationship between the resources used in the production and the quantity and quality of services generated, within a suitable time. This paper therefore focuses on technical efficiency using inputs and outputs, expressed in physical terms.

3.1 DATA ENVELOPMENT ANALYSIS (DEA)

DEA is a non-parametric linear programming model that estimates the magnitude of departure from efficiency frontiers for each Decision Making Unit (DMU). A DMU is an entity that produces outputs and uses up inputs. In public transport, each transport undertaking constitutes a DMU. DEA methodology has several advantages over the traditional regression-based production function approach. It handles multiple inputs and multiple outputs and does not require a prior weight (as in index numbers). It also does not require any specific assumptions about the functional form between inputs and outputs. It emphasizes individual observations rather than statistical estimates (as in regression analysis). Also, it is a dynamic analytical decision-making tool that not only provides a "snapshot" of the current efficiency of the DMU compared with the group, but also indicates possibilities for improving relative efficiency. It uses benchmarking approach to measure DMU efficiency relative to others in their group and can assist in identifying best-practice or efficient DMUs and inefficient DMUs within the group. The DEA results can allow policy makers to develop policies that can assist the relatively inefficient DMUs to improve their performance.

This paper measures the overall technical efficiency (OTE) of the 22 Public Transport Undertakings for the period from 2000-01 to 2011-12 for which reliable and complete data are available. The technical efficiency refers to the extent to which a STU can produce the maximum output from its chosen combination of factor inputs. The efficiency of an organization is calculated relative to the group's observed best practice. In other words, it calculates a maximal performance measure for each DMU relative to all other DMUs in the observed population with the sole requirement that each DMU lie on or below the external frontier.

Analysis of technical efficiency is done using DEAP software (Tim Coelli's DEAP Version 2.1) to compare the efficiency of BEST vis-à-vis other undertakings. Both input-orientated technical efficiency measure and output-orientated measure under Variable Returns to Scale (VRS) are calculated to have a better idea of efficiency within the firm and to understand the kind of changes needed to improve efficiency. Input-orientated technical efficiency measure tries to examine to what extent input quantities can be proportionally reduced without changing the output quantity produced. One could alternatively examine to what extent output quantity can be proportionally expanded without altering the input quantities used. This is the output-orientated measure as opposed to the input-oriented measure.

Malmquist index summary of firm means is generated using the same software to understand the change in Total Factor Productivity of the firms over the period of study. The Malmquist productivity index is very

useful in calculating productivity growth in the presence of inefficiency, allowing explicit calculation (and isolation) of changes in efficiency.

4. SOURCE OF DATA

As a first step, a list of 22 transport undertakings was prepared and information regarding their operations for the period between 2000-01and 2011-12 was collected using secondary data from Central Institute of Road Transport (CIRT) Pune. Care was taken to exclude firms which are too large to be compared with BEST. Period under consideration allowed construction of panel data needed for generating Malmquist productivity index.

To evaluate the relative efficiency of the Transport Undertakings, the following variables are considered.

1.Fleet Size (Input 1) comprises the average number of buses on road of a Transport Undertaking; it is representative of the capital input.

2.Total Staff (Input 2) refers to the total number of employees working in a Transport Undertaking; it is representative of the labour input.

3.Fuel cost (Input 3) refers to the cost fuel (including Diesel and CNG for some firms) consumed in a year and is measured in Indian Rupees.

4.Passenger-kilometer (Output) in Millions is a measure of service utilization which represents the cumulative sum of the distances ridden by each passenger. It is normally calculated by multiplying the passenger load to the distance between individual bus stops.

5. RESULTS AND DISCUSSION

Note that a value of Malmquist index less than 1 denotes regress or deterioration in performance, whereas values greater than 1 denote improvements. Also note that this measure captures performance relative to the best practice in the sample, where the best practice represents a 'world frontier', and the world in our case is defined as the transport undertakings in the sample. A closer look at table 1 tells us that, on an average, productivity of all firms taken together has decreased by 3.4% over the period of study between 2000-01 and 2011-12 and BEST experienced a decline of 3.1%.

Table.1

Firm	Malmquist index TFP Change (2001 to 2012)	Tech. Efficiency (2012)
BEST- Brihanmumbai Electricity Supply And Transport undertaking	0.969	0.604
Mean (Industry)	0.964	0.807

Technical efficiency of BEST for the year 2012 assuming Variable Returns to Scale (VRS) is also calculated and produced in table 1. Remember to note that the firm with a score of 1 is on the efficiency frontier and therefore the most efficient one. With an efficiency score of 0.604, BEST is way below the industry average.

Input oriented (VRS) DEA of BEST for the year 2012 Indicates that a common 39.6 % reduction in all inputs (Radial Movement) is possible while maintaining the same level of output, as shown in Table 2 below.

Table 2

Input orientated DEA					
Scale assumption: VRS					
Results for firm: BEST					
Technical efficiency = 0.604					
PROJECTION SUMMARY:					
variable		Original Value	radial movement	slack movement	projected value
output	1	123352.6	0	0	123352.6
input	1	4607	-1825	-727.435	2054.562
input	2	36028	-14272	-8834.8	12921.18
input	3	33615.38	-13316.3	0	20299.09
peers					**lambda weight**
CNI-Metropolitan Transport Corporation Ltd (Chennai)					0.571
KMTU- Kolhapure Municipal Transport Undertaking					0.429

Additionally, a further 15.7% reduction in the use of input 1 and 24.5% reduction in the use of input 2 are possible while maintaining the same level of output, by using the best practices as followed by the peers CNI and KMTU. Their Lambda weights indicate to what extent BEST can borrow the efficiency enhancing practices from each of them.

Table 3

Output orientated DEA					
Scale assumption: VRS					
Results for firm: BEST					
Technical efficiency = 0.596					
PROJECTION SUMMARY:					
variable		Original Value	radial movement	slack movement	projected value
output	1	123352.6	83685.826	0	207038.426
input	1	4607	0	-1209	3398
input	2	36028	0	-14519	21509
input	3	33615.38	0	0	20299.09
peers					**lambda weight**
CNI-Metropolitan Transport Corporation Ltd (Chennai)					0.970
KMTU- Kolhapure Municipal Transport Undertaking					0.030

A publically owned transport undertaking like BEST however need to keep in mind social obligations like providing connectivity, subsidized travel options to disadvantaged sections of population etc as well as being a model employer. Therefore reducing the workforce by as much as 65% to maximize efficiency may not be socially and politically feasible. Hence it is necessary to conduct output oriented analysis to see what is the efficiency maximizing output level using the given inputs, as per the industry practices. The study, as shown in Table 3 reveals that the output level can be increased from 123352.6 to 207036.426, which work out to be a 67.8% increase using the same input basket.

In fact, as the slack movement indicates, this higher output can be produced even while separately reducing fleet size by 26% and number of workers by 40%. Here again, CNI and KMTU are the peers for BEST to adopt best practices from.

6. CONCLUSION

It becomes apparent from the above analysis that BEST as an organization needed to urgently acquire the necessary skills to enhance its efficiency in resource utilization. While a private firm needs to be efficient to survive in the long run, a public sector entity like BEST may survive with public funding. Resources being perennially scarce, sustainability issues need to be addressed in this context. The Input and output oriented technical efficiency measures indicate that much more needs to be done to improve efficiency. These could be in the form of better scheduling of trips, routes, personnel, maintenance of buses etc.

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