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Assessment Of Performance Of Indian Private Electricity Distribution Utilities Using Data Envelopment Analysis:A Comparative Study Of Brpl And Tpddl

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Abstract : The overall health of the electricity sector, consisting of generation, transmission, and distribution sectors, depends on the efficiency of the distribution sector, as it acts as the final interface with the end consumers. In India, financial stress and persistent operational inefficiencies among the discoms have posed significant challenges. Against this backdrop, the study analyses the performance of private electricity distribution companies in India using Data Envelopment Analysis (DEA) along with a comparative financial analysis of two major private DISCOMs in Delhi—BSES Rajdhani Power Limited (BRPL) and Tata Power Delhi Distribution Limited (TPDDL). The study adopts the input-oriented DEA model with Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) to compare the efficiency of the private DISCOMs based on the cost of power, number of employees, and interest cost as inputs and net sale of energy as output. In addition, the paper explores the performance and financial viability of BRPL and TPDDL for the period of five years from 2018-19 to 2022-23 based on the key performance parameters such as Aggregate Technical & Commercial (AT&C) losses, billing & collection efficiency, Liquidity Ratios, Solvency Ratios, Profitability Ratios, and Efficiency Ratios. The findings from the DEA reveal that only a few private DISCOMs are technically and scale-efficient on their optimal front, while the rest of the utilities are inefficient largely because of their scale inefficiency. The findings show that both BRPL and TPDDL are far better compared to the overall average on AT&Cs losses. Financial ratio analysis shows that TPDDL maintains stronger liquidity and solvency positions, whereas BRPL has relatively higher but more volatile profitability. The findings offer useful insights for policymakers and utility management to enhance efficiency, financial sustainability, and overall performance of distribution utilities in India.

IndexTerms **-** CCR DEA, BCC DEA, operational efficiency, ROA, ratio analysis.

I. INTRODUCTION

Electricity is very significant for the progress of any modern society. It powers industries, provides lighting in homes, fuels technological innovation, and enables cities to rely on electricity for public utilities like street lighting and water supply. The power distribution utilities supply all of this electricity. In India, electricity is governed by the Electricity Act, 2003. There are different State Electricity Regulatory Commissions in the states that determine tariffs for the generation, supply, and transmission of electricity. The electricity sector in Indian states was under the control of state electricity boards or departments. Still,

the Electricity Act 2003 called for the unbundling of these boards/departments into separate companies based on their activities, namely generation, transmission, and distribution of electricity. In addition, the private sector's role in the distribution sector is minimal, accounting for only 7% of total electricity sold, with the remaining 93% sold through government-owned distribution utilities. Distribution is the final link in the electricity value chain, as it is the only sector that comes into contact with the end consumer. Therefore, the financial health of the distribution utilities is essential for the entire sector; otherwise, it would lead to non-payment of dues by the other sectors, i.e., the transmission and generation utilities.

In the 2000s, Delhi's electricity sector was restructured and privatized to improve efficiency and service quality. The Delhi Vidyut Board (DVB) was subsequently split up into separate entities, each dealing with generation, transmission, and distribution. Distribution Companies (DISCOMs) included BSES Rajdhani Power Limited (BRPL), BSES Yamuna Power Limited (BYPL), and Tata Power Delhi Distribution Limited (TPDDL).

This paper assesses the performance of private distribution utilities operating in India using Data Envelopment Analysis with three inputs and one output. Then the study would shift to comparing the financial performance of BRPL and TPDDL over the last five years. The study is done by comparing specific financial ratios like liquidity, solvency, activity, leverage and profitability ratios which hopes to provide insights into their operational effectiveness.

II. LITERATURE REVIEW

Sarangi et.al (2021) evaluated the efficiency of 45 electric discoms from 21 Indian states for the year 2018-2019 using a two-stage analysis- an input-oriented data envelopment model which aligned with constant returns to scale and a regression analysis to test whether efficiency scores have an impact on the discoms' financial viability represented by the ACS-ARR gap. Significant findings include that only a few discoms in the select set are technically efficient, and that the analysis showed that significant losses could be reduced. Das and Srikanth (2020) analysed the challenges facing the Indian power sector, with a particular focus on the financial difficulties experienced by power distribution companies. The researchers find out a critical issue: a supply-demand mismatch. This mismatch was due to overly optimistic demand projections closely tied to expected GDP growth. The study highlighted that power procurement costs account for a substantial share of discoms' expenditures, exceeding 80% of their total spending. Srinivasan and Sekhar (2022) studied the financial performance of APSPDCL during the period of 2017 to 2022 using current ratio, quick ratio, debt equity ratio, inventory turnover ratio, and net profit ratio. Their analysis showed that the current ratio of the company kept decreasing, the quick ratio was unsatisfactory, and the solvency position was also unsatisfactory, and the net margin showed a decreasing trend. The authors recommended increasing liquidity and solvency to improve the discom's financial health. Josh (2019) analysed the financial performance of Uttarakhand Power Corporation Limited over a 10-year period from 2008 to 2018. He studied the liquidity, activity and profitability ratios of the company and found that current ratio showed a decreasing trend whereas quick ratio was found to be below standard in the industry however average collection period although below par showed improvement over the years which is important in the electricity sector to meet payments of power purchase and other operational expenses. Rai and Prakash, (2019) compared the financial performance of power generation companies listed in BSE from 2010 to 2017 and conducted comparison between public sector companies and private sector companies listed in BSE involved in the activity of power generation. They found that although performance of private sector companies on gross profit was higher, the private sector companies outperformed on the indicators of net profitability ratios and Earnings per Share. Rao, (2014) studied the operational performance of APSPDCL for the period of 2007-2012 using financial statements including common size income statements, common size financial statements and found that during the years of study there was continuous increase in employee costs and interest and finance charges which was increasing the operational expenses of the utility. He recommended the increase of current assets to finance the working capital requirements. Srinivas (2012) conducted a detailed analysis of the financial statements of Karnataka Power Corporation Limited (KPCL) spanning a five-year period. The study revealed that KPCL sustained a satisfactory liquidity position, shown by favourable current and quick ratios. These ratios indicate that KPCL has sufficient short-term assets to cover its short-term liabilities, ensuring operational stability. The study also evaluated KPCL's solvency and found that it had the capacity to meet long-term financial

obligations. Priyaaks (2012), in his research article on financial performance he has pointed that Financial statement analysis is the process of investigating relationships between financial statement elements and making comparisons with appropriate information. It is a tool in decision-making processes related to stocks, bonds, and other financial instruments.

III. OBJECTIVES:

1. To assess the performance of all private discoms operating in India using DEA by taking cost of power, employee cost and interest cost as inputs and net energy sold as output.
2. To compare the operational efficiency of BRPL and TPDDL by analysing their AT&C losses.
3. To evaluate and compare the liquidity ratios of BRPL and TPDDL.
4. To assess and compare the solvency ratios of BRPL and TPDDL.
5. To compare the efficiency ratios of BRPL and TPDDL.
6. To measure the profitability ratios of BRPL and TPDDL.
7. To identify trends in the financial ratios during the period of study.
8. To give recommendations or suggestions following the findings of the study so that management of the utilities can improve their financial health.

IV. DATA ENVELOPMENT ANALYSIS

Data Envelopment Analysis (DEA) is a non-parametric tool developed by Charles et al (1978). It helps measure the efficiency of multiple entities within a sector or the entire industry. In DEA, the entities are known as decision-making units (DMUs). Efficient DMUs are given a maximum score of 1 and serve as benchmarks for inefficient units. Efficient DMUs represent best practices, and inefficient ones need to follow them to become efficient (Bobde, 2018). Technical efficiency in DEA measures the conversion of inputs into outputs by a DMU relative to the efficient frontier. And the scale efficiency shows if inefficiencies found are due to the operational size. In other words, it indicates whether DMU is operating in the scale that it should optimally.

$$SE = CRS : VRS$$

Models in DEA

The CCR model developed by Charnes, Cooper, and Rhodes (Charnes et al, 1978) assumes Constant Returns to Scale. Here, the assumption is that all the DMUs operate at the most productive scale. On the other hand, the BCC model suggested by Banks, Charnes, and Cooper can have returns that are increasing or decreasing (Banks, Charnes, and Cooper, 1984). So, it assumes Variable Returns to Scale.

Selection of input and output variables

For solving DEA, we need to select certain inputs and output variables. Here, the number of outputs and inputs taken for a particular study is generally less than one-third of the DMUs selected for the analysis. Different studies employ different variables (Jamasb and Pollitt, 2001). But care must be taken that the variables chosen reflect the resources used (Yadav et al, 2011). The inputs and outputs selected depend on the methodology, the needs of the study, and also on the availability of data (Thakur et al, 2006). Considering all these, the study has selected the following variables for analysis: Cost of power, employee cost, and interest cost as inputs and net energy sold as output.

V. FINANCIAL STATEMENT ANALYSIS

Financial statements are a set of summary reports about the financial performance, position, and flow of an organization. Financial statement analysis is the process of analysing the financial statements of a company for decision-making. It is used by external parties to get an idea of the overall health of the organization and to judge the financial performance and value of the business. It is used by internal parties as a tool for financial

management. It involves analysis of the items in the balance sheet, income statement, cash flow statement, and various ratios that can be derived from these items, which would provide an indication of the liquidity, solvency, operating efficiency, profitability, and net worth of the business. It can be carried out in the traditional manner by ratio analysis, common size statements, comparative statements, etc., or by using statistical techniques such as stochastic frontier analysis, data envelopment analysis, or Malmquist productivity index, regression analysis, etc.

Data Collection:

Data has been collected from various secondary sources, such as annual audited financial statements of BRPL and TPDDL, tariff orders of various private discoms issued by their respective SERCs, and yearly reports compiled by PFC.

VI. RESULTS AND DISCUSSION:

Table 1: Result of CRS/VRS formulation of input oriented DEA model for private discoms

Sl.no	Discoms	CRS TE	Peers	VRS PTE	Peers	SE	RTS
1.	D&D PD	1	-	1	-	1	constant
2.	DNHPDCL	1	-	1	-	1	constant
3.	BRPL	0.751	10,1	1	-	0.751	decreasing
4.	BYPL	0.851	10,1	0.897	11,14,2	0.948	decreasing
5.	TPDDL	0.803	10,1	1	-	0.803	decreasing
6.	Torr Ahmedabad	0.822	1,10	0.904	3,5,2	0.909	decreasing
7.	Torr Surat	0.821	10,1	0.821	1,10,2	1	constant
8.	AEML	0.707	1,10	0.774	11,14,2	0.914	decreasing
9.	TPNODL	0.890	1,2,10	0.922	11,2,10	0.965	decreasing
10.	TPSODL	1	-	1	-	1	constant
11.	TPWODL	0.932	2,10,1	1	-	0.932	decreasing
12.	TPCODL	0.885	10,1	1	-	0.885	decreasing
13.	NPCL	0.743	1,2,10	1	-	0.743	Increasing
14.	CESC	0.865	10,1	1	-	0.865	Decreasing
15.	IPCL	0.889	1,10	1	-	0.889	increasing

CRS - Constant Returns to Scale (CCR technique), TE- Technical Efficiency
VRS – Variable Returns to Scale, PTE – Pure Technical Efficiency
SE – Scale Efficiency, RTS – Return To Scale

Insights from DEA Results:

Discoms Operating at Full Efficiency (CRS and VRS TE = 1): D&D PD, DNHPDCL, TPSODL are fully efficient under both CRS and VRS, indicating optimal operational performance at their current scale. These companies do not have peers since they are considered benchmarks for other companies.

Discoms with Decreasing Returns to Scale (Decreasing RTS): BRPL, BYPL, TPDDL, Torr Ahmedabad, AEML, TPNODL, TPWODL, TPCODL, CESC show decreasing returns to scale, meaning they are too large and could benefit from downsizing or optimizing their input-output relationship. Their CRS efficiencies (TE) are lower than their VRS efficiencies (PTE), indicating that inefficiencies are largely due to their scale rather than pure technical inefficiency.

Discoms with Increasing Returns to Scale (Increasing RTS): NPCL, IPCL are facing increasing returns to scale, which means that these discoms are small in size and have the potential to expand their operations to increase their efficiency levels. By adopting expansion in their operations, these discoms can attain their optimal size and thereby increase their CRS and efficiency scores. These companies would require expansion in their operations to attain their optimal performance levels..

Discoms with Mixed Efficiency Scores: BYPL, TPDDL, Torr Ahmedabad, AEML, TPWODL, TPCODL, IPCL show high VRS scores but relatively lower CRS scores, suggesting they are technically efficient but need to adjust their scale of operations. For example: BYPL has a VRS efficiency score of 0.897, indicating strong performance at current input-output levels, but its CRS score of 0.851 indicates room for improvement in scale efficiency.

Table 2: KPIs for Operational performance for BRPL and TPDDL

YEAR	BRPL			TPDDL			National
	BE	CE	AT&C loss	BE	CE	AT&C loss	AT&C loss
2018-19	91.27	99.66	9.04	92.07	99.93	7.99	21.64
2019-20	92.72	98.86	8.33	93.17	98.78	7.96	20.73
2020-21	92.16	97.99	9.69	92.85	99.43	7.67	21.91
2021-22	92.24	98.85	8.82	92.89	100.00	7.11	16.23
2022-23	92.84	100	7.16	93.64	99.34	6.98	15.37
MEAN	92.246	99.072	8.608	92.92	99.50	7.54	19.18
SD	0.62	0.79	0.95	0.57	0.50	0.47	3.13

BE - Billing Efficiency, CE – Collection Efficiency, AT&C loss – Aggregate Technical and Commercial Loss

BRPL: The BE ranges from 91.27 to 92.84, CE is very high touching 100% in the year 2022-2023. AT&C is also considerably low. TPDDL: Both BE and CE is very high and AT&C loss is even lower than BRPL indicating high operational performance.

Table 3: KPIs for liquidity and solvency

YEAR	BRPL				TPDDL			
	CR	QR	D/E	DSCR	CR	QR	D/E	DSCR
2018-19	0.15	0.11	5.67	1.56	0.37	0.26	1.41	1.14
2019-20	0.14	0.12	5.21	0.9	0.47	0.37	1.37	0.92
2020-21	0.14	0.13	4.16	1.78	0.38	0.31	1.26	1.14
2021-22	0.21	0.18	1.93	1.46	0.37	0.27	1.08	1.15
2022-23	0.15	0.13	1.56	1.15	0.38	0.30	0.88	1.02
MEAN	0.16	0.13	3.71	1.37	0.39	0.30	1.20	1.07
SD	0.03	0.03	1.88	0.35	0.04	0.04	0.22	0.10

CR – Current Ratio, QR – Quick Ratio, D/E – Debt Equity Ratio, DSCR – Debt Service Coverage Ratio

For BRPL, The CR and QR remains mostly stable with little movement except for the year 2021-2022 which shows a sudden spike 0.21(CR) and 0.18(QR). Similarly, both the liquidity ratios of TPDDL while mostly stable shows sudden spike in a different year 2019-2020 with 0.47(CR) and 0.37(QR). Overall by analysing the arithmetic mean the liquidity position of TPDDL is better than BRPL though the liquidity can be improved for both the companies. DE for TPDDL shows a gradual decrease with mean of 0.88 so we can say the company is very solvent. DE for BRPL shows steep decline from an alarmingly high 5.67 for 2018-19 to acceptable 1.56 in 2022-2023. The primary driver for such a steep decline seems to be increase in retained earnings which forms a part of equity. However debt has not decreased much and company must look into decreasing the reliance on outsiders' funds. Both BRPL and TPDDL have shown satisfactory DSCR, but BRPL(mean 1.37) slightly outperforms TPDDL(mean 1.07). However in 2019-2020 the DSCR of both discoms falls below 1 which indicates challenges in servicing debts.

Table 4: KPIs for profitability and operational efficiency

YEAR	BRPL					TPDDL				
	NPM	ROE	ROA	TAT	RD	NPM	ROE	ROA	TAT	RD
2018-19	0.03	0.16	0.02	0.71	14	0.04	0.11	0.03	0.78	13
2019-20	0.03	0.15	0.02	0.66	16	0.05	0.12	0.04	0.73	15
2020-21	0.09	0.27	0.04	0.51	21	0.06	0.11	0.04	0.64	16
2021-22	0.04	0.07	0.02	0.56	19	0.06	0.11	0.04	0.68	10
2022-23	0.09	0.18	0.06	0.62	15	0.05	0.10	0.04	0.80	7
MEAN	0.05	0.17	0.03	0.61	17	0.05	0.11	0.04	0.73	12
SD	0.03	0.07	0.02	0.08	3	0.01	0.01	0.00	0.07	4

NPM – Net Profit Margin, ROE - Return On Equity Ratio, ROA - Return On Assets Ratio, TAT - Total Asset Turnover Ratio, RD - Receivable Days for sale of power

NPM of BRPL shows fluctuation between 0.03 and 0.09 over the five year period of study. For TPDDL, NPM shows little change. ROE of BRPL is better than TPDDL however BRPL shows more fluctuation (SD 0.07) whereas TPDDL (SD 0.01). BRPL's ROA shows gradual upward movement from 0.02 to 0.06 while TPDDL shows consistent ROA. TAT of BRPL starts from 0.71 and ends at 0.62 however TPDDL shows boomerang movement of ROA in this 5 year period. RD of TPDDL is quite low and shows gradual decrease in the number of receivable days indicating very excellent collection efficiency.

VII. OVERALL FINDINGS AND SUGGESTIONS:

Focus on Scale Adjustments: Most discoms facing inefficiency have issues related to their scale rather than their internal operations. Companies with decreasing returns should aim to reduce excess resources or consolidate operations, while those with increasing returns should seek expansion opportunities.

Benchmarking and Peer Analysis: Discoms with inefficiencies should analyze the practices of their peers (indicated in the DEA output) to adopt strategies that could improve their efficiency. Peer-based benchmarking can highlight areas of improvement in resource allocation and operational strategies.

Constantly Monitor Scale Efficiency: The discoms need to check for their efficiency regarding scale constantly, meaning they need to check if they are operating at the most optimal scale. Based on the market dynamics, they can check periodically, if necessary, for making adjustments. This analysis shows that although several discoms are technically efficient, most discoms need scale efficiency.

These discoms should consider scaling down their operations or restructuring their resource utilization to improve their scale efficiency. They can also study their peers (listed under CRS/VRS) to understand best practices in optimizing input-output ratios.

1. Operational Performance (Table 2 - Billing Efficiency (BE), Collection Efficiency (CE), AT&C Loss) Average billing efficiency (BE) of BRPL is 92.25%, while collection efficiency (CE) is 99.07%. The average AT&C loss is 8.61%, above the national average of 19.18%. TPDDL has performed better than BRPL, with an average BE of 92.92% and CE of 99.50%. The average AT&C loss was 7.54%, below the national average and representative of higher efficiency in operations.

Recommendations: BRPL should concentrate on reducing the AT&C losses to match its performance with TPDDL and increasing overall efficiency.

2. Liquidity and Solvency (Current Ratio, Quick Ratio, Debt to Equity Ratio, DSCR - Table 3)

BRPL: Current Ratio (CR): Current Ratio is averaging 0.16, and the Quick Ratio of 0.13 is well short of the optimal standard of 1:1. This indicates the company's liquidity positions are a problem. Debt-to-Equity Ratio (D/E Ratio): The company's D/E ratio of 3.71 indicates a high degree of leverage. Debt Service Coverage Ratio (DSCR Ratio): At 1.37, the company's DSCR Ratio indicates it is able to generate sufficient cash flows to meet the

TPDDL: Higher liquidity ratios with an average CR of 0.39 and QR of 0.30, reflecting a stronger liquidity position compared to BRPL. More favorable D/E ratio of 1.20, reflecting lower leverage compared to BRPL. Uniform DSCR of 1.07, reflecting strong capacity to fulfill debt liabilities.

Recommendations: BRPL should concentrate on enhancing liquidity by cutting down short-term borrowings. TPDDL should retain the same solvency ratios but keep a watchful eye on the level of debt.

3. Profitability and Operational Efficiency (Net Profit Margin (NPM), ROE, ROA, TAT, Receivable Days - Table 4)

BRPL: The average net profit margin stands at 5%, while the return on equity for the same period has been around 17%. This indicates that the company is moderately profitable. However, the return on assets is much lower at 3%, which says assets are underutilized. The total asset turnover stands at an average of 0.61, indicating scope for improvement in utilization.

TPDDL: Higher profitability, with an average NPM of 5%, ROE of 11%, and ROA of 4%. TAT is higher at 0.73, demonstrating better utilization of assets than BRPL. Receivable days are lower for TPDDL, which means faster collections.

Recommendations: BRPL should work toward better utilization of its assets and decrease the days receivable for improving profitability. TPDDL should sustain gains from operational efficiencies but put more effort into optimizing collection times to achieve profitability.

For BRPL: Enhance liquidity and manage current liabilities effectively. Minimize AT& C losses and enhance asset productivity for better profitability. Implement best practices borrowed from TPDDL for improved cash flows and minimizing receivable days.

For TPDDL: Maintaining present levels of operational efficiency, financial stability, and monitoring debt levels, which might affect sustainable growth. Based on this analysis, TPDDL is better than BRPL in most areas related to operation, but BRPL can close this gap by improving scale efficiency, liquidity, or asset use.

VIII. CONCLUSION

This study assessed the operational and financial performance of private electricity distribution companies (DISCOMs) in India using a combination of Data Envelopment Analysis (DEA) and detailed financial ratio analysis, with a focused comparative evaluation of BSES Rajdhani Power Limited (BRPL) and Tata Power Delhi Distribution Limited (TPDDL). Given the critical role of distribution utilities their efficiency and financial health are vital for the sustainability of the entire electricity value chain.

From the DEA results, it is noticed that a very few private DISCOMs operate at full technical and scale efficiency. Utilities like D&D PD, DNHPDCL, and TPSODL emerged as benchmarks, achieving efficiency scores of 1 under both CRS and VRS assumptions. However, most of the private DISCOMs, including BRPL and TPDDL, demonstrate decreasing returns to scale. This is an indication that inefficiency among these utilities is majorly caused due to a scale-related factor rather than pure technical inefficiency. These kinds of findings accentuate the importance of optimal scale management, therefore suggesting restructuring, consolidation, or efficient resource allocation to overall efficiency for giant utilities.

The comparative operational performance analysis of BRPL and TPDDL indicates that both utilities are significantly outperforming the national average with respect to billing efficiency, collection efficiency, and AT&C losses. TPDDL has consistently reported lower AT&C loss than BRPL, an indication of stronger operational controls, better collection mechanisms, and effective loss-reduction strategies. BRPL has also grown during the study period; however, the persistence of relatively higher losses suggests further scope for enhancement through the adoption of best practices from TPDDL.

Ratio analysis gives further clarity on the differences between the financial structures of the two power corporations. TPDDL reflects relatively stronger liquidity and solvency positions with lesser leverage ratios and stable debt-equity ratios. It signifies good management of finances and minimal resort to borrowed capital. BRPL reflects relatively low liquidity even after demonstrating good improvement in the debt-equity ratio over the periods. Return on equity ratios depict BRPL to be relatively more profitable with greater variability compared to TPDDL, which maintains stable profitability through effective asset management and minimized receivable times.

On the whole, these findings suggest that privatization in electricity distribution, as epitomized by the Delhi experience, has been able to achieve meaningful gains in operational efficiency and financial discipline against the national average. However, even private players have Their challenges of scale efficiency, liquidity management, and asset utilization remain. The study emphasizes that sustained performance will require continuous benchmarking, periodic efficiency reviews, and targeted financial restructuring.

In conclusion, although TPDDL appears to be a relatively stronger performer on most operational and financial parameters, BRPL has notable potential to bridge this gap by removing size-related inefficiencies, improving liquidity levels, and efficient utilization of assets. This study can produce important learnings for policymakers and utility sector management to develop strategies to make this sector more efficient and financially sustainable for overall success in building a more resilient and consumer-driven power distribution sector in India.

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