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Operational and Financial Performance Optimization of Power Distribution Utilities in India

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1. Introduction

In the current scenario of exponentially increasing demand for energy, it has been a litmus-test for power utilities to operate and manage their power industries in an efficient and economical way. As pointed out by IEA (2015), the critical component which is vital for sustainable future is the distribution of power. Pargal & Banerjee (2014a) discussed the huge mounting losses in Power Distribution Utilities (PDUs) and estimated that the financial losses constituted about 17% of India's gross fiscal deficit and 1 percent of GDP. The motivation for this study stems from the current scenario of the inefficient operational performance of PDUs in addition to the poor financial status of power utilities (Meher and Sahu, 2016; PWC, 2016; IEA, 2015; and CRISIL, 2015; Khetrapal and Thakur, 2014). The power distribution sector has been one of the major concern for many years, primarily due to operational and financial problems (Yadav et al. 2013 and Jain et al. 2010, Jain and Thakur 2010, Saxena et al. 2010, Bajaj and Sharma 2006, Thakur et al. 2006). The state PDUs serve majority of the distribution of power in India, and therefore the financial and operational performance of PDUs is of paramount importance. This calls for an urgent need for performance optimization for sustainable distribution sector (Pangal and Banerjee, 2014).

This study proposes a multi-variable techno-commercial performance evaluation conceptual methodology to assess and optimize the operational and financial performance of State-owned PDUs in India. Essentially, this study addresses a major question that has not yet been addressed empirically for Indian power distribution sector. The study investigates the operational and financial performance of PDUs in India based on the absolute values of the parameters defined in the Integrated Rating Methodology[1] (IRM) of Ministry of Power (MoP, 2017).

[1] IRM is the methodology formulated by the MoP, Government of India in 2012 to evaluate the performance of PDUs

2. Literature Review

Dudenhefer (2009), in his writing manual, gives a detailed explanation on conducting the literature review and emphasizes on organizing the literature review according to specific themes such as methodology or data or results, etc. As the scope of the research is about performance optimization, the literature is confined to specific studies that have employed performance optimization methodology, namely Data Envelopment Analysis. Also, the IRM of GoI is also reviewed in brief as the proposed methodology considers variables defined in IRM.

Data Envelopment Analysis (DEA)

Thakur (2005) made the maiden study of DEA application on the state-operated electric utilities for efficiency evaluation and benchmarking of the utilities in the context of policy development to increase the efficiency of the utilities, considering the core problem of demand-supply gap. Thakur et al. (2006) discussed the inefficient operations of some utilities and considered variation in geographic condition as an embedded parameter in cost input. Meenakumari et al. (2008) argued that for Arunachal Pradesh to become efficient, it has to reduce two of its inputs viz. installed capacity and circuit length. However, technically these two inputs are fixed inputs and cannot be reduced as argued. Jain and Thakur (2010) highlighted various problems faced in power sector viz. demand-supply gap, low service quality, low collection rates, high network losses, and poor service coverage. Further, Jain et al. (2010) studied utilities concerning cost parameters including operations and maintenance, administrative and general cost as input parameters and suggested for unbundling of utilities for better performance. Khurana and Banerjee (2015) used DEA methodology to evaluate the performance of state-owned PDUs, and the result showed that, in 2010, the PDU of Kerala was most efficient. It was followed by Gujarat and West Bengal. Bihar, Jharkhand and Uttar Pradesh were the most inefficient PUD according to the study.

Integrated Rating Methodology (IRM)

MoP (2013) introduced the annual rating system of PDUs and the rating services, called Annual Integrated Rating. The primary objective of the annual IRM is to devise a mechanism for incentivizing or dis-incentivizing the PDUs for overall operational and financial performance improvement, to facilitate assessment of PDUs by banks funding, and to support various programs of the government. As per the methodology, the scores are assigned by the performance on each of the PDU considering various operational & reforms parameters, external parameters, and financial parameters broadly. Each of these parameters further has many sub-parameters with the weight of 47%, 33%, and 20% respectively.

It is very evident from the literature review that there is a consensus that the PDUs and the distribution sector as a whole is in a crisis and have many

unsolved problems and requires strategic solutions, given the dearth of performance evaluation studies of PDUs in India using financial parameters. This calls for the need of immediate attention for an operational and financial turnaround.

3. Research Gap & Objective

Firstly, the extant studies on performance evaluation of PDUs in India by Yadav et al. (2013, 2011, 2010), Jain et al. (2010), Jain et al. (2010), Saxena et al. (2010), Thakur et al. (2008, 2006, 2005) focused mainly on technical parameters viz, energy sold, network length, number of customers, T&D loss, AT&C loss, average interruption and so on, and considered only total cost of supply as the sole financial parameter in their study. Further, the IRM incorporates more than seven financial parameters such as cost coverage ratio, collection efficiency, Revenue and Expenditure growth, Fixed asset to Total Debt ratio, Receivables days, and Payables days apart from many other operational parameters. However, there is no other study on performance evaluation of PDUs incorporating the above said financial parameters of MoP in addition to other operational parameters such as average cost of power purchase, O&M cost, employee cost, quality of service, village electrification, Renewable Purchase Obligation, etc. Secondly, the existing IRM evaluates the performance of PDUs based on ratings for each parameter subject to some requirements prescribed in the methodology and provides rankings to each PDU. However, the absolute values of each of the parameters are not considered directly for performance evaluation. Thirdly, the IRM does not provide any target levels for each parameter to be achieved by the inefficient PDUs so that they can become efficient. This study addresses these major research gaps in the past research and provides recommendations for future research. The study poses the following research question–"Is there any alternate methodology to rank the state PDUs based on absolute values as a possible substitute for the existing integrated ranking methodology of MoP, GoI?" To answer the research questions, the objectives of the study is to construct a multi-variable performance evaluation and ranking model for PDUs based on the absolute values of the operational and financial parameters defined by MoP.

4. Conceptual Framework

Dhontu and Yoo (1998) defines DEA is an operation research-based non-parametric method that uses mathematical linear programming technique for relative performance efficiency measurement of decision-making units (DMUs) that are characterized by multiple inputs and outputs to identify the efficient frontier frontier for 'n' observations and provides a single measure of performance, generally referred as relative efficiency. Banker, Charnes, and Cooper developed BCC model (1984) with variable return to scale assumption and proposed DEA model as given below.

$$\theta^* = \min \theta$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} \le \theta x_{io} \quad i = 1, 2, ..., m;$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{ro} \quad r = 1, 2, ..., s;$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j \ge 0 \quad i = 1, 2, ..., n.$$

According to Zhu et al. (2008), among the available wide variety of modeling techniques, DEA is a relatively new non-parametric method for performance efficiency evaluation that has got very much attention in recent times. Not only that, as highlighted by Abbott (2005) and Jamasb and Plitt (2001), DEA is accepted worldwide as one of the major frontier technique for benchmarking energy sectors, very particularly the electricity industry. Moreover, according to Bogetoft and Otto (2011), European countries have been increasingly adopting DEA approach for benchmarking and performance improvement since 1997.

Therefore, this study proposes a novel techno-commercial model for performance optimization of PDUs based on DEA methodology and considering variables defined in IRM of GoI. The choice of variables is also based on the objective of the research and the variables considered in the study are the same variables used in the IRM.

The operational parameter are AT&C loss, average cost of power purchase, O&M cost, employee cost, quality of service, village electrification and RPO compliance. The financial parameter includes cost coverage ratio, Revenue and Expenditure growth, fixed asset to total Debt ratio, Receivables days, and Payables days. Inputs are AT&C loss, average cost of power, O&M cost, employee cost, expenditure, receivables days, debt-equity ratio and output parameters are quality of service, village electrification, RPO Compliance, cost coverage, fixed asset to total debt ratio, and payables.

5. Implications & Conclusion

The study makes three significant contributions to performance evaluation and benchmarking of PDUs in India. This study is the first to propose a conceptual model for performance optimization of PDUs in India based on DEA methodology, considering all the operational and financial parameters as defined by MoP. To best of our knowledge, there is no such multi-variable study conducted in India considering the variables defined by MoP for

performance evaluation of PDUs. Therefore, this study is making a major contribution in developing an alternate methodology for performance evaluation and ranking of PDUs as a possible substitute to the existing IRM of MoP incorporating all the operational and financial parameters as defined by MoP for performance evaluation of PDUs. The second significant contribution is related to providing targets levels for efficiency improvement of inefficient PDUs. The existing integrated rating methodology of MoP merely provides ratings and ranks the PDUs based on their score, but fails to set targets for performance efficiency improvement. However, the conceptual model thus proposed as part of the study, will also provide estimates of targets for various operational and financial parameters to be achieved by inefficient PDUs so that they become efficient. The target levels, thus estimated, will help in strategic policy framework development by MoP for performance improvement of PDUs and also aid in managerial decision making in each PDUs for efficient, effective and sustainable PDUs. Therefore, the third significant contribution is to the existing literature on operational and financial performance optimization of state-owned PDUs in India using DEA methodology. In addition to that, the study also provides directions for future research on performance optimization for a sustainable power distribution sector as well as sustainable future.

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