Assessment of Service Agility in Power Distribution Company

M Anil¹ and M Suresh²
¹,² Amrita School of Business, Coimbatore, Amrita Vishwa Vidyapeetham, India

Email: ¹anilmkseb@gmail.com; ²drsureshcontact@gmail.com

Abstract Power Distribution Company (DISCOM)s are basically engaged in providing electricity to power the various customer needs of the people in its area of operation. The availability of quality power free from voltage sags, voltage swells, dips etc. without any interruption contributes to customer delight in the sector. Unfortunately, the network constraints brought in by overhead, bare conductors to convey power from generating stations to transmission Sub-stations and from there to the end consumers is a serious cause for outages to customers and create dissatisfaction among them. This paper attempts to develop assessment framework of service agility for a case DISCOM in India using multi-grade fuzzy approach. The service agility attributes are identified and classified using Importance Performance analysis (IPA). This assessment framework helps managers of DISCOM for understanding their current service agility level and focus on the weaker attributes to enhance their service performance. This assessment framework can help DISCOM’s managers to understand their current level of service agility and focus to improve their service performance.

Keywords: Service agility; Power Distribution Company; Service Quality; Energy Management; Multi-grade Fuzzy; Importance Performance analysis

1. Introduction
Unlike traditional production-oriented organisations, service delivery organisations differ in their overall functioning. In addition to Service Quality and Product Quality, the employee behaviour and the ability of employees and customers to co-create a service delivery process in the service-scape play an important role in the satisfaction levels derived out of service delivery process by both the service provider and the service recipient alike. In a product-service continuum, if we arrange various types of services available in the scenario, the services of a Power Distribution Company (DISCOM) to its customers take a position more towards the services end than to the product end of the continuum. DISCOMs are basically engaged in providing electricity to power the various customer needs of the people in its area of operation. The availability of quality power free from voltage sags, voltage swells, dips etc. without any interruption contributes to customer delight in the sector. Unfortunately, the network constraints brought in by overhead, bare conductors to convey power from generating stations to transmission Sub-stations and from there to the end consumers is a serious cause for outages to customers and create dissatisfaction among them. Though network hardening measures like converting bare overhead network to aerial bunched cable (ABC) system or underground (UG) cable system offer a solution to the issue, the prohibitively high cost of implementation thwarts the progress of such measures in a power distribution utility; with limited resources for sourcing capital outlay from the routine operational profits obtained by the utilities, in the strict regulatory regime in vogue, especially after meeting the Corporate Social Responsibilities of the utilities.

The functional aspects of a power distribution company include complex networks, feeding from multiple sources, inadvertent access to bare (uninsulated) energised network to the public etc. which
contribute to serious issues as regards the safety of general public and to the service provider employees of the utility. The rate of occurrence of accidents, in spite of the deployment of personal protective equipments (PPEs) by the employees, contract workers etc.; are on the rise. The members of the general public are also not saved from chances of accidents, mostly due to unintended contact with the bare conductor systems of network with foreign conducting objects or due to snipping of bare conductors of the network and consequent falling to the ground and remaining energised in spite of the various protective systems and protocols to render such snapped conductors de-energised in the event of contact with the earth. Standardisation of procedures and construction practices go a long way in providing safety to employees and public. Inculcating a safe work culture through training and re-training of the employees, contractors’ personnel and imparting safety awareness propaganda to the public are useful means to reduce the causation of accidents to the public and employees alike. An umpteen number of customers are installing solar photovoltaic generation on their roof-tops and getting their status converted to power producers (PROSUMERs) creating “grid-tied” solar photovoltaic systems in distributed de-centralised mode and the consequent bi-directional power flows in the network is another potential causative factor of accidents to the employees of the utility, engaged in maintenance activities of the network. The organisation, Case Company advises its employees to create permanent identification marks within the network to identify the presence of such PROSUMERs and to switch off their solar generation while undertaking repairs and maintenance in such parts of the distribution network.

2. Literature Review

The agile methods in production are more popular in the industrial manufacturing parlance [1]; the applicability of leanness, agility and leagility has been brought to the service industry [2;3;4], of late. Healthcare service delivery [5;6;7] and office management were the popular early areas of application of these techniques in service sector[8]. Later on, logistics, supply chain management and tourism and transportation sectors were subjected to agility assessment and consequent improvement in wastage reduction, resource utilisation effectiveness and finesse in service delivery process were brought into these areas. The lean service publications were very few for the period from 1993 to 2001 and the trend slowly took off to the level of 30 annual publications by the year 2011 [9]. Agility in service delivery process is very important in service intensive industries [10;11;12;13]. The business of power distribution is a service intensive industry as the people element in this sector is critical and can influence the level of satisfaction to the customers in a great way. No previous study involving fuzzy logic based Importance Performance Analysis (IPA) was observed to be made in the business of a Power Distribution Company (DISCOM) upon survey of available literature.

Unlike other infrastructural sector industries, power distribution is more visible a service and the various processes involved create a multitude of customer touch points or interaction points which the service delivery personnel have to manage effectively and skilfully to create value for the customers. Even a very slight aberration on the part of the service delivery agent of the power distribution company is sufficient to create a strong dent in the customer relationship of the company, which needs to be maintained for a life time as the service provider- customer relationship often prolong for quite a long time and often transcends to generations of customers.
Importance- Performance Analysis (IPA) has been used as an effective technique in evaluating service attributes based on the comparative analysis of attribute importance vis-à-vis attribute performance [14]. In importance-performance analysis, attribute performance and attribute importance are both independent variables [15] and they are plotted in an X-Y scatter plot with attribute performance on X-axis and attribute importance on Y-axis. In the scatter plot thus obtained, the mean values of attribute performance and attribute importance are utilised to divide the plot area into four quadrants with attributes in the North-West quadrant (Quadrant I) need more attention as they are more important, but have low performance levels. The quadrant on the north-east portion (Quadrant II) consists of those attributes having high importance as well as performance levels. The south-west and the south-east quadrants (Quadrants III & IV respectively) consist of those attributes with low importance. The level of performance for attributes in south-east quadrant (Quadrant IV) is high; which is an unnecessary or undesired situation and the performance levels for these attributes are redundant. The critical attributes are those in Quadrants I & II. Those attributes in quadrant I are highly important, but the performance levels are less. Hence, these attributes are to be given more care and performance levels of these attributes are to be increased.

3. Research Methodology

The study utilised multi-grade fuzzy logic to assess the agility index of the power distribution company. The various attributes for the study were enlisted from the first author’s own experience of having worked in a power distribution utility for a long period spanning from 1991 to 2020 and after considering inputs from colleagues and accomplices. The conceptual model for agility assessment with two enablers, five criteria and thirty eight attributes was developed as shown in Table 1. Questionnaire based responses of five experts in the field of power distribution were collected personally by the author on a 10-point scale, after giving a brief description about the attributes, criteria and enablers. Weightages were worked out from the responses of the experts, to obtain the importance against each attribute, criterion and enabler. Ratings were obtained by interviewing five operational level Engineers and performance levels were assessed from the weightages obtained by interviewing the experts.

Mean of the attribute level performance and importance were worked out to obtain mean value of attribute performance and importance. X-Y scatter plot was drawn with importance on Y-axis and performance on X-axis and the mean values were plotted as lines in the importance-performance grid to obtain the quadrants to assess criticality of attributes.

The service agility index (A) is computed as the product of overall assessment level of ratings, based on each criteria/enabler (R) and the overall weights (W), as given by the experts at primary, secondary and tertiary levels.
Table 1. Conceptual model for agility assessment

| SI No | Enablers | Criteria | Attributes |
|-------|----------|----------|------------|
| A1    | Customer Satisfaction | Technical Quality | Freedom from Voltage sags, Swells and Dips |
| A2    | Customer Satisfaction | Technical Quality | Frequency Stability |
| A3    | Customer Satisfaction | Technical Quality | Resilient Power Grid |
| A4    | Customer Satisfaction | Technical Quality | Low and Informed Outages |
| A5    | Customer Satisfaction | Technical Quality | Adherence to Standards of Performance of SERC |
| A6    | Service Quality | Informed Outages | |
| A7    | Service Quality | Adaptiveness | |
| A8    | Service Quality | Empathy with Customers | |
| A9    | Service Quality | Fair and Friendly Deal | |
| A10   | Service Quality | Good maintenance of Physical & Peripheral Evidences | |
| A11   | Service Quality | Better presentability of VISIBLE Assets | |
| A12   | Service Quality | Better management of Customer Touch Points | |
| A13   | Service Quality | Deployment of Automation & ICTs in Service Delivery | |
| A14   | Service Quality | Online Payment Mechanism | |
| A15   | Service Quality | Enhanced HMIs and Automatic Telephone Answering Services | |
| A16   | Perceived Quality | No outages | |
| A17   | Perceived Quality | Quality Power Supply | |
| A18   | Perceived Quality | Reliability of Supply | |
| A19   | Perceived Quality | Accurate Metering | |
| A20   | Perceived Quality | Performance Effectiveness | |
| A21   | Perceived Quality | Convenient Location of the Servicescape | |
| A22   | Perceived Quality | Consistency of Service Providing Personnel | |
| A23   | Perceived Quality | Assurance | |
| A24   | Perceived Quality | Courtesy of Service Providing Personnel | |
| A25   | Perceived Quality | Tangibles- Facility & Personnel- Neat & Tidy | |
| A26   | Perceived Quality | Responsiveness of Service Providing Personnel | |
| A27   | Perceived Quality | No waveform distortion at the point of common coupling | |
| A28   | Perceived Quality | No harmonic distortion at the point of common coupling | |
| A29   | Public Safety | Reduced chances of Accidents from assets | |
| A30   | Public Safety | Standardisation of Procedures and Construction | |
| A31   | Public Safety | Mass Education aimed at giving Electrical Safety Tips to Public | |
| A32   | Safety and Security | Employee Safety | Adherence to Construction Standards | |
| A33   | Safety and Security | Employee Safety | Deployment of Personal Protective Equipments | |
| A34   | Safety and Security | Employee Safety | Inculcating Safe Work Culture through training & re-training | |
| A35   | Safety and Security | Employee Safety | Network Hardening Measures | |
| A36   | Safety and Security | Employee Safety | Enforcing & Promoting Safe Practices | |
| A37   | Safety and Security | Employee Safety | Responsibility to maintain Safe condition | |
| A38   | Safety and Security | Employee Safety | Bi-directional Power flow issues | |

The multi grade fuzzy procedures has been adopted from [1;16;17;18].

\[ OA_i = R_i \times W_i \]

OA: Service Agility Vector
Ri: Rating of the drivers
Wi: Weightage of the drivers
The scale of assessment of Service Agility Index was graded into five levels, as per principles of fuzzy
determination of the index with value between 8 and 10 representing “Extremely agile”, between 6 to
8 representing “Agile”, between 4 and 6 representing “Fairly agile”, between 2 to 4 representing
“not agile” and between 0 and 2 representing “Extremely not agile”.

4. Case Study

Case Company is engaged in the business of Generation, Transmission and Distribution of Electricity
within the geographical boundary of a State in India. Trading of Electricity is also undertaken by this
organisation to meet the shortages which often ranges between 60 – 80% of the total need for power
from private power producers or through power exchanges as per short-term, medium-term and long-
term power purchase agreements (PPAs); the rest of which is met from internal generation apart from
the share of generation from Centrally owned Generating Stations (CGS). The legal environment of
business of Case Company is set as per the provisions of Electricity Act, 2003. Amongst the various
portfolios handled by the organisation viz., Generation, Transmission, Distribution, Power System
Operation, Protection & Control, SCADA & Telemetry and Power Line Carrier Communication; the
power distribution plays an important role as this portfolio is closely linked with serving a large
customer base spread across the length and breadth of the State. Electric Power supply is closely
linked with the development of the nation and electric power industry is considered as an industry of
industries as electricity is an important factor of production, the consumption of which contributes to
the GNP of the nation.

4.1 Characteristics of Distribution Company (DISCOM)

The technical quality of power (or simply, power quality) and the service quality of the service
delivery personnel engaged at various customer touch points of the utility do have important
contributions to make, for attaining customer satisfaction. When we think of customer delight, the
perceived quality of service, as seen from the customers’ side are also very important. Ideally, the
customer expects no outage to happen in the network with characteristics of 24 x 7 supply with no
interruption at all. When non-linearity of loads are increasing in various customer installations, the
quality of waveform (which ought to be perfectly sinusoidal) at the point of common coupling (PCC)
of the grid (the point where the customer installation physically joins the distribution grid) gets
distorted giving rise to harmonic distortion and the total harmonic distortion (THD) at the point of
common coupling is to be maintained at less than 5% (IEEE 519: 1992). Soft skills possessed by the
service providing personnel increases the perceived value of services provided by them to the
customers and creates positively higher levels of customer satisfaction, which can be termed as
customer delight. The resilience of the network or the elasticity of the network also contributes to
customer satisfaction.

The resilience is the property of a power grid/ network to remain unperturbed in the event of a loss of
generating unit, transmission line, transformer etc. comprising the network; so that the customer
segment would not feel about the loss by way of lack of power quality such as voltage sag, flicker etc.
or power supply outage. In fact, flickers and voltage sags can be treated as momentary outages for an
infinitesimal duration of time; which is too short to perceive, due to persistence of sensory perception.
The visibility of service delivery process in a power distribution company is very high and this over-emphasises the importance of proper management of the customer as well as public touch points carefully and adroitly. Information Technology (IT) implementation in power distribution sector enhances the scope for increasing service quality by resorting to providing advance customer information about duration of the impending outage planned, power availability etc. to balance the dynamic situation existing in power distribution market and the ambitious expectations of customers of the utility. The flexibility of grid operations can also be met by the distribution system operator (DSO) of a utility, if dynamic forecast and customer information management can be carefully intertwined and if the customers’ consumption behaviour can be influenced by the utility managers to create a ‘win-win situation’ to the utility as well as its customer base.

In this study, responses were gathered in a 10-point scale for attributes corresponding to criteria such as technical quality, service quality, perceived quality and public & employee safety of a power distribution company and the service agility index is evaluated using multi-grade fuzzy method. The weightages are calculated from expert responses and ratings were collected from operational level managers and importance- performance analysis (IPA) was undertaken to identify critical attributes in the study. The Importance- performance (IP) plot obtained from the study is shown in Figure 1 below.

![Importance Performance Analysis (IPA)](image)

**Figure 1. Importance Performance Analysis for attributes**
5. Conclusion

The service agility index of Case Company was obtained, which means that Case Company is an “agile” power distribution company. As per the Ministry of Power, Government of India, the performance rating of Case Company is one among the best in the country. The performance level of service attribute A14 viz. Online Payment Mechanism is low, though it is a highly important attribute. Similarly, attributes A4, A17, A18, A20 and A24 viz. Low and Informed Outages, Quality Power Supply, Reliability of Supply, Performance Effectiveness and Courtesy of Service Providing Personnel need to have better attention of the management and their performance levels have to be improved. The management must concentrate on improvement of performance levels of these attributes in quadrant I of the IP plot. Improvement in performance levels of these service attributes could be made with greater adoption of information technology to provide timely information about outages to the customers; by investing more money in hardening the power distribution network of the utility to enhance the reliability of the network to better insulate the network from the effect of touching of tree branches and by providing soft skill training to the service providing employees of the utility aimed at improving their emotional resilience and capability to build and sustain quality & conducive interpersonal relationships.

The attributes A33, A2 and A34 corresponding to Deployment of Personal Protective Equipments (PPEs), Frequency Stability and Inculcating Safe Work Culture through training and re-training respectively have the highest levels of performance as well as importance, as elicited in the study. The other attributes which have above average levels of importance and performance are A5, A26, A38, A37, A21, A29, A3, A36 and A19; corresponding to Adherence to Standards of Performance of State Electricity Regulatory Commission (SERC), Responsiveness of Service Providing Personnel, Bi-directional Power flow issues, Responsibility to maintain safe condition, Convenient location of Service-scape, Reduced chances of accidents from Assets, Resilient Power grid, Enforcing and Promoting Safe Practices and Accurate Metering respectively.

The low priority attributes are those in quadrant III and the attributes in quadrant IV of the IP plot represent those attributes with low importance level and high performance level. For such high levels of performances, the resources spent by the management is probably a wasteful exercise, and re-allocation of resources to quadrant I attributes for improving their performance levels would be a welcome activity on the part of the management to improve the agility of the company.

In the current study, the service agility index of a typical power distribution company was evaluated and the importance and performance levels of various attributes were analysed. A power utility has other functional areas viz. Generation, Transmission etc. The agility index assessment could be done in those fields which may include operational safety Index in a generating station, where the presence of rotating machinery and energy conversion processes add to the Health, Safety & Environment (HSE) hazards, which could be assessed using multi-grade fuzzy. Similarly, in the event of an unexpected turn around in such a station, the disaster preparedness and mitigation of problems could also be analysed using multi-grade fuzzy.
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