
Assessment of Technologies for Discoms in NCR and Development of Power Distribution Technology Implementation Index

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ABSTRACT

Power distribution system acts as a bridge between the customers and the utility. With changing times, the consumers expectation is not power supply to them but a reliable and quality power supply with timely redressal of complaints. With advent of IT, and mobile technologies changing of our lives, consumers expects the utilities with accurate metering and billing free from any errors with facilities like online payment of bills and from mobile applications. All of these can be possible only by adopting innovative and smarter technologies to curb human intervention and provide better services to the consumers in terms of handling complains and automate the consumer's redressal mechanism. IT and associated technologies also address in solving energy audit issues and identification of more problematic areas and which needs more focus and attention.

The paper tries to assess the level of technologies implementation in power distribution companies in National Capital Region and proposes a power distribution Technology Index.

Literature Review

MP Gupta (2007) et all empirically assessed the level of IT use in government organizations, and study the role of top management, IT management, user satisfaction, organizational culture, and IT use through descriptive and inferential statistics.

Meeta Dasgupta (2011) tried to bring together different aspects of

technological innovation and technology strategy at North Delhi Power Ltd, Delhi which has taken various initiatives to turnaround the dilapidated power distribution industry in India. It details the various technological initiatives taken by the company to revamp the power distribution situation of the country.

Hiroshi Kashiwazaki et.al (2002)

elaborates New Technologies for Electric Power Distribution Systems, the intelligent substations applying IT (information technology) and system configurations aimed at high-speed communication. , with the incorporation of needs for the future intelligent control of substations, protection, monitoring, and communication systems that have advantages in terms of high performance, functional distribution, information-sharing and integrated power distribution management.

Kam-Hoong Cheong in his thesis on IT Strategy for utilities did extensive study on existing IT strategies within electric utilities, mostly formulated with the traditional mind-set of the industrial-age that focused primarily on technology, is inadequate and ineffective in dealing with today's IT which has a broader implication on an organization's business activities. In order to enhance the effectiveness of future IT strategy, a framework that adopts a system approach is proposed in this thesis.

P.V.Chopade B.E.Kushare Dr. D.G.Bharadwaj discusses Information Technology Solution for Power Distribution System Automation, provided IT solution which will enable the business operation at the transaction level and improve the overall quality in Decision Support System. Information Technology (IT) would thus become the foundation for sustainable reforms.

R. P. Gupta and S. C. Srivastava (2007), described the indigenous development and implementation of a

Power Distribution Automation system at pilot level in Indian Institute of Technology (IIT) Kanpur, India. Electric Power Distribution Automation (DA) system is being increasingly adopted by the electric utilities to reduce the operational problems of distribution networks.

Aurobinda Basu, Surajit Banerjee, Gautam Banerjee(2006) focuses on Reduction in T&D Losses in CESC by IT based Surveillance focuses on various IT based initiatives which had led to reduction of T&D losses in Kolkata.

K V Ravithran (1999) talks about the ,Power system of Kerala techno economic analysis, analyses the trends in supply and demand variable affecting the power system and power system efficiency of the state in terms of load factor , demand factor transmission and distribution network and tariff structure.

United Energy (2013), a Victorian power distribution Company in Melbourne , in its Distribution annual Planning Report, elaborates the company strategy in effective utilization of various technologies like GIS,SAP,SCADA,AMI etc for better services to the customers and increasing efficiency of the organization .

Robinson (2013) has effectively tries to gives the brief idea regarding the impact of electricity on economic status of people in Delhi and effectiveness of Delhi Electricity Regulatory Commission (DERC) regulation for annual/multiyear tariff rates calculation.

Research Objective

To empirically evaluate the status of technology implementation among the power distribution companies by developing a comprehensive index, viz., Power Distribution Technology Index (PDTI). The paper also tries to find out correlation between the AT&C losses incurred by the power utilities over the years and automation and information technologies they have implemented in improving their system.

Hypothesis

The through literature review of technologies used by Discoms in India as well as over the world and interaction with Discom officials at various forums and meetings led to formulation of hypothesis. The hypothesis are as follows:

Ho1- There is no difference in level of technology implementation in power distribution companies.

Ho2: There is no correlation between technology implementation index & AT&C loss of power distribution companies.

Research Techniques Used

The tools and techniques used in this study is mixed mode approach was adopted including qualitative analysis and grounded theory which is one of the well known qualitative analysis techniques has been used in this research. Along with grounded theory of research, few simple quantitative methods too has been used to develop technology index.

Grounded Theory

“Grounded Theory is the study of a concept! It is not a descriptive study of a descriptive problem” (Glaser, 2010). “Most grounded theorists believe they are theorizing about how the world is rather than how respondents see it” (Steve Borgatti).

A grounded theory design is a systematic, qualitative procedure used to generate a theory that explains, at a broad conceptual level, a process, an action, or an interaction about a substantive topic (Creswell, 2008). The phrase “grounded theory” refers to theory that is developed inductively from a corpus of data. “Grounded Theory is the most common, widely used, and populer analytic technic in qualitative analysis” (the evidence is: the number of book published on it) (Gibbs, 2010). It is mainly used for qualitative research, but is also applicable to other data (e.g., quantitative data; Glaser, 1967, chapter VIII).

The basic idea of the grounded theory approach is to read a textual database and “discover” or label variables (called categories, concepts and properties) and their interrelationships.

The data do not have to be literally textual- they could be observations of behavior. Often they are in the form of field notes, which are like diary entries.

Types of data collections :

- Interviews
- Observations
- Documents

- Historical Records
- Vidoetapes

The data collection was basically in two forms:

Primary Data collection: The methods of data collection were basically in form of survey, focused and unstructured interview. The researcher made use of various forums, seminars and workshop

for conducting interviews and collect the data from the Discoms officials.

Secondary Data Collection: The secondary data collection mainly comprised regulatory and audit reports, information from Discoms websites etc,

Summary of primary and secondary data referred are as follows:

Table 3. Summary of sources of data collection

Sl No	Factors Considered for Technology Implementation Index	Details	Nos
1	Utility Customers Survey	No. Customers Surveyed	300
2	Utility Energy Audit Reports	No. of Audits Reports Referred	21
3	Discoms Reports Shared with Power Regulator	No. of Discoms Report	15
4	MOP Reports	No. of Ministry of Power Reports Referred	12
5	Inputs from Customer Care Dept and Helpline No		
6	Utility Website	Websites of Power Distribution Companies	7
7	Press Release & Power Market News	No. of Press Released referred	35
8	Interview with Power Utility Officials	No. of Utility Officials Interviewed	45

The author made use of MOP DRUM training program where Haryana Discoms officials came to BSES for training. The author conducted semi structure interview with Haryana Discoms officials about various technologies being currently used and technology which are at different stages of implementation. The workshop

and DRUM training program interaction and semi structured interview helped in grouping of ideas and concepts .

Codes identified during earlier workshops facilitated by *constant comparison* between data from participants from the Discoms , data and category, category and other categories.

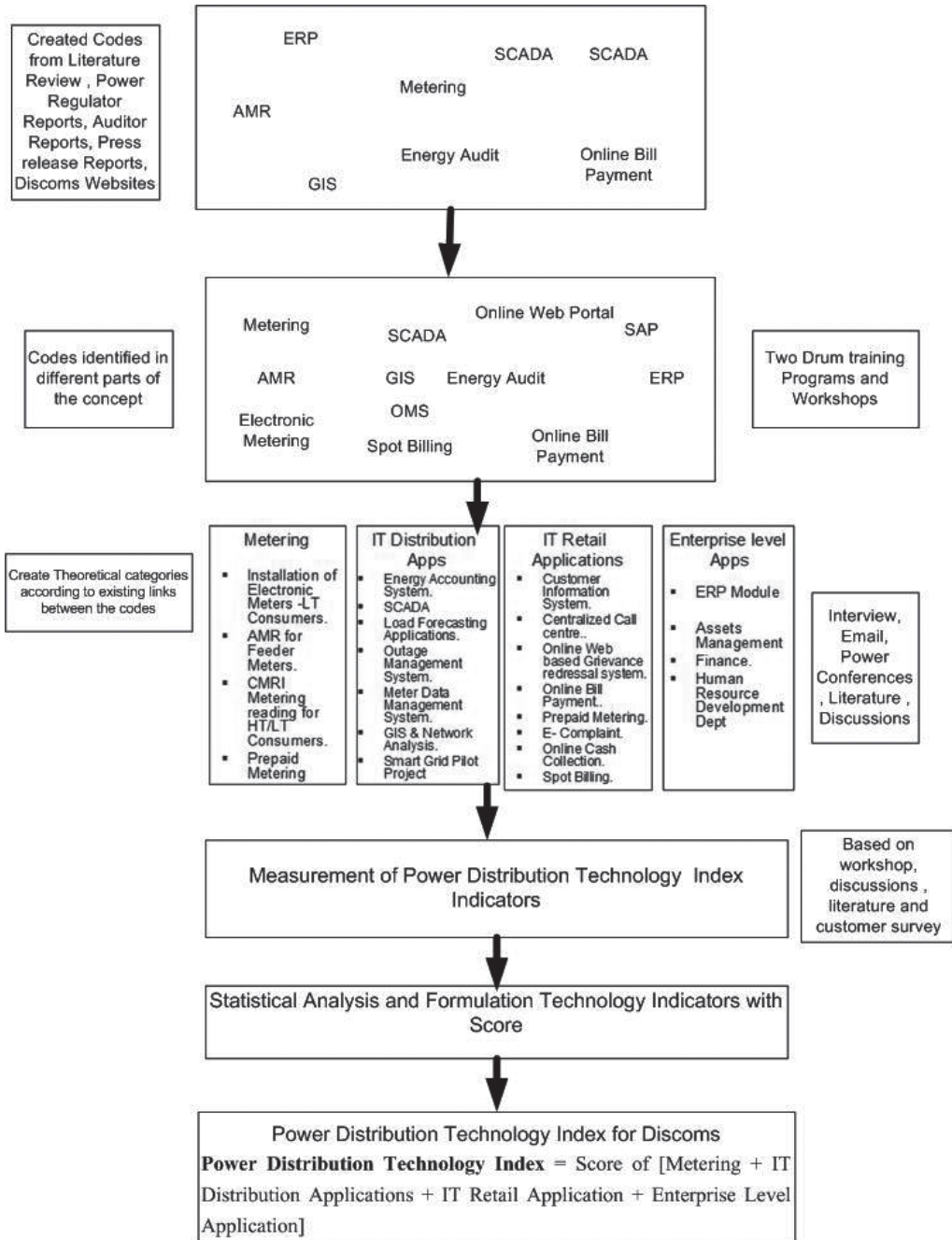


Fig 3. Dissertation logic scheme based explanation of obtaining the grounded theory (source: created by the author)

Power Distribution Technology Index (PDTI)

Measuring multiple dimensions of IT & an automation technology in Power distribution sector is indispensable in understanding its components, benchmarking success, and catalyzing improvement. While there have been some laudable efforts to measure wellbeing, these capture only limited aspects of technology implementation in power utility sector, and are uneven in breadth and scope across different utilities in Indian Power Sector scenario.

Power Distribution Technology Index (PDTI) is a tool designed to comprehensively measure and track the level of Information Technology (IT) and automation technologies implementation in power distribution companies. The research area currently is National Capital

Region of India. The instrument designed can be used a powerful tool to measure the success and failures of different which are being implemented in power distribution sector.

The research focuses on development of Power Distribution Technology Index (PDTI) is to provide a rigorous tool to benchmark technology adoption and diffusion within utilities. Power Distribution Technology Index depends on the policy choices, investments, and implementation capabilities of multiple stakeholders—mainly utility, government, civil society, and business.

The overall definition can be disaggregated into various dimensions of Power Distribution Technology Index that define the basic architecture of the model which has been defined below:

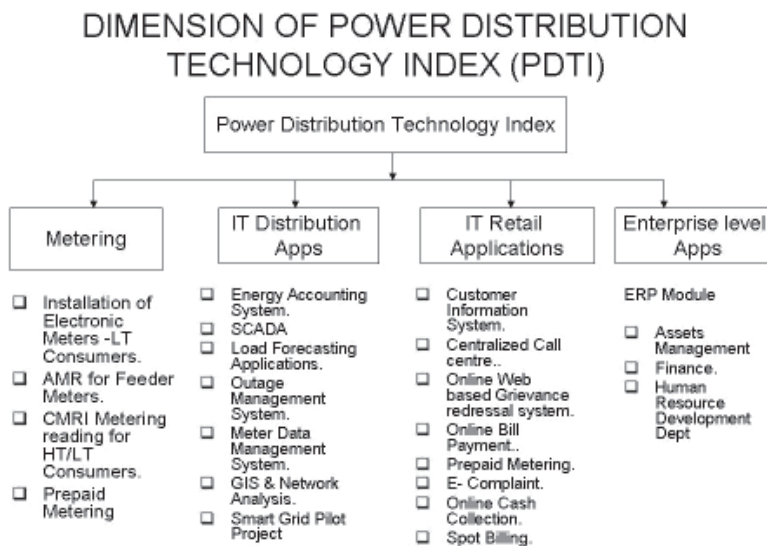


Fig 1. Dimensions of Power Distribution Technology Index grouped by Researchers

Dimension of Power Distribution Technology Index (PDTI)

The four dimensions of the of Power Distribution Technology Index roughly mirror of the progression of contemporary technologies which are being implemented in achieving automation and increasing efficiency for better customer satisfaction.

The first dimension captures the degree to level of implementation of different types of metering technologies which are the most essential part for any Power distribution company. The current scenario has witnessed the major sea change transformation in metering from mechanical meters to current prepaid meters just as we do pre paid recharge in our mobiles. The Metering technologies discussed in the research are divided into four components:

- Installation of Electronic Meters -LT Consumers.
- AMR for HT Consumers.
- AMR for Feeder Meters.
- CMRI Metering reading for HT/LT Consumers.
- Prepaid Metering

The second dimension of Power Distribution Technology Index captures the degree to which a power utility has implemented IT (Information Technology) to address its various needs and developing Power Distribution applications. IT Distribution Apps are divided into following major components:

- Energy Accounting System.

- SCADA
- Load Forecasting Applications.
- Outage Management System.
- Meter Data Management System.
- GIS & Network Analysis.
- Smart Grid Pilot Project

The third dimension IT Retails Application confine the level customers are able to get in touch with power distribution company for their various issues . This dimensions exhibits initiatives and ways developed by power utility to reach its consumers and how IT applications can help in solving its various issues.

The IT Retails Applications dimension is divided into the following components:

- Customer Information System.
- Centralized Call centre..
- Online Web based Grievance redressal system.
- Online Bill Payment..
- Prepaid Metering.
- E- Complaint.
- Online Cash Collection.
- Spot Billing.

The fourth dimension Enterprise Level Apps mainly arrests the degree to which power utility has implemented SAP Module or any other similar modules in assets management and its human resource details.

The Enterprise Level Applications dimension is divided into the following two components:

- Assets Management

- Finance
- Human Resource Development Dept.
- Performance Management System

The Power Distribution Technology Index provides the platform to assemble sets of technology implementation

It lets each power distribution companies to discover explicit areas of strength or weak point in context to technology being implemented and executed by them, as well as to benchmark themselves against peer power distribution.

The Power Distribution Technology Index is designed based on extensive research on technologies being

implemented by power utilities and quantify in depth each components and dimensions which leads to overall score of utilities. As mentioned the Index spotlights on indicators of technology implementation results; rather than measuring inputs, the Power Distribution Technology Index focuses on what level of technology progress has already been achieved within a power utility.

The four different dimensions of the model—Metering Technologies, IT Distribution Apps, IT Retail Applications and Enterprise level Applications—are assigned weighted in the overall index and sum of the four components which are

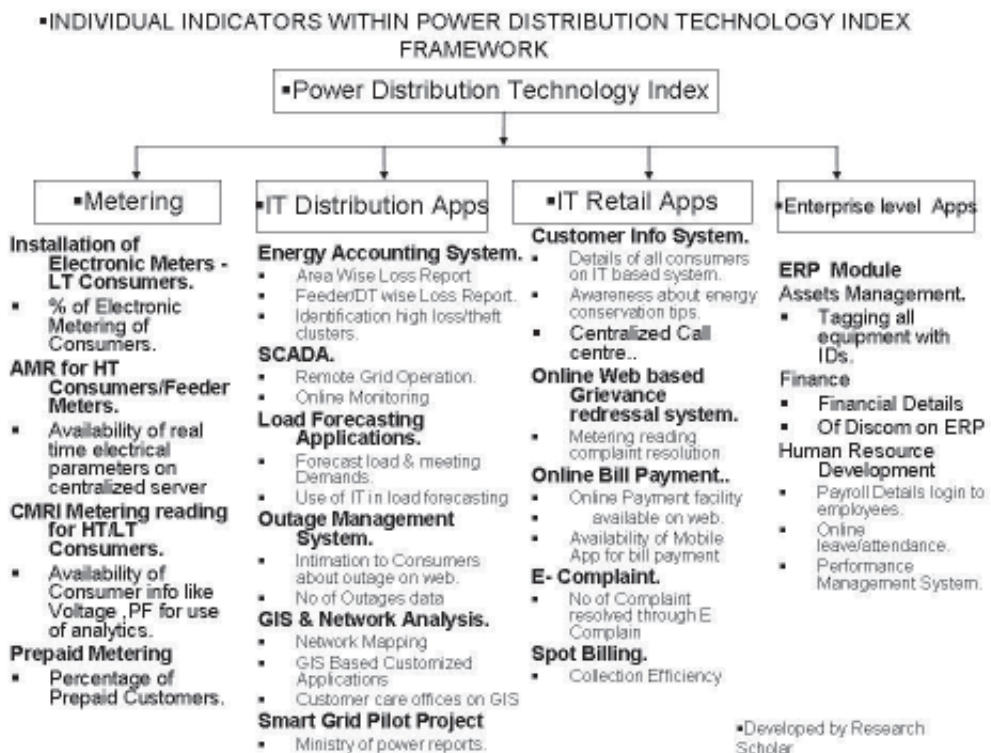


Fig 2. Power Distribution Technology Index with Indicators

being weighted differently gives the clear picture of each dimensions . Finally score is developed for different power distribution companies calculated using methods discussed in Research Design and methodology section.

Measuring Individual Components

Each technology identified in the research which has been used by the power Discoms are well defined in order to measure the level of technology implementation. The measurement of the technology implementation is being done using indicators against each technology.

Category	Technologies	Indicators	Definition
Metering	Installation of Electronic Meters -LT Consumers	Reduction of AT&C Losses.	Decrease in AT&C losses over the years
		100 % Metering of Consumers. Increase in electricity consumption	% People having electronic meters
	AMR for Feeder Meters	Availability of real time electrical parameters on web	Automated capturing & monitoring of data from Meter
	Prepaid Metering	% of prepaid meters installed in the Discoms	Total no of prepaid consumers by total consumers
IT Distribution Apps	Energy Accounting System	Area Wise Loss Report	Divisionwise/Circlewise loss report
		Feeder/DT wise Loss Report.	DT wise Loss Report.(Year)/Chapter)
		Identification high loss/theft clusters	Use of energy accounting system to identify areas/pockets with high losses
	SCADA	Remote Grid Operation.	Manless Grids of Discom
		Online Monitoring	Centralized SCADA Centre
	Load Forecasting Applications	Use of IT in forecasting load	Load Forecasting application is being done using software or application
	Meter Data Management System	Existence of analytics based Reports	Prevention of theft & various reports based on data collected from meters by use of analytics
	Outage Management System	Intimation to Consumers about outage on web.	Providing accurate Information on the extent of outages and number of customers affected.
		Outage Data History/Causes	Identifying the location of fuse(s) or breaker(s) that operated to interrupt a circuit or portion of a circuit
		No of Outages data	Data Availability of no of outage area wise per day on software application .
	Geographical Information System & Network Analysis	Network Mapping	Network Maps availability on website
		GIS Based customized applications	Availability of customized GIS Applications
		Customer care offices on GIS	Mapping of Discom Offices.
	Smart Grid Pilot Project	Ministry of power reports.	
Customer Information System	Centralized Call Centre	Time Taken for new Connection /Details of all consumers in IT system	Discom maintains all consumers details in IT module / Time taken to new connection from Discom
		Awareness about energy conservation tips	Awareness among consumers to save electricity and reduce their bills.
	Centralized Call Centre	Round the clock customer care No	Availability of Customer care no which is available round the clock

IT Retail Applications	Online Bill payment	A	Various types of Bill payment options on website of Discom
		Availability of Mobile App for Bill Payment	Availability of Mobile App on play store for payment facility
	E Complaint	No of Complaint resolved through E Complaint	
	Spot Billing	Collection Efficiency	Consumers gets bill at spot when meter comes in his home to take reading
Enterprise level Apps	ERP Module for Finance	ERP Module implementation for Finance Dept	Financial Details Of Discom on ERP
	ERP Module for HR	Payroll Details login to employees.	Payroll details of all employees are in ERP
	ERP Module for HR	Online leave/attendance	Employees attendance management system is through ERP
	Performance Management System of employees	Appraisal and Performance of Employees using ERP Software	ERP platform is being used for appraisal system
	ERP for Assets Management	Tagging all equipment with IDs.	All Discom Assets are maintained in ERP

Table 2. The individual indicators within the Power Distribution Technology Index Framework

Data Analysis

Calculation of Power distribution Technology Index (PDTI)

Based on the data primary data collected by the researcher and also information derived from the secondary sources of information, technologies in each category has been assigned a marks out of 5 which helps in judging the level of technology implantation in the Discoms.

Formula for Power Distribution Technology Index

Power Distribution technology index is an indicator of extend of the technologies being used by the Discoms and also how

this has helped in reducing their operational efficiency.

Total Technology Score = Summation of Individual Technology Scores of Discoms

Power Distribution Technology Index of Discom = Summation of (Weights * Individual Technology Indicators Score)

Power Distribution Technology Index = Score of [Metering + IT Distribution Applications + IT Retail Application + Enterprise Level Application]

The table below shows the different technologies taken up for study and their individual scores and weights-

Sl	Category	Technologies	Total Score	Weights	Avg Score (Delhi)	Avg Score (Haryana Discom)	Delhi Weighted Score	Haryana Weighted Score
1	Metering	Installation of Electronic Meters -LT Consumers	5	0.4	4	4	1.6	1.6
		AMR for Feeder Meters	5	0.05	4	3	0.2	0.15
		Prepaid Metering	5	0.05	4	1	0.2	0.05
		Energy Accounting System	5		5	2	0.75	0.3
		SCADA	5		5	1	0.75	0.15

2	IT Distribution Apps	Load Forecasting Applications	5	0.15	4	1	0.6	0.15
		Meter Data Management System	5		5	1	0.75	0.15
		Outage Management System	5		5	1	0.75	0.15
		Geographical Information System & Network Analysis	5		5	2	0.75	0.3
		Smart Grid Pilot Project	5		1	0	0.15	0
3	IT Retail Applications	Customer Information System	5	0.2	5	4	1	0.8
		Centralized Call Centre	5		5	3	1	0.6
		Online Bill payment	5		5	4	1	0.8
		E Complaint	5		4	3	0.8	0.6
		Mobile Apps	5		4	1	0.8	0.3
		Spot Billing	5		5	4	1	0.8
		ERP Module for Finance	5		5	1	0.75	0.15
		ERP Module for HR	5		4	1	0.6	0.15
4	Enterprise level Apps	Performance Management System of employees	5	0.15	5	1	0.75	0.15
		ERP for Assets Management	5		5	1	0.75	0.2
			100	1	89	39	14.95	7.55

Table No 4. Discoms Power Distribution Technology Index Score

Category	Total	Delhi	Haryana	Delhi %	Haryana %
Metering	15	12	8	80	67
IT Distribution Apps	35	30	8	86	27
IT Retail Apps	30	28	18	93	64
Enterprise Level Apps	20	19	4	95	21
	100	89	38		

Table 5. Scores of individual technology of Discoms

Relation of Power Distribution Technology Index and AT&C losses

After evaluation of technologies being used by power distribution companies using power distribution technology index, researcher tried to find out whether there is any relation between AT&C losses

incurred by Discoms and level of technologies being implemented.

The loss figures of the Discoms and their technology index is shown in the figure below:

		AT & C Losses					
DISCOM	Technology Index	2003	2005	2007	2009	2011	2013
Delhi Discom	22	45	36	27	22	19	
Haryana Discom	10	38	34	26	26	23	

Source AT&C Loss: Ministry of Power Reports

Table 7. Loss Trends of Discoms with Technology Index

The figures shows below the Discoms loss trajectory with respect to years which also be compared with the technologies index computed for these Discoms.

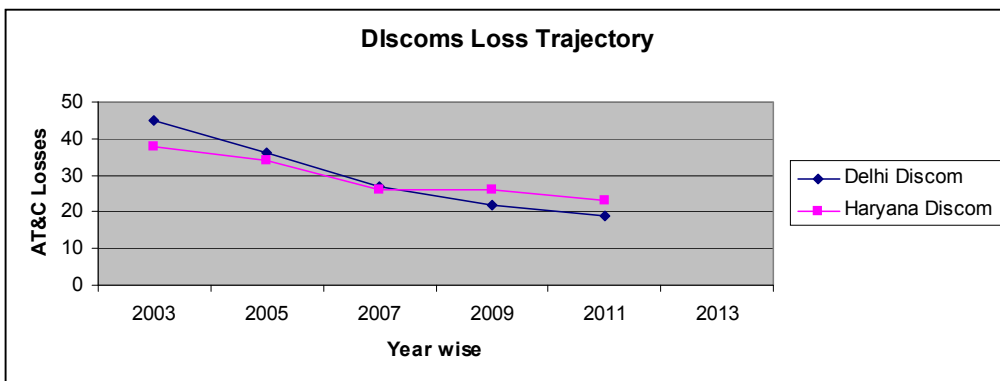


Fig 4. Discoms Loss Trajectory

Conclusion

The power distribution utilities in India are have already implemented few IT and automation technologies and the rest are in the different stages of implementation of these technologies. Based on the data collected through survey and interviews and further analysis the results were derived, there is difference in level of technology implementation in power distribution companies. The power distribution technology index is a clear indicator of

technology implementation in Discoms which clearly shows PPP Discoms score better than Govt Discoms in National Capital region. If we closely look at AT&C losses at these Discoms we can clearly see Discoms with higher index have been able to reduce their AT&C losses as well. But if observe at the loss levels of the both Discoms there is not much difference in loss level but huge gap in terms modern technology implementation in both Discoms.

One of the key outcomes of the research which gives answer to AT&C losses and technology was Metering. Metering for all and replacement of electronic meters from mechanical meters increase income of the Discoms and which substantially led to lowering of the AT&C Losses. Metering for all initiative and conversion of mechanical meters to electronic meters brought down AT&C level drastically in 2003-2005, the loss levels from 45% to 36%. Implementation of Information Technology cannot be directly responsible for drastic reduction in AT&C losses. Technology takes its own time for acceptance among users and brings affects on AT&C losses. AT&C depends directly on many factors & especially commercial losses & social economic conditions where sometimes technology has to play little role. Information Technology implementation in billing also led to increase billing efficiency of the Discoms which in turn led to reduction of AT&C losses.

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