

SYNOPSIS

**Strategic Technology Management in Power Distribution Companies
with Specific Reference to National Capital Region of India**

**Doctoral Thesis submitted
In partial fulfillment of the requirements for the award of the degree of**

DOCTOR OF PHILOSOPHY

In

MANAGEMENT

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Introduction

Just like in other sectors, effective deployment of Information and Communication Technologies (ICT) in Power Industry can help in building a strong and efficient power distribution system. The power of technology has already been leveraged effectively by electric utilities in the developed countries. However, the use of technology in electric utilities in India is significantly less effective, when compared to developed countries in the world. Inefficiency in the electricity distribution system results in high Aggregate Technical and Commercial (AT&C) losses, poor quality of power and reduced reliability of power supply to consumers, leading to consumer dissatisfaction. It also affects the financial health of these utilities. Such of the Indian Electrical Utilities, which harnessed the power of these technologies have succeeded in lowering their AT&C losses to a great extent, thereby improving their financial health and customer satisfaction.

Strategic Technology Management life cycle in any sector consist of eight phases , starting with technology creation, monitoring , assessment, technology transfer, technology acceptance, utilization, maturity and decline. Out of these phases, three phases – technology assessment, acceptance (by employees and customers) and utilization – are critical for effective utilization of any technology in any sector.

A preliminary literature survey revealed that no in-depth research was conducted so far, on Strategic Technology Management in Power Distribution Companies (Discoms) in India. In view of the above, this research was taken up to study three critical phases of Strategic Technology Management (technology assessment, acceptance (by employees and customers) and utilization) in four Power Distribution Companies in National Capital Territory Region of India.

Strategic Technology Management life cycle starts with technology creation, then monitoring and next move to Technology assessment. Out of eight phases of life cycle, three areas selected for this research are technology assessment, technology acceptance and technology utilization

Technology Assessment: Focuses on assessment of suitability of different technologies for deployment in a power utility, considering the benefits and ease of implementation.

Fig 1 Strategic Technology Management Life Cycle and Selected areas of research

Technology Acceptance: refers to the acceptance of the Technology by the employees and customers of the Electrical Utility. Since a number of technologies are used in a power distribution system, it is difficult to study acceptance of all technologies. So, only one of technologies i.e.; Geospatial Technology was taken up for study.

Technology Utilization: phase of Technology Management Life Cycle was selected for studying. the utilization of technologies and how it helps the organization, in increasing operational efficiency by building awareness on the services provided by the Discom among its consumers and addressing their day-to-day problems.

Problem Statement and Research Focus

The research taken up attempts to make assessment of major technologies, used in the four power distribution companies in National Capital region.

Of the various ICT technologies being used in power distribution system, web technologies has been taken up as assessment study for the research and GIS has been taken as technology adoption and diffusion in the power distribution system.

The purpose of this research is assessment of websites of power distribution companies in National Capital Region. Key factors considered as determinants of Web site quality were identified & is quoted in literature. The user online website assessment tools were used for assessment for various parameters.

The research work also tries to assess the level of technologies implementation in power distribution companies in National Capital Region. The research aims at developing Technology Implementation Index which provides information about various information/ communication & automation technologies used by Power Distribution companies.

The research tries to find out factors responsible for adoption and diffusion of geospatial technology in power distribution companies in National Capital region. The study was carried using questionnaire based from Discoms Staff to gather information and understands various which held responsible for use of technology in power Discom. Research focuses to determine the levels of user intention to adopt the GIS and to investigate the relationship between user acceptance factors and user intention to adopt the GIS in power distribution system.

GIS technologies are still in nascent stage in terms of technology acceptance and diffusion in the power companies. The research is an attempt to investigate and assess the factors affecting the use of GIS technologies among state owned and quasi-government se companies in National Capital region.

The study wrap up by submitting recommendations and conclusions, encapsulating the research outcome, directions for future research in expanding penetration and use if technologies in power distribution companies in India.

Research Objective Funnel

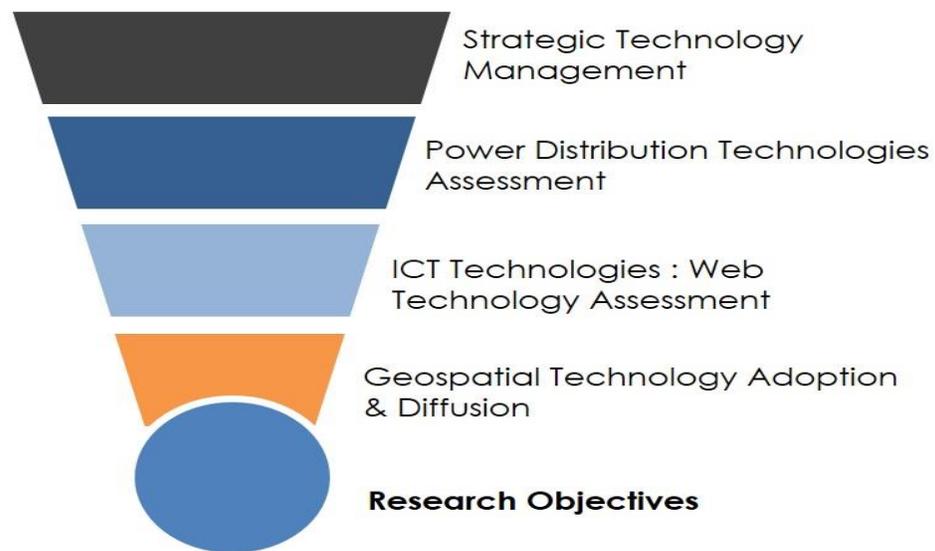


Fig 1 Showcasing research objective Funnel.

The research work focuses on the need of robust website for power Discoms as it is one of the most important links between Discom and consumers directly. The research tries to identify the critical parameters, which play important role in building the website and how factors like response time play crucial role in addressing major issues of the consumers. The research makes assessment of the websites of distribution companies in NCR based on different parameters defined in the new framework discussed in later chapters of the thesis. The research work tries to develop new framework for assessment of technologies used in power distribution industry. The new framework takes into consideration factors which are required in developing power distribution Index.

Adoption and diffusion of technologies is a matter of concern for most of Power Discoms in India. One of the main rationale of the research was to find out how employees of quasi-government and government power distribution companies were utilizing geospatial technologies in their organization and various factors that was associated with level of utilization

- Determine level of accessibility to geospatial technologies
- .Determine current utilization of technology by staff in the organization.

Research to determine the levels of user intention to adopt the GIS and to investigate the relationship between user acceptance factors and user intention to adopt the GIS.

Literature Survey

Initially, Literature survey was conducted to focus on research work done so far, in area of Strategic Technology Management in general and specifically in power distribution sector in India and abroad. Subsequently, literature was reviewed in each of the specific areas, selected for this research. Literature related to Technology Acceptance and adoption and diffusion of technology was also studied. Summary of the research done so far was documented and gaps in research were identified.

LITERATURE SURVEY PROCESS

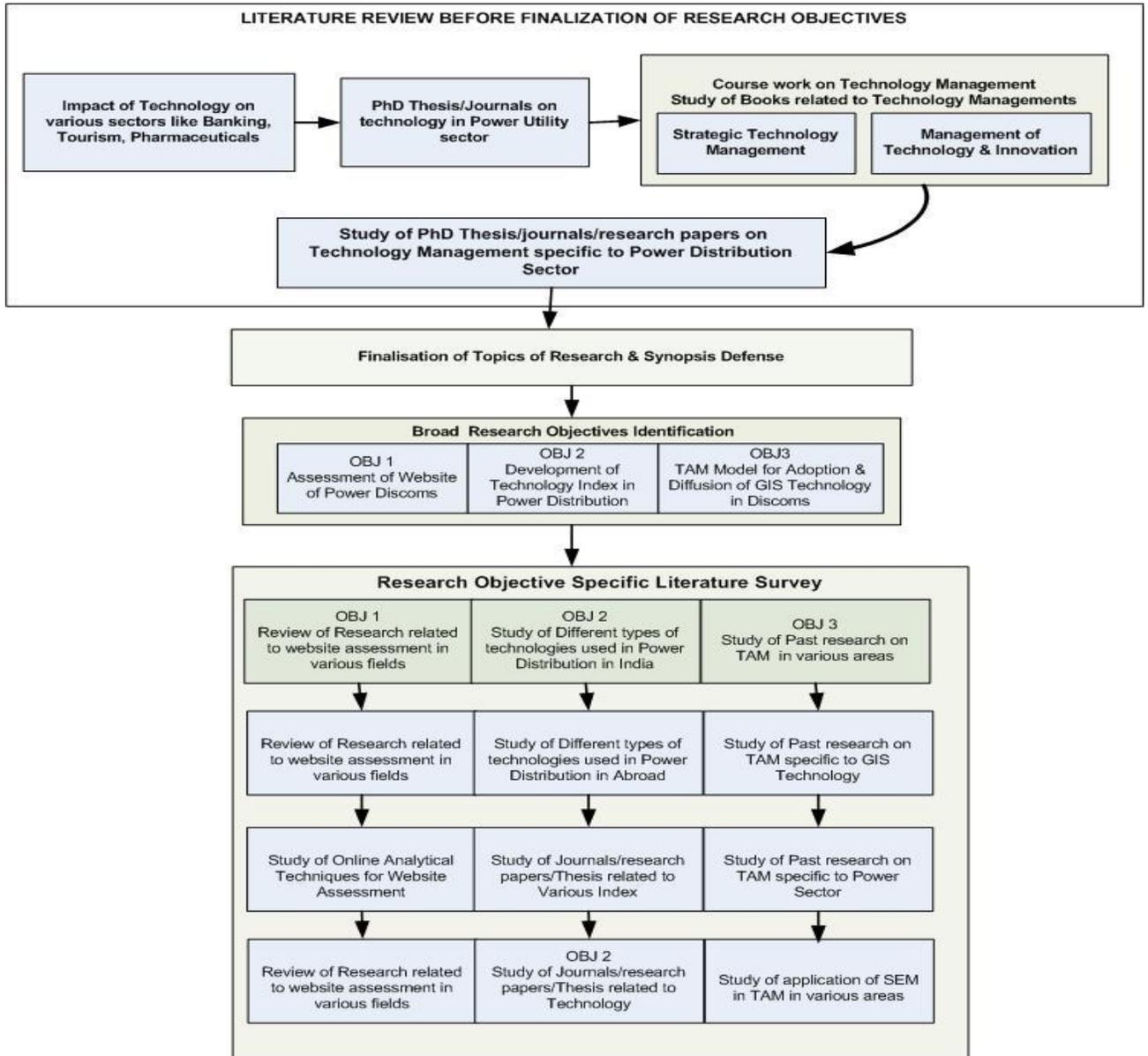


Fig 2 Literature Review Process

The literature survey done is broadly classified into following broad topics:

- Technology Management in Power Distribution sector in India
- Technology Management in Power distribution Sector Abroad
- Website Assessment.

- Power Distribution Technology Implementation Index
- Adoption & Diffusion of GIS in Power Distribution System
- Acceptance of GIS based on TAM Model

Following is the summary of literature reviewed, relevant to the research topic.

Summary of Literature Survey						
S No	Broad topic	Type of literature surveyed				
		Articles	Thesis /Project Reports	Seminar proceedings	Total	Relevant to topic
1	Technology Management in Power Distribution sector in India	8	1	2	11	11
2	Technology Management in Power distribution Sector Abroad	3	6	2	11	11
3	Website Assessment.	7	7		14	14
4	Power Distribution Technology Implementation Index	8	12		20	20
5a	Technology Acceptance Model in different Sectors	17	3	3	23	23
5b	Acceptance of GIS based on TAM Model	4	5	2	11	11
					0	
	Total	47	34	9	90	90

Table 1 Summary of Literature reviewed

Gaps in Contemporary Research and Identification of Research areas.

Following Table gives the research areas taken up, after identification of the gaps in the literature surveyed

Summarization of Research Conducted, Research Required and Validations of the research Objectives			
SL No	Research Conducted , so far	Research gap	Validations of research topic and objectives
1	Research Papers indicates research efforts has been done in India towards technologies being used in power distribution sectors and various innovations. But most of the research study few technology is discussed and the complete research in which all technologies are considered in integrated environment and its impact on company losses is still. Missing	The requirement is study all technology in integrated environment and study its correlation and impact on AT&C losses and power distribution company performance.	Identified research gap validates the research objective 2.
2	Research Conducted till date in areas of implementation and development of Technology Index in many sectors like banking , pharmaceutical etc. in India and no research could be found on development of Power distribution technology Index	The requirement is develop the Power Distribution Technology Implementation Index in Indian context	Identified research gap validates the research objective 2 with reference to National Capital Region of India.
3	Research Conducted till date on website assessment has been in developed countries like Europe , US and Asian developed countries Specific to India very few research could be found and also power sector has been completed missed out	The requirement is develop the Website Assessment Index for power distribution companies in India and compare them	Identified research gap validates the research objective 1 with reference to National Capital Region of India.
4	Research Conducted till date in areas of GIS technology adoption in various sectors has mainly been in Europe, USA and Australia. Recent research of South East Asian Counties has also been reported. So the survey data discussed in the research papers present the status of adoption of Geospatial Technologies in these regions	The requirement is to study effective adoption of GIS in India as still GIS is in nascent stage in India across various sectors.	Identified research gap validates the research objective 3
5	Not much of Research conducted till date in areas of GIS technology adoption in in power distribution sector in Europe, USA and Australia..	The requirement is to study effective adoption of GIS in India in power distribution sector which is still has to go long way in harnessing the advantages of this technology	Identified research gap validates the research objective 3 with reference to National Capital Region of India.

Table 2 Gaps in Contemporary Research and Identification of Research areas

Research Methodology

The research methodology involved collection of data from all relevant respondents using questionnaires, which was supplemented with capture of secondary data so that they can be correlated. . The research was broadly divided into three phases based on the objectives for research. Extensive literature survey was done before the finalization of the research objectives by identifying the gap in the research. After research objectives were finalized, literature related to objective specific was done in order to understand the insights of the research work done earlier and identify the research variables to construct and data collection.

Literature review related to objective specific was done separately for all three objectives. Then questionnaire was framed based on research variables defined and data was collected. The data was collected using both qualitative as well quantitative methods for the surveying. The results were analyzed and inferences were drawn.

The figure below depicts the complete research process adopted during the research.

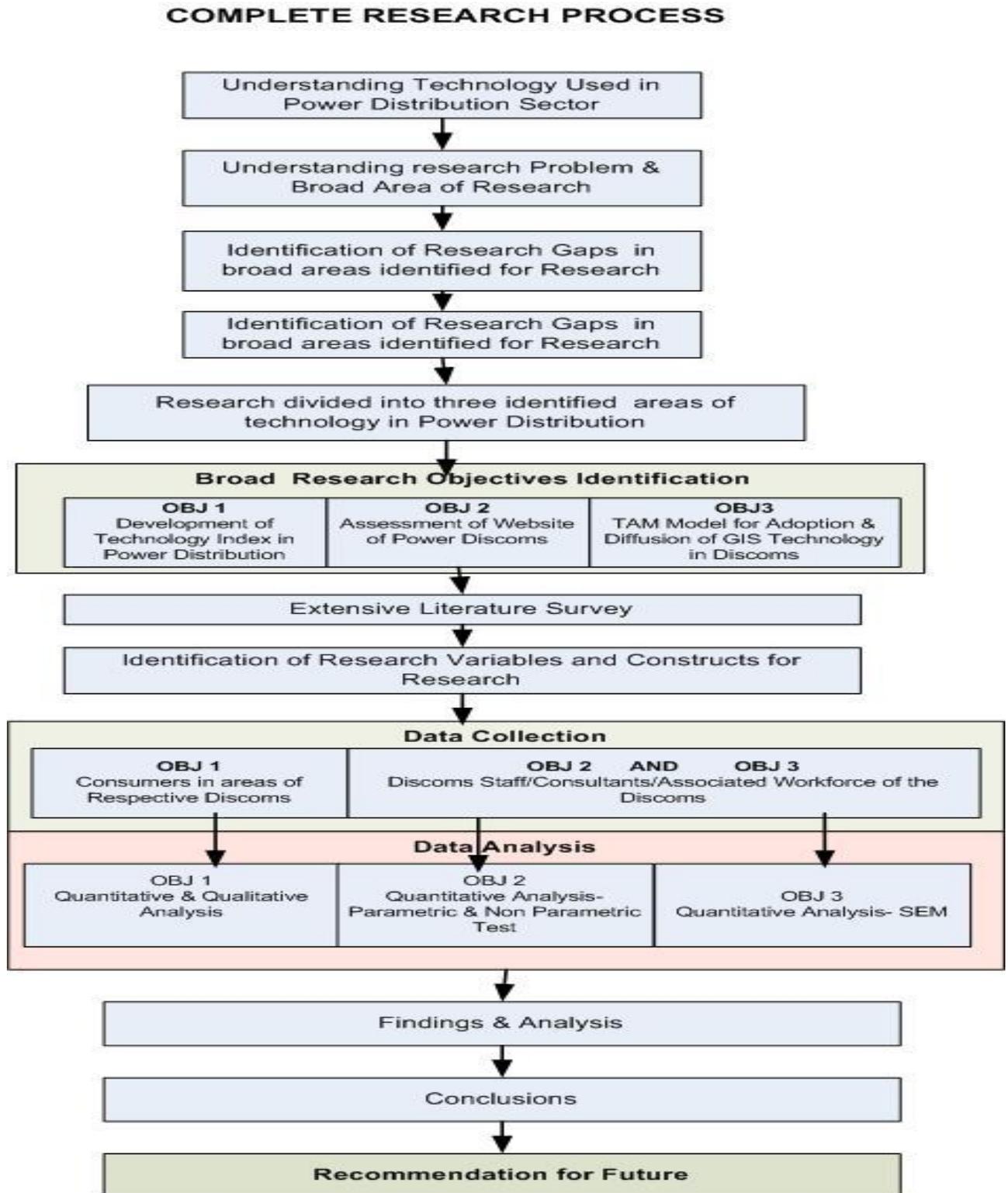


Fig 3. Complete Research process designed by Researcher

Research Objectives and Hypothesis

Following objectives were identified for the research:

Objective 1. 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 research also tries to find out correlation between the AT&C losses incurred by the power utilities over the years and level of automation and information technologies they have applied in improving their system.

Hypothesis based on technological implementation level

- H0- The level of technology implementation is same in power distribution companies.
- H1- There is difference in level of technology implementation in power distribution companies

Hypothesis based on relationship

- H0: There is no correlation between technology implementation index & AT&C loss of power distribution companies.
- H1: The technology implementation index & AT&C loss are correlated in power distribution companies.

Objective 2. To develop a Website Assessment Index for assessment of quality of websites of power distribution companies in National Capital Region.

Hypothesis regarding the website assessment of Power Discoms

H01: There is no significant correlation between total web quality and four categories of website assessment in power distribution companies in National Capital Region.

H02: There is no significant difference in the power utility wise website Assessment among the power distribution companies in National Capital Region.

H03: There is no significant difference in the category-wise Website assessment among the power distribution companies in National Capital Region

H04: There is no difference in adequate accessibility, speed, navigability, and content quality category wise web quality of Website assessment among government & private distribution companies in National Capital Region.

Literature survey, study of several of various government reports and deep understanding of technology management of Power Distribution companies has resulted in the formulation of the research hypothesis.

Objective 3. To investigate and assess the factors affecting effective use of Geospatial technology in Power Distribution companies in National Capital region.

Hypothesis covering factors which affect adoption of GIS adoption

H1: Discoms Staff attitude (AT) for GIS has a favorable impact on intention (INT) to practice the system.

H2: Perceived Ease of Use (EU) has an encouraging impact on attitude (AT) of Discoms Staff.

H3: Perceived Ease of Use (EU) has an encouraging impact on Perceived Usefulness (PU) of Discoms workforce.

H4: Perceived Usefulness (PU) has an encouraging impact towards Intention (INT) of Discoms workforce.

H5: Perceived Usefulness (PU) has a promising stimulus on Attitude (AT) of Discoms Staff.

H6: Efficiency Gain (EG) has an encouraging impact on the Perceived Usefulness (PU) of Discoms Staff.

H7: Discom Organization Culture (DC) has a favorable influence on Intention (INT) of Discom staff.

H8: Top Management Support & Govt Initiatives (MS) has encouraging impact on Intention (INT) of Discom staff.

H9: Employees Age & Years of Experience (AE) has an encouraging effect on Intention (INT).

H10: Discom Process Engineering (PE) has an encouraging effect on Attitude (AT).

Research Methodology

For research objectives 1, quasi-government owned Discom of Delhi and Govt owned Discom of Haryana were mainly officials who were having expertise of technologies were selected, 117 from Delhi Discom and 106 from Haryana Discom were surveyed using a structured questionnaire.

For research objectives 3, Quasi government owned Discom of Delhi and Govt owned Discom of Haryana, 204 from Delhi Discom and 200 from Haryana Discom staff and officials were surveyed using a structured questionnaire.

It was supplemented with qualitative analysis through focused group discussions / interviews with officials, who are conversant with adoption and diffusion of technology in Power Discom companies. The researcher also made use of different methods of grounded theory like historical documents, observations and reports to get insights into the level of technology implementation in power distribution companies in National Capital Region.

Total Technology Score = Summation of Individual Technology Scores of Discoms

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

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

For the Research Objective -2, five power distribution companies in National Capital Territory were selected and responses were captured from their urban LT (Low Tension) Connection consumers of the companies using questionnaires.

Sl No	Power Discom Company	Serving Geographic Area	Total LT Consumers (Approx.)	Calculated Sample Size needed for 95% confidence level	Responses Received
1	BRPL	South & West Delhi	17,87,018	384	410
2	BYPL	Central & East Delhi	10 78 272	384	386
3	NDPL	North Delhi	1000000	384	391
4	DHBVN	Gurugram	200553	384	384
5	PVVNL	Noida	149510	384	390

Apart from this, online tools for website assessment were also used. These online tools assess the websites on the basis on multiple parameters, after taking inputs from the customers that browse the sites.

The study clearly reveals that significant correlation between total web quality and four categories of website assessment in power distribution companies in National Capital Region. Overall web quality clearly depends upon on other categories of Web assessment Index.

SL	Power Distribution Company	Accessibility (15)	Speed (15)	Navigability (15)	Content Quality (55)	Total Web Quality (100)
1	BSES	14	14	15	50	93
2	NDPL	11	14	15	51	91
3	Haryana Power Discom	12	12	12	47	83
4	UP Power Discom	9	10	11	33	63
	Total	46	50	53	181	330

Table 3 Cross Tab Analysis

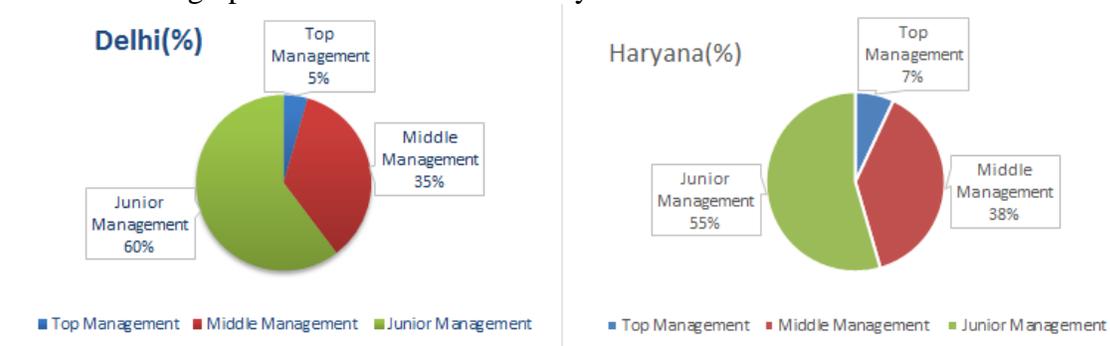
- Calculated $\chi^2 = 18.9$; Tabulated χ^2 at 5% = 16.92
- Degree of Freedom- $3*3 = 9$
- Level of Significance – 5% i.e.; .05
- Calculated χ^2 is greater than χ^2 table value. So, we have sufficient evidence to reject H_0 . This clearly suggests that there are differences in the various parameters of web sites of power distribution companies in National Capital region.

The research design framed from literature review led to development of various constructs with indicators for technology assessment and adoption in power distribution companies helped in identifying factors that facilitated or hindered the GIS current technology adoption and diffusion level. The variables ie; exogenous and endogenous defined in the construct for research were analyzed through SEM Method through AMOS software Version 21.

Demographic Surveyed Data for Delhi and Haryana Discoms

Analysis of respondent profiles of Discoms						
	Delhi		Haryana		Total	
Level of Management	No	% of total	No	% of total	No	% of total
Top Management	9	4.4%	14	7.0%	23	5.7%
Middle Management	72	35.3%	77	38.5%	149	36.9%
Junior Management	123	60.3%	109	54.5%	232	57.4%
Total	204	100.0%	200	100.0%	404	100.0%
Experience(In years)						
0-5	17	8.3%	79	39.5%	96	23.8%
5-15	130	63.7%	85	42.5%	215	53.2%
15-25	45	22.1%	36	18.0%	81	20.0%
25 and above	12	5.9%	0	0.0%	12	3.0%
Total	204	100.0%	200	100.0%	404	100.0%
Qualification						
Post-graduates	12	5.9%	23	11.5%	35	8.7%
Graduates	155	76.0%	103	51.5%	258	63.9%
Diploma	37	18.1%	41	20.5%	78	19.3%
ITI		0.0%	33	16.5%	33	8.2%
Total	204	100.0%	200	100.0%	404	100.0%

Table 4 Demographic Data of Delhi and Haryana Discoms



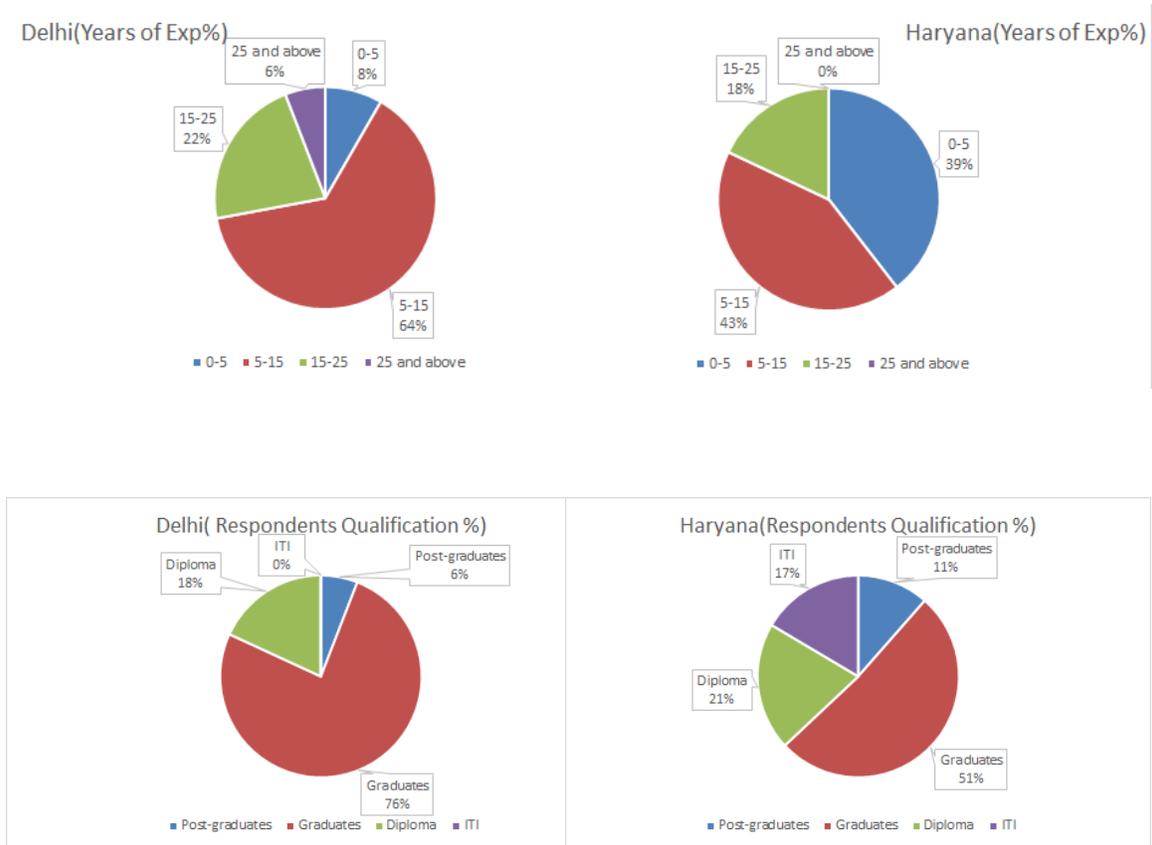


Table 4 Pie Chart representing Demographic Data of Delhi and Haryana Discoms

Findings

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. Thus better the technology Index lower is the AT&C losses.

The findings of this research study suggests that there are significant differences in the quality of power distribution companies web sites of National Capital region , especially the PPP(Public Private Partnership) companies score high in respect of content, usability, and navigation. Also there is significant difference in various parameters of websites for

power distribution companies taken in the study. The state run power Discoms are falling behind in meeting the information and service needs of their citizens and are at the early stages on the maturity curve, in so far as the effectiveness of their web sites is concerned.

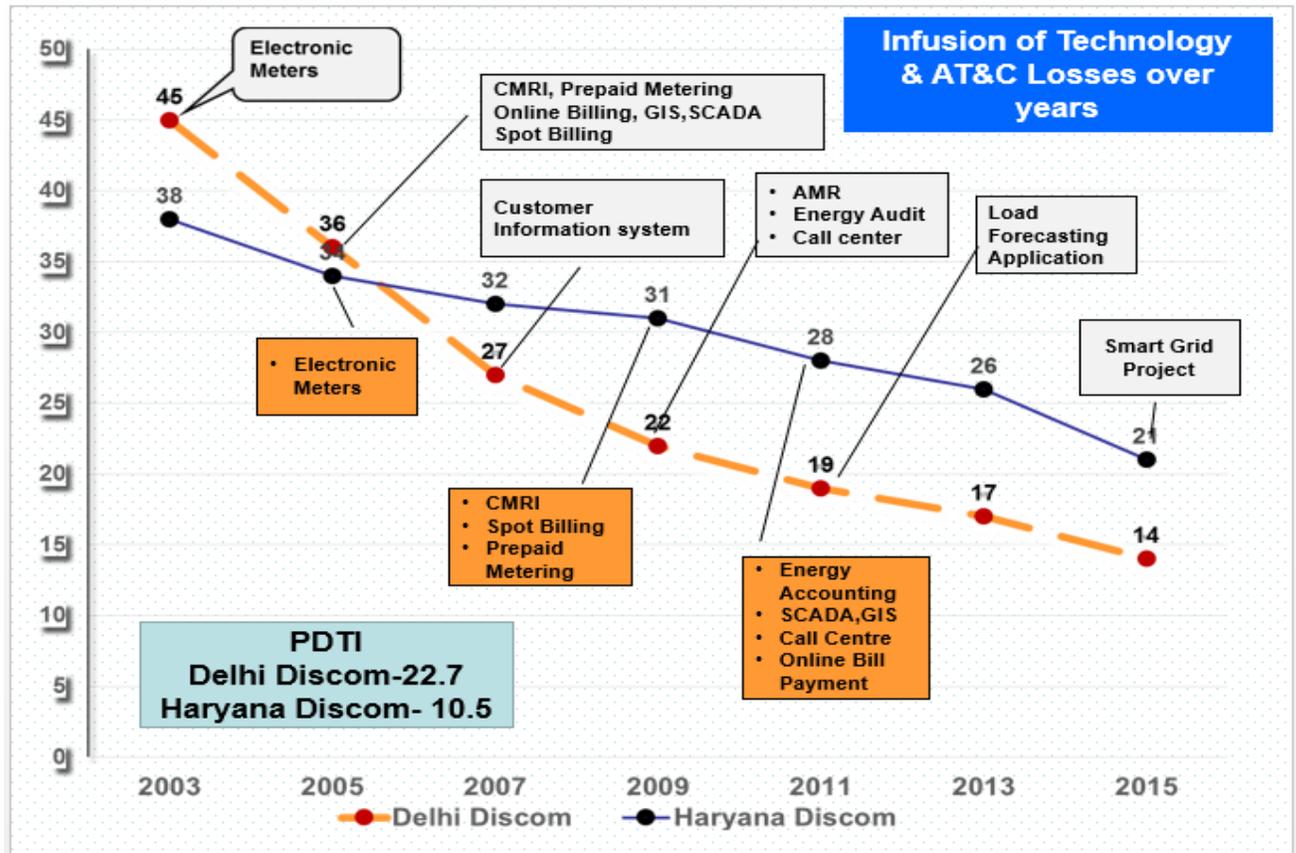


Fig 5 Infusion of technologies and AT&C losses over the years

Analysis of Assessment of websites of power distribution companies

The findings of this research study suggests that there are significant differences in the quality of power distribution companies web sites of National Capital region , especially the PPP(Public Private Partnership) companies score high in respect of content, usability, and navigation. Also there is significant difference in various parameters of websites for power distribution companies taken in the study. The state run power Discoms are falling behind in meeting the information and service needs of their citizens and are at the early stages on the maturity curve, in so far as the effectiveness of their web sites is concerned.

Analysis on Acceptance of Geospatial Technology among Workforce in Public Private Partnership Discom

The study reveals that Ease of use has positive influence on perceived usefulness. Though GIS Technology may be not very easy to use, Discoms staffs are interested to learn it, if geospatial technology can help in their day to day work and make their work easier. Discom internal teams demonstrated the user group usefulness of the geospatial technology and how their present process can be improved using GIS. Since the majority of the Discoms staff comprise employees inherited from parent SEB (State Electricity Board) whose average age group are mainly above 50 are more concerned about usefulness of the technology and ease of use of technology. The study clearly suggests a strong positive relationship between ease of use of technology and usefulness. If the use of technology is easy and handy , with user friendly interface the user take lot of interest and has positive influence on attitude of the user referred here as Discom staff. Lots of training programs are organized for the staff to percolate the ease of use of geospatial technologies and made them friendly with GIS system. The training programs highlights easy reports and information which are required for which they have run post and pillars can accessed using GIS system without much difficulty. Thus ease of use one of important factor for acceptance of the technology in Power Discoms. Social Influence refers to working environment within the organization which are in favor or against the use of GIS technologies. Social Influence is one of the important factor determining the use of technology for technology implementation to be successful social acceptance among seniors as well among the middle management is mandatory.

The results suggest that if the top managers and middle managers consistently support and encourage use of technology; it has strong influence on acceptance and adoption of geospatial technology in power distribution. The study revealed that some managers, with support from middle managers, have re-engineered many processes and enabled them GIS based. This enabled initially reluctant users to deploy GIS and reap the benefits

of the technology in this process. This is also very evident from the study which shows strong positive relationship between social influence and intention to use geospatial technology.

Findings Analysis on Acceptance of Geospatial Technology among Workforce in Government owned Discom in Haryana:

The results obtained after SEM analysis using AMOS gives some important and interesting results about acceptance of GIS technology in Govt Discoms. Ease of Use and Efficiency Gain, we can clearly see have positive impact and influence on Perceived Usefulness but Perceived Usefulness has negative impact on both attitude as well as Intention. This implies that GIS application which is built for Discoms staff may be easy to use but they cannot be able to still conceive how this will help in their day to day operations and help in solving their problems.

It can be concluded that GIS tools and applications should be aligned with requirements of user Depts and helps in solving them. Discoms can also depute few staff from various departments on short term basis so that they can help GIS Dept. in requirement analysis. Ease of Use has positive influence on attitude but perceived Usefulness has negative influence on attitude which means staff mindset is positive in using GIS technologies as they find them easy .Discoms should form a team or task group which may involve GIS core people along with business process staff from different Depts to understand the ground realities problem faced by the user depts. Social Influence has negative influence on intention which means that atmosphere and work environment is not very favorable and good for use of GIS. Negative Influence also suggests many times senior management staff discourages the use and significance of GIS which has negative impact and intention on workers staff.

The research shows that majority of the staff of both Discoms who were working much more concerned and reluctant to technology adoption and diffusion due fact of fear of loss of their value and job. On the other Discoms staff in middle management were not very much concerned with the change in technology taking place. The senior

management of both Discoms were very positive in taking measures for adoption and diffusion of technology in their respective Discoms. This clearly relevant from the demographic profile of the respondents among who majority of them from junior management cadre.

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Significant Contribution to Management Domain

The author has used various techniques to carry out the research and arrive at conclusions and based on that the author feels the following research contributions has been made in the field of research in this area:

- As per literature survey findings, such study and survey on technologies used in Indian Power Distribution sector has not been conducted till date. Thus, this research paves the way for researchers and industry to understand the issues in acceptance of technologies in this sector
- Websites and Portals are fast becoming convenient platforms for customers not only to access useful information but also to make bill payments, lodge customer complaints etc. However customers use them only if the websites are user friendly. So far, no research was done on acceptance of web technologies by customers of Indian Power distribution companies. This research provides insights into critical factors for use of websites of the Power Distribution Companies by the users. This research study also formulated an index for website assessment , factoring the parameters

- As multiple technologies are deployed in power distribution sector, an overall Technology Assessment Index is proposed for the first time to assess deployment of technologies in power distribution sector. Technology Assessment Index can be used as tool for comparative assessment of technologies in use in different companies. It can also be used as a bench marking tool by policy makers in ranking the states based on Technology Assessment Index.
- The research study establishes the relevance of qualitative methods of research especially the grounded theory which has been used by the researcher in the research and this can form base of similar types of research of other locations too.
- Since the research was conducted for quasi-government and government power Discoms in Delhi NCR, the same research methodology can be used to study the same in other Indian States too, giving due consideration to prevailing social and cultural factors .
- Considering that technology acceptance by employees and customers are critical for enhancing operational efficiencies of all industries, the same methodology can be adopted with modifications, if needed, for taking up studies in other sectors, as well.

Limitations of the Research Study

Research covered only four Power distribution companies of National Capital Region, which are government owned or quasi-government. It did not cover any wholly privately owned Power Discoms. With regard to customers, it covered only LT consumers and did not cover any High Tension (HT) Customers. Also, only one technology among the various technologies being used up in the power distribution sector i.e.; GIS has been taken up to study adoption and diffusion of technology in power distribution company. Besides, it could not capture any financial or commercial information with regard to the benefits of technology utilization, due to confidentiality issues..

Recommendation for Future Work

- Research can be conducted in other regions / states of India, where most of these technologies may be in different stages of implementation. Studies may also focus on the reasons for failure of Accelerated Power Development Reform Projects, started by Ministry of Power, Government of India.
- Research can also be conducted in other countries with similar socio-economic conditions as India, like South Asian and African countries.
- The research can be further extended and in depth research can be carried out on adoption and diffusion of other technologies like SCADA, automation etc.

Conclusion

The first objective of this research is achieved in form of development of comprehensive index, viz., Power Distribution Technology Index (PDTI). This Index which was applied for evaluation of technologies implementation in Discoms. The research led to interesting results of correlation of technology and AT&C losses.

The second objective resulted in assessment of website of power distribution in National Capital region based different defined parameters and hence the quasi-government companies score high in respect of content, usability, and navigation than state owned counterparts.

The last objective of research of assessment of Adoption & Diffusion of GIS among State Owned & Quasi Government Power Distribution Companies in NCR helped in development of new research model which was used in this research to assess the Quasi-government companies and state government companies in Power Discom.

Similar types of research assessment can also be done for any other companies in India using research Model.