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

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In partial fulfillment of the requirements for the award of the degree of

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In

MANAGEMENT

By

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THESIS COMPLETION CERTIFICATE

This is to certify that the thesis on "**Strategic Technology Management in Power Distribution Companies with Specific Reference to National Capital Region of India** "submitted by Mr. Varun Prakash, in Partial fulfillment of the requirements for the award of the Degree of Doctor of Philosophy is an original work carried out by him under our joint guidance. It is certified that the work has not been submitted anywhere else for the award of any other diploma or degree of this or any other University**.** We also certify that he complied with the Plagiarism Guidelines of the University.

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DECLARATION OF AUTHORSHIP

I declare that this thesis titled "Strategic Technology Management in Power Distribution Companies with Specific Reference to National Capital Region of India" submitted by me in partial fulfillment of the requirements for the award of the degree of Doctor of Philosophy in Management of the ICFAI University Jharkhand, Ranchi is my own work. It contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or another institute of higher learning, except where due acknowledgment has been made in the text. I further state that I complied with the Plagiarism Guidelines of the University while preparing the thesis.

Varun Prakash

Date:

Place:

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Abstract

Effective Deployment of Information and Communication Technologies (ICT), in particular, Geospatial Technologies, can help the Power industry in performance improvement by building a strong and efficient power distribution system. Inefficiency in electricity distribution system results in high AT&C (Aggregate Technical & Commercial Losses) 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.

The power of Technology has already been leveraged by electric utilities organizations in the developed countries, whereas deployment of ICT in India is significantly less, as compared to developed countries in the world. The states in India, which harnessed the power of these technologies have succeeded in lowering their AT&C losses to a great extent, thereby improving the financial health of organizations. The research work has assessed the level of ICT deployment in Discom at NCR and evolve Technology Implementation Index, which captures relevant aspects on the use of various information, communication & automation technologies in Power Distribution companies.

This research has assessed of websites of Discoms in NCR, involving key determinant factors for website quality.The research further tries to find the aspects affecting acceptance and dissemination of ICT, in particular, Geospatial technology in Discoms in NCR and explore the association amid user acceptance aspects and user purpose to implement the ICT technology. The survey has been carried out among the staff of Power Distribution Companies (Discoms) using a questionnaire to gather information on the level of usage of ICT and factors influencing the use of technology in Discoms. The research resulted in form of development of comprehensive index, viz., Power Distribution Technology Index (PDTI). Further research resulted in the assessment of website of power distribution in National Capital region based different defined. The major part of the research of assessment of Adoption & Diffusion of GIS among State Owned & Quasi Government Power Distribution Companies in NCR helped in the development of new research

framework which was used in this research to assess the Quasi-government companies and state government companies in Power Discom.

The study wraps up by presenting conclusions, encapsulating the research outcome and outlining directions for future scope of research on the topic.

THESIS LAYOUT

The research work described in the thesis is divided into 10 Chapters.

Chapter 1 starts with an introduction to the power distribution in India and worldwide. The chapter mainly discusses the AT&C losses situation in Indian and overseas power utilities and level of technology adoption in India compared to other countries of the world.

Chapter 2 discusses different types of the technologies used in the power distribution sector and also throws light in details about information technology, automation, and communication technologies used in power distribution sector.

Chapter 3 focuses on earlier research work done in areas of technology management in power distribution sector. A literature review related to technology acceptance model and adoption and diffusion of technology has been studied. Research work done on acceptance of GIS based on TAM (Technology Acceptance Model) is in detail. The research gaps after the literature review have been identified and listed.

Chapter 4 discusses in detail the objective undertaken for the research work. Each research objective which has been defined after a thorough analysis of research gaps in literature review and literature review is then defined ahead using hypothesis. Each research objective is then followed by hypotheses formulated for the research.

Chapter 5 gives a detailed description of the methodology followed to carry out the present study. The chapter also covers the research design, which includes understanding characteristics of the research problem, followed by definition of research variables.

Chapter 6 covers the website assessment and evaluation of four power distribution companies in National Capital Region focusing on various categories which are used to analyze the website of these companies.

Chapter 7 covers development of a new framework for the formulation of Power Distribution Technology Implementation Index. The chapter throws light on different

concepts and framework for the development of Technology Implementation Index and their comparison based on the parameters defined in the framework.

Chapter 8 covers the survey done on adoption of geospatial technologies among the quasi-government and government owned Discoms and also provides a comparative analysis of the results of the survey based on identified parameters.

Chapter 9 have research objectives taken one by one along with data analysis data performed by applying various statistical and analytical techniques including Chi Square, Correlation, Regression and Structural Equation Modelling using the research methods and techniques considered.

Chapter 10 summarizes the complete research study. Each objective was taken individually and based on analysis the conclusion are drawn for each objective. The chapter concludes by presenting the major findings leading to the significant research contribution, implications, and limitations of the research.

CONTENTS

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LIST OF FIGURES

LIST OF TABLES

List of Abbreviations

1. ICT- Information and Communication Technology
2. Discoms – Power Distribution Companies
3. AMR- Automated Meter Reading
4. AT&C – Aggregate Technical and Commercial Losses
5. BSES- Bombay Suburban Electric Supply Co
6. CRM-Customer Relationship Management
7. ERP- Enterprise Resource Planning
8. GIS- Geographical Information System
9. IT – Information Technology
10. NCR- National Capital Region
11. OMS – Outage Management System
12. PDTI- Power Distribution Technology Index
13. PLC- Programmable Logic Controller
14. PPP- Public Private Partnership
15. SEM- Structural Equation Modeling
16. STM- Strategic Technology Management
17. SCADA- Supervisory Control and Data Acquisition
18. TAM- Technology Acceptance Model
19. TPDDL- Tata Power Delhi Distribution Limited
20. WAI- Website Assessment Index
21. EHV-Extra High Voltage

Chapter 1

Introduction

Chapter 1: Introduction

1.1 Indian Power Distribution Industry & ICT

(With focus on current state and problem identification)

Power Systems mainly consists of transmission and distribution system in which power distribution system consist the final link to consumers from where the power is generated. Power saved is considered as power generated.The same concept can be applied if AT&C losses of our country could be reduced. Thereby financial health of Discoms could be improved. This will result in saving to Government. Although AT&C losses have declined in recent years as depicted in the below bar chart.

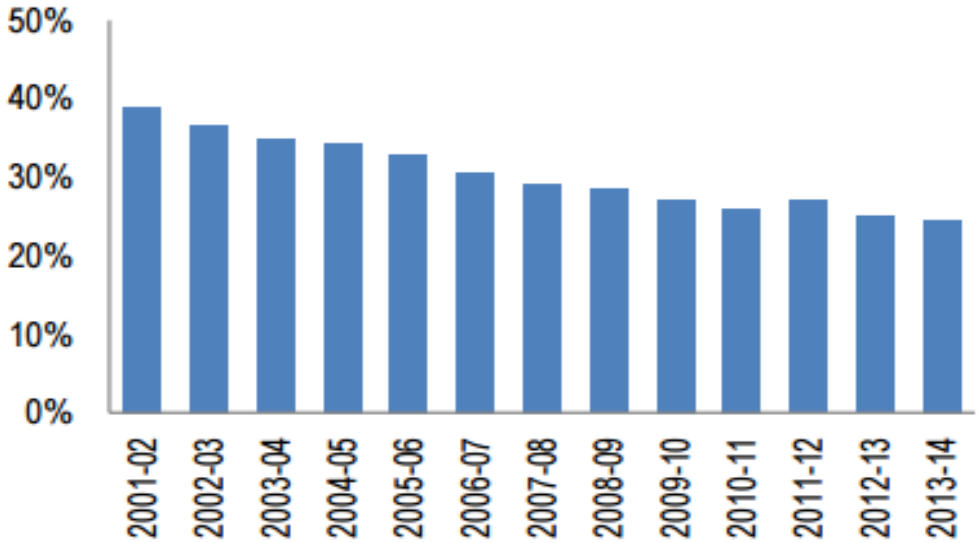


Figure 1 All India AT&C Loss Trajectory
Source: http://www.prsindia.org

The AT&C losses of India are compared with countries of the Indian subcontinent, South East Asian Countries and Developed Countries as per World Bank Publication and Indicators report. On other hand, if we compare AT&C losses of other countries we can get a clear picture how India is way behind as reflected in below table. (Fig 2).

NAME OF THE COUNTRY	2004	2005	2006	2007	2008	2009
ARGENTINA	15	15	15	16	13	15
AUSTRALIA	6	7	7	7	7	7
AUSTRIA	5	5	6	6	5	5
BANGLADESH	9	8	7	7	5	2
BELGUIM	5	5	5	5	5	5
BRAZIL	17	17	17	16	17	17
BULGARIA	12	11	11	11	10	11
CANADA	7	7	8	8	8	8
CHINA	6	7	6	6	6	5
COLUMBIA	19	19	19	20	19	15
CZECH REPUBLIC	6	6	6	6	6	5
DENMARK	4	4	3	5	6	6
EGYPT ARAB REP	12	16	11	11	11	11
FINLAND	3	4	4	4	4	4
FRANCE	6	6	6	6	6	6
GERMANY	6	5	5	5	5	4
GREECE	9	9	8	8	8	5
HUNGARY	12	11	11	10	10	10
INDIA	**26**	**25**	**25**	**25**	**23**	**24**
INDIONESIA	13	12	11	11	10	10
IRAN,ISLAMIC REP.	17	19	19	19	18	40
ISRAEL	3	3	3	3	2	3
ITALY	7	7	6	7	7	7
JAPAN	5	5	5	5	5	5
KAZAKHASTAN	16	10	9	10	9	8
KOREA REP.	16	4	4	4	4	4
MALASIYA	5	4	1	2	3	4
MEXICO	16	16	16	16	17	16
NEPAL	19	20	21	22	19	31
NETHERLAND	4	4	5	4	4	4
NEW ZEALAND	13	7	7	7	7	7
NORWAY	8	7	8	7	7	8
PAKISTAN	25	24	22	19	21	20

Figure 2 AT&C Losses of Different Countries
Source: World Bank Publication, World Development Indicators, (for various years)

In different dataset Power distribution losses in European nations are 3-4%, whereas in India it is up to 50% in certain regions. The same has been shown in the Power Loss Map below (Fig 3).

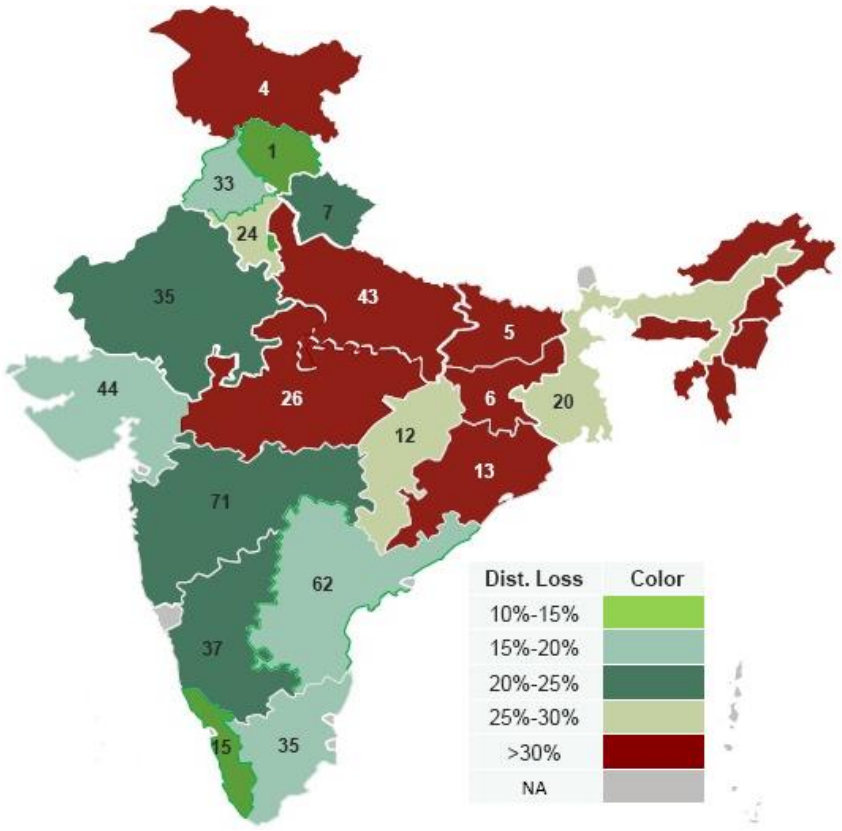


Figure 3 Power Loss (%) Map for 2010-11
Source: Saurabh Kamdar (2012), 7th Annual Conference on Power Distribution in India

The reduction in commercial losses can be achieved by improving billing efficiency. Where in the investment of IT by Discoms can help?

Initial literature review for all technologies which are being used by Discoms in the world was done and exhaustive study of these technologies was undertaken. In fact, out of many power distribution companies in India, the study was narrowed down to four Discoms in National Capital Region. Thereafter, the research taken up initially tries to make an assessment of the different type of technologies being used in power distribution system among the four Discoms in National Capital Region.

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

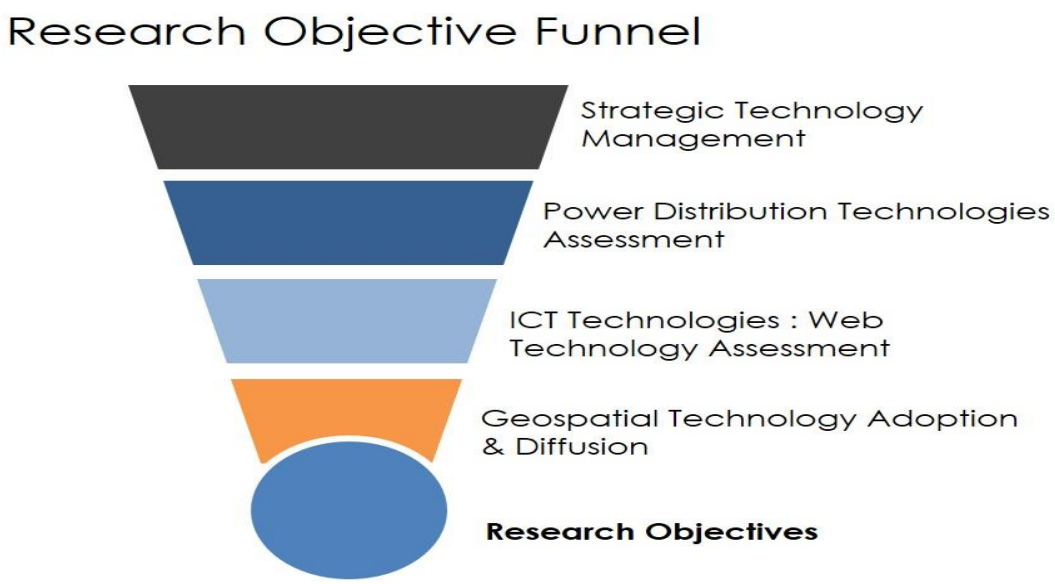


Figure 4 Showcasing research objective Funnel.
Source: Designed by Researcher

1.2 Technology Adoption in Power Distribution Sector In India

Nandan Nilekani (2008), in his report to Ministry of Power, has described in detail, the level of Technology Adoption in Indian scenario as compared with other countries can best be described in Figure 5 below, which draws comparison among the following

- Indian State Electricity Boards (SEBs)
- Indian Best State Electricity Boards (SEBs)
- Asian Countries like Hong Kong, Thailand.
- Developed Countries like the United States of America (USA), United Kingdom (UK).

As shown, following Technology Elements were taken into consideration for comparison of Technology deployment among the utilities:

- Internet
- System Integration
- Networking
- Automation
- Metering Technology

The details of each of the parameter is discussed in more details in later chapters

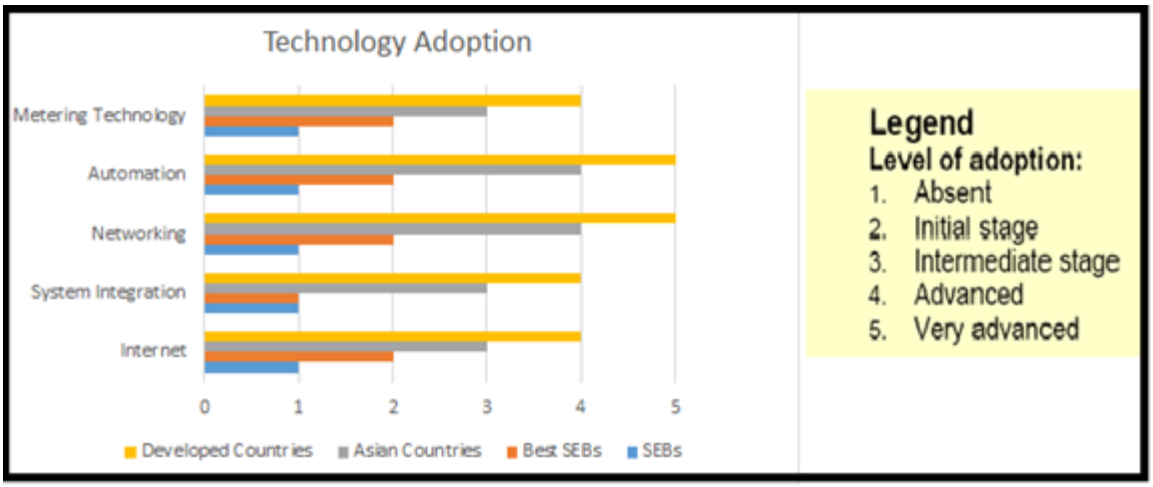


Figure 5 Comparison of Technology Adoption in different countries

Source: Ministry of Power Report (Govt of India), 2008.

The graph clearly demonstrates India is behind in terms of implementation of Information and Communication technologies as compared other companies around the world. Indian companies should learn from global counterparts in terms of implementation of these technologies as they have way long experience in using these technologies.

A significant amount of work has been done related to ICT adoption in various industries but not much focus was placed power utilities in India. However, little has been said about the effectiveness of the strategy.

The endeavor is to find an appropriate answer to these questions with empirical evidence.

1.3 Introduction to Strategic Management of Technology

(With Focus on Identification of Research Areas)

The Strategic Technology Management (Fig 6) is life cycle approach with eight phases, which starts with technology creation, then monitoring and then moves to Technology assessment, transfer, acceptance , utilization, maturity and decline Out of the eight phases of life cycle , the areas selected for this research are technology assessment, technology acceptance and finally technology utilization.

Technology Assessment: The research area of technology assessment focuses on different technologies which are in being used in power utility and which are in different stages of implementation. Different technologies are associated with different business and the operational process leading to excellence.

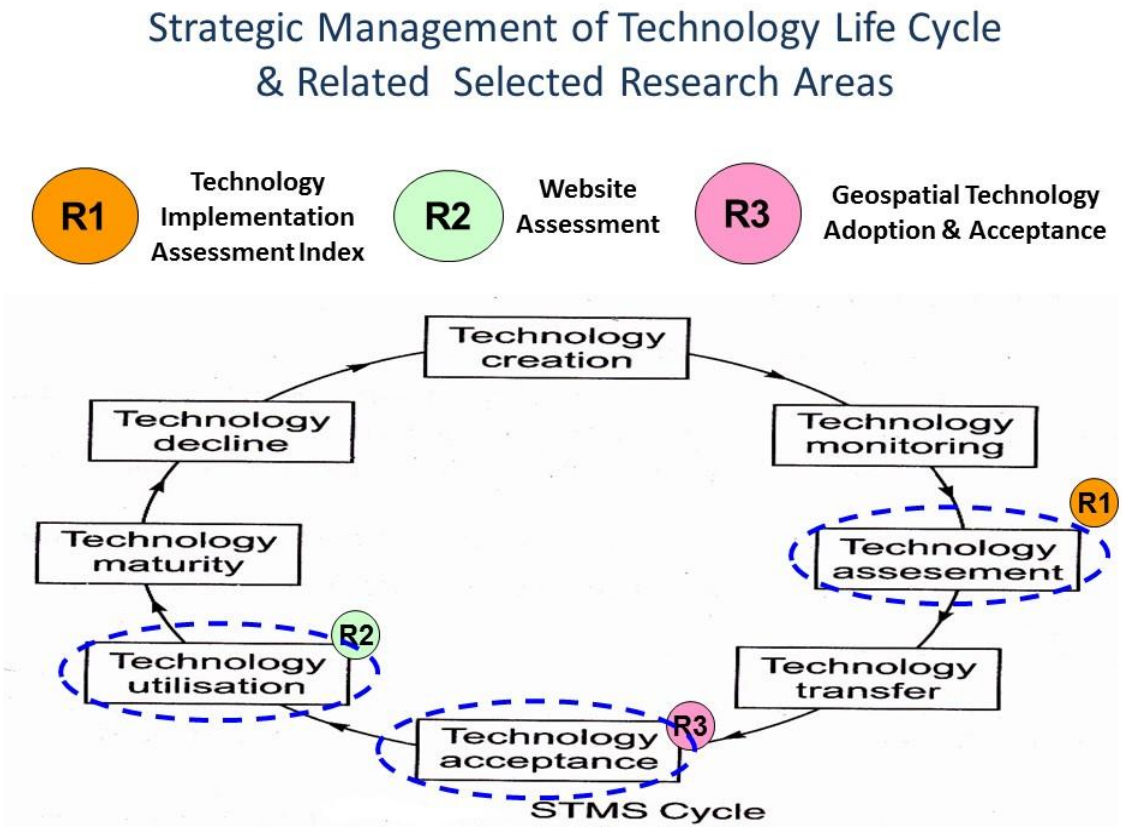


Figure 6 Strategic Technology Management Life Cycle & areas of research
Source: Dr. Vijay Kumar Khurana Presentation
(https://www.slideshare.net/VijayKrKhurana/technology-management-15896736)

Technology Acceptance: Since a number of technologies are used being in power distribution system, to analyze acceptance of all technologies would be a difficult task, so only one of technology i.e.; GIS is being taken for study.

Technology Utilization: This phase of the life cycle has been selected to analyze the utilization of technologies and how this has helped the organization, for example, web-based application has helped in increasing billing efficiency, solving consumer grievances and giving a tool to the consumer so that they can directly interact with power Discom.

1.4 Summary

This chapter explains the current scenario of Indian power distribution sector and challenges faced in the current context. The chapter elaborates the AT&C loss level in India over the years and also compares the same with that of different countries. The level of technology adoption which is also one of a key area of research undertaken by the researcher is also discussed and compared with that of different developed and Asian countries. The identified research area for the study will also be discussed in details in the coming chapters. The delimitation scope of the research is also discussed in those chapters.

Chapter 2

Background of the Study

Chapter 2: Background of the Study

2.1 Overview

One of the objectives of the research has been the development of Technology Implementation Index, so there is need to study the modern and innovative technologies which are being used in power sector in the comprehensive and integrated way. Each technology plays a pivotal role in determining Discoms performance and efficiency. The chapter throws light on technologies involved in the three pillars of technology being used in Power distribution sector i.e.; Automation, Communication and Information Technology. On the basis of technologies review, the importance of each technology is being studied and hence forth this will be used in the development of Power Distribution Index will be used to compare the level of technology implementation among the Discoms.GIS technology which one of the innovative technologies being used has been selected to study adoption and diffusion of technologies in forthcoming chapters.

2.2 Current State of Technology in the Indian Power Sector

Most of the power distribution companies in India is suffering from manual and old orthodox process, poor customer satisfaction, and high revenue leakage. Many Discoms Have developed and deployed many IT applications, but most of them are in form of islands and holistic integration approach of technology management and implementation. On the other hand many Discoms implemented various modern and innovative technologies but still, they are at a very nascent stage in adoption and diffusion of technologies.

2.3 Role of Technology in Power Distribution

Broadly there are three aspects of technology in power distribution sector which are as follows:

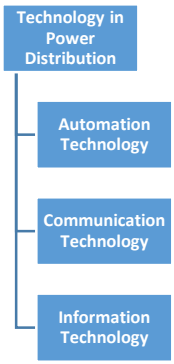


Figure 7 Broad Aspects of Technology in Power Distribution Sector
(Source: Designed by the Researcher)

In the current scenario, in most of the Discoms in India, there has been limited interaction among these technology mentioned in the fig above. Web technologies (IT) can be used to great extent as direct means to communicate with the customers. There is a serious need for all Discoms to focus on adoption of IT which can be a game changer in the transformation of their power utility business.

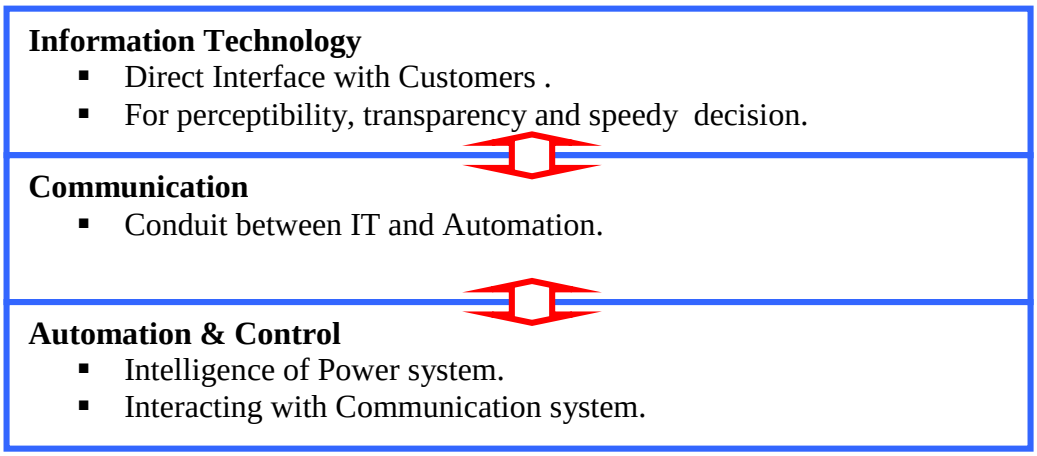


Figure 8 Convergence of three aspects of Power distribution technology
Source: Designed by Researcher

Automation and control Technologies assist the Discoms in the acquisition of data and supervision and monitoring of the power system. Many Discoms has started using many of these technologies but the adoption has been in isolated form and not as integral two-way integration with other technologies in Discom. These automation technologies generate a large amount of the data which can be further used as analytics which in turn can help Discoms in solving many of their problems and better decision making.

Communications technologies act as the duct for the flow of data arrested by automation and control systems, to Information Technology (IT) for the collection of various data and creation of an analytical method to resolve the problem.

2.4 Information Technology

Most of the developed countries have made use of advance IT technologies to increase their efficiency, production and commercial gains. IT, when made part of the commercial process, reduces human errors and also check on corruption.

A few prominent IT applications to the power sector are described below:-

2.4.1 Integrated metering, billing and collection systems

One of the key aim to integrate billing, payment, and collection is check on corruption and frauds and to increase collection efficiency. In order to reduce commercial losses, increase billing and collection efficiency has to be one of most import objective of the power Disco. Increasing billing and collection efficiency is one of the important aspects of IT applications which power distribution companies' focuses on in order to reduce AT&C losses. Discom should have multiple convenient payment options for customers so that they can pay bills easily without much difficulty. In order to achieve this in recent years, all Discom have put lots of thrust on increasing customer care centers and strengthening the website through which customers can pay bills.

The Discom website is the single platform for any type of information related to bills and payments like E-Bills, Bill History, energy consumption pattern etc.

The various payment options information available for customers through website are as follows

Bill Payment Kiosk: These are basically customer care offices spread throughout the geography of the Discom in order to provide the assistance to customers in person for various bill related issues and also payment counter where they can pay their bills directly.

Instant Payment Options; The Discom website provides a gamut of instant bill payment options. The figure below explains the options available where customers can pay their bills instantly online.

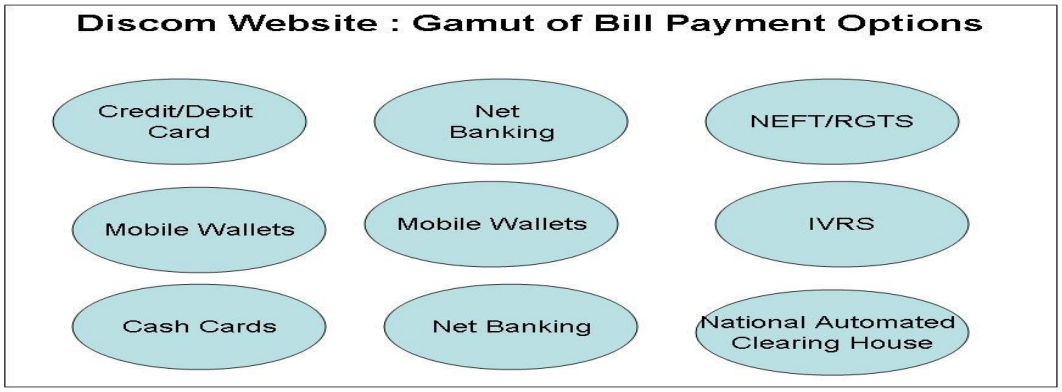


Figure 9 Bill Payment options on Discom Website
Source: Compiled by Research Scholar (2016)

Bank Branches: The Discoms have tie-ups with various banks to provide the convenience to the customers to pay bills.

Apps &Wallets: With the advent of Mobile Application, the consumer today options of payments through various Apps like PAYTM through them can also avail many cash back offers.

Thus Discom website provides one gateway for all consumer bill related queries and payment options and also help to solve their complaints and grievances.

2.4.2 Energy Accounting system

Energy accounting system constitutes an important of IT application in Discom. There is mainly three types of Energy Audit report prepared in the Discom.

Grid EHV (Extra High Voltage) Level Losses: It basically refers to input energy received by the Discom at transmission level and output energy distributed at downstream in the Discom.

11 KV Feeder Losses: Identification of HT feeders with different level of losses, these losses are computed by calculating the difference in energy at HT level and summing up of the energy of all DTs associated with HT feeder.

Distribution Transformer (DT) Losses: The DT losses are mainly computed by comparing the total amount billed to the consumer by the Discom and total energy that has been delivered to the Discom by taking DT meter reading. In order to map all correct consumer to DTs consumer indexing exercise plays a critical role. Correct Consumer Indexing help in delivering better energy Audit. Most of the Discoms there is a problem of a lot of discrepancies in consumer indexing.

The figure below depicts distribution network and metering done at a different level downstream right from transmission level up to the consumer.

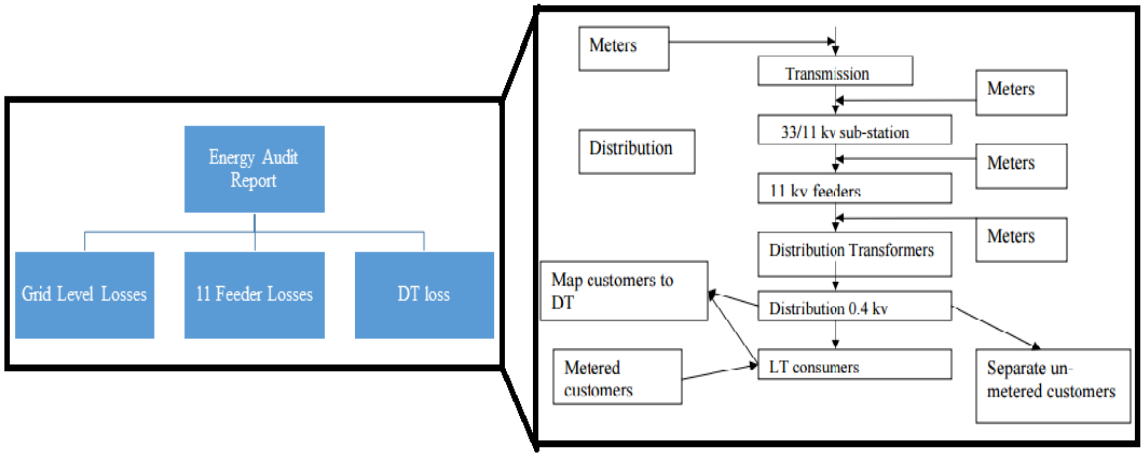


Figure 10 Broad View of Metering System in Power Discoms
Source: Nandan Nilekani Report (2008) and Compiled by Research Scholar(2016)

2.4.3 Complaint handling –

Power distribution business in India is still not treated as a service industry for providing uninterrupted power supply to consumers. In the current scenario, consumers find difficult to lodge complaints and get information like when power will be restored etc. Discoms should have IVRS system, dedicated call centers and other mediums like a mobile app from where consumers can communicate with Discoms.

2.4.4 Enterprise resource planning (ERP)

Kanth, R. (2012) elaborates need for ERP is to enable the flow of information among all the stakeholder within as well as outside the organization. Major Global companies which provide ERP solutions include SAP, Oracle, and Microsoft.

SAP Utilities

Kanth R (2012) explains SAP came up with its product Project IS-U/CCS in Aug 2002. The SAP (IS-U) acts as a central repository for all types of consumers like residential, commercial and industrial billing data. The IS-U contains all types of information like billing, invoice, reminders and new connection consumers.

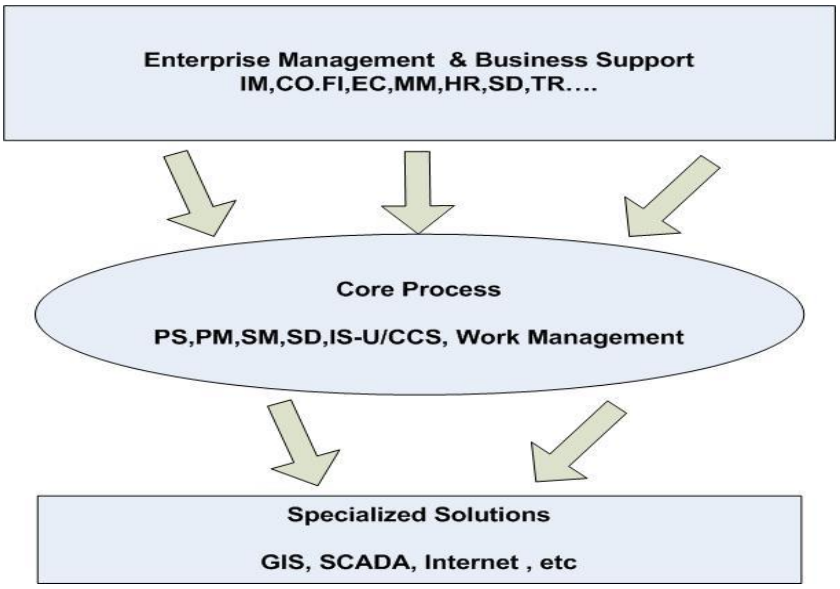


Figure 11 IS-U/CCS as a component in the ERP Solution
Source: Kanth.R (2012), Information Technology Implementation in Indian Power Distribution

SAP for Utilities consists of two types of products:

- CRM – Customer Relationship Management: This has been framed in order to ensure complete promotion, customer acquirement, sales and customer services. It is tightly unified with the IS-U: CRM which act as a front end interface (contracts, customer services, market campaigns and whereas IS-U acts as-is a backend for billing, payment processing, work management purposes.

- BW – Business Warehouse: It is used for analytical reports. The package contains business content with lots of predefined info Cubs and reports.

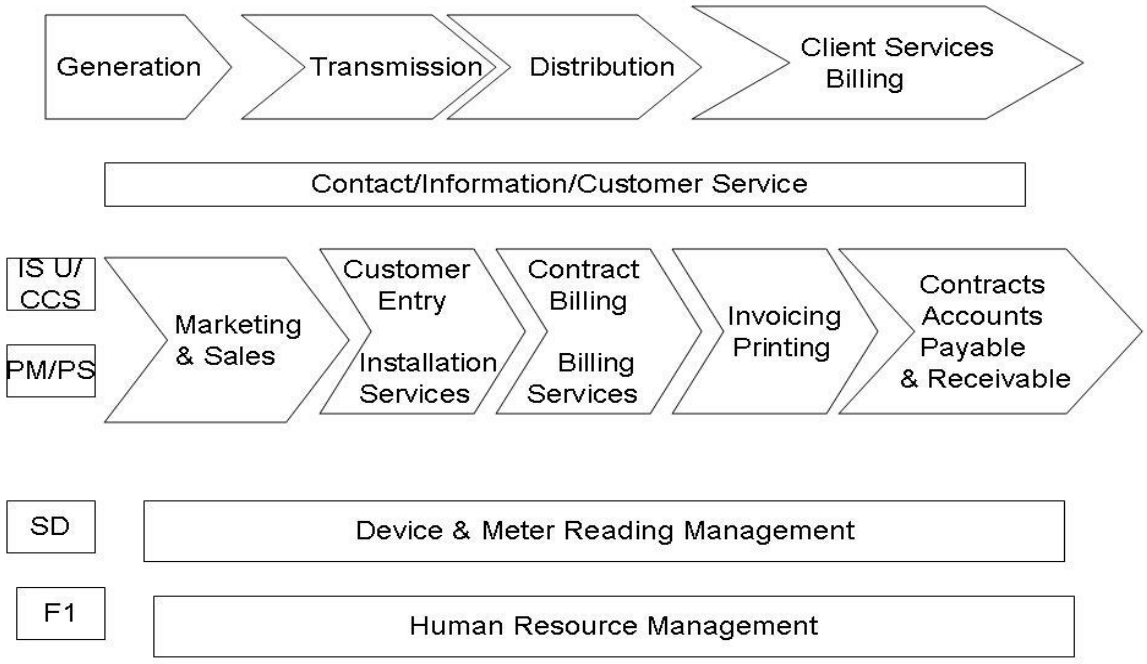


Figure 12 Functional Scope of SAP-ISU
Source: Kanth.R (2012), Information Technology Implementation in Indian Power Distribution

ERP Modeling of Distribution Business

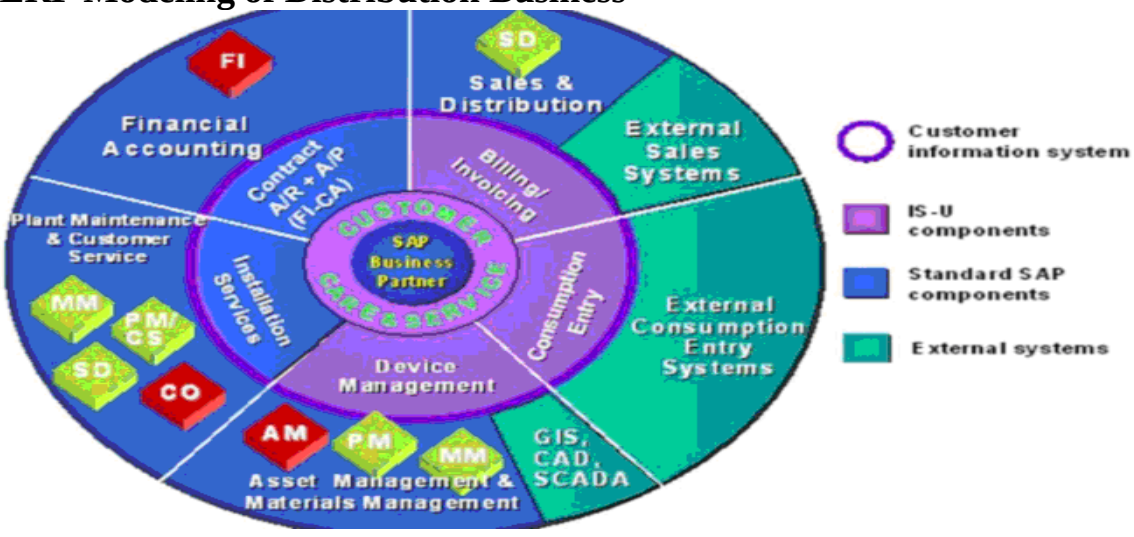


Figure 13 IS-U/CCS as an integrated component of the SAP enterprise information. Source: Kanth.R (2012), Information Technology Implementation in Indian Power Distribution

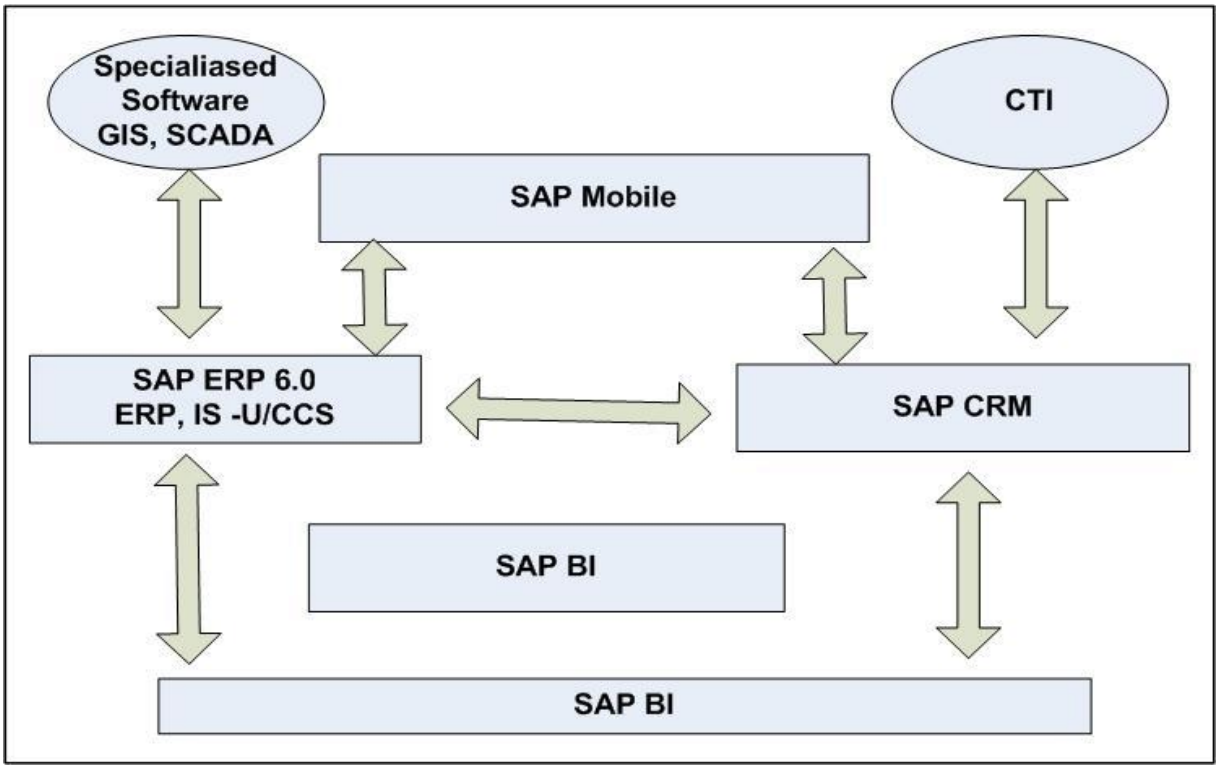
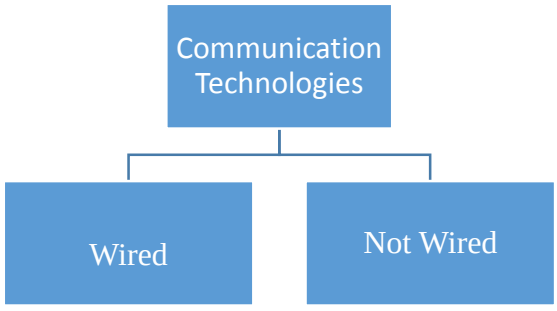


Figure 14 Integration with Other SAP and Non-SAP Solutions (An Example)

Source: Kanth.R (2012), Information Technology Implementation in Indian Power Distribution

2.5 Communication

Gungor, V (2016) explains that communication technologies are largely classified into two types: Wireless and Wired.



The Wired communication requires a physical medium like cable to communicate data while wireless communication wants microwaves or radio-waves. In the current context, wireless technologies commonly used are ZigBee and RF Mesh as Smart Grid whereas wired communication technology as Power Line Communication (PLC). European countries use PLC to a greater extent, RF mesh is more widely used in the USA**.**

Technology	Spectrum	Data Rate	Coverage Range	Applications	Limitations
GSM	900-1800Mhz	Upto 14.4 Kpbs	1-10 Km	AMI, Demand Response, HAN	Low Data rates
GPRS	900-1800Mhz	Upto 170 Kpbs	1-10 Km	AMI, Demand Response, HAN	Low Data rates
3G	1.92-198 Ghz	384 Kbps- 2 Mbps	1-10 Km	AMI, Demand Response, HAN	Costly Spectrum Rates
WiMax	2.5 Ghz, 3.5 Ghz, 5.8 Ghz	Upto 75 Mbps	10-50 km(LOS), 1-5 km(NLOS)	AMI, Demand Response, HAN	Not Widespread
PLC	1-30 MHz	2-3 Mbps	1-3 km	AMI, Fraud Detection	Harsh, Noisy Channel Environment.
Zigbee	2.4 GHz-868-915 MHz	250 Kbps	30-50 m	AMI, HAN	Low data rate, short range

Table 1 Different types of Communication System commonly used in Power Distribution system around the world

Source: Gungor, V., Sahin, D.et al. Smart Grid Technologies: Communication Technologies and Standards.

2.6 Automation & Control Technology

2.6.1 SCADA (Supervisory control and data acquisition)

SCADA is one ground-breaking automation technology that has been used to control, monitor and generate various types of required for the utility. According to Ravindranath, R. S. (2009), this technology are extensively positioned in various industries to provide remote supervisory and control. It comprises of automated methods to support in the supervision and control of the power grid.

SCADA system mainly comprises of following components:

1. Human Machine Interface (HMI): It is an interface which displays the data and also acts as a controller of the system

2. Supervisory (computer) system: It manages and assembles the data and sends instructions to the electrical units.

3. Remote Terminal Units (RTUs): It acts as a sensor and collects signals for processing. It decodes sensor signals to digital data and maps digital data to the system.

4. Programmable Logic Controller (PLCs):

These are used as field devices. They are cost-effective, multipurpose, bendable, and configurable than special-purpose RTUs.

5. Communication setup: It acts as an interface connecting the supervisory system to the Remote Terminal Unit

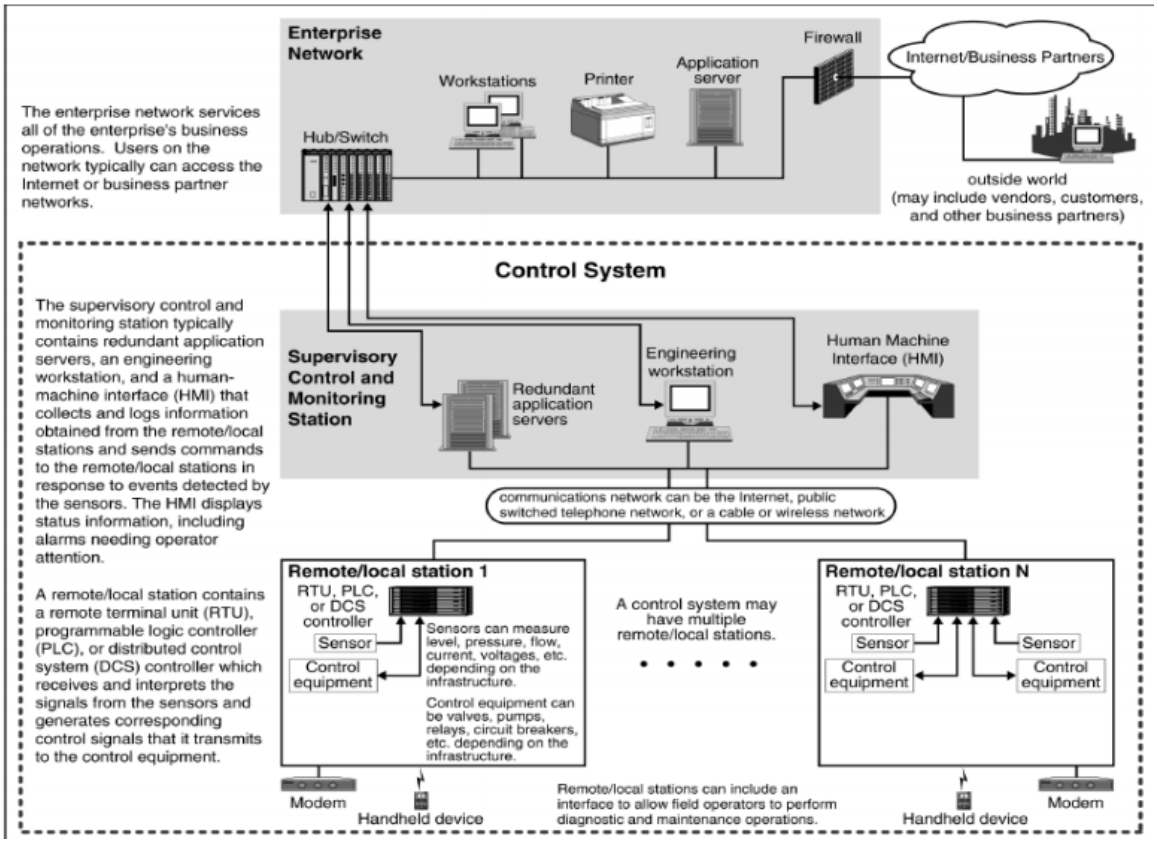


Figure 15 SCADA Architecture
(Source: Ravindranath, R. S. (2009), *Smart Grid Supervisory Control and Data Acquisition (SCADA) System Security issues and counter measures,* Visveswaraiah Technological University)

2.6.2 Outage Management System

Outage Management System. (2009), basically, refers to computer aided systems which provide the information to the Operation and Maintenance Departments crew team about where there is no power supply or there have been some faults due to which power is being interrupted. The OMS system also assists team about the electrical assets which are associated with fault and overall give them a picture in knowing the extent of fault and how many consumers are being affected due to the fault in the circuit.

OMS is an integrated solution with major modules which are involved are GIS, customer information system (CIS), customer centric applications like call center and interactive voice response (IVR) system.

Today OMS has been used as an integrated solution to calculate customer satisfaction Indexes like SAIFI and SAIDI based on various inputs data and analysis reports.

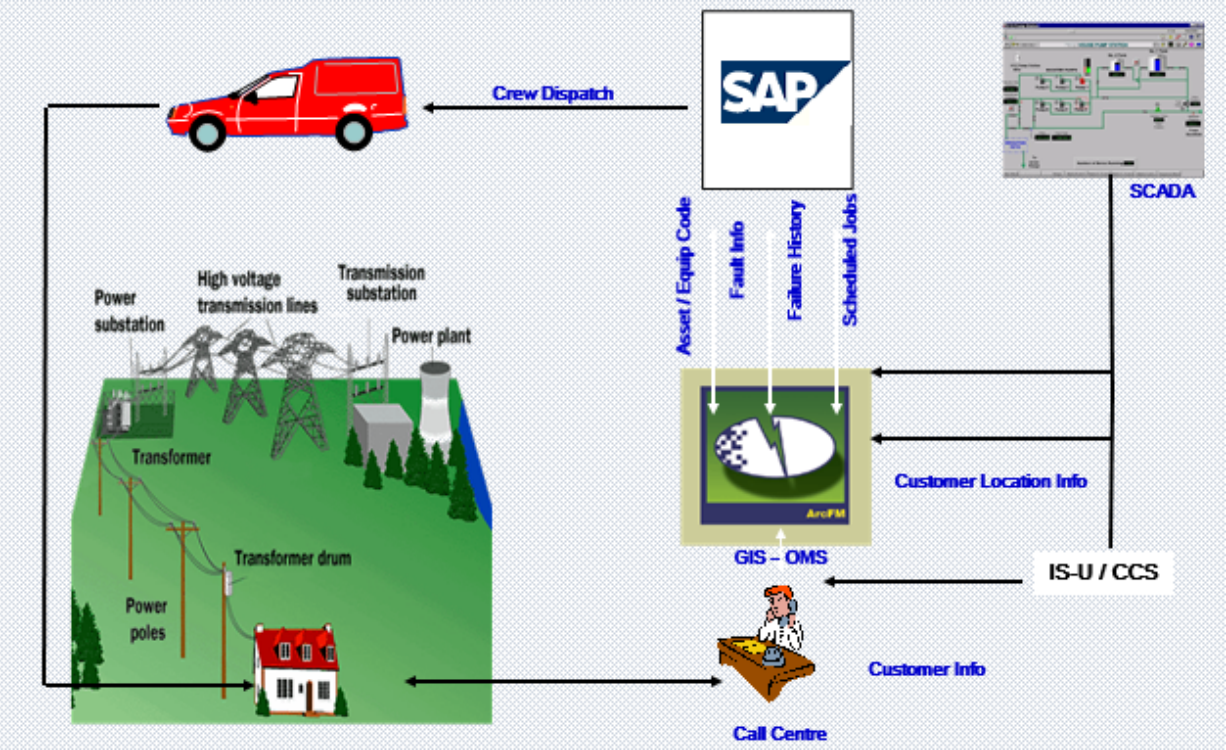


Figure 16 Outage Management System Working (An Example)

Source: BSES Reports and Presentations (2015)

2.6.3 Automated Meter Reading (AMR)

According to Chunjuan WEI, Junjie Yang (2009), AMR technology collects data from energy meters and transfer the same to the master station for various purpose like billing. It also helps in reducing human error, dependency on a human being for metered reading and overall it also helps in reducing the billing cycle thus increasing collection efficiency. One of the major benefits of AMR is one can connect/disconnect meter remotely based on the information like nonpayment of bills etc.

There are basically two types of AMR architecture in AMR.

- GSM Based Communication: It forms links for communication amid meter and central station through GSM Model.
- Hybrid Communication: In hybrid communication there are two stages;
  a) Meters and Data Concentrator Unit (DCU)
  b) DCU and Host Central Station.

AMR consists of four main constituents:

1. Electrical meter: The electronic meter processes and measures the electrical energy supplied to the consumer. It is also an interface which transmits data from remote terminal to collector.
2. Collector: It receives, processes and stores information received from electronic meters.
3. Concentrator: The collectors receives a signal from the concentrator for meter reading on a steady basis.
4. Central Hub: The central server responsible for managing the entire system.

2.6.4 Geographical Information System (GIS) & Network Analysis

In power sector, GIS has been implemented to monitor the quality, distribution, and losses, in the power structure. The implementation of GIS is towards the ability to manage assets inventory more efficiently, as it enables organization a map-based view of assets with the work information. Along with this GIS also enables the user to present the graphical values of their work. The new tool GIS would let the field users do the expected in much better

and faster way but have a capability for each and every action that have to be performed in the organization. Benefits of GIS implementation on any utility organization are noticed in terms of "efficient updating of assets & facilities, more efficient retrieval of information, efficient engineering design and planning, elimination of redundant data entry, outage tracking and management" and many more to make the efficient and adequate supply.

Along with this GIS also enables the user to present the graphical values of their work. The new tool GIS would let the field users do the expected in much better and faster way but have a capability for each and every action that have to be performed in the organization. Benefits of GIS implementation on any utility organization are noticed in terms of "efficient Update of assets &facilities, more efficient retrieval of information, efficient engineering design and planning, elimination of redundant data entry, outage tracking and management" and many more to make the efficient and adequate supply. GIS sets the organization to an extent where it can with other tasks also keeps tracks on the consumers i.e. how many new consumers joined with the organization and who unsubscribed from the service. This can only be done by when each component (line, customer number, pole, and meter) is track-able and available in the digital database. GIS represents the maze as it's on the ground and show its real picture on the system, such as plots, houses connecting lines for each customer, etc. Mr. Rajesh Bansal, Head Network Operation, Reliance Energy Ltd said that application-oriented approach for enterprise level GIS implementation in Discom not imposing user to use GIS. GIS should solve user problems and this will enhance the use of GIS in the organization.

The organization noticed several major gainful benefits after GIS implementation such as effective updating and facilities of the assets, efficient retrieval of information, elimination of redundant data, efficient engineering design & construction planning, outage management and tracking, facility management & automated mapping and row & route management.

2.7 Summary

The Chapter “ Research Background “ mainly tries to throw light on technologies being used in power distribution system in India and abroad in detail. Before going further in our research in the development of technology implementation index and adoption and diffusion of technology in Power Discom it is essential to understand this technology in details. The three pillars of technology in power distribution system namely automation, communication and information technology has been described in detail with its subsets.

Chapter 3

Review of Literature

Chapter 3: Review of Literature

The literature on various aspects of the research topic was reviewed, as per the Literature Survey process, depicted in Fig 17.

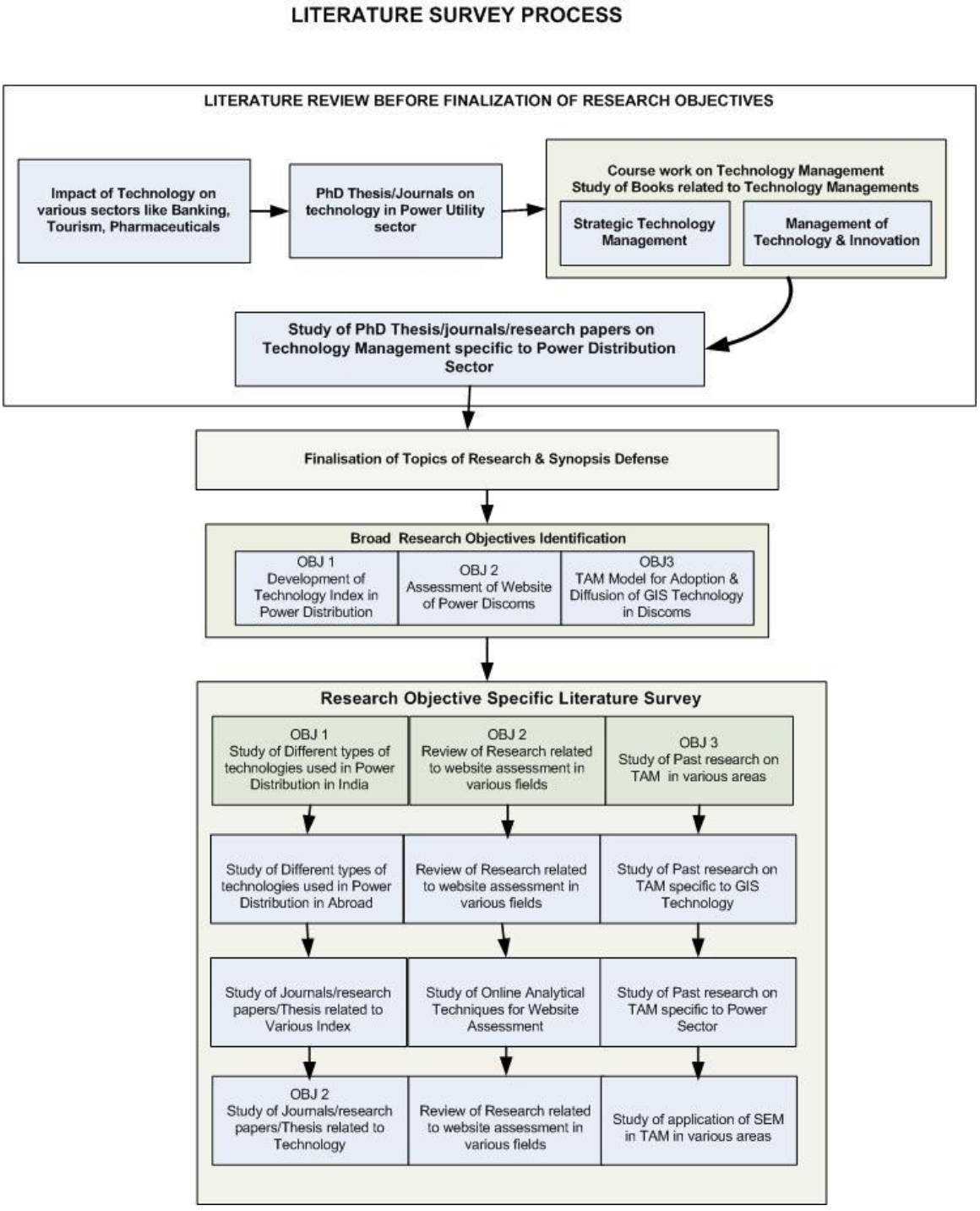


Figure 17 Literature Survey Process adopted for this research

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

3.1 Overview of Literature Survey done

M P Gupta (2007) demonstrates the use of Information Technology in different government organization and impact of top management, organization culture in use of IT

Meeta Dasgupta (2011) explains various technological innovations taken by Tata Power Delhi Distribution Ltd which has helped in revamping power distribution business.

Hiroshi Kashiwazaki et.al (2002), discusses the intelligent substations using IT and high-speed communications which help in protection, monitoring and information sharing in integrated power distribution system.

Kam-Hoong Cheong (1999), in his thesis on IT Strategy for utilities did extensive study of existing IT strategies within electric utilities, mostly formulated with the traditional mindset 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 system approach is proposed in this thesis.

P.V.Chopade B.E.Kushare Dr.D.G.Bharadwaj (2012) discusses the importance of IT in power distribution system and IT along with automation technology can play a key role in improving the quality of power distribution system. R. P. Gupta and S. C. Srivastava (2007), has described homegrown designed and developed power distribution automation system at IIT campus in Kanpur. This can be used by power utilities to reduce operational issues of networks.Aurobinda Basu, Surajit Banerjee, Gautam Banerjee (2006) has explained the reduction in T&D Losses in CESC by IT based Surveillance focuses on various IT based initiatives which had led to a reduction of T&D losses in Kolkata.

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 tried to give the brief idea regarding the impact of electricity on the economic status of people in Delhi and effectiveness of Delhi Electricity Regulatory Commission (DERC) regulation for annual/multiyear tariff rates calculation.

Zafar Husain et.al explains about technology management in the automobile sector. The case study was done by collecting data by interviewing and observation technique.

David, Bin Xie(2003), explains the current scenario of manufacturing technology implementation and initiatives. The comparison study was done with US and Chinese furniture market. Priyanka Kokil (2007), explains about Ganga, e-Gram, and Communication Information Center (CIC) projects using SAP-LAP analysis.

In the following tables, a summary of relevant literature surveyed in the following areas is presented:

1. Technology Management in Power Distribution sector in India
2. Technology Management in Power Distribution Sector Abroad
3. Website Assessment.
4. Power Distribution Technology Implementation Index
5. Adoption & Diffusion of GIS in Power Distribution System
6. Acceptance of GIS based on TAM Model

3.2 Technology Management in Power Distribution Sector in India

Research Work related to Technology Management in Power Distribution Sector in India						
SL No	**Literature Reviewed**	**Literature Type**	**Author**	**Brief Summary**	**Research Gap**	**Year**
1	Information Technology Solution for Power Distribution System Automation	Australian Universities Power Engineering Conference M. Negnevitsky, ed. Hobart, Australia. September 2). 28. 200~	P.V.Chopade,et al	The paper explains IT to improve business process and enhance the quality of Decision Support System.	Need and Evaluation of Level of IT implementation in Power Discoms	2005
2	Improving the Quality of Customer Service of Electrical Power Supply using an Integrated Outage Management System	M.K.S. Sastry, (2006), Asian Journal on Quality, Vol. 7 Iss: 3, pp.70 – 81	M.K.S. Sastry,	This paper describes the development process and various functionalities of OMS system. The paper also discusses various components, functional aspects, and various integration related issues.	The need to study level of implementation of OMS in Power Discom	2006
3	Enabling excellence in operations through technological innovation	Meeta Dasgupta, Emerald Emerging Markets Case Studies Collection, (2011)	Meeta Dasgupta	The study explains various technological innovations taken by Tata Power Delhi Distribution Ltd which has	The comparison of technologies implementation between Govt Discoms and Quasi	2011

				helped in revamping power distribution business. .	Govt Discoms.	
4	Automatic meter reading (AMR) based distribution security monitoring and distribution-supervisory control and data acquisition (D-SCADA) control	Journal of Electrical and Electronics Engineering Research Vol. 3(6), pp. 108-120, August 2011	T. Ananthapadmanabha, A. D. Kulkarni, Madhvaraja, and A. P. Suma	The research paper highlights how automatic meters are installed in the distribution system to monitor and control the load.	The necessity to gauge AMR practice and implementation in Discom.	2011
5	Tata Power Delhi Distribution Ltd: measuring beyond the metrics	Monica Singhania, R. Venkatesh, "Tata Power Delhi Distribution Ltd: measuring beyond the metrics", Emerald Emerging Markets Case Studies Collection, (2012)	Monica Singhania, R. Venkatesh	The research paper highlights plan of developing growth and to combat the climate change.	The need to study level of technology implementation and strategy in Govt Discoms after study from PPP Discom	2012
7	Smart Grid: New Era of Electricity Distribution Network	2012 IACSIT Coimbatore Conferences IPCSIT vol. 28 (2012) © (2012) IACSIT	Mahesh Manik Kumbhar1+ , A. B. Nandgaonkar2, S.L. Nalbalwar3, Pradnya R. Narvekar4	The paper explains the concept of Smart Grid which is a collection of new power delivery concepts which consists of new power delivery components, control, and monitoring of	Understanding the Smart Grid and study where Indian Discoms at stages of implementatio	2012

		Press, Singapore		the power distribution system	n of Smart Grid.	
8	GIS in Power Sector Management	International Journal of Engineering Research and Technology. ISSN 0974-3154 Volume 6, Number 6 (2013), pp. 759-766 © International Research Publication House http://www.irphouse.com	Surendra Kumar Yadav	The article explains use of GIS in power sector in various types of analysis and generation of reports like network analysis, energy audit, load flow analysis and reducing theft. . .	Assessment of level of GIS adoption in Power Discoms	2013
9	Service Quality in Power Sector	BTech Thesis Mechanical Engineering NIT Rourkela	Mr. Senthil Nathan	The thesis confirms the significance of the service quality and changes required and things that can be done to improve the service quality.	The study service quality using different technological interventions.	2010
10	Technology development & Implementation for Power Distribution Automation System	IIT Kanpur website : iitk.ac.in	R. P. Gupta and S. C. Srivastava	This paper describes the in-house design development of automation in power distribution system as the pilot level at IIT Kanpur campus.	Understanding New Power Distribution Automation System and Assessment of Technology in Power Discom	1999

Table 2 Research Work in Technology Management in Power Sector in India

3.3 Technology Management in Power Distribution Sector Abroad

Research Work related to Technology Management in Power Distribution Sector Abroad						
Sl No	**Literature Reviewed**	**Literature Type**	**Author**	**Brief Summary**	**Research Gap**	**Year**
1	IT Strategy for Electric Utilities - A Framework Towards Effectiveness	Doctor of Philosophy Dept. of Industrial Control Systems School of Electrical Engineering and Information Technology KTH, Royal Institute of Technology Stockholm, SWEDEN	Kam-Hoong Cheong	The study aims at identifying the state-of-the-practice of existing utilities' IT strategies and the important factors affecting the effectiveness of the strategies, one of the goals is also to provide a framework which utilities can use to enhance the effectiveness of their IT strategies.	Only IT Strategy has been covered other automation and communication technologies which give a holistic view of Discom has not been covered.	1999
2	Non-Technical Losses in Electrical Power Systems	A Thesis Presented to The Faculty of the Fritz J. and Dolores H.Russ College of Engineering and Technology Ohio University	Dan Suriyam ongkol	The thesis examines types of electricity thefts and how power stimulation methods can help in reducing losses. It also explains the load flow analysis. .	Such type of research has not been carried out in the Indian context.	2002
3	Some Options for Improving the Governance of State-Owned Electricity Utilities	Energy and Mining Sector Board Discussion Paper No-11 February 2004	Timothy Irwin and Chiaki Yamam oto	This paper describes methods government can achieve without privatizing. It also explains the changes in corporate governance. And also the relationship between company and government.	Evaluation of Technology and various cultural factors between Sate Owned Discom and Quasi Govt Discom in India	2004

4	Electricity Distribution Engineering and Geographic Information System (DeGIS).	Shape the Change XXIII FIG Congress Munich Germany, October 8-13, 2006	Olaniyi Saheed Salawudeen, Nigeria and Usman Rashidat, Nigeria	The aim of the project is to locate and map all the facilities of PHCN and mapping resulted in customized maps, tables, softcopy of the map and project report.	Such type of research has not been carried out in the Indian context.	2006
5	Technological and Business Challenges of Smart Grids-Aggregator's Role in Current Electricity Market	Master's Thesis Lappeenranta University of Technology Faculty of Technology Electrical Engineering	Oleg Gulich	The thesis explains various technological challenges being faced for Smart Grid implementation.	Such type of research has not been carried out in the Indian context.	2010
7	Analysis of Electricity Distribution Network Operations Business Models &Capitalization of Control Room functions with DMS.	Ph.D. Thesis, Institute of Energy Technology Lappeenranta University of Technology	Anna Tanskanen	The thesis offer analytical framework for power utilities for development of future network models .	Such type of research has not been carried out in the Indian context.	2010
8	A literature review on technology road-mapping: A the case of power-line communication	African Journal of Business Management Vol. 5(14), pp. 5477-5488,18July, 2011 ISSN 1993-8233 ©2011 Academic Journals	KarnchanaChoomon and Nopporn Leeprechanon*	The paper investigates the study of PLC (Power Line Communications) in planning and execution of technology road map.	Such type of research has not been carried out in the Indian context.	2011
9	Implementing a Utility Geographic Information System for Water, Sewer &Electric.	MS Thesis, Department of Geology &Geography, North West Missouri State University.	Davie Crawford	The thesis explains the use of GIS for different departments for the City of Calhoun, Georgia.	Such type of research has not been carried out in the Indian context.	2012

10	Modeling of technical losses in the Senegalese transmission and distribution grid and determination of non-technical losses	Master's Thesis Project	Maxime Guymard	The goal of this Master's Thesis is to estimate technical and non-technical losses. Moreover, some recommendations are suggested to reduce transmission and distribution losses.	Such type of research has not been carried out in the Indian context.	2012
11	Information Is Power: The Intelligent Utility Network	IBM Global Business Services, White Paper	Mark Welch and Kieran McLoughlin,	The paper explains about intelligent utility network that helps in solving rising energy costs, old infrastructure and leveraging automation technologies.	Such type of research has not been carried out in the Indian context.	2011

Table 3. Research Work in Technology Management in Power Sector in Abroad

3.4 Literature Review of Earlier Research Work related to website Assessment.

Many studies have been attempted to evaluate the websites (Nielsen, 2000; Alexander and Tate, 1999; Bauer and Scharl, 2000). These studies measure the quality of website on the basis of certain parameter like information content, navigation, design, general look and feel, user friendliness, security and significance of the information. Some methods and tools are also in the making to enable the process of website assessment.

As per Wang et al. (2005) the measurements used for evaluation of websites and also recognizes the reasons responsible for observed success or failure of a website. Some studies also attempted to access websites for diverse divisions such as e-commerce websites (Oppenheim and Ward, 2006; Basu, 2002; Huang et al., 2006, Kumar and Sareen, 2010), academic and e-learning websites (Olsina et al., 1999; Buenadicha et al. 2001, Bu¨yu¨ko¨zkan et al., 2007) and healthcare services web sites (Bilsel et al., 2006Welch and Pandey, 2007;). There have been a few lessons that focused on structure for assessment of e- Government web site as well (Middleton, 2007, Miranda et. al., 2009).

Miranda, F.J, Cortés R and Barriuso C. (2006) evaluates the Spanish private and saving banks based on various parameters which were used for the research.

Francisco Javier Miranda et al (2010) assess the role of internet and evaluation of websites of the European football clubs. The research focused on the development of website assessment index based on parameters like accessibility, speed, ease of navigation and content.

P.H. Hsieh, C.S. Huang et al (2013) demonstrates the *efficiency and effectiveness* of Taiwan's governmental web services.

JieWu, Dong Guo (2015) demonstrated performance measurement of websites of the provincial government of China.The research showcased difference development of the province has a clear impact on e-government efficiency.

Parameters used in assessment of Websites			
Sl No.	Dimension	Description	Researchers Contribution
1	Content	Relevance and Structure of information	West(2007); Henriksson et al.(2006), Garcia et al.(2005) Holzer and Kim(2005); Smith(2001); Radha and Murphy (1992);
2	Navigation	Ability to effectively navigate around the site in search of required information	Olsen et al.(2008),Henriksson et al.(2006),Gracia et al (2005); Merwe and Bekker(2003);Basu(2002);Smith(2001); Bauer and Schari(2000); Smith(2001); Bauer and Schari(2000);
3	Transparency	Availability of decisions/guidelines/rulings/reports etc.	Blakemore et al(2007); Parajuli(2007); Akkermann et al (2004); Philips(2001); Zhu K.(2002);
4	Interactivity	Coexistence and convergence of various means to interact with users	UN(2005); Philips(2001); Norris (2001); Misic and Johnson(1999) ,
5	Accessibility	Being easy to meet or deal with the web site	West(2007); Henriksson et al.(2006); Holzer and kim(2005); Garcia et al.(2005);Henry(2002);Smith(2001);
6	Usability	Determines the structure of navigational ease and search engine effectiveness	Middleton(2007);Melitskiet al(2005);Tolbert and Mossberger ,(2003)Nielson(2000); Newman and Landay(2000); Shubin and Meehan(1997);

Table 4 Dimension of the website used in assessment of government websites

3.5 Literature Review of Power Distribution Technology Implementation Index

Need for Qualitative Research i.e. Grounded Theory for Power Distribution Technology Index

In view of the challenges faced to get a comprehensive perspective of the various facets of technology implementation in power Discom, the researcher used a combination of surveys using a structured questionnaires along with grounded theory as one of the qualitative methods of research The researcher made use various grounded theory data collection methods like interviews, observations, documents and historical records to access the level of technology implementation, which would have been difficult to capture through survey questionnaires .

The section below describes:

1. A brief Introduction to Grounded Theory
2. Stages of Grounded Theory Research.
3. Literature Review on how Grounded Theory has been used in research

3.5.1 Grounded Theory

A Grounded Theory design is an organized, qualitative method used to produce a theory that explains, at a broad conceptual level, a procedure, an act, or a communication about a topic (Creswell, 2008). Grounded theory is most widely used qualitative analysis used for research as mentioned in Gibbs(2010).

Various methods of data collection:

- Interviews
- Observations
- Documents
- Historical Records
- Videotapes

The figure below illustrates the flow of Grounded theory study adopted.

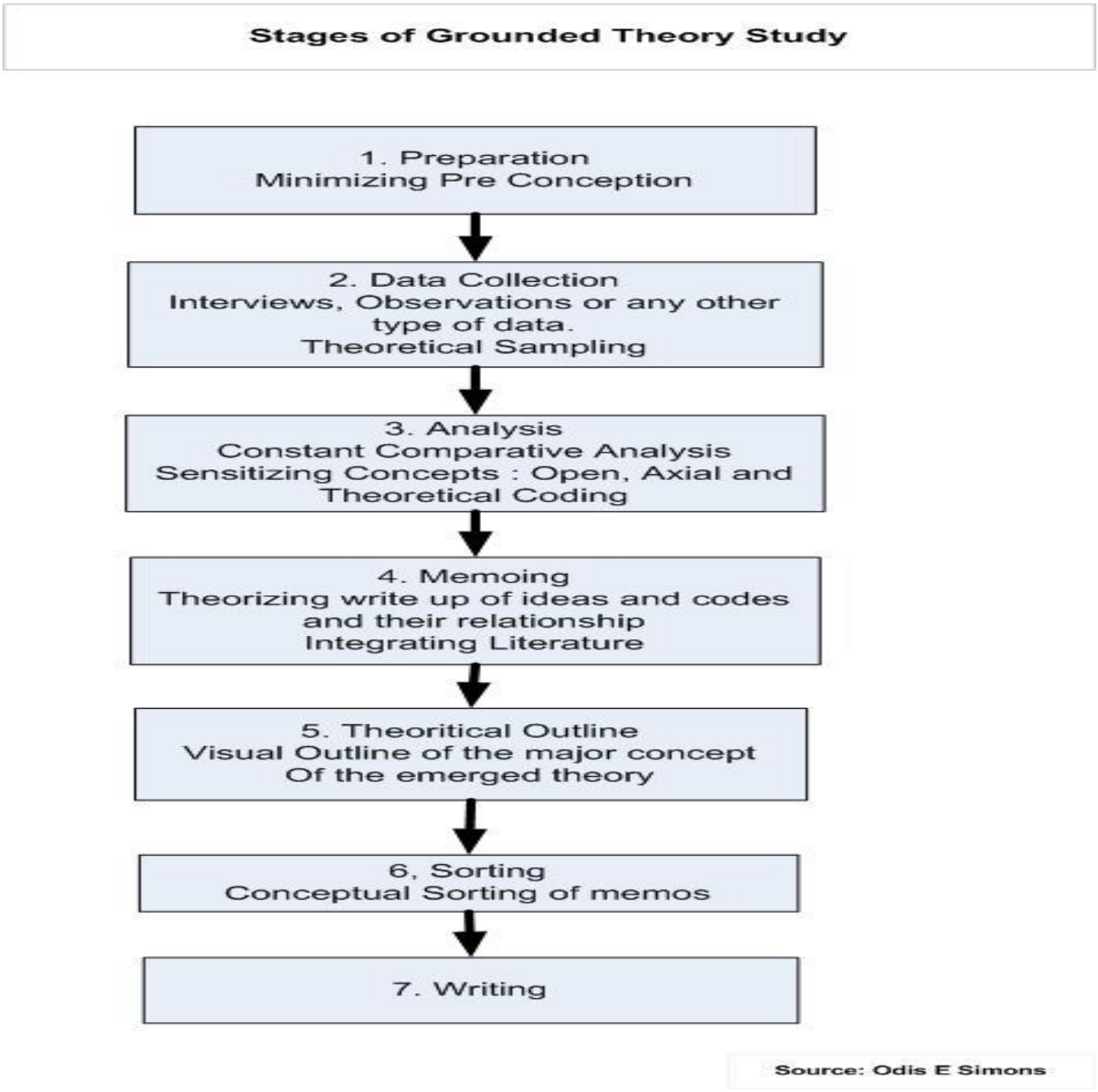


Figure 18 Stages of Grounded Theory Study
Source: Odis E Simons

3.5.2 Research Work on Grounded Theory done Earlier

The table below illustrates the qualitative research work done using Grounded Theory done in the various field earlier. The summary provides information on Ph.D. theses research, papers published in journals and E-books based on Grounded Theory

Research Papers & Thesis Discussing Research Conducted on Ground Theory					
Sl	Literature Reviewed	Literature Type	Author	Abstract	Year
1	Using Grounded Theory in Nursing	E-Book Springer Publishing Company	Rita Sara Schreiber, Phyllis Noerager Stern	The research demonstrates the use of grounded theory in nursing research.	2001
2	A Grounded Theory study of the multicultural experiences of school psychologist	Ph.D. Thesis, University of Maryland	Kenya Noreen Mewborn	The thesis explains ways in which psychologists manage racial/ethnic transformations in the diverse school context. The result explained efforts of psychologists in bringing down cultural differences in the message styles, beliefs, and behaviors of students, parents, and school staff members.	2005
3	A grounded theory: Realizing family potential through choice of schooling	Ph.D. Thesis University of Notre Dame Australia	Angela McCarthy	The research explains the methods family used in making educational choices in Western Australia.	2006
4	The Grounded Theory Review: An International Journal	The Grounded Theory Review (2010), vol.9, no.2	Judith A. Holton, Ph.D.	The journal publishes various research done on Grounded theory.	2010

5	A Grounded theory approach to faculty's perspective and patterns of online social presence	University of Nevada, Las Vegas	Rebecca A. Cox-Davenport	The research study investigates a grounded theory to create the outlines and insights of nursing faculty in the formation of social procedures in an online course.	2010
6	Pushing On: A Grounded Theory Study of Maternal Perinatal Bereavement.	Ph.D. Thesis, Loyola University Chicago	Patricia Moyle Wright	This classic grounded theory study was undertaken to discover a substantive theory of maternal perinatal bereavement, which was empirically derived from the words of the participants.	2010
7	Managing the Self: A Grounded theory study of the identity development of 14-19 years old same sex attracted teenagers in the British schools and colleges	Ph.D. Thesis, University of Southampton	Roger Philips Jones	The thesis investigates the information of 14-19 years old LGB teenagers concerning self-unearthing, disclosure to others, managing with negative thoughts and forces.	2011
8	From Grounded Theory to Emerging Strategies	Palgrave Macmillan	Nasrin R. Khalili	EBook on Ground Theory	2011
9	Bachelor's of Midwifery (BM) students experience of Reflective Practice: A	Master Thesis, Australian Catholic University	Catherine Lara Wright	The research examines grounded theory study to explore 2nd year ACU Bachelors of Midwifery (Melbourne) student's experience of reflective practice. The study identified	2012

	Grounded Theory Study				
10	Changes in Corporate Sustainability -A constructivist grounded theory research-	Master Thesis Aalborg University	Alexandra Maria Almasi	The thesis examines the development of tools with help of business model and various other concepts.	2012
11	Customer Satisfaction in Indian Retail Banking: A Grounded Theory Approach	The Qualitative Report 2013 Volume 18, Article 56, 1-21 http://www.nova.edu/ssss/QR/QR18/mandal56.pdf	Pratap Chandra Mandal and Sujoy Bhattacharya	The research used Grounded Theory for Customer Satisfaction in Indian retail banking customers.	2013
12	Living well with chronic pain: A classical grounded theory	Ph.D. Thesis, University of Canterbury	Bronwyn F Lennox Thompson	The thesis uses grounded theory of research of patients living in chronic pain.	2014

Table 5 Research on Ground Theory Earlier

3.6 Literature Review Related to Adoption & Diffusion of GIS in Power Distribution System

3.6.1 Earlier Studies Examining User Acceptance

The literature review is basically divided into two parts. The first part discusses on model and theories on technology acceptance, technology diffusion. The second part focuses and

throws light on Geographical Information system, evolution of GIS in electricity distribution companies, research related to GIS and how this technology has been instrument for power distribution companies

3.6.2 Evolution of Technology Acceptance Model

The advancement of TAM has been awfully thrilling and has undergone many changes. The changes were due to the diversity of the information system and were test. The next section explains how Technology Acceptance Model (TAM) was developed initially and how later on it was evolved and changes to various factors which were important for analysis and forecasting of adoption of technology in the organization.

3.6.3 The Theory of Reasoned Action

TRA was coined by Fishbein and Ajzen (1975) describes the relations among beliefs, approaches, norms, intents, and behaviors of individuals. As per TRA, an individual's behavior is determined by its behavior intention to accomplish it.
The theory can be well expressed by the equation:

Behavioral Intention = Attitude + Subjective norms

As per TRA, the attitude of an individual towards a behavior is determined by his principles on the consequences of this behavior, multiplied by his assessment of these consequences.
The model recommends that external stimuli impact attitudes by modifying the assembly of the person's views.

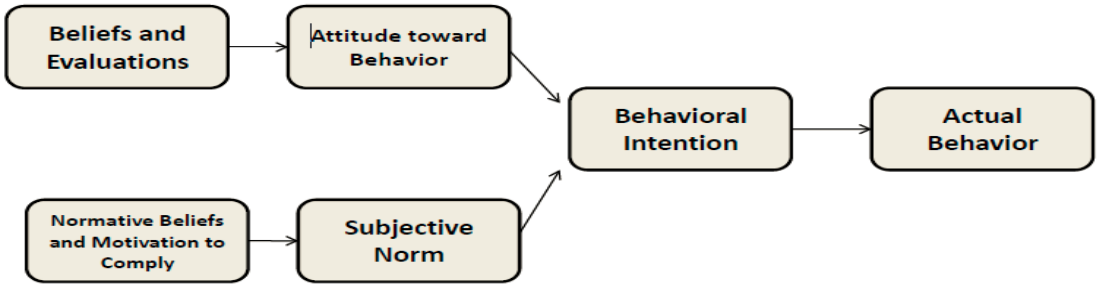


Figure 19 Theory of Reasoned Action

3.6.4 The Theory of Planned Behavior

TBP theory that relations beliefs and behavior. The idea was Icek Ajzen to increase the predictive power of the theory of reasoned action by including perceived behavioral control. The theory explains human behavior.

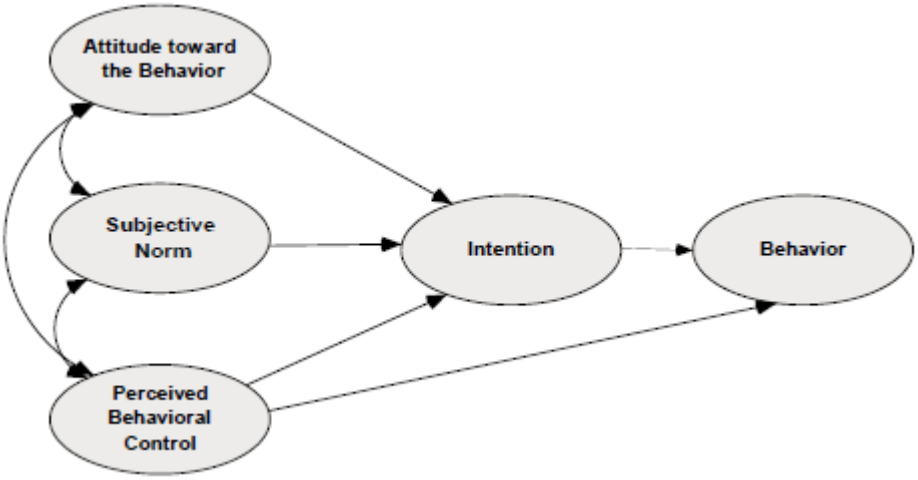


Figure 20 Graphical view of the theory of planned behavior (Ajzen, 1991).

3.6.5 Decomposed Theory of Planned Behavior

The decomposed theory of planned behavior inflates the TPB concept by deconstructing t attitude into three variables: perceived usefulness, ease of use, compatibility. The subjective norm is comprised of two variables: peer influence and superior's effect. Perceived behavioral has three variables: self-efficacy, resource facilitating conditions and technology facilitating conditions.

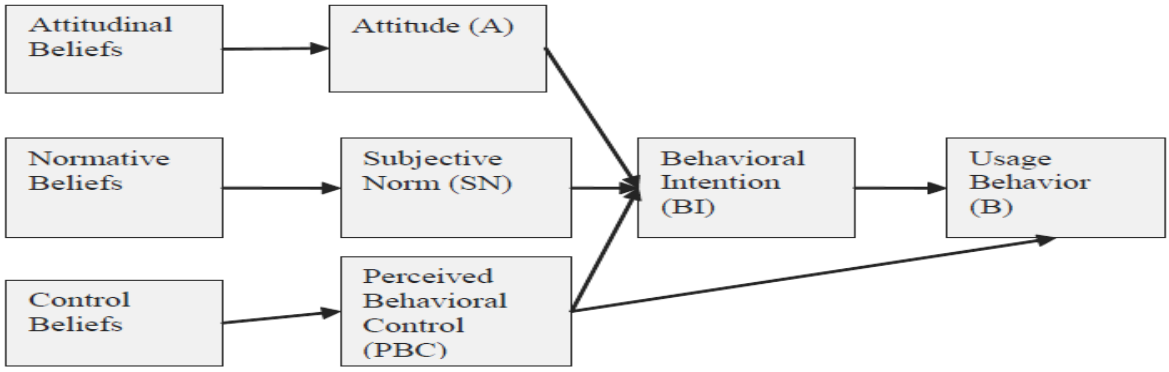


Figure 21 Decomposed Theory of Planned Behavior

3.6.6 Technology Acceptance Model

The TAM Model is one most widely and accepted the theory of technology management and explains on in what way users accept and use a technology. TAM discusses whenever a new technology or innovation takes place what are the factors responsible for users and staff of the organization to use and accept technology.

As per the definitions:

Perceived usefulness (PU) – As per the definition of Fred Davis, the degree to which individual trusts that with help of IT system, it would augment and improve his or her job performance".

Perceived ease-of-use (PEOU) – As per Davis the extent to which an individual thinks that using an IT system would be effort free. (Davis 1989).

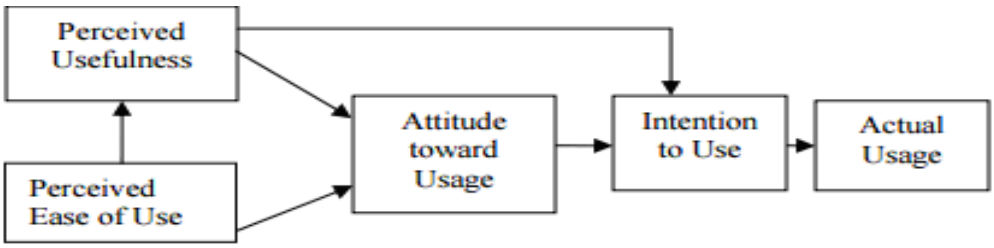


Figure 22 Technology Acceptance Model (TAM) (Davis, 1989)

The following figure 23 shows the various extensions of Tam Model which has been evolved over the period of time taking into various factors as per different research was done.

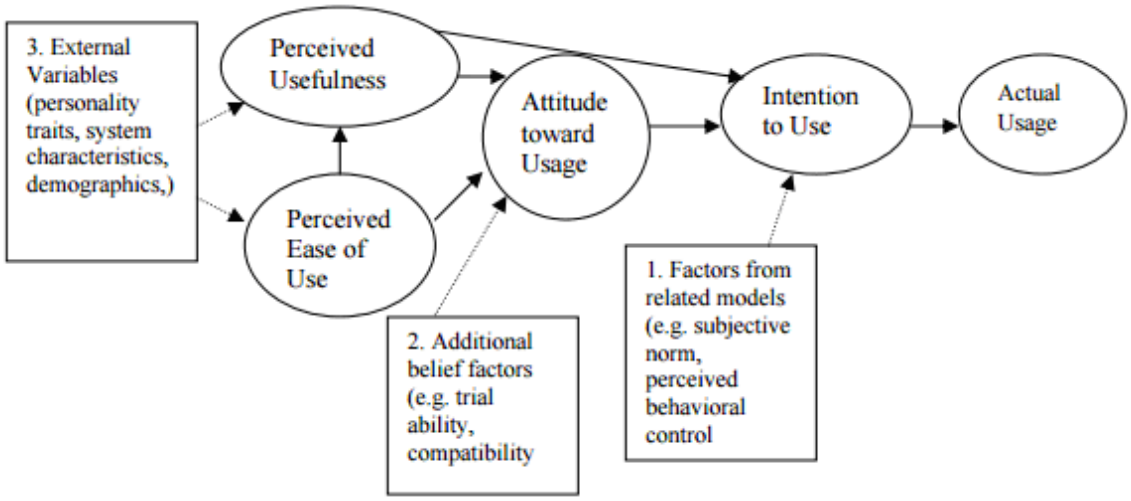


Figure 23 The Extension to TAM (adapted from Wixom and Todd,(2005)

Researchers namely Venkatesh and Davis (2000) established and evolved TAM2 by adding social factors like (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) in order to predict the acceptance of the technology (Figure 24).

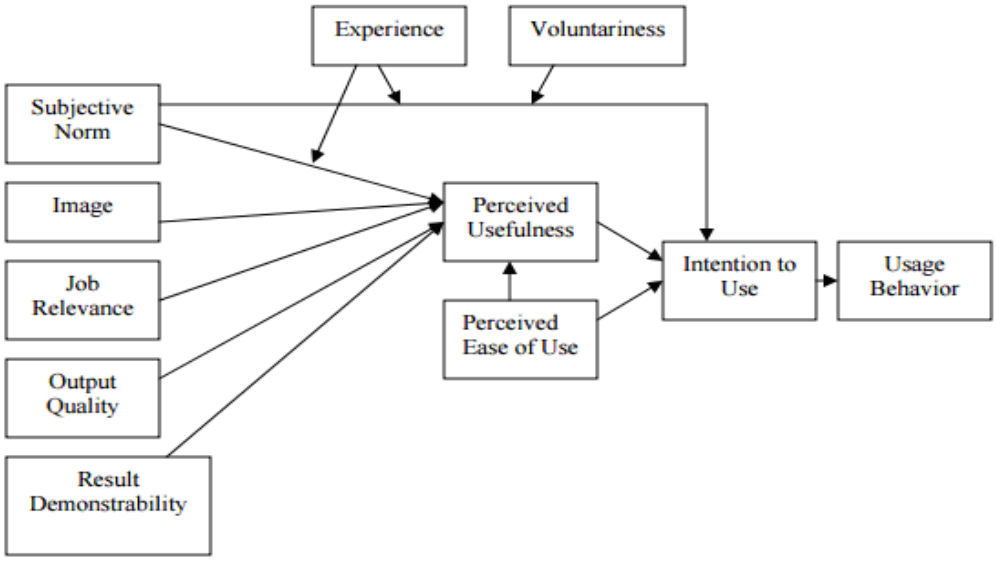


Figure 24 The Extended Technology Acceptance Model (TAM2) (Venkatesh and Davis, 2000)

3.6.7 Studies Examining User Acceptance

Eva- Maria Emsenhuber, Stephan Zielke (2012) explains technology acceptance model which predicts purchasing decision criteria of electric vehicles. Usha Kaul (1988) thesis finds that the approach adopted for developing a GIS by each utility is different, and the process of learning and a scope of what is required to carry out the objectives of the system has affected the process of development for the system. Several factors explain this: the external conditions in which these utilities operate, the internal organizational circumstances, including the role of an individual, the development approach, identification of users and their needs, definition of the scope of the system, desired application of GIS, and the level of management support. The thesis recommends the strategies that should be followed by electric utilities for successful development of a GIS.

Clarence Rayford Bodrey Jr (2006) evaluates the knowledge, attitude, and behavior regarding the longevity of the OSDS project procedure by the Coastal Health District's Environmental Health Mangers and Inspectors. The objectives were to: Describe the environmental health department participants by demographics & determine the OSDS project procedure adoption rate among environmental health department participants regarding Voluntariness, Relative Advantage, Compatibility, Image, Norms, Complexity, Result Demonstrability, Observability &Trial ability. The research explained the model

which included important factors that have the impact of various adopting factors in Chinese swine farming industry.

3.7 Research Conducted on Technology Acceptance Model in different Sectors

Various researches have been carried out in India as well as abroad on Technology Acceptance Model (TAM) applied to various sectors like education space, agriculture etc. The thorough review of the research done earlier still find the gap of research to be carried out in India in power distribution sector.

The Table 6 chronologically lists some of the research paper and thesis discussing the research conducted on technology acceptance Model in various sectors.

Research Papers & Thesis Discussing Research Conducted on Technology Acceptance Model in different Sectors

SL No	Literature Reviewed	Literature Type	Author	Gist & Essence	Research Gap	Year
1	Facilitators and inhibitors for the strategic use of information technology	Information & Management 27 (1994) 71-87	William R. King *, Thompson S.H. Teo	The research made a comparison of companies which has used IT and which have no used IT for strategic purposes. Thus it reveals how technologies help companies in taking various strategic decisions.	Factors affecting acceptance of GIS technology in the workforce in power distribution sector is a matter of research as not work has been carried out in this area. GIS technology is still in nascent stage in India and benefits of technology stills needs to be understood by the Discom Staff.	1994
2	Factors affecting farmers' adoption of technologies in farming system: A case study in OMon District, Can Tho province, Mekong Delta.	Moonrise 10: 94-100 (2002)	Truong Thi Ngoc Chi1 and Ryuichi Yamada2	The study examines various factors which are responsible for the adoption of technologies for young farmers.	Factors affecting acceptance of GIS technology in the workforce in power distribution sector is a matter of research as not work has been carried out in this area.	2002
3	Beyond Adoption: Development and Application of a Use-Diffusion Model	Journal of Marketing Vol. 68 (January 2004), 59–72	Chuan-Fong Shih &Alladi Venkatesh	The research reveals adoption do home technology use.	The concept note of the paper can be used in the research and be applied to adoption and application of technology in Discom	2004

4	Geographic Information Systems (GIS) and Instructional Technology Diffusion : K-12 Student & Educator Conceptualizations	North Carolina State University	Shannon Hill White	The paper evaluates Conceptualizations of GIS and Instructional Technology (IT) in schools.	Diffusion of GIS technology and to develop a model for research.	2005
5	Detailed Review of Rogers Diffusion of Innovations Theory & Educational Technology - Related Studies Based on Rogers Theory	The Turkish Online Journal of Educational Technology – TOJET April 2006 ISSN: 1303-6521 volume 5 Issue 2 Article 3	Ismail Sahin	The paper discusses popular adoption models and its applications which have been found out in various disciplines like political science, public health, communications, and education.	The process of research used in different can be useful in current areas of research,	2006
6	Effective Quality and Cognitive Absorption: Extending Technology Acceptance Research	Proceedings of the Hawaii International Conference on System Sciences, January 2006	Ping Zhang, Na Li, and Heshan Sun	The research paper tries to develop a model that exhibits the causal relationship among PAQ, cognitive beliefs, and IT use. The result indicate that PAQ has direct impacts on cognitive beliefs.	Application of Technology Models in Research on GIS technology in Power Sector	2006
7	An Analysis of the Technology Acceptance Model in Understanding University Students' Behavioral Intention to Use e-Learning	Park, S. Y. (2009)., 12 (3), 150–162.	Sung YoulPark	The research paper explains the application of TAM Model to study behavioral intention to use E-learning.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector	2009

8	Technology Adoption and Integration: A Descriptive Study of a Higher Education Institution in a Developing Nation	Ph.D. Thesis, Virginia Polytechnic Institute, and State University	Bertha Kate Nyirongo	The thesis investigates the adoption of the computer technology and the Internet in teaching and learning at the university.	Application of Technology Acceptance Model in various research but not in with reference to Indian Power Distribution Sector	2009
9	The ADOPT Model: Accelerating Diffusion of Proven Technologies for Older Adults	Springer	Ange Wang & Lynn Redington & Valerie Steinmetz & David Lindeman	The paper discusses the ADOPT model that highlights factors that affect technology adoption and use applicable to older adults.	Application of Technology Acceptance Model in various research but not in with reference to Indian Power Distribution Sector	2010
10	Cultural and Language Effects on Technology Acceptance and Attitude: Chinese Perspectives	International Journal of Information Technology, Vol. 16, No 1, 2010	Jane M. Carey, Charles J. Kacmar	The paper explains TAM Model to investigate culturally-specific user interface preferences that mark technology acceptance and approach toward technology.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector	2010
11	Access, Adoption, and Diffusion Understanding the Long-term Impacts of Improved Vegetable and Fish Technologies in Bangladesh	IFPRI Discussion Paper 00995 June 2010	Neha Kumar Agnes R. Quisumbing	The paper explains long-term effects of vegetable and polyculture fish production technologies o individual and household in Bangladesh.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector	2010
12	Recent Related Research in Technology Acceptance Model: A Literature Review	Australian Journal of Business & Management Research, Vol1 No-9 [124-127], Dec 2011	Shih-Chih Chen, Shin Han Li, Chien YI Li	This study reviewed 24 studies to understand the past, present, and future of Technology Acceptance Model.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector	2011

13	A two Dimensional Framework for RFID Adoption and Diffusion: Strategic Implications for Developing Countries	Journal of Technology Management & Innovation, Vol 6 Issue 2, 2011	Nyoman Adhiarna et al	The paper explains the study of RFID adoption and emphases on the phases of adoption, level of investigation and concerns of developing countries.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector	2011
14	Customers' Adoption Factors and Willingness to Pay for Home Energy Information Management System in Taiwan	2012 International Conference on Smart Grid Systems (ICSGS 2012) IPCSIT vol.45 (2012) © (2012) IACSIT Press, Singapore	Jyh-Yih Hsu and Hai-Lun Yen +	The paper examines residential customer inclinations and readiness to pay.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector. Also, need to develop a Technology Index which will set as a benchmark for measurement of implementation of Technology in Discom.	2012
15	Diffusion of innovation at the bottom of the_ pyramid: the impact of a payment system on_ the adoption of electricity in rural Uganda	Master of Science Thesis, KTH Industrial Engineering, and Management	Jonas Eder Christopher Mutsaerts	This thesis elaborates way by which a payment system has an impact on the diffusion of renewable electricity in rural Uganda.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector	2013
16	Private Healthcare in Malaysia: Investigation on Technology Profiles and Technology Acceptance Factors	Information Systems International Conference (ISICO), 2 – 4 December 2013	Aliza Sarlan, Rohiza Ahmad, Wan Fatimah Wan Ahmad, P.D.D. Dominic	This study investigates IT profiles of Malaysian small, medium and enterprise (SME) private healthcare as well as personal perception towards Health Information System (HIS) usage in their organization.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector.	2013
17	Diffusion and adoption of e-extension technology (computers and the internet) among extension agents in extension work in	African Journal of Agricultural Education Vol. 1 (5), pp. 094-099, November 2013.	Mansour Ahmed Mohamed Hefny	The study examines the impact of e-extension technology on business events and agriculture decision making.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector. Also, need to develop	2013

	Sohag Governorate, Egypt				a Technology Index which will set a benchmark for measurement of implementation of Technology in Discom.	
18	Technology Diffusion: Measurement, Causes, and Consequences	Working Paper 19052 http://www.nber.org/papers/w19052 National Bureau of Economic Research	Diego A. Comin Martí Mestieri	The paper elaborates question design patterns that describe the Diffusion of technologies and what are the key drivers of the technology.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector. Also, need to develop a Technology Index which will set a benchmark for measurement of implementation of Technology in Discom.	2013
19	Review of Technology Acceptance Model usage in predicting e-commerce adoption	International Journal of Application or Innovation in Engineering & Management (IJAIEM) Web Site: Volume 4, Issue 1, January 2015 ISSN 2319 – 4847	Michael Nyoro1, John W. Kamau2, Gregory W. Wanyembi3 et al	The research paper discusses and made a review of 25 e-commerce adoption publications.	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector	2015
20	Cultural Differences and Information Technology Acceptance	Proceedings of the 7th Annual Conference of the Southern Association for Information Systems	Amel Ben Zakour	The research paper elaborates the effect and impact of culture on adoption of technology (IT).	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector	2011
21	The Literature Review of Technology Acceptance Model: A Study of Bibliometric Distributions		Shu-Hsun Chang, Chien-Hsiang Chou et al	The paper describe the Literature review of TAM Model on the basis of Bibliometric Distributions	Application of Technology Acceptance Model and various cultural factors in various research but not in with reference to Indian Power Distribution Sector	2012

Table 6 Technology Acceptance Model Research conducted in different sectors

3.8 Research Conducted on Acceptance of GIS technology based on TAM Model

Geospatial technologies have been widely used these days in various sectors like power, environment, retail, mining etc. Acceptance of GIS technologies by the user has also an area of research by the researchers since long. This section tries to find out the research which has been carrying out in Acceptance of GIS technologies in various domains.

The table shows the research papers as well doctoral and Master thesis research done on acceptance of GIS Technologies worldwide. In India, the user acceptance of GIS technologies has been a matter of great concern, especially in power sector.

Research Papers & Thesis Discussing Research Conducted based Technology Acceptance Model on Geospatial Technology

SL No	Literature Reviewed	Literature Type	Author	Gist & Essence	Research Gap	Year
1	GIS Applications in Italian Archaeology	Archeological e Calcolatori 9, 1998, 191-236	P. Moscati	The paper exhibits application and usage of GIS technologies in archaeology.	The Study of geospatial technology applications and its acceptance with reference to power distribution sector in India needs to be studied.	1998
2	Diffusion of Innovation: GIS Technology Adoption by Coastal Georgia Environmental Health Departments	Master of Science Thesis, Georgia Southern University	Clarence Rayford Bodrey Jr.	The study focuses on research about Diffusion of Innovation with GIS technology and local governments by identifying attributes of the knowledge attitude and behavior of adoption by Health District Environmental Health Managers and Inspectors were trained on a GIS mapping and database process innovation, the OSDS project.	Diffusion of Innovation with Geospatial Technology in Environmental studies has been done but still, not much research has been carried out in Indian Power Sector.	2006

3	The Diffusion of GIS: A French Canadian Cross-Cultural Comparison of the Impact of National GI Policies	3rd AGILE Conference on Geographic Information Science – Helsinki/Espoo, Finland	Stéphane Roche	The Research aims to answers questions like What criteria should be used to measure the organizational and institutional impacts of GIS? To what extent is the adoption and use of GIT facilitated or impeded by the institutional and cultural context within which it takes place? What mechanisms might be used at the regional, national and international levels to facilitate the diffusion of GIS?	Demographic and cultural context as a factor is GIS technology adoption has not been used in research in India especially in Power Distribution Sector.	2010
4	Factor Affecting Police Officers Acceptance of GIS Technologies: A Study of the Turkish National Police	Ph.D. Thesis, University of North Texas	Bekir Cakar	It also examines factors affecting police officers satisfaction while using GIS technology.	Factor affecting acceptance of GIS technology in workforce in power distribution sector is a matter of research as not work has been carried out in this area. GIS technology is still in nascent stage in actual in India and benefits of technology stills needs to be understood by the Discom Staff.	2011
5	The different identities of GIS and GIS diffusion	int. j. geographical information science, 1999, vol. 13, no. 3, 267± 281	Tai O Chan and Ian P Williamson	The paper investigates GIS is being developed to solve problems of the organizations. The diffusion of GIS technology helps the companies to ease out many problems.	Solving problems through GIS as part of culture still is not prevalent in India	1998

6	The Diffusion of GIS in Journalism	Ph.D. Thesis, Louisiana State University	Ben S. Wasike	The study examines the adoption of GIS among reporters and forecast diffusion of GIS in the journalism industry.	Diffusion of Innovation with Geospatial Technology in Journalism studies has been done but still, not much research has been carried out in Indian Power Sector.	2011
7	The Diffusion of GIS at Municipalities in the Netherlands	MSc Thesis, UNIGIS	R. Colijn	The study examines the diffusion of GIS technology in municipalities and finds out benefits of GIS adoption.	Diffusion of Innovation with Geospatial technology in government departments like municipality in abroad studies has been done but still, not much research has been carried out in Indian Power Sector.	2000
8	A Model of the Decision Process for GIS Adoption and Diffusion in a Government Environment	Department of Geomatics The University of Melbourne	Tai On Chan , Ian P. Williamson	The study examines factors responsible for GIS adoption in Australian State government agencies		1996

Table 7 Research on GIS Acceptance based on TAM

3.9 Strengths of the Contemporary Research done

Based on the review of the reported literature, the following strengths of contemporary research are observed:

- Many international and national research journals have published and have given significant importance and thrust to research on the application of ICT and automation technologies in power distribution sector. Some of the books have also discussed issues concerned with the strategic adoption of technologies in different sectors, which can be applied Indian power sector too. Such publications provide a major boost to research in this area.

- Power Sector has now recognized the significance of application of ICT technologies and adoption and diffusion for sustaining and improving their financial conditions. Workshops, seminars and conferences are frequently held to provide a forum for researchers in this area to meet and share their research findings and also keep the managers updated with the latest research and technical developments in this area. Papers from seminar proceedings of many such interactions are referred in the literature and we indicated in the reference section.

3.10 Gaps in Research and Identification of Research areas.

Table below identifies the research areas after identification of the gaps in literature and leads to the validation of the research topics and objectives

Summarization of Research Conducted, Research Required, and Validations of the Research Objectives			
SL No	**Research Conducted**	**Research Required**	**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 an integrated environment and its impact on company losses is still. Missing	The requirement has studied all technology in integrated environment and studies its correlation and impact on AT&C losses and power distribution company performance.	Identified research validates the research objective 1.
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 to develop the Power Distribution Technology Implementation Index in Indian context	Identified research validates the research objective 1 with reference to National Capital Region of India.

3	Research Conducted till date on website assessment has been in developed countries like Europe, the 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 the Website Assessment for power distribution companies in India and compare them	Identified research validates the research objective 2 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 the effective adoption of GIS in India as still GIS is in a nascent stage in India across various sectors.	Identified research validates the research objective 3
5	Not much of Research conducted till date in areas of GIS technology adoption in power distribution sector in Europe, the USA, and Australia.	The requirement is to study effective adoption of GIS in India in power distribution sector which still has to go long way in harnessing the advantages of this technology	Identified research validates the research objective 3 with reference to National Capital Region of India.

Table 8 Gaps in Contemporary Research and Identification of Research areas.

3.11 Summary

The chapter starts with the overview of current state of technology in Indian power sector. The chapter then focuses on research work is done, so far, in areas of technology management in power distribution sector in India and abroad. Each research objectives taken for research is then separately taken with respect to research work done in those areas earlier. Website assessment of power distribution companies which has been taken for research, the researcher tries to find out different kinds of research done in this areas not only in power sector but in general. Research work was done earlier and literature review related to technology acceptance model and adoption and diffusion of technology is also summarized in detail. Research work done on acceptance of GIS based on TAM (Technology Acceptance Model) is discussed in detail. The chapter concludes with the strength of the research and also gaps in contemporary research and identification of research areas. The next chapters elaborate research methodology and techniques taken for research.

Chapter 4

Research Objectives and Hypothesis Formulation

Chapter 4: Research Objectives and Hypothesis Formulation

4.1 Introduction and Relevance of the Topic

The present study aims at examining the assessment of technology applications adoption and diffusion in power distribution companies. The research tries to study different types of technologies being in used in Discoms but focuses on adoption of applications of the technologies.More specifically, the research aims to develop strategic technology management framework for better use of technology applications in power distribution companies of NCR. The study identifies aspects that can help power distribution companies in India to overcome the technical, managerial, social and cultural barriers to effective ICT applications adoption.

Literature review done shows the (ICT) have become an important part of many processes in Discoms. Therefore research requires an understanding of types of technologies which are implemented in Power distribution and processes.

4.2. Problem Statement and Research Focus

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 applications to curb human intervention and provide better services to the consumers in terms of handling complaints and automate the consumer's redressal mechanism. Various applications build on 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 research work tries to develop a new framework for the assessment of applications of technologies used in power distribution industry. The new framework takes into consideration factors which are required in developing power distribution Index.

The research work focuses on the need of a robust website for power Discoms as it is one of the most important links between Discom and consumers directly. The research tries to

find out different parameters which play important role in building the website and how factors like response time play a crucial role in solving many issues of the consumers. The research marks evaluation of the websites of Discoms in Delhi NCR based on different parameters defined in the new framework.

Adoption and diffusion of applications of technologies still remain as a matter of concern for most of the Discoms in India.The one of the main rationale of the research was to discover the how employees of quasi-government and government power distribution companies were utilizing geospatial technologies applications in their organization and various factors that were associated with level of utilization

- Calculation of level of acceptance of GIS technologies.
- Consumption of GIS technology by the staff

With the development of technology, a numerous number of studies has been carried out for acceptance of Information Technology (IT) system in the organization, still, there is a need for study of acceptance of GIS in Indian Power distribution sector.

4.3 Research Objectives

Following Research Objectives were framed on the base of the breaches of research, noted in the Literature Survey. :

4.3.1 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). And to find out the correlation between the AT&C losses incurred by Discoms over the years and PDTI in improving their system.

4.3.2 Research Objective 2

To identify key factors were measured as elements of quality of websites. Therefore to test its validity Chi-square test was used to analyze Discoms websites.

4.3.3 Research Objective 3

The first objective emphasis on developing the new research framework for the development of power distribution technology Index. The second objective of the research dealt with evaluation of Discoms website

The next comes to study of the factors which influence the Discom staff for adoption and usage of these technologies applications in their work. Since in Objective two we came across lots of different technologies which has been in use in power Discom but studying all technology was difficult so GIS technology which is one of the most recent and innovative technology has been taken up for the study.

The success of any technology depends on how well the applications built on technology has been used the organization in several of their operational and business processes. Research Objective 3 aims at addressing this by developing a new framework and test it and later on a comparison of government Discoms with quasi-government Discoms.

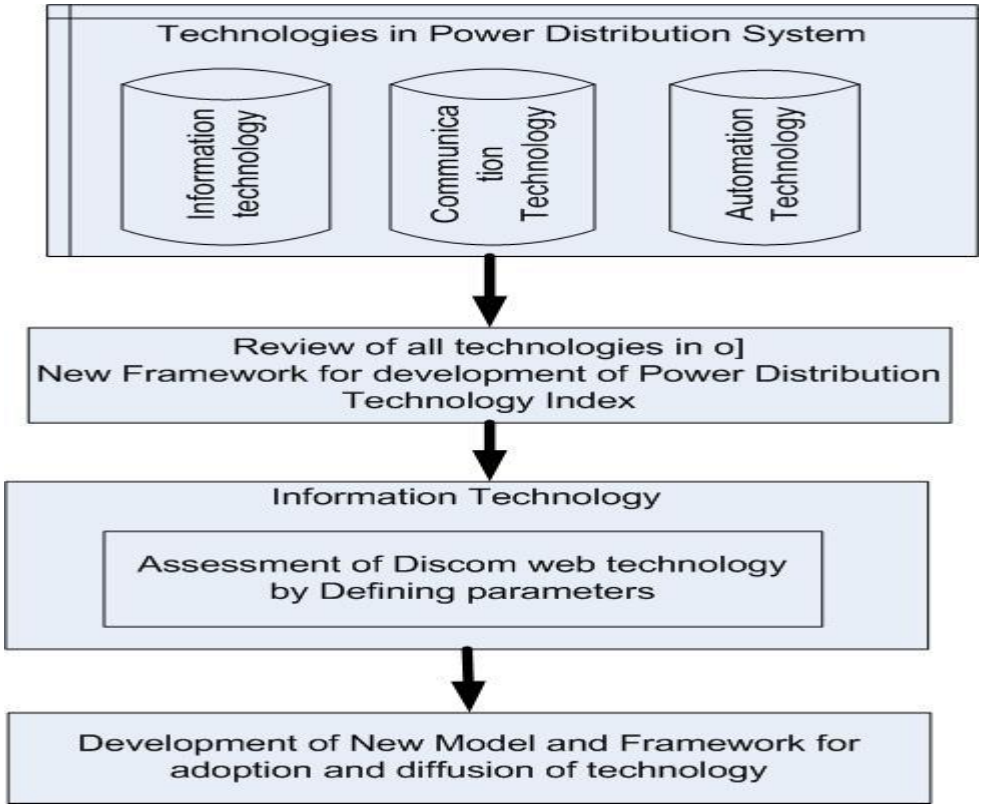


Figure 25 Sequence of Defining Objectives in the research

Therefore the third research objective is to assess the Adoption & Diffusion of GIS among State Owned & Quasi Government Power Distribution Companies in NCR. The research intends to study various factors for adoption of GIS technologies and acceptance factors and intentions of the users to accept GIS technologies which are still in nascent stage in terms of technology acceptance and diffusion in the power companies. The research is an attempt to inspect and consider the aspects affecting the usage of GIS technologies among state-owned and quasi-government companies in National Capital region.

4.4 Hypotheses Formulation

Literature Survey and deep understanding of power distribution sector resulted in the formulation of the following research hypothesis. Three sets of hypotheses have been formulated. One set is 'Hypothesis on the level of technology implementation which was relevant from the development of technology Index for Power Discoms 'The second set is Hypothesis determining the website assessment of power Discoms.The third set

‘Hypothesis covering dimensions of a factor which affects adoption of GIS adoption in power distribution companies’.

4.4.1 Hypothesis on the level of technology implementation

Hypothesis based on technological implementation level

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

H1- There is a difference in level of technology implementation in power distribution companies

Hypothesis based on relationship

- H0: The technology implementation index & AT&C loss are correlated in power distribution companies.
- H01: There is no correlation between technology implementation index & AT&C loss of power distribution companies.

4.4.2 Hypothesis regarding the website assessment of Power Discoms

The hypothesis formed in the research of website assessment index for power distribution companies in National Capital region are as follows:

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 substantial difference in the Discom wise websites in NCR.

H03: There is no substantial difference in the category-wise Discoms Website.

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, the 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.

4.4.3 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 an 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).

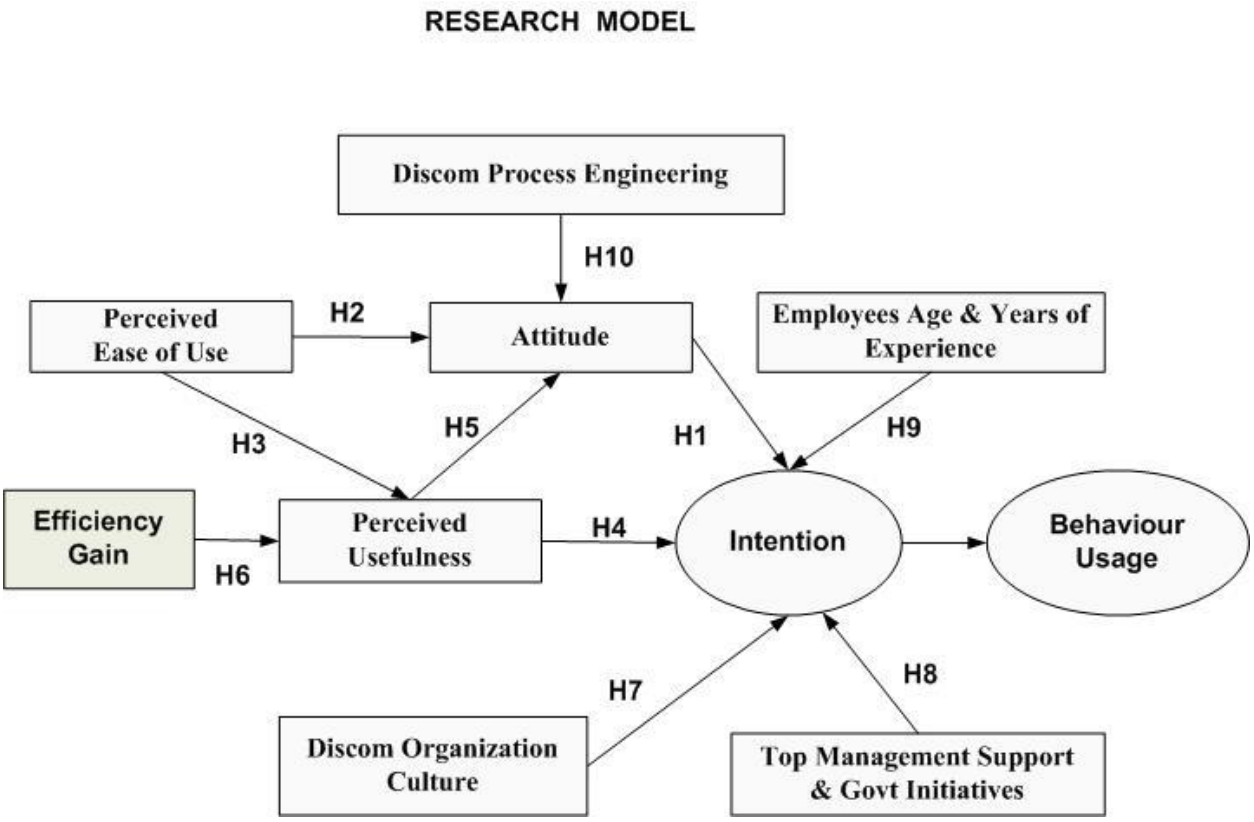


Figure 26 Research Framework

4.5 Research Overview

The Research Aim focusing on the factor and concern that underpin the most effective technology adoption by Power utilities for their various process and current issues faces which can be addressed. The Research Methodology is explained in Chapter-3 which showcases description of the research methods used for various objectives mentioned earlier in this study.

The research endeavor was to understand how these power distribution companies have been using technologies, to what extent in their various operational process as well as business processes.

4.6 Research Framework

A research framework helps to structure the research process into logical steps and appropriate stages. The establishment of an action plan helps to guide and direct the research so that there is a clear connection between all the stages i e formulation of research aim and objectives, literature review, data gathering and investigation and conclusions known in the course of analysis. Figure 27 provides an overview of the research framework which was framed and undertaken during the research.

The research process was supported at all stages by a detailed literature review and study of conceptual as well as empirical literature. The literature was reviewed and done in four various phases of the research. The first stage was a preliminary exploration of the current position of various types of technologies used in Indian Power distribution sector and also the technologies used by other some other power distribution companies in the world especially in developed nations. This helped in the formulation of the research proposal and also helped in the formulation of the problem statement and research objectives. This is mainly presented in Chapter 2 as in introduction to research resulted in the design of research objectives. The second stage of the review was done to study the research contextual of objectives. This helped in identification of research variables and research areas. This part of the literature review is presented in Chapter-3. The third stage of literature study was linked to the study of methodologies. It was the significant stage of a literature study as only by using appropriate methodologies in relevance to technology implementation, adoption and diffusion were established. This resulted to the devising of research design and methodologies. The fourth stage of a literature review or advanced literature review was conducted after the questionnaire survey. It helped in the formulation of research construct for the semi-structured interview survey and case studies analysis. The whole process of literature review facilities constant knowledge building block by block that is required for the research process. The research methodology was designed to achieve research objectives by way of including effective data collection, analysis, and their validation methodologies.

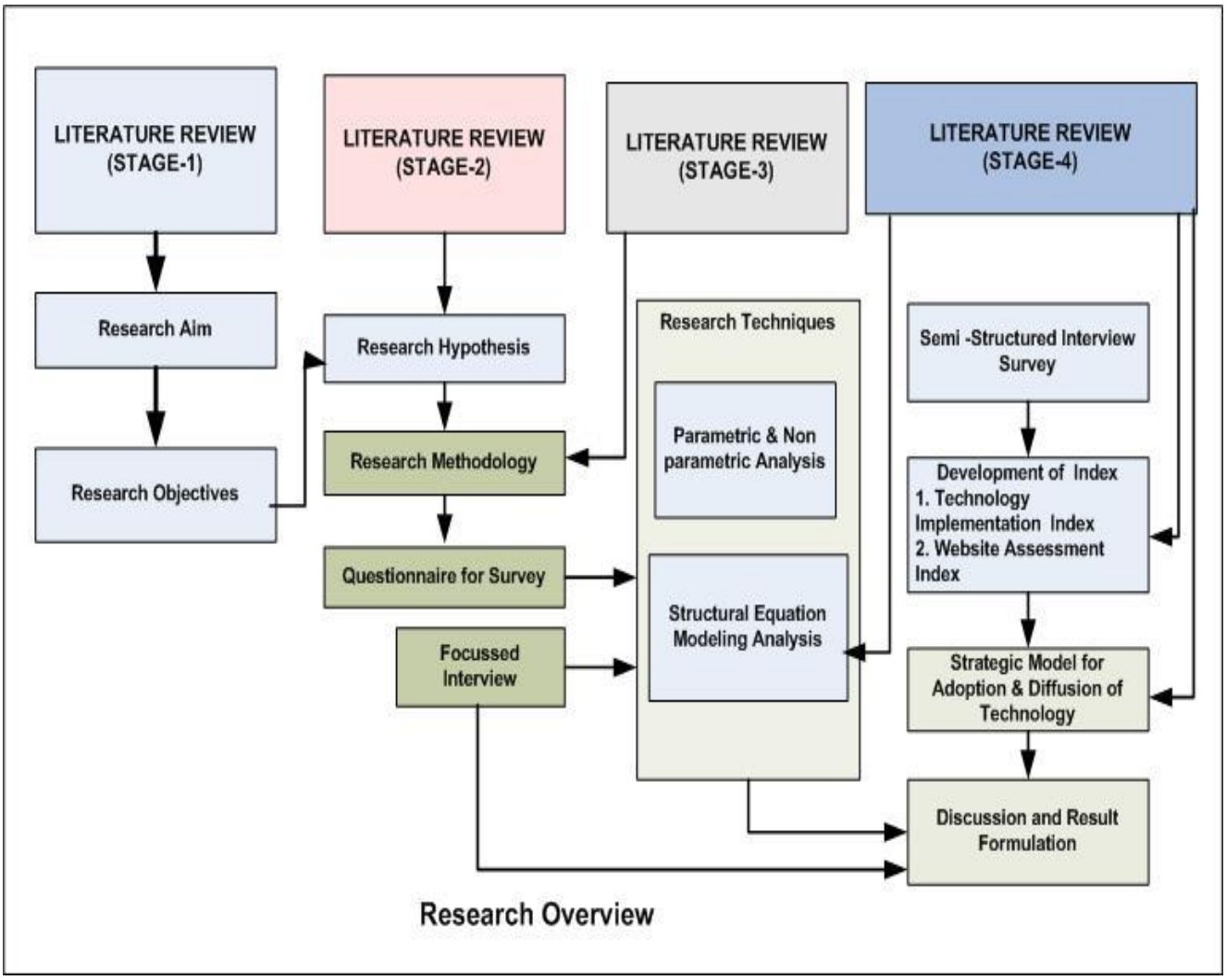


Figure 27 Research Overview
Source: Designed by Researcher

4.7 Delimitation of Scope

This section helps to identify a planned, justified scope of study beyond which generalization of the results was not intended. The identified delimitations are additional to the limitations and key assumptions. .'Delimitations' are within the control of the researcher, whereas the 'limitations' are not. Limitations caused by the methods used are identified and explained in Chapter 10 as a summary of all the limitations that became evident throughout the course of the study. Key assumptions are described in relevant sections.

The identified limitations are discussed below:

- Data was collected only from four Power distribution companies in National Capital Territory region. In order to generalize the same to other power Discom companies, nature, the size of the company and management style have to be considered as they have an impact on the level of acceptance of the technology.
- However, the methods used can also be generalized and be used to study the technology adoption and diffusion for power distribution companies of other parts of India too.
- The results can be generalized also other state electricity boards but for the factors and indicators might not be relevant for other state distribution companies.
- The research conducted in developing technology index can be used for other state electricity boards in India.
- The frameworks developed by the researcher for strategic management of technology can be extended to government owned state electricity boards as study contains both governments as well as quasi-government companies.
- The website assessment Index can be generalized and be used to study the use of power distribution websites by the consumers for solving their various issues and bill payment.

4.8 Summary

The Chapter discusses in detail the objective taken for the research work. Each research objective which has been defined after analysis if research gaps and literature review is then defined ahead using hypothesis. Each research objective is then followed by the assumed hypothesis for the research. The chapter deliberates the research overview and limitation of research scope. The delimitation refers to basically the key assumptions and identified limitations taken for the research work The Next chapter explained the research methodology adopted for the research.

Chapter 5

Research Methodology

Chapter 5: Research Methodology

5.1 Introduction

How the research problems can be solved in a well-designed manner is actually the meaning of Research Methodology. In this research, the major concepts are research variables or the factor which used to define the technology index and which affects the adoption of GIS in Power distribution sector.

The design to solve a research problem or developing some new Indexes or benchmarks for comparison is challenging task and requires a bit of innovation. This task was systematically approached by identification of new research variables, develop the conceptual framework, formulation of research hypothesis and designing of the research methodology to meet and solve the objective problem taken in research. A number of innovative and creative ideas were explored to get inputs, feedback from officials of power distribution companies to solve the research problem through well-defined methodology.

5.2 Chapter Overview

The chapter is divided into four sections. Section 5.3 describes the research design followed in the study which involves the understanding characteristics of research problem also which is followed by definition of research variables. Sec 5.4 provides a description of scales used for measuring the constructs.The data gathering and sampling technique are described in Sec 5.5.Sec 5.6 provides detailed information about the hypothesis formulated based on literature review and research design.The research methods involved in the study like questionnaire survey, interviews and survey population is mentioned in sec 5.7.After data collection, then involves data analysis which includes parametric and non-parametric analysis and SEM is mentioned in sec 5.8. Sec 5.9 covers data analysis-synthesis methodology and framework for results formulation. Justification of use of statistical tools and software packages is mentioned in sec 5.10. Lastly, the justification for using appropriate statistical procedures used in the study is provided in sec 5.10.

5.3 Research Design

Steering ahead from research questions to conclusion is termed as Research Design

5.3.1 Understanding the characteristics of Research Problem

To comprehend the research problem, the research study title is again mentioned as:
"A Study on Strategic Technology Management in Power Distribution Companies with Specific Reference to National Capital Region of India".

Research Design may be generally classified as:
1. Exploratory Research Design
2. Descriptive and Diagnostic Research Design
3. Hypothesis-Testing Research Design.

1. Exploratory Research Design:

This type of research design is used is to frame a research problem for the development of a hypothesis. The aim of studies is the finding of ideas and comprehensions. It aims merely to discover the research questions and does not intend to offer ultimate and conclusive answers to prevailing problems. Typically, the following three approaches are considered in the perspective of a research design for such studies. They are

- A survey of the related literature.
- Experience survey.
- Analysis of 'insight-stimulating' instances.

2. Descriptive Research Design:

It is a study designed to depict the participants in a precise way. It can also be referred as about research describing people who take part in research.

There three ways in which descriptive research project can be done:

- Observational also referred as a way of observing and recording the participants.

- Case study: It can be referred as in-depth study of individuals or group of individuals
- Survey: It is defined as brief interview or discussions with an individual with reference to the specific topic.

3. Hypothesis-Testing Research Design:

In this type of research design researcher test hypothesis between two or more variables.
In this research study of the identified research variables requires the use of quantitative as well as qualitative methods. Thus Data were collected using a questionnaire based survey hours. The data collected were then used for further analysis.

5.3.2 Research Variables

Factors affecting the assessment of Technology and adoption of GIS for power distribution sector are the research constructs that are required to be studied. In Table-9 these constructs namely Perceived Ease of Use, Attitude, Efficiency gain, Perceived Usefulness, Discom Organization Culture and Intention all were selected on the basis of literature review done earlier. All the variables are studied extensively because these would be factors determining the adoption of geospatial technologies, assessment of technology and website of Discoms.

Macro Variables also referred as Constructs with attached indicators, which can also be termed as micro variables. Indicators are the dimensions that help in measuring and quantifying the macro variables. These needs to be elaborated and explained. Literature review and understanding of the power distribution sector has helped in identification of the macro variables for the identified factors which would be further divided into the measurable dimensions. Variables for which dimensions are identified and can be measured quantitatively are measured and analyzed through the quantitative assessment approach. For other variables, dimensions are identified, measured and analyzed through further analysis utilizing qualitative analysis approach. Table-9 list macro variables identified macro variables and the assessment approach for each macro variables.

Macro Variables and its related Micro Variables identified and Study Required for Each Variable			
Sl No.	**Macro Variables**	**Micro variables**	**Type of Study Required**
	Website Assessment Factors		
1	Information Content	Not Required	Qualitative / Quantitative Assessment
2	Technical Details		Qualitative / Quantitative Assessment
3	Commercial		Qualitative / Quantitative Assessment
4	Communication Content		Qualitative / Quantitative Assessment
5	Sustainability		Qualitative / Quantitative Assessment
6	Customer Service		Qualitative / Quantitative Assessment
7	Payment Options		Qualitative / Quantitative Assessment
8	Regulator Information		Qualitative / Quantitative Assessment
9	Govt of India (Ministry of Power Initiatives)		Qualitative / Quantitative Assessment
10	Consumer Care Services		Qualitative / Quantitative Assessment
11	Me Details	Not Required	Qualitative / Quantitative Assessment
12	Contact Us	Not Required	Qualitative / Quantitative Assessment
13	Customer Information Centre	Not Required	Qualitative Assessment/ Quantitative Assessment
14	Vendors/Tenders	Not Required	Qualitative / Quantitative Assessment

15	Other Information		Qualitative / Quantitative Assessment
16	Right to Information		Qualitative / Quantitative Assessment
	Technology Index Factors		Qualitative / Quantitative Assessment
17	Metering	Installation of Electronic Meters -LT Consumers	Qualitative / Quantitative Assessment
		AMR for HT Consumers	Qualitative / Quantitative Assessment
		AMR for Feeder Meters	Qualitative / Quantitative Assessment
		AMR for DTs	Qualitative / Quantitative Assessment
		CMRI Metering reading for HT/LT Consumers	Qualitative / Quantitative Assessment
		Prepaid Metering	Qualitative / Quantitative Assessment
18	IT Distribution Apps	Energy Accounting System	Qualitative / Quantitative Assessment
		SCADA	Qualitative / Quantitative Assessment
		Load Forecasting Applications	Qualitative / Quantitative Assessment
		Meter Data Management System	Qualitative / Quantitative Assessment
		Outage Management System	Qualitative / Quantitative Assessment
		Geographical Information System & Network Analysis	Qualitative / Quantitative Assessment
		Smart Grid Pilot Project	Qualitative / Quantitative Assessment

19	IT Retail Applications	Customer Information System	Qualitative / Quantitative Assessment
		Centralized Call Centre	Qualitative / Quantitative Assessment
		Online Web Based Consumer Grievances Redressal System	Qualitative / Quantitative Assessment
		Online Bill payment	Qualitative / Quantitative Assessment
		E-Complaint	Qualitative / Quantitative Assessment
		Spot Billing	Qualitative / Quantitative Assessment
20	Enterprise level Apps	SAP Module for Finance	Qualitative / Quantitative Assessment
		SAP Module for HR	Qualitative / Quantitative Assessment
	Technology Adoption Factors		Qualitative / Quantitative Assessment
21	Perceived Usefulness Referred from Davis (1989); Davis et al. (1989); Moore and Benbasat, (1991)	GIS provides me better picture of my queries	Qualitative / Quantitative Assessment
		GIS Increase visualization of and extent of the problem.	Qualitative / Quantitative Assessment
		GIS is good feedback system to confirm reports.	Qualitative / Quantitative Assessment
		GIS improves in my decision making.	Qualitative / Quantitative Assessment
		GIS is overall useful in my day a today work	Qualitative / Quantitative Assessment
22	Perceived Ease of Use. Referred from Davis (1989); Davis et al. (1989); Moore and Benbasat, (1991)	My interface with the GIS is clear and understandable.	Qualitative / Quantitative Assessment
		Using a GIS application does not require a lot of skill.	Qualitative / Quantitative Assessment

		Using a GIS application does not require a lot of mental effort.	Qualitative / Quantitative Assessment
		Learning to operate the system is easy for me.	Qualitative / Quantitative Assessment
		I would find the system to be flexible to interact with.	Qualitative / Quantitative Assessment
23	Social Influence. Referred from Thompson et al. (1991); Venkatesh et al. (2003)	Within Depts, the environment is good for use of GIS.	Qualitative / Quantitative Assessment
		Other Depts. personnel often asks for GIS-based reports	Qualitative / Quantitative Assessment
		Senior Management encourages use of GIS.	Qualitative / Quantitative Assessment
		Workforce think GIS as reliable decision support system	Qualitative / Quantitative Assessment
24	Efficiency gain Referred from Davis (1989); Davis et al. (1989); Moore and Benbasat, (1991)	Using GIS has reduced my field visit to large extend	Qualitative / Quantitative Assessment
		Using GIS saves my time.	Qualitative / Quantitative Assessment
		GIS has provided a single platform for field staff & supervisors to view the problem.	Qualitative / Quantitative Assessment
		GIS has helped in providing better services to customers	Qualitative / Quantitative Assessment
		GIS has reduced fault time and helped in faster fault restoration	Qualitative / Quantitative Assessment
25	Attitude Adapted from Taylor and Todd (1995); Thompson et al. (1991); Venkatesh et al. (2003)	I like working with user-friendly system like GIS	Qualitative / Quantitative Assessment
		Using GIS system is exciting	Qualitative / Quantitative Assessment
		GIS system makes work more attention-grabbing.	Qualitative / Quantitative Assessment
		Working with the GIS system is enjoyable.	Qualitative / Quantitative Assessment

		GIS system can be used in policy decisions.	Qualitative / Quantitative Assessment
26	Intention Adopted from Venkatesh & Davis (1996); Venkatesh & Davis (2000); Agarwal& Prasad (1997)	Given that I have access to the GIS, I intend to use it in my job	Qualitative / Quantitative Assessment
		I often use GIS in my job	Qualitative / Quantitative Assessment
		Often I try to explore different thoughts using GIS & technical skills	Qualitative / Quantitative Assessment
		In my spare time, I try doing new things using GIS	Qualitative / Quantitative Assessment
		I often contact GIS staff for technical support.	Qualitative / Quantitative Assessment

Table 9 Identification of Micro Variables for the Macro Variables and the Type of the Study Required for Each Variable

5.4 Measurement of Constructs

The present study used the following constructs

- Perceived Ease of Use
- Attitude
- Efficiency Gain
- Perceived Usefulness
- Social Influence
- Intention
- Top Management Support & Govt Initiatives
- Discom Process Engineering
- Discom Organizational Culture

Each of the constructs was measured using measurement scale used in the literature. Each instrument comprises of a set of statements. All statements ranges on a likely scale of 1 to 5

1 - Totally Disagree

2 -- Disagree

3 -- Neutral

4 -- Agree

5 -- Totally Agree

The questionnaire is presented in the Annexure B & C.

5.4.1 Perceived Ease of Use:

It discusses to use of technology in which user find how easy is the system to use without requiring much of effort. The technology introduced here with referred as GIS technology should be easy to reminisce and should be easy to absorb and disseminate. The interface of the GIS system should be trouble-free to work upon and a person can start using these technologies after basic training.

5.4.2 Attitude

Attitude toward use is defined as "an individual's overall affective reaction to using system" (Venkatesh, et al., 2003, p. 455). Melone (1990) also defines user attitude in "a predisposition to respond favorably or unfavorably to a computer system, application, system staff member, or a process related to the use of that system of Application".

5.4.3 Efficiency Gain

Efficiency gain refers to how the GIS technology has helped them in their current daily activities. Also how the geospatial technologies have reduced their efforts while giving the same output and reduced field efforts. Since GIS empowers the field engineers about field conditions while sitting on their PC in the office, it used to measure the degree of which technology has helped them in their work.

5.4.4 Perceived Usefulness

This was defined by Fred Davis as "the degree to which a person believes that using a particular system would enhance his or her job performance".

5.4.5 Discom Organization Culture

It refers to individual belief and impacts created by seeing their peers, supervisors, and others around support or discourage the use of technology in the organization. The user's gender, age, and experience also have an important impact on the Discom Organization Culture

5.4.6 Intention

The intention in this research study has been used as an independent variable or exogenous variable and used to study the impacts of the endogenous variables used in the research.

5.4.7 Top Management Support & Govt Initiatives

It refers to senior management support and thrust for using GIS in Discom and also various Govt initiatives where GIS has been involved

5.4.8 Discom Process Engineering

It refers to various initiatives where GIS has been linked with the various operational process as well as the business process.

5.4.9 Discom Organizational Culture

It basically refers to an environment in Discoms which are in favor or against the use of GIS.

5.4.7 Summary of Measurements & Constructs

Construct	Author of the scales	No of indicators	Type of scale
Perceived Usefulness	Davis (1989); Davis et al. (1989); Moore and Benbasat, (1991)	5	Likert Scale
Perceived Ease of Use	Davis (1989); Davis et al. (1989); Moore and Benbasat, (1991)	5	Likert Scale
Efficiency gain	Davis (1989); Davis et al. (1989); Moore and Benbasat, (1991)	5	Likert Scale
Attitude	Taylor and Todd (1995); Thompson et al. (1991); Venkatesh et al. (2003)	5	Likert Scale
Intention	Venkatesh & Davis (1996); Venkatesh & Davis (2000); Agarwal & Prasad (1997)	5	Likert Scale
Top Management Support & Govt Initiatives	Proposed by Research Scholar	5	Likert Scale

Discom Process Engineering	Proposed by Research Scholar	5	Likert Scale
Discom Organizational Culture	Proposed by Research Scholar	5	Likert Scale

Table 5.2 Summary of Measurements & Constructs

5.5 Sampling and Data Collection

A non-probabilistic method of sampling was followed.In the survey, every item has an equal chance of getting selected, and however, in non-probabilistic sampling, it is assumed that sample within the population has even characteristics. Therefore we can believe that sample is representative of the population such that the results will be accurate. Especially with respect to social institutional settings non-probabilistic sampling is common as it saves time and other resources. (Samuel 2013). The current method is combination of judgment and conventional sampling (Zikmund 2012)

Out of approx. 63 power distribution companies in India, four power distribution companies in National Capital Territory were selected for the research.

For technology implementation and adoption in power Discoms research hypotheses and objectives, initially 400 questionnaires were circulated in each Discom but the response rate was very low, at 20 percent even after several follow up and repeated calls. It was primarily due to their busy schedule and also due to the hesitation of the employees to respond on such a sensitive topic. So, it was supplemented with qualitative analysis By personal interviews with Discoms staff at conferences, forums, also at training sessions and also at their offices. The researcher also made use of different methods of grounded theory like historical documents, observations report to get the insights of the level of technology implementation in power distribution companies in National Capital Region.

Summary of primary and secondary data referred are as follows:

Sl No	Factors Considered for Technology Implementation Index	Details	Nos
1	Utility Customers Survey	No. Customers Surveyed	300/Discom
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	Utility Website	Web sites of Power Distribution Companies	7
6	Press Release & Power Market News	No. of Press Released referred	35

Table 10 Summary of sources of data collection

The total population size here refers to some of the key officials of the Discoms who had complete knowledge of different technology implementation

Interview with Power Utility Officials at Workshop/Conferences

Sl No	Power Distribution Company	Total Population	Sample Size
1	Delhi Discom	153	117
2	Haryana Discom	187	106

Table 11 Summary of sources of contacts with Utility Officials

Determination of Sample Size in the research on website assessment of power distribution companies:

In order to determine sample size for this research, the total population considered for this research was only urban LT (Low Tension) Connection consumers of the power distribution companies. The number of LT connection consumers for these power distribution companies were derived from the websites of these companies. Later on, in

order to derive the sample size for the research, the confidence level of 95% was selected and margin error of 5 % was considered for the research. Table 9.2 below gives detail description of the required sample size with respect to the population considering the assumptions in terms of confidence and error made above. The responses received were after sending the research form was almost congruent to the sample size advised. Apart from this online technique is also used which has views and inputs for millions of customers of these Discoms. The online techniques take the inputs of the customer to a larger extent as millions of customers rate these websites on the basis of various parameters and various analysis is done based on various online analytical techniques.

The sample size is calculated based on the assumption of the confidence level of 95% and margin error of 5 %.

Sl No	Power Utility Company	Serving Area	Total LT Domestic Consumer (Approx.)	Ideal Sample Size	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	1056883	384	391
4	DHBVN	Gurugram	200553	384	384
5	PVVNL	Noida	149510	384	390

Table 12 Summary of consumer questionnaire feedback
Total Consumer*- Source: Power Distribution Companies websites (bsesdelhi.com, tatapower-ddl.com, pvvnl.org, dhbvn.org.in)

GIS Technology Adoption & Diffusion

Power Discom staff and officials are busy with a tight schedule of resolving of power supply it was a bit difficult to get data from them, While the questionnaire does not seek any confidential information, information gathering from power Discom companies has indeed been a difficult exercise. Around questionnaire were circulated to 700+ people of the different power companies were approached.

The data enabled valid analysis, confirming to the scholar's own experience. The data is gathered in approximately 2 years and the data gathered empowered alignment of

responses into three data sets on the basis of organization size. Few important executives were identified who would give the right information about the in-depth adoption and diffusion of technology in power Discom So even the size of the Sample size might be less but due to the people with key information it may be considered that informed which has been gathered for the research would provide the best insights for the research.

Power Distribution Company	Total Employees(Approx.)	Sample Size
Delhi Discom	2100	204
Haryana Discom	1463	200

Table 13 Summary of Power Utilities Staff Sample Size

5.6 Research Methods

Different research methods which have been used in this study are as follows:

5.6.1 Questionnaire Survey

Questionnaire Design

As per the definition mentioned in Kothari (2005, p 95-121), a questionnaire refers to Group of questions that are suitable for the research topic and its objectives and the responses to which will provide necessary data to test research hypothesis.

Section I contains questions that assess the website of the power distribution companies in terms of content, navigation, speed, and accessibility Each factor or dimensions of the website was further divided into micro variables and indicators and the same was questioned with consumers of power distribution companies in their area.

Section II uses a tool for mapping technology which is being used in different power distribution companies. The different technologies are classified into different categories and each category is then further sub-classified and indicators linked to each macro variable to measure the research content and answer the research questions.

Section III contains questions which are used to study and investigate the various factors responsible for adoption and diffusion of technology in government as well as Quasi-government power distribution companies in National Capital Region.

5.6.2 Survey

The survey for the research comprises of a different section of people based on the hypothesis chosen to answer research questions. Broadly there are two different sections of people were identified for the research.

The first survey consists of the consumer in different areas of power distribution companies. The population consisted of the consumer from different segments of consumers from different RWA (Resident Welfare Associations), normal consumers, consumer's livings in JJ Clusters etc. The populations surveyed were to answer how people used the website of the power distribution companies for their various tasks and different information provided by the website of power Discoms.

The second survey for technology assessment and adoption in power distribution companies comprises of Discoms own staff, consultant and also staff working in Discoms in third party payroll at a different level in the hierarchy in the Discoms. Since the research was to focus on technology adoption and implementation within the organization, in order to get in-depth details and insight staff were interviewed as well surveyed using questionnaire

5.6.3 Interviews

As per Boyce and Neale (2006), in-depth interview is one of the qualitative research methods which involves conduct of interview to a small group which has key importance in research.

The different types of interview format are as follows:

- Structured interviews: It refers to a type of interview done by the researcher in which types and number of questions are fixed by the researcher.
- Unstructured interviews refer to the types of interviews which are shapeless and questions are not prepared beforehand and the interview goes on in an informal manner.
- A semi-structured interview is a mix of structured and unstructured interview containing characteristics of both structured and unstructured interview. In this

interview has a list of questions beforehand but can go beyond that also and ask additional questions.

In Phase I, a survey method along with focused interview was used to staff of quasi-power distribution companies i.e.; BSES & TPPDL to provide information on technology accessibility, use, and factors affecting usage.

In Phase II, structured as well unstructured interview method was used to study and investigate the various factors responsible for adoption and diffusion of technology in government power distribution in National Capital regions of Faridabad and Noida

5.6.4 Pilot Survey

After data collection questionnaire is validated and tested through a pilot survey. The respondents of the pilot survey are selected from the same population.A pilot survey was undertaken to test the potential response rate, suitability, and clarity of the questionnaire so that the researcher can finalize the questions and go for further research.

Questionnaire for the pilot survey was distributed to people at various public places like Malls, Customer Care centers and also few door to door surveys. The response rate was about 80-90 % but since the questions were related to power Discoms at many places, the research scholar had to bear severe anger of the residents due to frequent power cuts in summer.

For technology implementation and adoption in power Discoms research hypotheses and objectives, initially400questionnaire for each Discom were circulated but the response rate was very low as low as 20 percent even after several follow up and repeated calls. Moreover the questionnaire that was filled were not up to mark to get the insights of the research questions Then researcher decided to adopt qualitative method of research ie Grounded Theory which was more of survey based on questionnaire to collect data from the power Discoms staff, for this several methods were used to meeting Discoms staff at conferences, forums, also at training sessions and also at their offices. The researcher made use of different methods of grounded theory like historical documents, observations reports to get the insights of the level of technology implementation in power distribution companies in

National Capital Region. This method actually worked in the research process and was successful in the data collection. The feedback and pilot give the researcher an indication of whether the interview is measuring the right concept being measured and hence its validity and reliability. Thus few interview questions, as well as questionnaire, were improved.

The modified questionnaire was forwarded for the main survey. The final form is in Appendix A.

5.7 Data Analysis

The Hypothesis determining the website assessment of power Discoms and also the Hypothesis determining level on technology implementation were tested through Parametric and Non-parametric statistical analysis discussed in Chapter 5 and 6. Hypothesis covering dimensions of a factor which affects adoption of GIS adoption were tested partially through the Parametric and Non-parametric test but for this hypothesis mainly 'Structural Equation Modeling (SEM) ' was used which is discussed in detail in Chapter 7.

5.7.1 Parametric and Non-Parametric Statistical Analysis

The data analysis included testing the hypotheses and defining the technical assessment and adoption in power distribution companies. This is one of the significant components of data analysis and which lays the foundation for the formulation of the results of various hypotheses assumed. The analysis was conducted through the statistical analysis software ie Statistical Analysis in Social Sciences (SPSS), version 21.

Cronbach's coefficient alpha is used to measure the research reliability. The Alpha's value ranges from 0 to 1 and hence is used to measure the reliability. Higher the score more reliable is the research

The formula can be defined as follows:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

Where

N = number of items

C-bar = average inter-item covariance among the items

V-bar = average variance.

The Chi-Square test was used to examination and test of hypothesis of various measurements of technology identified for determining Technology Index

Chi-square often seen as a test of goodness of fit and also can use to test to judge the significance of the association between the attributes.c2 is then calculated as follows:

$$\chi^2 = \Sigma \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where

Oij= observed frequency of the cell in the ith row and jth column.

Eij = expected frequency of the cell in the ith row and jth column.

5.7.2 Structural Equation Modeling (SEM) Analysis

According to Hoyle (1995), SEM has widely used research tool test hypothesis about connections between observed and latent variables. In other words, we can say as per MacCallum & Austin (2000) it is used to test directional and non-directional relationship among observed and latent variables.

The basic approach to performing a SEM analysis is as follows:

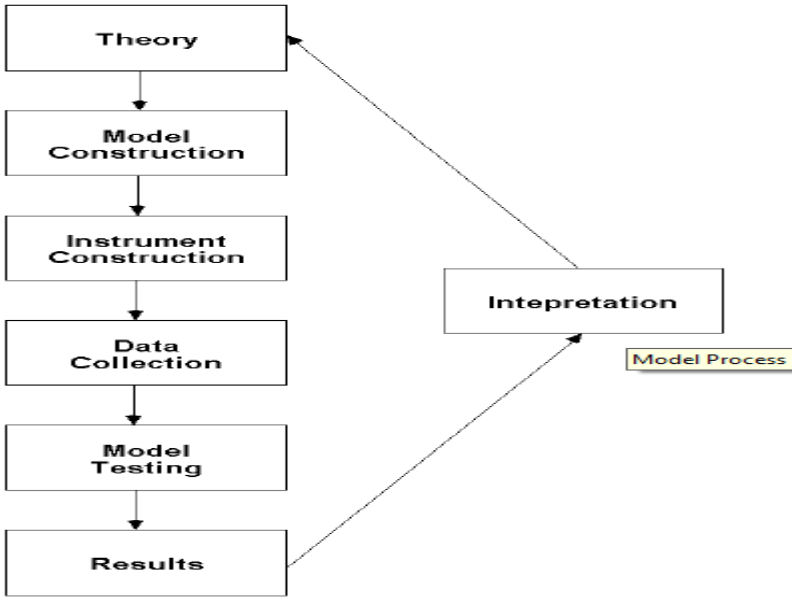


Figure 28 Process Flow of SEM Analysis

The research design framed from literature review led to the development of various constructs with indicators for technology assessment and adoption in power distribution companies helped in identifying factors that eased or delayed the GIS current technology adoption and diffusion. The variables ie; exogenous and endogenous defined in the construct for research was analyzed through SEM Method through AMOS ver. 21 software which is discussed in detail in Chapter 7.

5.8 Data Analysis Result Synthesis Methodology and Framework for Results Formulation

5.8.1 Categorization of People based on Technology Adoption

Diffusion of Innovation (DOI) Theory by E.M. Rogers in 1962, is one of the first early born social science concepts on technology management.

The different set of adopters and their characteristics are as follows:

1. Innovators – These are the type of people who take lead in trying innovation, interested in new ideas and willing to take risks.

2. Early Adopters – These are types of people who are at leadership roles and always welcome accepting new ideas. There is no need to convince as they are aware of the future changes.
3. Early Majority – They are not a leader but adopt the changes and innovation.
4. Late Majority – They are not convinced of the change and adoption takes place only after a majority of the people have tried and adopted.
5. Laggards – They are conservative and traditional and not accept the changes.

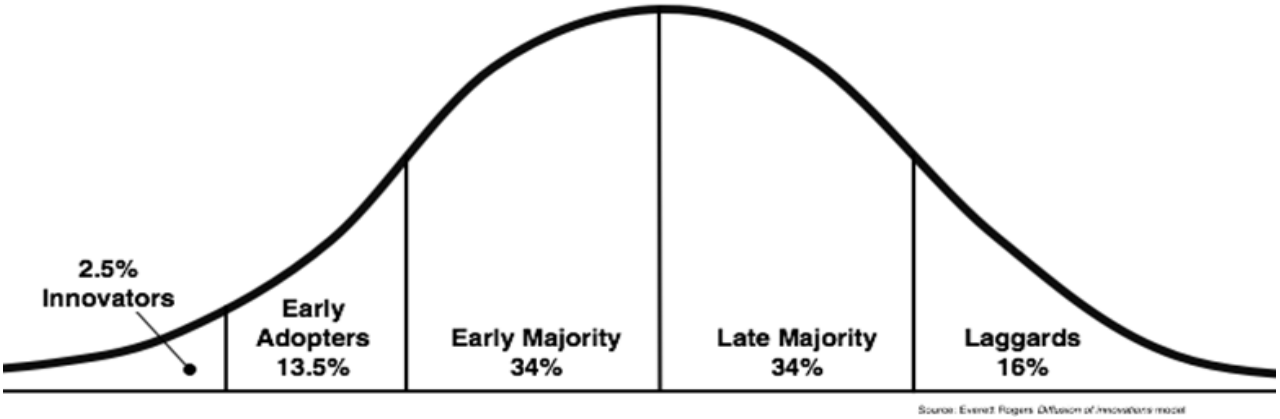


Figure 29 Rogers Diffusion Theory

Research Analysis has to develop an organizational level framework for increasing effective adoption of technology by:

- Categorization Discoms staff under the above discussed three groups
- Understanding their specific requirement.
- Bringing maximum staff to the early adopters and normal users category

As per Rogers's diffusion theory, the promptness of technology adoption is evaluated by two features:

p= adoption speed

q=later growth speed.

A good ICT could have lesser p-value but once a threshold level of organization adopts it, the q value would be more since this technology has network effect i.e.; this would lead to adoption by other Discoms too.

Research Analysis would define factors that affect p and q as these would be the factors that would help in minimizing the Chasm period.

5.9 Justification for Use of Statistical Tools and Software Packages

Why has SEM Technique been used?

There is high multi-co linearity among the variables i.e.; independent variables overlap and using regression we cannot segregate the complete impact of one variable from another.

Researcher wanted to confirm whether these independent variables are converging to one factor for Confirmatory Factor Analysis using SEM (AMOS) Software

5.10 Summary

This chapter comprises of the detailed description of the methodology for a research study. It also provides a description of scales used for measuring the constructs in the study The hypothesis undertaken for the research is also explained.The research methods involved in the study like questionnaire survey, interviews and survey population is talking about.Once data collection process is completed, various parametric and non-parametric test undertaken for the research is also explained. Validation of Software techniques used in the research is elaborated.

Chapter 6

Proposed Framework for Formulation of Power Distribution Technology Implementation Index

Chapter 6: Proposed Framework for formulation of Power Distribution Technology Implementation Index

6.1 Overview

Power distribution system acts as a bridge between the customers and the utility. With changing times, the consumer's expectation is not power supply to them but a reliable and quality power supply with timely redressal of complaints. With the advent of IT and mobile technologies changing of our lives, consumers expect 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 complaints 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 research tries to access the level of technologies implementation in power distribution companies in National Capital Region

6.2 Research Approach and Techniques

The tools and techniques used in this study is a mix of 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 to have been used to develop technology index.

6.3 Grounded Theory

"If somebody wanted to know whether one drug is more effective than another, then double blind clinical trial would be more appropriate than grounded theory study. However, if someone wanted to know what it was like to be a participant in a drug Study, then he or she might sensibly engage in a grounded theory project or some other type of qualitative study." (Strauss and Corbin, 1998, p. 40).

6.4 Process Flow and Methodology

6.4.1 Data collection in grounded theory

GTM utilizes purposive sampling better known as theoretical sampling in which the respondents are selected on the basis of criteria set the researcher and initial outcomes.
Initial outcomes of the data show that topics needed examination, therefore, the sampling were steered by the ongoing theory development. Data grouping and studies take in sporadic orders (see Figure 30).This process is also known as the repetitive cycle of initiation and deduction, consists of gathering data and continuous evaluation between results and new verdicts for further data gatherings (Strauss and Corbin, 1990; Miles and Huberman, 1994).

The researcher conducted an extensive literature review of Power distribution companies websites, Power regulator reports, Auditor reports, Press release and on the basis on this, the research was narrowed down to the creation of codes related to technologies used in power distribution companies.

6.4.2 Interviews Coding: Analytical Approach and Flow

Charmaz (2006), elucidates coding as the first step in data analysis which helps to understand how people respond to it, experiences and overall content of the interview.
In order to analyses and examine the interviewee coding methods is often used in grounded theory. Line-by-line coding also known as Open Coding helps in starting which results in listing out the themes for research as well as the interviewee. The focused also known as selective coding is of great use in transcripts.

6.4.3 Developing categories

The complete process of coding interview and development of theory is depicted in Figure 30. Then the coding number of interviews the researcher finds out subjects that are significant to respondents.

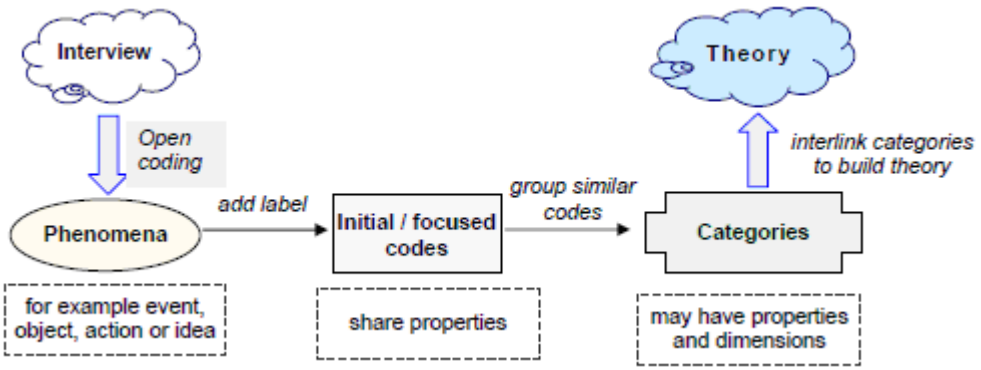


Figure 30 Coding Stages in Grounded Theory (after Straus & Corbin, 1998)

Based on interviews conducted on various platforms like Power conferences, workshops, email etc., literature and discussion, categories of technologies are created by finding the links between the codes in the grounded theory. Based on discussion and literature and various regulatory and audit reports, each technology is measured and given weights. Later on statistical analysis of weighted means is used to calculate the Index number for each technology and finally, the sum of the different dimensions of the technology is added to derive at the Power Distribution Technology Index of the Discoms.

The grounded theory research coupled with quantitative analysis is used to measure the power distribution technology Index and measure the same for different power distribution companies.

The research methodology adopted for the research of development for Power Distribution Technology Index is described below:

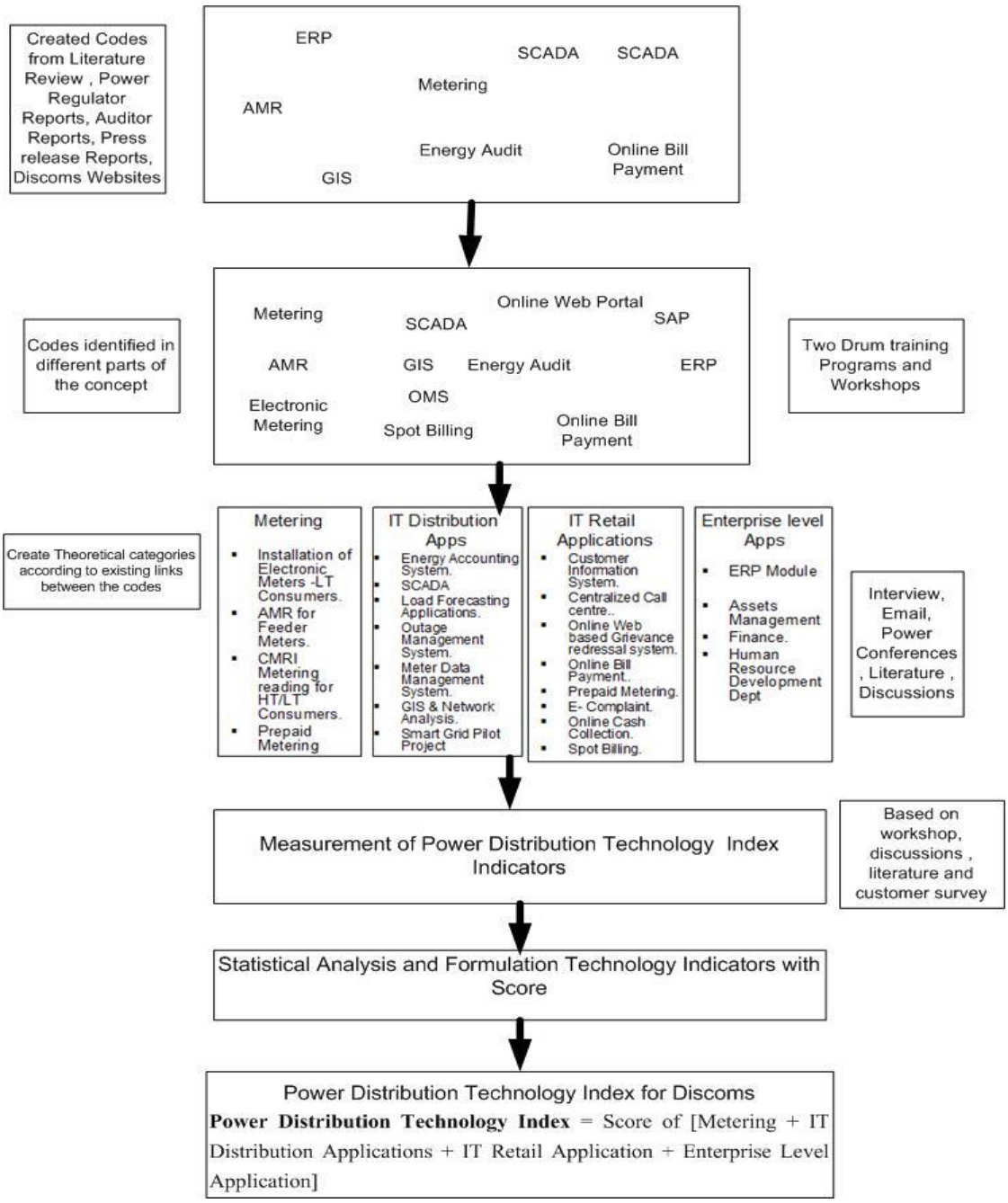


Figure 31 Dissertation logic scheme based explanation of obtaining the grounded theory (Source: Designed by Researcher**)**

6.5 Introduction to 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 an instrument to benchmark technology adoption and diffusion in utilities

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

6.6 Dimension of Power Distribution Technology Index (PDTI)

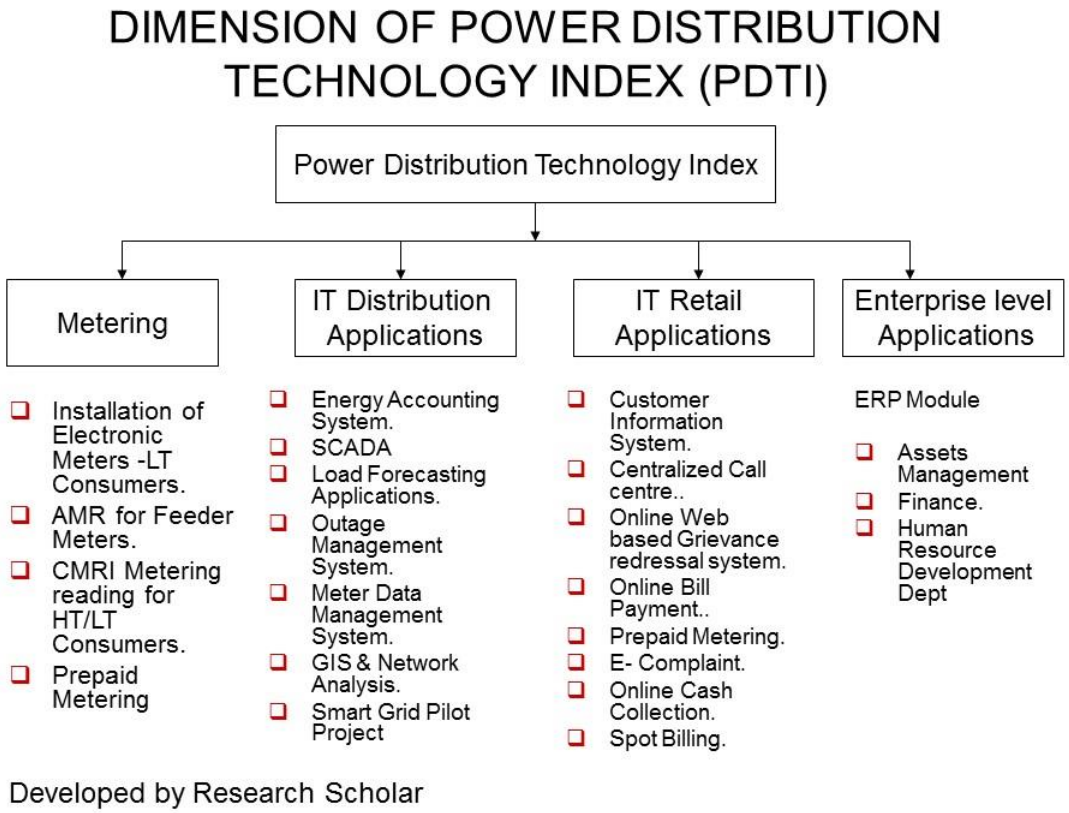


Figure 32 Dimensions of Power Distribution Technology Index grouped by Researchers

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 the level of implementation of different types of metering technologies which are an essential part of 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 of IT Retail Application captures the level, customers are able to get in touch with power Distribution Company for their various issues. This dimension 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 Retail Applications dimension is divided into the following components:

- Customer Information System.
- Centralized Call Center.
- 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 components:

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

The Power Distribution Technology Index provides a platform to present a holistic perspective of technology implementation in major application areas of Distribution.
It allows each power distribution company to discover explicit areas of strength and weakness in the context of technology being implemented by them, as well as to benchmark itself vis-a-vis other power distribution companies.

The Power Distribution Technology Index is designed based on extensive research on the application of technologies being implemented by power utilities and quantify each component, which leads to an overall score of utilities. As mentioned earlier, the Index spotlights on indicators of technology implementation results; rather than measuring inputs, the Power Distribution Technology Index focuses on what level of technological progress has already been achieved within a power utility.

The four different dimensions of the framework—Metering Applications, Distribution Apps, Retails Applications and Enterprise level Applications —are assigned weights in the overall index and sum of the four components which are being weighted differently gives the clear picture of each dimension. Finally, the score is developed for different power distribution companies calculated using methods discussed in Research Design and Methodology section.

6.7 Hypothesis

A 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 the formulation of hypothesis. The hypotheses are as follows:
H0- There is no difference in the level of technology implementation in power distribution companies.

H1: There is no correlation between technology implementation index & AT&C loss of power distribution companies.

6.8 Measuring Individual Components

Each technology identified in the research which has been used by the power Discoms is 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.

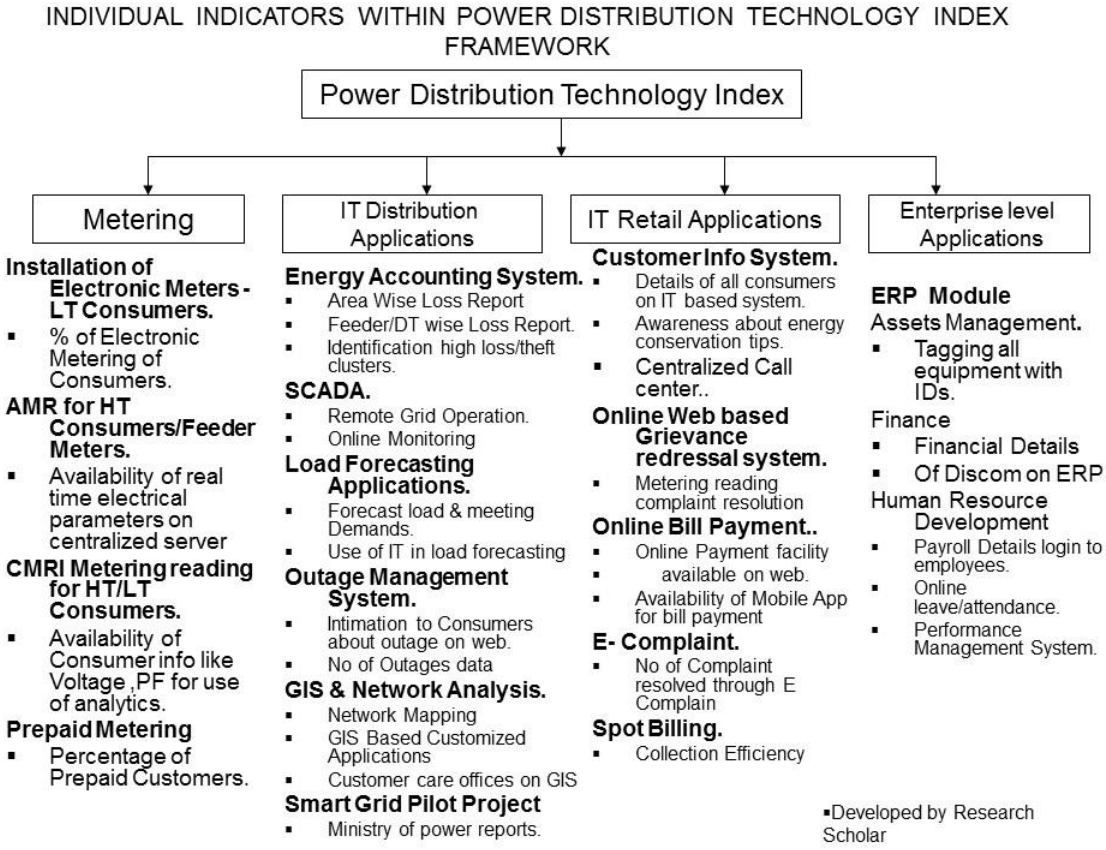


Figure 33 Power Distribution Technology Index with Indicators
Source: Designed by Researcher

The table below demonstrates the Technology Indicators along with the definitions which have been defined by the researcher after exhaustive Literature Survey, Interaction with Discom Officials and also using Grounded Theory of research.

Sl	Category	Technologies	Indicators	Definition
1	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 the 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
2	IT Distribution Apps	Energy Accounting System	Area Wise Loss Report	Divisions/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 the outage on the 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 the 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.	

3	IT Retail Applications	Customer Information System	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
		Online Bill payment	Availability of bill payment option on Discom Website	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 into his home to take reading
4	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 14 The individual indicators within the Power Distribution Technology Index Framework.

6.9 Summary

The Chapter starts with giving an overview of the Power Distribution Technology Index, its usefulness in the current context. Later the chapter moves to discuss the research process and flow used in the research, as the research uses both qualitative and quantitative techniques, both of them are discussed. The qualitative technique used in the research ie; Grounded theory is also discussed in details and the different steps followed in the grounded theory for the research. The chapter then moves to portray the different dimensions of the Power distribution technology Index and explains in details the same. Later on, each dimension of the technology of Power Distribution Technology Index are measured using indicators and the definitions of each indicator are defined in detail way. Chapter 8, later on, discusses the interpretation of data and analysis done and summarized the results and conclusions in the following chapter.

Chapter 7

Assessment of Websites of Power Distribution Companies in National Capital Region

Chapter 7: Website Assessment of Power Distribution Companies

7.1 Overview & Need of Website of Discom Research

A user-friendly website is one key success for Discoms in the contemporary world. In recent times, there has been a surge in e-commerce companies like Flipkart, Snapdeal whose whole business framework works upon the user friendliness, response time etc. of the website.

Consumers of power distribution companies have lots of complaints and issues like bill related issues, where to pay bills, facility of online payment or through apps, can they pay bills in banks. Queries like if consumers want a new connection, what are the procedures and documents required for this. Every new connection adds revenue adds revenue and helps in lowering commercials losses. Ease of releasing new connection by Discoms by mentioning the required documents required and procedures involved. Increasing consumer load is another query customer always asks, all these information can be provided on the website which will help consumers a lot and also help Discom commercially as fixed charges for the consumer's increases. Other information like energy conservation tips, following these tips, can help consumer saving their money. The website is also a platform for to get vital information like energy consumption pattern.

Discom is also launching new schemes like zero balance so that consumers pay all their dues. The website is also a platform for a various Discoms announcement like outages in various areas, so they are informed well before hand and there is no panic. For example, Tata power has launched initiative " SARAL" where customers have an opportunity to escalate their complaints /grievances, suggestions and feedback directly to the level of Chief Commercial Officer telephonically and gets their concern resolved within 48 hrs. Overall website of Discom is a podium for a number of announcements.

The research aims at evaluating website of four main power distribution companies in National Capital Region, focused on various categories which are used to analyze the website of these companies.

The research aimed to develop a website assessment suitable for assessment of websites of power distribution companies in National Capital Region. Key factors measured as factors of Web site quality were identified & is quoted in literature.

7.2 Introduction

In spite of growing demand for electricity and importance of electricity in our lives and growing number of internet users in India, little attention has been given to the functional aspects of power company websites which are a significant source of information to the citizens. Lots of work has been done in terms of research of website parameters in banking and educational sector but little work has been done in India in terms of research in websites of power distribution companies.

7.3 Broad Categories for assessment of Website in Power Distribution Companies

The Website assessment mains constituents are categories, factors, weights, ratings and the total score (Evans and King, 1999). On the basis of extensive literature review four main categories were classified for the quality of website are as follows:

(1) Site content

(2) Speed

(3) Accessibility

(4) Navigability

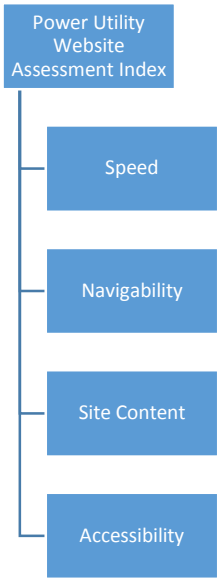


Figure 34 Broad Parameters for Website Assessment

7.3.1 Accessibility

The first category in the website assessment is accessibility. The quality of the website is high if the user can effortlessly distinguishable and accessible to the users. As per Murray, (1997) number of hits on the page is the only factor in deciding its quality.

Two important factors which are used to measure this category are as follows:

- Search engines ranking: According to this higher search engine rankings interpret into better traffic on a site which leads to better accessibility.
- Popularity: The next important factor is popularity. Most common method of measurement of popularity is the number of hits on the website. Apart from this other method to measure website popularity is number external links associated with the website.

7.3.2 Navigability

The good navigability refers to the system when users are not lost on the website and each page should provide proper links to the main contents. A number of clicks necessary to access relevant information on the site. According to Nielsen J. (1999), a best website

navigation system should able to answer three questions: 'where the user is? Where has the user been? Where the user should go?' The navigation should be such that when visitors navigate through the site, they end up where the site hoped they would (Prigent, 1996), finding what they were looking for, or are they hitting a "dead end" in the chosen navigation route. Consistency in terms of layout, coloring, and terminology (Miranda et al, 2009; Henriksson et al., 2006; Garcia et al., 2005; Smith, 2001) makes navigation more effective. Moreover, features like navigation menus (Smith, 2001) and sitemaps (Panopaulou et al, 2008; Holzer and Kim, 2005; Smith, 2001; Henriksson et al., 2006) also play an important role in determining the quality of navigation.

Another factor in this regard is the availability of web site's internal search engine. These internal search engines serve as a useful navigational aid for those sites that contain large volumes of information (Alexander and Tate, 1999; Gehrke and Turban, 1999), as they provide an easy and quick way for locating the information sought for.

7.3.3 Speed

Access speed and response time is one of the important factors for website quality for the user due to time factor involved with it. The speed of the website calculated through chronometer can be influenced by factors like hardware, web traffic, connection hours etc. The time taken to load the main page is directly related to size, thus home page less content more is the access speed.

7.3.4 Site Content:

Site content of the power distribution companies can be accessed considering the relevant information which must appear to the consumer regarding their details. The websites are the platform to provide the necessary information to the customer regarding their bills, usage of electricity, tariff and the power cuts which utility has scheduled. It acts as an interface to access relevant information about utility & their initiatives.

7.4 Website Assessment Approach

The figure below demonstrates the approach and methodology developed and followed by the researcher for this research. The figure depicts stepwise study and data collection process used for the research.

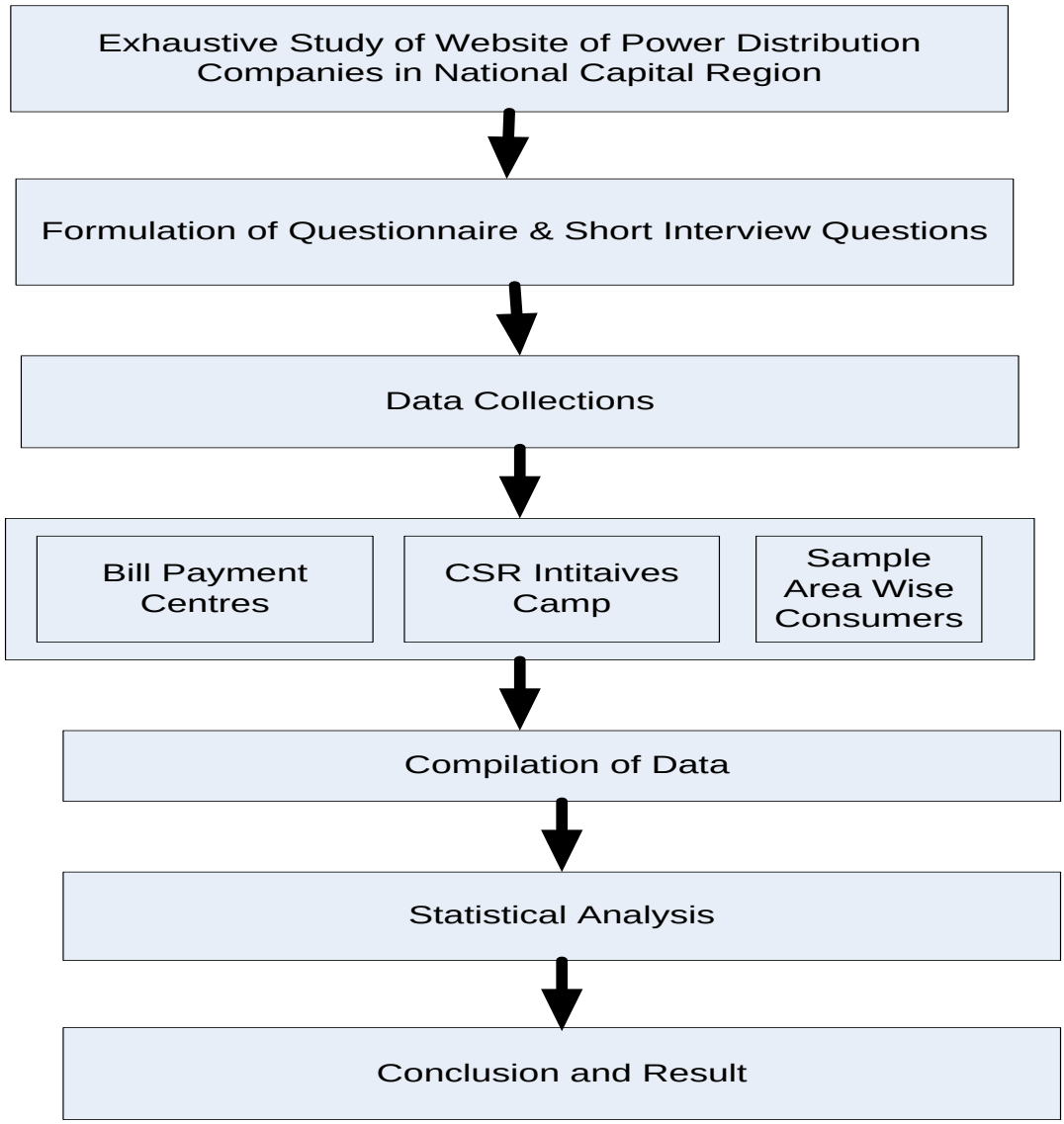


Figure 35 Data Collection Process for Website Assessment of Discoms

7.5 Exhaustive Study of Websites of power distribution companies in National Capital Region

The researcher made an in-depth study of the website of these power distribution companies hosted on the internet and conducted the exhaustive list of comparison between

these four websites. The table below compares the website of the four power distribution companies of National Capital region based on categories and subcategories and each category is further subdivided into various parameters.

Categories	Sub Category	PARAMETERS	BSES	NDPL	HARYANA DISCOM	UP DISCOM
Accessibility		Presence in search engines				
		Popularity	1.00	2	3	4
Speed						
Navigation		Sitemap	V	V	V	V
		Key word Search Function	X	X	V	V
Content Quality	Information Content	Profile	V	V	V	V
		Management Team/Board of Directors	V	V	V	V
		Vision	V	V	V	X
		Mission	V	V	V	X
		Corporate Philosophy	V	V	X	X
		Corporate Governance	V	V	X	X
		Customer Profile	V	V	V	V
		HR Initiatives	V	V	X	X
		Sector Perspectives	X	V	X	X
		Business Excellence	X	V	X	X
		Pioneering Initiatives	X	V	X	X
		Policies	V	V	V	V
		Awards and Recognitions	V	V	X	X
		Consultancy Services	X	V	X	X
		Media Room	V	V	V	X
		No of Website Visitors	V	X	X	X
		Advertisement on FM RADIO	X	X	X	X
		Check Energy Calculator	V	V	V	X
		Citizen's Charter		V	X	X

			V			
		Area wise AT&C Loss, I/P Energy, Collection for Last 10 Years	X	X	X	V
		Applause	V	V	X	X
		Citizen Charter	V	X	X	
		High Power Theft Prone Areas	V	X	X	X
		Meter Replacement	V	V	V	V
		Maintenance Shutdown Schedule	V	X	X	X
		MLA Fund Scheme Project Status	V	X	X	X
		Tenders	V	V	V	V
		Sub Cluster Wise DT Loss Report	V	X	X	X
		Regulatory	V	V	V	V
		Power Procurement Tender	V	X	X	X
		Aggregate Revenue Requirement	V	V	V	V
		Journey of Power Utility	V	X	X	X
		Understanding Power Tariff	V	X	X	X
		Land Mark Judgments	V	X	X	X
	Technical Details	Details of Transformers Issued(Repaired & Guaranteed)	X	X	X	V
		Quantity & Cost of Material Issued against Theft	X	X	X	V
		List of Power Transformers	X	X	X	V

		Grid wise Installed PT/DT capacity	X	X	X	V
	Commercial	Divisonwise Details of Revenue, Energy Receipt	X	X	X	V
		Divisonwise & Category wise no of consumers	X	X	X	V
		Divisonwise & Category wise connected load of Consumers	X	X	X	V
		Division wise details of arrears	X	X	X	V
		Divisonwise & Category wise details of assessment & realization	X	X	X	V
		Divisonwise AT&C Losses	X	X	X	V
	Communication Content	Location of Offices	V	V	V	X
		Location of Complaint Centers	V	V	V	X
		Help Line No	V	V	V	V
		Theft Information Contact No	V	V	V	V
		Contact e-mail	V	V	V	V
		Bill Collection Van	V	V	V	X
	Sustainability	Overview	X	V	X	X
		CSR Report 2012-2013	X	V	X	X
		UNGC Study 2013	X	V	X	X
		UNGC COP FY 2012-13	X	V	X	X
		CSR Library	X	V	X	X
		Affirmative Action	X	V	X	X

		Calculate Your Carbon Footprint	X	V	X	X
		Climate Change	X	V	X	X
		Electric Car Charging Stations in TPDDL area	X	V	X	X
	Customer Service	Customer Care Initiatives	V	V	V	X
		Outage Details	V	V	V	X
		Outage bulletin	V	V	V	X
		Bill on Email	V	V	V	X
		Doorstep Service	V	X	X	X
		Bill Related	V			
		Connection Related	V	V	V	V
		Meter Related	V	V	V	V
		Share Info	V			
		No Supply	V	V	V	V
		Complaint Status	V	V	X	X
		Grievance Redressal Mechanism	V	V	V	X
		Grievance Redressal	V	V	V	V
		FAQ	V	V	V	V
		Theft penalty Calculator	X	X	V	X
		No Power Cut Feeders	X	X	V	X
		New Connection Form	V	V	V	V
		Power Summary	X	X	V	X
		Energy Conservation Tips	X	X	X	X
	Payment Options	Bill Payment Kiosk	V	V	X	X
		Debit/Credit Card/ Net Banking	V	V	V	V
		Counters	V	V	V	V
		Cheque-In Mail	V	V	X	X
		Drop Boxes	V	V	X	X
		Pay Outlets	V	V	X	X

		ITZ Cash	V	V	X	X
		Pay by Phone	V	X	X	X
		Download Last E-payment receipt open	X	V	X	X
		Download Duplicate Bill	X	V	X	X
		Make Demand Note	X	V	V	V
	Regulator Information	Standard of Performance of the distribution licensee	X	X	V	
		Tariff	V	V	V	V
		Orders	V	V	V	V
		Approved Documents	X	X	V	V
		True up petition for FY 12-13 and ARR for FY 14-15	V	V	X	X
		Electricity Act 2003	V	V	V	V
		Supply Code 2007	X	V	V	X
		Tariff Order 13-14	V	V	X	X
		Un electrified areas	X	V	X	X
		Environmental , Social Policy & Procedures	X	X	V	X
	Govt of India (Ministry of Power Initiatives)	RAPRP	Not Applicable	Not Applicable	V	V
		RGGVY	Not Applicable	Not Applicable	X	V
		Networking				V
		HVDS	V	V	V	V
		Theft Prevention/ Energy Accounting	V	V	V	V
	Consumer Care Services	Connection related problem	V	V	V	V

		Consumer Grievance Redressal System	V	V	V	V
		Forum for Redressal of Consumer Grievances	V	V	V	V
		Decisions of Forum for Redressal of Consumer Grievances	X	X	V	X
		Complaint Registration and Status	V	V	V	X
		Complaint Escalation	V	V	X	X
		Complaint Redressal at Independent Forums	X	V	X	X
		Demand Side Management	X	V	X	X
		List of Defaulters	X	X	X	V
		Public Awareness Programs	V	V	V	X
	Me Details	My Customer	V	V	V	V
		Medium Load Customer	V	V	X	X
		Domestic Customer	V	V	X	X
		Consumption History	V	V	V	X
		My Account	V	V	V	X
	Contact Us	Corporate Office	V	V	V	V
		Pull SMS service		V		
		Customer Care Centers	V	V	V	V
		Head of Department (HoD) – Customer Services	V	V	X	V

		Area wise Managers List	X	V	X	X
		Client Managers [HT Connections]	X	V	X	X
		Client Managers [Government & Institutional Connections]	X	V	X	X
		Corporate Communications	V	V	V	V
		Feedback	V	V	V	V
	Customer Information Centre	Download Frequently Asked Questions [FAQ] (File Type: .PDF Size: 1MB)	X	V	X	V
		Pull SMS service	V	V	X	X
		Tariff Details	V	V	V	V
		Neutral Mixing and Earthling	X	V	X	X
		Know Your Meter	V	V	X	X
		Know Your Bill	V	V	X	X
		Utility Trained Electricians	V	V	X	X
		Consumer Newsletter	V	V	V	X
		Service Guarantee for New Connection	X	V	X	X
		Holiday List-Power U	X	V	X	X
	Vendors/Tenders	Tender Advertisements	V	V	V	V
		Download Tender Document	V	V	V	V
		Vendor Login / Create Login	X	V	X	X
		New Vendor Registration	X	V	X	X
	Other Information	Safety	V	V	X	X
		Report Unethical Issues	X	V	X	X

		Energy Conservation	V	V	V	V
		Power Utility GIS Maps	V	V	X	X
		Careers	X	V	X	X
		Training & Development	X	V	X	X
	Right to Information	The Particulars of its Organization, functions, and duties.	X	X	X	V
		The Powers and duties of its officers and Employees.	X	X	X	V
		The Procedure followed in the decision-making process, including channels of supervision and accountability.	X	X	X	V
		The Norms set by it for the discharge of its functions.	X	X	X	V
		The Rules, Regulations, Instructions, Manuals, and Records, held by it or under its control or used by its employees for discharging its functions.	X	X	X	V
		A Statement of the categories of documents that are held by it or under its control.	X	X	X	V

		The Monthly remuneration received by each of its officers and employees, including the system of compensation as provided in its regulations.	X	X	X	V
		The Particulars of facilities available to citizens for obtaining information, including the working hours of a library or reading room, if maintained for public use.	X	X	X	V
		The Names, Designations and other particulars of the public information officers.	X	X	X	V

Table 15 Exhaustive comparison of Websites of power distribution companies in National Capital Region

7.6 Definition of Website Assessment Categories and Weights

After a thorough study of the website of the power distribution companies, the researcher's study for assessment of website was divided into various subcategories. Further, each subcategory was divided into factors. Factors considered for each category are assigned weights based on their significance, literature review and also consumer inputs. The cumulative sum of the weights assigned equals to 100.

The content of the website of these power distribution companies is classified into mainly following subcategories:

Sl No.	**Sub Category**
1	Information Content
2	Technical Details
3	Commercial
4	Communication Content
5	Sustainability
6	Customer Service
7	Payment Options
8	Regulator Information
9	Govt of India (Ministry of Power Initiatives)
10	Consumer Care Services
11	Me Details
12	Contact Us
13	Customer Information Centre
14	Vendors/Tenders
15	Other Information
16	Right to Information

Table 16 Various Subcategories of Website Content

The various categories and the factors involved along with weights used in the research is mentioned in the table below:

Categories	**Sub Category**	**Factors**	**WEIGHTS**	**TOTAL WEIGHTS**
Accessibility		Presence in search engines	5	
		Popularity	10	15
Speed			15	15
Navigation		Sitemap	10	
		Keyword Search Function	5	15
Content Quality	Information Content	Profile	1	10
		Management Team	1	
		Corporate Philosophy	1	
		Sector Perspectives	1	
		Business Excellence	1	
		Pioneering Initiatives	1	

		Policies	1	
		Awards and Recognitions	1	
		Consultancy Services	1	
		Media Room	1	
	Communication Content	Location of Offices	2	15
		Location of Complaint Centers	2	
		Helpline No	5	
		Theft Information Contact No	2	
		Contact e-mail	2	
		Bill Collection Van	2	
	Customer Oriented Applications	Outage Details	3	15
		Theft Calculator	2	
		No Power Cut Feeders	1	
		Online Payment	3	
		New Connection Form	2	
		Power Summary	2	
		Energy Conservation Tips	2	
	Regulator Information	Standard of Performance of the distribution licensee	1	5
		Tariff	1	
		Orders	1	
		Approved Documents	1	
		Consumer Services	1	
	Consumer Care Services	Connection related problem	2	10
		Consumer Grievance Redressal System	2	
		Forum for Redressal of Consumer Grievances	2	
		Decisions of Forum for Redressal of Consumer Grievances	2	
		Sitting of Forum for Redressal of Consumer Grievances at Circle Level.	2	

Table 17 Website Assessment Index Parameters with weight age

7.7 Online Website Assessment Technique

An online Website Assessment technique has been used by the researcher for assessment of website based on various parameters for power distribution companies. The online analytical techniques use an algorithm to access the website and provide various information based on data like page views, loading speed of the website, website traffic and also generates a ranking based on these parameters.

The table below refers to the partial list of Website Analytical Assessment tools which has been used in the research to test various parameters of the website of the power distribution companies.

Sl No	Website Online Assessment Tools used in the research
1	Alexa
2	popuri.us
3	socialmeter
4	TweetVolume
5	Quarkbase
6	BlogPulse Profiles
7	Technorati Blogging Central
8	Statbrain.com
9	Cubestat
10	DnScoop
11	WebsiteOutlook
12	WebPagetest

Table 18 List of Online website assessment tools used in the research.

7.8 Summary

The chapter describes in details the research-based approach of assessment of websites of power distribution companies. The chapter begins with the introduction of assessment of Power Distribution companies, exhaustive and in-depth study was done on the websites of power distribution companies. Further, the chapter portrays the research methodology for study, also various online assessment tools used in the research. The analysis and interpretation of the research methods proposed in this chapter are explained in Data Analysis and Interpretation Chapter No 8. The next chapter explains about interesting and innovative research done fist of its kind India ie; development of Power Distribution Technology Implementation Index.

Chapter 8

Proposed Framework for Assessment of Adoption & Diffusion of GIS among State Owned & Quasi Government Power Distribution Companies in NCR

Chapter 8: Proposed Framework for Assessment of Adoption & Diffusion of GIS among State Owned & quasi-Government Power Distribution Companies in NCR

8.1 Introduction

GIS, in recent times, is becoming a popular technology for power distribution companies.Government and policy makers have given due importance to geosciences in power segment and also significant amount of money has been invested by the government, there is need to investigate the effective utilization and behaviors of user acceptance of geospatial technology in State-owned Government Power distribution companies and quasi-power distribution companies which have been formed as a result of joint venture between government and quasi-government companies like BSES and TPDDL.

With the development of technology, *a* number studies have been carried out for acceptance of Information Technology (IT) system in the organization, still, there is a need for study of acceptance of GIS in Indian Power distribution sector.

.GIS technologies are still in nascent stage in terms of technology acceptance and diffusion in the power companies. The research is an attempt to examine and evaluate the elements touching the use of GIS technologies among state-owned and quasi-government companies in National Capital Region.

8.2 Methodology

Introduction

The main idea of the study was to determine the how employees of government and quasi-government power distribution companies were utilizing technologies in their organization and various factors that were related to the level of application.

The study was intended to answers few research questions:

- Determine level of accessibility to geospatial technologies
- .Determine current application and use of GIS technology by staff in the organization.
- Identify factors that enabled or encumber the adoption of GIS l.

For Research Technology, adoption and diffusion objectives quasi-government owned Discom of Delhi and Govt owned Haryana was selected.

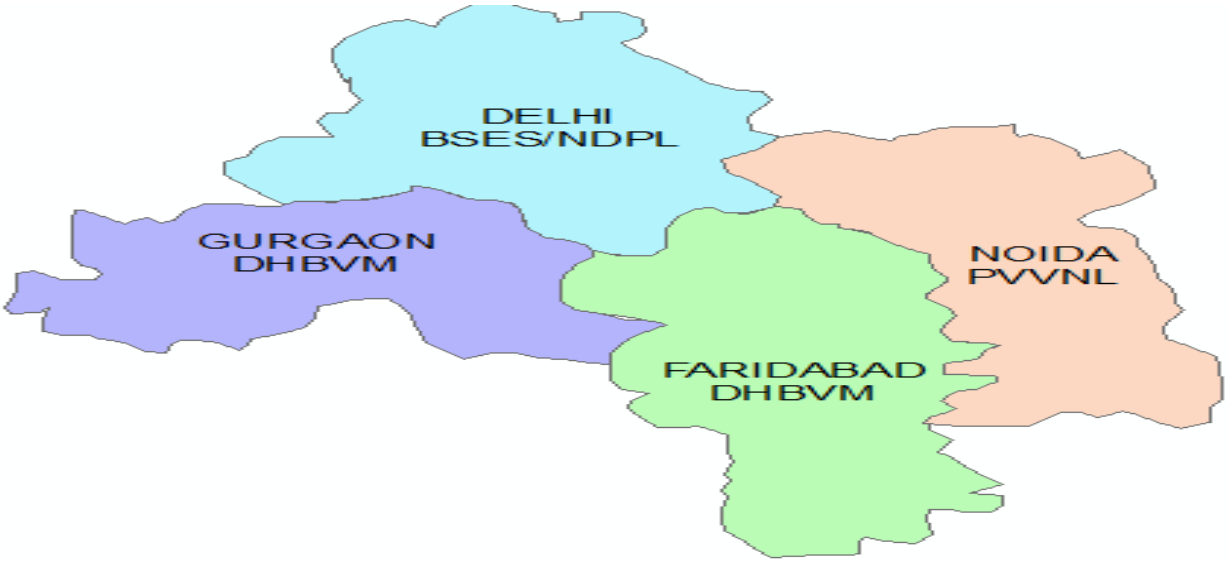


Figure 36 Geographical Area showing Study area in National Capital Region

8.3 Research Design

Both Quantitative and qualitative method were for research data gathering and then further analysis. The research questions formed the basis of research design.

8.3 Variables

8.3.1 Endogenous Variables

Endogenous or Dependent Variable: Intention to Use

In this research, the dependent variable is an intention to use the GIS technologies in Power distribution companies in National Capital Region.

8.3.2 Exogenous Variable

Ease of Use

It refers to a level where modernization can be easily understood and operated. Further, also user discovers it better than existing substitutes. As per Zeithaml et al. (2002) the user can say innovation is "Perceived ease of use" only of the user can handle and use it easily.

Perceived Usefulness

According to Davis (1989), perceived usefulness (PU) is effective if it aids the user in job performance and increases its productivity.

Efficiency Gain

As per Hu et al. (2005), Efficiency Gain refers to point at from where user think his performance efficiency has increased due to use GIS technology. For power utility staff who are in the field, power restoration time is one of key performance factor.

Social Influence

Social influence refers to the external effect that person feel when one has to use the technology or innovation and how important other beliefs influence personal choice in using new system (Fishbein and Ajzen, 1975). Individual are influenced by the majority when a large number of people use the technology then the person is also likely to adopt it as well (Ash, 1951).

Table 1. Social Influence: Subconstructs, Definitions, and Measurements

Social Influence		
Construct	**Definition**	**Items**
Subjective Norm (Chattopadhay et al., 1999; Harrison et al., 1997; Venkatesh et al., 2000, Venkatesh et al., 2003)	The individual's perception that an entity or a person who is important to him thinks whether he should use the system	1. People who influence my behavior think that I should use EIS 2. People who are important to me think that I should use EIS
Social Factors (Bergeron et al., 1995; Venkatesh et al., 2003)	The individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations	1. The organization has supported the use of EIS 2. I use the system because of the proportion of coworkers/peers who use EIS
External Ties (Geletkancyz et al., 1997)	The individual's external ties that conform and impact the use of the system	1. Competitors have used and are using EIS 2. EIS is obsolete in the industry
Self-Identity (Lee at al., 2006; Venkatesh et al., 2003)	The individual's comparison of other's expectation with his own value, beliefs, and previous experience and transformation of these into his own self-expectation	1. Using EIS will increase the organization's profit 2. Using EIS will be efficient for me 3. Using EIS is as easy as using any other system's I have previously used
Image (Venkatesh et al., 2003)	The degree to which the use of an innovation is perceived to enhance one's image or status in one's social system	1. People in my organization who use EIS have a high profile 2. Having EIS is a status symbol in my organization
Power (Stupak et al., 2001)	The individual's ability to persuade his peers or subordinates to do what he wants or the same thing as he does	1. The perceived ease of use and perceived usefulness of EIS will enable me to persuade my subordinates to make decisions by using EIS 2. Using EIS strengthens my position and influence in the organization

Figure 37 Social Influence Definitions and Measurements

8.4 Framework for assessing acceptability of technology and Definition of Hypothesis

Conceptual Framework

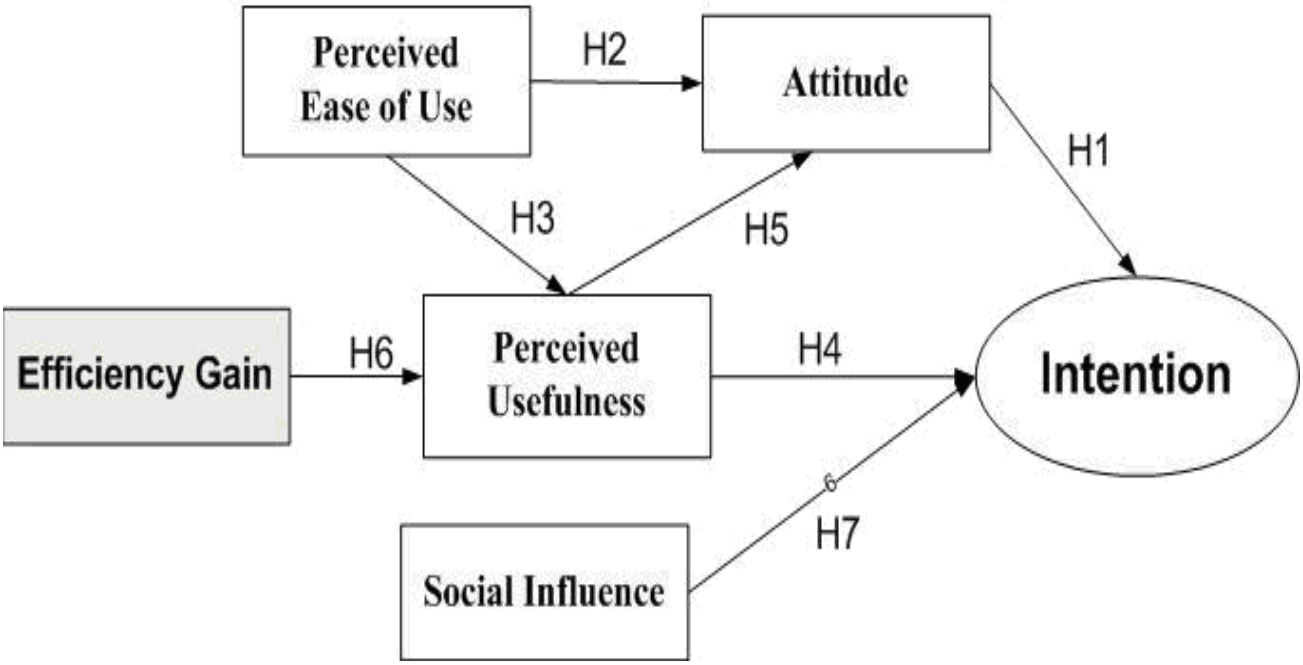


Figure 38 Conceptual Research Model
Source: Cakar, B. (2011).

Proposed Research Framework for Adoption & Diffusion of Technology

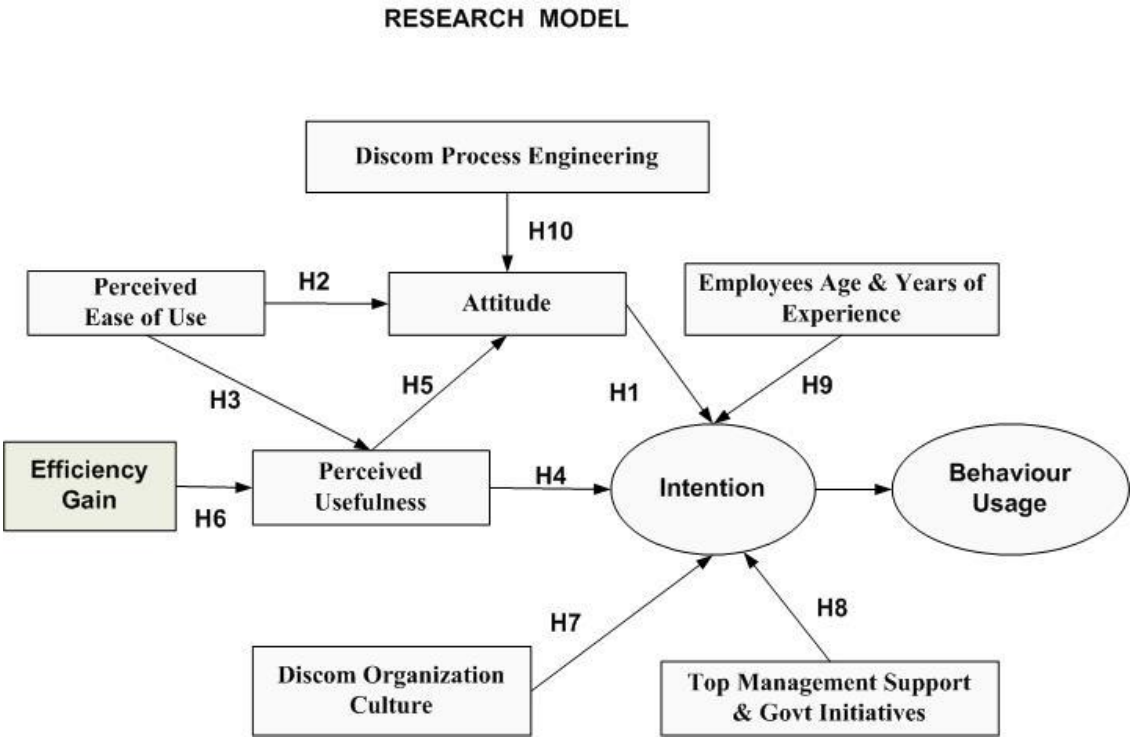


Figure 39 Research Framework developed by the Research Scholar

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 a favorable influence on Intention (INT) of Discom staff.

H9: Employees Age & Years of Experience (AE) has a favorable influence on Intention (INT) of Discom staff.

H10: Discom Process Engineering (PE) has a favorable influence on Attitude (AT) of Discom staff.

8.5 Survey Construction & Data Collection

In this research survey as well interview method was used to collect information mainly keeping in view key indicators mentioned. The survey through email as well hard copy printout was used to collect information from the power Discoms. It was supplemented with interviews. The research variables like perceived usefulness and perceived ease of use were measured by survey method in 5-point Likert scaling design (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

	Constructs	Indicators
1	PU	**Perceived Usefulness: Variables to measure usefulness of GIS Applications**
1.1	PU1	GIS provides me better picture of my queries
1.2	PU2	GIS Increase visualization of and extent of the problem.
1.3	PU3	GIS is good feedback system to confirm reports.
1.4	PU4	GIS improves in my decision making.
1.5	PU5	GIS is overall useful in my day to day work
2	EU	**Perceived Ease of Use Adopted from Davis (1989); Davis et al. (1989); Moore and Benbasat, (1991)**
2.1	EU1	My interaction with the GIS technologies is clear and understandable.
2.1	EU2	Lot of expertise is not required for using GIS
2.1	EU3	Intellectual Efforts are not required for utilization of GIS in work
2.1	EU4	It is simple and easy to operate GIS
2.1	EU5	GIS System has got various options for easy operability
3	DC	**Discom Organization Culture**
3.1	DC1	Within Depts, the environment is good for use of GIS.
3.2	DC2	Other Depts. personnel often asks for GIS-based reports
3.3	DC3	Senior Officers encourages the use of GIS.

3.4	DC4	Workforce think GIS as reliable decision support system
4	EG	**Efficiency gain Adopted from Davis (1989); Davis et al. (1989); Moore and Benbasat, (1991)**
4.1	EG1	Using GIS has reduced my field visit to large extent
4.2	EG2	Using GIS system has saved my time to a great extent.
4.3	EG3	GIS has provided a single platform for field staff & supervisors to view the problem.
4.4	EG4	GIS has helped in providing better services to customers
4.5	EG5	GIS has reduced fault time and helped in faster fault restoration
5	AT	**Attitude Adopted from Taylor and Todd (1995); Thompson et al. (1991); Venkatesh et al. (2003)**
5.1	AT1	I like working with user-friendly system like GIS
5.2	AT2	Using GIS system is exciting
5.3	AT3	GIS system makes work more attention-grabbing.
5.4	AT4	Working with the GIS system is enjoyable.
5.5	AT5	GIS system can be used in policy decisions.
6	INT	**Intention Adopted from Venkatesh & Davis (1996); Venkatesh & Davis (2000); Agarwal & Prasad (1997)**
6.1	INT1	Given that I have access to the GIS, I intend to use it in my job
6.2	INT2	I often use GIS in my job
6.3	INT3	Often I try to explore different thoughts using GIS & technical skills
6.4	INT4	In my spare time, I try doing new things using GIS
6.5	INT5	I often contact GIS staff for technical support.
7	PE	**Discom Process Engineering**
7.1	PE1	GIS Based drawings proposal submission done in Discom
7.2	PE2	Business Process like TF linked with GIS
7.3	PE3	GIS drawings Mandatory for all finance clearances
7.4	PE4	Discom DPR Submission to Govt with GIS Drawings
8	MS	**Top Management Support & Govt Initiatives**
8.1	MS1	Regular training to Depts Bottom Line Users
8.2	MS2	Discom Top Managements supports the use of GIS
8.3	MS3	Mid-level Managers percolates down the GIS initiatives to the system
8.4	MS4	GIS as a part of Government Regulator Audits
8.5	MS5	Govt schemes and initiatives to encourage GIS technologies

Table 19 Research Constructs & Indicators

8.6 Data Analysis Plan

The data was collected through survey and interview method. The data collected from the survey, structural equation modeling (SEM) analysis was performed with help of AMOS software.

Structural equation modeling (SEM) is of widely used quantitative software techniques used by researchers in the social and behavioral sciences.
Confirmatory Factor Analysis (CFA), is a measurement model which provides validity test for constructs. A construct is an unobserved latent factor whose usefulness has been empirically supported (Harrington, 2009).

Statistical Analysis Criteria
The level of Significance: The significance level is used for rejecting the hypothesis in hypothesis testing. The level of significance of 0.05 or 5% ($p < 0.05$) was taken up for the study.

8.7 Summary

The chapter discusses on adoption of geospatial technologies among the quasi-government and government owned Discoms and later compares also the results based on the analyses. The chapter also elaborates the research process adopted to conduct the research and types of variables used in the research. The research framework designed based on literature and other sources are then converted to constructs and indicators.The analysis techniques used and the framework framed for the research is also discussed on which later data analysis could be done. Next Chapter 8 discusses the interpretation of data and analysis done for various research objectives.

Chapter 9

Interpretation of Data and Analysis

Chapter 9: Interpretation of Data and Analysis

9.1 Power Distribution Technology Index (PDTI)

The data is collected in two forms:

Primary Data Collection: The methods of primary data collection were in form of survey, focused and unstructured interview. The researcher made use of various forums, seminars and workshop for conducting interviews and data from the Discoms officials.

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

Summary of primary and secondary data collected is as follows:

Sl No	Factors Considered for Technology Implementation Index	Details	Nos
1	Utility Customers Survey	No. Customers Surveyed	300/Discom
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	Utility Website	Websites of Power Distribution Companies	7
6	Press Release & Power Market News	No. of Press Released referred	35

Table 20: Summary of sources of data collection

The total population size which included quasi-owned Discom of Delhi and government Discom of Haryana here refers to some of the key officials of the Discoms who had complete knowledge of different technology implementation.

Interview with Power Utility Officials at Workshop/Conferences

Sl No	Power Distribution Company	Total Population	Sample Size
1	Delhi Discom	153	117
2	Haryana Discom	187	106

Table 21: Summary of power Utility official's contact

9.2.1 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 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 the extent 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	Score	Weights	Delhi Discom	Haryana Discom	Delhi Discom	Haryana Discom
1	Metering	Installation of Electronic Meters -LT Consumers	5	0.25	4	4	1	1
		AMR for Feeder Meters	5		4	3	1	0.75
		Prepaid Metering	5		4	1	1	0.25
2	IT Distribution Apps	Energy Accounting System	5	0.25	5	2	1.25	0.5

		SCADA	5		5	1	1.25	0.25
		Load Forecasting Applications	5		4	1	1	0.25
		Meter Data Management System	5		5	1	1.25	0.25
		Outage Management System	5		5	1	1.25	0.25
		Geographical Information System & Network Analysis	5		5	2	1.25	0.5
		Smart Grid Pilot Project	5		1	0	0.25	0
3	IT Retail Applications	Customer Information System	5	0.3	5	4	1.5	1.2
		Centralized Call Centre	5		5	3	1.5	0.9
		Online Bill payment	5		5	4	1.5	1.2
		E-Complaint	5		4	3	1.2	0.9
		Mobile Apps	5		4	1	1.2	0.3
		Spot Billing	5		5	4	1.5	1.2
4	Enterprise level Apps	ERP Module for Finance	5	0.2	5	1	1	0.2
		ERP Module for HR	5		4	1	0.8	0.2
		ERP Module for HR						
		Performance Management System of employees	5		5	1	1	0.2
		ERP for Assets Management	5		5	1	1	0.2
			100	1	89	39	22.7	10.5

Table 22 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 23 Scores of individual technology of Discoms

9.2.2 Relationship between Power Distribution Technology Index and AT&C losses

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

Table below in chronological order in which technologies has been implemented in the Discoms

Sl	Category	Technologies	Delhi Discom	Haryana Discom
1	Metering	Installation of Electronic Meters -LT Consumers	2003	2006
		AMR for HT Consumers	2004(High-End Consumers)	Not Implemented
		AMR for Feeder Meters	2006	Not Implemented
		AMR for DTs	Not Implemented	Not Implemented
		CMRI Metering reading for HT/LT Consumers	2005	2009
		Prepaid Metering	2005	2008
2		Energy Accounting System	2006	2010
		SCADA	2004	2010

	IT Distribution Apps	Load Forecasting Applications	2011	Not Implemented
		Meter Data Management System	2005	Not Implemented
		Outage Management System	2003	Not Implemented
		Geographical Information System & Network Analysis	2004	2011
		Smart Grid Pilot Project	2014	Not Implemented
3	IT Retail Applications	Customer Information System	2007	2008
		Centralized Call Centre	2006	2010
		Online Web Based Consumer Grievances Redressal System	2006	2010
		Online Bill payment	2005	2010
		E-Complaint	2006	Not Implemented
		Spot Billing	2005	2009
4	Enterprise level Apps	ERP Module for Finance	2008	Not Implemented
		ERP Module for HR	2008	Not Implemented
		Performance Management System of employees	2008	Not Implemented
		Assets Management	2008	Not Implemented

Table 24 Technologies implemented by Discoms year wise

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	2015
Delhi Discom	22	45	36	27	22	19	17	14
Haryana Discom	10	38	34	32	31	28	26	21

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

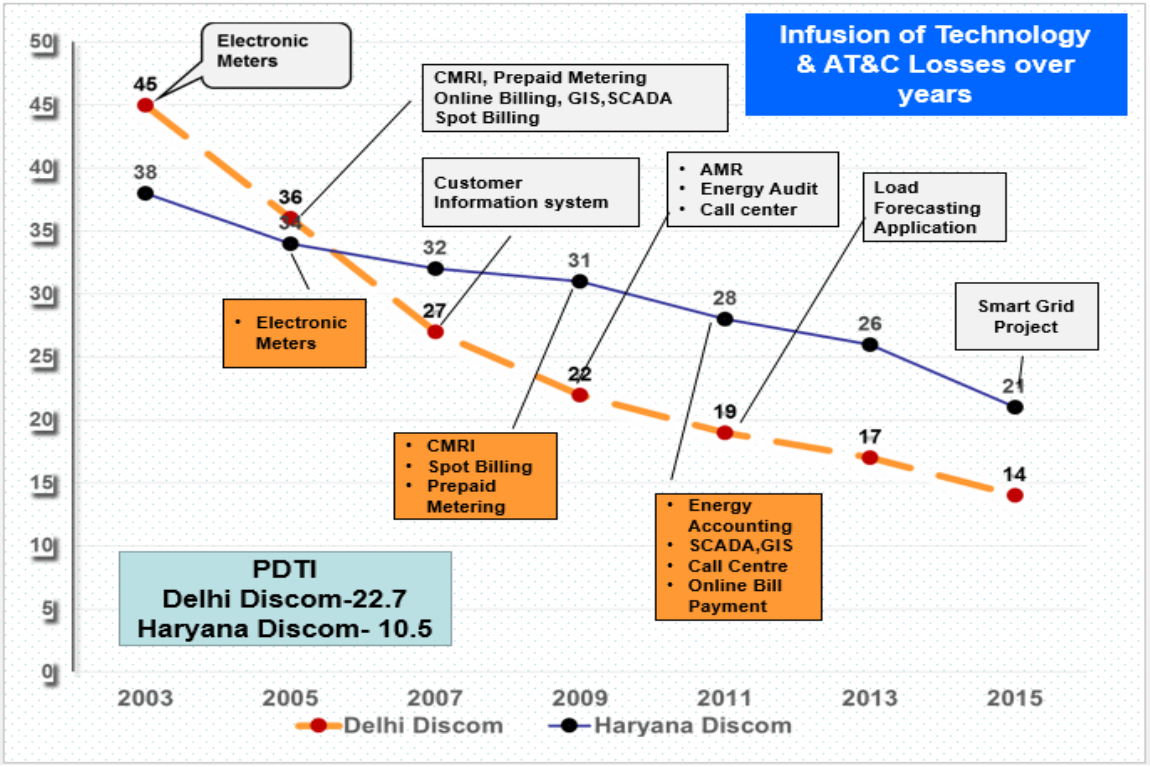


Figure 40 Discoms Loss Trajectory Infusion of Technology
Source: Discoms Websites & Designed by Researcher

9.2 Website Assessment of Power Distribution Companies

The questionnaire was designed to access use of websites of Discoms in NCR.The questionnaire was then distributed to residents of these areas mainly adults & students living in societies of these regions.

Determination of Sample Size in the research of website assessment of power distribution companies:

In order to determine the sample size, the total population taken was only urban LT (Low Tension) Connection consumers of the power distribution companies. The number of LT connection consumers for these power distribution companies were derived from the websites of these companies. Later on to determine the sample size for the research the confidence level of 95% was selected and margin error of 5 % was considered for the research. The fig below gives detail description of the required sample size with respect to the population considering the assumptions in terms of confidence and error made above. The responses received were after sending the research form were almost congruent to the

sample size advised. Apart from this online technique is also used which has views and inputs for millions of customers of these Discoms. The online techniques take the inputs of the customer to a larger extent as millions of customers rate these websites on the basis of various parameters and various analysis is done based on various online analytical techniques.

Required Sample Size†

Population Size	Confidence = 95% Margin of Error				Confidence = 99% Margin of Error			
	5.0%	3.5%	2.5%	1.0%	5.0%	3.5%	2.5%	1.0%
10	10	10	10	10	10	10	10	10
20	19	20	20	20	19	20	20	20
30	28	29	29	30	29	29	30	30
50	44	47	48	50	47	48	49	50
75	63	69	72	74	67	71	73	75
100	80	89	94	99	87	93	96	99
150	108	126	137	148	122	135	142	149
200	132	160	177	196	154	174	186	198
250	152	190	215	244	182	211	229	246
300	169	217	251	291	207	246	270	295
400	196	265	318	384	250	309	348	391
500	217	306	377	475	285	365	421	485
600	234	340	432	565	315	416	490	579
700	248	370	481	653	341	462	554	672
800	260	396	526	739	363	503	615	763
1,000	278	440	606	906	399	575	727	943
1,200	291	474	674	1067	427	636	827	1119
1,500	306	515	759	1297	460	712	959	1376
2,000	322	563	869	1655	498	808	1141	1785
2,500	333	597	952	1984	524	879	1288	2173
3,500	346	641	1068	2565	558	977	1510	2890
5,000	357	678	1176	3288	586	1066	1734	3842
7,500	365	710	1275	4211	610	1147	1960	5165
10,000	370	727	1332	4899	622	1193	2098	6239
25,000	378	760	1448	6939	646	1285	2399	9972
50,000	381	772	1491	8056	655	1318	2520	12455
75,000	382	776	1506	8514	658	1330	2563	13583
100,000	383	778	1513	8762	659	1336	2585	14227
250,000	384	782	1527	9248	662	1347	2626	15555
500,000	384	783	1532	9423	663	1350	2640	16055
1,000,000	384	783	1534	9512	663	1352	2647	16317
2,500,000	384	784	1536	9567	663	1353	2651	16478
10,000,000	384	784	1536	9594	663	1354	2653	16560
100,000,000	384	784	1537	9603	663	1354	2654	16584
300,000,000	384	784	1537	9603	663	1354	2654	16586

Figure 41 Determining Sample Size in the Research for Website Assessment for Power Distribution Companies
Source: http://research-advisors.com/tools/SampleSize.htm

Sl No	Power Utility Company	Serving Area	Total LT Domestic Consumer (Approx.)	Ideal Sample Size	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

Table 25: Summary of consumer questionnaire feedback

Total Consumer*- Source: Power Distribution Companies websites (bsesdelhi.com, tatapower-ddl.com, pvvnl.org, dhbvn.org.in)

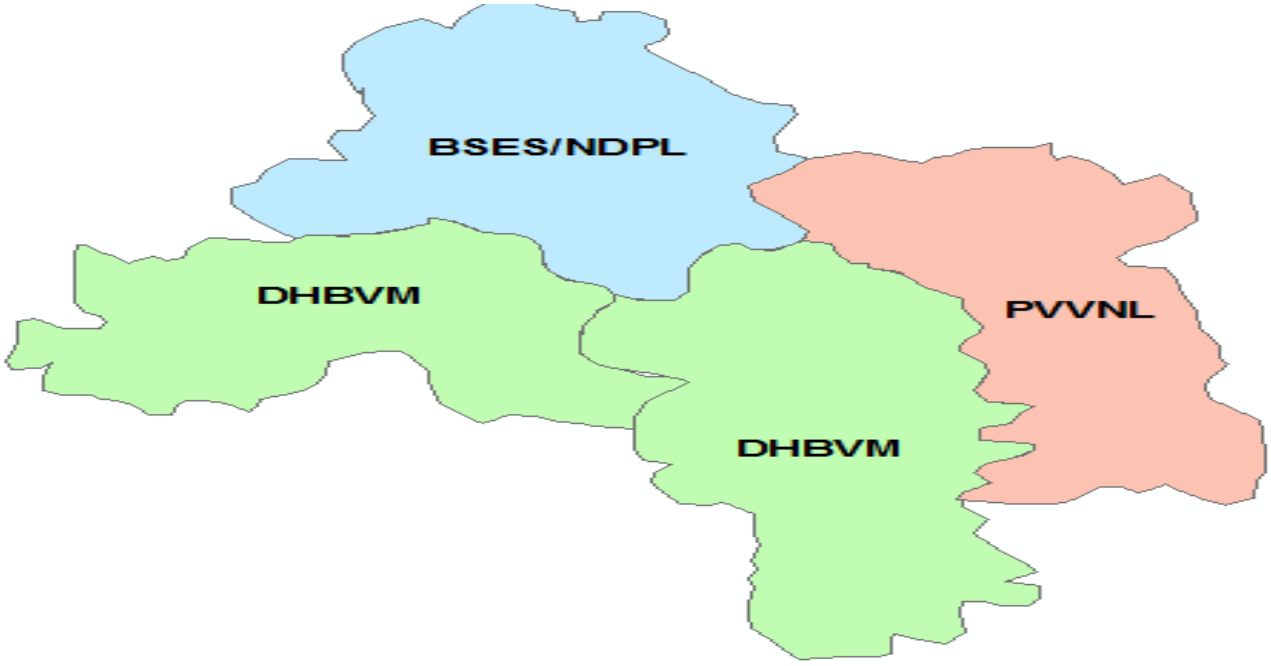


Figure 42 Map Showing areas of National Capital Region for Website Assessment of Power Distribution Company
Source: Designed by Research Scholar (2016)

Demographic Profile of the respondents of different Discoms who participated in the Survey for Research

BRPL- BSES Rajdhani Power Ltd		
Sex	Male	360
	Female	50
Age Group (Yrs)	20-30	159
	30-40	204
	40-50	47
	50+	0
Education Level	Pursuing Graduation	40
	Graduates	330
	Post Graduates	40
Occupation	Student	40
	Self Employed	62
	Working in pub	270
	Other	38

BYPL- BSES Yamuna Power Ltd		
Sex	Male	342
	Female	44
Age Group(Yrs)	20-30	101
	30-40	246
	40-50	39
	50+	0
Education Level	Pursuing Graduation	93
	Graduates	266
	Post Graduates	27
Occupation	Student	93
	Self Employed	56
	Working in public/pvt. Sector	224
	Other	13

Table 26 Demographic Profile of the respondents of BSES

TATA POWER- DDL		
Sex	Male	358
	Female	33
Age Group	20-30	98
	30-40	249
	40-50	44
	50+	0
Education Level	Pursuing Graduation	87
	Graduates	273
	Post Graduates	31
Occupation	Student	87
	Self Employed	79
	Working in public/pvt.	187
	Other	38

Table 27 Demographic Profile of the respondents of Tata Power DDL.

DHBVN- Haryana Discom		
Sex	Male	347
	Female	37
Age Group	20-30	189
	30-40	174
	40-50	21
	50+	0
Education Level	Pursuing Graduation	93
	Graduates	266
	Post Graduates	31
Occupation	Student	93
	Self Employed	79
	Working in public/pvt.	185
	Other	27

PVVNL- UP Discom		
Sex	Male	370
	Female	20
Age Group	20-30	85
	30-40	214
	40-50	91
	50+	0
Education Level	Pursuing Graduation	85
	Graduates	270
	Post Graduates	35
Occupation	Student	85
	Self Employed	95
	Working in public/pvt. Sector	175
	Other	35

Table 28 Demographic Profile of the respondents of Haryana and UP Discoms.

Some of the reasons which the research revealed for not using the website by the consumer were as follows:

	Reasons for not using website in Delhi		%
1	Lack of Awareness.	33	3%
2	Lack of initiative from Discoms	51	5%
3	Busy Schedule of citizens	24	2%
4	Use of Drop Boxes/Payoutlets/Paytm/Banks	261	23%
5	Security and reliability issues in online bill payment.	251	22%
6	Nearby Discom Bill Payment Offices	369	33%
7	Intermediaries some shopkeepers and middle men	91	8%
8	Lack of internet facility	37	3%
		1117	100%

Table 29 Reason mentioned by the consumers for not using website in Delhi

	Reasons for not using website in Noida & Gurugram		%
1	Lack of Awareness.	93	17%
2	Lack of initiative from Discoms	89	16%
3	Busy Schedule of citizens	25	5%
4	Nearby Discom Bill Payment Offices	131	24%
5	Use of Drop Boxes/Payoutlets/Paytm/Banks	67	12%
6	Security and reliability issues in online bill payment.	91	17%
7	Intermediaries some shopkeepers and middle men	18	3%
8	Lack of internet facility	32	6%
		546	100%

Table 30 Reasons mentioned by the consumers for not using the website in Noida & Gurugram.

The various categories and the factors involved along with weights used in the research is mentioned in the table below:

Categories	Sub Category	Factors	WEIGHTS	TOTAL WEIGHTS
Accessibility		Presence in search engines	5	
		Popularity	10	15
Speed			15	15
Navigation		Sitemap	10	
		Keyword Search Function	5	15
Content Quality	Information Content	Profile	1	10
		Management Team	1	
		Corporate Philosophy	1	
		Sector Perspectives	1	
		Business Excellence	1	
		Pioneering Initiatives	1	
		Policies	1	
		Awards and Recognitions	1	
		Consultancy Services	1	
		Media Room	1	
	Communication Content	Location of Offices	2	15
		Location of Complaint Centers	2	
		Help Line No	5	
		Theft Information Contact No	2	
		Contact e-mail	2	
		Bill Collection Van	2	
	Customer Oriented Applications	Outage Details	3	15
		Theft Calculator	2	
		No Power Cut Feeders	1	
		Online Payment	3	
		New Connection Form	2	

		Power Summary	2	
		Energy Conservation Tips	2	
	Regulator Information	Standard of Performance of the distribution licensee	1	5
		Tariff	1	
		Orders	1	
		Approved Documents	1	
		Consumer Services	1	
	Consumer Care Services	Connection related problem	2	10
		Consumer Grievance Redressal System	2	
		Forum for Redressal of Consumer Grievances	2	
		Decisions of Forum for Redressal of Consumer Grievances	2	
		Sitting of Forum for Redressal of Consumer Grievances at Circle Level.	2	

Table 31 Website Assessment Index Parameters with weightage

9.1.1 Online Analytical Techniques Used

The research has used various available online tools which give results immediately once URL of the website is fed as input.For example Alexa, Cubestat etc. also have been used and their description along with results for different power distribution companies has been described in the figure below:

Sl No	Tools for Monitoring a Website's Popularity	About	BSES	NDPL	DHBVN	PVVNL
1	Alexa	Started in 1996, Alexa is the most popular traffic ranking service today. It tracks traffic statistics of websites and provides a numerical rank based on the data that they collect. You can find a website's Page Views and Reach (the % of internet users that have visited the website).	Rank in India 1,467	15,456	20,290	29,584
			Search Visits 33.50%	42.00%	40.00%	30.40%
2	Cubestat	Cubestat is another simple web tool that provides you with a host of information about a website's popularity daily page views. What's unique about Cubestat is that it estimates a website's monetary value (in U.S. dollars) – the more expensive the website is, the more popular it is.	Website Worth: $151,529.06	Website Worth: $26,004.55	NA	NA
			Daily Pageviews: 37953	Daily Pageviews: 6513	NA	NA
			Daily Ads Revenue:	Daily Ads Revenue:	NA	NA
3	.webpagetest.org	Test the speed to load the page of website.	Load Time :8.785s	5.583s	8.333s	2.758s

Table 32 Online Analytical techniques used

9.1.2 Statistical Techniques Used

Chi-Square Test: This is one of the widely used tests to compare observed and expected data in the research. The Chi-Square test has been applied to study the results.

The study clearly reveals the significant difference between total web quality and four categories of website assessment of Discoms in NCR. Overall web quality clearly seems to depend upon on other categories of Web Assessment Index.

Sl No	Name of the Power Uility	Accessibility (15)	Accessibility (O-E)	Accessibility (O-E)2/E	Speed(15)	Speed (O-E)	Speed(O-E)2/E	Navigability (15)	(O-E)2/E2	Content Quality(55)	(O-E)2/E2	Web Quality(100)	TOTAL(O-E)	(O-E)2	(O-E)2/E	
1	BSES	14	1	0.066666667	14	1	0.0666667	15	0	50	0.4545455	93	-7	49	0.49	
2	NDPL	11	4	1.066666667	14	1	0.0666667	15	0	51	0.2909091	91	-9	81	0.81	
3	Haryana Power Discom	12	3	0.6	12	3	0.6	12	0.6	47	1.1636364	83	-17	289	2.89	
4	UP Power Discom	9	6	2.4	10	5	1.6666667	11	1.066667	33	8.8	63	-37	1369	13.69	
		46		4.133333333	50		2.4	53	1.666667	181	10.709091	330	230	52900	17.88	>13.28

Table 33 Chi-Square Analysis

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

The Chi-Square test evidently shows that null hypothesis assumed is rejected and thus there is a significant difference between total web quality and four categories of website assessment Discoms in NCR.

Public Private Companies Discom scores better in terms of website factors associated with website assessment Index and has better and more informative website which is quite

relevant from the table. There is also a difference in website components of all four Discoms.

9.3 Findings &Analysis on Adoption and Diffusion of GIS among Workforce in PPP Discom in Delhi and Govt Discom in Haryana

9.3.1 Introduction

The findings of Adoption and diffusion of GIS technologies have been grouped into two parts. The first part deals with results of acceptance of GIS Technologies in Quasi Government Companies in Delhi and second part of result analysis deals with government-owned state electricity boards Discoms in NCR.

This section showcases the results obtained from the data collected. The section is divided into two parts, first part describes the descriptive statistics of the exogenous and endogenous variables in the research. Reliability analysis used to test the internal steadiness of the tools used in the research. The second part deals with the structural equation model analysis done to validate the new framework designed by the researcher.

9.3.2 Analysis on Acceptance of GIS among Workforce in Public Private Partnership Discom in Delhi

The study was conducted for one quasi-owned Discom of Delhi and one government Discom of Haryana for technology adoption and diffusion

The study was conducted among the employees of Discoms, 226 surveys were dispersed to staff, out of which 216 responded to the questionnaire 14 respondents were not used as their survey responses were incomplete. The rest 204 responses were considered for the research study and analysis.

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%

Summary of Demographic Data of the respondents of Delhi Discoms

Rank	Sr Manager	9
	Manager	30
	Asst Manager	42
	Sr Supervisor	26
	Supervisor	65
	Lineman	32
Yr. of Experience	0-5	17
	5-15	130
	15-25	45
	> 25	12
Education	Post Graduates	12
	Graduates	155
	Diploma	37

Table 34 Demographic Surveyed Data for Delhi and Haryana Discoms

The majority of the respondents, i.e. 61% were from junior management cadre. It is the junior management cadre who actually uses the technology for their work and brings the use of GIS directly to the mainstream of work in power Discom. Only 4% of the upper middle management cadre participated but the interaction with them helped to understand the social environment for the use of technology.35% of the middle management cadre took part in the research which helped in bringing the insights of the actual scenario of the use of GIS technology in Discom

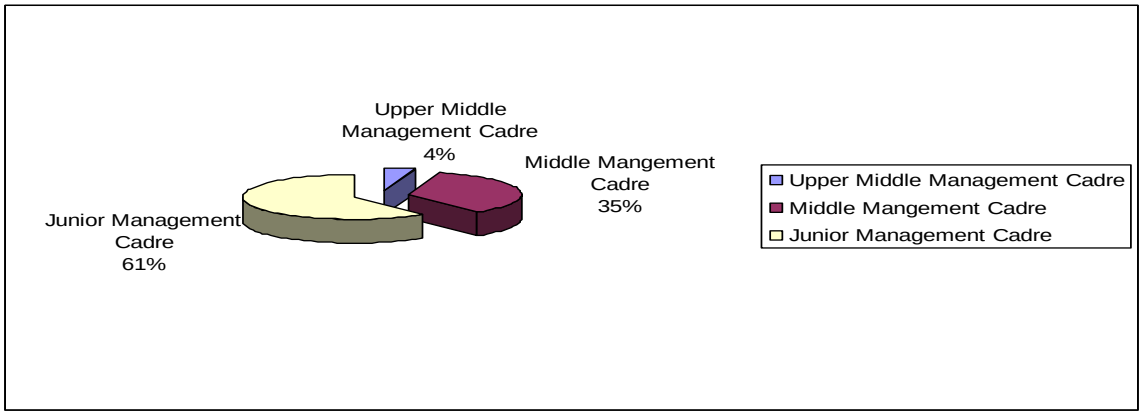


Figure 43 Distribution of Discom Officials who took part in research with respect to Management Cadre for Delhi Discom

64 % of the workforce of the Discoms who participated in the research were of work experience of the range 5-15 years .22% of the staff who were of work experience in the range 15-25 years. Only 6% of the Discoms staff who participated in the research were of work experience more than 20 years. 8% of the Discom staff were off work experience 0-5 years

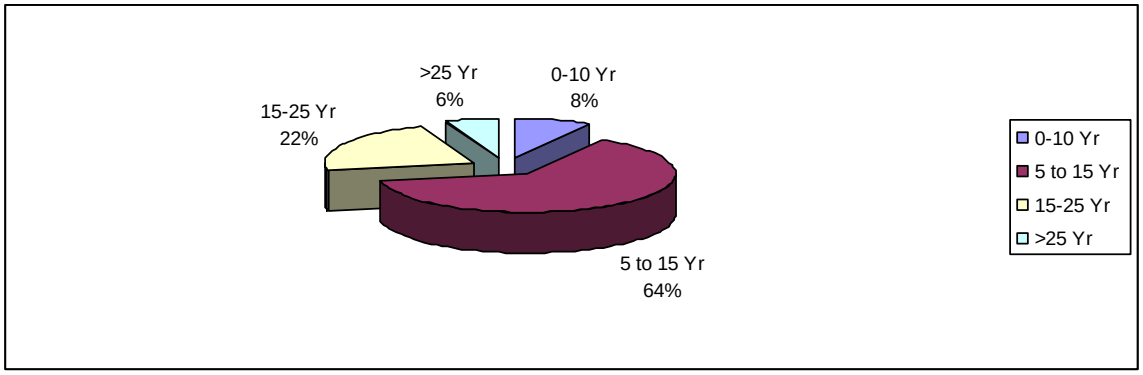


Figure 44 Distribution of the respondents with respect to number of years of experience (Delhi Discom)

76% of the staff who participated in the research were graduates with the majority of them having a technical qualification. Only 6% of the staff who were postgraduates were part of the research, while 18% of the staff were either diploma holder or ITI by qualification.

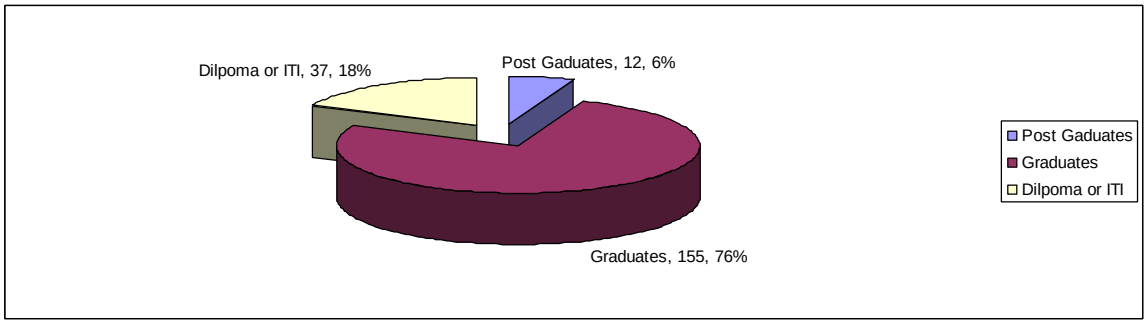


Figure 45 Distribution of respondents with respect to number of years of experience (Delhi Discom)

Descriptive Statistics:

The table illustrates the descriptive statistics of the data collected from the respondents.The analysis has been using SPSS 21 software and the descriptive statistics includes mainly sum, mean, and standard deviations

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
PU1	204	1	5	3.15	.953
PU2	204	1	5	3.45	.820
PU3	204	1	5	2.93	1.125
PU4	204	2	5	3.21	.756
PU5	204	1	5	2.44	1.003
EU1	204	1	5	3.06	.916
EU2	204	1	5	3.26	.992
EU3	204	1	5	2.90	1.041
EU4	204	1	5	3.09	.948
EU5	204	1	5	2.96	1.084
DC1	204	1	5	3.23	1.041
DC2	204	1	5	2.86	1.171
DC3	204	2	5	3.86	.684
DC4	204	1	5	3.12	1.177
EG1	204	1	5	3.56	.948
EG2	204	2	5	3.51	.821
EG3	204	1	5	3.38	1.046
EG4	204	1	5	3.02	1.174
EG5	192	1	5	2.73	1.214
AT1	204	2	44	4.78	6.890

AT2	204	2	5	3.38	.871
AT3	204	1	5	2.75	1.209
AT4	204	2	5	3.32	.861
AT5	197	2	5	3.22	.985
INT1	204	2	5	3.51	.809
INT2	204	2	5	3.24	.964
INT3	204	1	5	3.15	.978
INT4	204	2	5	3.15	.941
INT5	204	1	5	3.73	.837
PE1	204	3	5	4.11	.395
PE2	204	4	5	4.06	.245
PE3	205	3	5	4.16	.430
PE4	204	3	5	4.21	.421
MS1	204	3	5	4.11	.395
MS2	204	4	5	4.06	.245
MS3	204	1	5	3.94	.730
MS4	204	3	5	4.21	.421
MS5	204	3	5	4.19	.460
AE1	204	1	4	2.25	.690
Valid N (listwise)	191				

Table 35 Descriptive Statistics

Research Model in AMOS (Delhi Discom)

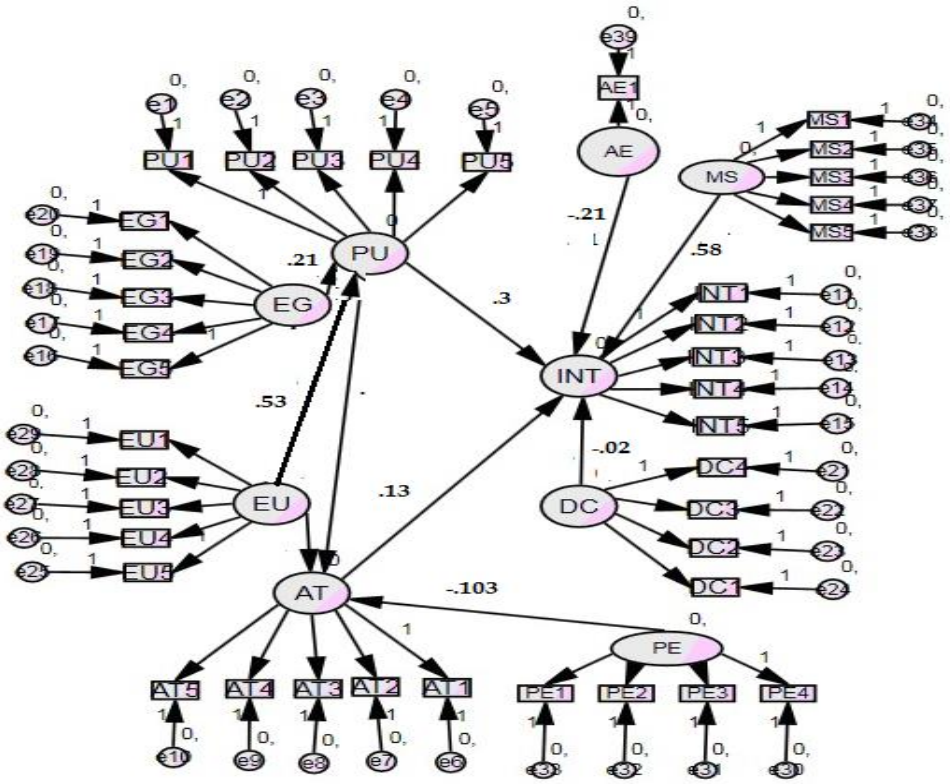


Figure 46 AMOS Research Model for SEM Analysis

Hypothesis Testing Results

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

The SEM analysis exhibits favorable association of attitude of Discoms Staff for GIS technologies and intentions of involving GIS in his work wherever required.The favorable association means 13% surge in intention for every surge in Attitude. So, the attitude of the Discoms Staff for using GIS system is positive.

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

This hypothesis was not supported. The finding (β = -.11) specifies negative effect which means that 11% decrease in (AT) attitude with the rise of one element increase in perceived ease.

Hence, there is deleterious effect of ease of use on the attitude of the Discoms Staff for adoption of GIS technology in their system

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

The analysis that the third hypothesis was supported. The finding (β = .53) exhibits a good encouraging association among perceived ease of use and perceived usefulness of Discoms Staff for the adoption of GIS technology. Thus we can say there's is 51 % surge in usefulness for one element increase in ease of use for Discoms staff.

Thus, how much technology is easy to use leads to the better use of GIS.

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

The finding (β = .38,) showed that hypothesis was supported and illustrates a good strong association among perceived ease of use and perceived usefulness of Discoms Staff for use of Geospatial technology. This favorable association exhibits 38% surge in intentions with every element rise in Usefulness of Discoms staff. Usefulness of GIS technology creates favorable effect and impact on the intention of the Discoms staff.

H5: Perceived Usefulness (PU) has a favorable influence on Attitude (AT) of Discoms Staff adoption of geospatial system

The usefulness of the GIS technology creates a favorable impact on the attitude of the power Discoms staff, the analysis results proves the same.

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

The analysis outputs clearly exhibit efficiency gain has an encouraging influence on the usefulness of the system. This can very well understand the fact that one standard increase in EG results in 21% increase in perceived usefulness.

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

The results showed that social norms have insignificant influence on the intentions for use of GIS technologies for their work. This favorable effect shows that for 2% surge in intention for the rise in Discom Organization Culture

H8: Top Management Support & Govt Initiatives (MS) has a favorable influence on Intention (INT) of Discom staff.

The hypothesis was supported as top management support and government initiatives have a favorable relationship with Intention of the Discom staff to make use of GIS technology. This clearly indicates that government is very much concerned with the use of GIS technology in Discoms and also due to this senior management of the Discom also support on the infusion of the technology in the various process of the Discoms. In fact, the government has initiated various audits based on GIS to infuse it in various process and also help them in reduced field visits of the staff.

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

The hypothesis was not supported on the basis of regression analysis and SEM Model.

The results show that there is an insignificant relationship between the age and experience of the employees and Intention to perform the work using geospatial technologies in the Discom.

A brief summary of the regression analysis performed through SPSS is mentioned below. The tables and figures below explain the hypothesis results.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.024[a]	.001	-.004	.811

a. Predictors: (Constant), AE1

b. Dependent Variable: INT1

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.079	1	.079	.120	.729[b]
	Residual	132.877	202	.658		
	Total	132.956	203			

a. Dependent Variable: INT1

b. Predictors: (Constant), AE1

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.579	.194		18.410	.000
	AE1	-.029	.082	-.024	-.347	.729

a. Dependent Variable: INT1

Table 36 Regression analysis performed through SPSS between Years of Experience and Intention of the Discom Staff.

Results are insignificant. There is an insignificant relation between the increase in age and experience of the Discom staff in the intention to use the technologies.

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

The tenth hypothesis is not supported. This exhibits there is no major association between Discom process engineering and attitude of the Discom staff. The insignificant relation suggests when GIS has been infused in various business and operational process of the Discoms and the attitude was insignificant among the staff. The results revealed that initially, the Discom staff were resistant to use the GIS but in most of the cases, it was found that later on when the benefits were visible they started using the technology and has a favorable impact on attitude.

Summary of Hypothesis with Results:

The table below shows the summary of the hypothesis which was assumed by the researcher on the basis of literature survey and gap identified during the research with results

Sl No	HYPOTHESIS	RESULTS
H1	Discoms Staff attitude (AT) for GIS has a favorable impact on intention (INT) to practice the system.	SUPPORTED (β = .13),
H2	Perceived Ease of Use (EU) has an encouraging impact on attitude (AT) of Discoms Staff.	Not SUPPORTED (β = -1.1),
H3	Perceived Ease of Use (EU) has an encouraging impact on Perceived Usefulness (PU) of Discoms workforce.	SUPPORTED (β = .53),
H4	Perceived Usefulness (PU) has a favorable influence on Intention (INT) of Discoms Staff.	SUPPORTED (β = .3),
H5	Perceived Usefulness (PU) has a promising stimulus on Attitude (AT) of Discoms Staff.	SUPPORTED (β = .47),
H6	Efficiency Gain (EG) has an encouraging impact on the Perceived Usefulness (PU) of Discoms Staff.	SUPPORTED (β = .21),
H7:	Discom Organization Culture (DC) has a favorable influence on Intention (INT) of Discom staff.	SUPPORTED (β = .02),
H8	Top Management Support & Govt Initiatives (MS) has a favorable influence on Intention (INT) of Discom staff.	SUPPORTED (β = .58),
H9	Employees Age & Years of Experience (AE) has an encouraging effect on Intention (INT).	Not SUPPORTED (β = -.21),
H10	Discom Process Engineering (PE) has an encouraging effect on Attitude (AT).	Not SUPPORTED (β = .-1.03),

Table 37 Hypothesis testing results (Delhi Discom)

9.3.3 Analysis on Adoption and Diffusion of GIS among Workforce in Government Owned Discom in Haryana.

In National Capital Region there are government companies namely PVVNL and DHVNL for states of Uttar Pradesh and Haryana respectively. The analysis was done on acceptance of GIS technologies in government Discoms in Haryana ie; DHVNL.

The study was conducted among the workforce associated with the Discoms and total of 217 Samples collected out of which 17 were missing more than 50% of the responses so were not included in the research. After elimination, only 200 responses were handled for analysis. The data was collected in a mixed-mode method of questionnaire survey as well unstructured interview both in telephonic as well as in person was conducted. The researcher also got opportunity to meet Haryana Discoms officials at Power Conference and various workshop and had informal talk with the officials

Demography Data

The following table provides the summary of the surveyed data collected by the researcher for analysis of acceptance of GIS technologies in Haryana Discoms of National Capital Region

Rank	Middle Mangement Cadre	38
	Upper Middle Amanagement Cadre	14
	Junior Management Cadre	109
	Consultants/Associated Staff	39
Yr of Experience	0-5	79
	5-15	85
	15-25	36
	>25	0
Education Level	Post Gaduates	23
	Graduates	103
	Dilpoma	41
	ITI	33

Table 38 Haryana Discom Demography Data

54% of the staff consulted were from junior management while 19%of the staff consulted were from middle management. The upper middle management staff who took part in the

research was 7%.Apart from this the researcher also involved 20% of the consultants and associated staff who were deputed and working in the Discoms.

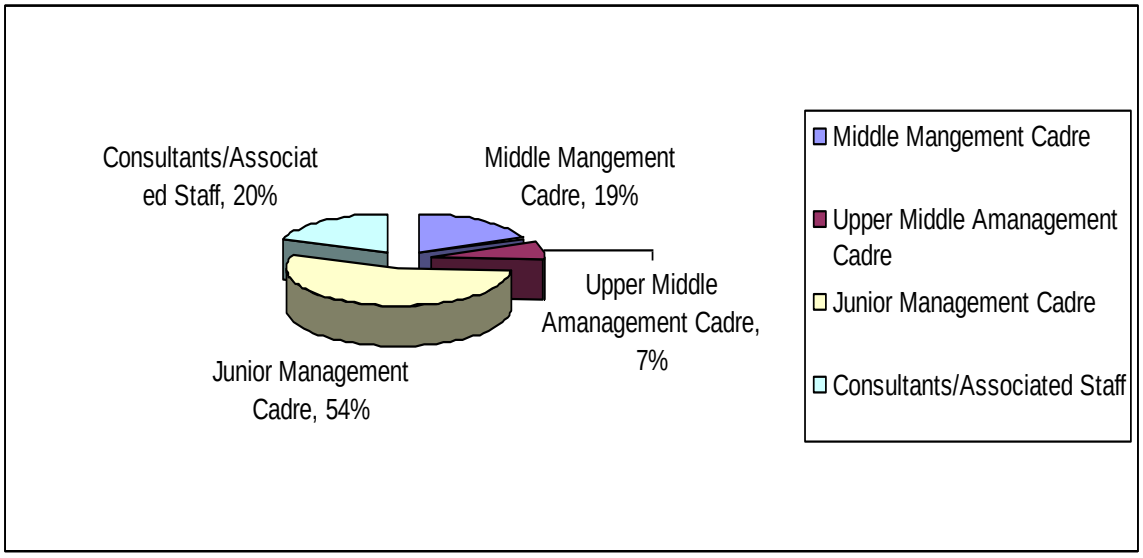


Figure 47 Distribution of the staff with respect to management cadre (Haryana Discom)

The Discoms staff who participated in the research had varied years of experience .40% of the staff were from 0-5 years of experience and nearly 42% of the staff were of 5-15 years of experience. 18% of the staff comprises of staff with experience 15-25 years.

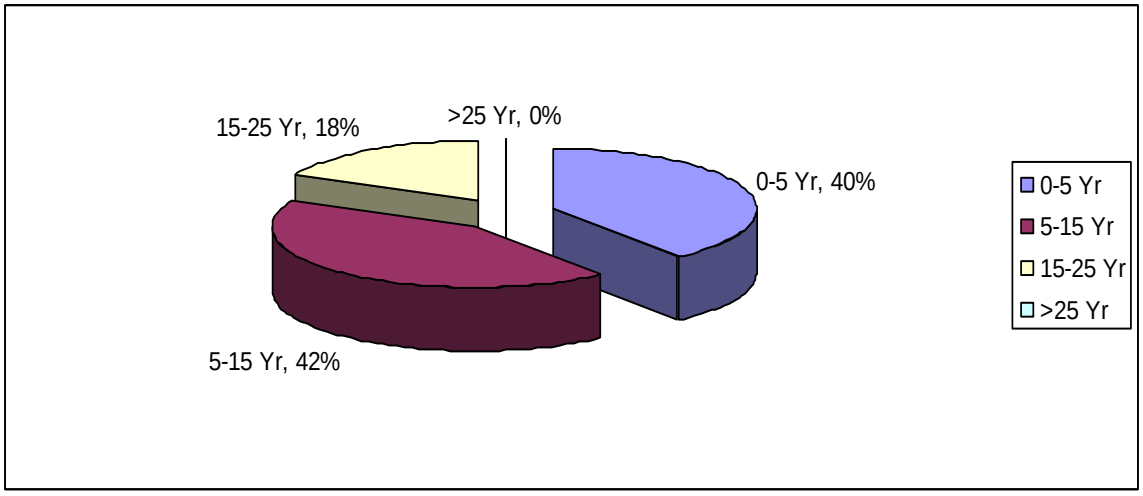


Figure 48 Distribution of the respondents with respect to years of experience Haryana Discom)

The qualification of the staff also saw the diverse group. 51% of the respondents were graduates, 37% of the staff who participated in the research were from diploma/ITI background while only 12% of the staff were post graduates.

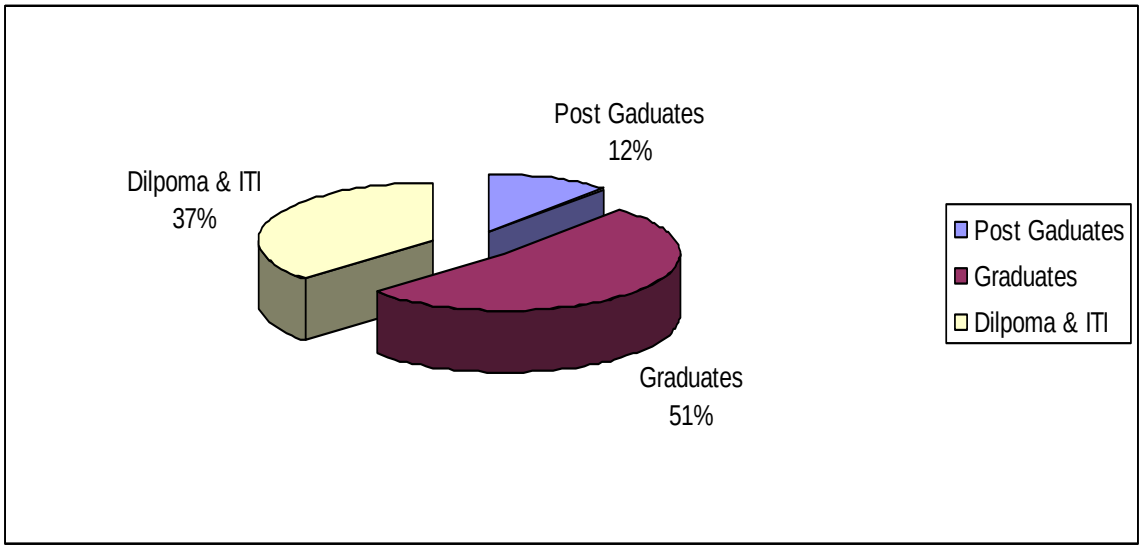


Figure 49. Distribution of the respondents with respect to educational qualification Haryana Discom

SEM results using AMOS for Haryana Discoms

The data collected was analyzed using Structural Equation Modeling Technique with help of IBM's AMOS software. The variables were endogenous and exogenous variables were modeled in the AMOS with their values and error content was also attached to each variable. The results were obtained using these variables and were analyzed.

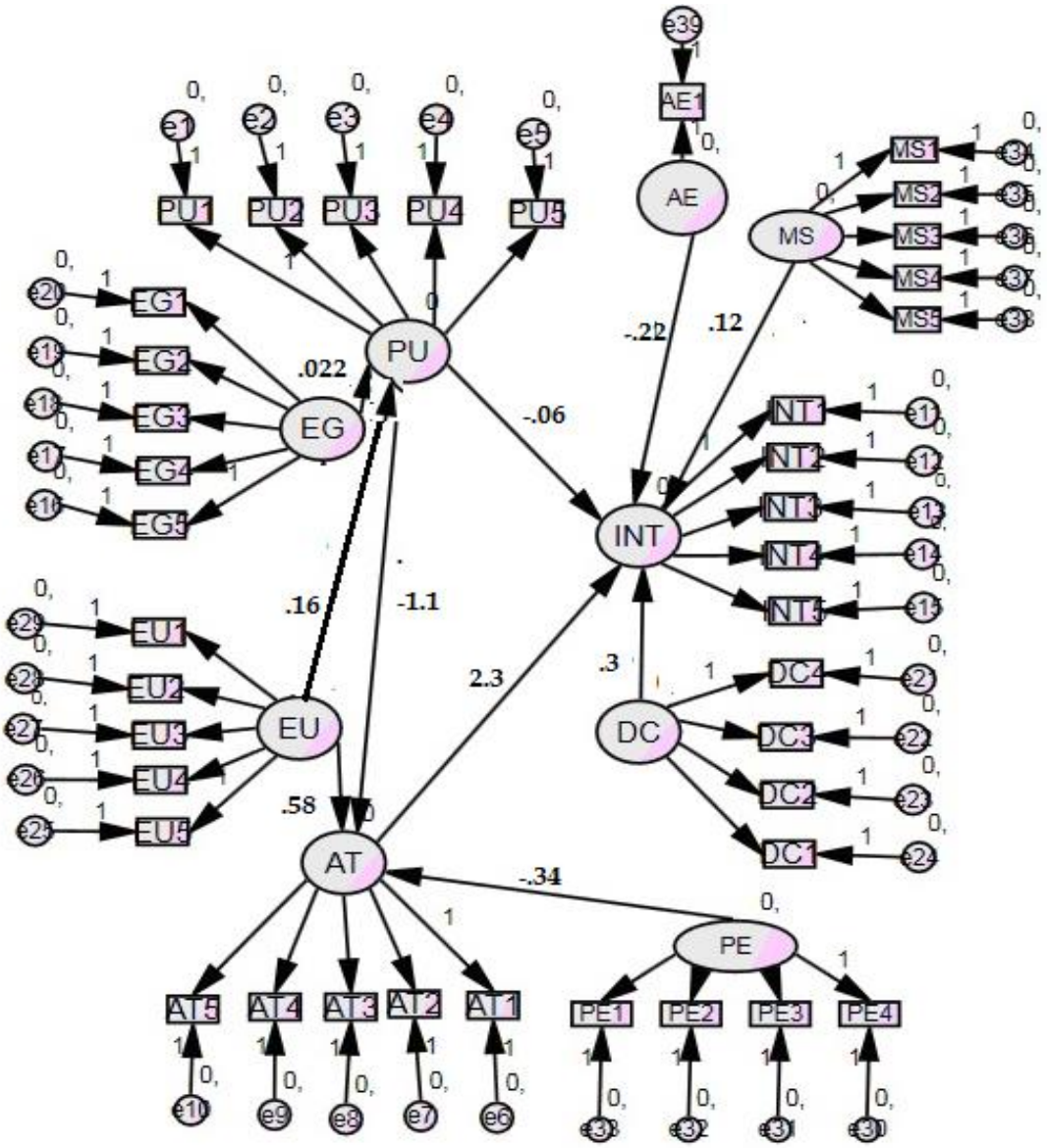


Figure 50 AMOS Model for SEM Analysis for Haryana Discom

Hypothesis Testing Results

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

The first hypothesis was supported, which indicates that there is a favorable significant relationship among attitude of Discoms Staff towards the GIS and intention to use the system. This favorable correlation suggests that one item surge in the attitude of Discom

staff results in a 23% surge in intention to use. So, the attitude of the Discoms Staff for using GIS system is very positive.

Sl No	HYPOTHESIS	RESULTS
H1	Discoms Staff attitude (AT) for GIS has a favorable impact on intention (INT) to practice the system.	SUPPORTED (β = 2.371)
H2	Perceived Ease of Use (EU) has an encouraging impact on attitude (AT) of Discoms Staff.	SUPPORTED (β = 0.558)
H3	Perceived Ease of Use (EU) has an encouraging impact on Perceived Usefulness (PU) of Discoms workforce.	SUPPORTED (β = 0.166)
H4	Perceived Usefulness (PU) has an encouraging impact towards Intention (INT) of Discoms workforce.	Not SUPPORTED (β = .-0.06)
H5	Perceived Usefulness (PU) has a promising stimulus on Attitude (AT) of Discoms Staff.	Not SUPPORTED (β = -1.167)
H6	Efficiency Gain (EG) has an encouraging impact on the Perceived Usefulness (PU) of Discoms Staff.	SUPPORTED (β = .022)
H7:	Discom Organization Culture (DC) has a favorable influence on Intention (INT) of Discom staff.	SUPPORTED (β = .3),
H8	Top Management Support & Govt Initiatives (MS) has a favorable influence on Intention (INT) of Discom staff.	SUPPORTED (β = .12),
H9	Employees Age & Years of Experience(AE) has a favorable influence on Intention(INT) of Discom staff using the GIS technologies	Not SUPPORTED (β = -.22),
H10	Discom Process Engineering(PE) has a favorable influence on Attitude(AT) of Discom staff using the GIS technologies	Not SUPPORTED (β = -.34),

Table 39 Hypothesis Results (Haryana Discom)

H2: Perceived Ease of Use (EU) has a favorable influence on attitude (AT) of Discoms Staff using the GIS technologies.

The second hypothesis was supported. The finding (β = .558) shows a favorable correlation among perceived ease of use and attitude for employees. This favorable association shows that for 55% increase in attitude is observed for every increase in ease of use.

H 3: Perceived Ease of Use (EU) has an encouraging impact on Perceived Usefulness (PU) of Discoms workforce.

The third hypothesis was supported. The finding (β = .166) illustrates positive encouraging affiliation amid ease of use and perceived usefulness of Discoms Staff. This favorable association shows 16 % surge in perceived usefulness for every increase in ease of use of Discoms staff.

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

The fourth hypothesis was supported. The finding (β = -0.06) illustrates inconsequential relationship amid perceived ease of use and perceived usefulness.Hence, it can be inferred that perceived usefulness has an inconsequential effect on the intention.

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

The fifth hypothesis was supported. The value (β = -1.16) illustrates deleterious affiliation amid perceived usefulness and attitude of Discoms Staff. This negative association means 116% fall in attitude with one element increase in usefulness.

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

The sixth hypothesis was supported. The finding (β = .022) shows that promising affiliation between efficiency gain and perceived usefulness of Discom staff. This favorable correlation submits that one item increase in efficiency increase results in 2% surge in perceived usefulness.

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

The hypothesis was supported. The finding (β = -0.822) specifies that there is a negative association amongst Discom Organization Culture and intention of Discoms staff. This means 82% fall in intention with one element increase in Discom Organization Culture.

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

The hypothesis is supported. The findings reveal the fact that top management support of the Discoms has a favorable relationship with Intention of the Discom staff. This implies that Discom top management is supportive and also the government has been taking various initiatives to ensure the proper absorption and implementation of the technology.

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

The Hypothesis is not supported and there is an insignificant relationship between the no of years of experience of the Discoms staff and Intention of the staff. The means that as a number of years of experience have increased the less is the intention towards the use of GIS technology. This also supports Rogers theory of technology diffusion.

The SPSS regression analysis also reveals the same the details of the analysis results is mentioned below:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.128[a]	.016	.011	.797

a. Predictors: (Constant), AE1

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.993	.120		33.162	.000

	AE1	-.105	.058	-.128	-1.810	.072
a. Dependent Variable: INT1						

Table 40 Regression analysis performed through SPSS between Years of Experience and Intention of the Discom Staff.

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

The hypothesis is not supported. The findings indicate that there is an insignificant relationship between Discom Process Engineering and attitude of the Discom staff. Since Haryana is still under implementation stage of GIS technologies the Discom process engineering has not been very aligned with GIS and so there is no relationship with reference to the attitude of the Discom staff.

The SPSS regression analysis was performed and the details of the results are described below which also confirms the hypothesis was not supported.

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.035[a]	.001	-.014	.898
a. Predictors: (Constant), PE4, PE2, PE1				

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.954	.343		8.603	.000
	PE1	-.054	.131	-.030	-.414	.679
	PE2	.009	.133	.005	.070	.944
	PE4	.039	.137	.020	.282	.778
a. Dependent Variable: AT1						

Table 41 Regression analysis performed through SPSS between Process Engineering and Attitude of the Discom Staff.

9.4 Summary

The research objectives discussed in a chapter in chapter 2 has been taken one by one and analysis of the data was performed using the research methods and techniques considered. The chapter analyses the website of Discoms in National Capital Region using the data collected and results and conclusion were drawn. Similarly, the formula for Power Distribution Technology Index was discussed and analysis was performed. The analysis on adoption and diffusion of GIS among the quasi-government and government-owned power distribution companies was performed and the conclusion was drawn. The next chapter discusses in detail the conclusion and results of the analysis performed.

Chapter 10

Summary & Conclusion

Chapter 10: Conclusion and Future Scope

10.1 Introduction

The research has been conducted on collecting both quantitative and qualitative data sequential mixed method manner. The research broadly divided into three phases based on the objectives for research. The extensive literature survey is done before the finalization of the research objectives by identifying the gaps. After research objectives are finalized, literature related to specific objective has been done in order to understand the insights of the earlier research. The research variables are identified for the research construct and data collection. A literature review related to the specific objective is done separately for all three objectives. Then questionnaire is framed based on research variables. The data analysis has been done using both qualitative as well quantitative methods. The results are analyzed and based on that inferences are drawn.

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

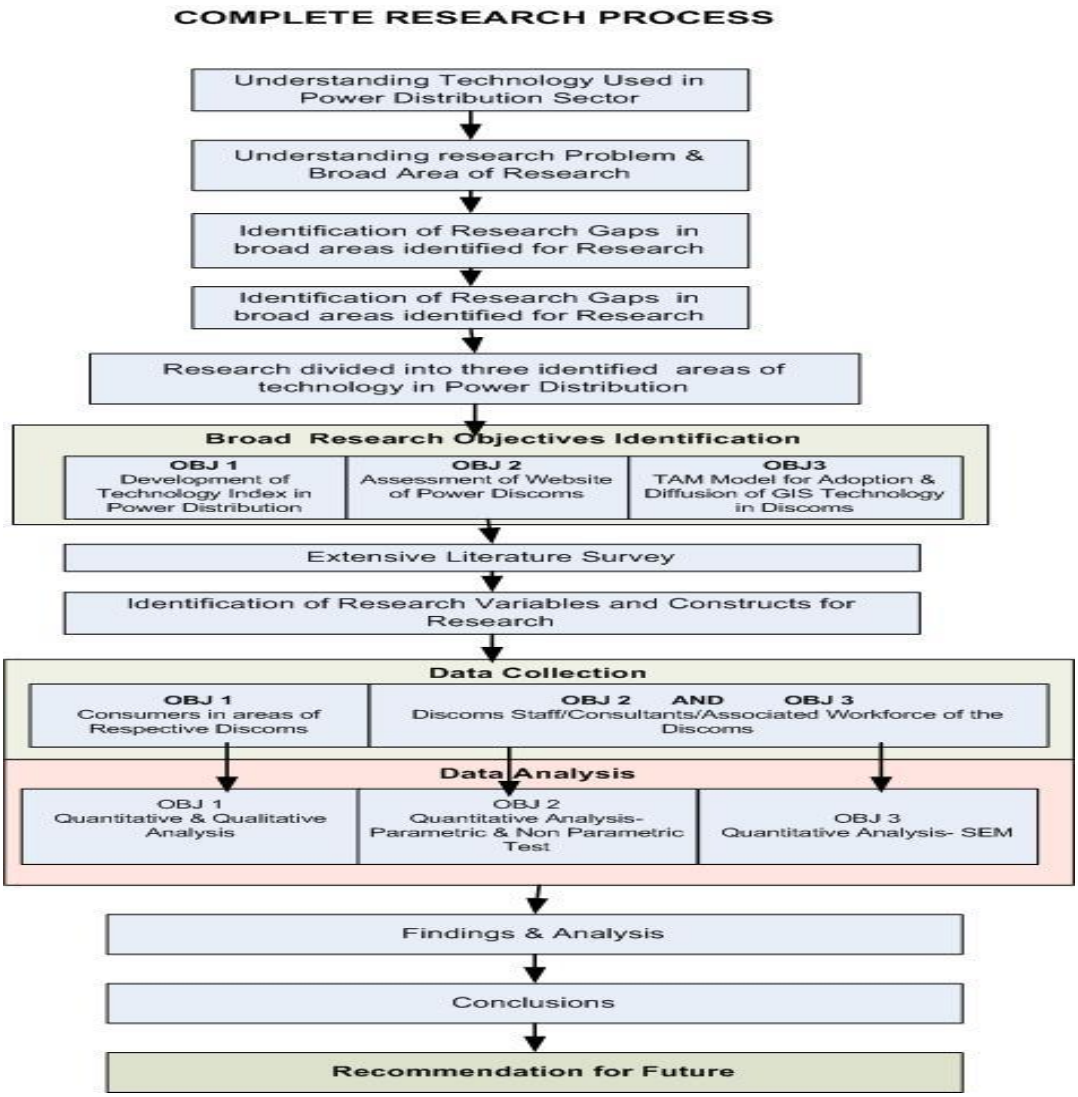


Figure 51 Complete Research process designed by Researcher
Source: Designed by Researcher.

10.2 Summary with respect to Research Objectives

The findings of the different components of the research are synthesized with respect to the research objectives.

Broadly research objectives proposed for achieving the research aim of' Strategic technology management. for power distribution companies in National Capital Region'.

10.2.1 Research Objectives 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 power distribution utilities in India have already implemented some 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 analyze the results were derived, there is the difference in the 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.

As per power distribution technology index, Delhi Discoms (22.7) score better than Haryana Discoms (10.5), which means technology deployment in Delhi is much better than Haryana Discoms. For Period 2005-2015, AT&C losses for Delhi Discoms from 36 to 14%, whereas for Haryana Discoms it got reduced from 34 to 21%.Delhi Discoms has implemented IT Apps (86%) for Power Distribution (GIS,SCADA etc)whereas Haryana implemented them (27%) .

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 61 % to 36 %. In Delhi Discoms Implementation of Information Technology was directly responsible for the drastic reduction in AT&C losses. Technology gradually marks acceptance among users over a period of time and reduces AT&C losses. AT&C depends directly on many factors, especially commercial losses and social economic conditions where sometimes technology has to play little role.

A better technology deployment at Delhi Discoms has contributed significantly towards larger reduction in AT&C losses.

10.2.2 Research Objectives 2

- The aim of this research is an assessment of websites of Discoms in NCR. The online website assessment tools were used for assessment of various parameters and determinants and then statistical techniques were used to test the hypothesis framed. In this research, we deliberate the intention of the Web assessment.To test its validity Chi-square test was used analyze power distribution companies' website.

The study reveals differences in Discoms websites of National Capital region, especially the PPP(Public Private Partnership) companies (Delhi score-92) score high in respect of content, usability, and navigation. Also, there is a significant difference in various parameters of websites for power distribution companies taken in the study. The state-run power Discoms(Haryana Score-83) 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 websites is concerned.

The Chi-Square test evidently shows that null hypothesis assumed is false and thus there is a significant correlation between total web quality and four categories of website assessment in Discoms. Also, there is a significant difference in the power utility wise website assessment among Discoms.

Public Private Companies Discom score better in terms of website factors associated with website assessment Index and has better and more informative website which is quite relevant from the table. There is also a difference in website components of all four Discoms.

The research revealed 78% of the users in Delhi and 69% in Haryana not use websites mainly due to online reliability issues/Payment of Bills at Nearby Discom Offices/Use of Drop Box/Banks. The research highlighted that following are some of the reasons, why a number of consumers have not used the website of Discom:

- Lack of Awareness. The research shows that many consumers of the Discoms were not aware of the various payment facilities available on the websites through which they can easily make payment without going anywhere and anytime.
- Intermediaries some shopkeepers and middlemen often succeeded in persuading the customer to avail manual bill payment services by them.
- Lack of initiative from Discoms regarding awareness for a website.
- Busy Schedule of the citizens: Middle-Class families who are many busy in their job takes help of these middlemen for payment of bills and any other queries.
- Lack of internet facility in consumers: Some consumer does not have access to the internet, due to which they cannot access the websites and are not aware of the various facilities provided to the consumers.
- Easy availability of nearby Discoms bill payment offices of bill payments and solve their other queries, especially in Delhi.
- Security and reliability issues in online bill payment. : Some consumers had a bad experience of getting debited from account but it was not credited to their consumer bill accounts. Later, they had to pay again and follow up to recover their money. So they feel it's better to go to customer care center and make bill payment rather than online payment by accessing the websites.

Better Quality website of Delhi is contributing towards higher use IT retail application by consumers which may reflect in better customer satisfaction.

10.2.3 Research Objectives 3

The third research objective aims at assessment of Adoption & Diffusion of GIS among State Owned & Quasi Government Power Distribution Companies in NCR.

The research intends to measure user purpose to adopt the GIS and to explore the affiliation amid user acceptance and intention factors to adopt the technology which is still in nascent stage in terms of technology acceptance and diffusion in the power companies. The research is an attempt to explore and evaluate the aspects touching the use of GIS

technologies among state-owned and quasi-government see companies in National Capital region.

SEM (Structural Equation Modeling) technique was used since is high multi-co linearity among the variables ie; independent variables overlap and using regression we cannot segregate the complete impact of one variable from another. The researcher wanted to confirm whether these independent variables are converging to one factor for Confirmatory Factor Analysis using SEM (AMOS Software). Conclusions and possible recommendation for acceptance of the technology have also been discussed ahead.

Conclusion: Analysis on Acceptance of GIS among Discom Workforce

For Haryana Discoms Staff ease of use is more important than usefulness of the application as per the (H2). The study reveals that although GIS technology may not be very easy to use, the employees knows their usefulness and importance in improving their work which can be revealed by the fact that ease of use has a favorable influence on perceived usefulness. .Technology make is not very easy to use to Discoms staffs are very much concerned about the usefulness of the technology and how GIS can help in their day to day work and make their work easier. Discom internal teams demonstrate the user group usefulness of the GIS and how their present process can be improved using GIS.

As per H4 & H5 a positive attitude towards using useful applications is contributing towards success of technologies deployment in Delhi.

Some of the applications are not easy and handy for the Discoms staff and so this creates negative attitude and also this, in turn, creates negative influence on intention of Discoms' staff.

The study reveals that current GIS user interface may not be very easy to use , but the employees knows their usefulness and importance in improving their work which can be revealed by the fact that ease of use has positive influence on perceived usefulness.

Research hypothesis infers H (6) reveals staff of both Delhi and Haryana Discoms feels if technology results in efficiency gain their intentions are positive for using the technology.

As per outcomes of hypothesis H (7), both Delhi and Haryana Discom organization culture is has positive intention in using GIS technology.

Research hypothesis H (9) reveals for both Delhi and Haryana Discoms, staff with more Years of Experience and Age do not encourage use of technology.

The research (H8) reveals Top Management of both Delhi and Haryana Discoms are very much concerned for implementation of GIS technology in Discom.

However, in Delhi, even Delhi Govt is more active and keen in this respect for eg. In Delhi, DERC (Delhi Electricity Regulatory Commission), Delhi Government Power Regulator has mandated GIS based audits for the schemes executed by the Discoms as well as GIS drawings to be attached for all DPR (Detail Project Report) submitted to DERC. But in Haryana, Govt initiatives still have not made processes GIS based.

As per outcomes of research hypothesis (H10) Delhi Discom staff do not back Discom Process Engineering, so Top Management is very keen in making business and operational process technology based. But has initiated these processes few years back and they are in advance stage,

For example, recently in Delhi Discoms, Network Planning and Quality Engineering has been re-engineered and has been made GIS based.

Similar is the case with Haryana also Discom staff do not back Process Engineering, but Haryana is still in nascent stage of implementing technology based Discom Process Engineering.

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 middle management staff of Discoms were not very much concerned with the change in technology taking place. The senior management of both Discoms was very favorable in taking measures for adoption and diffusion of technology in their respective Discoms. This clearly relevant from the demographic profile of the staff who took part in the research most of them were from junior management cadre.

10.3 Significant Research Contribution

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 have not been conducted till date. Thus, this research paves the way for academics and executives to understand the concerns in technology acceptance 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 a tool for comparative assessment of technologies in use in different companies. It can also be used as a benchmarking 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 the 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 the 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.
- Framework was developed for assessment of websites of power Discoms in India. This helps in comparative assessment of websites and help in improving the websites of Discoms in India.

10.4 Limitations of the Research

Limitations of the research are as follows:

- Though Power Discoms have many departments and huge staff at different levels, all of them could not be covered. The researcher tried to cover all the major departments, relevant to the research.
- The survey could not capture any financial or commercial information, as respondents did not want to divulge the same due to confidentially issues.
- Research data collected from 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.
- Only one technology among the different 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.
- The study considered only the factors at the individual level but not at group/team level. Besides, the study did not consider organizational factors like organizational culture, leadership styles etc.
- The frameworks developed by the researcher for strategic management of technology can be further extended to government owned state electricity boards and many other factors and indicators which might be relevant as per their cultural and demographic conditions.

10.5 Recommendation for Future Work

- The survey can be conducted in other regions of and states where most of these technologies are in different stages of implementation. Studies may also focus on the reasons for the failure of Accelerated Power Development Reform Projects, started by Ministry of Power, Government of India.
- The research can be further extended and in-depth research can be carried out on adoption and diffusion of some specific technologies like SCADA, automation etc. The research framework, which has been used in the research, can be used for research in other countries with similar socio-economic conditions as to Indian conditions, which may include South Asian and African countries.
- The research framework, which has been used in the research, can be used for research in other countries with similar socio-economic conditions as to Indian conditions, which may include South Asian and African countries.
- The Power distribution technology Index can be used as research tool for assessment of technologies in other regions of and states of India .

10.6 Summary

The Chapter summarizes the complete research process adopted for the study; fig 51 explains the complete research process taken up in the research. Each objective was taken individually and based on analysis the conclusions were framed against each objective. The chapter then summarizes the major findings leading to discussions on the significant research contributions, the implications of the research and limitations of the research. Areas for further research are suggested to close the gaps and to keep enriching the research.

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APPENDIX A:

Questionnaire for Power Utility Website Assessment Survey

SL No	**Power Utility Website Assessment Survey**				
	Please take a few moments to complete this survey consisting of the questions regarding Web Assessment of Power Distribution Co. We would really appreciate your participation in improving the services.				
Demography Data	Name: Sex: Male Female	Age -	Email :	**Address :**	
		Occupation :	Student		
			Self Employed		
			Working in public/Pvt. Sector		
			Business		
			Other		
	Questions?				
	Have you visited the website of your power distribution company?			**Yes**	**No**
	Categories	**Sub Category**	**Please rate the website of Power Distribution Co on basis of following factors**	**Range[1-10]**	**Consumer Ratings (Eg.8)**
1	Accessibility		Presence in search engines	[0-10]	
2			Popularity	[0-10]	
3	Speed				
4	Navigation		Site map	[1-10]	
5			Keyword Search Function	[1-10]	
6	Content Quality	Information Content	Profile	[1-10]	
7			Management Team/Board of Directors	[1-10]	
8			Vision	[1-10]	
9			Mission	[1-10]	
10			Corporate Philosophy	[1-10]	
11			Corporate Governance	[1-10]	
12			Customer Profile	[1-10]	
13			HR Initiatives	[1-10]	
14			Sector Perspectives	[1-10]	
15			Business Excellence	[1-10]	
16			Pioneering Initiatives	[1-10]	
17			Policies	[1-10]	
18			Awards and Recognitions	[1-10]	

19			Consultancy Services	[1-10]	
20			Media Room	[1-10]	
21			No of Website Visitors	[1-10]	
22			Advertisement on FM Radio	[1-10]	
23			Check Energy Calculator	[1-10]	
24			Citizen's Charter	[1-10]	
25			Area wise AT&C Loss, I/P Energy, Collection for Last 10 Years	[1-10]	
26			Applause	[1-10]	
27			Citizen Charter	[1-10]	
28			High Power Theft Prone Areas	[1-10]	
29			Meter Replacement	[1-10]	
30			Maintenance Shutdown Schedule	[1-10]	
31			MLA Fund Scheme Project Status	[1-10]	
32			Tenders	[1-10]	
33			Sub-Cluster Wise DT Loss Report	[1-10]	
34			Regulatory	[1-10]	
35			Power Procurement Tender	[1-10]	
36			Aggregate Revenue Requirement	[1-10]	
37			Journey of Power Utility	[1-10]	
38			Understanding Power Tariff	[1-10]	
39			Land Mark Judgments	[1-10]	
40		Technical Details	Details of Transformers Issued(Repaired &Guaranteed)	[1-10]	
41			Quantity & Cost of Material Issued against Theft	[1-10]	
42			List of Power Transformers	[1-10]	
43			Grid wise Installed PT/DT capacity	[1-10]	
44		Commercial	Divisonwise Details of Revenue, Energy Receipt	[1-10]	

45			Divisonwise& Category wise no of consumers	[1-10]	
46			Division wise &Category wise connected load of Consumers	[1-10]	
47			Division wise details of arrears	[1-10]	
48			Divisonwise& Category wise details of assessment &realization	[1-10]	
49			Division wise AT&C Losses	[1-10]	
50		Communication Content	Location of Offices	[1-10]	
51			Location of Complaint Centers	[1-10]	
52			Help Line No	[1-10]	
53			Theft Information Contact No	[1-10]	
54			Contact e-mail	[1-10]	
55			Bill Collection Van	[1-10]	
56		Sustainability	Overview	[1-10]	
57			CSR Report 2012-2013	[1-10]	
58			UNGC Study 2013	[1-10]	
59			UNGC COP FY 2012-13	[1-10]	
60			CSR Library	[1-10]	
61			Affirmative Action	[1-10]	
62			Calculate Your Carbon Footprint	[1-10]	
63			Climate Change	[1-10]	
64			Electric Car Charging Stations in TPDDL area	[1-10]	
65		Customer Service	Customer Care Initiatives	[1-10]	
66			Outage Details	[1-10]	
67			Outage Bulletin	[1-10]	
68			Bill on Email	[1-10]	
69			Doorstep Service	[1-10]	
70			Bill Related	[1-10]	
71			Connection Related	[1-10]	
72			Meter Related	[1-10]	
73			Share Info	[1-10]	
74			No Supply	[1-10]	
75			Complaint Status	[1-10]	
76			Grievance Redressal Mechanism	[1-10]	
77			Grievance Redressal	[1-10]	

78			FAQ	[1-10]	
79			Theft Penalty Calculator	[1-10]	
80			No Power Cut Feeders	[1-10]	
81			New Connection Form	[1-10]	
82			Power Summary	[1-10]	
83			Energy Conservation Tips	[1-10]	
84		Payment Options	Bill Payment Kiosk	[1-10]	
85			Debit/Credit Card/ Net Banking	[1-10]	
86			Counters	[1-10]	
87			Cheque-In Mail	[1-10]	
88			Drop Boxes	[1-10]	
89			Pay Outlets	[1-10]	
90			ITZ Cash	[1-10]	
91			Pay by Phone	[1-10]	
92			Download Last E-payment receipt open	[1-10]	
93			Download Duplicate Bill	[1-10]	
94		Regulator Information	Standard of Performance of the distribution licensee	[1-10]	
95			Tariff	[1-10]	
96			Orders	[1-10]	
97			Approved Documents	[1-10]	
98			True up petition for FY 12-13 and ARR for FY 14-15	[1-10]	
99			Electricity Act 2003	[1-10]	
100			Supply Code 2007	[1-10]	
101			Tariff Order 13-14	[1-10]	
102			Unelectrified areas	[1-10]	
103			Environmental , Social Policy & Procedures	[1-10]	
104		Govt of India (Ministry of Power Initiatives)	RAPDRP	[1-10]	
105			RGGVY	[1-10]	
106			Networking	[1-10]	
107			HVDS	[1-10]	
108			Theft Prevention/ Energy Accounting	[1-10]	
109		Consumer Care Services	Connection related problem	[1-10]	
110			Consumer Grievance Redressal System	[1-10]	
111			Forum for Redressal of Consumer Grievances	[1-10]	

112			Decisions of Forum for Redressal of Consumer Grievances	[1-10]	
113			Complaint Registration and Status	[1-10]	
114			Complaint Escalation	[1-10]	
115			Complaint Redressal at Independent Forums	[1-10]	
116			Demand Side Management	[1-10]	
117			List of Defaulters	[1-10]	
118			Public Awareness Programs	[1-10]	
119		Me(Consumer) Details	My Customer	[1-10]	
120			Medium Load Customer	[1-10]	
121			Domestic Customer	[1-10]	
122			Consumption History	[1-10]	
123			My Account	[1-10]	
124		Contact Us	Corporate Office	[1-10]	
125			Pull SMS service	[1-10]	
126			Customer Care Centers	[1-10]	
127			Head of Department (HoD) – Customer Services	[1-10]	
128			Area wise Managers List	[1-10]	
129			Client Managers [HT Connections]	[1-10]	
130			Client Managers [Government & Institutional Connections]	[1-10]	
131			Corporate Communications	[1-10]	
132			Feedback	[1-10]	
133		Customer Information Centre	Download Frequently Asked Questions [FAQ] (File Type: .PDF Size: 1MB)	[1-10]	
134			Pull SMS service	[1-10]	
135			Tariff Details	[1-10]	
136			Neutral Mixing and Earthing	[1-10]	
137			Know Your Meter	[1-10]	
138			Know Your Bill	[1-10]	
139			Utility Trained Electricians	[1-10]	

140			Consumer Newsletter	[1-10]	
141			Service Guarantee for New Connection	[1-10]	
142			Holiday List-Power U	[1-10]	
143		Vendors/ Tenders	Tender Advertisements	[1-10]	
144			Download Tender Document	[1-10]	
145			Vendor Login / Create Login	[1-10]	
146			New Vendor Registration	[1-10]	
147		Other Information	Safety	[1-10]	
148			Report Unethical Issues	[1-10]	
149			Energy Conservation	[1-10]	
150			Power Utility GIS Maps	[1-10]	
151			Careers	[1-10]	
152			Training & Development	[1-10]	
153		Right to Information Act	The Particulars of its Organization, functions, and duties.	[1-10]	
154			The Powers and duties of its officers and Employees.	[1-10]	
155			The Procedure followed in the decision-making process, including channels of supervision and accountability.	[1-10]	
156			The Norms set by it for the discharge of its functions.	[1-10]	
157			The Rules, Regulations, Instructions, Manuals, and Records, held by it or under its control or used by its employees for discharging its functions.	[1-10]	
158			A Statement of the categories of documents that are held by it or under its control.	[1-10]	
159			The Monthly remuneration received by each of its officers and employees, including the system of compensation	[1-10]	

			as provided in its regulations.		
160			The Particulars of facilities available to citizens for obtaining information, including the working hours of a library or reading room, if maintained for public use.	[1-10]	
161			The Names, Designations and other particulars of the public information officers.	[1-10]	
	Outreach	Govt Initiative	ESA, MELA CAMP		
		Company Initiative			
		NGO			

APPENDIX B:

Questionnaire for Technology Implementation Index

Name:
Age:
Years of Experience:
Designation:
Name of Company:

Respondents form for Technology Implementation Index						
	There are no right or wrong answers to the questions. Please circle the most suitable choice for you. 1=Totally disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Totally agree					
Sl	**Category**	**Technologies**	**Indicators**	**Definition**	**Process Adopted**	**Respondents Rating**
1	Metering	Installation of Electronic Meters -LT Consumers	Reduction of AT&C Losses.	AT&C Loss Reports	5	
			100 % Metering of Consumers. Increase in electricity consumption	>% People having electricity >Increase in consumption of electricity		
		AMR for HT Consumers	Availability of real-time electrical parameters on the web	Automated capturing & monitoring of data from Meter	5	
		AMR for Feeder Meters	Availability of real-time electrical parameters on the web	Automated capturing & monitoring of data from Meter	5	
		AMR for DTs	Availability of real-time electrical parameters on the web	Automated capturing & monitoring of data from Meter	5	
		CMRI Metering reading for HT/LT Consumers	Availability of Consumer info like Voltage, PF for use of analytics	Automated capturing & monitoring of data from Meter	5	
		Prepaid Metering	Increase in revenue/Frequent defaulters/Government Consumers	Bills are paid before use of electricity just as prepaid mobile.	5	

2	IT Distribution Apps	Energy Accounting System	Area Wise Loss Report	Divisions/Circle wise loss report	5	
			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	5	
			Online Monitoring	Centralized SCADA Centre		
		Load Forecasting Applications	Forecast load & Meeting Demands.	Matching of Demand & Supply of Power especially during summers/ Existence of Power Purchase group in Discoms	3	
			Power Cut time Per year.			
		Meter Data Management System	Existence of analytics based Reports	Prevention of theft & various reports based on data collected from meters by use of analytics	5	
		Outage Management System	Intimation to Consumers about the outage on the web.	Providing accurate Information on the extent of outages and number of customers affected.	5	
			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	Translating customer call patterns into specific "problem" locations requiring a response by line crews. – Prioritizing restoration efforts and managing resources based on defined criteria such as the size of outages, and the locations of critical facilities		
		Geographical Information System & Network Analysis	Network Mapping	Network Maps availability on website	5	
			GIS Based applications like Energy Audit/OMS etc.			
			Customer care offices on GIS	Mapping of Discom Offices.		
		Smart Grid Pilot Project	Ministry of power reports.		2	
3	IT Retail Applications	Customer Information System	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	5	
			Awareness about energy conservation tips	Awareness among consumers to save electricity and reduce their bills.		
			No of Offices	Availability of Customer Care office at Division/circle/zone level		
		Centralized Call Centre	Round the clock customer care No	Availability of Customer care no which is available round the clock	5	
		Online Bill payment	Save of time	Various types of Bill payment options on website of Discom	5	
			On time payment.	Availability of E-bills from website of Discom	5	

		E-Complaint	Billing complaint resolution time. /Metering reading complaint resolution / New Connection complaint resolution		5	
		Spot Billing	Collection Efficiency	Consumers gets bill at spot when meter comes in his come to take reading	5	
4	Enterprise level Apps	SAP Module for Finance			2	
		SAP Module for HR	Payroll Details login to employees.	Payroll details of all employees are in SAP	3	
			Online leave/attendance	Employees attendance management system is through SAP		
		SAP for Assets Management	Tagging all equipment with IDs.	All Discom Assets are maintained in SAP	5	

APPENDIX C:

Questionnaire for Adoption & Diffusion of GIS among Workforce in Power Distribution Companies

Name:

Dept.:

Designation:

Name of the Company:

Adoption & Diffusion of GIS among Workforce in Power Distribution Companies							
There are no right or wrong answers to the questions. Please circle the most suitable choice for you. 1=Totally disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Totally agree							
Constructs		**Indicators**	Totally Disagree	Disagree	Neutral	Agree	Totally Agree
1	PU	Perceived Usefulness: This part of the scale is prepared to determine your level of perceived usefulness on GIS applications					
1.1	PU1	GIS provides me better picture of my queries	1	2	3	4	5
1.2	PU2	GIS Increase visualization of and extent of the problem.	1	2	3	4	5
1.3	PU3	GIS is good feedback system to confirm reports.	1	2	3	4	5
1.4	PU4	GIS improves in my decision making.	1	2	3	4	5
1.5	PU5	GIS is overall useful in my day to day work	1	2	3	4	5
2	EU	Perceived Ease of Use Adopted from Davis (1989); Davis et al. (1989); Moore and Benbasat, (1991)					

2.1	EU1	My interaction with the GIS technologies is clear and understandable.	1	2	3	4	5
2.1	EU2	Lot of expertise is not required for using GIS	1	2	3	4	5
2.1	EU3	Intellectual Efforts are not required for utilization of GIS in work	1	2	3	4	5
2.1	EU4	It is simple and easy to operate GIS	1	2	3	4	5
2.1	EU5	GIS System has got various options for easy operability	1	2	3	4	5
3	DC	Discom Organization Culture (developed by Researcher)					
3.1	DC1	Within Depts, the environment is good for use of GIS.	1	2	3	4	5
3.2	DC2	Other Depts. personnel often asks for GIS-based reports	1	2	3	4	5
3.3	DC3	Senior Officers encourages use of GIS.	1	2	3	4	5
3.4	DC4	Workforce think GIS as reliable decision support system	1	2	3	4	5
4	EG	Efficiency gain Adopted from Davis (1989); Davis et al. (1989); Moore and Benbasat, (1991)					
4.1	EG1	Using GIS has reduced my field visit to large extent	1	2	3	4	5
4.2	EG2	Using GIS system has saved my time to a great extent.	1	2	3	4	5
4.3	EG3	GIS has provided a single platform for field staff & supervisors to view the problem.	1	2	3	4	5
4.4	EG4	GIS has helped in providing better services to customers	1	2	3	4	5
4.5	EG5	GIS has reduced fault time and helped in faster fault restoration	1	2	3	4	5

5	AT	Attitude Adopted from Taylor and Todd (1995); Thompson et al. (1991); Venkatesh et al. (2003)					
5.1	AT1	I like working with user-friendly system like GIS	1	2	3	4	5
5.2	AT2	Using GIS system is exciting	1	2	3	4	5
5.3	AT3	GIS system makes work more attention-grabbing.	1	2	3	4	5
5.4	AT4	Working with the GIS system is enjoyable.	1	2	3	4	5
5.5	AT5	GIS system can be used in policy decisions.	1	2	3	4	5
6	INT	Intention Adopted from Venkatesh & Davis (1996); Venkatesh & Davis (2000); Agarwal& Prasad (1997)					
6.1	INT1	Given that I have access to the GIS, I intend to use it in my job	1	2	3	4	5
6.2	INT2	I often use GIS in my job	1	2	3	4	5
6.3	INT3	Often I try to explore different thoughts using GIS & technical skills	1	2	3	4	5
6.4	INT4	In my spare time, I try doing new things using GIS	1	2	3	4	5
6.5	INT5	I often contact GIS staff for technical support.	1	2	3	4	5
7	PE	Discom Process Engineering (Developed by Researcher)					
7.1	PE1	GIS Based drawings proposal submission done in Discom	1	2	3	4	5
7.2	PE2	Business Process like TF linked with GIS	1	2	3	4	5
7.3	PE3	GIS drawings Mandatory for all finance clearances	1	2	3	4	5
7.4	PE4	Discom DPR Submission to Govt with GIS Drawings	1	2	3	4	5
8	MS	Top Management Support & Govt Initiatives (Developed by Researcher)					
8.1	MS1	Regular training to Depts Bottom Line Users	1	2	3	4	5

8.2	MS2	Discom Top Managements supports the usage of GIS	1	2	3	4	5
8.3	MS3	Mid-level Managers percolates down the GIS initiatives to the system	1	2	3	4	5
8.4	MS4	GIS as a part of Government Regulator Audits	1	2	3	4	5
8.5	MS5	Govt schemes and initiatives to encourage GIS technologies	1	2	3	4	5

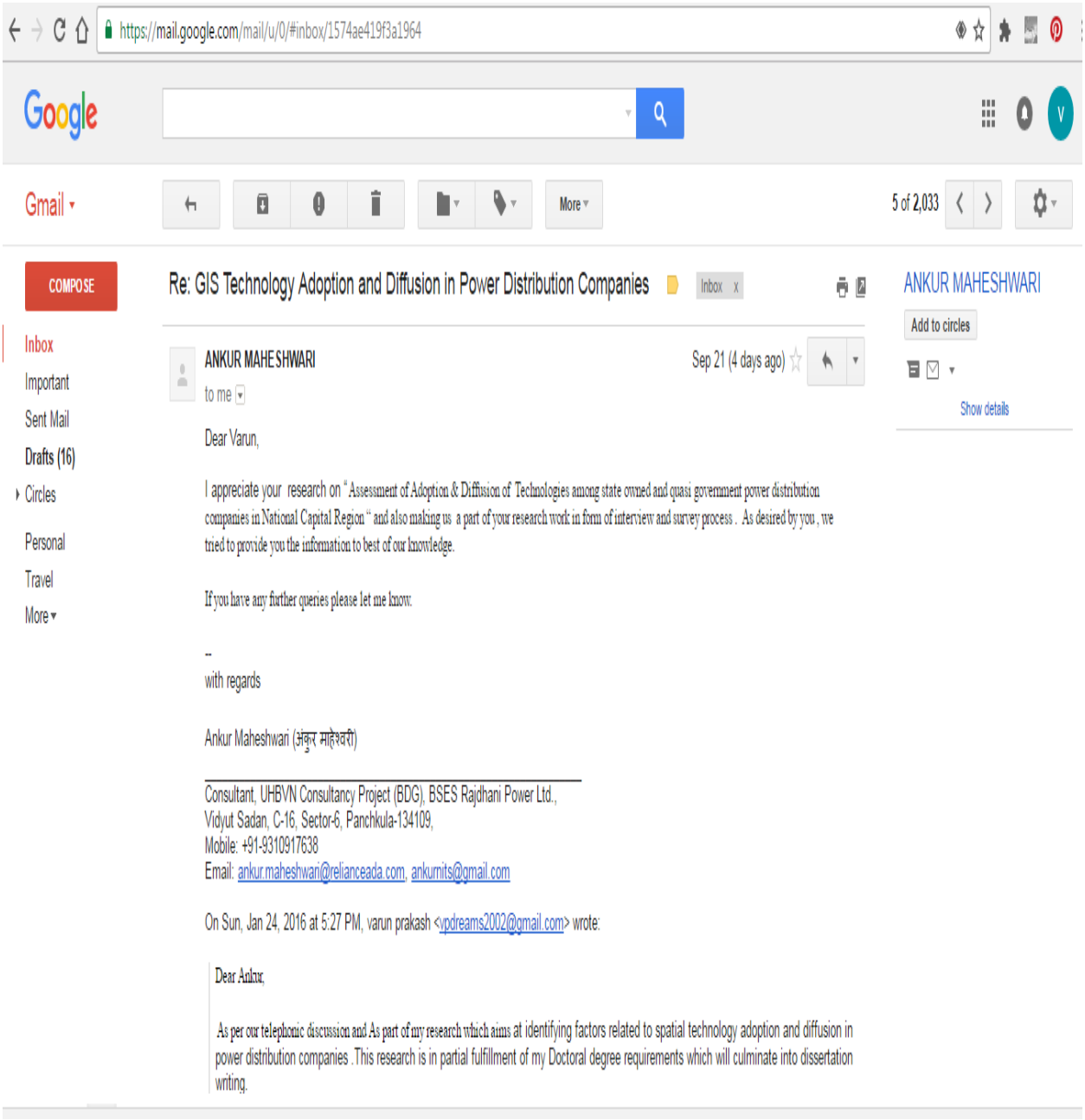
APPENDIX D:

Time Plan for Data Collection

SL No	ACTIVITY	Time Line (From)	Time Line (To)
	Phase 1: Survey & Data Collection for Quasi Government Power Distribution Companies		
1	Communication with the University Research Dean concerning study, purpose, and duration; and participants' solicitation.	April -15	Jul-15
2	Identification of participants by name and department.	Jul-15	Aug-15
3	Handover of a survey instrument to participants and convenience them for submission within stipulated time period.	Aug-15	Sep-15
4	While Collecting filled survey instruments from participants conducting a brief interview	Sep-15	Nov-15
	Phase 2: Survey & Data Collection for Government Power Distribution Companies		
1	Identification of Interview participants	Nov-15	Dec-15
2	Identification of prospective person for interview	Dec-15	Jan-16
3	Preparation of possible interview questions	Jan-16	Feb-16
4	Email & Phone call to prospective officials for interview dates and time		Feb-16
5	Conducting Interviews		Mar-16
7	Thanks, Mail to all officials participated in interview		

APPENDIX E:

Mails for Data Collection with Discoms officials



https://mail.google.com/mail/u/0/#inbox/1574ae419f3a1964

Google

Gmail

More

5 of 2,033

COMPOSE

Inbox

Important

Sent Mail

Drafts (16)

Circles

Personal

Travel

More

Re: GIS Technology Adoption and Diffusion in Power Distribution Companies Inbox x

ANKUR MAHESHWARI

Sep 21 (4 days ago)

to me

Dear Varun,

I appreciate your research on "Assessment of Adoption & Diffusion of Technologies among state owned and quasi government power distribution companies in National Capital Region " and also making us a part of your research work in form of interview and survey process . As desired by you , we tried to provide you the information to best of our knowledge.

If you have any further queries please let me know.

--
with regards

Ankur Maheshwari (अंकुर माहेश्वरी)

Consultant, UHBVN Consultancy Project (BDG), BSES Rajdhani Power Ltd.,
Vidyut Sadan, C-16, Sector-6, Panchkula-134109,
Mobile: +91-9310917638
Email: ankur.maheshwari@relianceada.com, ankurnits@gmail.com

On Sun, Jan 24, 2016 at 5:27 PM, varun prakash <vpdreams2002@gmail.com> wrote:

Dear Ankur,

As per our telephonic discussion and As part of my research which aims at identifying factors related to spatial technology adoption and diffusion in power distribution companies .This research is in partial fulfillment of my Doctoral degree requirements which will culminate into dissertation writing.

ANKUR MAHESHWARI

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