

# Application of Diffusion of Innovation theory to understand the factors impacting Discoms staff acceptance and use of Geospatial Technology innovations: a Case Study of Public Private Partnership Discom in Delhi

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**Abstract**-The main rationale of the research was to discover the how employees of quasi government power distribution companies were utilizing geospatial technologies in their organization and various factors that was associated with level of utilization:

- Determine level of accessibility to geospatial technologies
- .Determine current utilization of technology by staff in the organization.
- Identify factors that facilitated or hindered the GIS current technology adoption and diffusion level.

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

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

**Keywords:** Geospatial, Power, Diffusion

## 1. INTRODUCTION

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

### Research Model and Definition of Hypothesis

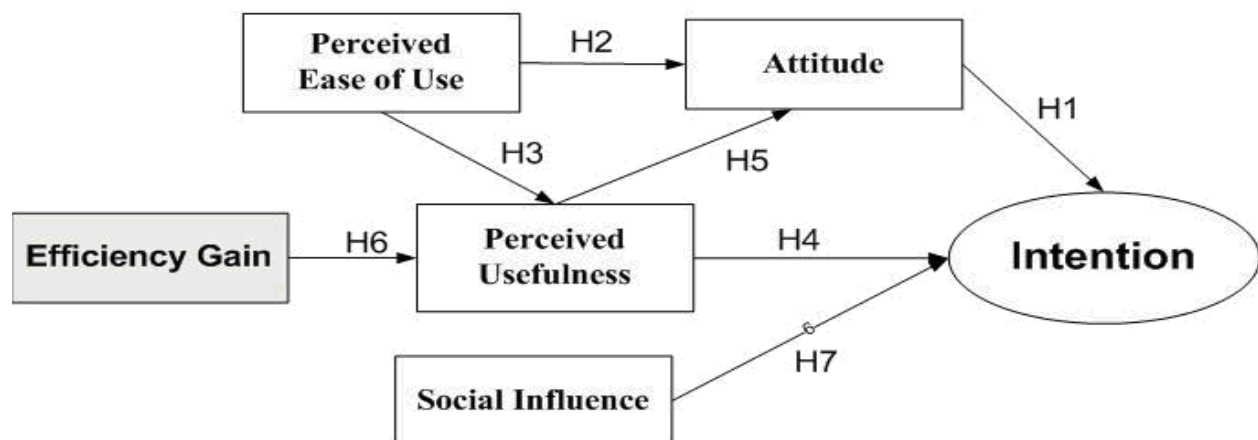


Fig. 1.1 Conceptual Research Model (Source: Cakar B. (2011))

## RESEARCH MODEL

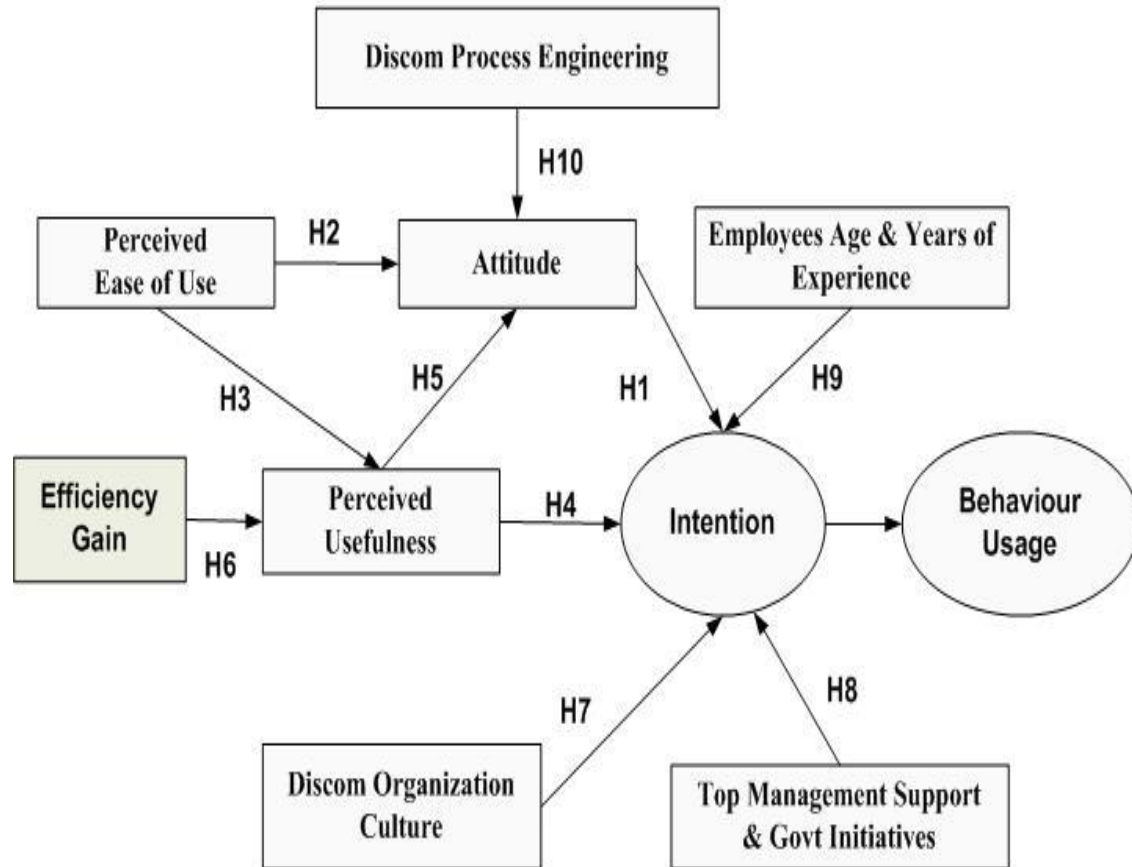


Fig. 1.2 Research Model developed by the Research Scholar

H1: Discoms Staff attitude towards the GIS technologies has a positive influence on his/her intention to use the system.

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

H3: Perceived Ease of Use(EA) has a positive influence on PU of Discoms Staff using the GIS technologies.

H4: Perceived Usefulness (U) has a positive influence on Intention of Discoms Staff using the GIS technologies.

H5: Perceived Usefulness (U) PU has a positive influence on Attitude of Discoms Staff using the GIS technologies.

H6: Efficiency Gain (EG) has a positive influence on the Perceived Usefulness (U) of Discoms Staff using the GIS technologies.

## 2. SURVEY CONSTRUCTION & DATA COLLECTION

A survey instrument was constructed to derive data for this research. The survey questions were designed to elicit data aimed at answering the research questions. All variables, such as perceived usefulness and perceived ease of use, were assessed via a survey in 5-point Likert scaling design (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree). The survey instrument measured variables of gender, age, rank, educational level, service year, and associated city.

Table-1.1 Research Constructs &amp; Indicators

S. No.	Constructs	Indicators
1	PU	Perceived Usefulness: This part of the scale is prepared to determine your level of
1.1	PU1	GIS provides me better picture of my queries
1.2	PU2	GIS Increase visualization of and extend 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 daya to day work
2	EU	Perceived Ease of Use Adopted from Davis (1989); Davis et al. (1989); Moore and
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 esay 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 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 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,
4.1	EG1	Using GIS has reduced my field visit to large extend
4.2	EG2	Using GIS system has saved my time to great extend.
4.3	EG3	GIS has provided single platform for field staff & supervisors to view 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
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);
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 contacts 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
8.1	MS1	Regular training to Depts Bottom Line Users
8.2	MS2	Discom Top Managements supports the usage 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

In this research survey as well interview method was used to collected information mainly keeping in view key indicators mentioned. The survey through email as well hard copy print out was used to collect information from the power Discoms. But during the research many times the employees from government power distribution companies

do not used respond through survey forms and hard copy survey sheets , then interview many times structured as well as unstructured was used to gather information about these government Discoms .

### 3. DATA ANALYSIS

The data was collected through survey and interview method. In order to analyze the data derived from the survey instrument, structural equation modeling (SEM), a multivariate statistical technique was used to analyze the quantitative data via AMOS .

Structural equation modeling (SEM) is a vast field and widely used by many applied researchers in the social and behavioral sciences. Over the years, many software packages for structural equation modeling have been developed, both free and commercial. However, perhaps the best state-of-the-art software packages in this field are still closed-source and/or commercial.

Confirmatory factor analysis (CFA), articulated as a kind of measurement model, provides a construct validity test for the scales (Harrington, 2009; Streiner, 2006). Construct validity is an examination of how constructs are related to each other. A construct is an unobserved latent factor whose usefulness has been empirically supported (Harrington, 2009). The use of CFA is “to identify latent factors that account for the variation and co variation among set of indicators” (Brown, 2006, p. 40). CFA is “a stand- alone analysis or a component or preliminary step of SEM analysis” (Harrington, 2009, p. 12)

#### 3.1 Criteria for the Statistical Analysis

Level of significance: The significance level is used for rejecting the hypothesis in hypothesis testing. The customary chosen significance of level is 0.05 or 5% ( $p < 0.05$ ) in this study. It means that "we are about 95% confident that we have made the right decision" (Spiegel & Stephens, 2008, p. 246).

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

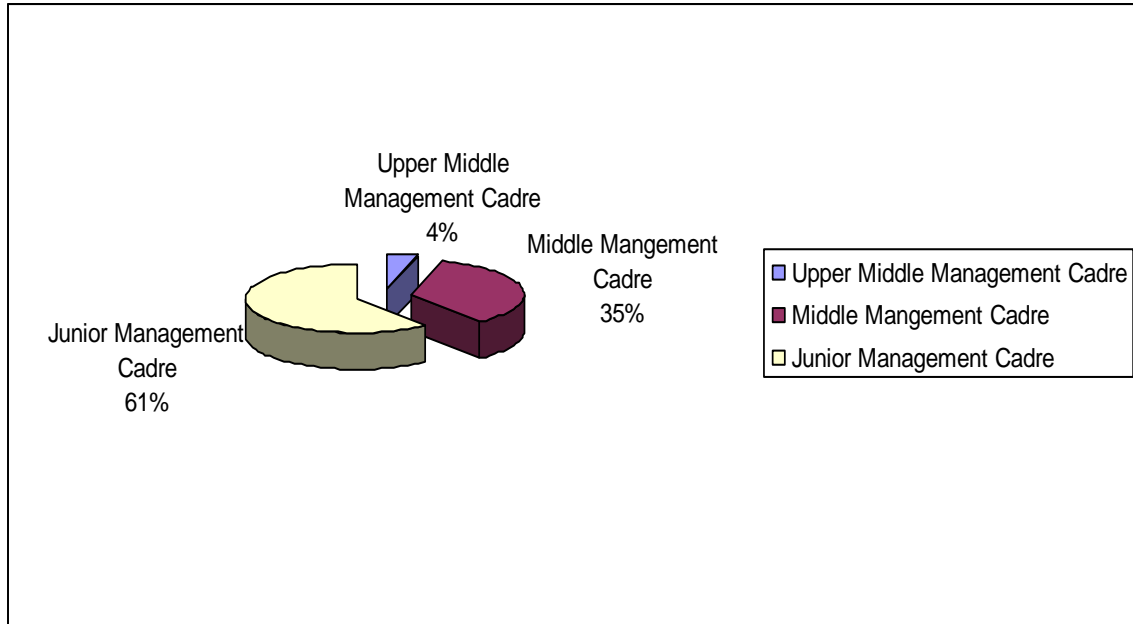
The study was conducted among the employees of Discoms, a total of 226 surveys were distributed to the employees, out of which 216 responded to the questionnaire fourteen respondents were not used because their surveys were missing more than 30% of the responses. After this elimination, the remaining 204 respondents were handled using the data imputation method, which replaced the missing values with the series mean without losing any cases.

**Table- 3.1 Demographic Surveyed Data**

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

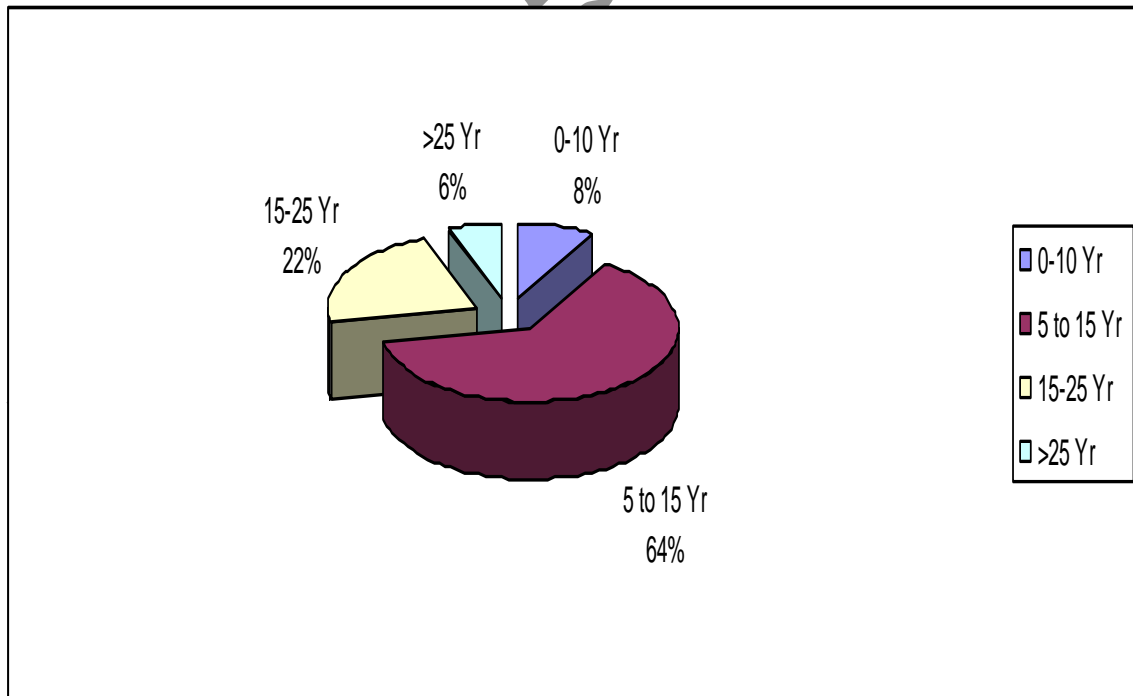
Majority of the officials ie; 61% who were part of the research work were from junior management cadre .It is the junior management cadre who actually uses the technology for their work and bring use of geospatial technology

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



**Fig. 3.1 Distribution of Discom Officials Who Took Part in Research With Respect to Management Cadre for Delhi Discom**

64 % of the work force 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 of work experience 0-5 years.



**Fig. 3.2 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 majority of them having technical qualification. Only 6% of the staff who were post graduates were part of the research, while 18% of the staff were either diploma holder or ITI by qualification.

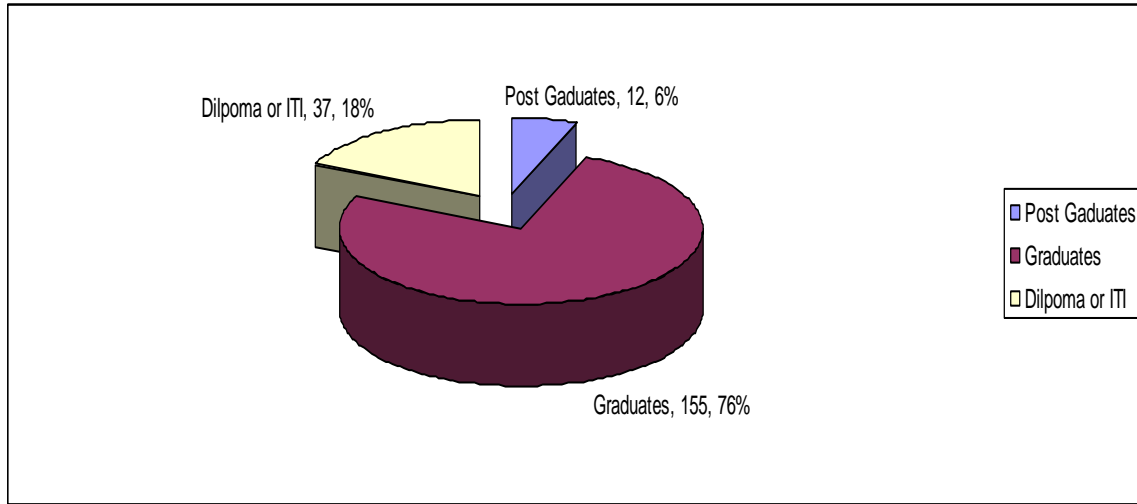


Fig. 3.3 Distribution of Respondents With Respect to Number of Years of Experience ( Delhi Discom)

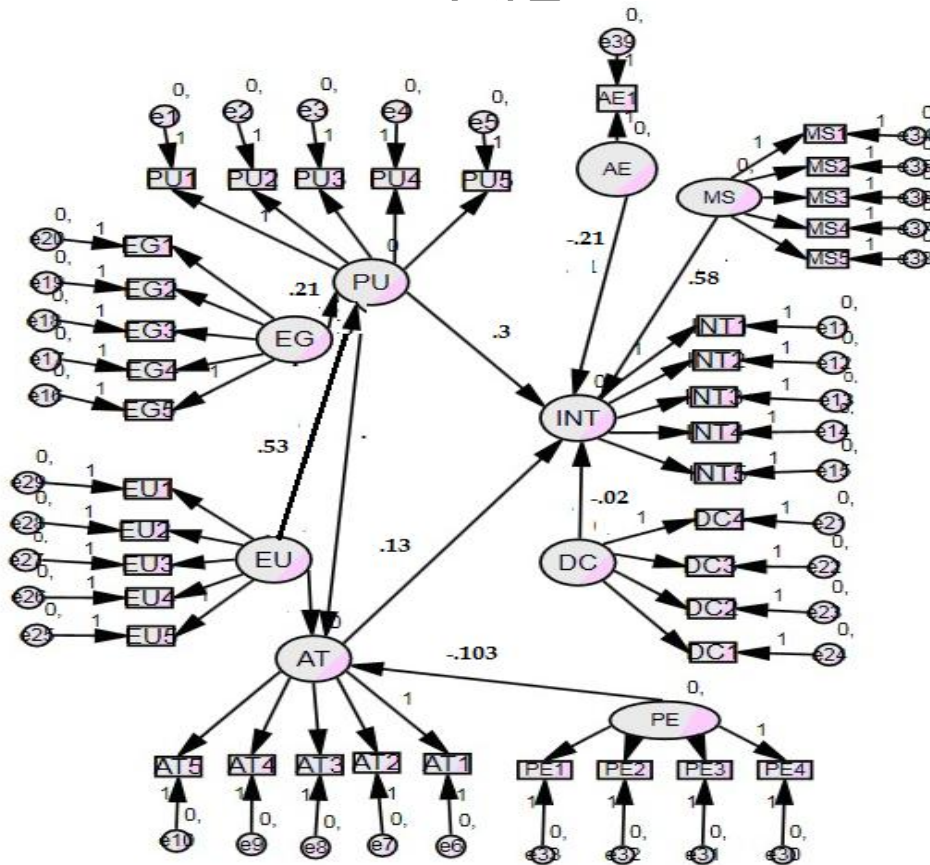


Fig. 3.4 AMOS Research Model For SEM Analysis for Delhi Discoms

#### 4. HYPOTHESIS TESTING RESULTS

**H1:** Discoms Staff's attitude (AT) of using the GIS technologies has a positive effect on his/her intention (INT) to make use of technologies for his work.

The SEM analysis exhibits positive relationship between attitude of Discoms Staff towards the GIS technologies and intentions of involving GIS in his work wherever required. This positive correlation suggests that one standard unit increase in attitude of Discom staff results in a 13% increase in intention. So, the attitude of the Discoms Staff for using GIS system is positive.

**H 2:** Perceived Ease of Use (EU) has a positive influence on attitude(AT) of Discoms Staff

The second hypothesis was supported. The finding ( $\beta = -.11$ ) indicates a negative correlation between perceived ease of use and attitude of Discom staff using the GIS technologies. This negative effect means that one standard unit increase in perceived ease of use results in a 11% decrease in attitude of Discoms staff.

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

**H 3:** Perceived Ease of Use(EU) has a positive effect on perceived Usefulness (PU) of Discoms Staff for adoption of GIS Technology

The analysis that the third hypothesis was supported. The finding ( $\beta = .53$ ) indicates that there is a positive relationship between perceived ease of use and perceived usefulness of Discoms Staff for adoption of GIS technology. This suggests that one standard unit increase in perceived ease of use results in a 51% increase in perceived usefulness of Discoms staff.

Thus, ease of use of GIS technology also increases the usefulness of the GIS technology in the power utility.

**H4:** Perceived Usefulness (PU) has a positive influence on Intention (INT) of Discoms Staff for adoption of Geospatial technology

The finding ( $\beta = .38$ ) showed that hypothesis was supported and indicates that there is a strong positive relationship between perceived ease of use and perceived usefulness of Discoms Staff using the GIS technologies. This positive correlation suggests that one standard unit increase in perceived usefulness results in a 38% increase in intention of Discoms staff. Usefulness of GIS technology creates positive effect and impact on intention of the Discoms staff.

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

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

**H6:** Efficiency Gain (EG) has a positive influence on the Perceived Usefulness (PU) of Discoms Staff for adoption of Geospatial technologies.

The analysis outputs clearly exhibits that efficiency gain has positive impact on the usefulness of the system. This can very well understood by the fact that one standard increase in EG results in 21% increase in perceived usefulness..

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

The results showed that social norms has negative impact on the intentions of the Discoms staff in adoption and use of the GIS technologies for their work.. This positive effect shows that one standard unit increase in social influence results in a 2% increase in intention of Discoms staff.

**H8:** Top Management Support & Govt Initiatives (MS) has a positive influence on Intention (INT) of Discom staff using the GIS technologies

The hypothesis was supported as top management support and government initiatives have positive relationship with Intention of the Discom staff to make use of GIS technology. This clearly indicates that government is very much concerned for 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 various process of the Discoms. In fact 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 a positive influence on Intention (INT) of Discom staff using the GIS technologies

The hypothesis was not supported as based on both regression analysis and SEM Model.

The results shows that there is a negative 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 explains the hypothesis results.

**Table-4.1 Model Summary<sup>b</sup>**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.024 <sup>a</sup>	.001	-.004	.811

a. Predictors: (Constant), AE1

b. Dependent Variable: INT1

**Table-4.2 ANOVA<sup>a</sup>**

Model	Sum of Squares	df	Mean Square	F	Sig.	
1	<b>Regression</b>	.079	1	.079	.120	.729 <sup>b</sup>
	<b>Residual</b>	132.877	202	.658		
	<b>Total</b>	132.956	203			

a. Dependent Variable: INT1

b. Predictors: (Constant), AE1

**Table-4.3 Coefficients<sup>a</sup>**

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

a. Dependent Variable: INT1

Table 4.3 Regression analysis performed through SPSS between Years of Experience and Intention of the Discom Staff.

The negative relation indicates that with the increase in age and experience of the Discom staff the intention to use the technologies decreases. This probably might be due to factor that most of the staff with more age thinks that their job or position in which they are right now will be in danger.

**H10:** Discom Process Engineering(PE) has a positive influence on Attitude(AT) of Discom staff using the GIS technologies

The tenth hypothesis is not supported. The results indicates that there is negative relationship between Discom process engineering and attitude of the Discom staff. The negative relation suggest when GIS has been infused in various business and operational process of the Discoms and the attitude was negative 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 positive impact on attitude.

**Table-4.4 Model Summary<sup>b</sup>**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.076 <sup>a</sup>	.006	-.014	6.939

a. Predictors: (Constant), PE4, PE2, PE3, PE1

b. Dependent Variable: AT1

**Table-4.5 ANOVA<sup>a</sup>**

Model	Sum of Squares	df	Mean Square	F	Sig.	
1	<b>Regression</b>	55.426	4	13.857	.288	.886 <sup>b</sup>
	<b>Residual</b>	9581.647	199	48.149		
	<b>Total</b>	9637.074	203			

a. Dependent Variable: AT1

b. Predictors: (Constant), PE4, PE2, PE3, PE1



Table-4.6 Coefficients<sup>a</sup>

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.803	12.420		.467	.641
	PE1	-.509	1.310	-.029	-.388	.698
	PE2	-.615	2.086	-.022	-.295	.769
	PE3	.856	1.206	.053	.710	.479
	PE4	.001	1.188	.000	.001	.999

a. Dependent Variable: AT1

Table-4.6 Regression analysis performed through SPSS between Process Engineering and Attitude of the Discom Staff.

## 5. 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.

Table-5.1 Hypothesis Testing Results( Delhi Discom)

S. No	HYPOTHESIS	RESULTS
H1	Discoms Staff attitude(AT) towards the GIS technologies has a negative influence on his/her intention(INT) to use the system.	Not SUPPORTED ( $\beta = .13$ ),
H2	Perceived Ease of Use (EU) has a positive influence on attitude(AT) of Discoms Staff using the GIS technologies.	SUPPORTED ( $\beta = -1.1$ ),
H3	Perceived Ease of Use (EU) has a positive influence on Perceived Usefulness (PU) of Discoms Staff using the GIS technologies.	SUPPORTED ( $\beta = .53$ ),
H4	Perceived Usefulness (PU) has a positive influence on Intention(INT) of Discoms Staff using the GIS technologies.	SUPPORTED ( $\beta = .3$ ),
H5	Perceived Usefulness (PU) has a positive influence on Attitude(AT) of Discoms Staff using the GIS technologies.	SUPPORTED ( $\beta = .47$ ),
H6	Efficiency gain(EG) has a positive influence on the Perceived Usefulness(PU) of Discoms Staff using the GIS technologies.	SUPPORTED ( $\beta = .21$ ),
H7:	Discom Organization Culture (DC) has a positive influence on Intention(INT) of Discom staff using the GIS technologies	SUPPORTED ( $\beta = -.02$ ),
H8	Top Management Support & Govt Initiatives(MS) has a positive influence on Intention(INT) of Discom staff using the GIS technologies	SUPPORTED ( $\beta = .58$ ),
H9	Employees Age & Years of Experience(AE) has a positive influence on Intention(INT) of Discom staff using the GIS technologies	Not SUPPORTED ( $\beta = -.21$ ),
H10	Discom Process Engineering(PE) has a positive influence on Attitude(AT) of Discom staff using the GIS technologies	SUPPORTED ( $\beta = -.103$ ),

## CONCLUSION

The ease of use has negative influence on attitude and also attitude has negative influence on intentions. This means that 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 although GIS technology may not be very easy to use, but the employees know 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. Technology may not be very easy to use to Discoms staffs are very much concerned about the usefulness of the technology and how geospatial technology can help in their day to day work and make their work easier. Discom internal teams demonstrate the user group usefulness of the geospatial technology and how their present process can be improved using GIS. Since the majority of the Discoms staff comprises of employees inherited from parent SEB(State Electricity Board) whose average age group are mainly above 50 are very much concerned about usefulness of the technology and ease of use of technology. The study clearly suggests a strong positive relationship between ease of use of technology and usefulness. If the use of technology is easy and handy, with user friendly interface the user take lot of interest and has positive influence on attitude of the user referred here as Discom staff. Lots of training programs are organized for the staff to percolate the ease of use of geospatial technologies and made them friendly with GIS system. The training programs highlights easy reports and information which are required for which they have run post and pillars can be accessed using GIS system without much difficulty. Thus ease of use is one of the important factors for acceptance of the technology in Power Discoms. Social Influence refers to working environment within the organization which are in favor or against the use of GIS technologies. Social Influence is one of the important factors determining the use of technology for technology implementation to be successful social acceptance among seniors as well among the middle management is mandatory. The results suggest that the top managers and middle managers consistently support and encourage use of technology; it has strong influence on acceptance and adoption of geospatial technology in power distribution. The study suggests top managers after rigorous study and recommendation from middle managers have re-engineered many processes and have made many internal processes and approvals GIS based. This binds the user from using GIS and user who was initially reluctant to use now after initial pressure to use GIS, later reaps the benefits of the technology in their process. This is also very evident from the study which shows strong positive relationship between social influence and intention to use geospatial technology.

## REFERENCES

- [1] Johnson, C. (2000). Crime mapping and analysis using GIS. Paper presented at the conference on Geomatics in Electronic Governance. Retrieved April 25, 2011, from <http://www.cdac.in/html/pdf/geom4.pdf>.
- [2] Karahanna, E., Straub, D. W., & Chervany, N. L. (1999). Information technology adoption across time: A cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS Quarterly* 23(2), 183-213.
- [3] Katz, E., Levin M. L., & Hamilton, H. (1963). Traditions of research on the diffusion of innovation. *American Sociological Review* 28(2), 237-252.
- [4] Kline, R. B. (1998). Principles and practice of structural equation modeling. New York, NY: Guilford Press.
- [5] Legris, P., Ingham, J., Collette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & Management*, 40(3), 191-204.
- [6] Rogers, E. M. (1983). Diffusion of innovations (3rd ed.). New York, NY: The Free Press.
- [7] Rogers, E.M. (2003). Diffusion of innovations (5th ed.). New York, NY: The Free Press.
- [8] Sahin, I. (2006). Detailed review of Rogers' diffusion of innovations theory and educational technology-related studies based on Rogers' theory. *Turkish Online Journal of Educational Technology (TOJET)*, 5(2), 14-23.
- [9] Santos, J. R. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. Retrieved February 16, 2011, from <http://www.joe.org/joe/1999april/tt3.html>.
- [10] Smelcer, J. B., & Carmel, E. (1997). The effectiveness of different representations for managerial problem solving: Comparing tables and maps. *Decision Sciences*, 28(2), 391-420.
- [11] Speier, C. (2006). The influence of information presentation formats on complex task decision-making performance. *International Journal of Human-Computer Studies*, 64(11), 1115-1131.
- [12] Spiegel, M. R., & Stephens, L. J. (2008). Schaum's outline of theory and problems of statistics (4th ed.). New York, NY: McGraw-Hill.
- [13] Sun, H., & Zhang, P. (2004). A methodological analysis of user technology acceptance. Proceedings of the 37th Hawaii International Conference on System Sciences.
- [14] Bakar, B. (2011). Factors affecting police Officer's acceptance of GIS technologies: A Study of the Turkish National Police University of North Texas. Retrieved from <http://digital.library.unt.edu/ark:/67531/metadc84182>.