CHAPTER 5
RESEARCH METHODOLOGY

This chapter will discuss the methodology used in this study for testing the proposed hypotheses through quantitative methods. Section 5.1 will discuss in brief the research design and sampling technique; section 5.2 will discuss operationalizations of the constructs. Research Model for testing is shown in Section 5.3. Section 5.4 will discuss the pre test and pilot test, followed by Measures taken for CMV and non response biases in section 5.5 and finally data collection and PLS SEM analysis plan will be discussed in section 5.6 and 5.7 respectively.

5.1 Research Design and Sampling Technique

We have adopted a quantitative research design as the second and dominant phase of our study, aiming to generalize the result of our study. Our objective is to find the factors responsible for acceptance of TEL among technical students in India. In the previous chapter we proposed an integrative model for TEL acceptance taking guidance from extant theories in literature and from the findings of exploratory study. We have proposed fourteen hypotheses involving relationships between various independent variables and dependent variable. We would like to test (non-experimental) these hypotheses statistically to see if these are supported. Data collection will be through survey questionnaire administered at one point of time (i.e. cross-sectional) to the participants.

Since, the objective of the present study is to find the factors of TEL acceptance among technical students in India; the participants for this study are students registered in undergraduate, master and doctoral degree programs in technical institutes in India. Some key characteristic of the population which are called ‘sample frame’ are desired to be present in the participants such as they should be full time students, residing in the campus of the
institute and preferably be in second year and above in their course (for undergraduates only) and should have gained a certain amount of experience by learning at least one subject using TEL courses/resources.

Survey technique will be used for selecting the sample (a smaller number of respondents from the target population) which employs structured questions for measuring people’s beliefs, attitudes and behaviour. The reason for using a sample in a study is to make inference about the population (from a smaller sample of population only), which reduces cost, time and effort (required to study the whole target population). We will employ non-probability sampling and the respondents will be selected through purposive sampling with ‘Criterion Sampling’ strategy suggested by (Palys, 2008) which involves searching for cases meeting certain criteria like: fulltime technical students, campus based with some TEL experience and from good engineering colleges in India.

The sample will be obtained by contacting technical students over their emails, Google groups, direct meeting and through their teachers (contacted by emails, phone and personal visits to institutes). Both ‘pen and paper’ and web based questionnaire will be prepared for use as per convenience with a motive to get maximum possible responses in lesser time. For our study internet/web based survey can be very useful (apart from pen and paper form) because of the assumed efficacy of technical students with internet, availability of Internet in most campuses of the institutes and time flexibility.

As a large sample size provides higher power in result, so we plan for a larger sample size for our study. As per Hinkin (1995), sample size should be in the range of 4 to 10 times of total numbers of items used in survey instrument. PLS path model estimation should at least meet the 10 times rule (Barclay, Higgins, & Thompson, 1995), which indicates the sample size should be equal to the larger of

1. 10 times the largest numbers of formative indicators used to measure a single construct, or
2. 10 times the largest number of structural paths directed at a particular construct in the structural model.

It means that if maximum number of indicators of the formative latent variable is ten in the research model (and if, it is larger than the number of structural paths directed at any construct in the model), then according to the 10 times rule, $10 \times 10 = 100$ represents the minimum number of observations needed to estimate the PLS path model.

5.2 Operationalizations of Constructs

**Subjective measurement.** Davis (1989) said that a construct of belief (like Perceived Usefulness) is to be measured as individuals’ subjective perceptual evaluation, rather than an objective actual assessment. Our study also has beliefs based constructs hence self reported, perception based measures also called as subjective measures are used for data collection. This approach is prevalent in extant IS literature for measuring similar perceptions and beliefs based constructs.

For measuring the constructs in the research model, we reviewed scales of measurement of similar constructs in literature. The measurement for most of the constructs in our study was adopted from the well established instrument (for measuring similar constructs) in extant literature. To suit the context of the study, slight rephrasing of items was carried out. Measure of TEL self efficacy was not found and was developed for this study by adapting from General computer self efficacy and Internet self efficacy scales by Marakas, Johnson and Clay (2007) and by adding few items. The details of development of TEL self efficacy scale is provided in Appendix E. We ensured that the definitions of the constructs are clear and suiting the context of our research problem. We reviewed and collected 2-3 similar scales (Appendix ‘F’ refers to alternate scales reviewed). After finalization of the best suited scale in our context, we got validated the scale items measuring the constructs by IS academicians and research scholars, and few changes as per suggestions, were made in the
texts for clarity and to suit the context of the study. For example, the first item of ‘Information quality’ was reworded as “Overall, I would give high marks to the quality of the information from TEL” from its original form “Overall, I would give the information from __high marks”. The chosen scales of research variables (all have multi-item scales) are given in following texts:

**Relative Advantage (RA)**

Definition: Degree to which students think that using TEL for study will be better than study using textbooks. The basis for comparison by students are: time and effort saving in information seeking and learning, better learning outcome, better learning performance, cost efficiency, increased productivity and cognitive ease in learning.

Scale is adopted from Ahn, Ryu and Han (2007) with seven items and was measured on a seven point scale where 1= strongly disagree and 7 = strongly agree.

Relative Advantage Scale (Reflective Measurement):

“RA1. Using TEL enables me to accomplish study tasks more quickly

RA2. Using TEL helps me to get better understanding of subjects

RA3. Using TEL improves my performance in my course

RA4. Using TEL saves me money

RA5. Using TEL increases my study tasks productivity

RA6. Using TEL improves my study tasks quality

RA7. Using TEL makes my study tasks easier”.

**Compatibility (Comp)**

Definition: The degree to which engaging in a course related study using TEL is perceived as being consistent with the students' existing values, beliefs, past information behavior
experiences and with their current information needs (i.e. TEL resources consistent with course syllabi).

Measure of Compatibility is adapted from the scale developed by Wu and Wang (2005) and Cho (2006). All the responses are measured on a 7 point scale from - (1) strongly disagree to (7) strongly agree.

Compatibility Scale items (Reflective Measurement) are:

“C1. Using TEL is compatible with most aspects of my course related study.
C2. Using TEL fits my course related study style.
C3. Using TEL fits well with the way I like to engage in my course related study.
C4. TEL Websites are suitable for searching for educational resources consistent with course syllabi”.

Subjective Norm (SN)

Definition:” Degree to which a student believes that people who are important to her/him think she/he should study using TEL”.

Students are likely to be influenced by what peer students and teachers think about usage of TEL. The two items scale was adopted from Venkatesh and Morris (2000) and scored on a seven point format ranging from strongly disagree to strongly agree.

Subjective Norm Scale Items (Reflective Measurement):

“SN1. People who influence my study behavior think that I should use TEL.
SN2. People who is important to me thinks that I should use TEL for study”.

Intention to use TEL (BI)

Definition: It is the measure of the strength of a student's intention to use TEL for study.

The Intention to use TEL scale items are adopted from Barnes and Vidgen (2012) and the three items were measured on a seven point scale format ranging from strongly disagrees to
strongly agree. (Behavioral Intention (BI) to use TEL and Intention to use TEL are considered same in this study).

Intention to use TEL scale items (Reflective Measurement):

“BI1. I intend to use TEL for study on a regular basis.

BI2. I predict I will continue to use TEL for study on a regular basis.

BI3. I plan to use TEL for study on a regular basis”.

**TEL Self-efficacy (TSE)**

Definition: TSE refers to a Student’s belief in ‘self capability’ to use the TEL systems efficiently for searching ‘course related’ needed information on the Internet, obtaining good quality relevant information content from the Net and studying using these TEL resources to attain the learning goal. It also includes student’s general computer self efficacy beliefs.

On reviewing literature for a suitable scale to measure TSE, none of the existing scale fitted the context. Five technical students were approached to identify the activities involved in TEL study. After discussions with them a list of 12 items was prepared. The nearest scales for Internet Computer Self Efficacy and General Computer Self-Efficacy scales by Marakas, Johnson and Clay (2007) were found partially covering the identified items. Total six items (three from each scale) were adapted from Marakas, Johnson and Clay (2007) and four new items (items nos. TSE1, TSE5, TSE6, TSE8) were added to cover the rest of the tasks. Scale development procedure is enclosed in Appendix E. Similar to the extant literature in IS, it was scored on a ten point score format ranging from “not at all confident to totally confident”.

TSE Scale Items (Formative Measurement):

“TSE1. I believe I have the ability to search relevant educational resources on the Internet for my study."
TSE2. I believe I have the ability to download relevant information from the Internet to my computer for further use.

TSE3. I believe I have the ability to install the software tools on my computer for displaying / playing the downloaded educational resources from the internet.

TSE4. I believe I have the ability to subscribe/register to different websites/ institutions / 'special interest groups' offering open educational resources and courses.

TSE5. I believe I have the ability to study comfortably from educational resources in digital/multimedia format.

TSE6. I believe I have the ability to clarify my doubts by communicating with online groups/forum.

TSE7. I believe I have the ability to post my comments, completed assignments and quizzes online.

TSE8. I believe I have the ability to learn effectively from online resources.

TSE9. I believe I have the ability to operate my personal computing devices and configure these for Internet connection.

TSE10. I believe I have the ability to identify and correct common operational problems with a computing device”.

**Prestige of Source Institution (P)**

Definition: A student’s beliefs about how society/academia view the source Institution is referred here as the prestige of source Institution. This is used for making judgment and decision on the authority of the contents while searching TEL resources for study on the web.

The prestige of the source Institution indicates the authority of TEL contents, determines how credible the students view the information content of the TEL resources. Rankings and ratings generated by third parties or agencies for the source institution are
often used by students to quickly assess the credibility of information content provided by TEL resources, as a thumb rule to filter out many unwanted contents and select few from the a large result set of a search operation for further evaluation and use. Four items scale is adopted from Sung and Yang (2008) and scored” on a 7 point scale ranging from strongly disagree to strongly agree”.

Prestige of Source Institution- Scale Items (Reflective Measurement):

“P1. The TEL source institution is looked upon as a prestigious institution in society overall;
P2. I think my acquaintances think highly of this institution (TEL Content provider);
P3. The TEL source institution successfully retains a prestigious place in various university ranking systems.
P4. Media coverage about this TEL institution is very positive”.

**Information Quality (IQ)**

Definition: It represents the students' overall evaluations of the information quality of TEL. It is based on students’ perception about the accuracy, completeness, currency, interface and instructional design of course content. Three items scale was adopted from Wixom and Todd (2005) and measured on seven point scale ranging from strongly disagree to strongly agree. Students were asked to rate the overall information quality of TEL on the basis of information's completeness, accuracy, currency and instruction design of multimedia content”. IQ scale items (Reflective Measurement):

“IQ1: Overall, I would give high marks to the quality of the information from TEL.
IQ2: Overall, I would give the information provided by TEL a high rating in terms of quality.
IQ3: In general, TEL provides me with high-quality information”.
Resource constraint of Incumbent Behavior (RC)

Resource constraint refers to student’s perceptions that they do not have externally based resources such as money and requisite resources, (e.g. textbooks) to perform their study effectively in traditional way (using textbooks).

(Remarks: Resource constraints can be perceived due to lack of textbooks, supplies in the library, unavailability of textbooks in the market, or because lack of adequate money to purchase costly textbooks). Eight items scale was adapted from Taylor and Todd (1995a) – from the construct ‘Facilitating conditions – Resources’ by following process suggested by the authors.

Scale items for RC(Reflective Measurement):

RC1. There will not be enough copies of reference textbooks for every student to use in the library.

RC2. For me having my own copies of reference textbooks are (unimportant=1
important=7).

RC3. Purchasing reference textbooks will be too expensive.

RC4. For me, being able to get reference textbooks at low price is (unimportant=1
important=7).

RC5. I won't be able to use all reference textbooks when I need these.

RC6. For me, being able to use a reference textbook when I need it is (unimportant=1/
important=7).

RC7. I won't be able to use all reference textbooks when I need these.

RC8. For me, being able to use a reference textbook when I need it is (unimportant=1'/
important=7').
**Interest in Subject (INT)**

Definition: Student's interest in a subject reflects more time on task in the subject, more attention, finding the subject intellectually challenging and has acquired more competency in the subject. Four items scale was adopted from Abrantes, Seabra and Lages (2007) and” measured on a seven point scale (1=strongly disagree / 7=strongly agree)”.

INT scale items (Reflective Measurement):

INT1. You were interested in learning course material for the subject.

INT2. You were generally attentive in class (for the subject).

INT3. You felt the subject challenged you intellectually.

INT4. You have become more competent in this area.

---

**Importance of Subject (IMP)**

Definition: Relative Importance given to a subject by students in a semester due to various reasons like the high credit points associated with the subject or core paper for the course which influences how much attention, time and effort they will invest in the study for this subject. It is measured on a semantic differential (SD) scale; four items scale for measuring Importance was adapted from Barki and Hartwick (1994) and Zaichkowsky (1985) and was measured on seven point SD scale.

IMP Scale items:

IMP1. Credit points wise Insignificant -1 2 3 4 5 6 7 - Credit point wise Significant.

IMP2. Not Important for your course -1 2 3 4 5 6 7 – Important for your course.

IMP3. Are of low priority to you -1 2 3 4 5 6 7 - Are of high priority to you.

IMP4. Not Beneficial to you -1 2 3 4 5 6 7 – Beneficial to you.
**Facilitating conditions (FC)**

Definition: It refers to objective factors, ‘out there’ in the environment, that several judges or observers can agree to make an act easy to do. In the context of our study, the facilitating conditions include hardware, software, Internet, local area network connections, etc., that allow students to access the Internet and Intranet when they want to, as well as the supports provided by the Institute to facilitate the use of the Internet, Intranet and the Web in campus. It is a control variable in our study. Measure adapted from Cheung, Chang and Lai (2000) and was measured on seven point scale where 1= strongly disagree and 7 = strongly agree.

FC1. The Internet/Intranet is available to me in campus when I need it.

FC2. A person or group is available for assistance with Internet/network difficulties.

FC3. TEL resources on my subjects (e.g. video lectures) are available on Intranet Server.

FC4. Overall, the use of Internet/TEL is very supportive (in campus).
5.3 The Research Model
5.4 Pre-test and Pilot study

Survey Instrument. Dillman’s (2000) guiding principles were followed for both online and ‘pen and paper’ based questionnaire development. The online questionnaire was built by using Google Forms and pen and paper version of survey instrument (same questions as online version) was created in Microsoft word (see Appendix G for survey questionnaire). The online Google form was tested with different browsers to avoid any inconsistency and ensure same appearance of the form to participants using different systems and tools. Dillman’s (2000) other guidance as applicable for our study like welcome note, beginning with easy to answer question, the use of a consistent format with limited use of colors in questionnaire design, were followed.

Pre-Test. All the variables and items in the ‘Survey Questionnaire’ were tested for their reliability and validity in our context. The face and content validity was established by rewording and simplifying several items based on the feedback received from four academicians and four research scholars in IS area. To develop an effective scale, it is essential to define the constructs carefully (MacKenzie, 2003). Apart from defining the constructs carefully we also ensured that each of the items were appropriate for measurement scale by adapting items from well established scales from literature and through validation by IS academicians and research scholars in IS areas.

Pilot Study. A pilot study emulates the procedures involved in main study (Dillman, 2000). Pilot test was conducted for checking the validity and reliability of the measurement before going for final data collection which is a very important step. Our sample for pilot study consists of technical students and a convenient sample of trainee IT professionals (freshly graduated students) who were employed with the main intention to check the reliability of constructs used in the research model. The link of survey questionnaire (developed with Google Form) was shared with the respondents. We got 114 valid responses out of 130 individuals contacted. The reliability of the data was analyzed through factor
analysis in SPSS and the measurement model was assessed in SmartPLS 3 software. Analysis result indicated desired outcomes. Some logical error in navigation in online form was found. We interviewed few of the respondents and based on their feedbacks we fixed the navigation of the form. Pilot test was conducted again by including different participants and results were found within acceptable value.

5.5 Measure for Common Method Variance

Method biases are serious problem in survey based study. These biases are generated when responses are obtained from the same source or by the measurement items themselves (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Common method variance arises from using the same method or single source to measure the independent and dependent variables within a relationship (Craighead, Ketchen, Dunn, & Hult, 2011). Following MacKenzie & Podsakoff (2012) and Craighead, Ketchen, Dunn, & Hult (2011) recommendations, both the procedural and statistical remedies were used to reduce or control these common method variance. Procedural remedy was accounted informing respondents that there is no wrong or right answer for the questions, assuring respondents that their responses would be kept anonymous, and their participation is voluntary. An iterative process of reviewing, pilot testing and revising the survey items based on the feedback from a group of academicians, research scholars, and participants was conducted to reduce the potential for context effects (Lindell & Whitney, 2001). A statistical remedy, Harman’s single factor test was also carried out to address common method variance and found that more than one factor was extracted with Eigen value greater than one and one general factor could not account for the majority of the covariance among the variables thus validating that the common method variance is not a concern (Craighead et al., 2011; Podsakoff et al., 2003; Podsakoff & Organ, 1986) for this study.
Steps for checking ‘Non response bias’: precautions were also taken while data collection for non response. In our survey design we have ensured that all questions are answered before the survey response submission (both online and pen and paper version). This controls for the item non response in our case. For survey/unit non response we ensured that survey is sent to a maximum number of students of Engineering Institutes located in diverse regions. Technical Students of more than fifty different Institutes registered for different technical discipline and different courses (undergraduate, post graduate or research level) participated in the survey. We pre inform the students through individual/group emails/messages that a survey will be send to them in near future, following guidelines of Fowler (2002). We also enclosed a small letter with our survey which introduced the survey and discussed the anonymity and confidentiality provided to the respondents and responses and also explains the importance of the survey. Students of different discipline of engineering course and various degree courses like undergraduates (B.Tech), Mater, PG Diploma and research were included in the survey.

5.6 Data Collection

The participants of our study are technical students registered in engineering institutes of repute in India. We used survey method and cross sectional study approach to collect the data from a respondent at one point of time only. Similar approach is used in prior studies in IS area for finding factors of technology acceptance (e.g. Chau ,1996; D’Ambra and Rice, 2001; Igbaria,1994; Liu and Arnett, 2000; Ong, Lai and Wang,2004). We tried to include students from various colleges located in different regions of India. Online link was shared with students and teachers of different colleges. Researcher visited eight colleges personally and administered pen and paper version of survey to students in their classrooms with the help of the teachers of the institutes. Prior Permission for administering the survey was taken and students were informed in advance about the survey. Students volunteered to spend 20
minutes either before or after the class to fill the survey form in presence of researcher, their teacher and/or monitor of the class. Token gift of a pair of Gel pens was distributed to each participant.

All the participants were campus based and registered in various discipline of engineering (like mechanical, electrical, information technology, computer sciences and engineering, civil, chemical, metallurgical, electronics etc.) in various courses like bachelor, master, PGDC or doctoral degree. Students were requested to fill the online form by clicking on the provided link. The online survey was designed using Google forms with all questions marked mandatory for submission of the form to ensure no missing data. For pen and paper version, forms were checked as soon as submitted, for missing entry and requested for completion when missing values were found. The list of Institutes is given in appendix D, whose students participated in the survey.

We collected 578 data points in total. However we employed validation process to identify invalid responses- like responses with all extreme values were discarded and few outliers were also identified and discarded. During and after data entry few odd missing values were found during validations which were replaced by the mean value of the corresponding variables. Few data entry errors (for pen and paper approach of data collection) were also detected during validation and were corrected. We insured that missing value was less than 5% missing per indicator and numbers of missing value per observation was less than 15% as suggested by Hair, Hult, Ringle and Sarstedt (2014). Finally 556 responses were found valid for analysis.

5.7 Planning for Data Analysis

Before going for analysis ‘Unit of Analysis’ is to be selected first. As objective of our study is to find factors of acceptance of TEL by technical students so we selected the individual technical student as unit of analysis.
**PLS-SEM statistical path modeling for data analysis.** We used SEM for analysis, which enables researchers to incorporate unobservable or latent variables measured directly by indicator variables and also SEM is a popular approach in social science (Anderson & Gerbing 1988; Bandalos 2002). They also facilitate accounting for measurement error in observed variables (Chin, 1998). SEM can partial least squares based structural equation modelling (PLS-SEM) or covariance based structural equation (CB-SEM) which are commonly used for data analysis methods by researchers and scholars (Lowry & Gaskin, 2014). PLS-SEM also called PLS path modeling method is chosen for this study, which is generally used to develop theories in exploratory research, in contrast to the covariant based SEM or CB-SEM which is primarily used to confirm or reject theories (Hair et al., 2014). The authors further provided a thumb rule for using PLS-SEM as:

- When the goal is for predicting key target constructs
- When formatively measured constructs are part of the structural model.
- When the structural model is complex (many constructs and many Indicators).

The current study’s objective is to find the factors of TEL and we have proposed our own model (theory building) for acceptance. It has a formatively measured construct (TEL self efficacy) too. The research model is also has many constructs and indicators. Hence, PLS-SEM path modeling is found justified in this study.

**Algorithm options and parameter settings for PLS path model**

For correct assessment of PLS path model, parameter settings and algorithmic options must be selected which include selecting the structural model path weighting method, the data metric, initial values to start the PLS-SEM algorithm, the stop criterion, and the maximum number of iterations (Hair et al., 2014). As recommended by the authors the following parameter settings were used:
- Path weighting scheme was selected as the weighting method as it is the recommended approach. This weighting scheme provides the highest $R^2$ value for endogenous latent variables and is generally applicable for all kinds of PLS path model specifications and estimations.

- Data metric option was used that z-standardizes data input for the PLS-SEM indicator variables (i.e., a mean value of 0, standard deviation of 1).

- Stop criterion of $1 \cdot 10^{-7}$ (i.e., 0.0000001).

- $+1$ as the initial value for all outer weights.

- Significance level was set at 0.05.

- A value of at least 556 for the maximum number of iterations is selected which is equal to the number of observations in data.

- Minimum number of bootstrap samples is set at 5000.

**Assessment of PLS path model**

Assessment of path model is done at two levels:

i) Evaluation of Measurement Model i.e. estimation of the relationships between the indicators and the constructs (measurement models) is focused first and when the measurement model was found valid then

ii) Evaluation of the Structural Model i.e. the estimation of relationships between the constructs (structural model) is carried out.

The details of data analysis and results (will be reported in next chapter) based on the methodical validation of measurement and structural model and testing of all the hypotheses. This concludes this chapter on methodology.