

Chapter 4
Research Design &
Methodology

4.1 Introduction

A research design is a basic plan that specifies the methods and procedures for collecting and analyzing needed information. According to Kinnear & Taylor 1996, “research design is the blueprint that is followed to complete the study and it ensures that the study is relevant to the problem and will use economical procedures”. The general tasks involved in research design are as below:

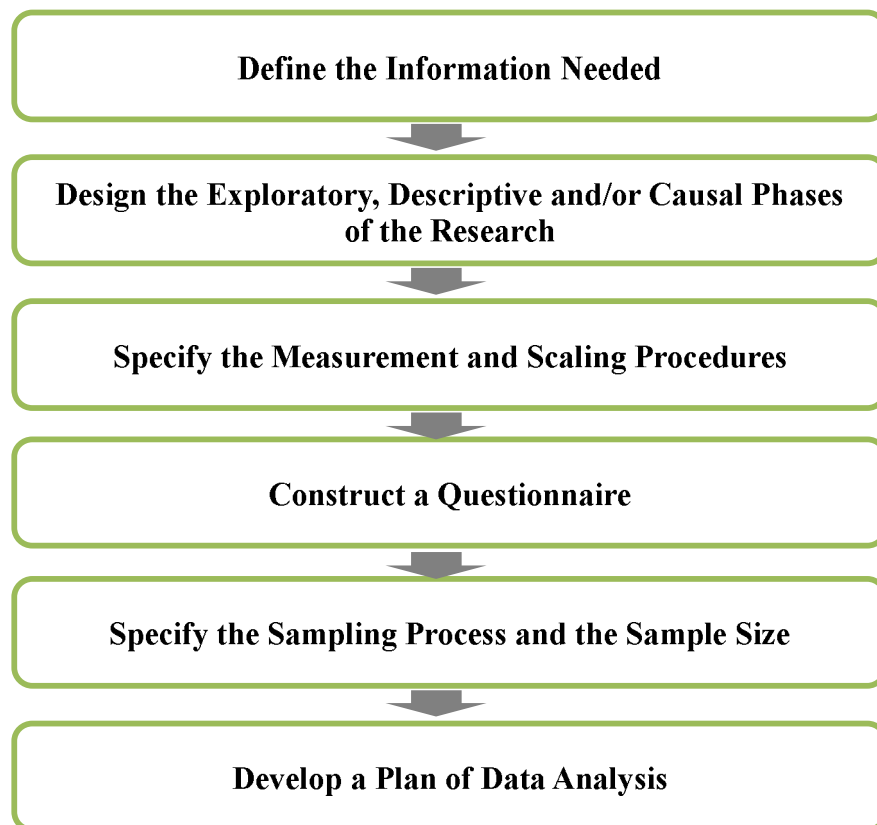


Fig- 4.1 Research Design Procedure

The research design can be classified into two major categories i.e. Exploratory Research and Conclusive Research. Exploratory research is generally carried out

during the initial stage of the research process so as to narrow the scope of research topic and to transform ambiguous problems into well-defined ones. The techniques that can be used so as to carry out the exploratory research are secondary data analysis, experience surveys, pilot studies and case studies. On the other hand Conclusive Research helps in providing specific information so as to determine and evaluate alternative courses of action. The conclusive research can be further divided into Descriptive Research and Causal Research. For our research objectives the use of both exploratory research and Conclusive research is done which is deliberated in the sections to follow.

4.2 Business Problem

After the literature review, the business problem can be summarized as follows:

There are an ample number of gas storage facilities in the world which are responsible for meeting base load and peak load demand of natural gas consumers and also provides the security in case of any future disruption in supply. Now as India doesn't have any storage facility, the future is not properly secured and thus "In the event of any disruption in consistent gas supply due to non-existence of Gas Storages will lead to actual and opportunity loss in CGD industry in India"

4.3 Research Problem

"Identification of variables and factors influencing development of conceptual framework for establishment of natural gas storage for CGD industry in India"

4.4 Research Questions

Research Questions that have been inferred from the literature reviewed are as follows:

Research Question 1

What are the various variables/factors that will influence the establishment of natural gas storage for CGD industry in India?

Research Question 2

What conceptual framework needs to be developed for establishment of natural gas storage for CGD industry in India?

4.5 Research Objectives

Research Objectives that have been derived from the research questions are as follows:

Research Objective 1

To determine various variables/factors influencing the establishment of natural gas storage for CGD industry in India

Research Objective 2

To develop a conceptual framework for establishment of natural gas storage for CGD industry in India

4.6 Research Process

So as to go forward with the research and to answer the research questions, an appropriate research model is framed out. First of all the variables are identified with the help of literature review, expert review and secondary information. Then a questionnaire is prepared in alignment with the variables identified. After the preparation of questionnaire a pilot test (Cronbach's Alpha Test) is carried out so as to check the reliability and validity of the questionnaire. Once this test is successful, data collection gets started in the form of surveys. Data is processed with the help of statistical techniques (factor analysis). Inferences are drawn and conclusion and recommendation are made based on the analyzed data.

For the preparation of questionnaire, inputs are taken from literature survey and expert reviews. Each question in the questionnaire is assessed on a 7 point Likert scale. This provides the data for processing through statistical tools. The qualitative research methodology is used for developing the conceptual

framework for establishment of natural gas storage for CGD industry in India based on the literature survey, empirical variables and factor analysis.

The research process has been explained in the flow diagram as below:-

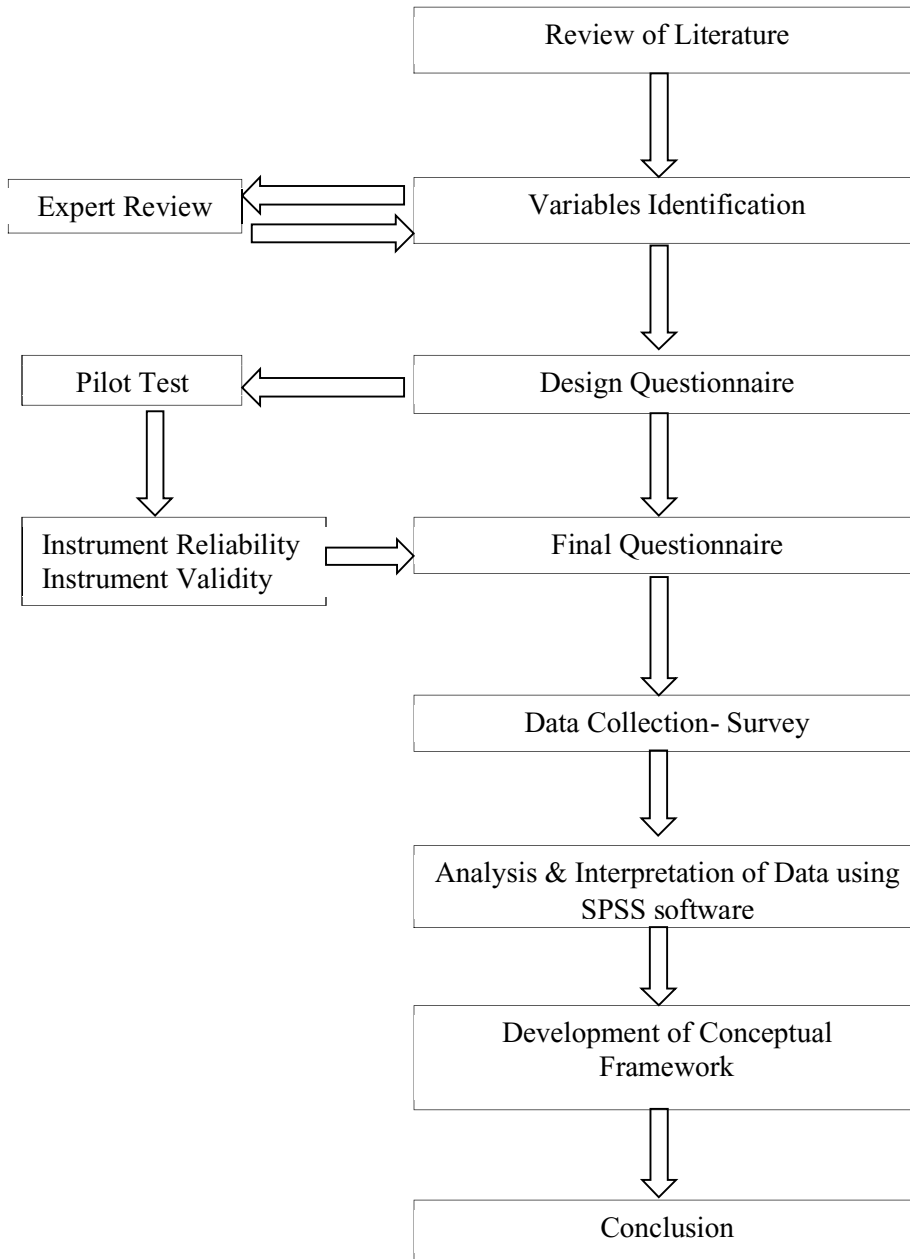


Fig- 4.2 Research process

4.7 Research Methodology

There being two objectives of this research study appropriate research methodology has been applied to each of the objective.

Exploratory research (qualitative research) is employed to develop initial ideas and insights and to provide direction for any further research needed. An exploratory study is essential when a researcher needs to identify problems, defines the problem more precisely and identifies any specific objectives or data requirements to be addressed through additional research (Kinnear & Taylor, 1996).

The exploratory research is highly flexible, unstructured and qualitative (Aakeret. Al. 2007). Exploratory research was carried out by a study of literature survey and input from the peers. The same is shown in figure as below:

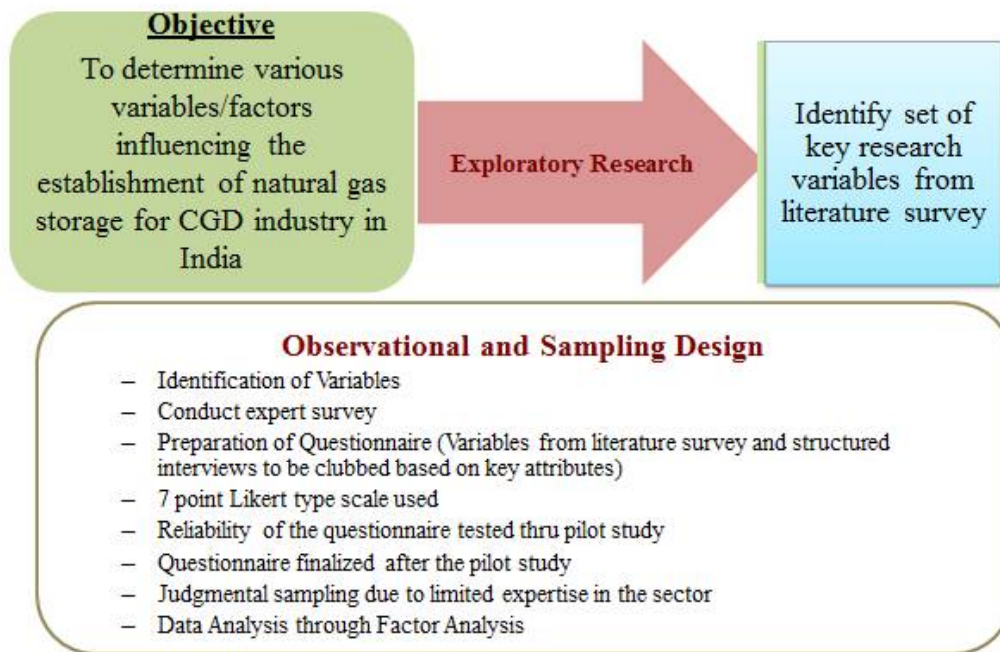


Fig- 4.3 Research Methodology for Objective-1

Further the qualitative research has been used for addressing Objective-2 where tabulated data and text from literature survey and primary surveys from peers has been used to develop a suggestive conceptual framework for establishment of Gas Storage for CGD in India. The same is shown in the figure as below:

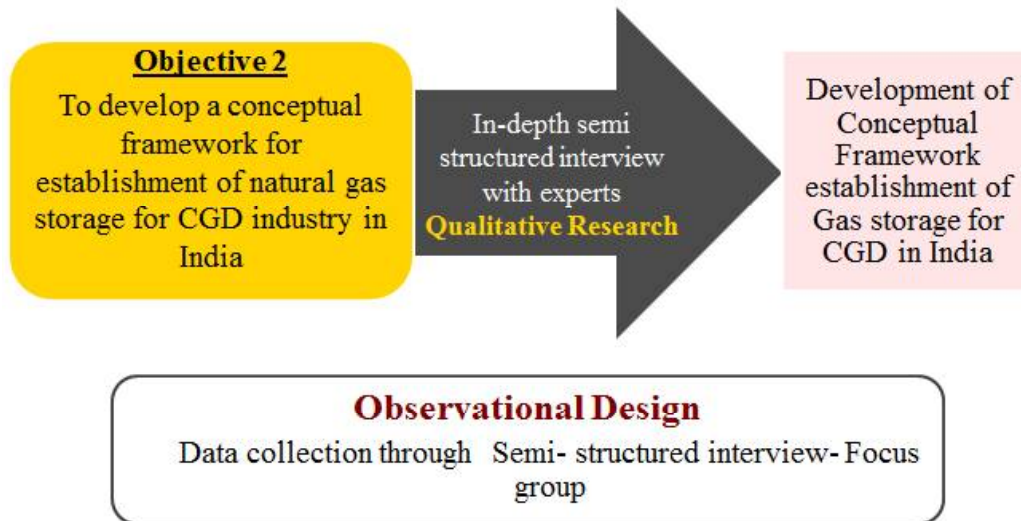


Fig- 4.4 Research Methodology for Objective-2

4.8 Variables affecting natural gas storage in CGD business in India

From the literature review and experts opinion following are the variables that will influence the establishment of gas storage in CGD industry in India.

1. War
2. Natural calamities like earthquake, hurricane etc.
3. Pipeline design to withstand high pressure
4. Injection/Deliverability rate
5. Pipeline damage
6. Land requirement
7. Land availability

8. Platform/pipeline breakdown
9. Terrorist attack
10. Third party damages
11. Price fluctuations
12. Availability of alternate/conventional fuel
13. Interruptions in trans-nations pipelines due to Geopolitical reasons
14. Supply and demand
15. Storage Capacity
16. Investment
17. Non utilization of cushion gas
18. Safety
19. Government policies and regulations
20. Strategic location considering geology and geography
21. Production of Shale gas, CBM etc. in India
22. Environment
23. Storage connectivity with pipeline infrastructure
24. Employment
25. Awareness about storage and CGD industry
26. Consumer's satisfaction
27. Experience
28. Skilled labor
29. Technology

The following table shows the source of these identified variables i.e. either the study (literature review) or the expert opinion:-

Table- 4.1 Identified Variables list

VARIABLE	SOURCE	YEAR
War	K S R K Verma, Elangovan	2008
Natural calamities like earthquake, hurricane etc.	Mitosunori, Komori, Kyosuke	2008
Pipeline design to withstand high pressure	E ShashiMenon, J M Champal	2005, 2012
Injection/Deliverability rate	NicoKyesrts, Michelle Hallack	2010
Pipeline damage	Mitosunori, Komori, Kyosuke	2008
Land requirement	Jianzhang Wu, KSRK Verma, Elangovan	2012
Land availability	Mitosunori, Komori, Kyosuke	
Platform breakdown/shutdown	K S R K Verma, Elangovan	2008
Terrorist attack	K S R K Verma, Elangovan	2008
Third party damages	SK S R K Verma, Elangovan	2008
Price fluctuations	Expert Opinion	
Availability of alternate fuel	Expert Opinion	
Interruptions in trans-nations pipelines due to geo political reasons	Expert Opinion	
Supply and demand	Chris Le Fevre, Shubhrat	2013,

	Shahu	
Storage Capacity	Young Myung Yang, Raghu, Thomas	2006, 2011
Investment	Serger Sorokin, A Goryachev	2012
Non utilization of cushion gas	N Breunese, Anyadiegwan, Anyanwu	2006, 2012
Safety	IFC World bank group, Mitosunori, Komori, Kyosuke	2007, 2008
Government policies and regulations	NicoKyesrts, Michelle Hallack, Chris Le Fevre	2010, 2013
Geology and geography	Mario Jorge Figueira, Confort, Cheila, O Arvesen, V Medbo,	2014, 2013
Production of Shale gas, CBM etc. in India	Expert Opinion	
Environment	Federal Energy, IFC World bank group	2004, 2007
Connectivity with pipeline infrastructure	Study 8	
Employment	Expert Opinion	
Awareness	Expert Opinion	
Consumer's satisfaction	Expert Opinion	
Experience	Mario Jorge Figueira, Confort, Cheila	2014
Skilled labor	Jianzhang Wu,	2012
Technology	Federal Energy, Jianzhang Wu, Young	2004, 2012

4.9 Sampling Design

For this research the sample design is made keeping the following points under consideration:

- **Type of Universe:**

For developing a sample design, first one needs to define the set of objects (universe) that one need to study. The universe can be finite or infinite. In this study finite universe has been considered.

- **Target population:**

Target population is a collection of objects or elements that show some common set of characteristics. The objects or elements possess information which the researcher extracts out and about which the inferences are to be made.

In this research, the target population which needs to be surveyed for analysis is any organization or individual having experience or interest in Natural Gas business. Thus the target population will embrace companies in Natural Gas business i.e. public sector & private sector companies, Regulator, Academia, Consultants and service providers. In this case target population considered is approximately 3000.

- **Sampling Element:**

A sampling element is the element about which or from which the information is desired in survey research. In this research the sampling element comprises of those official respondents who have knowledge about the Natural Gas business or are having good experience in the Natural Gas industry and specially CGD industry.

- **Sampling Unit:**

A decision regarding the sampling unit needs to be taken before the selection of the actual sample. It is an element or a unit containing elements(s) which is available for selection in the form of a respondent. In this research the sampling unit is an individual who holds a position of manager (or above) and having more than 5 years in relevant public and private organizations, academia, consultancies or service providing agencies.

- **Extent:**

The meaning of extent is to what range the target population is geographically distributed. In this research the extent is unrestricted as Gas Storage facilities for City Gas Distribution is a new concept and till now has not been implemented in India. While collecting the data the only consideration that was made was the knowledge of respondents and their experience in Natural Gas business and specially CGD business. There were no geographic restrictions.

- **Sampling Technique:**

In this research for data collection stratified sampling has been used. The target population was divided into different strata (Public sector and private organizations involved in gas operations and CGD business, Academia, Consultants and service providers). Further the number of elements from each stratum is selected on the basis of availability of element.

- **Theoretical Premises**

Theoretical term is generally seen to be synonymous with hypothetical. If something is theoretical, it may not yet have happened but due to various sources, it is believed to happen in this way. The sources may be predictions based on case

studies, investigations and observations or mathematical evaluations. It is usually more than a simple guess; there will be foundations beneath a theoretical expectation. Following theories were studied to match the relevancy with this study:-

- Stakeholder theory
- Theory of Constraint (TOC)
- Resource value based theory (RVBT)

These theories were studied to deliberate the theoretical premise for this study. After due deliberation, it is observed that Stakeholder's theory is the most relevant for this study. Stakeholder theory suggests that the purpose of a business is to create as much value as possible for stakeholders.

- **Sample Size:**

Yamane formula has been used so as to determine the sample size for the research. The formula given by Yamane is

$$n = N / (1 + N (e)^2)$$

Where

n = Sample size; N = Population size; e = Level of precision

The target population identified was 3000. Now applying Yamane formula sample size of 353 is obtained, keeping N=3000 and e=0.05 in Yamane equation.

As research moved forward a valid survey of 395 respondents, having knowledge or experience in the Natural Gas Industry directly or indirectly was taken. Upstream, midstream, downstream, academia, consultancy services, etc. were the categories of industrial domain from where responses were received.

Table- 4.2 Respondents summary

Types of Respondent	No. of respondent	Percentage of the Total
Upstream & Midstream	68	18%
Downstream	217	54%
Academia(Students, faculties)	69	18%
Consultants and Service providers	34	8%
Misc.	7	2%
Total	395	100%

Following is the list of companies from where the responses were obtained:-

Table- 4.3 Respondent companies details

S.NO	Name of the organization
1	GAIL
2	IOCL
3	Indraprastha Gas Limited
4	Mahanagar Gas Limited
5	Maharashtra Natural Gas Limited
6	Central UP Gas Limited
7	Adani Gas Limited
8	Bhagyanagar Gas Limited
9	Green Gas Limited
10	Gulf Oil Lubricants India
11	Nandan Petrochemicals
12	Engineer Limited
13	Seal For Life Limited

14	Kline and Company
15	Infosys
16	Feedback Infra Private Limited
17	Markets and Markets
18	EXL Services
19	Mount Meru Petroleum Limited
20	Evalue serve
21	GD Research Center Private Limited
22	Tractebel Engineering Limited
23	Wood Group Kenny
24	ICF International
25	Bhotika Pipeline Service Limited
26	PWC
27	KPMG
28	Resonance Energy
29	UPES
30	IIT Delhi
31	TU Eindhoven
32	Rajiv Gandhi Institute of Petroleum Technology
33	Banking
34	Online retailer
35	Osnar Paints and Contracts
36	PNGRB (Regulator)
37	Int. Certification Services

4.10 Instrument Design

The instrument that was used in the data collection exercise for the research was a questionnaire which contained 29 questions with pre-defined choices on seven point likert scale and 2 open ended questions. The details of the instrument

development, scale formation, questionnaire format, data collection validity and reliability test are mentioned in the subsequent sections.

4.10.1 Questionnaire development

Structured and undisguised questionnaire was used in the survey as they are reliable, standardized, simple to administer, easy to tabulate and analyze, where the responses permitted to the respondents were predetermined on a 1-7 likert scale. There were 2 open ended questions to let the respondents answer in their own words.

4.10.2 Information sought

The list of variables found from literature survey was presented to the respondents in the form of questions and they were asked to choose an option (in the 7 point likert scale), how a particular variable would influence development of conceptual framework for establishment of Natural Gas Storage for CGD in India. (Strongly disagree to strongly agree rating). Towards the end of the questionnaire (Attached as Appendix-E in this thesis) the respondents were asked to give their qualitative observation on two questions namely:

Q1- As per your opinion which type of storage(s) is more feasible for Indian CGD industry. (More than one option can be selected)

- Underground Gas Storage- Depleted Reservoir
- Underground Gas Storage- Salt Caverns
- Underground Gas Storage- Aquifers
- Aboveground Gas Storage- Gas Holders
- Aboveground Gas Storage- LNG Storage
- Storage in Pipeline- Line Pack
- Can't say

Q2- In your opinion, why gas storage is necessary for CGD companies in India?

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4.10.3 Method of administration:

The questionnaire was handed over predominantly in person experts in midstream and downstream Natural Gas sector, so that access to the right stakeholders and their response rates could be better compared to mail interview. The respondents completed answering the questionnaire at their convenience. Questionnaire were also handed over during one to one meeting with senior officials of the Government, Planning Commission, Regulatory Board, Oil PSU's, Chief Executives, Private Sector Oil companies Senior Executive and HOD in Academia Institutions. Questionnaires were given to the student pursuing Petroleum Engineering, MBA Oil & Gas in their class room and were also sent by email to various other stake holders.

4.10.4 Instrument reliability:

Reliability is concerned with consistency of the measurement, which means whether the questions in the survey get same type of response when the conditions remain the same. Reliability is also associated with internal consistency, which means whether the same characteristic is measures by different persons. They are four ways to estimate the reliability of the instrument (Questionnaire). They are Inter-ratter (Assessor) or Inter-observer reliability, Test retest reliability, Parallel-forms reliability and internal consistency reliability. Each of these estimates evaluates the reliability of the questionnaire differently. Among these, the internal consistency is the most frequently used method to validate the reliability of the instrument and the same has been used in the present case.

4.10.5 Instrument validity:

Validity deals with how accurate the measurements are per se, and also a reflection of sample representativeness. Validity is impacted by robustness of survey design and whether right and easily understood questions are asked to the respondents. It is to ensure that whether the instrument is measuring what it

supposed to measure as that is the core of validity estimation. The instrument has qualified the discriminant validity criterion, convergent validity criterion and concurrent validity criterion (Construct Validity- Criterion).

4.11 Pilot Testing:

The questionnaire was pre-tested with 30 Midstream & Downstream stakeholders in Natural Gas industry (respondent). The responses were added in a dummy table to make sure the questions were understood correctly and the answers were in line with the questions asked.

4.12 Quantitative Analytical Tool Used

In this research prime objectives of statistical analysis were to reduce the set of variables into fewer numbers of manageable factors. As stated earlier, there are 29 variables in this study whose interdependence was examined to reduce them to a set of 6 factors. SPSS 16 software was used for analysis.

4.13 Concluding Remark

Research objectives and research questions formulation based on the problem statement have been presented in this chapter. Overall approach and rationale for this research study discussed in details logically by explaining the philosophical assumptions, scientific paradigms scientific approach, research method and research study. Further data collection methods have been discussed in this chapter. Data collection was done by developing a questionnaire on 7 point Likert scale. Questionnaire was administered with respondents from upstream, mid-stream and downstream organizations in addition to consultants and academia. Data also collected through semi structured interview using focus group technique. Interview data was transcribed and later on analyzed using Atlas TI software. Methods used to ensure quality of research is described in details using sample adequacy test, test reliability, internal consistency.