Chapter – 4

Research Methodology

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4.0 Introduction:

Designing an appropriate, accurate and quality research methodology for the given problem is highly essential from the point of view of researcher. Therefore, due attention is paid for designing and then adhering to the appropriate research methodology throughout the research process for improving the quality of research.

4.1 Research Problem & Objective

4.1.1 Rationale of the study:

The Renewable energy is the key to the development of society and country as well. Moreover, the Government of India has set a goal of 175 Gigawatts (GW) cumulative renewable power installed capacity by the end of 2022 and submitted this Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention of Climate Change (UNFCCC). Further, India has set a target to increase the country`s share of renewable energy installed electricity capacity to 40 percentage by the end of 2030. NITI Ayog launched the India Energy Security Scenarios 2047 (IESS 2047), explores a range of potential future energy scenarios for India. As per MNRE annual report, so far cumulative installed renewable power capacity in India as of 31 March 2018 reached to 69.784 GW, 31 March 2019 reached to 78.316 GW and as of 31st March 2021 reached to 94.434GW . This indicates that India`s renewable energy (RE) potential is vast and largely untapped. As per IESS 2047, recent estimates show that India's solar potential is greater than 750 GW and its announced wind potential is 302 GW (may be higher than 1000 GW). It shows opportunity for achieving as high of 410 GW of wind and 479 GW of solar PV by 2047.

With respect to the enormous demand for power in India, the opportunity of renewable power is also growing. However, the untapped renewable energy resources of the country were not being put to optimum use preliminary due to various constraints and challenges/weakness for the financing investment for

financier, investors, promoter, regulator of electricity and private power developer as well. This research study focuses on various dimensions of SWOT analysis and provides such opportunities to bridge the gap between installed renewable energy capacity and untapped potential.

4.1.2 Statement of the problem:

As far as renewable energy is concern, it is one of the most important, live and vibrant topic for research. It is due to the fact that now a days every countries both developing and developed countries committed and focusing on the renewable energy projects due to environmental awareness, energy security of the country, naturally available sources of energy and lot many reasons best known to everyone, However due to some constraints, weaknesses, challenges and threats same is not being optimally utilised to the tune of availability. In this context various studied have been conducted regarding the renewable energy sources, financial & investment opportunities, awareness, Project cost effectiveness, regulatory policies, support mechanism, challenges, competitions faced by various developers, EPC contractors, policy makers, national & international players, consumers and people at large. Thus it seems to be important to have research study considering all aspect of renewable energy projects. Hence the descriptive and analytical study undertaken to identify and analyse the factors in terms of SWOT analysis and to find a suggestive overview. The statement of problem is as under:

"SWOT Analysis of Renewable Energy Projects"

4.1.3 Objective of proposed Research

India has abundant natural resources and available resources are able to meet India's demand of electricity. In this context, it is felt important to research study and analyse the various issues / constraint / factors / parameters related to the development of renewable energy projects in India as well as renewable energy project development, globally to leverage the experience of developed countries, the analysis of which could help to address the various issues, constraints and weaknesses which prevents the implementation of renewable energy projects in India, thereby assist in identification of strength, weakness in the form of barriers, challenges, opportunities by resolution of the issues

amicably to encourage the exploitation of naturally available renewable energy resources and threat related to it.

In this reference, the objective of the present study is to examine the current Renewable Energy mix scenario of India and global as well, financing and investment opportunities, barriers and challenges associated with renewable energy projects, key driving policies and regulations', support mechanisms required for growth of sector, impact of cost competitiveness, the recent market dynamics and to outline a suggestive overview of the possible approaches, policies/incentives to encourage the financing investment in Renewable Energy projects.

The study has the following specific objectives:

1. To understand the Global and Indian Renewable Energy mix scenario, available potential of renewable energy resources, present scenario of renewable energy projects, scope of development of Renewable Energy Projects.
2. To understand the changing scenario, key driving policies & regulations, support mechanisms for renewable energy projects.
3. To understand the developmental opportunities and strengths for renewable energy project.
4. To understand & analyse the manufacturing resources & value chain for development of renewable energy projects.
5. To understand the market dynamic & cost competitiveness for development of renewable energy projects.
6. To understand and analyze the challenges, weaknesses and threats of Renewable energy projects.
7. To study about the perception of stake holders on viability of Renewable Energy projects.
8. To outline a suggestive overview to overcome the challenges, weaknesses and threats associated with, for development of Renewable Energy projects.
9. Suggestive measures to utilize optimally the available potential of renewable energy resources and development of renewable energy projects sustainably.

Table 4.1: Research Objectives & its association with sources of information:

Research Objectives	Sources of information (Types of research)
Determine the current renewable energy mix scenario of India and Global as well and understand the present scenario of renewable energy projects in India as well as globally.	Primary Research
Understand the changing scenario & key driving policies and regulations, support mechanisms to provide development opportunities	Primary Research
Barrier and challenges to utilize the potential available resources, opportunities, weaknesses, strength for development of utility scale renewable energy projects.	Primary research: Secondary research
Diagnose the manufacturing resources, Value chain, & its impact on development in terms of porters five force	Primary research: Secondary research
Identify stake holders and study the perception of stake holders on Renewable Energy Projects	Primary research: Secondary research
Analyze the challenges, threats changing policy drivers, market dynamics¸ cost competitiveness on Renewable energy projects.	Primary research: Secondary research
Determine strategies and suggestive overview to overcome the challenges, weaknesses & threats for development of Renewable Energy projects.	Primary research: Secondary research

Propose the suggestive measures & supportive actions to utilize optimally the available potential of renewable energy sources and to develop the renewable energy projects sustainably.

Primary research:

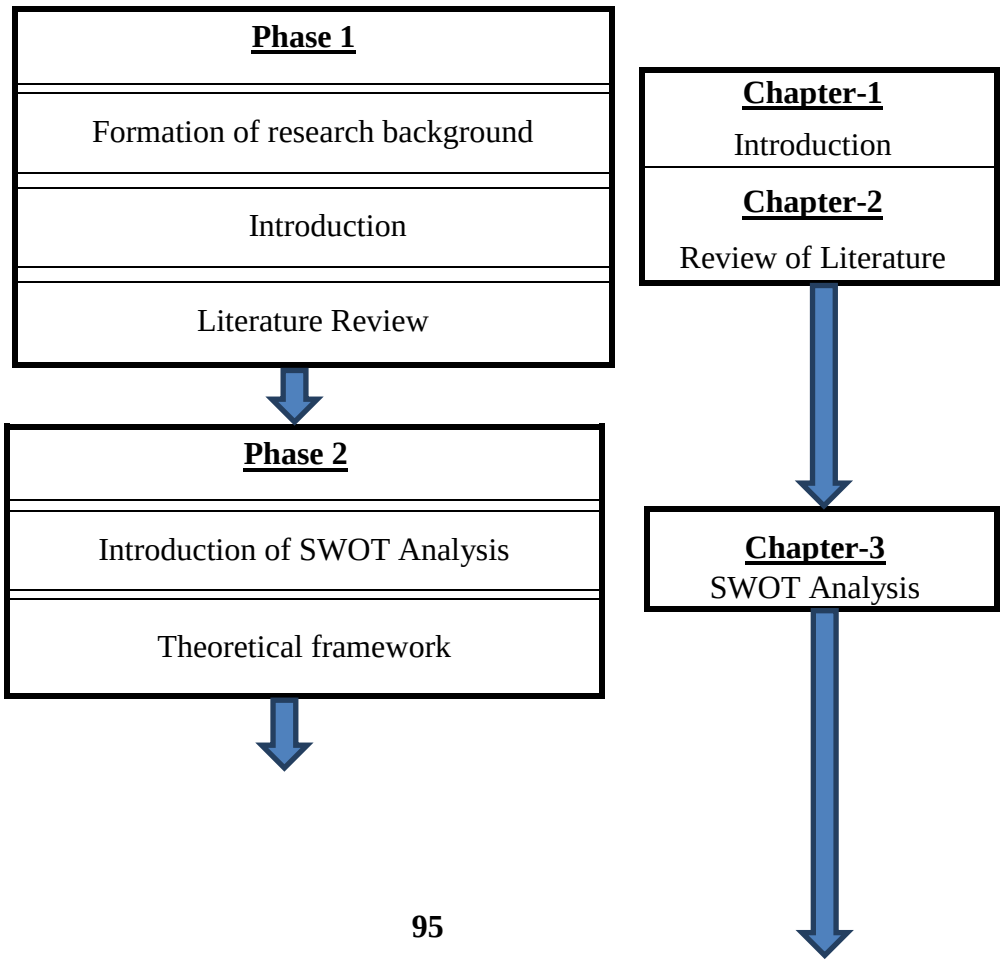
Secondary research

4.1.4 Significance of the study:

The result of this study will be helpful and valuable to stake holders, policy makers, financiers and investors, developers, EPC contractors, decision makers for both government and private sectors of our countries as well as to a broader international audience.

This study also provides a sound literature for an academician and the research scholars to pursue further research in the area of renewable energy projects.

4.1.5 Research Phases: Table : 4.2



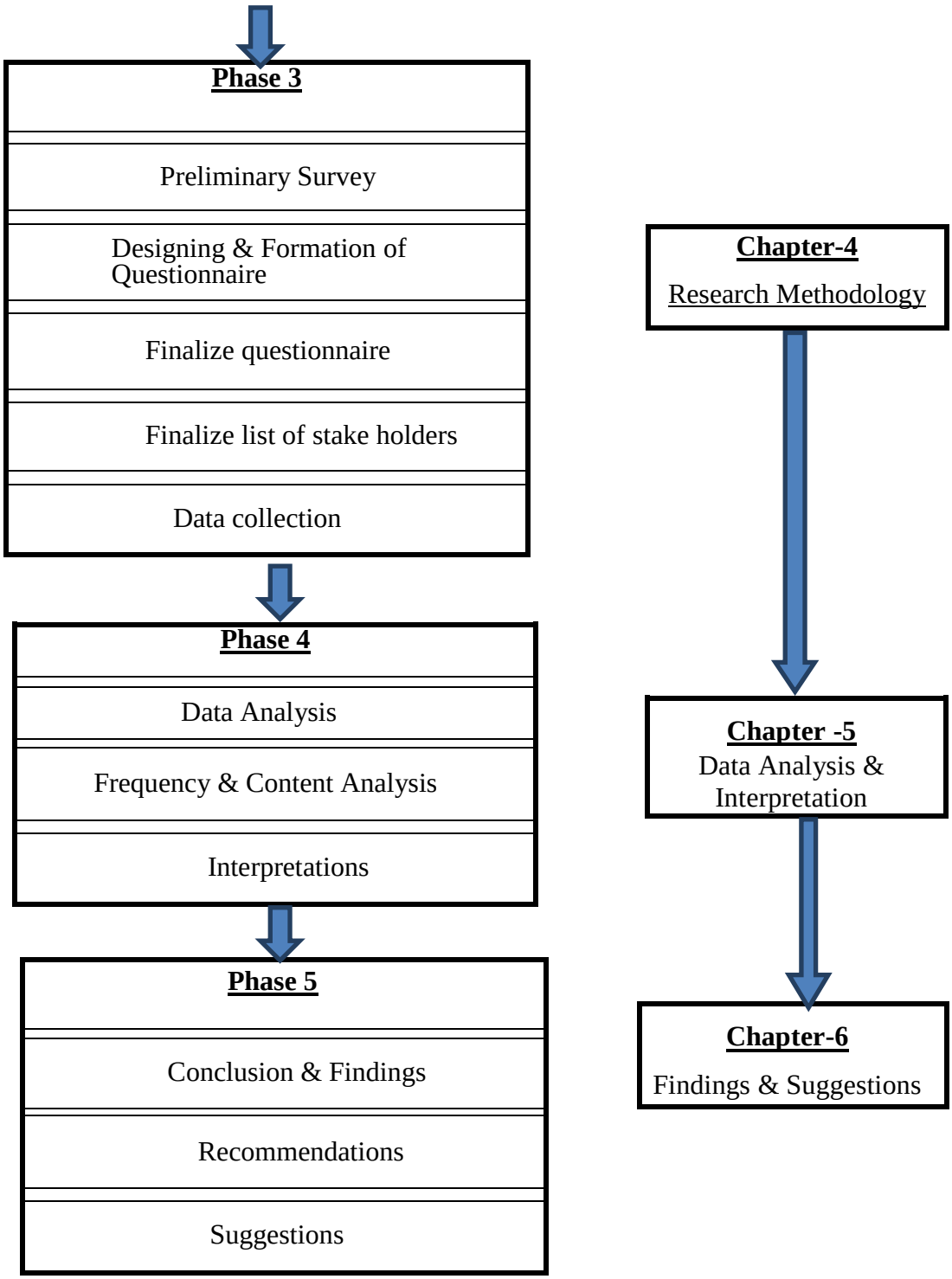


Figure 4.1 represents an overview of the complete research process. The all five phases are integrated to each other to form a complete research process.

4.2 Research design:

The research design is conceptually overall research frame work or structure of the proposed research to be conducted. The research design is referred to as the blue print of a research study and is as good as the

``glue`` which holds all the elements of the research projects. Hence it is imperative that an appropriate and effective research design is to be prepared for initiating effective research process to put the perspective ideas in a shape. The research design is defined by different authors differently (Creswell, 2014) ``defines research design as a procedures used in collecting and analysing the measures of the variable as specified in research problems``. (E.Spector, 1981) defined that `` any scientific investigation, be it in the social or natural science, must begin with some structure or plan, which defines the number and types of variables to be studied and their relationship to one another this structure is termed as Research Design``. (E.McNABB, 2010) ``Research design stands for advance planning of the methods to be adopted for collecting the relevant data and the techniques to be used in the analysis, keeping in view the objectives of the research and the audibility of time and money``.

In this study, the combination of two types of research design will be used:

- Exploratory research:
- Descriptive research

As per (W.Paul Vogt, 2012) ``Ideally, if the research employ combine research designs methods, researcher will get better (more valid) results``.

This is the exploratory and descriptive study of a SWOT analysis of the renewable energy projects. The study is in the form of exploratory research as no such study has been conducted so far. The purpose of the exploratory research is to achieve new things by going insight into the renewable energy projects and more accurately understanding & investigation of the objectives defined in the research through the literature reviews on the renewable energy resources, challenges, government regulatory policies and support mechanism, cost competitiveness and through the survey of the existing renewable energy projects.

The descriptive natures of the study are based on the fact that the research describes the phenomenon existing in the renewable energy projects which helps to study the current situation of the renewable energy scenario. The descriptive research used to identify and obtain the information of the parameter or characteristics of the projects situations through the questionnaire to be framed keeping the research objectives in consideration. More over the consequential conclusions can be drawn for the entire populations involved in the renewable energy projects industry.

4.3 Data collection:

4.3.1 Primary Research Data:

The primary research data will be collected from the various employees and management personnel of prominent organizations, Independent power producers and financial institutions, stake holders, the utility scale renewable energy projects sectors both public sector as well as private sector developers and investors of organized sector, bulk purchasers and others who have been contributing significantly in the development and exploitation of renewable energy sources about perception of renewable energy through Non Disguised closed ended Questionnaire and structured interviews. The questionnaire will be framed on the base of objectives of the study. The questionnaire will be pretested and revised if necessary.

4.3.2 Secondary Research Data:

The secondary data will be collected from reliable and authentic sources like published research papers, published articles, research reports, newspapers, and various authentic websites. The other data which will be used for the purpose of the study will be taken from books, e-books, internet literatures, magazines, journals and electronic media through both online and offline mode.

4.4 Research Population:

The population for the purpose of research consists of aggregate of all the individuals or elements or units of the universe that have some common set of characteristics. The population parameters for the research shall be typically in units or numbers say all the employees, management personnel, developers, investors, stake holders, institutions, consultant, financiers, equipment suppliers, EPC contractors in the field of utility scale renewable energy.

4.4.1 Target Population

Target population for present research is population under consideration that possess the information and characteristics that is required for the research and from the information of which inference are to be drawn.

In the present research, the target population for the survey consists of organization, manufacturing units, consultant or individual involved in and have interest in the field of utility scale renewable energy projects in India and world as well. Here, the companies involved in and actively available in India and also, those global companies who have keen interest in the field of renewable energy and going to establish projects in India to exploit the untapped potential of renewable energy sources. Such target population for this research study comprise of the stake holders, policy makers, financiers, investors, developers, Regulators, R&D institutions Consultants, EPC contractors, decision makers, Service providers, Equipment supplier, EPC companies select employees & management personnel's of public sector and private sectors as well as Academicians of our countries. Over and above, international experts in the field of utility scale renewable energy projects were also included in target population.

4.4.2 Sampling element:

The sampling element is the people or the object chosen from the population of interest usually as respondent or participation in the research study which truly represent the population, from which the information as desired in survey is obtained. Based on which the inferences about that population is to be drawn.

In the present study, the questionnaire related to survey is designed to obtain information on various traits or aspects of the renewable energy projects which have or likely have influence on the research topic, the sampling elements constitutes deciding authorities, middle or senior management professionals of respective organisations/ institutions/companies or contractors academicians or have involvement or association with the utility scale projects and have influence on the decision making.

4.4.3 Sampling Frame

Sampling frame consist of the list, published list of sampling unit or group of stake holders, organisations or regulators, consultants, policy makers of the identified target population. The select respondents have a stake in the utility scale renewable energy projects shall identified as part of sampling frame.

4.4.4 Sample Design:

In this research, the sample design on the basis of suitability and availability of the requisite sampling frame will be used. Here, stratified random sampling method will be preferred by the researcher to select the employees, developers, investors, stake holders, institutions in the field of utility scale renewable energy projects.

4.4.5 Sampling Technique:

A stratified sampling technique is used during the data collection process. As per stratified sampling process, the target

population were divided into different stratum such as suppliers, EPC contractors, Stake holders, Consultants, Service providers, Policymakers and Regulators, decision makers, senior management, academicians, Public Sector Organizations and Private Sector Organizations involved in solar and wind utility scale renewable energy projects. Number of elements or units from each sample strata in selected group is finalised based on the available units (elements) in that strata.

4.4.6 Sampling Unit

Sampling Unit is the available object or element from which of sample is done. In the present research study a sample is selected from the stake holders, policy makers, financiers, investors, developers, policy makers, Regulators, R&D institutions Consultants, EPC contractors, decision makers, Service providers, Equipment supplier, EPC companies, institutions, select employees & management personnel's of public sector and private sectors, Academicians of India and international experts in the related fields.

4.4.7 Sample Size

The exact percentage or number of representative sample element (units) from selected each stratum from suppliers, EPC contractors, Stake holders, Consultants, Service providers, Policymakers and Regulators, decision makers, senior management, academicians, Public Sector Organizations and Private Sector Organizations involved in solar and wind utility scale renewable energy projects is considered as sample for research study. As each stratum is having more homogeneous characteristics than the other stratum, thereby estimating each of the stratums more accurately leads to better estimate of the Target population, hence stratified sampling method is used to have more reliable, accurate and detail information. However, the exact sample size determination for the purpose of collection of the primary data is calculated as under:

Formula for determining Sample Size:

$$\mathbf{n = \pi\ (1 - \pi)}$$
$$\mathbf{z^2 \div D^2}$$

Where

n = required sample size.

π = the estimated population proportion (based on the researcher's judgment and estimate that 75 per cent (0.75) of the target population involved in Renewable Energy Projects.

z = Considering 95 per cent confidence level, gives the associated z value of 1.96, per normal table.

D = the level of precision and desired precision is such that the allowable interval is set as D = p (sample proportion) – π (population proportion) = + or – 0.05.

The sample size determination formula is obtained from Naresh K. Malhotra and Satya Bhushan Dash (2011) 'Marketing Research – An Applied Orientation' 6th Edition, Pearson, Page number 364`.

According to the given formula, the Sample Size is works out as under:

$n = \pi\ (1 - \pi)\ z^2 \div D^2$

$n = 0.75\ (1\text{-}0.75)\ (1.96)^2 \div (0.05)^2$

$n = 0.75\ (0.25)\ (3.8416) \div (0.0025)$

$n = 0.75\ (0.25)\ (3.8416) \div (0.0025)$

$n = 0.6375 \div 0.0025$

n = 255.12 so, sample size is round off with 255 numbers of sample.

Representative sample taken from various select employees & management personnel's of the Renewable Energy projects companies/stakeholders

Table: 4.3 Sample size determination

Sr No	Stakeholders	Approx Nos	Nos of Management Personnel's	Total Nos
1	Project Developers	8-10	3-4	35
2	EPC contractors	20-25	3-4	95
3	Consultant	8-10	2-3	30
4	Policy maker	3-4	1-2	5
5	Investor/Financier	6-8	2-3	15
6	Manufacturers / Suppliers	8-10	2-3	20
7	R& D Institutions	4-5	1-2	10
8	Independent Power Producers/ Generators Equipment Supplier	6-8	3-4	20
9	Academicians	6-8	1-2	10
10	MNCs/ Globally	5-6	2-3	15
	Total			255

4.5 Research gaps identified in the literature review:

The researcher gone through various research studies regarding the renewable energy carried out in past. The review of literature made it clear that no study had been carried out in the Indian context in the area of SWOT analysis of renewable energy Projects as Holistic Approach -opportunities, weakness, challenges and to provide suggestions /recommendations for tapping the untapped potential of renewable energy sources in India in view of SWOT analysis. This has encouraged me to work on this topic. In this proposed research study, I try to bridge this gap in the literature.

In this present study, I have to make number of recommendations / suggestions regarding future drivers to encourage stake holders, policy makers, financiers and investors, decision makers for both government and private sectors and financial institutions of our countries as well as to a broader international institutions to invest in a right way & fearlessly for the uninterrupted growth of renewable energy in utility scale to tap the untapped renewable energy sources potential provided by the nature free of cost and free of pollution which might be helpful to meet the massive target, ultimately helps in pollution free and sustainable India. As the entire world is grappling with the problem of acute shortage of energy, energy security, pollutions which is so vital for all developmental activities. To meet the ever increasing demand, fossil fuels such as coal, oil and natural gas have been overexploited in an unsustainable manner. In this critical situation, new and renewable sources of energy are most viable options for the future concerning the sustainable energy and locally available in abundance.

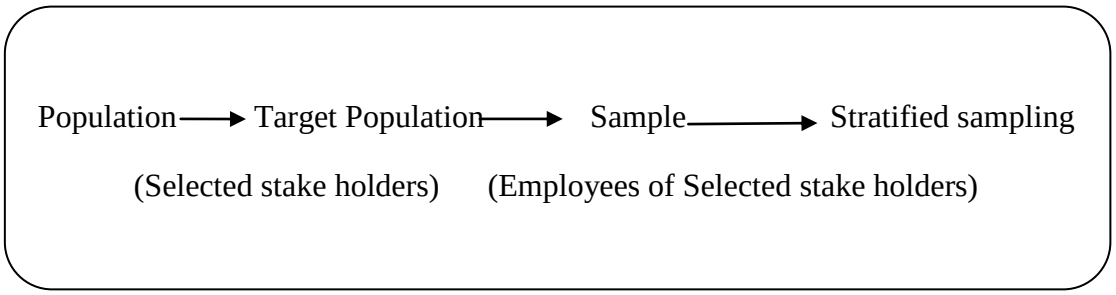
4.6 Data Analysis and Interpretation:

(Holliday, 2007) ``Data analysis is the process of making sense of the data and discovering what it has to say``. The present study is of SWOT analysis of Renewable Energy Projects in terms of development and tapping of untapped renewable energy and financial investment in the renewable energy.

- The approach adopted is basically analytical and descriptive in nature.
- Collected Data Analysis will be done extensively and the area of research which needs more attention and elaboration will be studied.
- On the basis of the literature review and objectives of this study, Researcher uses the business model to analyse and interpret the related parameters.

- Systematic Literature Review (it is a critical & in depth evaluation of previous research) method, have also been applied.
- The primary data collected through interview and with the help of structured and non-disguised questionnaire will be scrutinized, edited and thereafter shall be presented in the form of Tables, Charts, Graphs, Diagrams and analysed as required.
- The statistical and mathematical tools and techniques for quantitative analysis includes Statistical Package for Social Sciences (SPSS), excel software applications used for calculation of average mean, standard deviation, hypothetical studied. The other analysis used is discounted cash flow analysis, sensitivity analysis, SWOT analysis, porters five force analysis etc. to arrive at the recommendations & conclusions.

Fig: 1.2 Sampling process in flow chart mode



4.7 Statistical Analysis tools used:

- Frequency Analysis
- Percentage Analysis
- Descriptive Analysis
- Factor Analysis
- Analysis of Variance (ANOVA)
- Chi-square test for association of variables
- Bi-variety Correlation
- Regression Analysis

- Factor Analysis
- Kruskal Wallis Test

4.8 Statistical Package:

Statistical package for social science SPSS v 21.0 has been extensively utilized to analyses the primary data and perform each statistical tests.

4.9 Reliability and Validity of the study:

According to the (Silverman, 2004) ``Reliability is the degree to which the finding of the research are independence of the accidental circumstances``. Validity on the other hands, according to (James H McMillan, 2001) , is the degree to which the interpretations and concepts have mutual meanings between the participant and the researched. According to (Dr. P. Narayan Reddy, 2008) ``the extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability``. If the results of a study can be reproduced under a similar methodology, then the instrument is considered to be reliable, In other words, if the results of the study can be reproduced under a similar methodology, then the research instrument is considered to be reliable while validity determines whether the research truly measures that which it was intended to measure or hoe trustful the results are ``.

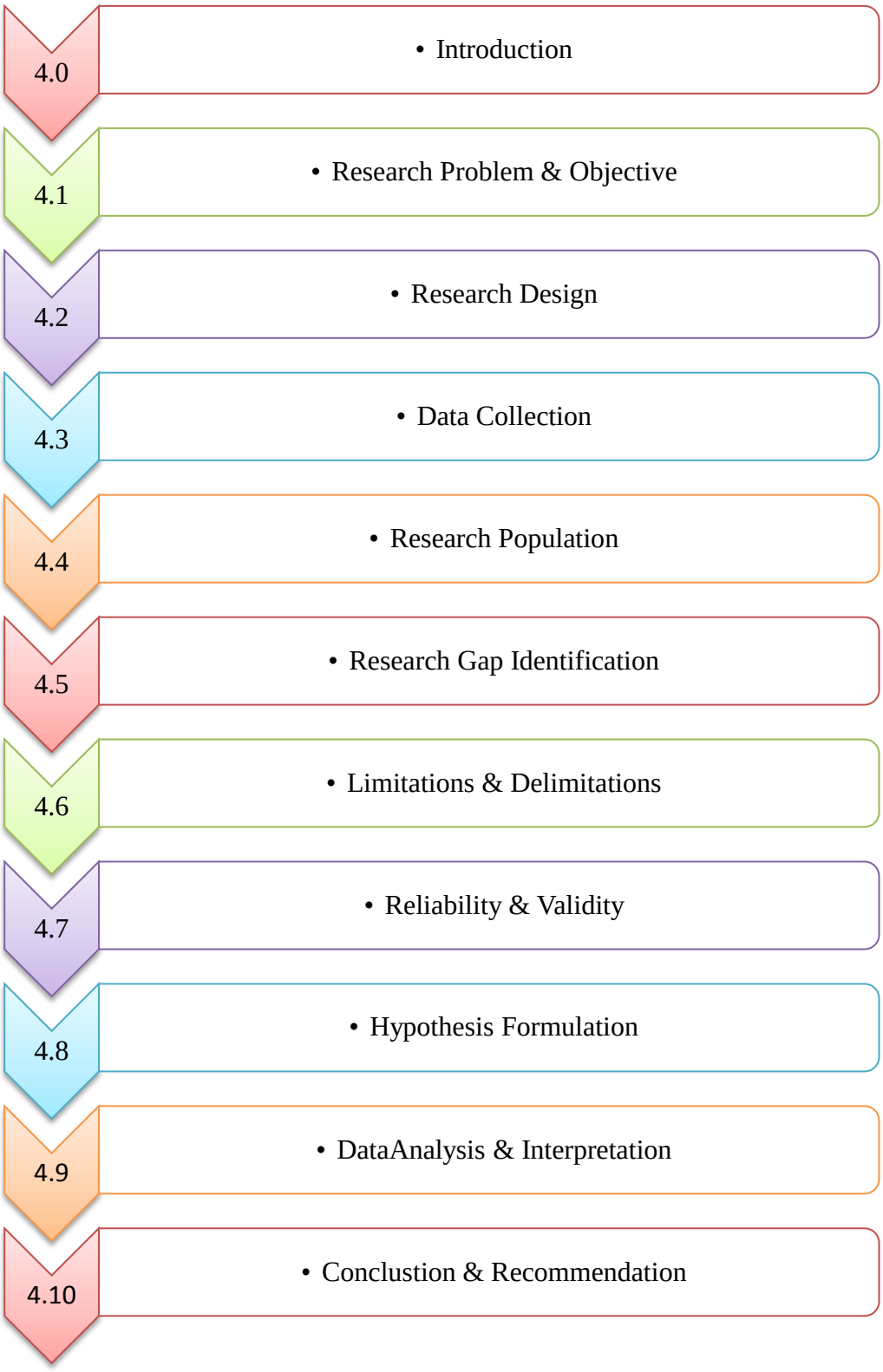
The reliability and validity for conducting any research study is very crucial aspect. In conceptual terms validity refers to the extent to which the data collecting tool is accurately measured what is intends to measure. For example, a research survey designed to explore depression but if it actually measures anxiety, than conceptually the survey is not to be considered as valid. The other measure of quality in a research quantitative study is reliability, or the accuracy or consistency of a survey. In other words, the extent to which a research tool consistently has the same results if it is used in the same situation on repeated occasions. The reliability and validity is thus very useful in drawing error free conclusions from the collected data. In order to ensure reliability and validity of this research study, consistency and

accuracy in data collecting tools or survey questionnaire has been formulated in consultation with experts in the field of renewable energy sectors and the content is updated as per the requirement of the research study.

In the present study the research study is on the ground of questionnaire, the reliability index is tested on the surveyed questionnaire. The researchers has utilised the statistical package for social science (SPSS) tools for reliability analysis with the support of Cronbach`s Alpha co-efficient, being a well-known method of reliability measurement in research, the range of which varies from 0 to 1. Here the Cronbach`s Alfa of given 252 nos of items is 0.975 which is nearby 1, which indicates that reliability index is **97.5%** , concludes that overall primary data information collected is most credible and best internal consistency of reliability between the given variables. The validity of the questionnaire has been measured with the help of Factor Analysis method. The factor analysis is applied to reduce the large numbers of variables into a small set of summarised variables, referred to as factors. In the present study the various factors related to statements of utility scale renewable energy projects has been factorised to explain he relationship among various variables. Hence in this present research study factor analysis is suitably utilized for varying the validity of the research. The factor analysis is being carried out on questions as narrated in chapter of data analysis & interpretations consisting of various factors through Principal Component Analysis (PCA).

4.10 Graphical form of Research Study:

Figure 4.2: Complete research methodology in the graphical form



4.11 Variable under Study:

Table 4.4 Finalization of variable for the research.

Independent Variables
• Challenges and barriers ✓ Financial challenges ✓ Evacuation issues ✓ Costing barriers ✓ Competitive barriers ✓ Technical barriers ✓ Awareness barriers ✓ Investment barriers • Policy & Regulatory ✓ Policy barriers ✓ Regulatory framework ✓ Support mechanism ✓ Political & Institutional barriers ✓ Government taxes, GST & duties ✓ Safe Guard Duties • Financial Investment: ✓ Investors interest ✓ Availability & Interest on loans ✓ Return on Investment • Manufacturing / suppliers ✓ Manufacturing capacity available ✓ Product up gradation ✓ Raw materials availability • Value chain ✓ Market competitions ✓ Logistic & delivery ✓ Materials availability ✓ Cost competitiveness • Cost of projects development

✓ Cost of materials ✓ Cost of equipment's ✓ Cost of land ✓ Cost of labours ✓ Taxes & duties
Dependent Variables
• Renewable energy resources potential: ✓ solar radiations, wind flow, weather conditions ✓ Differ at Various regions of India • Renewable energy project capacity development ✓ site availability, evacuation facility availability, • Renewable energy project viability • Government Target • Stake holders perception

4.12 Hypothesis:

(Kothari, 2004) ``When a predicted or hypothesized relationship is to be tested by scientific methods is a research hypothesis and is a predictive hypothetical statement which relates independent variables to a dependent variable``. Here, independent variables as well as dependent variable are defined and accordingly, the hypothesis statement is prepared. Following are the major hypothesis to be tested with appropriate statistical tools.

H01: There is no significant difference in the perception about different state/area have different Renewable Energy potential.

H02: There is no significant difference in the perception about potential of renewable energy (solar & Wind energy) in India across Type of Organization

H03: There is no significant association between available renewable energy potential and achievement of Government target.

H04: There is no significant difference in the perception about existing policies and supports helps in achieving the government target for renewable energy projects across different States of India.

H05: There is no significant association between central and state level policy supports for decision of installation of renewable energy

H06: There is no significant difference in the perception about criticality of various risks associated to investment in utility scale renewable energy projects across various organization groups.

H07: There is no significant association between installation of renewable energy projects and opportunities for green employment generation to boost India's economy

H08: There is no significant relationship between potential of renewable energy (solar & wind energy) and opportunities for solar power project development.

H09 : There is no significant difference in the perception about effectiveness of value chain for RE project component from other countries across Types of Organization.

H010 : There is no significant difference in perception about cost for procurement of materials for renewable energy projects from India & abroad across types of organizations.

H011: There is no significant relationship between Government target and available manufacturing capacity in India to meet target.

H012 : There is no significant difference in the perception about cost competition for development of solar and wind power projects across the various states of India.

H013 : There is no significant difference in the perception about project cost viability about solar / wind power project across Types of Organization

H014 : There is no significant difference in the perception regarding the initial cost of the setting up of utility scale solar / wind power projects across Years of Experience group

H015 : There is no significant difference in the perception regarding the operation & maintenance cost of the setting up of utility scale solar / wind power projects across Types of Organization

H016: There is no significant difference in the perception about awareness for renewable energy project development across various regions/ states of India.

H017 : There is no significant difference in Regulatory policy related factors affecting the development of utility scale renewable energy projects within different experience group.

H018 : There is no significant difference in factors related to current challenges for installation of renewable energy projects within different organizational group.

References

1. Creswell, J. W. (2014). *Research Design - Qualitative, Quantitative and Mixed methods approaches* (4th Edition ed.). California, USA: SAGE Publications Inc.

2. Dash, N. K. (2011). *Marketing Research* (Vol. 6th Edition). USA, Georgia: Pearson.

3. Dr. P. Narayan Reddy, D. G. (2008). *MArketing Research* (1st Edition ed.). Hydrabad, Andhra Pradesh, India: Excell Book, New Delhi.

4. E.McNABB, D. (2010). *Case Research in Public Management.* (1. edition, Ed.) New York, USA: Routledge, Taylor & Francis Group.

5. E.Spector, P. (1981). *Research Design -Quantitative applications in Social Sciences.* London: SAGA International Publications, New bury Park London.

6. Holliday, A. (2007). *Doing annd writting Qualitative Research* (second edition ed.). London, USA: SAGE Publications Ltd, London,California and Delhi .

7. James H McMillan, S. S. (2001). *Research in Educataion: A conceptual Introduction* (5th ed.). New York, USA: Addison-Wesley Longman.

8. Kothari, C. R. (2004). *Research Methodology - Methods and Techniques* (2nd Revisied Edition ed., Vol. 2nd Revisied Edition). New Delhi, NCR, India: New Age International Publishers.

9. Silverman, D. (2004). *Qulitative Research - Theory, Method and practices.* (2. Edition, Ed.) London, USA: SAGE Publications.

10. W.Paul Vogt, D. C. (2012). *When to use Which Research Design.* New York, London, New York, USA: The Guilford Press, www.guilford.com.