CHAPTER 3

RESEARCH METHODOLOGY

This chapter covers the research design and research methods used in this study to carry out systematic investigation in order to establish facts and reach the conclusions.

3.1 Research Process:

Research process is a road map to achieve research objective. It involves research design which depends on type of research. Research process consists of series of actions or step necessarily carries out research and the desired sequencing of the steps (Kothari C.R., 2004).

The research process is the step-by-step procedure of developing one's research and research paper. However, one can seldom progress in a step-by-step fashion as such. The research process involves identifying, locating, assessing, analyzing, and then developing and expressing the ideas. All of these activities will be based on primary and secondary sources from which recommendations or plans are formulated.

3.2 Research Methods

Research methods or techniques; refer to the methods the researchers use in performing research operations. Thus research methods are the methods used for data collection in research. Research methods involve surveys, interviews, case studies, observation, experiments, etc. It can be said that research methods are mainly used to gather information so that the researcher can find answers to the research problem. (Saunders et al., 2009)
RESEARCH PROCESS FLOW CHART

Identification of Research Topic

Literature Review Identification of Research Gap

Research Question

Formulation of Research Objective

Identification of Variables & Preposition of theoretical model

Hypothesis Formulation

Questionnaire Development Sampling Pilot Study & Pretesting

Conducting Survey

Hypothesis

Findings

Conclusion / Recommendation

Figure 3.1 Research Process Flow Chart
3.3 Research Methodology

Research methodology is a way to systematically solve the research problem. Research methodology not only describes the research methods but also considers the logic behind the methods that are used in the context of the research.

In our research, we have implemented descriptive research methodology, used to describe characteristics and/or behavior of sample population.

Descriptive studies are closely associated with observational studies, but they are not limited with observation data collection method, case studies as well as, surveys can also be specified as popular data collection methods used with descriptive studies.

Descriptive studies can contain the elements of both, qualitative and quantitative methods within a single research. In descriptive studies data collection is facilitated without changing the environment.

Three main purposes of descriptive studies can be explained as describing, explaining and validating research findings. It explains the overarching theoretical and philosophical frameworks which guides the research.

Research methodology involves the theoretical frameworks and learning of the various techniques that can be used in the conduct of research and the conduct of tests, experiments, surveys and critical studies. (Saunders et al., 2009)

3.4 Research Design:

Research design for research project is analogous to architectural plan for building construction. Saunders et al. (2009) has nicely explained the research design through concept of Research onion.

The process suggested by Saunders et al. (2009) in the Research onion concept (Fig.3.2) occurs in layers. This involves series of decisions before arriving in to overall approach to the research design and data collection technique.
3.4.1 Research Philosophy:

The way you view the world with some assumptions decides research philosophy you are going to adopt. Research strategy and methods depends on these assumptions. Knowledge and the process by which this knowledge is developed and our view about this influences the philosophy we adopt. (Saunders et al. 2009).

We have adopted Positivism as a research philosophy in this research as researcher maintains distance from the research subject in this research. Survey based approach is used for primary data collection which relate to the positivism.

3.4.2 Research approaches: There are two types of research approaches deductive and inductive. Researcher can use deductive approach in which he can develop a theory and hypotheses and design a research strategy to test the hypothesis or inductive approach in which
he will collect data and develop theory as the result of his data analysis (Saunders et al. 2009). In this research we have used deductive approach.

3.4.3 Research strategy: Research strategy is defined as a road map towards the goal of research and how to achieve this goal, to answer research questions (Saunders et al., 2009).

Following are different research strategies:

i) Experiment
ii) Survey
iii) Case study
iv) Action research
v) Grounded theory
vi) Ethnography
vii) Archival research

We have adopted survey as our research strategy.

Survey strategy is usually associated with the deductive approach. It is used to answer who, what where, how much and how many questions. It is most common strategy for business and management research and therefore tends to be used for exploratory and descriptive research (Saunders et al., 2009).

3.4.4 Choice of method: In a research researcher can use single data collection technique and corresponding data analysis procedure (mono method) or use more than one data collection technique and data analysis procedure (multiple method). Mixed method approach is where both quantitative and qualitative data collection techniques and analysis procedure is used (Saunders et al., 2009).

In this research we have used Mono method, where quantitative data and data analysis procedure is used to answer research questions.

3.4.5 Time horizons: Research may be time constrained or “snap shot” research which is called as cross sectional study or it may be with longer time duration or diary or series on snap shots (Saunders et al., 2009).
As like most academic research, this research is a **cross sectional study**. Cross sectional studies are generally use survey strategy.

**3.4.6 Techniques and procedures:** Data collection and data analysis is the innermost layer of the Research onion as shown in Fig. 3.2. Here researcher has to ensure that there is no bias in collecting the data.

In interpretation of data, data is analyzed against the theoretical framework. As we are working deductively (from theory to data) hypotheses have been developed from the theory. Data collected through survey is analyzed to test these hypotheses.

We have planned and used following data analysis techniques in this research.

i) Descriptive Statistics
ii) Normality Test
iii) Outlier test
iv) Reliability test
v) Hypothesis testing-Using Correlation analysis and Chi square test
vi) Multiple Regression analysis

<table>
<thead>
<tr>
<th>Objective</th>
<th>Data Analysis Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality test for data</td>
<td>Normal Curve distribution</td>
</tr>
<tr>
<td>Data Reliability Test</td>
<td>Cronbach Alpha</td>
</tr>
<tr>
<td>Outlier test</td>
<td>Skewness and Kurtosis</td>
</tr>
<tr>
<td>Hypothesis Testing</td>
<td>Correlation Analysis Pearson Correlation coefficient Chi-Square test</td>
</tr>
<tr>
<td>Key drivers of overall success rate</td>
<td>Regression Analysis- Multiple linear regression ($R^2$ and Beta coefficient)</td>
</tr>
<tr>
<td>Data trend, Mean, Standard Deviation</td>
<td>Descriptive Statistics</td>
</tr>
</tbody>
</table>

**Table 3.1 Data Analysis techniques used in this study**
3.5 Research Questions

Research question is probably the most important task in the research process because the question becomes the driving force behind the research—from beginning to end. Research questions are one of a number of key questions that the research process will address. These are often the precursor of research objectives. Clear research questions, based on the relevant literature, will act as a focus for the research that follows. Research can be distinguished from intelligence gathering as it is theory dependent. Writing a research proposal helps to organize ideas, and can be thought of as a contract between you and the reader. The content of the research proposal should tell the reader what study is about, why it is being done. (Saunders et al., 2009)

Research Questions for this study:

**Main Research Question:** How do Indian Manufacturing organizations select and implement a suitable Process Excellence Methodology from Lean, Six Sigma and Theory of Constraints?

**RQ1:** Which factors are responsible for successful implementation of Process Excellence Methodology in Indian Manufacturing Organizations?

**RQ2:** Which Process Improvement Methodology is preferred by Indian Manufacturing Organizations?

**RQ3:** How performance of Indian Manufacturing Organizations improved after implementation of Process Improvement Methodology?

3.6 Research Objectives:

Research objectives are likely to lead to greater specificity than Research or investigative questions. Research Objective is a clear, specific statements that identify what the researcher wishes to accomplish as a result of doing the research. Research objectives are likely to lead to greater specificity than research or investigative questions. Maylor and Blackmon (2005) recommend that research objective can be your personal objective. You may conduct research to achieve these personal objectives like learning some specific field, or obtaining specific research knowledge. It can be your career goal also.
Following are the research objectives for this research:

i) To develop a theoretical framework for the Process Excellence Methodology implementation in Indian manufacturing organizations.

ii) Empirically validate the theoretical framework for the Process Excellence Methodology implementation in Indian manufacturing organizations.

iii) Suggest guidelines for implementation of Process Excellence Methodology in Indian manufacturing organizations.

3.7 Theoretical Framework:

“A theory is a simplified representation of the limited part of reality” (Pawar, 2009). Science tells us fact about this universe in meaningful way called as theory. A theory is not a permanent and can be changed depending on new inventions in science.

“A theory is a statement of relations among concepts within a set of boundary assumptions and constraints” (Bacharach, 1989). A statement of relationships between various things in empirical world can be defined as theory (Bacharach, 1989).

“How, when and why” are the questions to be answered by theory and not question “what” for which answer is the goal to be achieved (Bacharach, 1989).

Dubin (1976) defines “theory as an attempt by man to model some aspect of the empirical world”.

As per Torraco (2005), a theory is a system for explaining a set of phenomena that specifies the key concepts that are operative in the phenomena and the laws that relate the concepts to each other. In their paper, Stewart and Harte (2011) states that the concept of theory is connected to notions of science that, in origin at least, refers to the investigating the world according to a set of rules and principles. Theory also is a unified, systematic explanation of a diverse range of social phenomena (Schewandt, 1997).

As per Pawar (2009), a theory is a human effort to provide a representation, through the use of human language, of the reality. The representation is used to provide an orderly depiction
of some phenomenon in the real world in a manner that some complexity of the real phenomenon is reduced in the representation. As theory seeks to represent only some part of the real-world phenomenon, a theory has its own scope and boundary conditions (Pawar, 2009; Dubin, 1976)

3.7.1 Research Framework:

A framework for research as a structure that provides “guidance for the researcher as study questions are fine-tuned, methods for measuring variables are selected and analyses are planned” (Liehr and Smith, 1999). Once data are collected and analyzed, the framework is used as a mirror to check whether the findings agree with the framework or whether there are some discrepancies; where discrepancies exist, a question is asked as to whether or not the framework can be used to explain them (Imenda, 2014).

3.7.2 Identification of variables and Building a theoretical framework:

An extensive literature review has been carried out to find out various success factors. As given in previous chapter the top 10 success factors represents view of most of the authors. These success factors are mainly responsible for successful implementation of Process Excellence implementation. Various success factors as observed in literature review have been identified as independent variables (with simplified names for planned survey purpose) and the dependent variable is organization’s performance. Organization’s performance is measured by various variables. The independent variables are used to form six success dimensions and the dependent variables are clubbed under three dimensions to form a main dependent variable “Organization Performance”. The theoretical framework is built on this assumption which has to be empirically tested.

3.7.3 Independent variables:

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Success Factors</th>
<th>Success Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Leadership</td>
<td>Top management commitment</td>
</tr>
<tr>
<td>2</td>
<td>Management Involvement &amp; commitment</td>
<td>Top management commitment</td>
</tr>
<tr>
<td>3</td>
<td>Organization Infrastructure</td>
<td>Top management</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>4</td>
<td>Customer focus</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>5</td>
<td>Employee Training</td>
<td>Training and Development</td>
</tr>
<tr>
<td>6</td>
<td>Understanding methodology, tools and techniques</td>
<td>Training and Development</td>
</tr>
<tr>
<td>7</td>
<td>Understanding customer requirement</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>8</td>
<td>Linkage to business strategy</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>9</td>
<td>Customer involvement</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>10</td>
<td>Supplier involvement</td>
<td>Supplier Relationship Management</td>
</tr>
<tr>
<td>11</td>
<td>Relationships with suppliers.</td>
<td>Supplier Relationship Management</td>
</tr>
<tr>
<td>12</td>
<td>Supplier Training</td>
<td>Supplier Relationship Management</td>
</tr>
<tr>
<td>13</td>
<td>Work Environment &amp; Culture</td>
<td>Organizational Culture</td>
</tr>
<tr>
<td>14</td>
<td>Team building and Team spirit</td>
<td>Organizational Culture</td>
</tr>
<tr>
<td>15</td>
<td>Employee recognition</td>
<td>Organizational Culture</td>
</tr>
<tr>
<td>16</td>
<td>Involvement of workers</td>
<td>Organizational Culture</td>
</tr>
<tr>
<td>17</td>
<td>Cultural change</td>
<td>Organizational Culture</td>
</tr>
<tr>
<td>18</td>
<td>Project management skills</td>
<td>Human Resource Management</td>
</tr>
<tr>
<td>19</td>
<td>Linkage to human resources</td>
<td>Human Resource Management</td>
</tr>
<tr>
<td>20</td>
<td>Number of Certified employees</td>
<td>Human Resource Management</td>
</tr>
</tbody>
</table>

**Table No. 3.2 Independent variables**
3.7.4 Dependent Variables:

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Performance measure</th>
<th>Performance Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Improvement in Quality of Products.</td>
<td>Quality Performance</td>
</tr>
<tr>
<td>2</td>
<td>Reduction in Process Variability.</td>
<td>Quality Performance</td>
</tr>
<tr>
<td>3</td>
<td>Improvement in delivery of Product.</td>
<td>Quality Performance</td>
</tr>
<tr>
<td>4</td>
<td>Reduction in Scrap and Rework.</td>
<td>Quality Performance</td>
</tr>
<tr>
<td>5</td>
<td>Reduction in Process Cycle Time.</td>
<td>Quality Performance</td>
</tr>
<tr>
<td>6</td>
<td>Improvement in Customer satisfaction.</td>
<td>Financial Performance</td>
</tr>
<tr>
<td>7</td>
<td>Improvement in Sales</td>
<td>Financial Performance</td>
</tr>
<tr>
<td>8</td>
<td>Increase in Market share</td>
<td>Financial Performance</td>
</tr>
<tr>
<td>9</td>
<td>Decrease in the per unit cost of manufacturing</td>
<td>Financial Performance</td>
</tr>
<tr>
<td>10</td>
<td>Increase in organization’s turnover</td>
<td>Financial Performance</td>
</tr>
<tr>
<td>11</td>
<td>Increase in organization’s profits.</td>
<td>Financial Performance</td>
</tr>
<tr>
<td>12</td>
<td>Increase in Return on investment.</td>
<td>Financial Performance</td>
</tr>
<tr>
<td>13</td>
<td>Improvement in retention rate of employees</td>
<td>Non-Financial Performance</td>
</tr>
<tr>
<td>14</td>
<td>Improvement in per employee productivity</td>
<td>Quality Performance</td>
</tr>
<tr>
<td>15</td>
<td>Increase in employee training hours</td>
<td>Non-Financial Performance</td>
</tr>
<tr>
<td>16</td>
<td>Improvement in Employee moral</td>
<td>Non-Financial Performance</td>
</tr>
<tr>
<td>17</td>
<td>Increase in employee motivation level</td>
<td>Non-Financial Performance</td>
</tr>
<tr>
<td>18</td>
<td>Increase in employee’s satisfaction with their work profile</td>
<td>Non-Financial Performance</td>
</tr>
<tr>
<td>19</td>
<td>Increase in employee satisfaction with support and facilities offered at workplace</td>
<td>Non-Financial Performance</td>
</tr>
<tr>
<td>20</td>
<td>Increase in employee involvement in problem solving process</td>
<td>Non-Financial Performance</td>
</tr>
<tr>
<td>21</td>
<td>Reduction in the equipment downtime</td>
<td>Quality Performance</td>
</tr>
</tbody>
</table>

**Table 3.3 Dependent Variables**

As shown in above, there are Six success dimensions (identified based on Literature review outcome) of PEM implementation:
i) Top Management Commitment (TMC)

ii) Customer Relationship Management (CRM)

iii) Training and Development (T&D)

iv) Supplier Relationship Management (SRM)

v) Organizational Culture (OC)

vi) Human Resource Management (HRM)

3.7.5 Description of Success Dimensions:

Table shows six success dimensions. These success dimensions are formed by grouping independent variables having similar characteristics.

i) **Top management commitment** (TMC): The decision of Process Excellence implementation is taken by top management considering need of the organization. The role of leadership is very important here. Leadership of the organization gives the direction, motivation to the employees. They also provides necessary organization infrastructure for PEM implementation. Management involvement and commitment influences the success of PEM implementation.

ii) **Customer Relationship management** (CRM): To survive in competition, organization has to fulfill and exceed the need of customer. Organization considers customer’s need for PEM selection and implementation. As per literature reviewed, understanding customer requirement and linkage to business strategy are critical success factors for PEM implementation. Many organizations involve customers in product and process improvement process.

iii) **Training and Development** (T&D): Required skills for PEM implementation is acquired through systematic and structured training. Organizations are preparing employees for PEM implementation by arranging specialized training. Six sigma is having very unique step by step training methodology called ‘belt system’. At bottom it starts with yellow belt, then green belt, black belt and at the top master black belt. As per literature reviewed employee training and understanding methodology, tools and techniques are critical success factors for PEM implementation.

iv) **Supplier Relationship Management** (SRM): A literature review also highlights the importance of Supplier Relationship Management, involvement of suppliers in PEM
implementation process and relationship with supplier are critical success factors as per most of the authors. The quality of spares, sub-assemblies and raw material supplied by supplier decides quality of final product. Many organizations extend their quality program to supplier. Supplier training is an essential part of PEM implementation.

v) **Organizational Culture (OC):** As per Literature review work environment and culture, team building and team spirit, employee recognition and involvement of workers are critical success factors for PEM implementation. Organization culture decides the attitude of employees towards the PEM implementation.

vi) **Human Resource Management (HRM):** Few of the authors linked human resource management to successful implementation of PEM. Human resource policies for development of employees for PEM implementation, like developing certified employees, recruiting employees with project management skills are critical for successful implementation of PEM.

Above dimensions results in to following Organization performance measures:

i) **Quality Performance**

ii) **Financial Performance**

iii) **Non-Financial Performance**

### 3.7.6 Description of Organization performance measures:

i) **Quality Performance:** This is an important performance measure. Quality of process, product, delivery and service determines the success of PEM implementation. Reduction in scrap and rework is an indication of improved quality. Process quality improvement reduces equipment downtime.

ii) **Financial Performance:** Decrease in the per unit cost of manufacturing, Improvement in Sales, Increase in market share, Increase in organization’s turnover, Increase in organization’s profits, Increase in Return on investment are measures of financial performance after PEM implementation.

iii) **Non-Financial Performance:** Increase in employee training hours, Improvement in Employee’s moral, Increase in employee motivation level, Increase in employee’s satisfaction with their work profile, Increase in employee satisfaction with support and facilities offered at workplace, Increase in employee involvement in problem solving process are grouped under non-financial performance measures after PEM implementation.
A theoretical framework as given in Fig.3.2 has been developed based on above success dimensions and organization performance measures.

Theoretical Framework:

![Diagram of theoretical framework]

Figure 3.3 Theoretical Framework

3.8 Research Hypotheses:

Research hypothesis is the statement created by researchers when they speculate upon the outcome of a research or experiment. A prevalent form of data analysis used in participant observation is analytic induction. This may lead to an initial hypothesis being redeveloped more than once. Further, deductive methods are used to arrive at a hypothesis that is testable, falsifiable and realistic. (Saunders et al. 2009).
Following hypotheses developed from theoretical framework:

1. $H_0$ There is no relation between Top management commitment and organization performance after PEM implementation.
   $H_1$ There is a positive relation between Top management commitment and organization performance after PEM implementation.

2. $H_0$ There is no relation between Customer Relationship Management and organization performance after PEM implementation
   $H_1$ There is a positive relation between Customer Relationship Management and organization performance after PEM implementation

3. $H_0$ There is no relation between Training and Development and organization performance after PEM implementation
   $H_1$ There is a positive relation between Training and Development and organization performance after PEM implementation

4. $H_0$ There is no relation between Supplier Relationship Management and organization performance after PEM implementation
   $H_1$ There is a positive relation between Supplier Relationship Management and organization performance after PEM implementation

5. $H_0$ There is no relation between Organizational Culture and organization performance after PEM implementation
   $H_1$ There is a positive relation between Organizational Culture and organization performance after PEM implementation

6. $H_0$ There is no relation between Human Resource Management and organization performance after PEM implementation
   $H_1$ There is a positive relation between Human Resource Management and organization performance after PEM implementation
Additional Hypotheses:

7. \( H_0 \): There is no significance difference among the four employee size groups in terms of their opinion on successful on PEM implementation
   \( H_1 \): There is a significance difference among the four employee size groups in terms of their opinion on successful on PEM implementation

8. \( H_0 \): There is no significance difference among the four turnover size groups in terms of their opinion on successful on PEM implementation
   \( H_1 \): There is a significance difference among the four turnover size groups in terms of their opinion on successful on PEM implementation

3.9 Questionnaire Design:

Based upon Research Objectives and Research Question a structured questionnaire has been designed to gather the data required to test hypotheses derived from Research Question. Other than few information gathering qualitative and quantitative questions, a Likert scale is used for designing questions. The respondents were asked to indicate their degree of agreement by checking one to five response categories. The questionnaire designed keeping in mind the education and experience level of respondents.

3.9.1 Pre testing and Piloting the questionnaire

To improve the final quality of questionnaire a pre testing and piloting was done. First level a pre testing was done by distributing a questionnaire to 5 selected subject and industry experts. A detail discussion was done on the purpose, content and language of the questionnaire with these experts. The purpose of the pre testing was also to identify whether the questionnaire accomplishes the study objective. The questionnaire is modified after taking input of pre testing.

Then the pilot test was conducted. Pilot testing was done to ensure that the constructed questionnaire is reliable. The pilot process selects a small number of respondents from the original sample to examine how the questionnaire might be received by the entire sample and identify any potential problems. We have selected a sample of 30 for pilot test. The sample was carefully selected having characteristics of respondents similar to the final target group.
Questionnaire has been sent by email to various manufacturing industries in Mumbai and few outside Mumbai.

It has been decided that Questionnaire shall be modified taking various inputs given by respondents. This will ensure improved response. From pilot study we understood that for good response personal follow up required with respondents. Though response rate of 25% and more is recommended (Frazer and Lawley, 2000), our observation is that response rate from organizations is lower than this.

3.10 Sampling

3.10.1 Sampling techniques:

The sampling techniques are divided into two types:

- Probability or representative sampling;
- Non-probability or judgmental sampling.

With probability samples the chance or possibility of each case being selected from the population is known and is usually equal for all cases. This means that it is possible to answer research questions and to achieve objectives that require you to estimate statistically the characteristics of the population from the sample. Probability Sampling is often associated with survey and experimental research strategies (Saunders et al., 2009).

With non-probability samples, the probability of each case being selected from the total population is not known and it is impossible to answer research questions or to address objectives that require you to make statistical inferences about the characteristics of the population. You may still be able to generalize from non-probability samples about the population, but not on statistical grounds. However, with both types of samples can be used to answer other forms of research questions (Saunders et al., 2009).

In this study, simple random technique derived from probability sampling techniques is being used.
3.10.2 Universe and Population:

As per Kothari C.R. (2004) Universe refers to the total of the items or units in the field of inquiry and ‘Population’ means the total of items about which information is desired. In this study universe is Indian manufacturing industry and population is manufacturing industry where any Process Excellence Methodology is implemented.

Population can be finite or infinite. Finite population consists of fixed number of elements. In infinite population it’s theoretically impossible to observe all the elements. If population is very large from practical consideration we then use the term infinite population. Here we use theoretical concept of infinite population as an approximation of a very large finite population (Kothari, C.R., 2004). In this study we are considering manufacturing organizations in India as infinite population.

3.10.3 Sampling unit

Employees working in Indian manufacturing organizations at middle or senior level of management and responsible for Process Excellence Methodology (Lean, Six Sigma or Theory of Constraints) implementation. These include Quality Assurance managers, manufacturing engineers, Six Sigma black or green belts, consultants hired by organizations for implementation of PEMs, owners or CEOs of organizations.

3.10.4 Sampling frame

The Sampling frame for any probability sample is a complete list of all the cases in the population from which sample will be drawn (Saunders et al. 2009). As it is difficult to get comprehensive list of all Indian manufacturing organizations, we used CII and IIMM industries directory and various other industries directory as sampling frame.

3.10.5 Sampling size and Sampling techniques:

In this study a random sampling method is used. Sample size of 1100 was selected for sending survey questionnaire.

3.10.6 Sample Size: based on assumption of infinite population

India is very big country having cottage industry, small scale manufacturing units, medium scale manufacturing units, large scale manufacturing organizations spread throughout and every corner
of country. It's almost impossible to count the exact number of manufacturing units in India. So the total population (N) i.e. the number of manufacturing organization in India is considered infinite while calculating sample size for this research. We have used following formula based on assumption of infinite population to calculate the sample size.

Assuming the percentage of manufacturing organizations using PEM to be 30 % (based on estimates by experts) the sample size N is required to estimate this percentage is :-

\[ N = \frac{z^2PQ}{d^2} \]

assuming \( N \rightarrow \infty \)

Where  
\( Z = 1.96 \) for 95% confidence

\( P = \% \) of users of PEM=30

\( Q = (100-P)=70 \)

\( d = 10\% \) of P = 3.0

(10\% error)

Calculating sample size n,

\[ n = (1.96)^2(30*70) = 896 \]

\( (3)^2 \)

Hence, sample size, assuming \( N \rightarrow \infty \)

N = 896 i.e. approximately 1000

3.11 Data Collection and conducting a survey:

Though there are various methods of data collection like sending questionnaire by post, telephonic interview, to contact respondent personally, sending questionnaire by email and online data collection, we have preferred online method. There are various reasons to select online method, one of the reason is considering the characteristic of respondent, and we know that he or she will have easy accessibility to internet either on computer or on mobile. We used Survey Monkey for actual survey. This is considering easy to access and submitting the completed questionnaire. However we have also kept option of filling hardcopy of questionnaire. But we have not received any response through hard copy. We have sent the questionnaire to
approx. 1100 respondents. We have received 185 responses. Thus the response rate was 16.82%. Out of 185 total 177 responses were found suitable for analysis.

<table>
<thead>
<tr>
<th>Questionnaire sent</th>
<th>Responses received</th>
<th>Response rate</th>
<th>Suitable responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100</td>
<td>185</td>
<td>16.82%</td>
<td>177</td>
</tr>
</tbody>
</table>

Table 3.4 Survey responses

3.12 Research Ethics

Once we decide to conduct survey, the respondents may be an individual, an organization. We have to collect information regarding these individuals or organizations, analyze it and report it to somebody else. Here the question of ethics arises. As an organization or individuals are subject to get affected by our action.

Cooper and Schindler (2008) have defined ethics as the norms or standards of conduct that guide moral choices about our behavior and our associations with others.

The way we select research topic, research design, survey method, collect and analyze data affects research ethics. This means that we will have to make certain that the way we design our research is both methodologically sound and ethically defensible to all those who are involved. The behavior of the researcher shall be as per social rules of the society of respondent (Zikmund 2000). A social norm decides the way person behaves in a particular situation. (Robson 2002; Zikmund 2000).

In this research while conducting survey we have considered ethical issues by maintaining confidentiality of respondents and giving them assurance that data collected will be used only for research purpose.

3.13 Conclusion

The study adopts positivism research philosophy and deductive approach. The survey method is used for data collection and various data analysis techniques deployed to achieve research objectives as given in 3.4.6 and table 3.1. Next chapter will discuss the data analysis carried out to answer the research question and to test the hypotheses in detail.