Chapter III
METHODOLOGY

3.1 Introduction

This chapter discusses development of research methodology adopted for data collection, treatment and comparison and verification of the hypotheses laid down by the researcher, to measure quality of engineering education in some of the engineering colleges within Pune University Area. The chapter contains the definitions and identification of stakeholders of engineering education system and enlists their expectations from the system based on proven experiences and traditional mindsets. To verify the extent to which these expectations of stakeholders are fulfilled, a detailed feedback process, based on questionnaire, is conceived and designed. The criterion for choosing the participants in the feedback process, based on random sample selection, is described in this chapter. The later part of the chapter discusses, at length, the philosophy of framing the questionnaire and tools and techniques used to analyze and present the results.

The issue of quality assurance in higher education has been at the top of the agenda of universities / institutions throughout the world. Many countries aim at creating a common higher education area, within which universal standards and programme structures to achieve an internationalisation of education, are formulated. In today’s environment, given the international competition for the students, staff, faculty and resources, all universities and institutions need to constantly improve their quality standards to maintain quality standing by demonstrating cost of poor quality. Present study proposes to find the link at different stages of education process specifically at input, process and output level, which will wide open the doors for understanding of quality management in educational institution.

The study has used self administered questionnaire and structured interviews to collect data from personnel in addition to data collection from 10 engineering colleges of different standing based on age, location, only for girls and co-education etc. and analysed these with statistical tools to find correlation between different factors of
education process. The stratification of colleges was necessary to get an inclusive picture. Statistical concepts [66] have become a global trendsetter in developing quality management strategy. The success is primarily due to its data-based approach, which eliminates personal bias. Statistical techniques are a pack of tools in the repertoire of any decision maker to arrive at rational decisions. Since statistical concept is based on data, the quality of the data assumes paramount importance. Statistical law of regularity says, if the data comes from a set controlled conditions the data will exhibit a predictable pattern called statistical models.

### 3.2 Statistical Models [67]

**Generic Model:** The conventional Statistical Process Control (SPC) and other techniques like Total Productive Management (TPM) and TQM etc. also play an important role in analysis. Cause and effect diagrams, check sheet and Pareto, process map or flow diagram are techniques for diagnosing the problem. All these techniques are used to identify source of variation and controlling variation.

**Data Oriented Statistical Models:** Binomial model, Poison model, Normal model, Process capability are the techniques which are based on the data collected for finding cause of the variation.

**Control Phase Models:** Results achieved will have to be monitored. Control charts are useful to monitor the system performance. Some of the frequently used charts are $\bar{X}$ - $R$, $p$ and $np$ charts, $c$ charts and $u$ charts etc.

Here the information has been provided on input factors to education process, core education process factors and the output of the education process which gives the relation of all these factors with the help of Tree Diagram Model [68].

**Tree Diagram Model:** A tree diagram model is useful for identifying the tasks and the factors involved in the main process. It is beneficial in solving complicated problem and achieving the objective in a systematic way. A tree diagram drawn for Factors involved in the engineering education process is shown in the Figure 3.1.
**Tree Diagram Model:** A tree diagram drawn for factors involved in the engineering education process

**Figure 3.1 Tree Diagram Model**
3.3 Hypotheses

The growth of undergraduate engineering education in India is phenomenal. The number of institutions conducting engineering programs is increasing every year by leaps and bounds. In the year 2000 it was 880, then in the year 2005 it went up to 1,635 and presently in 2007 it is 1,825. The discussion about the quality of higher education is taking place at all levels of academics. Hence the objective of this study is to measure the quality of undergraduate engineering education within Pune University Area through the

1. performance of the institutions
2. performance in relation to stakeholders’ priorities
3. relative performance of the institutions
4. finding priorities for the performance improvement of individual institutions

It is proposed to validate or otherwise the following hypotheses.

Hypothesis 1: Student feedback about the education process contributes significantly towards enhancing the quality of education

Hypothesis 2: A clear mission, objective and commitment of the management towards satisfaction of the stakeholders in the institute is necessary to improve the quality of education in the institute

Hypothesis 3: Sensitivity of the management towards satisfaction of the stakeholders is essential to improve the education process

Hypothesis 4: Research development and training activities through faculty development programs goes a long way towards enhancing quality of education

Prima facie’ the present investigator has no loyalty to any of the above hypotheses. Only data can validate the above hypothesis.

3.3.1 Engineering Education Process Approach

The study of Figure 3.1 gives fair idea about engineering education in simple manner. Engineering education activity has process input, process output and the main teaching
learning process. Factors involved and the stakeholders connected to these processes and
the sub-processes are shown in Figure 3.2 which also illustrates the education process by
using analytical tool known as ‘Cause and Effect diagram’. [69]

3.4 Identification of Stake Holders

While studying factors involved in engineering education process with the help of Tree
Diagram Model, the important stake holders of the education process are identified and
are shown in Figure 3.3

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Figure 3.2 Engineering Education Process

Figure 3.3 Stakeholders of the Education process
**Student:** Since every education system should and must be student or learner centric. The Student has been identified to be the first stakeholder of the engineering education system. He or she is the living entity who is the beneficiary or the loser, can be an idol or a culprit, can impact and get affected by policies and decisions executed in the system. The student is the first and foremost evaluator to decide quality, values and ethics in the system and therefore, is the most prioritized element to accept or reject any model of education in the hierarchy of the engineering education system.

**Teacher:** The teaching learning process should be, and is, a dialog or interaction, between students and teacher. Since teacher is an equally respectable personality in the Indian culture at par with the parents, the second hierarchical stakeholder of technical education system is the Teacher. Being an Acharya, or Guru, the teacher is responsible for shaping and molding the personality and future of the student. Whether he enters the profession by choice or by accident, he orients himself with the traditional practices followed in the teaching learning process, sometimes innovate styles, tries to remain a learner throughout and contributes to the society as an individual.

**Management:** The Management or administrator of engineering education institute / college, may be private or government, are identified as the third stakeholder. They are the major resource generation agencies, which facilitate the whole teaching learning process with required inputs. They are the entities which responded in time to the privatization policy of the government, sensed the need of the time and acted with vision to share the responsibility.

The above three stake holders are an integral part of the institution and may be described as ‘Internal Stakeholders’.

**Industry:** The student is the final outcome or a live product of the teaching-learning process in engineering education system. Industry at large is a buyer of this product; it renders a finishing touch to this human resource (HR), making it more competent and skilled. With the involvement of such HR, industry contributes to the overall economic development of the country, along with Agriculture and lifts the living standards of the citizens. We, therefore, consider Industry as the next stakeholder of engineering education system.
Parents: In India, unlike in western countries, because of the highly bonded family structure, parents feel themselves responsible for educating their wards. The type of education, which can bring materialistic and mental happiness to the children therefore, becomes the choice of the majority of the families. Also the concept of student financing his own education is very rarely seen in the society. The parents are payers or financers to the engineering education system in most of the cases. We, therefore, consider Parents as another important stakeholder of engineering education system.

The above two stakeholders are not a part of the institution but are interested in the institute and its final product. They may be defined as ‘External Stake holders’.

Finally, it is the society at large which tastes the fruits of the up-liftment in whatever aspect is affected due to technical education system. In a civilized culture, an educated person should exhibit a sense of social obligation. He / she should behave as a responsible citizen who repays directly or indirectly to the society. Development of an individual results in societal progress, which in turn, links to national development. The actions and activities of all the above-identified stakeholders have finally an impact on the society. Therefore indirectly Society is also a stake holder of technical education System [70].

3.5 Research Methodology
After identifying the stakeholders in the engineering education system and their expectations, the following research methodology is adopted to study the measurement of quality in undergraduate engineering education. A detailed questionnaire was administered for each stakeholder, based on his or her mentality, philosophy and expectations.

3.5.1 Philosophy of Questionnaire Design
We explain below the thought process or the philosophy of the stakeholder that was sensed by the researcher in his interaction throughout his professional tenure. Since every stakeholder has his own place or layer in the hierarchy of engineering education system, the design of the question set stake-holder-wise has minute reflections as human being or a system entity. The questions are broadly related to the academic side of engineering education system.
Since we have been stressing upon the thought that every education system must be learner-centric, a large number of questions have been designed in the questionnaire for the students. This element of the system has emotional concerns with many other elements like teacher, his teaching style, the evaluation process, the infrastructure facilities, the placement opportunities etc. The questionnaire surely includes all these aspects.

3.5.2 Design of Questionnaire

A distinct and exclusive question-set is designed for each stakeholder. Every question set has about 20 to 25 questions whose answers are sometimes objective, sometimes multiple-choice types, sometimes just assertive or negative. Sometimes, the stakeholders are requested to express their opinion in their own words. The Table 3.1 shows questionnaire identification number for each stake holder.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Questionnaire Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>1</td>
</tr>
<tr>
<td>Teacher</td>
<td>2</td>
</tr>
<tr>
<td>Management</td>
<td>3</td>
</tr>
<tr>
<td>Industry</td>
<td>4</td>
</tr>
<tr>
<td>Parents</td>
<td>5</td>
</tr>
</tbody>
</table>

These question sets are appended to thesis.

3.5.3 Data Acquisition

The set of questionnaire is handed over to respective stakeholders personally with brief information of the objective. The filled in questionnaires have been collected through personal visits or through courier. The soft copy of the questionnaire was circulated through internet and intranet of different colleges taken for study and the answers received are expected to reflect the perception of the stakeholder with honesty and faith. The whole feedback process to be executed through this question set is implemented by a random sampling technique.
3.6 Identification as Benchmark [71]

While working with the results of different engineering colleges under Pune University, the need for selecting one of the engineering colleges as a benchmark under Pune University was felt. This need drew attention towards College of Engineering Pune (COEP), because it is pioneer in offering engineering education for undergraduates for the last 150 years. Benchmarking provides an established standard of measurement and helps to focus on the mission. It also helps organizations to move away from being introspective towards being externally focused. Benchmarking is one of the important management methods to identify and fill the gaps in performance by putting in place best practice, thereby establishing superior performance. Even though the need was of identification of Benchmark College and based on students performance for so many decades as COEP stood best engineering college, but for study purpose we thought of calling it as ‘Branded College’ in place of ‘Benchmark College’. This issue involves sentiments of lot many people in the society and need introspection. However it is a fact that none of the department of the College of Engineering Pune has undergone through the process of quality inspection by NBA or any such authority but people in the society have very high perception about this college as far as engineering education is concerned. Hence COEP is taken as branded college for our further study. In this study data has been collected on COEP also. The final statistical analysis will show that it has maximum score and can be called as a ‘Benchmark College’.

3.6.1 Why COEP as Branded College? [72]

College of Engineering has completed successfully 150 years on 1st February 2005. The historical development of the college witnessed not only the development of the college but the development continued on the national and international platform. Important landmarks are listed below.

- 1854–The college was established with the name ‘Poona Engineering Classes and Mechanical school’
- 1864–The name of the college changed to ‘Poona Engineering College’ and the college was affiliated to Bombay University
• 1866–The first batch of 20 students passed out with the degree in Civil Engineering
• 1869–The college workshop was established
• 1879–Agriculture and Forestry departments were started, which was known as ‘College of Agriculture’, Pune
• 1904–This year college restricted the scope of teaching and learning to engineering courses only
• 1911–The college was named as ‘College of Engineering Pune’
• 1912–The college was known as ‘Government College of Engineering, Pune (COEP). It is the 2nd oldest Engineering College in India
• 1914–Mechanical Department was established
• 1932–Electrical Engineering Degree course was started
• 1944–Course revised and Electrical and Mechanical course combined into one
• 1948–E & TC and Metallurgy department were established
• 1949–College got affiliated to Pune University
• 1952–Electrical and Mechanical Engineering were separated
• 1965–Instrumentation apartment was established
• 1974–Mechanical and Metallurgy sandwich courses were established
• 1992–Computer department was established
• 1996–Sandwich course in Production engineering was established
• 2001–Information Technology department was established
• 2002–College got autonomous status
• 2005–College completed 150 years

College has produced more than 25,000 graduate engineers, 2500 Post Graduate Engineers and 45 Ph.D.s in various branches of engineering. Apart from above this college has been producing outstanding engineers like,
• Bharat Ratna Sir M. Visvesvaraya,
• Shri Sumant Mulgaonkar, Ex (MD) TELCO Ltd.,
• Padmashree Ms. Leela Poonawala formar Chairman of Alfa laval
• Padmashree Mr. B.G. Shirke, Chairman Shirke Group of Industries Pune,
• Shri Madhukar Bhagwat, Tata Honeywell, Pune
• Dr. S.B. Sonde, Chairman National Board of Accreditation, New Delhi & Former Vice-Chancellor of Goa University
• Dr. Madharao Chitale, World Authority in Water Management
• Late Shri H.K. Firodiya, Former President of Bajaj Tempo ltd.
• Dr. Sanjay Dhande, Director, IIT Kanpur
• Prof. V.R. Deshpande, former Vice Chancellor of Dr. Babasaheb Ambedkar Technological University
• Shri S.P. Ranade, first Director of MITCON, Pune

And many more have contributed in the development of the nation.

Every year more than 110 student of this college go abroad for higher studies. More than 150 companies do visit campus every year for conducting recruitment programs.

Moreover the college has been functioning under University – Affiliated College System. Institution plays a key role in knowledge creation and preservation. Due to globalization, revolutionary changes are taking place in technical education all over the world. So as to remain as a leader, COEP has arrived at its vision statement as follows

‘Committed to provide value based, demand driven technical education of the highest standards by establishing a self-reliant centre of excellence, thereby contributing to the country’s dream of becoming a developed nation through socio-economic transformation.’

The institute has as its mission

‘The institute is committed to provide quality technical education and research and development services to meet the needs of industry, business, service sector, and society at large.’

College of Engineering, Pune as an autonomous body has developed a quality conscious system of technical education with quality bench marks to build technical education. The
choice of COEP as a branded college for the sake of comparison and gap analysis is therefore justified.

3.7 Identification of Factors for Present Study

Factors identified and taken for studying quality of engineering education are

- Management, Leadership, Mission and Goal
- Teaching process- faculty, students, teaching and learning process
- Physical resource- Library, IT lab, work-shop, other related labs
- Industry and Institute linkage
- Research and Development

While identifying the above factors the following two major inputs have been considered as guidelines [73, 74]

- AICTE has set the norms for effective operations of degree level engineering educational institutions/colleges
- NBA has set the guidelines for assessment of quality in education

For measurement of quality of education NBA has set the norms under the guidance of apex body AICTE. Quality of engineering education covers the factors shown in Table 3.2 for the undergraduate engineering program along with score to achieve.
Table 3.2 Factors Involved in Engineering Education with Score [74]

<table>
<thead>
<tr>
<th>Factors</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Resource Faculty</td>
<td>200</td>
</tr>
<tr>
<td>Students</td>
<td>100</td>
</tr>
<tr>
<td>Finance and Physical resource</td>
<td>100</td>
</tr>
<tr>
<td>Mission and Goal</td>
<td>100</td>
</tr>
<tr>
<td>Research and Development</td>
<td>30</td>
</tr>
<tr>
<td>Institute industry Interaction</td>
<td>70</td>
</tr>
<tr>
<td>Teaching learning process</td>
<td>350</td>
</tr>
<tr>
<td>Supplementary processes</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total score</strong></td>
<td><strong>1000</strong></td>
</tr>
</tbody>
</table>

While forming questionnaire the above factors are used as input for the categorizations of questions. The new factors are devised from the common factors of the Table 3.2. This has been done in view of the design aspect of questionnaire for the individual stakeholder. The new factors are as given in Table 3.3.

Table 3.3 Factors Identified for Framing Questionnaire with Respective Score

<table>
<thead>
<tr>
<th>Factors</th>
<th>Maximum score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management, Leadership, Mission, Goal</td>
<td>300</td>
</tr>
<tr>
<td>Teaching process – Faculty, Student, Teaching learning process</td>
<td>450</td>
</tr>
<tr>
<td>Physical resource- Finance and physical resource like IT, Library, Labs etc</td>
<td>100</td>
</tr>
<tr>
<td>Industry and institute linkage</td>
<td>100</td>
</tr>
<tr>
<td>Research and development</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total score</strong></td>
<td><strong>1000</strong></td>
</tr>
</tbody>
</table>

Questionnaires are designed in four phases:

i. Determining questions (items) to be used in the questionnaire

ii. Selecting the response format

iii. Writing the introduction to questionnaire

iv. Determining the content of the final questionnaire
The purpose of determining a questionnaire is to know precisely how to increase stakeholders' level of satisfaction by finding weak service areas and suggesting about service area where improvement is desirable. First a pilot response has been tried out to know the reliability and validity of the questionnaire, which we found satisfactory and readers understood it while giving the answers. The pilot study has been carried out in the organization where the candidate is employed. Then the questionnaires were distributed to all the stakeholders.

3.8 Reliability and Validity of the Questionnaire [75, 76]

While developing a questionnaire, it is important to ensure that the data obtained from it reflect reliable and valid information. These two attributes demonstrate the importance of careful thought while designing questionnaires to measure perceptions and attitudes.

**Reliability** (through repeatability) is defined as the extent to which measurements are free from random-error variance. Random error decreases the reliability of measurement. If a measure repeatedly produces the same response, it can be considered reliable.

**Validity** refers to the degree to which evidence supports the inferences from scores derived from measure, or the degree to which the scale measures what it is designed to measure. To be valid, the measure must be free of systematic influences that move responses in another direction.

Any worthwhile study on quality must quantify the quality so that it can be measured and treated statistically.

In developing the questionnaire, the Likert type response format [77] has been considered. This format helps to index the quality of service by the strength of response toward each item. The Likert scale is useful for measuring attitudes and perceptions. It is used to get an understanding regarding stakeholders’ feelings about the quality of goods and services. It is also easy to administer. The Likert type format has been designed to allow stakeholders to respond in varying degrees to each item that describes the service. This format describes a scaling procedure in which the scale represents a bipolar continuum. The low end of the scale represents a negative response while the high end
represents a positive response, as given in Table 3.4.

**Table 3.4 Examples of Likert-Type Response Formats**

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Very dissatisfied</td>
<td>Dissatisfied</td>
<td>Neither satisfied nor dissatisfied</td>
<td>Satisfied</td>
<td>Very Satisfied</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Very poor</td>
<td>Poor</td>
<td>Neither poor nor Good</td>
<td>Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

The advantage of using the Likert-type format rather than the checklist format is reflected in the variability of scores that result from the scale. This also helps stakeholders to express the degree of their opinion about the service they received rather than restricting them to a "yes" or "no" answer. From a statistical perspective, scales with two response options have less reliability than scales with five or seven response options. Moreover reliability seems to level off after five scale points and it serves no purpose by using more than five to seven scale points.

An introduction is always attached with the questionnaire so that it serves as a guideline to the stakeholder; it explains the purpose of using multiple items which are similar to each other, before giving their opinion of the quality of education which has been given in the institute.

Lastly the scale helps in quantifying the data which can be treated statistically and mathematically.
3.9 Sampling Methods

Sampling is a method by which a small number of items (the sample) is drawn from a larger number of items (the population) in order to draw a conclusion about the population based upon information from sample.

Representative sampling is absolutely essential to defend the validity of the results of survey which will serve as basis for taking important and perhaps costly management decisions. There are five common methods of sampling in common usage namely Random sampling, Stratified sampling, Cluster sampling, Systematic sampling, Quota sampling

Statistical Sampling

The sample is determined based on statistical probability. The major characteristics of statistically chosen samples are:

- Random selection is used to include cases in the sample
- Appropriate sample size can be statistically determined

A major advantage of this method is that it is possible to generalize results to the population from which the sample was drawn. Statistical sampling is a method that increases the chances that the sample is representative of the population.

Therefore it is of vital importance that sampling is made as accurate as possible since it will be a key factor in justifying the validity of survey findings. This is because the findings from a stakeholder satisfaction measurement survey are going to be the basis for deciding priorities for improvements.

Stratified Sampling [78]

Stratified sampling is designed to reflect prior knowledge about the population. In this, groups are formed as A, B, C, D, and E for the sampling and then random sample is taken within each group or stratum. Stratified sampling gives more precise information than random sampling. Hence the same method is used for grouping the information and it is
also a good and appropriate data collection analysis and display method.

In this study random sampling is used in getting responses from different stakeholders against the respective questionnaire.

Stratified sampling is used in selection of ten colleges under Pune university area for collection of data and data analysis. Stratification is done based on location of the college, age of the college and boys/girls or co-ed college also whether the college is from rural or urban area. The information on selection of colleges based on stratification factors has been given in Table 3.5

<table>
<thead>
<tr>
<th>Classification of the colleges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colleges from Urban with 25 years age</td>
</tr>
<tr>
<td>College 1,2,3</td>
</tr>
<tr>
<td>Colleges from Rural and Urban with 10 to 15 years age</td>
</tr>
<tr>
<td>College 4,5,6,7</td>
</tr>
<tr>
<td>Colleges less than 10 years age (newly opened)</td>
</tr>
<tr>
<td>College 8,9</td>
</tr>
<tr>
<td>College 10 Branded College</td>
</tr>
</tbody>
</table>

The names of the colleges have been withheld to maintain confidentiality.

More than 600 samples were collected for processing and this sample size has been checked and validated by using Chi Square test. This test is useful in analyzing more than two populations. This test has shown that the sample is representative as the value of chi-square is in the acceptance limits of Chi-Square distribution.
3.10 Analysis of Data and Reporting

Stakeholders’ satisfaction and the perception about the education process is drawn with the help of questionnaire in the following manner.

- Send the questionnaire to various stakeholders
- Solicit their response
- Study the results
- Find the areas of strength and weakness
- Devise a tool for the performance measurement of the institute

A questionnaire is prepared comprising on an average 20 criteria to assess education process quality. These 20 criteria are grouped into five service quality dimensions to determine stake holder’s perception of education rendered by the institution.

The questionnaires were sent in the order shown in Table 3.6, to stakeholders, to solicit their response. The responses received in numbers from different stakeholders are shown in Table 3.6.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Teachers</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Management</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>Industry</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>Parents</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
<td>05</td>
</tr>
</tbody>
</table>

Along with the responses through questionnaire collected efforts are made to get the student examination result from Pune University.
Examination result of university for last 5 years has been taken and studied for the Mechanical Engineering, Computer Engineering and E & TC Engineering branch. These are the most popular branches of engineering and are available almost in all the colleges under Pune University. The results are of final year of engineering. The results of Common Entrance Test (CET) examination of the same batches have also been collected to get the information on performance of students at the time of entry to the engineering degree program.

3.11 Tools Used for Carrying Out Analysis [79]

The correlation and regression analysis are important statistical tools to determine the degree of the relationship and nature of the relationship. The regression analysis enables us to predict the value of the dependent variable from the value of the associated independent variable.

3.11.1 Line Regression and Co-relation Analysis

It is a technique that permits us to determine the degree of relationship between two variables. In the study undertaken A, B, C, D, E are five independent variables representing five quality dimensions. Y is a dependent variable representing overall satisfaction. The co-relations between each of the quality dimensions & overall customer satisfaction scores reflect the importance of each quality dimension in predicting overall stakeholder satisfaction.

3.11.2 Multiple Regressions

In simple linear regression, a relationship between two variables is examined.

In order to examine the relationship of overall satisfaction with many other factors within the survey, Multiple Regression Analysis is used to examine all factors simultaneously in their prediction of overall satisfaction.

This allows us to determine which variable or variables best predict overall customer satisfaction. Best is defined as factors that uniquely predict stakeholder satisfaction.
Data has been collected and analyzed for the five important factors given below for the measurement of quality of engineering education

- Physical Resource
- Management Leadership
- Teaching Process
- Institute – Stakeholder linkage
- Research and Development

Analysis of data obtained has been carried out by using analytical tools listed below [79, 80]

- Cause and effect diagram - analytical tool
- Process mapping
- Tree diagram - data collection analysis and display method
- Brand name / Benchmarking - management methods
- Service quality dimensions
- Likert response scale
- Statistical random sampling
- Stratified sampling
- Gap analysis by area chart
- Radar diagrams
- Linear regression
- Multiple regressions
- ANOVA - Analysis of variance

The above tools have been applied by using software Microsoft Excel 2002, Microcal Origin version 3.5 and Minitab 11.21.

The results are analyzed and discussed in the next chapter, ‘Results and Discussions’.