CHAPTER 3 – METHODOLOGY

3.1 Data Collection:

The study is focused on different processes and sub-processes in a typical Maritime Education & Training (MET) institution. Since Tolani Maritime Institute (TMI) is a premier institution and is in the process of adapting various methods for quality improvement, TMI was taken as a case study. The data and information was therefore collected from TMI and related areas. This included internal data and also external data from various stakeholders. Different questionnaires were developed for seeking information from the stakeholders like shipping companies, faculty members, alumni and parents. Similarly feedback from the students on the quality of teaching was also taken. Internally data regarding admissions, examination results and placements was also collected.

Data collection was on the basis of different hypotheses that were selected at the commencement of the study. Further since the aim of the study was to assess applicability of TQM in maritime education and training, all aspects/ activities in a MET institution were considered. Thus, the present investigation forms a micro level in depth study of marine engineering program at TMI.

TMI started functioning in 1998 and the pioneer batch of four-year marine engineering program graduated in 2002. Till the time of study six batches have graduated and thus data for these students from admission till completion of the program was available and the same was analyzed. The admission data of the existing four batches at the time of study was also available.

All the information and data received was analyzed and many statistical and quality management tools were used for analysis. These are appended in Table 3.1.

Table 3.1 – TQM tools used in the study

S.N.	TQM tools used
1	ANOVA
2	Box plots
3	Chi Square test
4	Control Charts
5	Correlation
6	Failure Mode and Effects Analysis
7	Flow chart
8	Graphs
9	Histogram
10	Interrelationship digraph
11	Ishikawa diagram
12	Quality Function Deployment
13	Quartile analysis
14	Radar chart
15	Regression analysis
16	SERVQUAL
17	SIPOC

The software and packages included MS Office (Word and Excel) and Minitab (version 11)

3.2 SIPOC Model:

Suppliers Inputs Processes Outputs Customers (SIPOC) is a business interaction model that provides a macro view of processes with respect to its supplier, inputs, outputs and customers [Goel (46)]. As per this ‘Suppliers’ are the people/ organizations that provide information, resources etc. to be worked on in the process; ‘Inputs’ is the material/ information that is used/ transformed during the process; ‘Process’ is the series of steps that transform and add value to the inputs; ‘Outputs’ is the product or service used by the customer; and ‘Customer’ is the people or company that receive outputs from the process [Pande (126)]. SIPOC model was created for the activities of TMI and is given in Figure 3.1.

Suppliers	Inputs	Processes	Outputs	Customers
• *Junior colleges* • *Boards*	• *Teachers* • *Teaching skills* • *Students* • *Books* • *Laboratories* • *Workshop*	• *Admissions* • *Transfer of knowledge* • *Development of skills* • *Assessment* • *Student affairs* • *Placements*	• *Graduating students* • *Knowledge* • *Skills* • *Attitude*	• *Shipping companies* • *Other industries* • *Parents* • *Students* • *Society*

Figure 3.1 – SIPOC model of a MET institution

The areas identified in the above model were studied in detail and keeping with the aim of the study, application of TQM principles and practices were applied as detailed in the following sections.

3.3 Data from shipping companies:

The marine engineers who graduate from different colleges in India are employed on board Indian and foreign ships. The main motivation to join foreign ships is not only higher salary but also almost no taxation, especially if the seafarer is able to claim NRI status. It is therefore an established fact that majority of Indian marine engineers do join the foreign fleet ships. Considering the above, it was felt necessary that to understand the expectations and to get feelings regarding the satisfaction level about the Indian marine engineers, our target population would have to be the foreign employers largely and also some Indian employers.

TMI graduates are placed in the ships of reputed shipping companies of the world. It was therefore felt pertinent to collect their expectations from the MET institutions and also get feedback about their perception of the performance of the graduates of TMI. Two questionnaires were therefore developed and sent to all major shipping companies. Questionnaires A & B are attached as Appendix A and B.

Questionnaire A was aimed at assessing the expectations and the requirements of the customers (shipping companies) from the marine engineering institutions (service provider) and had questions in the following areas of operations of marine engineering institutions:

1. Admissions and selection of students for the program.
2. Conduct of the marine engineering program.
3. Infrastructure and facilities.
4. Career progression of the students.

Questionnaire B on the other hand, was developed to assess the satisfaction level of the shipping companies from TMI. It was also envisaged that the questions would help in identifying the gaps that exists between the expectations of the customers (shipping companies) and their experience.

Based on the system of SERVQUAL following five dimensions of service quality were targeted:

Tangibles: The physical facilities, equipment etc.
Reliability: The ability to perform the promised service dependably and accurately. It means that the firm honours its promises.
Responsiveness: Willingness to help customers and provide prompt service.
Assurance: Knowledge and courtesy of employees and their ability to inspire trust and confidence.
Empathy: Caring, individualized attention that the firm provides its customers.

A total of 19 questions on above five dimensions were created in this questionnaire, which was sent to major shipping companies that engage graduates from TMI. One more question indicating the overall satisfaction was also included. The responses were on a Linkart 5 scale with ‘strongly disagree’ to ‘strongly agree’.

The questionnaires were forwarded to 55 shipping and ship management companies, worldwide that engage Indian marine engineers and especially all those companies that select from TMI. Responses from 33 companies from around the world were received. The response therefore was 60%. A list of these companies is attached as Appendix C.

Chi-Square Test

Expected counts are printed below observed counts

Table 3.2 – Response matrix

	Companies taking graduates from TMI	Companies not taking graduates from TMI	Total
Response asked	**40**	**15**	**55**
	43.13	*11.87*	
Response received	**29**	**4**	**33**
	25.88	*7.13*	
Total	**69**	**19**	**88**

Chi-Sq = 0.226 + 0.822 + 0.377 + 1.371 = 2.797
DF = 1, P-Value = 0.094

The calculated Chi-Sq value of 2.797 is less than the critical Chi-Sq value of 3.94 from the table (at $\alpha = 0.05$). The responses received are therefore considered adequate.

The questionnaires were followed up with individual interviews with representatives of many shipping companies. The interviews were aimed at clarifying certain opinions and to get further information, especially about the competitive institutions so that benchmarking could be achieved and specific areas for improvement could be identified. This also helped to conduct a SWOT analysis of TMI with respect to the expectations from the industry.

3.4 Admission:

Admission data for 10 years starting from the pioneer batch admitted in 1998 till the admission in 2007 for the marine engineering program was analyzed. The objective of the analysis was to assess the quality of the incoming students and establishing any other pattern or outcomes.

Students are selected after an on-line test of two-hour duration, which is conducted in various centres across the country. This test was started in 2001 and so far seven batches have been admitted since then.

Students from all parts of the country are admitted in TMI and are therefore from different boards of secondary education. For meaningful understanding the data has been

grouped in four groups. These are Central Board of Secondary Education (CBSE), Indian School Certificate Examination (ISCE), Maharashtra State Board and Other State Boards.

The data for admissions was analyzed to establish relationship between their Physics, Chemistry and Mathematics (PCM) marks and the performance in the test.

3.5 Design and description of curriculum:

3.5.1 Design Inputs:

The inputs for the curriculum for the marine engineering program in TMI are based on the following:

Directorate General of Shipping: Incorporating the international requirements based on STCW Convention of the IMO. The Convention specifies competency requirements in different functions like marine engineering, electrical systems, maintenance etc. DGS has incorporated these in its Maritime Education & Training Assessment (META) Manual, giving specific number of classroom and laboratory contact hours for each subject (course). The curriculum remains descriptive.

Birla Institute of Technology and Science, Pilani: BITS being the university concerned specifies the unit (credits) for each course and a descriptive curriculum is accepted. This however, is further developed into a course handout that is more like a lesson plan indicating objectives of the course, each module and its contact hours, text and reference books and the assessment schedule.

Industry: The marine engineering program is a professional program and the graduates join commercial ships. Inputs from the industry are therefore necessary.

3.5.2 Description of curriculum:

The curriculum as accepted is in descriptive form and does not specify the learning objectives of individual modules and thus the depth of the module is left to individual teachers to decide. Many of the teachers in MET institutions are ex-marine engineers and substantially utilize their experience while teaching. The absence of these objectives thus

allows them to concentrate on one topic in a module that is liked by them at the cost of another, which they may not like. Syllabi of other MET institutions conducting four-year marine engineering programs are also given in similar descriptive form.

While improving the existing quality management system and while implementing different TQM techniques in TMI this issue was identified and it was decided to address this lacuna. A small group of senior faculty members from different core competencies worked on this issue.

3.5.3 Design of curriculum:

Noriaki Kano of Tokyo Rika University, Japan had suggested a model of design characteristics and customer satisfaction. As per this design the characteristics could be divided in three categories, namely dissatisfiers, satisfiers and delighters.

'Dissatisfiers' or 'must be' are the expected characteristics and if not fulfilled will leave the customer extremely dissatisfied. These may not be in the requirements of the customer as they are taken for granted. The 'satisfiers' on the other hand are the characteristics that the customer wants and expects and their absence will lead to dissatisfaction. 'Delighters' are the characteristics that the customer has not even expected and these will therefore lead to delight. Over a period of time however, the customer starts expecting these characteristics and they change to 'satisfiers'. A graphical display of these three characteristics is given in Figure 3.2. [El-Haik (37)].

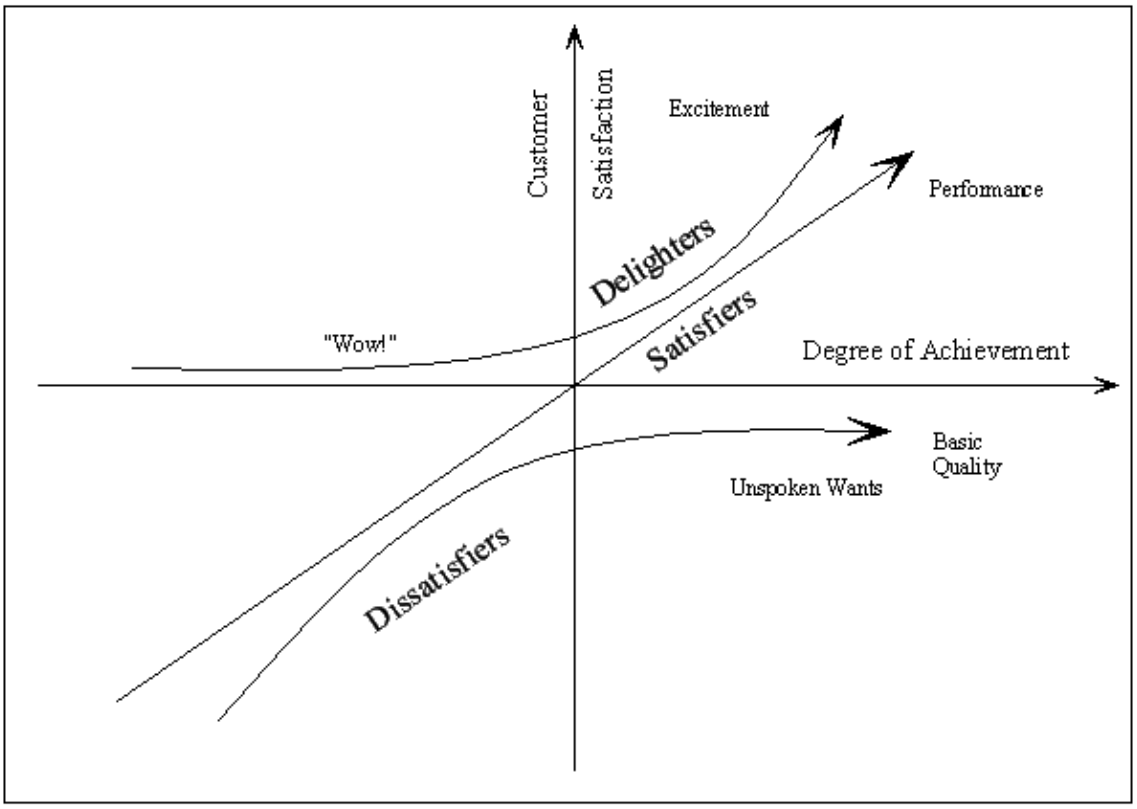

Figure 3.2 – Design characteristics as per Kano model

Based on the study and personal interviews of the representatives of the shipping companies an assessment of these three characteristics was done and 61.0% of the respondents confirmed that they would be delighted if the MET institution provided some specialized inputs to the students. 39.0% indicated that they would be happy.

Shipping industry, like any other industry today, is very dynamic. The technology and operating environment are constantly changing. Furthermore since ships operate worldwide their operations are subjected to international, regional (e.g. European Commission) and national requirements. It is therefore necessary that the curriculum of the marine engineering program is also dynamic. A system of periodical review of the syllabus with well-defined sources of inputs, responsibility for review and validation is necessary. This was done in TMI and procedure for this very important issue developed and adapted. Technique of QFD was implemented to get the inputs from the industry to identify specific areas for improvement.

3.6 Quality Function Deployment (QFD) development:

Brue (18) writes that QFD is a systematic approach for transitioning the voice of customer into design requirements. The QFD uses the 'Principle of Deployment', which states that the product quality can be assured through the quality of sub-systems; the quality of sub-systems can be assured through the quality of parts; and quality of parts can be assured through the quality of the process elements [Sivaloganathan (155)]. The customer requirements (whats) are plotted on the rows in a matrix. The design requirements (hows) are now indicated in columns. While developing importance ratings for the design elements relationship matrix is used. A strong relationship is given a numerical value of '9', a medium relationship is given a value of '3' and a week relationship is given '1' [Sivaloganathan (155)].

Based on the information received from the respondents of shipping companies from the questionnaire A, the expectations of the prospective employers were identified and arranged in their respective importance. The salient features for the nearest competitor institution were also noted. While some of such information was expressed in bits and pieces at different forums, this was probably the first time that such an elaborate and frank exercise was conducted in the maritime education and training sector. In fact few of the companies did express this sentiment.

The next step was to identify the technical characteristics that were needed to fulfill the desired expectations. A matrix was therefore created between the expectations and the technical characteristics. This allowed relationships between the two and the same was given certain weights based on 'strong influence'; 'weak influence'; and 'no influence'. This correlation between the two factors eventually resulted in prioritizing the customer requirements and therefore prioritizing the technical characteristics.

The above exercise resulted in identifying the strengths of the institution and also the areas for improvement. This information was plotted in the traditional 'house of quality' format.

The steps taken in developing the 'house of quality' can be summarized as follows:

1. Identification of the customer's requirements and their importance.
2. Identification of technical characteristics that would be required to fulfill the customers' requirements.
3. Development of correlation between the above two factors.
4. Denoting values to the above and thereafter calculating the absolute weight for prioritized customer requirements.
5. Eventually arriving at the prioritized technical characteristics.

3.7 Faculty teaching potential:

It is only the teaching staff that can, in fact, influence the real quality of a MET institution. An institute can only be as good as its teachers. In a professional program like the marine engineering the learning of students depends substantially on the experience of the maritime teacher and the methodology of teaching.

MET is mainly a vocational education and aims at providing qualified personnel for the shipboard activity. The shipping industry is affected by the supply and demand mechanism and is faced with periodic ups and downs. The maritime education and training field too faces these movements periodically. The operation and management of the MET institution therefore, at times, work in a different way than the normal times [Nakazawa (112)].

In any training institute, especially in the maritime sector, the style of teaching of a teacher always reflects the processes that the teacher has undergone while obtaining knowledge and skills. Many of the teachers would have, besides the teaching experience, industrial experience. At times there may be shipboard experience. Therefore both academic career and professional career influence the style of teaching and both are necessary to provide a perfect blend of theoretical knowledge and practical experiences.

A good teacher must always upgrade the knowledge. This can be based on self-study of information available in the library or on web. However, attending conferences, seminars, and workshops, both nationally and internationally, can make a significant achievement. This would be further enhanced if a teacher writes and presents a paper at some gathering

or the paper is published in a reputed journal. Such up-gradation measures enhance the quality of teachers and reflect in the quality of teaching.

It is also true that the teaching quality is not always in direct proportion to the teaching experience. Further the conferences/ seminars attended by the teachers may not necessarily be domain specific to the teacher's area of teaching. In spite of these issues this mechanism definitely provides some measurable assessment of the potential of teachers in a maritime education and training institution.

Considering these important points, in this study a methodology was adapted to identify the potential of faculty individually and to further calculate the faculty potential of complete institute. The criteria were as follows:

1. Academic qualifications
2. Teaching experience
3. Industrial experience, including certificate of competency for marine faculty, which is based on industrial work.
4. Up-gradation initiatives, this includes the papers published and presented. It also includes seminars, conferences etc attended, both nationally and internationally.

Each teacher was awarded points on a scale of 1 to 4 on the above four aspects as per following table:

Table 3.3 – Aspects for teaching potential

Academic Qualification	Under Graduate	Graduate	Post Graduate	Doctorate
Teaching Experience	≤ 1 yr	≤ 3 yrs	≤ 6 yrs	> 6 yrs
Industrial Experience	≤ 1 yr	≤ 2 yrs	≤ 4 yrs	> 4 yrs
Certificate of Competency	Class IV / II Mate	Class II / I Mate	Class I / Master	Combined/ Extra Chief/ Extra Master
Up-gradation Initiatives	Seminar/ Conference attended	Paper Published	Nationally Published & presented	Internationally Published / Presented
Points	1	2	3	4

The ideal situation would be when the score of the institution is 4.0 for all the four aspects as can be observed on Figure 3.3.

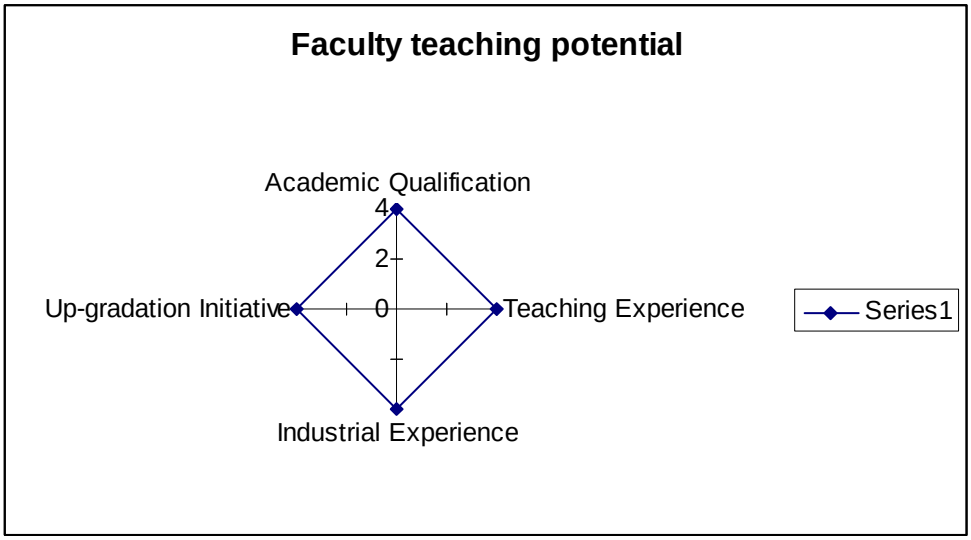

Figure 3.3 – Faculty teaching potential radar plot (ideal/target situation)

3.8 Performance improvement in the program:

Based on grades received in all the courses in the semester, Grade Point Average (GPA) is calculated for each student. The grades obtained in subsequent semesters are added to calculate Cumulative Grade Point Average (CGPA) at the end of each semester and eventually the final CGPA at the time of graduation.

To study the overall effectiveness of the four-year marine engineering program the pattern of CGPA of last four graduating class was studied. The data for 1st two years was not considered for this study as it was the period of settling down and also during this period the institution shifted from Pune city to the custom-built campus in Induri.

The analysis was carried out by comparing the GPA at the end of 1st semester with the final CGPA at the time of graduation. Percentage change during the eight semesters was calculated.

3.9 Input output analysis:

With an objective of assessing the effectiveness of the program, the correlation between the input and output of the program was analyzed

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3.9.1 Correlation between admission performance and process performance in the Institution:

Data of last six batches graduated from TMI was analyzed. The data of first batch was not considered. The total number of students was as follows:

Table 3.4 – Student data matrix

Year of Entry	1999	2000	2001	2002	2003
Year of Graduation	2003	2004	2005	2006	2007
Number of Students	102	96	102	126	117

3.9.2 Admission Criteria:

The parameters considered were percentage marks in Physics, Chemistry and Mathematics. An on-line test for admission was used in last three batches and that data is also considered.

Further the students were grouped in four educational boards namely CBSE, ISCE, Maharashtra and all other State boards.

3.9.3 Process Performance Criteria:

The four-year marine engineering program is divided in eight semesters where a student has to complete 56 courses. These 56 courses are grouped in four categories and the performance data for these categories was examined. The final Cumulative Grade Point Average (CGPA) of the students was also considered. The courses in these four categories are as follows:

Applied Science – Engineering Mathematics I and II, Introduction to Computers and Computer Applications, Probability & Statistics, Operation Research, Principles of Management, English Language Skills, Technical Report Writing, Material Science, Corrosion.

Electrical Engineering – Applied Electricity, Electrical Measurement, Electronics, Electrical Machines, Alternators & Motors, Marine Electro Technology, Marine Control Engineering, Thermodynamics, Applied Thermodynamics, Marine IC Engines I and II, Marine Boilers & Steam Engineering, Marine Refrigeration, Power Plant Operation

Mechanical Engineering – Applied Mechanics I and II, Workshop Technology, Workshop Practice I and II, Strength of Materials, Dynamics of Vibrations, Mechanics of Materials, Mechanics of Machines, Hydraulics, Pumps & Pumping Systems, Geometrical Drawing, Engineering Drawing, Machine Drawing, Marine Engineering Drawing, Marine Machine System Design, Naval Architecture – Basic Ship Structures, Ship Construction, Naval Architecture I and II

Marine Engineering – Maritime Geography, Seamanship, Fuels & Lubricants, Marine Auxiliary Machinery I and II, Marine Environment Protection, Marine Fire Fighting & Control, International Conventions, Ship Operation & Management, Marine Cost Engineering, Watch keeping.

3.9.4 Correlation of admission and performance data:

Pearson Correlation Coefficients were calculated to establish the following relationships:

Table 3.5 – Type of admission and performance data

Admission Data	Subsequent Performance Data
Mark in Physics, Chemistry and Mathematics Marks in on-line test (only for last three batches)	Marks in Applied Science group Marks in Electrical Engineering group Marks in Mechanical Engineering group Marks in Marine Engineering group Final CGPA

The above calculation was done for following groups.

1. All students in the batch
2. All students from CBSE Board
3. All students from ISCE Board
4. All students from Maharashtra Board
5. All students from all State Boards

Initially attempt was made to establish relationships between the average PCM aggregate marks and specific groups of courses that were completed during the four year program. However, it was felt that the analysis may be more meaningful if the marks in physics, chemistry and mathematics were considered separately. Accordingly this analysis was carried out for the last five batches that have graduated from TMI.

Pearson correlation coefficients between marks obtained in physics, chemistry, mathematics and marks obtained in different groups; including the final CGPA were calculated. Regression analysis considering the marks in groups being dependent variable and marks in physics, chemistry, and mathematics being independent variables was carried out. For assessing meaningful relationship, the complete data of each year was used and this was also divided in four boards, namely, CBSE, ISCE, Maharashtra and Other State Boards.

3.10 Analysis of the non-conforming product:

In spite of the good quality input and good teaching methodology some students do not perform as well as desired. It is imperative that such students and the factors leading to this situation are also studied.

3.10.1 Analysis of courses and failures:

As per the system followed in BITS and also in TMI, relative grades are given to the student for each of the course taken in a semester. The grades are A, B, C, D and E. E grade is considered ‘exposed’ or failure and the student securing this grade has to re-register for this course whenever it is offered next.

The complete four-year program is of 56 course plus internship. All students that have failed in the six batches that have graduated from TMI from 2002 to 2007 were analyzed and failure rate was calculated. This study resulted in identifying courses with higher failures rates and these can now be monitored closely so that reasons for failures higher than usual can be attended.

3.10.2 Control Charts:

A student of TMI has to take seven or eight courses in every semester. For understanding the application of control charts the marks obtained by students in a semester was analyzed. The average marks obtained in seven courses in the final year were taken. The difference between maximum marks and the minimum marks in these courses was calculated. Thereafter average (X Bar) and differences (Range R) were drawn.

3.10.3 Analysis of failure & withdrawn students:

Some students are not able to complete the program in the prescribed duration of four years. They may either withdraw from the program or take extra semester/s to complete the program. The reasons could be the following:

1. Secured admission elsewhere – the other options generally are information technology, other disciplines of engineering, National Defence Academy, Deck Cadet etc.
2. Not able to cope up with the program – Mostly due to semi-regimented schedule. Even nominal physical exertion is beyond the capability of some of the students.
3. Asked to leave on disciplinary reasons.
4. Withdrawn after too many 'E' grades (failures) are accumulated and the student is just not able to go on further.

Data of all such students was studied to observe any pattern or get further information that may eventually be used for improving the overall process.

3.11 Placements:

The students who successfully complete the marine engineering program in TMI are selected by the renowned shipping and ship management companies of the world that employ Indian marine engineers. Since the program has an in-built component of internship within the final year, the companies usually select in the 3rd year of the program. The students then complete the internship in ships of these companies and join them back once again after graduation. Very few companies do not offer ships for

internship and they complete this period in reputed shipyards and join the companies after graduation.

The placement statistics was analyzed. It was observed that due to the excellent economic situation and the world economy, the shipping markets are also quite good. The demand for quality marine engineers is very high and TMI has been achieving complete placement for all its batches that have graduated.

3.12 Feedback from the faculty members of the institution:

The teaching staff forms the most significant component of any institution as it acts like an interface between the management and the student. Further it delivers the knowledge to the students and is instrumental in translating the outcome requirements of the program into the inputs and thereafter delivering these to the students in best possible way. This becomes all the more important in MET institutions where the teacher has the responsibility and obligation of not only transferring the necessary knowledge and developing the required skills but also to transform the young entrants into a professional who will not only do the job well but compete with marine engineers from other countries and be an ambassador of India wherever the ship takes him. The quality of teaching staff and more importantly their motivation, attachment and dedication can make this extremely important work effective.

It was therefore felt imperative that the views of teachers on various issues related to the functioning of TMI were considered. Accordingly a questionnaire was developed. Similar questionnaires from other educational institutions were studied. Some inputs from the questionnaire of the Glasgow College of Nautical Studies (44) were also considered. The questionnaire was also based on the different categories indicated in the Educational Criteria for Performance Excellence of the Baldrige National Quality Program [2006 (10)].

The questionnaire of 65 questions where responses were desired on a Linkart 5 scale with ‘strongly disagree’ to ‘strongly agree’ was developed in the following categories:

1. ***Leadership and Governance:*** About the senior leadership of TMI and also about the system of governing the TMI by the management. It also aimed to

get the views on communications within TMI and also on awareness among teachers on strengths, weaknesses, opportunities and threats to TMI.

2. ***Customer Focus:*** About understanding their perception and awareness about the internal and external customers of TMI and their requirements etc.
3. ***Measurement and Analysis:*** Regarding their awareness and uses of different data that is measured and subsequently analyzed. This would include feedback from different stakeholders, examinations, measures for continual improvements etc.
4. ***Staff Focus:*** On various personnel and self-development issues, inducting training; recognition; workload etc and their satisfaction with the working environment.
5. ***Process Management:*** Regarding management of different processes and sub processes; involvement of faculty members.
6. ***Process Outcome:*** Information and comments on the eventual outcome of all that is happening at TMI. This would include the effectiveness of teaching; safety and protection of environment; educational and recreational environment in the campus; student-teacher relationships; values; stakeholders and overall personal satisfaction.

The questionnaire is attached as Appendix D.

A total of 38 faculty members replied to the questionnaire. These were from four disciplines e.g. Applied and Social Sciences, Mechanical Engineering, Electrical Engineering and Marine Engineering. The questionnaire was followed up with interview with some teachers with an aim to obtain clarity of their responses. The data obtained was analyzed.

3.13 Feedback from alumni:

In spite of the above system, the students do not at any stage comment on various other issues, including facilities and infrastructure, environment and their overall experience in TMI.

During the study it was felt that the alumni could be competent on commenting on all these issues, especially considering their exposure in the industry for sometime. Accordingly a questionnaire was developed (Appendix E).

The 12 questions in the questionnaire were aimed at following:

1. Facilities and infrastructure
2. Career development
3. Extra curricular activities
4. Teachers and teaching methodology
5. Campus environment
6. Placement
7. Overall satisfaction

The responses were on a Linkart 5 scale with ‘strongly disagree’ to ‘strongly agree’. The questionnaire was sent to about 300 graduates, both by soft copy in email and hard copy by post. Following responses were received:

Table 3.6 – Responses from alumni

Year of graduation	Nos. of response
2004	16
2005	30
2006	95
2007	8

Most of the graduates are slowly settling in their sea going careers and many of the graduates of earlier batches are now engaged in appearing their competency examinations for promotion. Further many graduates have moved over to different career options and are difficult to trace or not interested in responding to the request of feedback. These factors explain why not very encouraging response was received, which however, is over 40%.

3.14 Feedback from students:

TMI has established a system wherein feedback from the students is regularly taken every semester. This is primarily focused on the teaching techniques adapted in the process of transfer of knowledge and development of skills. The data collected is analyzed and is discussed with individual faculty members. The questionnaire was developed after consultations with the teachers and the mechanism is now well set with sufficient acceptance from the teaching staff. The outcomes have validated that the system is functional and necessary.

3.15 Feedback from parents:

The four-year marine engineering program is a compulsorily residential program with substantial emphasis on overall development of the student. The students are exposed to many extra and co-curricular activities and sports. It therefore becomes necessary to receive feedback from the parents on all these and some other issues.

3.16 Application of other TQM tools:

Many tools of TQM and statistical quality control have been used in the study in different areas as mentioned in earlier sections. It was felt necessary to use some other tools in other activities of the MET institution. Three of such initiatives are described below.

3.16.1 Root Cause Analysis:

The root cause analysis tool in TQM was invented by Kaoru Ishikawa of Japan in 1969 and is therefore referred as Ishikawa diagram. It is also referred as cause-and-effect diagram or fishbone diagram as it looks like fishbone. This tool requires the division of the main problem in different causes and their further sub-division so that many causes can be identified. This tool works on the premise that there may be many reasons contributing to a single failure. This exercise identifies potential sources of variations. These variables must be specific, measurable and controllable. It is important to identify the causes and not the symptoms [Mohanty (101)].

Marine engineering is a multidisciplinary branch of engineering. Furthermore a substantial emphasis is given on hands-on practical training. This is necessary, as the marine engineers have to operate and maintain different machineries onboard ships with minimum crew members. The marine engineering training in a MET institution therefore involves working in workshops in different sections and machineries. Inculcating safety culture by following safe working practices is an integral part of the overall training. Accidents are expensive and must be avoided. Shipping companies too, give much emphasis to this aspect.

Considering the importance of this issue, a root cause analysis of the hazardous situation in workshop was carried out. This technique of TQM helped in putting different causes and factors in six logical groups, namely materials, methods, machines, manpower, measurement, and environment.

3.16.2 Interrelationship Diagraph:

This technique is used to display the interrelated factors in a problem. This results in a graphical display of logical relationships between different factors in a problem.

Library is an important resource centre in an academic institution and makes available information as necessary. This tool of TQM was used in the environment of the library. The problem considered was – “a book is desired by a faculty member, but it is not available in library”. Different factors contributing to this situation were identified. The interrelationships between different factors leading to this situation were studied and a graphical display was developed to identify the most significant contributory factor.

3.16.3 Failure Mode and Effects Analysis:

Failure Mode & Effect Analysis (FMEA) is a systematic analysis for identifying potential failures. Thereafter action can be initiated to avoid their recurrence and reduce the possibility of failures. This analysis requires identification of potential modes of failures, the effect of such failures on the operations, probability and possible severity of such failures and finally establishing means to address the causes. FMEA is a risk minimization technique [Goel (46)].

The marine engineering program in TMI is a compulsorily residential program. Therefore success of the program is not only based on academic issues but also many other issues that relate to facilities, infrastructure and logistics. Services like food, medical, communication and transport were selected for conducting FMEA.

3.17 Quality costs:

There are two types of costs that can be associated with quality, namely costs due to poor quality and other being costs associated with improving quality. The later would include costs of all preventive measures taken to ensure quality and these are also referred as preventive costs. The focus of the preventive costs is to assure quality by avoiding or reducing the possibility of situations leading to losses/ delays. These would include costs of operating the quality system, training provided to the employees etc. The other group in this is the costs of various testing done during the production of a product of service, including the test on incoming material. These are referred as appraisal costs.

The costs of poor quality, on the other hand refers to the cost of failure indicated, expenses incurred when a non-acceptable product has been produced or such type of service is offered to the customer. These costs aim at situation when a non-conforming product has been identified within the organization and measures are implemented to improve the quality of the product or service. Expenses for such measures are referred as internal failure costs. Expenses would include the cost of re-work, extra time/ money spent on corrections etc. The internal failure costs would include costs incurred when the services offered are not of acceptable standard. At times, in spite of all effects a non-conforming product may reach customers. Expenses incurred in this situation are referred as external failure costs.

It can also be said that the appraisal and prevention costs are the costs of conformance whereas both internal and external failure costs refer as the costs of non-conformance. Quality costs are the costs associated with preventing, finding, and correcting defective work [Kaner (76)].

An exercise of establishing a quality management system eventually leading to total quality management cannot be complete till the understanding of cost of quality is achieved and incorporated in the system. The aim of the organization should be to reduce

failure costs by investing/ increasing expenses on appraisal and prevention costs. The difficulty is that the cost accounting system does not recognize this concept and therefore these are never discussed or raised to the attention of top management who any way mostly is not aware of these.

Traditionally the accounting and record keeping of costs in an educational institution is based on expenses on different heads e.g. salaries, consumables, books etc. If we try to find out the cost of admission activity it will not be possible. Thus the concept of cost of quality is neither understood nor followed in educational institutions. It may be better if activity based costing is maintained as it is the activity that drives the cost. Synergy between the quality management and costing system will result in optimizing the activity costs.

The cost of quality technique is a tool for management in its pursuit of quality improvement and profit contributions. The failure costs can be represented by the traditional iceberg where usually only the top is seen and attended to. For eventual improvement all the costs that lie below the top must be also considered [Campanella (20)].

Considering this aspect of quality management an analysis of such quality costs in TMI was carried out. Following costs were considered:

Preventive Costs:

These costs are those that are associated with preventing defects in processes.

Cost of maintenance of the quality management system of TMI – This included cost of updating the system, internal and external audits, including amount paid to the certifying organization.

Cost of periodic training that is provided to the faculty members for improving teaching abilities and as continued education.

Appraisal Costs:

These are the costs of evaluating a product or a service throughout the process of intake till it is delivered.

Cost of admission process – This included cost of conducting on-line tests, interviews and related administrative work.

Cost of examination process – This included the expenses incurred in conducting the assessment on a continuous basis. The costs of conducting class tests, mid semester and comprehensive examinations were assessed. The man-days utilized and stationary used were considered.

Internal failure costs:

The internal costs are incurred when a student does not perform up to the accepted standard and include following costs:

Cost of re-examination – The cost of re-examination, including the cost of re-registration for the courses that have to be repeated was assessed.

The cost of counseling was also assessed. TMI has a system where a student who has more than 2 E-grades is called and counseled individually. This obviously involves additional time.

Cost of correspondence with the parents of such non-performing students is also assessed.

External failure costs:

These costs would include costs incurred after the product i.e. graduate is found to be not meeting the requirements of the industry. This would include expenses incurred in dealing with the organization where this graduate has worked. These would also include the cost of loss of image/ loss of further placement opportunities in this organization. This situation obviously would result in dissatisfaction of the shipping company. The difficult part is to translate this dissatisfaction in terms of money.

3.18 Hypotheses:

For achieving the objectives set in the study following hypotheses were considered:

1. *A properly developed and organized selection process is necessary for recruiting students who can be subsequently molded during the educational and training process to a good product. [A good product (student) is the one who is preferred by the shipping companies i.e. has a Cumulative Grade Point Average (CGPA) of greater than 6.0].*

The premise of the above hypothesis was that companies were deciding on the basis of the performance of the student in the program. During the period of the study, international trade has escalated substantially with number of ships increasing many folds. The requirements of marine engineers have also moved up and it was observed that all successful graduates joined different companies and their CGPA was not very relevant.

On the analysis of the information of placement of last six years it was also established that different companies had different methodology for selection. The CGPA though gave an indication of the performance of the student, other factors like test, interview or psychometric test contributed in finalizing the selection.

2. *There is a relationship between the admission performance and the subsequent performance during the program in the MET institute.*

As explained in section 3.9, the data of the batches admitted and graduated was analyzed to establish relationship between the admission performance and the performance outcomes after concluding the program.

3. *Total quality management can be applied in the field of maritime education and training in general and in the area of marine engineering education in particular.*

Different techniques and tools of TQM were used in analyzing the effectiveness of different processes and sub-processes. These are explained in details in next chapter.