CHAPTER 4 – RESULTS AND DISCUSSIONS

Different data for all the processes and sub-processes in MET institution (TMI) had been collected and analyzed using relevant TQM and statistical tools. These analyses were carried out keeping in mind the objectives set at the commencement of the project and hypotheses considered. The results of such analyses and discussions thereon are appended in following sub-sections:

4.1 Analysis of data from shipping companies (customers):

4.1.1 Expectations of the customers:

The questionnaire A was used to record the expectations of the shipping companies as the prime customers of the product. Questionnaire B was used to record their perception of the services received from TMI. This exercise therefore not only resulted in giving the needs of the shipping companies and their expectations from the MET institution but also provided a feedback on the way they feel about TMI.

The information received from questionnaire A was used to develop the 'house of quality' using the system of quality function deployment (QFD). The customer requirements in their marine engineers, as identified are as follows:

Institute must have an entrance test for admission
Graduate engineer after a dedicated four-year program
Shipping companies would select based on CGPA
Expected attitude – sincerity and discipline
Overall development of a student
Graduates must demonstrate willingness to learn
Motivated
Educated and trained
Loyalty to profession

Technical characteristics required for fulfilling these requirements were identified. These have to be included in the program so that the customer requirements may be addressed. These are as follows:

Selection process for the intake
Classrooms, workshop and laboratories
Good blend of faculty members
Teaching methods
Sports facilities
Library and computer support
Scholarships
Good wages on ships
Shore job opportunities

A correlation matrix between the customers' requirements and the necessary technical characteristics was developed. Suitable weights were given to the relationships based on the following scale:

⊘ strong relationship = 9 points;
○ medium relationship = 3 points; and
△ weak relationship = 1 point.

The survey provided the importance given by the shipping companies to each of their requirements. An assessment of all factors led to target values for each of these requirements and eventually calculating the absolute weight for each requirement. These values and the correlation matrix information resulted in calculating the final figure of relative weight for each of the technical characteristics. By this mechanism the characteristics could be prioritized based on the importance given by the shipping companies.

The house of quality was thereafter developed and is given in Figure 4.1. As per the study the most significant prioritized technical characteristics are:

Good blend of teaching faculties – good teachers from all disciplines (domain knowledge)
Teaching method
Classrooms, workshop and laboratories
Library and computer support

This exercise has also indicated internal relationships between different technical characteristics. These are displayed above the house of quality and follow the legend given below:

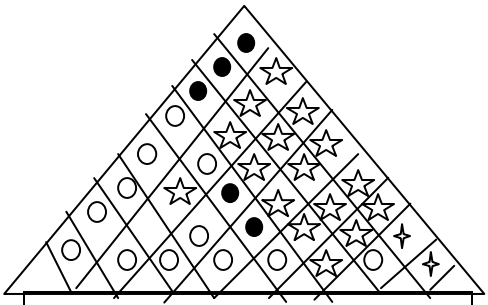
☆ Strong negative relationship
✧ Negative relationship
○ Positive relationship
● Strong positive relationship

The other interesting expectations of the industry from the MET institutions are as follows:

Requirement of extensive infrastructure was re-emphasized during the survey. 53.7% of respondents from shipping companies emphasized the need of well-equipped workshop and 46.3% opined that live equipment should be available in the institution. Availability of simulators and adequate library were at 14.6% each.

73.2% of the respondents maintained that the faculty in a MET institution should be a blend of marine engineers and domain experts from other disciplines like mechanical/ electrical engineering, mathematics etc. The fixed mindset on traditional training was once again re-established when only 2.4% indicated preference for higher qualifications for teachers.

An interesting observation was seen when 78.0% of the respondents wanted a marine engineer to continue to work in their organizations for more than 12 years. Another 19.5% preferred that the engineers should be with the same company till two years after becoming Chief Engineer (about ten years after graduation). This response reflects wishful thinking as many engineers leave the profession as early as after four or five years at sea.



Customer Requirements (What's)		Technical Characteristics (How's): Selection Procedure for intake	Class Rooms, Workshop & Laboratories	Good blend of faculties	Teaching methods	Sports & extra curricular facilities	Library and IT support	Scholarships	Good wages on ship	Shore job opportunities	T.M.I.	Competitors	Importance to customer	Target Value	Scale up factor	Sales point	Absolute Weight	Prioritized customer Requirements
	Institution entrance test	◎	○	○	△	○	○	△	△	△	3	4	4	2	0.7	1	2.7	
	Graduate Engineer	◎	◎	◎	◎	△	◎	○	○	○	5	4	7	2	0.4	1.5	4.2	
	Shipping Co. selection based on CGPA	◎	◎	◎	◎	△	○	△	○	○	4	4	3	2	0.5	1	1.5	
	Expected attitude – sincerity & discipline	△	△	◎	○	○	△	△	○	○	4	3	3	3	0.8	1.5	3.4	
	Meets specific industry requirements	○	◎	◎	◎	○	◎	△	△	△	4	3	6	5	1.3	2	15	
	Overall development	△	◎	◎	◎	◎	◎	△	△	△	4	3	7	3	0.8	1	5.3	
	Demonstrate willingness to learn	△	○	◎	◎	△	○	○	○	○	3	3	7	4	1.3	1.5	14	
	Motivated	△	△	◎	○	△	○	◎	◎	◎	4	3	6	4	1.0	1.5	9	
	Educated & Trained	○	◎	◎	◎	△	○	△	△	△	4	3	8	5	1.3	2	20	
	Loyal to profession	△	△	◎	○	△	△	○	○	◎	3	3	5	3	1.0	1	5	
Tech Competitive Assessment (based on survey)	Tolani Maritime Institute	3	4	5	4	5	5	4	4	3								
	Competitor institution	4	4	4	3	3	4	3	4	3								
Degree of technical difficulty (on a scale of 1 to 5)		4	2	3	2	1	1	3	2	4								
Target Value (on a scale of 1 to 5)		3	4	5	4	2	2	3	3	3								
Absolute Weight		196	326	480	370	138	272	142	154	184								
Relative Weight		**217**	**481**	**704**	**585**	**164**	**370**	**198**	**208**	**238**								

Customer Competitive Assessment

Prioritized Technical Characteristics

Figure 4.1 – House of quality of expectations of shipping companies from MET institutions

4.1.2 Assessment of satisfaction of shipping companies:

The views on the service quality received from TMI by different shipping companies were taken in Questionnaire B. It was aimed that the questions would help in identifying the gaps that exists between the expectations of shipping companies and their experience.

The questions were based on the system of SERVQUAL covering the five dimensions namely tangibles, reliability, responsiveness, assurance and empathy. The overall satisfaction was also measured.

A total of 40 professionals from 33 shipping companies responded on the questions. The findings are as follows:

Pearson Correlative Coefficient (r) indicating the correlation of the above five dimensions with the overall satisfaction with the institute was calculated. The 'r' values and the respective 't' values are as follows:

	r	t
Tangible	0.352	2.411
Reliability	0.084	0.508
Responsiveness	0.316	2.106
Assurance	0.422	3.081
Empathy	0.528	4.395

The 't' value from the t-distribution table and 36 degrees of freedom with a 95% confidence level is 1.6905.

The above assessment indicates that TMI should address to improve the reliability related aspects of its operation. The existing operations indicate strong areas in the aspects of assurance and empathy.

Some of the specific areas of strength are physical infrastructure, placement process and receptive staff. On the other hand areas for improvement are needed in the area of practical skills. It was also clear that graduates from other competitive institutions are also doing better and therefore TMI should try hard to improve.

4.1.3 Gap analysis:

The study also resulted in identifying gaps between the expectations of the shipping companies from the MET institutions and their perception of the service quality received from the MET institutions, in this study especially TMI.

Only characteristics, having a cumulative weight of more that 75% in the prioritized technical characteristics were considered for assessing the gaps. This was with the premise that the remaining were not significant.

Accordingly the gaps were calculated for the following technical characteristics:

Classrooms, workshop and laboratories
Blend of teaching faculties
Teaching methods
Sports facilities
Library and computer support
Overall satisfaction

The results are indicated in Figure 4.2. It can be observed that the areas for improvement are identified.

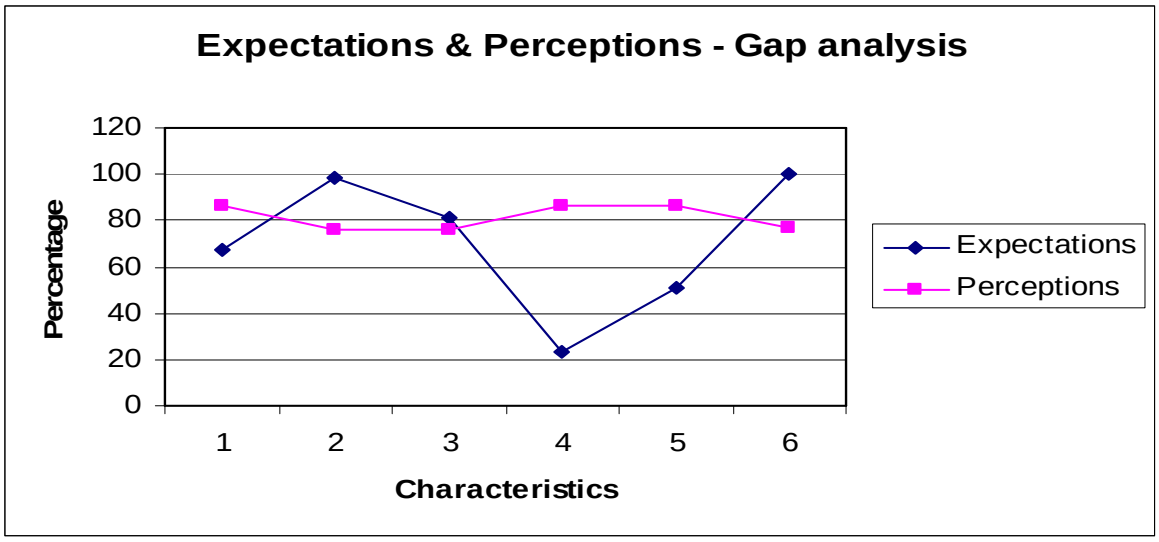


Figure 4.2 – Gap analysis between the expectations of the needs of shipping companies and the perceptions of the quality of service received by them

4.1.4 Placements:

Different methods are used by the shipping companies for selecting students from MET institutions for placements as was evidenced by the survey carried out for this study. 41.5% of the respondents opined that they would select on the basis of the percentage marks/ CGPA obtained in the marine engineering program. A similar 41.5% preferred their own interview whereas 19.5% preferred their own test for selection. Interestingly 26.8% suggested that they would prefer a combination of all three. Thus different companies have different criteria for their selection.

In the written test the companies preferred questions on engineering knowledge (43.9%); logical ability (46.3%); communication skills (14.6%); and ability to quickly respond to unfamiliar situations (12.2%). These figures were also confirmed during interviews with some companies. This information validates the belief that a marine engineer should possess an all-round personality backed with adequate knowledge and necessary skills.

TMI has been achieving 100% placement in last few years indicating that all successful graduates are getting absorbed in the industry. This reflects as an achievement for the TMI. The starting salaries that have been offered to these graduates vary from company to company. Considering that almost all the significant and important shipping companies have been recruiting from TMI, it can be safely accepted that the packages offered are appropriate as per international standards

The difficulty however, arises where we try to assess the subsequent career development of those graduates after few years. This is due to the fact that TMI is comparatively a new institution and the graduates of the pioneer batch have only completed little more than five years after graduation. The other difficulty is the lack of information on a regular basis from the alumni. Maritime industry being so international it is difficult to keep a tab on the whereabouts of the graduate. However, occasional success stories of the graduate do reach TMI and it is generally felt that the graduates are doing well and have been accepted in the industry. The information regarding their completion of the competency examination for further promotions is also not completely available and it is difficult to guess success rate.

4.2 Admissions:

In India there are four main avenues to become a certified marine engineer. These are dedicated four-year marine engineering degree program; one-year conversion course after a degree in mechanical engineering; two-year conversion course after a diploma in mechanical engineering; and a sandwich training scheme requiring part training in a MET institution and part training onboard ship. As part of this study, the respondents from shipping companies were asked their first preference, 82.9% preferred their marine engineers from a dedicated four-year marine engineering degree program. This validates and confirms the importance of this program.

4.2.1 Selection for the admissions:

73.2% of the respondents preferred MET institution having a detailed selection process covering various aspects. 53.7% of the respondents preferred an entry level test by the MET institution whereas 34.1% preferred selection on the basis of PCM marks; 17.1% preferred selection on the basis of 12^{th} class aggregate marks; and 14.6% preferred interviews by the MET institution. Only 7.3% wanted psychometric test. The selection methodology at TMI has a combination of all these methods and can construe to be covering the needs of the customers. 56.1% of the respondents wanted the MET institution to inform the shipping company about the methodology adopted for selection.

4.2.2 Motivation for selecting career of seafaring:

Traditionally the ships globally were manned by seafarers from the traditional maritime countries like UK, Greece, Norway, Russia, Japan etc. Economic developments with higher salaries for other shore-based jobs resulted in such nationals leaving the seafaring and Indian started getting jobs in ships owned and managed by foreigners. Seafaring in general and marine engineering in particular has never been a very preferred option of the Indian youth. This issue becomes very relevant today due to the extreme shortage of seafarers worldwide. Further the economic growth in the country and the expansion of the IT sector has made these sectors more popular with the students who pass 12^{th} class. The representatives from the shipping companies were asked about the main motivation of the Indian youth to join this career. The responses are appended in Table 4.1.

Table 4.1 – Motivation to join MET institution

SN	Motivation to join MET institution	Percentage
1.	Attractive salaries at sea	80.5%
2.	Opportunity to see the world	14.6%
3.	Adventure	9.8%
4.	Charm of wearing uniform	7.3%

It is pertinent to add an earlier study made by Saxena (145) where some of these motivations were compared with the ground realities in the shipping career and are indicated in Table 4.2.

Table 4.2 – Perceptions while joining sea career and reality

Perception	Reality
Excellent monetary benefits	Not extremely high – other sectors are also high
Worldwide travel	Travel Yes – seeing places No (due shorter stay in ports)
Adventurous life	Routine work – only adventure is rough seas/ pirates! Very few persons on board
Status in community	Yes but at a cost of being away from the family
Unusual career	Yes

It can be observed that in the changed economic situation in the country and the overall benefits in the shipping career, especially at the initial levels, not being very attractive, shipping may not be the main career choice of an average 12^{th} class student. It may however be necessary to tap the market in the smaller cities and look for the students from the middle or lower-middle class or even economically lower class. Such students would not only be interested in this career but would also remain in this career.

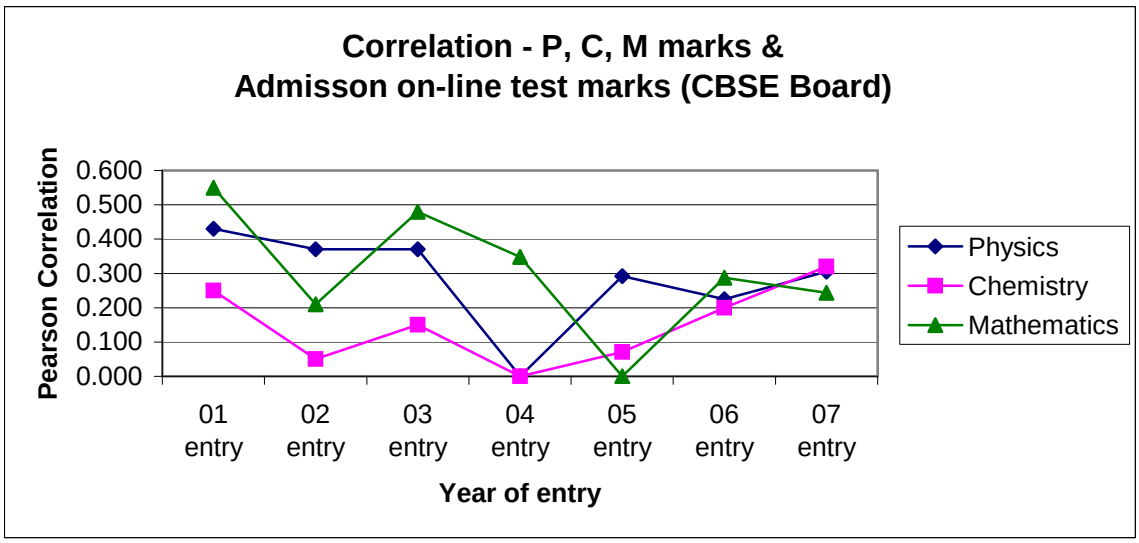
Commenting on the shortage of the seagoing officers, the Secretary General of IMO commented that if the global pool of competent, properly qualified and efficient seafarers is to be increased, seafaring must be seen as a viable career choice for people of right caliber [Mitropoulus (99)].

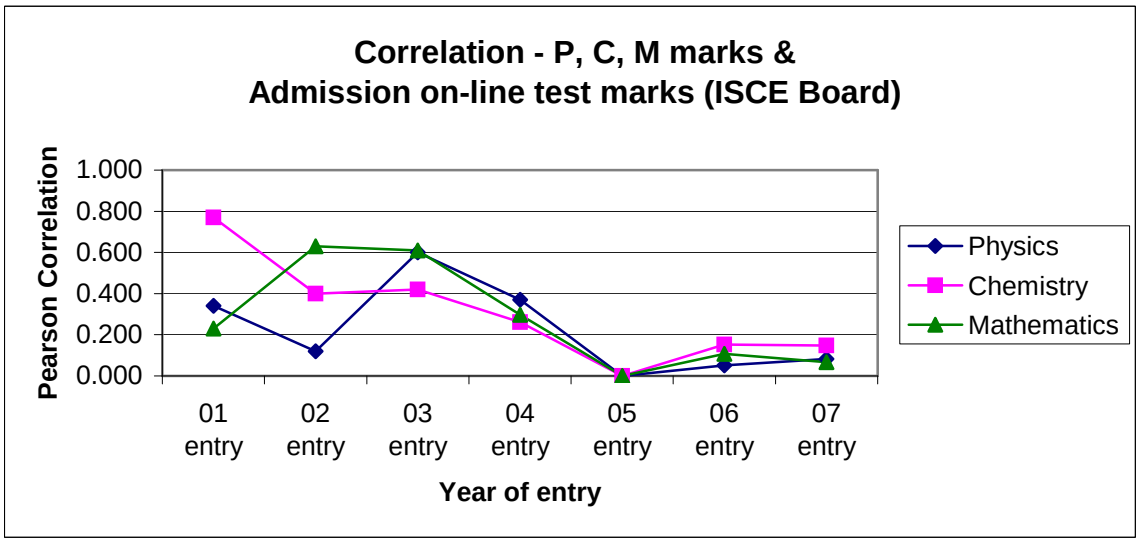
Barnett (11) suggested the reasons for going to sea as being student from an area that is a traditional seafaring supply place; family influences; good career prospects; a long term interest in the sea; travel. It is interesting that for Indians the motivation for joining sea would be rather different as the argument in favour of traditional areas is not really applicable with not many students joining MET institutions from the coastal areas. In India, besides the high salaries, other motivation is the feeling of adventure; to do

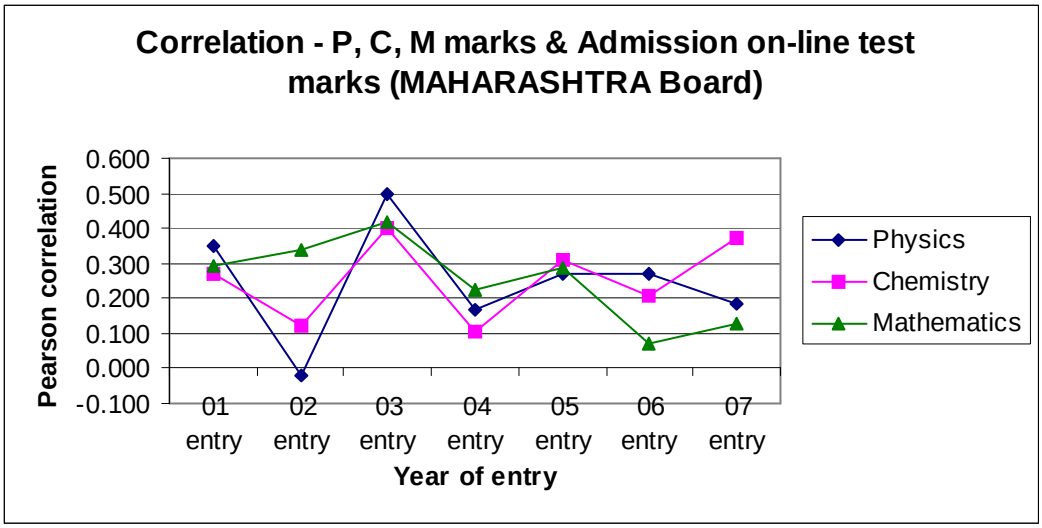
something different; or international travel. These are not deep rooted and very soon the charm of sea job wears out leading to frustration [Saxena (145)].

4.2.3 Admissions – Online entrance test:

An analysis of seven batches that have joined TMI since 2001 was carried out. Pearson Correlation Coefficients were calculated between the online test marks and the marks obtained by the candidates in 12th class in Physics, Chemistry and Mathematics. No significant correlation was observed however, it was seen that this correlation was higher in the case of students from CBSE board than students from other boards. The correlation for different state boards was less. The figures with this analysis are given at 4.3.







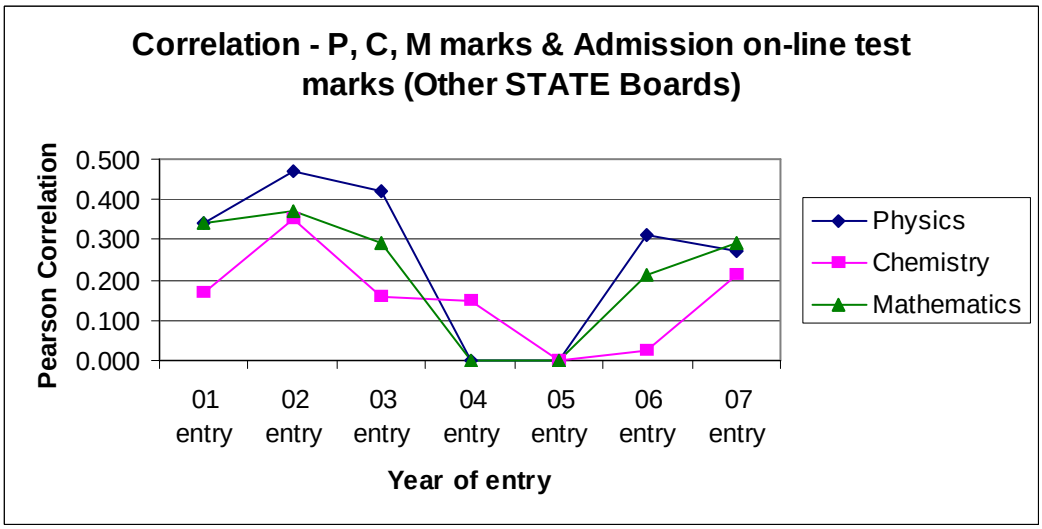
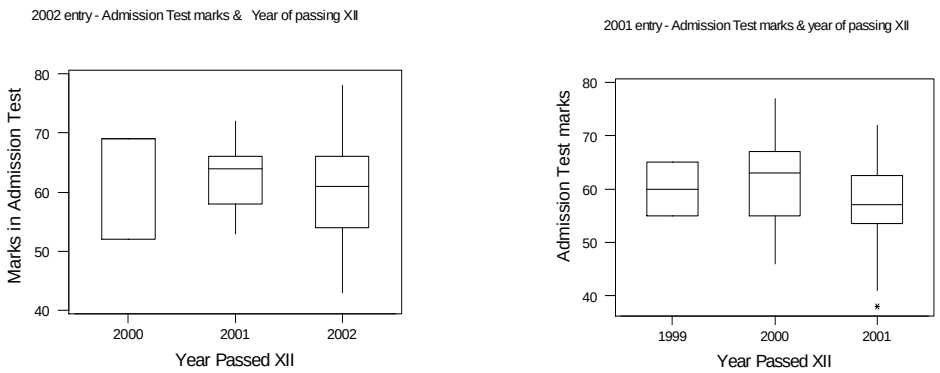


Figure 4.3 – Correlation of P, C, M marks with admission on-line test marks of all boards

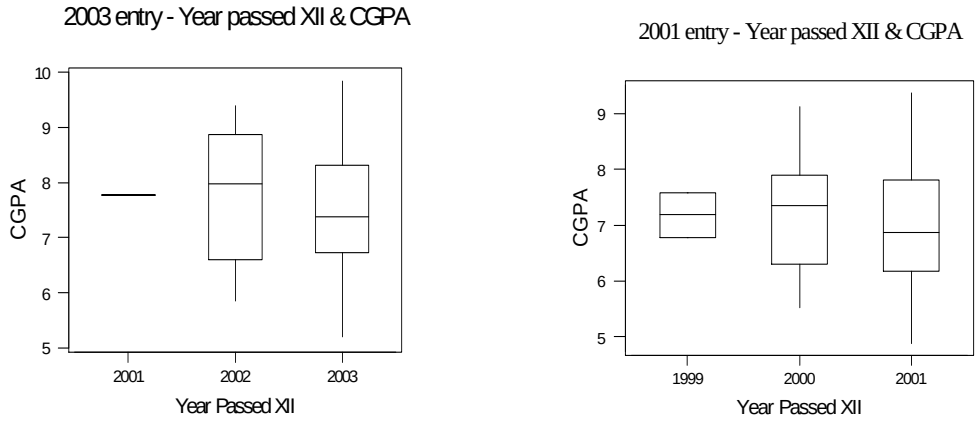
Significantly it was observed that the students who drop one or two years after 12th for appearing in various competitive examinations perform better in the online test at TMI. This may be due to better preparation for different engineering admission examinations. While this trend was observed in all years, box plots of two years are given at Figure 4.4 as example:



Figures 4.4 – Box plots of admission test marks and year of passing XII

4.2.4 Admission data analysis:

It is pertinent to add that such students were found to be performing better in the four-year marine engineering program too. This analysis was carried out for three batches that have graduated. The results are given bellow in Table 4.3 and box plots as Figure 4.5:



Figures 4.5 – Box plots of CGPA and year of passing XII

Table 4.3 – Correlations between P, C, & M and CGPA for students passing XII earlier than the admission year

	Physics	Chemistry	Mathematics
2001 entry – Students passed XII earlier	0.614	0.596	0.786
2001 entry – Students passed XII in 2001	0.340	0.394	0.461
2003 entry – Students passed XII earlier	0.574	- 0.213	0.575
2003 entry – Students passed XII in 2003	0.277	0.136	0.123

It is therefore established that the students that take a break after 12^{th} class and prepare for competitive examinations perform better in the marine engineering program.

An analysis of the PCM marks at admissions was made for batches admitted from 1998 till 2005. All four quartiles were calculated to establish the spread of the data. The average PCM mark had shown an improvement over the years. It was however, necessary to see the spread of date and to establish trends, if any. The result is appended in Figure 4.6. It is seen that quartiles one, two and three are increasing indicating a better trend. Q 4 has also been increasing.

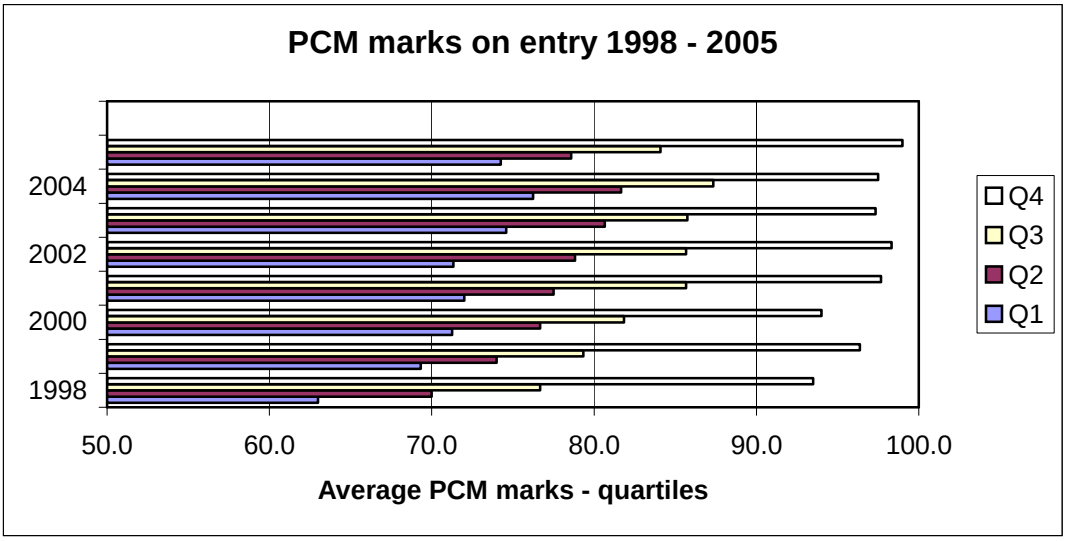


Figure 4.6 – Quartile analysis for PCM marks on entry

4.3 Design of Curriculum:

The descriptive curriculum for each module for each of the courses in the program was divided in general learning objectives (GLO) and then in more detailed specific learning objectives (SLO). This was done by a team from TMI taking into account the requirements of subsequent job as a marine engineer on board ship and considering the overall development of knowledge and skills among the students. Inputs from the industry, both marine and non-marine were also taken. Blooms Taxonomy was referred to incorporate correct words as per the requirements. Details as referred in further subsections were also considered.

As an example the topic of 'Boiler water treatment' is included in this study. This topic is dealt with in 2nd year in the course "Marine Boilers" and once again in the final year in the course on "Power Plant Operations". The GLOs & SLOs for the same topic are shown in Table 4.4.

Target Group- Fourth year Marine Engineering

Traditional method :

Effect of impurities in boiler water, testing of boiler water and treatment

Suggested GLO/ SLO Method:

Table 4.4 – Syllabus with GLO & SLO - Boiler water treatment

General Learning Objectives	Specific Learning Objectives
A. Student learns about scale formation, corrosion, requirement of water treatment and procedure for testing and treatment of boiler water. (Duration 06 hrs)	1.1 Describe the constituents of sea water and types of salts 1.2 Describe effects of various salts and mechanism of scale formation 1.3 Explain solubility and temperature dependence of solubility 1.4 Explain the need and method of removal of hardness salts 1.5 Understand types of corrosion (scab pitting, air bubble pitting) 1.6 Describe effect of quality of boiler water on boiler corrosion (dependence on pH, alkalinity and Oxygen content) 1.7 Describe the mechanism of neutralization of hardness 1.8 Describe procedure for testing (sampling boiler water by titration (test for alkalinity, salinity, phosphate reserve) 1.9 Calculate quantity of chemicals to be added 1.10 Calculate frequency and rate of Blow down.

Bloom's Taxonomy, proposed in 1956 by Benjamin Bloom, an educational psychologist at the University of Chicago divides educational objectives into three "domains:" Affective, Psychomotor, and Cognitive. The ‘Affective’ skills describe the way people react emotionally. The ‘Psychomotor’, on the other hand refers to the ability to physically manipulate a tool or instrument. It is the ‘Cognitive’ skills that are important for the education, especially with an idea of developing the syllabi. The six levels of this taxonomy, along with suitable verbs that can be used are given below in Table 4.5 [Felder (41)].

Table 4.5 – Bloom’s taxonomy

Levels	Explanation	Verbs that can be used
Knowledge	Student acquires specific knowledge	List; tell; state; name
Comprehension	Student understands the information and is able to interpret the facts	Explain; discuss; compare; predict
Application	Student applies the knowledge gained and solves a problem	Solve; illustrate; construct; show; examine
Analysis	Student can analyze a problem	Analyze; distinguish; explain; investigate
Synthesis	Student creates new ideas and looks at the future	Create; compose; devise; predict
Evaluation	Student evaluates the bias or justification behind any information and is able to relate to new issues	Justify; verify; discuss; determine

4.4 Faculty Teaching Potential:

An assessment of the faculty members was made and an analysis was carried out as per the modal suggested by Nakazawa (112). In this study the methodology adapted was to identify the potential of each faculty individually and to further calculate the faculty potential of complete institute. Each teacher was awarded points on a scale of 1 to 4 on the above four aspects as per the weight indicated in Table 3.3. This calculation was carried out for all teachers in TMI and the outcome for the complete institution is appended below:

Table 4.6 – Faculty teaching potential

S.N.	Potential attributes	Average score
1	Academic qualifications	2.5
2	Teaching experience	3.0
3	Industrial experience, including certificate of competency for marine faculty, which is based on industrial work.	2.2
4	Up-gradation initiatives, this includes the papers published and presented. It also includes seminars, conferences etc attended, both nationally and internationally.	1.3

This data was also plotted on the Figure 4.7.

Faculty teaching potential of the institution is the ratio of the area of smaller quadrangle, representing the potential that is available in the institution and the area of the larger quadrangle, which represents the maximum possible potential.

In this case the teaching potential works to 30.87%.

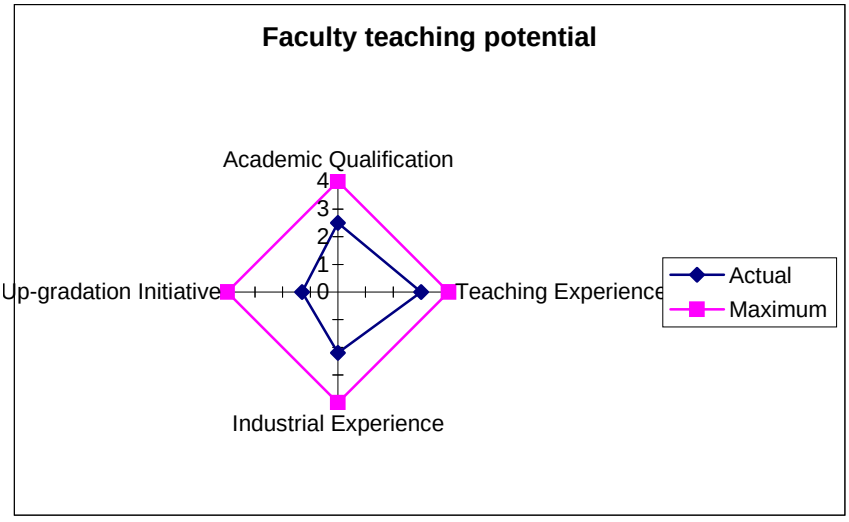


Figure 4.7 – Faculty Teaching Potential

It can be observed that the faculty is well experienced and possess adequate qualifications. However, more initiatives are desired for up-gradation of faculty members. This can be achieved by encouraging them to write papers, attend conferences and seminars etc.

4.4.1 Teaching methodology and improvement:

As required under the STCW Convention (161), all teachers in an MET institution must complete Training of Trainers and Assessors (TOTA) course. However, it is very doubtful that this two-week course can really help develop teaching techniques in a sustainable way. This is especially important, as there are teachers that are ex-seafarers who know much about shipping but not really about teaching. On the other hand there are many teachers from traditional engineering colleges who teach courses in mechanical, electrical and other basic science subjects and have adequate experience but have almost no knowledge of ships and shipping. Traditionally acceptance of such teachers by students is rather less as against the professional ex-seafarers.

It is therefore imperative that certain initiatives are taken to rectify or amend the situations of both sets of teachers. Besides the difficulty as mentioned above, the salary disparity between the two sets of teachers also brings in yet another difficulty. The ex-seafaring marine engineers are obviously paid much higher corresponding to the package offered in the industry. The other teachers though receive higher than elsewhere but definitely not very close to the seafaring teachers.

Recognizing the need of faculty development and considering the unique situation mentioned above, TMI has established following initiatives:

Marinization workshop – In this workshop orientation of ships and shipping industry is given to the non-marine faculty. This includes awareness of terminology; application of courses like thermodynamics, mechanics, mathematics etc to ships. This awareness gives the opportunity to the teachers to cite these applications while teaching such basic engineering subjects thereby increasing the interest level in the class.

Teaching methodology workshop – Different methods of improving teaching and presentation skills are discussed in this workshop. Teaching staff is encouraged to develop these skills. Various aspects of classroom management are also looked into.

Information exchange workshop – Faculty members of TMI regularly attend conferences and seminars and at times present papers. The information gathered by those who attend is disseminated to all teaching staff in this workshop. The conference proceedings are kept in the Library for reference.

The above workshops are arranged in each semester break so that maximum teachers can attend. These provide a platform for learning; exchanging views and information; and acts as a catalyst for continual improvement.

4.5 Process outcomes and improvement:

The QMS was developed in TMI in 1999 and was certified complying with the standards of ISO 9002:1996 in October 1999. The system was upgraded to the requirements of revised ISO 9001:2000 standards in October 2003. The management of TMI took a proactive view of the quality management and agreed to incorporate different techniques of TQM in the functioning of TMI so that it may eventually develop into an institution of excellence.

The implementations and thereafter effectiveness of such initiatives were observed, analyzed and checked in this study. The results are given in this sub-section.

4.5.1 Academic activities:

Various analyses have been included in this chapter. However, the intention in this section is to bring about the continual improvement that has been achieved in the academic aspects of the program. 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.

4.5.1.1 Final results:

TMI awards grades in different courses of the four-year marine engineering program. The grades are A, B, C, D, and E and results are declared in GPA after 1st semester and subsequently CGPA after each semester. A student eventually gets a final CGPA on completion of the program. The division is awarded by BITS, Pilani based on the following criteria:

CGPA of 9.0 or more:	Distinction class
CGPA between 7.0 and less than 9.0:	First class
CGPA below 7.0:	Second class

The results of five batches that have graduated were analyzed. It is observed that the percentage of distinction and first classes is gradually increasing. This reflects the improvement being achieved in the academic activities. The Figure 4.8 depicts this trend and validates the effectiveness of improvement initiatives.

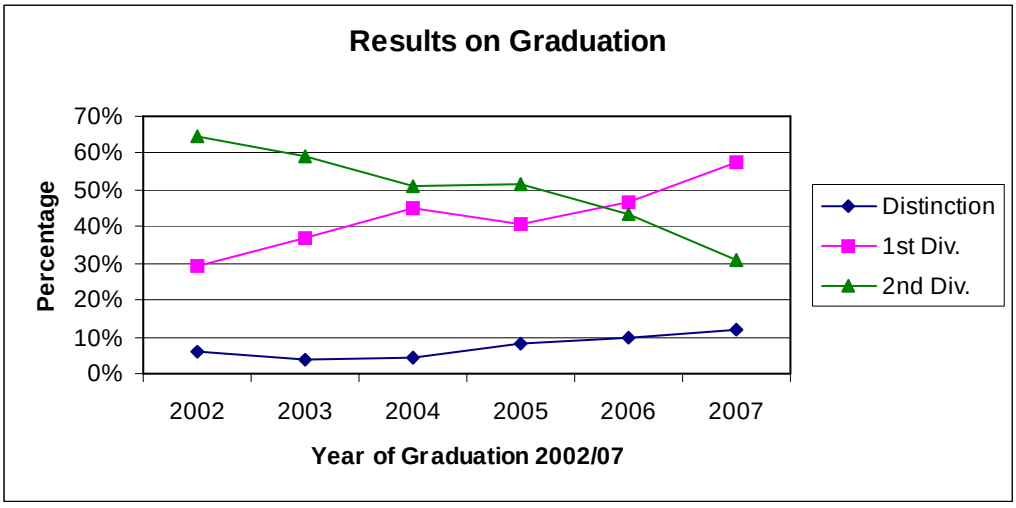


Figure 4.8 – Improvement in CGPA (in-process improvement)

4.5.1.2 In-process results:

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.

It is observed that the CGPA improved for 75% (2000 entry) to 88% (2003 entry) students. The average increase was for 0.68 (2000 entry) to 0.88 (2003 entry). These results confirm that the program is effective and knowledge & skills, along with values are getting added to the student body during the program. The result is appended in Figures 4.9 and 4.10.

Another interesting conclusion was that 97.1% of students that had secured a GPA of 6 or less in the 1st semester improved their CGPA by the completion of their program. In other words there is continuous improvement from majority of the students.

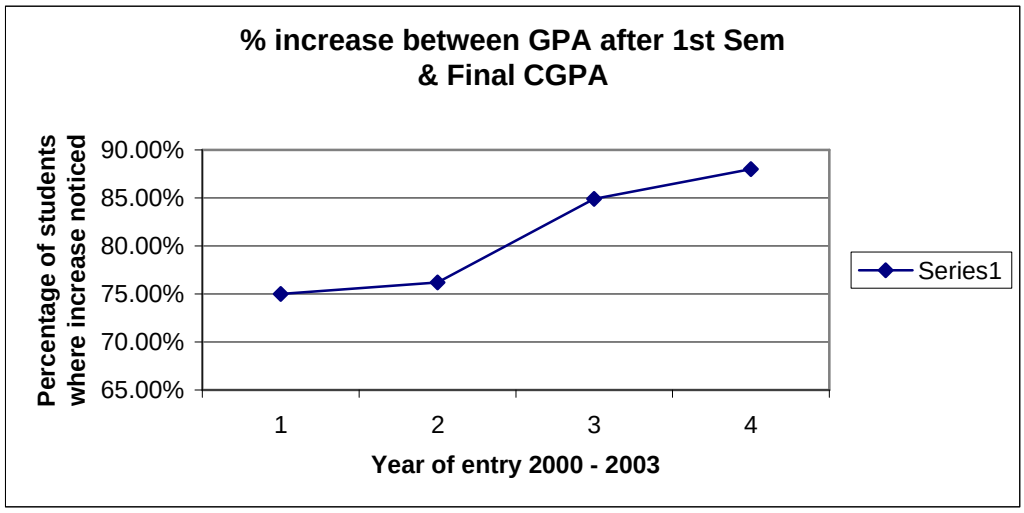


Figure 4.9 – Percentage of students whose CGPA increased during program

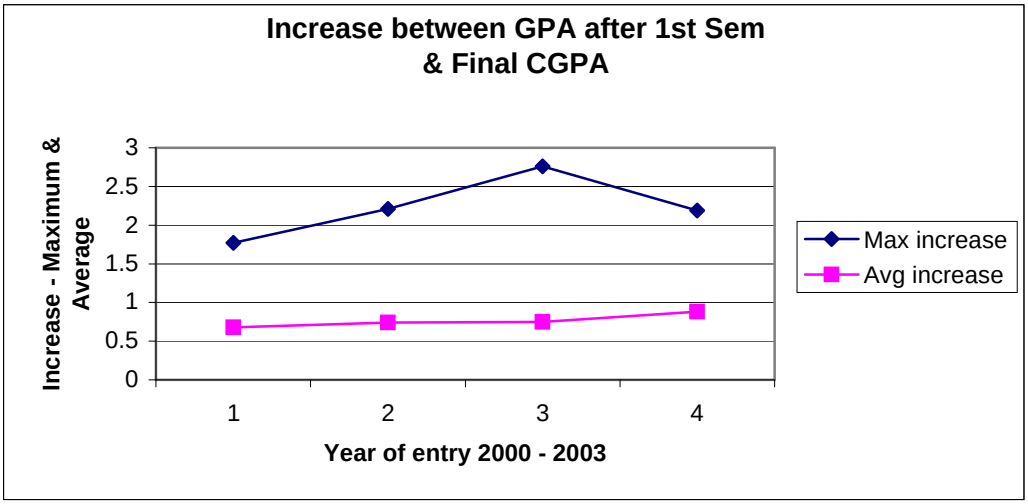


Figure 4.10 – Maximum & average increase in CGPA during program

The above results also validate the effectiveness of different initiatives that have been implemented for improving quality.

Performance of batches presently in TMI was also analyzed. The same trend was observed and it was confirmed that the CGPA increases during the program. The result of 2006 entry batch is given below as Figure 4.11:

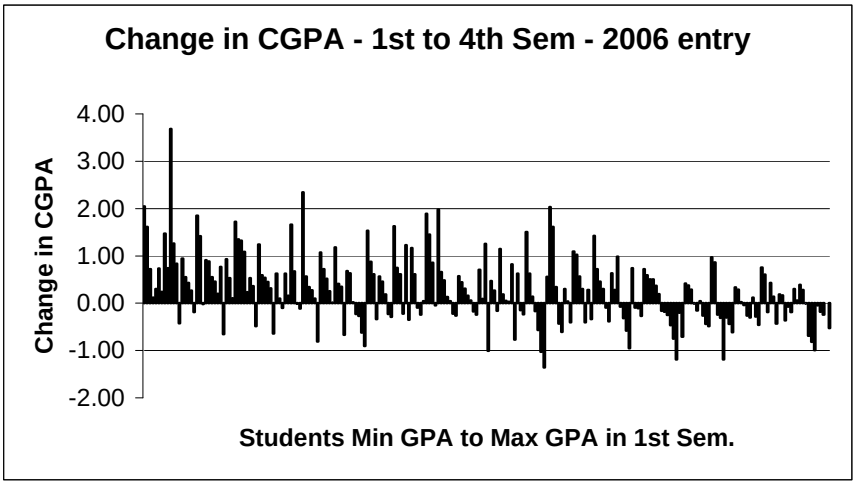


Figure 4.11 – Change in CGPA of existing students

4.5.2 Correlation between admission performance and performance in the program:

Data of last six batches graduated from TMI was analyzed. The total number of students was as follows:

Table 4.7 – Number of students for analysis

Year of Entry	1998	1999	2000	2001	2002	2003
Year of Graduation	2002	2003	2004	2005	2006	2007
Number of Students	99	102	96	102	126	117

4.5.2.1 Admission Criteria:

The parameters considered were percentage marks in Physics, Chemistry and Mathematics. The students in TMI come from different national and state boards and this information was considered important for analysis. It has been observed that the level of knowledge is different among students from different boards. An on-line test for admission was used in last three batches and that data is also considered. Further the students were grouped in three educational boards namely CBSE, ISCE, Maharashtra and all other State boards.

4.5.2.2 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, and 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.

4.5.2.3 Correlation of admission and performance data:

Pearson Correlation Coefficients were calculated to establish the following relationships:

Table 4.8 – Admission and performance criteria

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

Initially the calculations were based on the aggregate PCM marks. However, for better understanding and with an aim to achieve confirmation of the following hypothesis, individual marks obtained in Physics, Chemistry and Mathematics were considered:

The average correlation figures obtained between the course groups and physics, chemistry and mathematics indicate some correlation. The results are given in Table 4.9. Further a graph representing the percentage of students admitted from different boards is given at Figure 4.12.

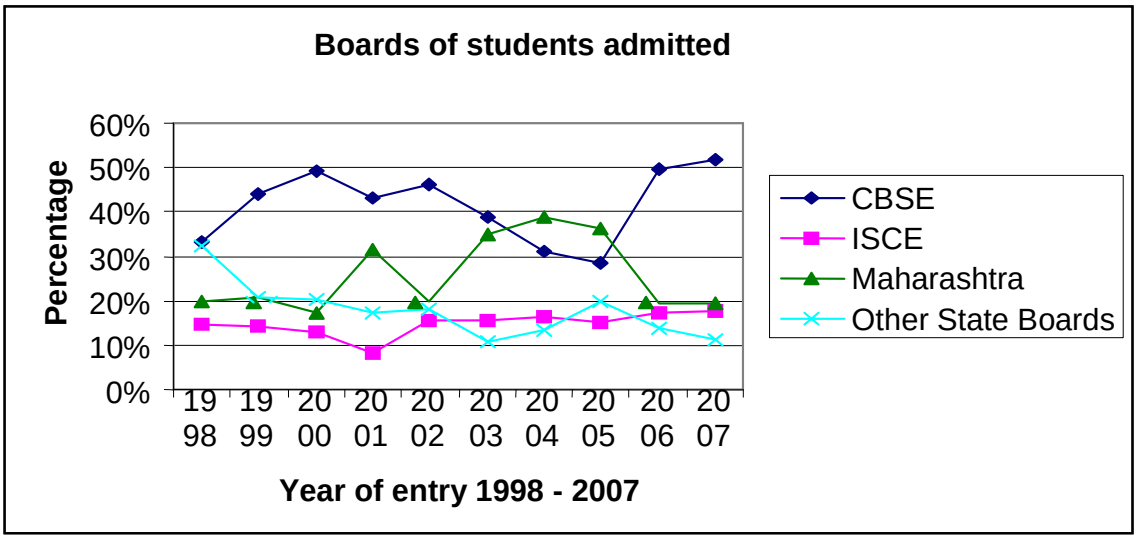


Figure 4.12 – Boards of students admitted in the program

4.5.2.4 Correlation between PCM marks and performance in different courses:

Table 4.9 – Average Pearson Correlations between PCM marks in 12th & performance in different group of courses in the program (1998 to 2003 entry)

		Physics	Chemistry	Mathematics
All Boards	Applied Science	0.30	0.26	0.35
	Electrical	0.29	0.24	0.28
	Mechanical	0.29	0.24	0.31
	Marine	0.28	0.24	0.24
	CGPA	0.30	0.26	0.30
CBSE	Applied Science	0.39	0.42	0.39
	Electrical	0.39	0.40	0.34
	Mechanical	0.31	0.34	0.33
	Marine	0.32	0.37	0.26
	CGPA	0.35	0.40	0.34
ISCE	Applied Science	0.39	0.48	0.45
	Electrical	0.38	0.41	0.46
	Mechanical	0.40	0.41	0.49
	Marine	0.40	0.38	0.43
	CGPA	0.42	0.48	0.50
Maharashtra	Applied Science	0.44	0.39	0.39
	Electrical	0.42	0.40	0.40
	Mechanical	0.42	0.44	0.39
	Marine	0.39	0.36	0.27
	CGPA	0.45	0.43	0.38
Other State Boards	Applied Science	0.17	0.13	0.25
	Electrical	0.10	0.08	0.05
	Mechanical	0.16	0.08	0.17
	Marine	0.15	0.05	0.14
	CGPA	0.14	0.06	0.13

It can be observed that the correlation is better for CBSE board (0.31 ~ 0.42) and Maharashtra state board (0.27 ~ 0.45) and Further correlation is much less for the students from other State boards (0.05 ~ 0.17). The difference between correlations across different course groups is not significantly better. The conclusions are important considering that the majority of students come from CBSE and Maharashtra boards. Almost similar correlations were also observed for students coming from ISCE board.

The average R Square figures as calculated are appended in Table 4.10.

Table 4.10 – R Square values for different boards

Groups	**Applied Science**	**Electrical**	**Mechanical**	**Marine**	**CGPA**
Total	19.3	15.7	16.2	14.1	16.9
CBSE	35.3	30.3	24.5	22.9	28.1
ISCE	46.3	46.2	48.0	41.5	50.5
Maharashtra	32.2	27.9	30.2	25.1	30.3
Other State Boards	22.2	21.0	19.2	21.8	18.5

The average F figures are given in Table 4.11. The F figures from statistical table for significance level 0.01 are also given.

Table 4.11 – F values for different boards

Groups	**Applied Science**	**Electrical**	**Mechanical**	**Marine**	**CGPA**	***F from Table***
Total	8.5	6.7	7.0	5.8	7.2	*4.0*
CBSE	9.1	7.1	5.7	5.0	6.6	*4.3*
ISCE	4.0	5.9	7.8	3.6	5.6	*6.7*
Maharashtra	3.4	3.9	3.3	2.4	3.1	*5.0*
Other State Boards	1.5	1.4	1.3	1.4	1.1	*6.1*

The analysis results were more meaningful when data of different boards was considered separately. Some observations and results are appended below:

CBSE – Significant correlation was seen between physics, chemistry and mathematics marks and applied science and marine groups and also with final CGPA. The R square values were also found to be significantly higher indicating a higher influence of physics, chemistry and mathematics on these groups.

ISCE – Higher correlation was observed for some years between physics, chemistry and mathematics marks and marks obtained in different groups like applied science, mechanical and CGPA. The R square figures were also comparatively higher.

Maharashtra Board – Some correlations were observed. The R square value was significant in some year/ group indicating no pattern. The calculated F values were less than the F values obtained from the table for significance level of 0.01.

Other State Boards – No significant correlations were observe in any of the groups, though data for one year (2001 entry) did show totally different results and was considered exceptional. Similarly R square figures did not show significant values. The calculated F values were less than the F values obtained from the table for significance level of 0.01.

While some correlation is observed in many instances no clear trend has emerged except following that can be summarized:

1. The students from CBSE board performed better than others (Figure 4.13).
2. Students of ISCE board had scored better in electrical group and had better final CGPA.
3. The regression equation was significantly valid for CBSE and ISCE boards with higher R square values.
4. No correlation/ regressions were observed in case of students from Other State Boards.
5. Correlation reduces when all boards collectively are considered.

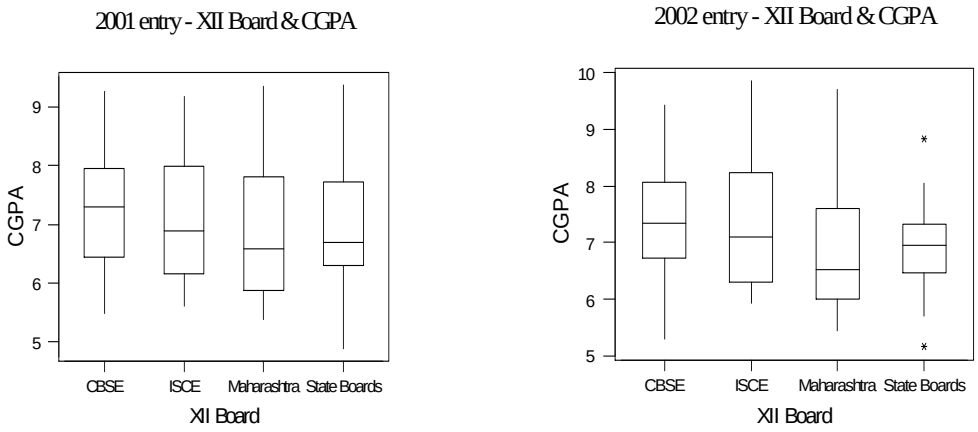


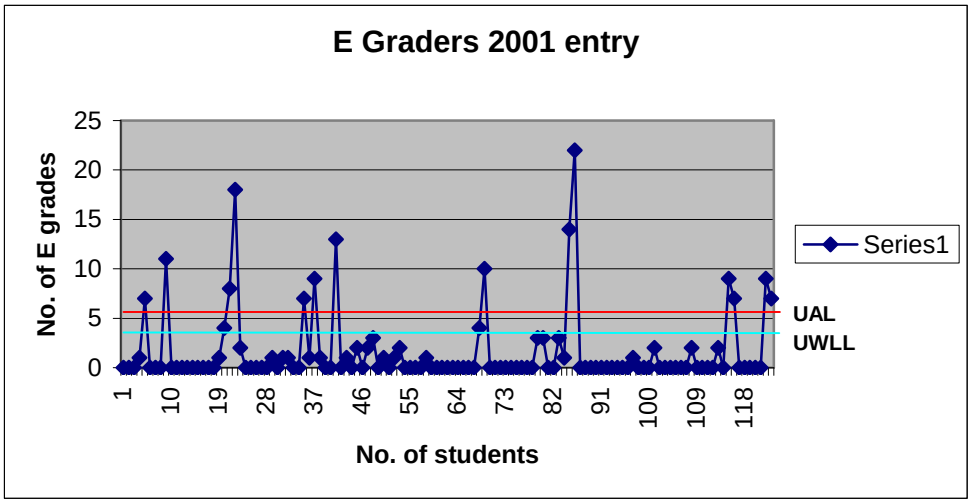
Figure 4.13 – Performance of students from different boards

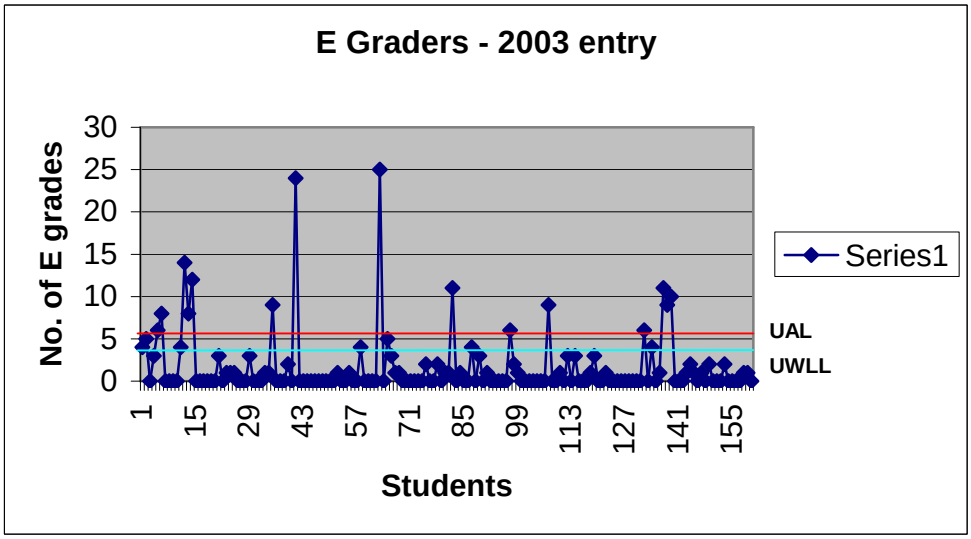
4.6 Analysis of non-conforming products:

A student who fails in a course or is not able to complete the program in the stipulated period of four years is considered as a non-conforming product. It is imperative that these situations are analyzed as given below:

4.6.1 Students Failure Analysis:

An assessment of all failures (E graders) for the last four graduated batches was made. The data was analysis by drawing c-charts. The Upper Action Line (UAL), Upper Warning Lines (UWL) and Lower Lines were calculated and the charts were drawn as given in Figure 4.14.





Figures 4.14 – Analysis of failures (2001 & 2003 entry)

The students above the UALs can be identified. It is recommended that this technique is followed for all semesters so that weaker students are identified at an early stage.

4.6.2 Course Failure Analysis:

An analysis of all 56 courses that are part of the four-year marine engineering program was carried out. For this study examination result data of last five graduating batches was collected. Percentage of failure (E graders) for each course was calculated.

The salient points of this analysis are appended below:

(a) Abnormally high failure rate was noticed for 2000 entry students for their first year I semester. On discussion it was found that the institute shifted to its new campus during the period and in the interim period the study schedule was disrupted.
(b) Higher than normal failure were noticed for the 2003 entry batch. The reasons for this could not be established.
(c) Difficult courses, where students normally tend to fail are identified. This is on the basis of consistency in number of failures. These are on table 4.12.

Table 4.12 – Difficult courses

Year	Semester	Courses
First	I	Applied Electricity, Geometrical Drawing
	II	Thermodynamics, Applied Mechanics II, Strength of Materials, Computer Applications
Second	I	Hydraulics, Applied Thermodynamics,
	II	Marine Boilers & Steam Engineering, Electrical Machines, Electronics
Third	I	Naval Architecture I, Mechanics of Machines, Pumps and Pumping Systems
	II	Naval Architecture II
Fourth	I	International Conventions & IMO

4.6.3 Control Charts:

As an example examination results of final year (seven courses) for first semester of 2007 was considered. The difference between maximum marks and the minimum marks in these courses was calculated. Thereafter average (X Bar) and differences (Range R) were drawn. The X Bar and R control charts are given as figure 4.15 and 4.16. Students that are above the Upper Control Limit (UCL) or those that are closer to this limit can be identified. Similarly students closer to the Lower Control Limit (LCL) can also be identified.

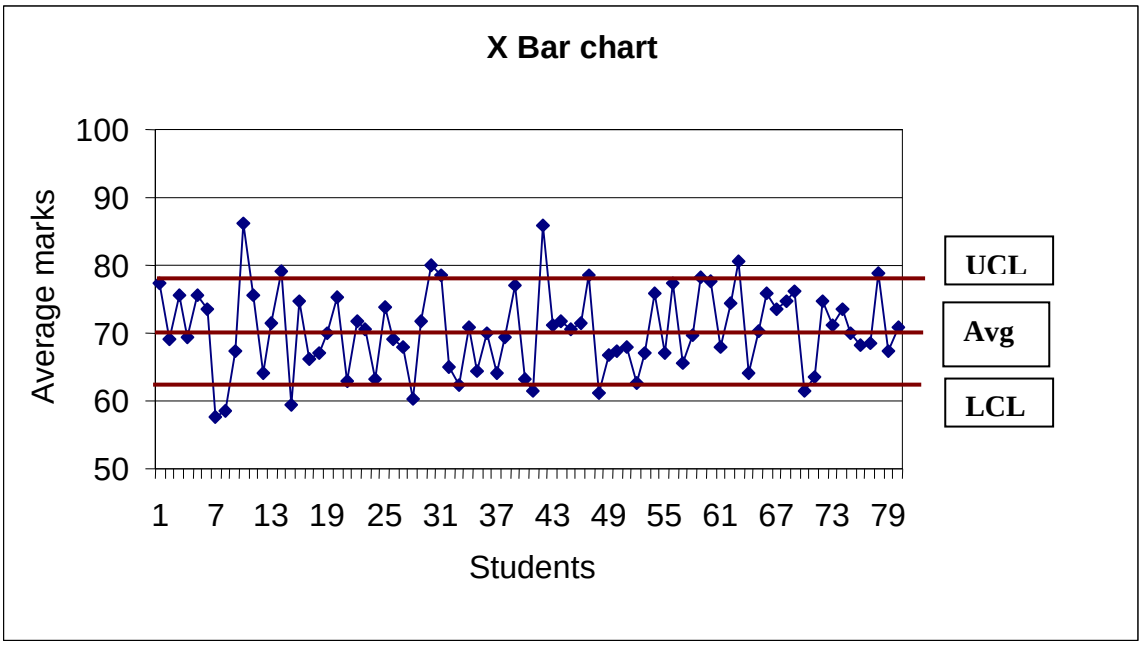


Figure 4.15 – X Bar chart of the examination result

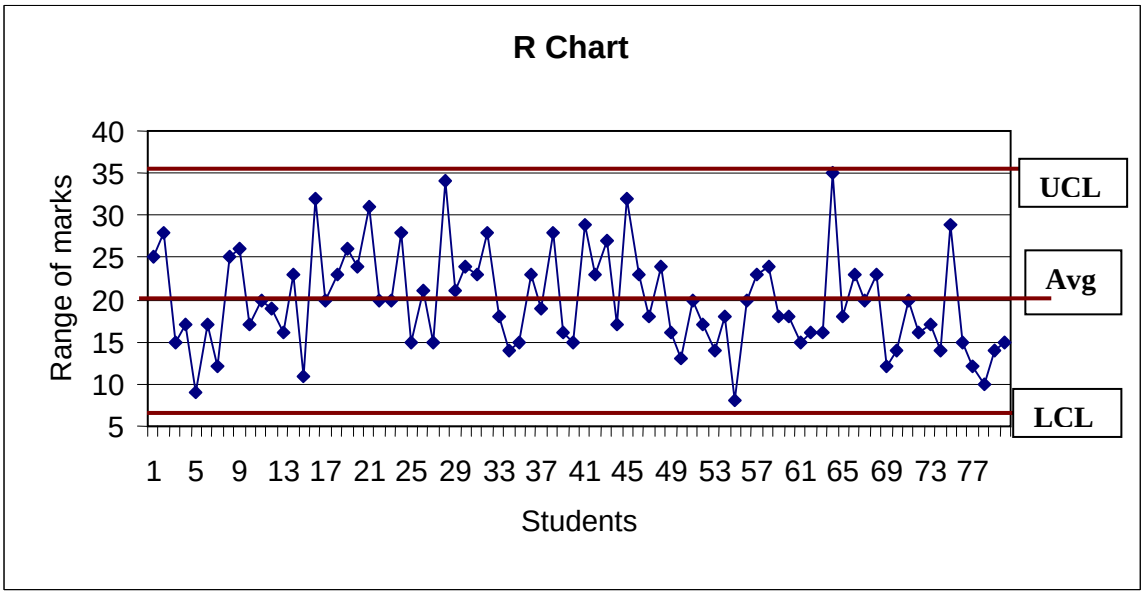


Figure 4.16 – R chart of the examination result

The above analysis resulted in identification of weaker students and also those students who have done well in many courses but secured lesser marks in any one course. This timely identification can help the students who can be suitably counseled/ guided by the authorities.

4.6.4 Analysis of failure and withdrawn students:

Cases of all students who have withdrawn from the program or extended the program from four years to more by one or more semesters were examined. Following could be the reason for withdrawal:

1. Secured admission elsewhere – the other options generally are computers, 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 are accumulated and the student is just not able to go on further.
5. Many ‘E’ grades – length of the program is extended than four years.

The marine engineering program is of four-year duration however; it can sometimes get extended due to following reasons:

1. More number of E grades.
2. Disciplinary reasons.

Analysis of all such students for the first five batches was done. Following conclusions are arrived:

1. The maximum percentage of students in this category is from ‘other state boards’ (34.8%). This does not include students from Maharashtra for whom the figure is 23.4%
2. The similar percentages for CBSE and ISCE are 16.9% and 13.4% respectively.

4.7 Feedback from faculty members:

The feedback and views from teachers in different areas namely Applied and Social Sciences, Mechanical Engineering, Electrical Engineering and Marine Engineering were

taken by the questionnaire having 65 questions on different aspects of functioning. These are given in Table 4.11. A total of 38 faculty members replied to the questionnaire that was confidential. In some cases the questionnaire was followed with personal one-to-one meeting with the relevant teacher. This was with an aim of getting more clarity on the views given in the questionnaire.

Table 4.13 – Aspects in faculty feedback

SN	Aspects	Covering areas
1.	Leadership & Governance	Senior leaders; internal communications
2.	Customer focus	Perception and awareness about internal & external customers and their requirements
3.	Measurement & Analysis	Awareness about collection of different data and its analysis; feedbacks from all concerned entities
4.	Staff focus	Self-improvement opportunities; recognition; environment and satisfaction
5.	Process Management	Management of different processes; involvement
6.	Process Outcomes	Effectiveness of teaching; environment in the campus; student-teacher relationships; values; stakeholders and overall personal satisfaction.

Pearson Correlative Coefficient (r) indicating the correlation of the above six dimensions with the overall satisfaction and the respective 't' values are as follows:

Table 4.14 – Analysis of feedback from faculty members

SN	Aspects	r	t
1.	Leadership and governance	0.38	3.43
2.	Customer focus	0.365	2.32
3.	Measurement and analysis	0.516	3.56
4.	Staff focus	0.617	4.64
5.	Process management	0.501	3.42
6.	Process outcomes	0.66	5.20

It can therefore be concluded that there is significant correlation between the above dimensions and the overall satisfaction level of the teachers. The analysis indicates that while all factors relate to the eventual satisfaction, more attention may be given to the aspect of customer focus. This becomes all the more important as understanding of customer needs and expectations is paramount for the eventual success of an institution.

The 't' value from t–distribution table with a 95% confidence level is 1.6879.

Calculated F value is 7.24

The value of F from distribution table in the degree of freedom of 30 (37-6-1) and number of predictors 6 is 3.81.

Since calculated F value is greater than the table value, we can conclude that there is a significant correlation and the regression equation can be used.

Satisfaction = 1.86 – 0.861 (leadership and governance) – 0.375 (customer focus) + 0.485 (measurement & analysis) + 1.01 (staff focus) – 0.027 (process management) + 0.375 (process outcomes).

It can therefore be concluded that the satisfaction level of the faculty members is substantially affected by ‘measurement and analysis’; ‘staff focus’; and ‘process outcomes’.

Besides the above conclusion following interesting aspects and views were also noted:

1. The awareness about the customer i.e. shipping companies and their requirements was more for the teachers in the marine engineering as against teachers from other areas. This was natural as these teachers were ex-seafarers and therefore understand the needs of industry. More communications/ awareness sessions would be desirable.
2. Many teachers opined that their current workload does not leave them enough time for further development and up-gradation. This is in spite of the fact that the contact hours per week are within the normal norms.
3. As per faculty members not many ex-graduates visit TMI. The alumni are mostly busy in their ship schedules. The interaction with TMI is expected to increase only after few years when the ex-graduates are settled in their lives.
4. TMI should encourage the awareness of merchant navy in the nearby schools. This is an important factor as besides marketing this initiative can lead to necessary awareness in the society about the career of seafaring.

4.8 Feedback from alumni:

The students do provide constructive feedback on individual teachers; however, they do not provide feedback on other aspects of their stay in the campus in TMI especially about the program and their overall experience in TMI. This information was collected from the alumni through a specially made questionnaire.

Table 4.15 – Analysis of feedback from alumni

SN	*Statement*	*Year*	*Strongly disagree*	*Disagree*	*Neither agree nor disagree*	*Agree*	*Strongly agree*
1	My institute has prepared me well for my career.	2004				56.3%	43.8%
		2005		3.3%		63.3%	26.7%
		2006			9.5%	64.2%	25.3%
		2007				75.0%	
2	My institute has adequate facilities for developing practical skills.	2004			6.3%	56.3%	37.5%
		2005		6.7%	6.7%	43.3%	36.7%
		2006		4.2%	4.2%	61.1%	30.5%
		2007				37.5%	50.0%
3	Encouragement is given to the students for participating in extra and co-curricular activities.	2004				68.8%	25.0%
		2005	3.3%	10.0%	16.7%	50.0%	13.3%
		2006	4.2%	8.4%	25.3%	40.0%	22.1%
		2007			62.5%	12.5%	12.5%
4	Hostel facilities are excellent in my institute.	2004	6.3%		6.3%	50.0%	37.5%
		2005			13.3%	46.7%	33.3%
		2006			14.7%	56.8%	27.4%
		2007	12.5%	25.0%	37.5%	12.5%	12.5%
5	Our teachers are knowledgeable and they teach well.	2004				43.8%	56.3%
		2005			23.3%	56.7%	20.0%
		2006	1.1%	5.3%	24.2%	55.8%	12.6%
		2007				62.5%	12.5%
6	Assessment system is transparent, fair and unbiased.	2004				56.3%	43.8%
		2005			13.3%	66.7%	13.3%
		2006	3.2%	11.6%	18.9%	51.6%	12.6%
		2007				62.5%	25.0%
7	Strict discipline maintained in the institute has contributed in my overall development.	2004				50.0%	50.0%
		2005			16.7%	56.7%	20.0%
		2006	4.2%	5.3%	20.0%	56.8%	13.7%
		2007				62.5%	12.5%
8	Principal and other senior staffs are concerned about my well-being.	2004				31.3%	68.8%
		2005			10.0%	46.7%	26.7%
		2006	1.1%	2.1%	17.9%	50.5%	28.4%
		2007				62.5%	25.0%
9	Placement efforts made by the institute are excellent.	2004				25.0%	68.8%
		2005				16.7%	76.7%
		2006			2.1%	20.0%	77.9%
		2007			12.5%	25.0%	50.0%
10	My institute recognizes good behaviour and talents of the students.	2004				68.8%	25.0%
		2005			13.3%	40.0%	36.7%
		2006	1.1%	3.2%	15.8%	55.8%	23.2%
		2007				37.5%	50.0%
11	The campus environment is conducive for all round development of my personality.	2004				68.8%	31.3%
		2005			6.7%	50.0%	36.7%
		2006		1.1%	14.7%	49.5%	34.7%
		2007				50.0%	37.5%
12	I am proud of my institute.	2004				31.3%	12.5%
		2005			10.0%	26.7%	53.3%
		2006			5.3%	45.3%	48.4%
		2007				62.5%	25.0%

The following points emerged from this exercise:

1. 88.6% of graduates felt that TMI had prepared them well for their career.
2. The graduates acknowledged excellent placement record.
3. Almost all graduates indicated that they are proud of TMI.

4.9 Feedback from students:

Students may provide data regarding evaluation of teachers; however, the institutional administration remains the evaluator and makes judgment and not the students. Therefore the administration needs to have a balanced method for taking inputs from students, peers, self-appraisals etc.

Past work has indicated that there are arguments to support or against the system of students giving ratings to the teachers. To make this exercise meaningful it is imperative that the teachers are taken into confidence while designing the questionnaire for receiving feedback from the students. The timing and methodology of collecting this information from students also need to be specific. In TMI this is done by the quality management team and is on a specific day after the mid-semester examination. This allows collection of independent data and enough time of implementing corrective measures, wherever necessary.

Table 4.16 – Analysis of feedback from student on a teacher

S.N.	STATEMENTS	Grade
1	I benefited from lectures and other guidance from this teacher	**3.21**
2	The teacher encouraged us to learn the subject through assignments and library / practical research	**3.03**
3	Teacher was dynamic and energetic in delivering the lectures / practical	**3.14**
4	In 9 out of 10 times, the teacher arrived and left the class at scheduled class timings	**3.59**
5	Instructor expected and encouraged discipline inside and outside the class	**3.21**
6	Discussion, interaction and asking questions in the class was encouraged	**3.31**
7	Instructor was accessible to students for academic help/advice in or outside of class	**3.28**
8	Instructor frequently referred to and discussed current and latest developments in the subject	**3.34**
9	The marks I revived in assignments and examination from this teacher were I think just and fair for the work I put in	**3.31**
10	As an overall rating, I would say the academic benefit to me from the instructor has been	**3.32**
	AVERAGE	**3.27**

In the above table a score of 3.27 out of a maximum of 4.0 is observed. This is done every semester and is discussed with the concerned teacher individually by the Principal. The records for past semesters reflect the trend. TMI has set the average score of all teachers at 2.7 as the objective under the quality management system. Teachers scoring less are suitably counseled and guided. The score, along with the peer review is also considered for the yearly appraisal.

4.10 Feedback from parents:

TMI has established a system of feedback that is taken at the end of the academic year. The data is analyzed and corrective and preventive actions are initiated, as necessary. A summery of that analysis is given as Table 4.17.

Table 4.17 – Analysis of feedback from parents

Satisfaction dimensions	**Particulars**	**Strongly agree**		**Agree**		**Neither agree nor disagree**		**Disagree**		**Strongly disagree**		
		No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**Total**
Physical facilities	Living conditions	52	52.0%	42	42.0%	6	6.0%	0	0.0%	0	0.0%	100
	Food											
	Wholesome	46	46.0%	34	34.0%	19	19.0%	1	1.0%	0	0.0%	100
	Taste	23	23.0%	43	43.0%	27	27.0%	6	6.0%	1	1.0%	100
	Laundry services	37	37.0%	34	34.0%	26	26.0%	3	3.0%	0	0.0%	100
	Medical attention	18	18.0%	21	21.0%	34	34.0%	26	26.0%	1	1.0%	100
	Communication											
	With ward	27	27.0%	27	27.0%	28	28.0%	14	14.0%	4	4.0%	100
	With institute authorities	45	45.0%	31	31.0%	16	16.0%	7	7.0%	1	1.0%	100
	Extra curricular activities	43	43.0%	37	37.0%	14	14.0%	6	6.0%	0	0.0%	100
Educational facilities	Educational Infrastructure	49	49.0%	45	45.0%	6	6.0%	0	0.0%	0	0.0%	100
	Assessment & evaluation	38	38.0%	39	39.0%	23	23.0%	0	0.0%	0	0.0%	100
	Feedback on progress	47	47.0%	32	32.0%	18	18.0%	3	3.0%	0	0.0%	100
	Personality development	37	37.0%	29	29.0%	33	33.0%	1	1.0%	0	0.0%	100
Placement	Internship & placement	73	73.0%	19	19.0%	8	8.0%	0	0.0%	0	0.0%	100
Overall satisfaction	Recommend TMI to others	87	87.0%	13	13.0%	0	0.0%	0	0.0%	0	0.0%	100

4.11 Application of other TQM tools:

Besides the tools mentioned in above sub-sections, few other tools of TQM were used in the study. These covered some other areas and activities of the MET institution. Three results of such initiatives are mentioned below.

4.11.1 Root Cause Analysis

Root cause analysis of the hazardous situation in workshop was done and all causes and factors contributing to this situation in workshop were identified. These are then placed in six logical groups, namely materials, methods, machines, manpower, measurement, and environment. The fish bone diagram was then drawn and is attached as Figure 4.17. Similar analysis can be carried out for any situation.

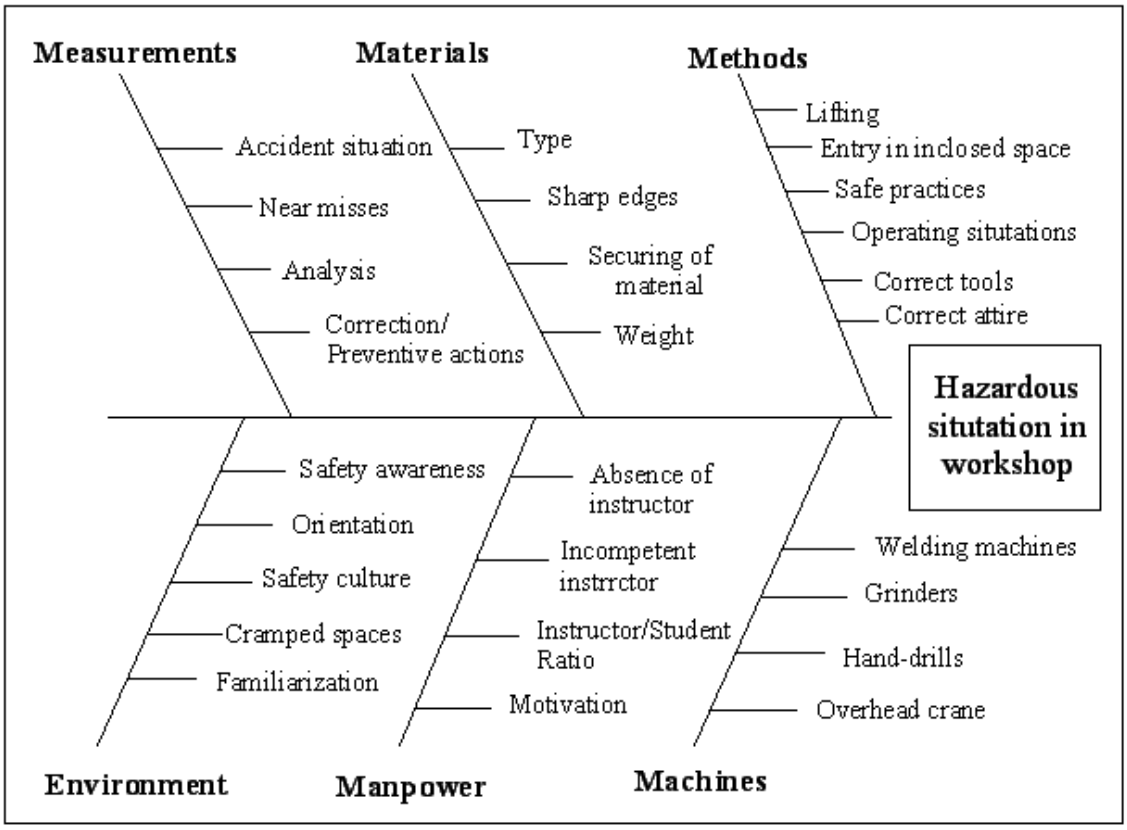


Figure 4.17 – Ishikawa diagram of hazardous situation in workshop

4.11.2 Interrelationship Diagraph:

The problem in library namely, “a book is desired by a faculty member, but it is not available in library” was analyzed. Different factors responsible for this situation were identified. The prime reasons could be as follows:

Book already borrowed by another user

Book is not in the stock i.e. was never in the library

Book ordered but is not available in market

Book issued but not recorded in program

Book is not in the right place

Book is missing

Different causes/ factors contributing to the above-referred prime factors were also identified and their interrelationships were noted. The interrelationship diagraph is given as figure 4.18.

'Performance of library staff' is noted as the most significant contributing factor and needs to be addressed. Similarly 'need not conveyed adequately' needs to be further investigated and corrective measures put in place. This will result in library providing the necessary support to its users and lead to higher satisfaction of the internal customers.

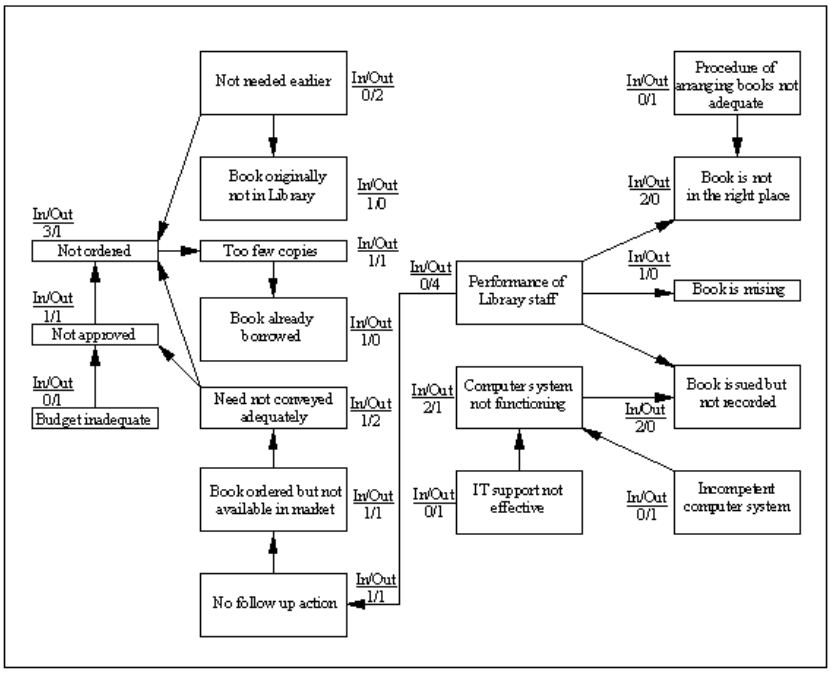


Figure 4.18 – Interrelationship diagraph for Library

4.11.3 Failure Mode and Effects Analysis

The marine engineering program in TMI is a compulsorily residential program. FEMA was carried out in services like food, medical, communication and transport.

The potential failure modes in the above areas identified. The potential effects of such failures and the potential causes of such failures were established. For each of these effects, severity on a scale of 1 to 10 and probability of occurrence, also on a scale of 1 to 10 were noted. Current control mechanisms were then identified and likelihood of the failure being detected by the control systems was established. A numerical value of 'Risk Priority Number' (RPN) was then calculated. Certain corrective actions are recommended for failure modes having RPN more than 100. The RPNs were recalculated indicating improvement [El-Haik (37)]. Table 4.18 shows the result of FMEA analysis

Table 4.18 – Failure Mode and Effects Analysis

Function	Potential mode	Potential effects of failure	Severity S	Potential causes of failure	Probability of occurrence O	Current process control	Detect ability D	Risk Priority Number RPN
Food served in hostel	Served late	Disturbed schedule, Commotions	5	Late cooking	2	Caterer supervision	3	30
				Late arrival of stock	2	Caterer Contract	6	60
	Served less	Not satisfied	6	Lesser qty prepared	3	Caterer supervision	8	**144**
	Stale food	Food poisoning, stomach trouble	9	Cooked too early	1	Caterer supervision	1	9
	Oily/spicy/under cooked	Not satisfied, wastage, health problem	5	Cooked in large quantity / different food habits	6	Caterer supervision	6	**180**
	Unhygienic	Health problem	6	Cleanliness	1	Caterer supervision	2	12
Medical Facilities	Unavailability of doctors	No treatments at times	2	Shift change / leave without notice	2	TMI Doctor	4	16
	Limited facilities	Delay in treatments	4	No facilities norms/requirements	6	Institute's ambulance	2	48
	Limited resources	Delay in treatments	4	No facilities norms/requirements	6	Institute's ambulance	2	48
Communication in Hostel	Telephone system	Cannot communicate	5	Lines down	2	Individual mobiles	1	10
	Internet facility	No access to emails	3	Server problem	2	IT assistance	4	24
Transport	Transport breakdown	No transport available	2	Lack of Maintenance	1	Supervision & maintenance plan followed.	6	12
	Transport for visiting hospital in town	Time & money spent in arranging transport	2	Only Ambulance available	5	Ambulance available anytime in account of student	2	20

4.12 Quality costs analysis:

The concept of quality costs is unique in TQM and reflects the allocation of financial resources for quality related activities of the organization. A detailed explanation of the quality costs is included in section 3.17 in chapter Three.

An analysis of such quality costs in TMI for the period 2003/04 and once again for the period 2006/07 was carried out. The first batch had graduated in 2002 and by 2003/04 different systems were already in place. Efforts for further improvements, however, continued and principles of PDCA cycle were used. The systems are now more matured though the continuous improvement goes on. The analysis therefore reflects improvements and the result is appended in table 4.19.

Table 4.19 – Analysis of Quality Costs

SN	Quality costs	Percentage of quality costs in 2003/04	Percentage of quality costs in 2006/07
1.	Appraisal costs	45%	53%
2.	Prevention costs	3%	4%
3.	Internal failure costs	42%	36%
4.	External failure costs	10%	8%

It can be appreciated that by concentrating on appraisal activities e.g. better selection of admitted students, early identification of weaker students etc, failure costs have reduced. This means that the different customers would be more satisfied. It is however, important to conduct a similar analysis after few years to establish trends, if any.

4.13 Implementation of TQM:

Implementation of TQM is a slow process and may be done in phases. Montano (107) writes that the TQM philosophy was first implemented in the area of admissions in the Lamer University, Beaumont, USA.

Canic (21) suggested a ten-step implementation cycle for TQM. The steps are as follows:

1. Identify a process/s
2. Define the purpose of the process/s
3. Identify the primary customers
4. Determine the customers' expectation about the process
5. Determine if expectations are being met and identify opportunities for improvement
6. Identify root causes for gaps
7. Plan improvements
8. Implement improvements
9. Evaluate improvements
10. Revise as needed

For TQM to be successful the employees of the institution, both teaching and non-teaching, have to understand the essence of TQM. This would require a change of culture, probably the most difficult part. The change has to be in all aspects of functioning of the institution. This would include its management, inter departmental and inter personal relationships, behaviour etc.

4.13.1 Expected constraints:

TQM can only be successful if there is long-term devotion and commitment from all, especially the senior management of the institution. It should not be desired that TQM would suddenly result in an excellent all round performance of the institution. Usually quality improvement initiatives are much published and slowly they fizzle out.

In this system the employees must know and understand the directions the institution is planned to take. This has to be done by the leaders who should appraise the others by suitable means of communications. They should also delegate and should be able to let the subordinates take decisions and be willing to accept situations if some thing goes wrong. This complete initiative can become a barrier if the senior and middle level staff is not able to accept it and fear the consequence of empowerment.

Many of the barriers to TQM involve an element of fear and uncertainty. Fear of the unknown, of doing things differently, of trusting others, and of making mistakes, are powerful defiance and resistance mechanisms [Sallis (143)].

Sharma (149) writes about some of the barriers in implementing TQM in an organization. These are as follows:

Cultural resistance.
Results are expected too fast.
Employees see it as another cost reduction initiative.
Employees believe that market issues take precedence over quality.
No perceived change in management behaviour.
This issue is of quality section and not mine.
No additional funding for this.

4.13.2 PDCA and Faculty empowerment:

True implementation would only be achieved if the faculty is committed and involved. Faculty empowerment therefore has an important part. The management of a MET institution is quite different from the management of a typical education institution. This is due to the fact that a large section of teachers/trainers are ex-seafarers who have already been exposed to a much disciplined, well-knit, self-motivated way of working on board ships. They also understand that concept of quality and quality management, as it is mandatory on the ships. On the other hand the MET institution would also have traditional teachers for many non-marine subjects, who would have been teaching in the traditional colleges before joining this institution. The culture and management of people therefore become extremely sensitive in this unique environment.

The creativity of the staff needs to be encouraged. This may be in any field or aspect of operations eg-improvement in teaching methodology, development of new courses, conduct of a seminars or conferences, arranging a guest speaker etc. These initiatives must follow a system of internal marketing so that all can be informed of these initiatives and happenings.

Any higher education, including marine engineering education, aims at providing required knowledge and skills and contributes to the development of manpower for the betterment of the socio-economic development of the country. Bagalkoti (8) refers to four conceptions of the purpose of higher education. These being the career earnings and employment; training for a research career; effective management of teaching provision; and extending life chances i.e. social development. All these four conceptions are idealistic and have an inbuilt reference to quality.

For total quality to be effectively present and implemented in an institution of higher education, all these above issues must be addressed. The objectives can however, be only achieved if there is an interest in the educational process by the students. It is therefore of paramount importance that an assessment is made to find the degree of involvement and integration of the students in all the activities.

The success of the implementation of TQM in education can only be achieved if the faculty members are motivated, empowered and more importantly, aware of their role in the system. What is expected from them must be conveyed to them. Since the teachers are usually from different backgrounds in a MET institution, it is necessary that besides the awareness and orientation inputs, a checklist of all relevant aspects is given to them as reference. The checklist should be based on PDCA theme and address the following:

Course design and availability of the latest syllabus
List of modules with GLOs and SLOs
Time planning for the above
Teaching material
Assessment and evaluation plan
Identification of weaker students
Report to supervisor regarding progress
Final evaluation
Feedback to management for review

Empowerment is granting the authority to do whatever is necessary to satisfy customers, and trusting employees to make the right choice without waiting for management approval [Evans (39)]. This helps in developing and encouraging the creative and intellectual abilities of the employees. For this to happen it is necessary to provide

sufficient information about customers and their needs to all through an effective system of internal communication.

4.14 Self-assessment of performance in institution:

Different systems of designing and monitoring the marine engineering education have already been established and are in place. These include the requirements of maritime administration as well as the requirements of the affiliating university. The requirements of other national bodies like AICTE, UGC etc. also contribute in providing a framework for monitoring various activities of a marine engineering college. Further for complying with the requirements of Regulation I/8 of STCW 95, all MET institutions, big or small, have their quality management systems certified by different agencies. All these systems require monitoring and maintaining certain records that are periodically verified to assess compliance.

While all these initiatives and requirements have been substantially effective there is definitely place for improvement. Further it is observed that in these systems the emphasis is on compliance and record keeping. The TQM on the other hand is a culture and emphasis is on continuous enhancement and involvement of all. These sentiments can be confirmed as indicated in figure 4.19.

Figure 4.19 – Comparison of external and internal systems of monitoring performance

	External system	**Internal system**
Quality as a threshold	Review by specified bodies in accreditation organization, certifying organizations - assessment - emphasis on compliance	Specification of learning outcomes. Assessment of outcome against objectives
Quality as a process	Review of system and procedures - audit - emphasis on documentation	Stakeholders view and feedback Evaluation of learning and teaching
	Emphasis on quality is periodic. Standards are interpreted by visitors. Culture of compliance/ conformity improved	Quality is a process of continuous enhancement. Review of outcomes.

The system of self-assessment is voluntary and can result in frank and true look on the functioning of the institution. This method therefore can be an excellent tool to assess the standard of implementation of TQM and continuous improvement.

4.15 Key Performance Indicators:

As per Goel (46) if it is important it must be measured. Goel further mentions that 'what gets measured gets done' and suggests a SMART goal modal. Here S represents Specific; M – Measurable; A – Achievable; R – Relevant; and T – Time-based. Various agencies taking this concept develop certain key performance indicators (KPIs) and that is used to grade organizations for excellence.

It is therefore appropriate that KPIs from different aspects of marine engineering education are identified. These KPIs can thereafter be self-assessed effectively by the marine engineering college/ university. This will not only result at improving the standard of marine engineering education in the country but also develop into a tool for remaining competitive in the global marine engineering education scenario. This will allow continuous/ periodic monitoring of various processes and sub-processes. Suitable trends can also be seen. This method of self-assessment would eventually lead to an outcome based quality management system. This system, along with appropriate commitment from the management and an effective leadership, would result in application of Total Quality Management in TMI

Saxena (146) while suggesting this initiative had drawn a parallel with the oil tanker industry. Tankers worldwide have been complying with the requirements of International Safety Management (ISM) Code, which demands certain systems and procedures to be in place, both for ship operations and co-ordination from shore. While satisfying these requirements ensures compliance, the industry still felt a need for more to be done by the tanker owners. The development of Tanker Management & Self-Assessment (TMSA) by the Oil Companies International Marine Forum (OCIMF) is such an initiative from the industry. The TMSA lists 12 key elements, which have to be addressed and through a mechanism of KPIs and self-assessment an operator can demonstrate its continuous emphasis on quality in tanker operations [OCIMF (121)].

Saxena (146) proposed to develop Maritime Education Management & Self-Assessment (MEMSA), a TMSA version for MET institutions. This will require the comparison and applicability of the 12 key elements of TMSA in the field of maritime education. A number of KPIs need be identified and it is envisaged that this unique system of self-assessment would help the marine engineering institutions to have an honest and sincere look on its operations and provide a system of continual improvement. A comparison between TMSA and MEMSA is given in table 4.20.

Table 4.20 – Comparison between TMSA and MEMSA

SN	TMSA	MEMSA
1.	Management, leadership & accountability	Management, leadership & accountability
2.	Recruitment and management of shore-based personnel	Recruitment and management of faculty and other staff
3.	Recruitment and management of ships' personnel	Selection of students
4.	Reliability & maintenance standards	Reliability & maintenance standards
5.	Navigational safety	Curriculum design & periodic review
6.	Cargo, ballast and mooring operations	Process of transfer of knowledge and development of skills
7.	Management of change	Management of change
8.	Incident investigation and analysis	Incident investigation and analysis
9.	Safety management	Safety management
10.	Environmental management	Environmental management
11.	Emergency preparedness and contingency planning	Emergency preparedness and contingency planning
12.	Measurement, analysis and improvement	Measurement, analysis and improvement

While implementing TMSA element 7 'change' has been found to be most difficult to comply. Changes are encountered regularly in any organization, including in a maritime institution and mostly due to factors over which organization has no control. The institution is a social system and therefore managing change from an existing pattern can become quite challenging. This aspect should be included in the management system and procedures established accordingly.

The students and also the teachers in a MET institution come from different parts of the country with different socio economic, cultural and academic backgrounds. They have to be moulded as per the requirements. The sea going staff comes in with vast experience but with little expertise in teaching. The pure academic staff, on the other hand, may be used to teaching in traditional colleges, with traditional and orthodox systems and with

little knowledge of shipboard activities. For them to adapt to this new environment is also a big change. A procedure for their induction must be therefore established.

The curriculum needs to be dynamic keeping in mind the changes in technology. Faculty development measures have also to be included in MEMSA. The faculty needs to be regularly upgraded and their knowledge developed. Changes in regulations, both national and international, also have to be addressed and included in the curriculum and in the operating mechanism of the institute.

Advantages of MEMSA:

MEMSA, if implanted earnestly, would provide a mechanism of systematic integration and follow up of all activities in the MET institution. The self-assessment would be able to identify areas for improvement. This system would require involvement of all concerned by allowing empowerment. The attachment of individuals with system will result in an improved operating environment. MEMSA could further be developed into a formalized accountability exercise with improved control and optimum utilization of resources.

Saxena (144) presented this concept of self-assessment in an exclusive seminar on marine engineering education in the Institute of Marine Engineering (India) in June 2007. This idea of KPIs has been accepted by the industry in India and the Board of Examinations, an independent body of professional engineering and nautical officers, has started work on this. This will then be presented to DGS for further implementation. It is pertinent to mention that many of the elements of MEMSA are included in the Baldrige National Quality Award criteria for education [Baldrige (10)]. Quality in Maritime Education & Training (QMET) has included this in its work program. QMET is a joint initiative of the Institute of Marine Engineers (India), (IMEI) which is the professional association of marine engineers in India; and the Company of Master Mariners in India (CMMI), which is the association of ship captains in India. QMET has been pursuing the DGS to accept various recommendations for the improvement of MET scenario in India.

4.16 Validation of Hypotheses:

Three hypotheses were considered at the commencement of this study. These are now discussed as detailed below.

Hypothesis 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 responses obtained after the survey of shipping companies and the emphasis given by them for the selection process establishes the importance of the selection process. The students who are admitted become the intake for the MET institution and actively take part in the process of transfer of knowledge and development of skills. The students that pass 12^{th} class are admitted based on the selection system of the different institutions. Selections are done on the basis of 12^{th} marks, test, interview etc. There is no uniform system in place. The expectations of the shipping companies on this aspect were assessed in this study. The preference of the respondents was admission test – 53.7%; PCM marks in 12^{th} – 34.1%; 12^{th} class aggregate marks – 17.1%; and interviews –14.6%. Interestingly 73.2% preferred that an institution must have a detailed selection process. The selection methodology at TMI has a combination of all these methods and can construe to be covering the needs of the customers. 56.1% of the respondents wanted the MET institution to inform the shipping company about the methodology adopted for selection. Informatively shipping industry personnel join the interview panel at TMI.

The performance of the students is continuously monitored during the program. It was established that there is an increase in CGPA over the semesters indicating in-process improvement. For the students admitted in 2000 improvement was noticed in case of 75% of the total students. This increased to 84.9% in students admitted in 2002 and 88% for the students admitted in 2003. The graphical presentation is given in Figures 4.9 and 4.10.

The shipping companies, being the primary customers of the MET institutions, select the students based on their own criteria that can be quite different from each other. While

41.5% had confirmed that they would consider selecting students on the basis of CGPA, others had opined in favour of their own selection test (19.5%) and interview (41.5%).

After the study it can be adequately concluded that:

1. From the shipping companies' point of view a good product (student) is not necessarily the one who has a CGPA of more than 6.0.
2. A properly developed and organized selection process is indeed necessary for selecting students for the marine engineering program. These can then be subsequently moulded during the program.

Hypothesis 2:

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

This study has analyzed the admission performance of the six batches that have graduated from TMI till 2007. This analysis was based on the marks obtained in physics, chemistry and mathematics in 12^{th} class and also in the on-line entrance examination conducted at different centres across the country. Similarly the performance of these students in the four-year marine engineering program was also analyzed. This was in the categories of final CGPA and also the marks obtained in different group of courses, namely applied sciences, mechanical engineering, electrical and electronics engineering, and marine engineering.

The Pearson correlations were initially calculated between PCM marks and marks in different groups. It was however, found that the analysis would be more meaningful if the marks in physics, chemistry and mathematics in 12^{th} class are considered individually and their correlation with performance in different groups is calculated. This exercise was done for students from CBSE; ISCE; Maharashtra board; and a fourth group of all other state boards. No significant correlation was noticed and the figures were CBSE (0.31 ~ 0.42); ISCE (0.38 ~ 0.50); Maharashtra (0.27 ~ 0.45); and (0.05 ~ 0.17). The difference between correlations across different course groups is not significantly better. A graph representing the representations from different boards is given at Figure 4.12.

It can therefore be concluded that considering to the available data and calculations there is no definite correlation and trends cannot be established. The above hypothesis is not validated.

Hypothesis 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."

The MET sector has normally been quality conscious primarily because it caters to the maritime industry which itself is very quality conscious. The ISM Code is mandatory for the shipping industry and requires establishing and maintaining procedures and systems. MET institutions, world over, have quality systems and many are ISO 9001:2000 certified. It is however, imperative that efforts are continuously on to aim for achieving further improvement. In this study a detailed work has been done for assessing the possibility of implementing TQM in a MET institution. Different techniques of TQM have been used in different processes and sub-processes of the institution. The areas covered included admissions, academic, teaching, evaluation, but also student services like hostel and also library.

As per the work concluded and documented in chapters three and four, it can be adequately confirmed that this hypothesis is valid. The TQM can therefore be implemented in the MET sector and the benefits will accrue for all the stakeholders.