A QUALITY FUNCTION DEPLOYMENT APPROACH TO IMPROVE TECHNICAL EDUCATION: A CASE STUDY OF TECHNICAL TRAINING CENTER (TTC)

BY

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A thesis submitted to the department of Industrial and Production Engineering of Bangladesh University of Engineering and Technology (BUET) in partial fulfillment for the requirements for the degree of **Master of Engineering in Advanced Engineering Management.**

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The thesis titled "A QUALITY FUNCTION DEPLOYMENT APPROACH TO IMPROVE TECHNICAL EDUCATION: A CASE STUDY OF TECHNICAL TRAINING CENTER (TTC) " submitted by Md. Hemayat Uddin, Student no:100608108 P : Session October 2006, has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Master of Engineering in Advanced Engineering Management** on September 28, 2011.

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....
MD. HEMAYAT UDDIN

This work is dedicated to my parents and my wife

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NOMENCLATURE

VOC	Voice of Customers
TTC	Technical Training Center
TQM	Total Quality Management
SCM	Supply Chain Management
QFD	Quality Function Deployment
PPP	Private Public Partnership
PKSF	Palli Karma-Sahayak Foundation
KOICA	Korea International Cooperation Agency
JAICA	Japan International Cooperation Agency
ISO	International Organization for Standardization
HOQ	House Of Quality
GOB	Government of Bangladesh
BRAC	Bangladesh Rural Advancement Committee
BMET	Bureau of Manpower Employment and Training
BKMEA	Bangladesh Knitwear Manufacturers & Exporters Association
BTEB	Bangladesh Technical Education Board

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ABSTRACT

Education itself is a multimillion dollars industry and is very important to the development of a country. The main purpose of quality assurance in education is to provide confidence to the professionals, students and their parents, employers and their various stakeholders that the requirements for quality education are met continuously.

Quality function deployment (QFD) is a method to transform user demands into design quality. QFD helps transform customer needs into engineering characteristics for a product or service. The customer needs is summarized in a product planning matrix called House of Quality. These matrices are used to translate customer needs WHATS into technical characteristics HOWS to satisfy the needs.

The quality of education and training being imparted in the technical institutions varies from excellent to poor, with some institutions comparing favorably with the best in the world and many others suffer from different degrees of handicap such as faculty shortages, infrastructure deficiencies, curricula obsolescence, lack of autonomy in academic financial, administrative, and managerial matters; poor involvement in knowledge creation and dissemination, and poor interaction with community and economy. In order to improve the teaching quality of TTC the author considers the principles of total quality management (TQM). The major tool employed is Quality Function Deployment (QFD). In this approach, several steps are followed to expose customer expectations into the service process and ensure that at each level of expectation the highest possible quality is provided. The main goal of this project is to translate the student's voice into teaching techniques applying QFD approach. For this purpose a questionnaire based survey is performed among the students of TTC to sort out the student requirements. From the collected data, a house of quality is developed and finally the teaching techniques are ranked with respect to the house of quality. The higher the relative weight of the technique, the more the concentration is needed.

Chapter I

INTRODUCTION

1.1 Introduction

Education is the backbone of a nation. Education is a basic human right and considered by many as a key tool for national development. Education of all kinds is important for the progress, prosperity and development of a country. It is one of the benchmarks to gauge the socio-economic development of a society. With the beginning of 21st. century, science and technology has advanced in educational excellence and information, openness and flexibility has contributed towards the development of this global village.

Technical Education plays a vital role in human resource development of a country by creating skilled manpower, enhancing industrial productivity and improving the quality of life. Technical Education covers courses and programs in engineering, technology, management, architecture, town planning, pharmacy and applied arts & crafts, hotel management and catering technology etc. Manpower of well educated, well trained and technically oriented is a very important pillar in the edifice of the development of a country.

Rapid economic growth demands a mixture of skilled worker; technician, engineers, research professionals and innovative scientist trained in the areas linked with national development and need of the industry. The accelerated economic progress of the Asian Countries like China, Japan, Malaysia and also Australia are the excellent examples in this point. It is an established fact that technical education and vocational training can help individuals to generate income and contribute towards economic growth and social development of a country by acquiring knowledge and skills.

In Bangladesh technical education system has grown into a fairly large-sized system, offering opportunities for education and training in a wide variety of trades and disciplines at certificate, diploma, degree, postgraduate degree and doctoral levels in institutions located throughout the country. Bangladesh government has setup 37 Technical Training centers (TTC) throughout the country. A lot of students are getting vocational training and being graduated from these institutions. Last year 47,140 students passed from 47 trades from TTC. Last Year overseas employment was 3,90,702 and they send 69,359 Crore Taka

as foreign remittances. The quality of education and training being imparted in the technical institutions varies from excellent to poor, with some institutions comparing favorably with the best in the world and many others suffer from different degrees of handicap such as faculty shortages, infrastructure deficiencies, curricula obsolescence, lack of autonomy in academic financial, administrative, and managerial matters; poor involvement in knowledge creation and dissemination, and poor interaction with community and economy. There are some factors which directly or indirectly influence the effectiveness of the vocational training. To improve the quality of technical education the applicability of TQM in higher education has been the debate for many years. In spite of that some tools of Total Quality Management like QFD has been adopted by many non-profit organizations world-wide such as higher education institutions [1].

The concept of QFD was created in Japan in the late 1960s. According to Akao after World War II, Japanese companies used to copy and imitate product development; nevertheless, they decided to move their approach to one based on originality. QFD was introduced, in that environment, as a concept for new product development. It can be better understood from the definition presented below which summaries the purposes of the technique: "QFD is a method for structured product planning and development that enables a development team to specify clearly the customer's wants and needs, and then to evaluate each proposed product or service capability systematically in terms of its impact on meeting those needs".

The QFD method includes building one or more matrices known as 'quality tables.' The first matrix is named the "House of Quality" (HOQ). It exhibits the customer's needs (VOC) on the left hand side, and the technical response to meeting those needs along the top.

QFD helps companies identify real customer requirements, and translates these requirements into product features, engineering specifications, and finally, production details. The product can then be manufactured to satisfy the customer. QFD is an integrative process which links together customer needs, product and parts design requirements, process planning, and manufacturing specifications during product development. Various tools and mechanisms are used to operationalize the QFD concept. For example, design for manufacturing and assembly (DFMA) is used as a part of the QFD process. QFD can also

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help identify consistent performance measures for the different stages in the product design-process design-manufacturing-customer chain. it is important to narrow the gap between internal quality and external customer satisfaction which identifies the customer expectations [2].

The purpose of QFD is to ensure that the voice of the customer is incorporated into the design and delivery of a product or service. The process ensures that customers' requirements, expressed in their own terms, become the basis for the definition of product or service quality. Organizations use the voice of the customer to drive changes to the way they do business. They align their processes to meet the needs of their customers the first time and every time [3].

QFD's success depends on organizational teamwork and constant focus on customer demands. These two factors can substantially reduce the time and cost needed to design and deliver a quality product or service. Thus it is imperative that the work of every unit in the organization is linked to meeting customer needs. The use of QFD helps to shorten the design and delivery process "by helping to focus priorities, providing better documentation, and facilitating communication among team members"

QFD improves customer satisfaction, reduces implementation, promotes team work, and provides documentation [4]. QFD seeks out both spoken and unspoken customers requirements.

The research findings reflect importance of QFD for new curriculum design, cost effectiveness, improving teaching process through keeping customer satisfaction as the yardstick. QFD can be used to measure customer satisfaction in educational institutions [5]. They utilized QFD in evaluating the MBA program at Grand Valley State University. The inputs for the QFD were obtained through several brain storming sessions of MBA students, faculty members, administrators, and business executives. The preliminary results of the pilot field test show that QFD is a very useful tool in ascertaining customer desires, prioritizing them, and directing organizational resources toward customer satisfaction.

1.2 Objectives of the study

The specific objectives of this project work are:

1. To enlist potential factors that affect the technical education of TTC
2. To translate the student requirement into teaching techniques using QFD
3. To rank the techniques concerning the students requirements.

1.3 Outline of Methodology

This study is based on a literature study and investigation. Data has been collected from two sources – primary sources and secondary sources. To consummate the survey the following steps have been followed:

1) Collection of Data:

    A) Primary Sources: To conduct the research, data has been collected from different primary Sources. Different questionnaire for the students, teachers and key personnel related to TTC.

    B) Secondary Sources: Different web sites of the sample institutions, different articles from Journals and newspapers.

2) Scrutinizing the feedback from questionnaire to find out usable samples.
3) Listing of the customer (students) requirements (WHATS)
4) Listing of the technical descriptors (HOWS)
5) Developing a relation matrix between WHATS and HOWS
6) Developing a interrelation matrix between HOWS
7) Competitive assessments and ranking the teaching techniques.

Chapter II

OVERVIEW OF TECHNICAL TRAINING CENTER

2.1 Introduction

In Bangladesh Technical Education System has grown into a fairly large-sized system, offering opportunities for education and training in a wide variety of trades and disciplines at certificate, diploma, degree, postgraduate degree and doctoral levels in institutions located throughout the country. Bangladesh government has setup 37 Technical Training center (TTC) throughout the country. A lot of students are getting vocational training and being graduated from these institutions. Last year 47,140 students passed from 47 trades from TTC. Last Year overseas employment was 3,90,702 and they send 69,359 Crore Taka as foreign remittances.

2.2 Objectives of TTC

1. To provide institutional based formal, informal and special vocational & technical training course in different employable trades.
2. To produce skilled manpower suitable for industries both at home and overseas market.
3. To provide productive employment to the population, so that they can earn and meet the basic needs.
4. To provide skill development/upgrading training through short courses as per need of employers under PPP (Private Public Partnership) Program.
5. To Increase employability of unemployed youths both men and women through vocational training in uniformity with the national goal of poverty alleviation and economic development.

2.3 Courses Offered and Duration

1. S.S.C Vocational Course   --------2 Years
2. Advanced Course------------------1Years
3. Trade Course----------------------06 Month
4. Special Course---------------------1 week /3 Month

Special Short Courses and Upgrading courses are running in the evening shift of all Technical Training Center. These TTCs are giving training to average 50000 students per year. With the help of JAICA Volunteer of Japan government and KOICA volunteer of Korean government , the quality of teaching are being improved by giving training to the instructors of TTC. The House Keeping course is being run in 14 TTC for female only so that they can go abroad easily.

2.3.1 Certification of Courses
The certificate of SSC (Voc) course is given by the Bangladesh technical education board and the certificate of short course is given by Bureau of Manpower, Employment and Training (BMET).

2.3.2 Public Private Partnership program (PPP)
1. Joint venture program with BKMEA
2. Training on welding trade with Western Marine Shipyard
3. Training for people of Monga areas with PKSF
4. Program with BRAC for electrification trade
5. Training with apex adelchi footwear
6. Training for solar technician with Grameen shokti

2.4 Statistics of TTC graduate
The students who are passing from TTC is near about 90% of the total admitted students. Among them Local employment is 30%, Self employment 20% and Foreign   employment 40% [6].
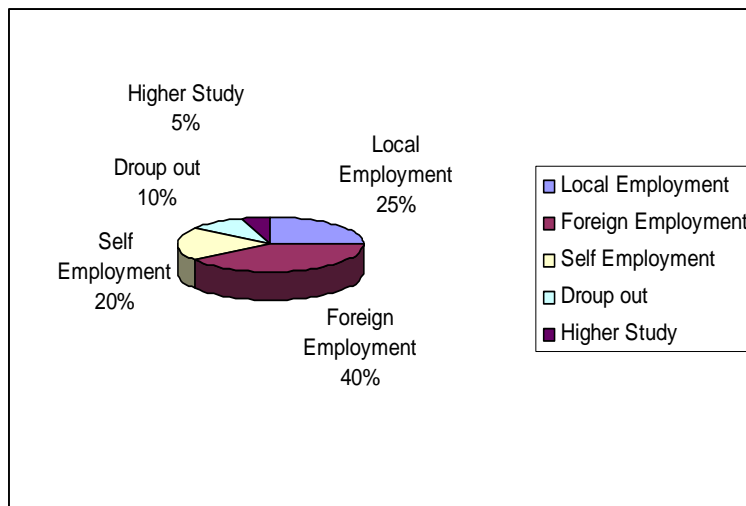
Fig 2.1: Statistics of TTC graduates

Country wise overseas employment is shown in the following table.

Table 2.1: Country wise overseas employment

Year	Worker Category				Total
	Professional	Skilled	Semi skilled	Less Skilled	
1976	568	1775	543	3201	6087
1977	1766	6447	490	7022	15725
1978	3455	8190	1050	10114	22809
1979	3494	7005	1685	12311	24495
1980	1983	12209	2343	13536	30071
1981	3892	22432	2449	27014	55787
1982	3898	20611	3272	34981	62762
1983	1822	18939	5098	33361	59220
1984	2642	17183	5484	31405	56714
1985	2568	28225	7823	39078	77694
1986	2210	26294	9265	30889	68658
1987	2223	23839	9619	38336	74017
1988	2670	25266	10809	29356	68101
1989	5325	38820	17659	39920	101724
1990	6004	35613	20792	41405	103814
1991	9024	46887	32605	58615	147131
1992	11375	50689	30977	95083	188124
1993	11112	71662	66168	95566	244508
1994	8390	61040	46529	70377	186336
1995	6352	59907	32055	89229	187543
1996	3188	64301	34689	109536	211714
1997	3797	65211	43558	118511	231077
1998	9574	74718	51590	131785	267667
1999	8045	90449	44947	116741	260182
2000	10669	99606	26461	85950	222686
2001	5940	42742	30702	109581	188965
2002	14450	50365	36025	118516	219356
2003	15862	74530	29236	134562	254190
2004	12202	110177	28327	122252	272958
2005	1945	113655	24546	112556	252702
2006	925	115468	33965	231158	381516
2007	676	165338	183673	289922	639609
2008	1864	292364	132825	448002	875055
2009	383	104627	18419	341922	465351
2010	387	90621	12469	279673	383150
Total	1,80,680	21,37,205	10,38,147	35,51,466	69,07,498

The students passing out from TTC are going to foreign country and earning a lot of foreign currencies. Remittance earned from 1976 to 2009 is shown on the following table.

Table 2.2: Remittance earned from 1976 to 2009

Year	Corer Taka	Yearly Increase %
1976	35.85	-
1977	125.16	249.18
1978	165.59	29.12
1979	266.95	60.95
1980	492.95	75.13
1981	620.74	1.18
1982	1176.84	60.97
1983	1568.76	27.86
1984	1256.49	-20.83
1985	1419.61	0.00
1986	1752.85	15.24
1987	2313.94	29.75
1988	2423.59	2.18
1989	2446.00	-0.79
1990	2691.63	3.13
1991	2818.65	-1.57
1992	3513.26	17.25
1993	3986.97	11.88
1994	4629.63	14.31
1995	4838.31	4.16
1996	5685.30	12.80
1997	6709.15	12.52
1998	77513.23	4.87
1999	8882.74	12.97
2000	10199.12	8.21
2001	11590.79	5.94
2002	16484.53	37.51
2003	18485.12	11.58
2004	21286.52	12.20
2005	27304.33	19.20
2006	38366.56	29.04
2007	45724.44	19.77
2008	61587.83	36.71
2009	73981.46	19.36
Total	4,62,344.90	

LITERATURE REVIEW

3.1 Introduction

Quality Function Deployment (QFD) is a quality tool that helps to translate the Voice of the Customer (VoC) into new products that truly satisfy their needs. Quality Function Deployment (QFD) is a planning tool used to fulfill customer expectations. It is a disciplined approach to design new product and it provides in depth evaluation of a product requirements. An organization can improve their quality of product by delivering engineering knowledge implementing QFD techniques.

QFD was introduced by Dr. Mizuno and Dr. Akao in the 1970s [7]. It was used in the early 1970s by Mitsubishi and Toyota to improve the quality of their products [8]. Toyota began to develop the concept in 1977. Between 1977 and 1979, it realized a 20 percent reduction in start-up costs on the launch of a new van . By 1982, start-up costs have fallen by 38 percent based on the 1977 baseline. In 1984, these costs have further fallen by 61 percent.

QFD is a team based management tool in which customers expectation are used to manage the design of the process [4]. Organizations today use market research to decide what to produce and how to satisfy customer requirements. Some customer requirements adversely affect others and customer often cannot explain their expectation. Confusion and misinterpretation are also a problem while a products move from marketing to design to engineering to manufacturing .This activity is where the voice of the customer becomes lost and the vouch of the organization adversely enters the product design. It is not productive to improve something the customer did not want initially. By implementing QFD an organization guarantees to implement the voice of the customer in the final products.

Quality Function Deployment helps identifying new technology and job functions to carryout operations. This tool provides a historic preference to enhance future technology and prevent design errors. QFD is primarily a set of graphically oriented planning matrixes that are used as the basis for decisions affecting any phase of the products development cycle. Results of QFD are measured based on the number of engineering specification, cost and quality. It is considered by many experts to be a perfect blueprint for quality by design.

Quality function Deployment enables the design phase to concentrate on the customer requirements, thereby spending less time on redesign and modifications. The saved time has been estimated at one third to one half of the time taken for redesign and modification using traditional means. This saving means reduced development cost and also additional income because the product enters the market sooner.

3.2 Phases of QFD process

There are four phases in QFD process .These are:

Phase 1, Product Planning: Building the House of Quality. Led by the marketing department, Phase 1 is also called The House of Quality. Many organizations only get through this phase of a QFD process. Phase 1 documents customer requirements, warranty data, competitive opportunities, product measurements, competing product measures, and the technical ability of the organization to meet each customer requirement. Getting good data from the customer in Phase 1 is critical to the success of the entire QFD process.

Phase 2, Product Design :This phase 2 is led by the engineering department. Product design requires creativity and innovative team ideas. Product concepts are created during this phase and part specifications are documented. Parts that are determined to be most important to meet customer needs are then deployed into process planning, or Phase 3.

Phase 3, Process Planning : Process planning comes next and is led by manufacturing engineering. During process planning, manufacturing processes are flowcharted and process parameters (or target values) are documented.

Phase 4, Process Control: And finally, in production planning, performance indicators are created to monitor the production process, maintenance schedules, and skills training for operators. Also, in this phase decisions are made as to which process poses the most risk and controls are put in place to prevent failures. The quality assurance department in concern with manufacturing leads Phase 4.

3.2.1 House of Quality

Quality Function Deployment is a tool for improving the development cycle and manufacturing products that better match customer needs. QFD accomplishes these goals through the use of a design tool that is known as the "House of Quality" (HOQ) as shown in Figure 3.1.
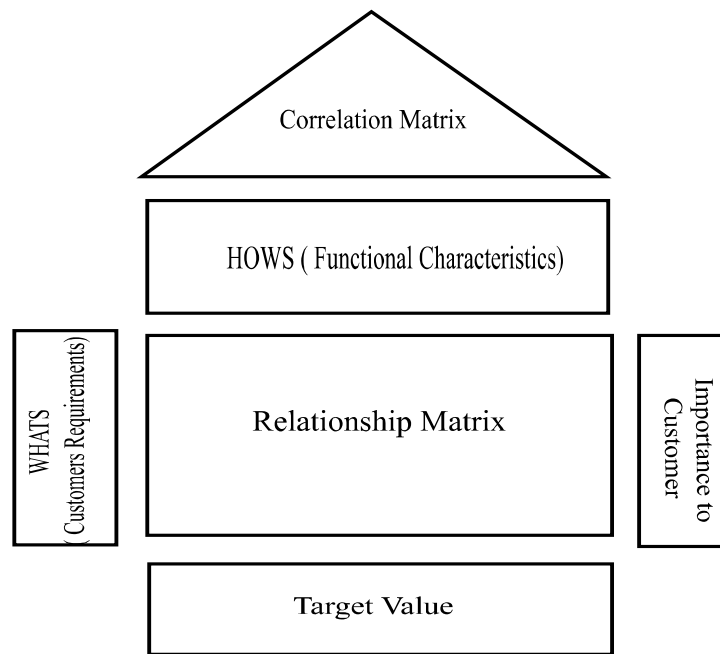
Fig 3.1: The House of Quality

The "Whats" room represents the voice of the customer and on the right is a customer competitive assessment that is expressed in form of a rating. The "Hows" room records the functional characteristics of a product including how customer needs can be met. The roof is the correlation matrix room which indicates the positive and negative relationships between the technical characteristics of the product. These relationships can help to generate new alternatives by highlighting areas for improvement in current products .After completing the "Whats" and the "Hows" rooms, these relationships can be worked out and expressed in a relationship matrix as indicated in the center of the house. Once the relationship matrix has been completed, the extent to which the product performance will satisfy customers is calculated and is expressed as an absolute score and a score that is relative to the target value.

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3.3 Benefits of QF QFD

3.3.1 The main 'process' benefits of using QFD

1. Improved communication and sharing of information within a cross-functional team charged with developing a new product. This team will typically include people from a variety of functional groups, such as marketing, sales, service, distribution, product engineering, process engineering, procurement, and production.

2. The identification of 'holes' in the current knowledge of the design team

3. The capture and display of a wide variety of important design information in one place in a compact form.

4. Support for understanding, consensus, and decision making, especially when complex relationships and trade-offs are involved

5. The creation of an informational base which is valuable for repeated cycles of product improvement

3.3.2 The main 'Bottom line' benefits of using QFD

There are many benefits to be realized by using Quality Function Deployment (QFD), including the following:

• Customer driven: The focus is on customer's wants, not what the company thinks. The "Voice of the Customer" drives the development process.

• Competitive analysis: Other products in the marketplace are examined, and the company product is rated against the competition.

• Reduced development time: The likelihood of design changes is reduced as the QFD process focuses on improvements to be made to satisfy key customer requirements. Careful attention to customer requirements reduces the risk that changes will be required late in the project life cycle. Time is not spent developing insignificant functions and features.

• Reduced development costs: The identification of required changes occurs early in the project life cycle. Minimizing changes following production reduces warranty costs and product support costs.

- <u>Documentation</u>: A knowledge base is built as the QFD process is implemented. A historical record of the decision-making process is developed.

3.4 The 3 main goals in implementing QFD

1. Prioritize spoken and unspoken customer wants and needs.
2. Translate these needs into technical characteristics and specifications.
3. Build and deliver a quality product or service by focusing everybody toward customer satisfaction.

3.5 Quality in educational institutes

While higher education institutions are the home for learning and creating knowledge through their research function, it is ironic that they have been lagging behind other organizations in embracing and implementing TQM. This inertia in the adoption of TQM seems to be due to certain structural and traditional characteristics of higher education institutions. There are also some special challenges that are not encountered in other organizations. Quality in higher education is treated from different perspectives in other articles in the literature. For example, measurement and evaluation of quality in higher education are studied in by different authors.

On the other hand, Owlia and Aspinwall discuss the findings of a survey conducted to examine the different views and investigated the impact on the satisfaction of customer and then the applicability of industrial quality management principles to higher education. Matthews described the progress of TQM implementation at the American institutions of higher education and identified the missing elements and major barriers of implementing TQM in these institutions.[9] He indicated that while progress has been made in the areas of curriculum development, and handling of operational problems, TQM has hit an academic wall in the overall direction of the institution and the functional areas of teaching and research. He identified the following four major barriers to applying TQM at the institutional and functional levels:

3.6 Total Quality Management in Higher Education

TQM has been used successfully in a variety of organizations, including manufacturing and service companies, health care organizations, government agencies and many others. The applicability of TQM in higher education has been the debate for many years. Although application of TQM in higher education institutions started later than in industries, gradually colleges and universities are adopting TQM principles. Some researchers have documented the experience of TQM implementation in some institutions of higher education. Total Quality Management has been adopted by many organizations world-wide, its implementation in non-profit organizations, such as higher education institutions, presents more challenges and difficulties than those encountered in business organizations. What are the problems of implementing TQM in higher education? Who is the customer? Can we identify the products? Can we specify a customer-driven definition of quality and introduce a management quality culture based on the industrial model in the education environment? What is the role that the students play in their own learning? Can we control and measure processes related to teaching and learning? These are some of the question elaborated by many researchers in the recent years [10 ~13].

Benowski , described the challenges facing the school of business in the institutions of higher education and the efforts for improving the quality of education in several universities[14]. Benowski, also cited several schools that have led the way in incorporating TQM into the curriculum and in using TQM to meet students' needs. Among these schools are University of Miami in Florida, Columbia University in New York, and University of Chicago in Illinois. All of these schools had external impetus from American corporations to implement TQM and they have achieved initial success in their TQM efforts.

3.7 Main Principles of TQM in Higher Education

The main "principles" of TQM in higher education are presented in more details:

• Focus on the customer: Among the essential elements of TQM, customer focus is probably the most important, as reflected by the weight assigned to it by various quality award criteria [9]. Customer identification in a higher education institution seems to present more difficulties than are encountered in business organizations With the term Internal

Customers, in a TQM program in an education institution, we refer to the parents, students, faculty, administration and staff of the institution. On the other hand, with the term External Customers we refer to society, businesses, future employers, families and other institutions that the student might continue his/her studies, that have an interest in the output of the institutions education process.

• <u>Commitment</u>: Top Management's leadership and commitment to quality is also one of the essential elements of TQM. Management's commitment is a prerequisite in order to start any quality initiative. Quality needs a change of culture and given that people resist to changes, management's commitment is an essential element for success. Commitment to quality can also be proven by the allocation of sufficient resources and time. By the term resources we refer to people, tools, training and processes that will boost and promote quality. In education institutions the issue of leadership differs from the typical leadership in a business organization. Presidents, chancellors or deans do not enjoy ultimate authority as the CEOs of business organizations. Depending on the country, the administration and governance of the university might be shared. This leads to diffusion of authority and responsibility, and, as a result the top administration lacks the authority to undertake drastic measures and changes in higher education institutions. University presidents and chancellors, as leaders, can naturally set goals, organizational values and performance expectations. However, since they lack the necessary authority, it is difficult to deploy these values and goals through the layers of the higher education institutions [9].

• <u>Total involvement</u>: Another crucial element in TQM in education is the involvement of all interested parties, mentioned above, in the educational reform. Quality is the responsibility of every member of the organization rather than the responsibility of the "administration", or the equivalent of a quality department in industry. Changes are an outgrowth of faculty involvement rather than those of the university administration. It has to be noted that the involvement of all interested parties is a crucial element for success.

• <u>Measurements</u>: Measurement against defined goals is a very important element for the successful implementation of a TQM program in an educational institution. In order to prove success, an institution must define quality objectives; measure the starting point of the quality effort, and use measurements for proving the attainment of improvements.

• <u>Continuous improvement:</u> The goal of every TQM effort is continuous improvement. TQM is a continuous, unending process of improvement. The TQM program should be reviewed and evaluated on a regular basis to ensure goals are still focused and objectives are being met. In a TQM program everybody is responsible for preventing and solving problems. TQM is a philosophy of never ending improvements achievable only by people. Furthermore, continuous improvement in academic institutions means exploring the needs and expectations of the institutions' customer base, re-evaluating the effectiveness of programs and total quality initiatives [13].

3.8 Problems faced in implementing TQM in education

The definition of customers and the ability of the customers to influence contents of the courses is one of the major concerns, which affect the TQM implementation. Students as customers after all lack the wisdom and knowledge to influence the contents of the courses. Clarity of purpose of educational institutions has never been so far an issue that has to be addressed [15]. The adoption of the industry sense of TQM,i.e. production processes, causes a lot of problems in the educational setting. The somewhat complex delegation and decision-making process in an educational setting creates another problem. While total quality management has been adopted by many organizations world-wide, its implementation in non-profit organizations, such as higher education institutions, presents more challenges and difficulties than those encountered in business organizations. A critical step in TQM implementation is the process of customer identification. In addition to customer identification, there are other issues such as leadership, cultural, and organizational issues that tend to create difficulties for TQM implementation in higher education [16].

Mathews identified the following four major barriers to applying TQM at the institutional and functional levels:

(1) The highly generic and inappropriate nature of an average institution's mission:

Most institutions of higher education have a highly generic mission. They try to satisfy a wide range of very diverse interests and thus end up trying to hit multiple targets with a single arrow. While the mission generally satisfies nobody, it is also sufficiently vague and all encompassing enough to infuriate nobody and thus it can be conveniently put aside and forgotten.

(2) A lack of agreement within the academic environment as to the meaning or implications of "quality and excellence":

Given the nature of academic endeavors, quality and excellence are highly subjective and often difficult to define. It is relatively easy to identify those areas in which efforts to achieve superior performance will be made (teaching and research being two of the most obvious). The measurement of an actual performance towards these noble goals poses serious problems since there are no universally agreed-upon measures for quality and excellence.

(3) The independence of key individuals within the academic environment:

The twin concepts of academic freedom and tenure have resulted in university administrations that have limited control over key personnel, especially those with tenure. Therefore, it is very difficult for a president of a college and/or university to include everyone in quality improvement efforts.

(4) The reluctance of college or university leaders to play an aggressive and creative role in TQM implementation:

Given the last two barriers, the leaders of many academic organizations have been somewhat reluctant to tackle the application of TQM to their own organizations.

Realizing the above barriers to TQM implementation, Mathews suggested the Following seven steps for TQM implementation:

(1) Identifying the institution's primary stakeholders;

(2) Developing a specific competitive quality-based mission;

(3) Establishing internal measures for quality and excellence in specific and identified area;

(4) Determining who has to commit to the chosen standard;

(5) Establishing motivation for those unwilling to commit to quality and excellence;

(6) Forming quality progress teams; and

(7) Reporting, recognition and rewards.

3.9 QFD and Higher Education

QFD is a planning technique which originated in Japan in 1972 and has proven its ability for quality improvement. Applying QFD, as a TQM technique, is one of the logical consequences of a customer- oriented approach to quality. In this technique, the customer's needs and expectation are identified and then translated into technical specifications which determine the design quality of the product or service. A multi- dimensional matrix, sometimes called the 'house of quality' because of its shape, is used as a basis for demonstrating the planning procedure. Identifying customer requirements, evaluating priorities of the requirements, identifying technical characteristics are the main steps in a QFD analysis. The widespread success reports of application of QFD in industry have generated interest for the academics and researchers to apply the QFD in the service sector like healthcare, banking, and higher education.

3.10 Application of QFD to an educational institute

Due to remarkable success of Quality Function Deployment in industry it has also been being applied in the higher educational institution since 1980s.It was used by many researchers like Jaraiedi and Ritz , Clayton , Lam and Zhao and Pitman et al [17~19]. The research findings reflect importance of QFD for new curriculum design, cost effectiveness, improving teaching process through keeping customer satisfaction as the yardstick. QFD

can be used to measure customer satisfaction in educational institutions.They utilized QFD in evaluating the MBA program at Grand Valley State University. The inputs for the QFD were obtained through several brain storming sessions of MBA students, faculty members, administrators, and business executives. The preliminary results of the pilot field test show that QFD is a very useful tool in ascertaining customer desires, prioritizing them, and directing organizational resources toward customer satisfaction.

Quality of Education is a myth in third world; it is a concept which is least understood, vaguely defined and not properly addressed; and contains a limited portion of overall Quality of Education concept. In order to address this grave misconception and eliminate existing ambiguity the authors have attempted to develop a preliminary model to assess quality from a system's perspective.

3.11 Quality assurance in Technical Education

The quality of engineering and technology education is complex and challenging due to various reasons, and can be analogous to industry, as illustrated in Figure 3.2. Any standard

Figure 3.2: The block diagram of an educational cycle
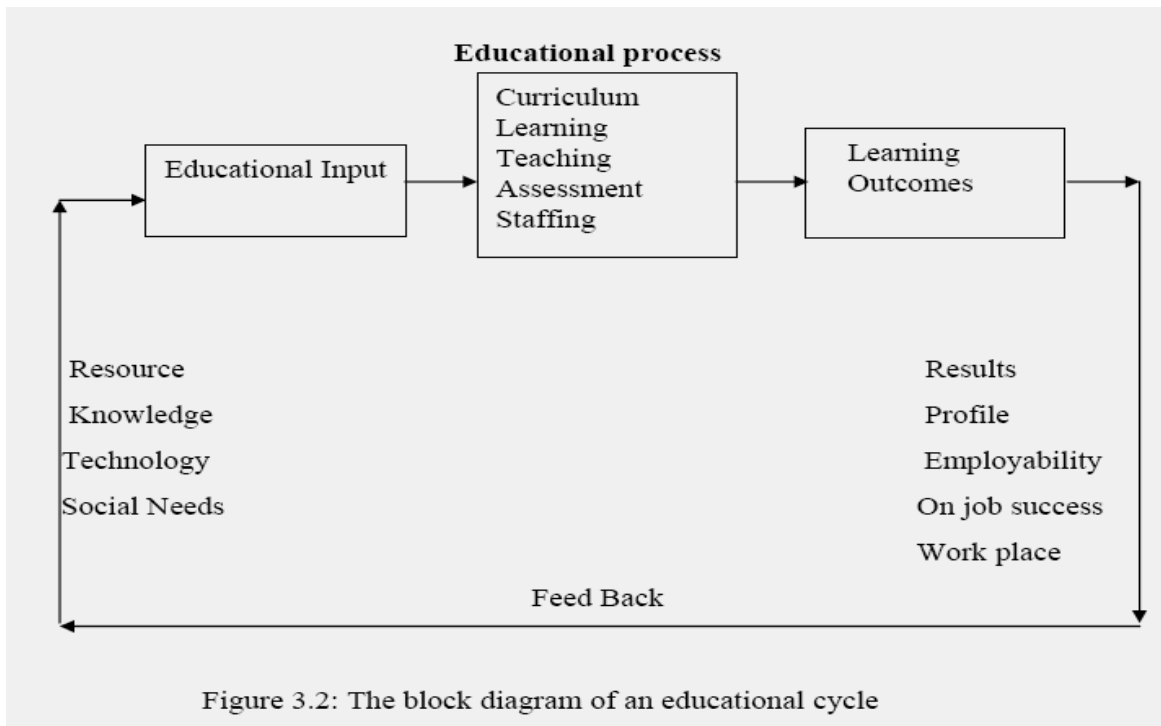
industrial activity includes three different stages, such as the input, the process and the output, where feed-back closes the loop. In this process, feedback gained from the output can be utilized to improve the quality of the process. This model has also been adopted for the quality assessment of education structures. The three stages of an educational process cycle are further elaborated on below.

•**Educational Input:** The Input parameters relate to various components, including the student's intake or student's enrollment into an engineering educational process, etc, and may be comprised of the following aspects: Societal needs; New knowledge; Advancing technologies; Human and material resources; Student enrollment process; Student fees structure and Student eligibility criteria, etc.

• **Educational Process:** The educational process lies in between the input and the output, and this is where teaching/learning is facilitated. It may consist of the following important factors: Curriculum design, learning styles, Learning methods, Teaching/learning facilities, Assessment methods and Staffing, etc.

•**Learning Outcomes:** The Output component is associated with the student output after finishing the course curricula. It consists of the following elements: Academic results, Professional profile, Employability, On-the-job success rate and Social and workplace activities, etc.

Chapter IV

INVESTIGATION, RESULTS AND ANALYSIS

4.1 Stages followed in investigation

The expectation of the customers have been gathered and analyzed according to the following steps:

```
┌──────────────────────┐              ┌──────────────────────┐
│ Identify students    │─────────────▶│ Collection of Data   │
│ group                │              │ "Voice of the        │
└──────────────────────┘              │ customer"            │
         │                            └──────────────────────┘
         ▼                                       │
┌──────────────────────┐                         ▼
│ QFD Team             │              ┌──────────────────────┐
│ ┌──────────────────┐ │              │ Students Important   │
│ │Teaching Techniques│ │             │ Rating               │
│ └──────────────────┘ │              └──────────────────────┘
└──────────────────────┘                         │
         │                                        │
         ▼                                        ▼
      ┌──────────────────────┐
      │ Incorporate Data into HOQ │◀────
      └──────────────────────┘
                 │
                 ▼
      ┌──────────────────────┐
      │ Determination of     │
      │ Relationship Matrix  │
      └──────────────────────┘
                 │
                 ▼
      ┌──────────────────────┐
      │ Determination of     │
      │ Correlation Matrix   │
      └──────────────────────┘
                 │
                 ▼
      ┌──────────────────────┐
      │ Technical assessment │
      │ Ranking the teaching │
      │ techniques           │
      └──────────────────────┘
```
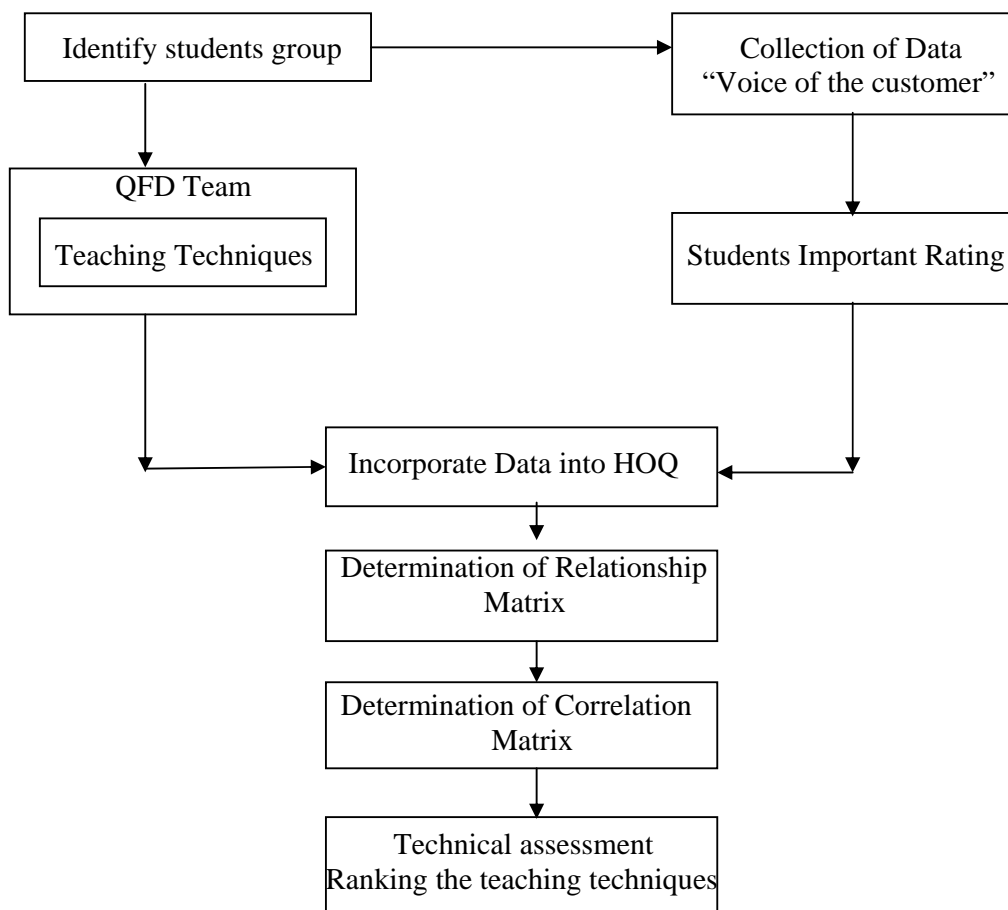
Fig 4.1: Flowchart depicting the steps followed for QFD method

4.1.1 Identifying the student group

There are two types of students in Technical Training Center.

1. SSC(Vocational) students
2. Students for short course

The degree of SSC (Voc) course is awarded by the Bangladesh Technical Education Board (BTEB).The duration of the course is two years. The students who admit into TTC complete the two year courses. A student must appear two board final exams in class nine and class ten. Then he gets a certificate.

Students for short courses continue their course in TTC for the duration of one month to one year. The certificate is issued by BMET under the Ministry of Expatriates' Welfare and Overseas Employment.

4.1.2 Collection of Data

There are 37 TTC in Bangladesh .For this project work data have been collected from five TTC of four regions.

- Sylhet TTC from sylhet region
- Sylhet Mohila TTC from Sylhet region
- Bangla –Germen TTC from Dhaka region
- Noakhali TTC from Chittagong region and
- Patuakhali TTC from Barishal region.

Data have been collected for the project work by following ways:

1. Focus Group discussion
2. Documentation
3. Observation
4. Questionnaires
5. Interview

By giving the printed questionnaire form to the students and teachers, discussion and direct interview were conducted among the students to find out their expectations and requirements.

4.1.3 Incorporate Data into HOQ

4.1.3.1 Analysis of data for the students of short courses

Following steps are followed for analysis.

Step 1-Listing of the student requirements (WHATs): Quality Function Deployment starts with a list of requirements of the students. This list is often referred as the WHATs that a student needs or expect in a particular service. The voices of the students are collected by surveying from two hundred fifty students. The students are selected from various trade courses like computer, Auto CAD, Refrigeration & Air condition, Catering etc. Thirty student's requirements have been listed. The key requirements of the students are listed in the House of Quality. The students' requirements are described below:

01. Laboratory facilities

02. Workshop facilities

03. Teaching aids (like OHP, Projector)

04. Availability of scholarship

05. Course duration

06. Exam system

07. Continuous assessment

08. Remedial Class for week student

09. Problem solving project for students

10. Group Discussion

11. Technical quiz

12. Games and Sports

13. Cultural Activities

14. A good qualified teacher

15. Sincerity of a teacher

16. Regularity of a teacher

17. Exposing student to new tech.

18. Transport facilities

19. Library facilities

20. Seminar hall/Conference room

21. Canteen facilities

22. Hostel facilities

23. Back up facilities for power

24. Usages of Internet

25. Computer facilities

26. Interactive website of Institution

27. Usage of learning Software

28. Industrial Attachment

29. Arrangement of job fair

30. Education Tour to industry

01. Laboratory facilities: It is one of the important requirements. Modernization of laboratories and creation of Labs and Workshops for new courses should be done properly.

02. Workshop facilities: The culture of seminars or workshops should be developed. This culture can play a vital role in case of job fair or internship program or alumni association.

03. Teaching aids (like OHP, Projector) :Establishment of Learning Resource Development Centers, Development/procurement of learning resources such as video films, multimedia and CAI packages should done properly. Other learning resources such as laboratory manuals, learning packages and packages specific for the development of competencies are needed. Creation of Learning Resources storage facility for ready access to teachers and students, acquisition and installation of appropriate hardware for class room and self learning from audio-visual resources should be done.

04. Availability of scholarship: Scholarship must be available for the poor but meritorious students.

05. Course duration: The time duration of courses must be adequate for completing the syllabus of the course.

06. Exam system: Exam system should be modern and updated.

07. Continuous assessment: A well defined system of comprehensive regular and continuous assessment to be developed to include regular tests, laboratory work,

assignments, student self-learning, student training in industry, student problem solving projects and other forms of student practices.

08. Remedial Class for weak student: Remedial classes should be provided for the weak students to improve the overall quality of the students.

09. Problem solving projects for students: The students have to be able to select the best solution to the problem and implement the solution. The students must be able to perform qualitative and quantitative analysis of a problem with the objective of understanding the problem and evaluating the alternative solutions to the problem.

10. Group Discussion: Group discussions are effective way to achieve most educational objectives in tutorials.

*11. Technical quiz***:** Students must appear in technical quiz program to improve themselves.

12. Games and Sports: For all kinds of education, games and sports are needed for mental development of a student.

13. Cultural Activities: Good education in its totality must include the overall development of the student and must not restrict to training in a specialized discipline. These extra curricular activities enhance and improve the inherent capabilities and skill of the students.

*14. A good qualified teacher***:** A good qualified teacher is one of the most important demands for an educational institute. A good teacher can arises the thirst for knowledge within the students.

15. Sincerity of a teacher: A teacher must be sincere enough. It is also necessary to boost the moral of the students by motivating the students. All these aspects when carefully implemented and nurtured bring about a total turn around in the quality of education.

16. Regularity of a teacher: A teacher must be regular to his duty.

17. Exposing student to new tech., Undertaking research for creation of new knowledge and new technologies and undertaking consultancy projects for industry and community,

18. Transport facilities: Transport facilities must be provided to the students for industrial tour.

19. Library facilities : Modernization, computerization and Strengthening libraries to meet requirements of research and consultancy works, services to community and industry. Establishment of Digital libraries in the institutions is must.

20. Seminar hall/Conference room: Conference room is needed to conduct the conference.

21. Canteen facilities : Canteen facilities must be provided to the students.

22. Hostel facilities:Living within the campus hostel a student can attend the class regularly and a teacher can monitor the students properly.

23. Back up facilities for power: A technical institute has lot of computers, electronic and mechanical devices. To operate these devices more power is needed. So back up facilities for power is needed to run the institute smoothly.

*24. Usages of Internet***:** Provision of Internet, campus networking and networking between institutions for enhancing access to and sharing of learning resources available in a cluster.

25. Computer facilities: For the technical education computer is a vital necessary. The global education system emphasizing on the increased application of computers in every aspect is the present demand. Improvement of computing facilities should be done within the institute.

26. Interactive website of Institution: If there is a website of an institute then it would be very easy for the student to see the various notice and circular.

27. Usage of learning Software: By using learning software a student can easily understand his study and he can evaluate himself.

28. Industrial Attachment: Industrial attachment is the part of technical education. After completing the theory course a student can get practical training from industry. The fresh engineers from technical institution need to be offered training in industries to give them first hand practical exposure.

29. Arrangement of job fair: Identification of employment opportunities for graduates through interaction with apex industry organizations. It can help a student to obtain easier access to job markets.

30. Education Tour to industry: Education tour is also necessary for the students to improve their practical knowledge.

Step 2: Arranging the students' requirements or WHATS according to weight: After getting a questionnaire students input a value to each question. The marks are summarized and then the percentages of weight assigned by the students are calculated. These are shown in the table below.

Table 4.1 : Percentage weight assigned by the students of short course to each question of students requirements

Serial	Students Requirements	Percentage Weight assigned by Students
1	A good qualified teacher	86.8
2	Workshop facilities	86.2
3	Sincerity of a teacher	85.2
4	Computer facilities	84.4
5	Regularity of a teacher	83.8
6	Industrial Attachment	83.0
7	Laboratory facilities	81.6
8	Exam system	81.6
9	Continuous assessment	78.8
10	Education Tour to industry	76.6
11	Back up facilities for power	76.4
12	Remedial Class for week student	76.0
13	Course duration	75.8
14	Library facilities	75.6
15	Group Discussion	75.4
16	Teaching aids(ex OHP,Projector)	75.2
17	Seminar hall/Conference room	75.2
18	Problem solving project for std	75.0
19	Hostel facilities	74.6
20	Usages of Internet	74.2
21	Usage of learning Software	73.8
22	Arrangement of job fair	73.6
23	Exposing student to new tech.	73.2
24	Interactive website of Institution	71.6
25	Availability of scholarship	70.6
26	Technical quiz	70.4
27	Canteen facilities	69.4
28	Transport facilities	69.0
29	Cultural Activities	68.6
30	Games and Sports	68.2

Step 3: Observing the gap of students' requirements between Importance to students and Actual performance of TTC:

The students are requested to assign a value to the Importance column and Actual performance column on the questionnaire sheet. Then the values are plotted into the graph. The graph shows the gap of students' requirements between the importance to students and the actual performance of TTC.
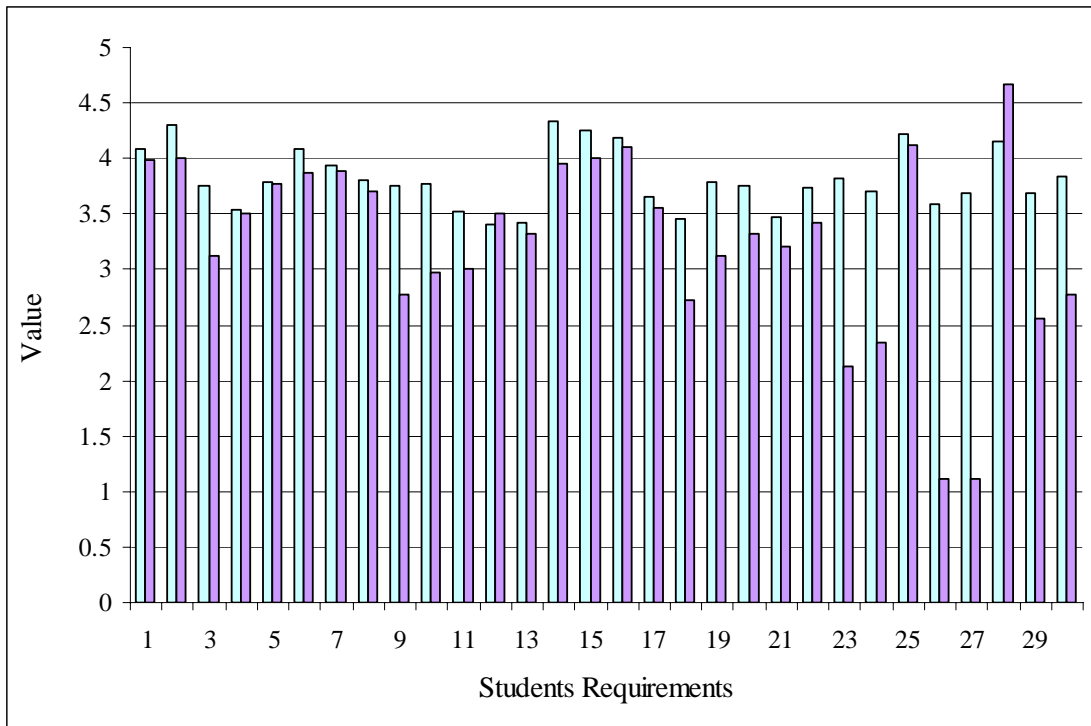
Fig 4.2 : Gap of students requirements between Importance to students and Actual performance of TTC for the student of short course

Step 4-list of the teaching techniques (HOWs): The goal of the house of quality is to design or change the design of a service in a way that meets or exceeds the student expectations. The student's needs and expectations have been expressed in terms of the student requirements, the QFD team must come up with service element or teaching techniques (HOWs) that will affect one or more of the student requirements. The information on teaching techniques was collected from students. Each techniques of teaching must directly affect a student perception and are expressed in measurable terms. QFD team summarized the suggestions and combined different technique and the number was reduced. Then the summarized teaching techniques were incorporated in the House of Quality.

The teaching techniques are:

1. Using multimedia aids

2. Time duration of lectures

3. Remedial class for weak students

4. Giving Individual Problem solving

5. Interaction with students and teachers

6. Industrial attachment to each course

7. Education tour to industry

8. Proper inspection and monitoring

9. Confirmation the attendance of students

10. Provide Hostel facilities

11. Standard Curriculum

12. Contact with the job provider

1. *Using multimedia aids*: The education can be made interactive to the students by using multimedia aids. A student can receive the lesson easily if it is conducted with the multimedia aids. Multi-media aids are also effective in developing communication skills and in enriching computer knowledge for analysis.

2. *Time duration of lectures*: The duration of lectures should be enough for the students to understand the topics completely. After conducting the class a teacher can get feedback from the students within the class room.

3. *Remedial class for weak students*: All the students are not same meritorious. Some students can understand easily and some students need time to understand. So, remedial class is needed for weak students.

4. *Giving Individual Problem solving***:** As a technical graduate a student must solve lots of problem in his professional life. So, While studying in the TTC he must be given problem related to his study and he must find out its solution.

5**.** *Interaction with students and teachers***:** Interaction with students is the best way to prepare for students' future careers and to develop students' interests in the subject. Interaction with students is best for developing practical application skills and constant assessment is the most effective in preparing for examination.

6. *Industrial attachment to each course*: Industrial attachment is the most effective way to prepare a student for the professional careen in the industry.

7. *Education tour to industry*: Through education tour a student can learn practically how the people work with the machinery.

8. *Proper inspection and monitoring*: It is an important aspect for every sector to fulfill the quality of education. If proper inspection and monitoring is being done then a student must be conscious about his future career which is the primary motto of setting up the educational institute.

9. *Confirmation the attendance of students*: Students do not want to attend the class regularly. So technical quiz, practical class must conduct regularly to confirm their regular attendance. For this attendance marks should be imposed on them.

10*. Provide Hostel facilities*: To attend the class regularly hostel facilities should be provided to the students.

11. *Standard Curriculum*: Curriculum should be standard enough to fulfill the demand of global labor market. So Labor market orientated courses should be offered. Need based periodic, updating and improvement of curriculum should be done.

12. *Contact with the job provider*: After completing the graduation from the institute a student look for a good job. To fulfill the career episode of a student the authority of the

institute must contact with the job provider. For this reason the authority can arrange job fair and open a job information desk within the institute.

Step 5- develop a relationship matrix between WHATs and HOWs:

The next step in building a house of quality is to compare the student requirements and teaching techniques and determine their respective relationships. Tracing the relationships between the student requirements and the teaching techniques can become very confusing, because each requirement may affect more than one teaching techniques, and vice versa. For this reason, the relationship is divided into three categories – strong, medium and weak relationship. And if there is no relationship the intersection quadrant is remain blank. The relationship has been completed by QFD team. Prioritized students' requirements Relationship between requirements and techniques Students' (customer) requirements Prioritized technical descriptors Interrelationship between teaching techniques teaching techniques (Technical descriptors).

Importance to customer:

A focus group ranks each customer (students) requirements by assigning it a rating. Numbers 1 through 5 are listed in the importance to customer (student) column to indicate a rating 1 for least important and 5 for very important. In other words, the more important the students' requirements, the higher are the rating.

Target value:

This is an objective measure that defines values that must be obtained to achieve the technical descriptor. How much it takes to meet or exceed the students' expectations is answered by evaluating all the information entered into the house of quality and the selecting target values.

The rating of Relationship

■ -for Very Strong relationship (value = 9)

● - for Medium relationship (Value = 5)

0 -for Weak relationship (Value = 1)

If there is no relationship then the value assigned is 0, and left blank.

Actual Performance:

This is the value assigned by the teachers and students to measure the present condition of TTC to fulfill the students requirements.

Absolute weight:

Finally, the absolute weight is calculated by multiplying the importance to customer to the weight assigned to Relationship matrix

Absolute weight = Importance to customer *($\sum$ weight assigned to Relationship matrix)

Relationship Symbol

Strong Positive ✔
Moderate Positive ✔
Moderate Negetive ➕
Strong Negetive ✚

Legend — How's
■ Very strong (9)
● Medium (5)
○ Weak (1) — What's

What's	1. Using multimedia aids	2. Time duration of lectures	3. Remedial class for weak students	4. Giving Individual Problem solving	5. Interaction with students and teachers	6. Industrial attachment to each courses	7. Education tour to industry	8. Proper inspection and monitoring	9. Confirmation of attendance of the students	10. Provide Hostel facilities	11. Standard Curriculum	12. Contact with the job provider	Importance to Students	Actual Performance of TTC
01. Laboratory facilities	●										○		4.08	3.98
02. Workshop facilities											○		4.31	4.00
03. Teaching aids(ex OHP,Projector)									■				3.76	3.12
04. Availability of scholarship											●		3.53	3.50
05. Course duration		■		●	○								3.79	3.77
06. Exam system		○									●		4.08	3.87
07. Continuous assessment		●						■	●		■		3.94	3.88
08. Remedial Class for week student		●	■	■	○			■	●		■		3.80	3.70
09. Problem solving project for std				■							■		3.75	2.78
10. Group Discussion									○				3.77	2.98
11. Technical quiz									○		●		3.52	3.01
12. Games and Sports									○		●		3.41	3.51
13. Cultural Activities									○				3.43	3.33
14. A good qualified teacher		●	■	●									4.34	3.95
15. Sincerity of a teacher		○	■	●					●				4.26	4.01
16. Regularity of a teacher									●				4.19	4.11
17. Exposing student to new tech.						●	■						3.66	3.55
18. Transport facilities						■	■		●	■			3.45	2.73
19. Library facilities													3.78	3.12
20. Seminar hall/Conference room										○	○		3.76	3.32
21. Canteen facilities										●			3.47	3.21
22. Hostel facilities										■			3.73	3.43
23. Back up facilities for power	■									○			3.82	2.12
24. Usages of Internet													3.71	2.34
25. Computer facilities													4.22	4.12
26. Interactive website of Institution					○							●	3.58	1.11
27. Usage of learning Software	■	●											3.69	1.12
28. Industrial Attachment						■		■	■		■		4.15	4.67
29. Arrangement of job fair						○					●	■	3.68	2.56
30. Education Tour to industry						○	■				■		3.83	2.78
Target Value (1-5)	4	5	5	5	3	3	4	5	4	4	3	2		
Absolute weight	110	95	60	185	47	98	99	107	161	90	280	51		
Relative weight	4	8	10	2	12	7	6	5	3	9	1	11		

Fig 4.3 : House of Quality for the students of Short courses

Step 6-Competitive assessments:

The competitive assessments have been done by focus group (Focus group consists of One Director of BMET ,two principals ,two vice principals, two chief instructors and two senior instructors of TTC) using average rating.

Step 7- developing prioritized teaching techniques (technical descriptor):
The QFD team identifies technical descriptors that are most needed to fulfill student requirements and need further improvement.

Table 4.2: Absolute weight and percentage weight of teaching
techniques for short course students

HOWS	Absolute weight	Weight Percentage
1. Using multimedia aids	110	7.92
2. Time duration of lectures	95	6.87
3. Remedial class for weak students	60	4.34
4. Giving Individual Problem solving	185	13.4
5. Interaction with students and teachers	47	3.4
6. Industrial attachment to each courses	98	7.09
7. Education tour to industry	99	7.16
8. Proper inspection and monitoring	107	7.74
9. Confirmation the attendance of the students	161	11.6
10. Provide Hostel facilities	90	6.51
11. Standard Curriculum	280	20.2
12.Contact with the job provider	51	3.69

Step 8: Ranking the teaching techniques with respect to their absolute weight:

Graphical representation of ranking of teaching techniques is shown in the following figure.
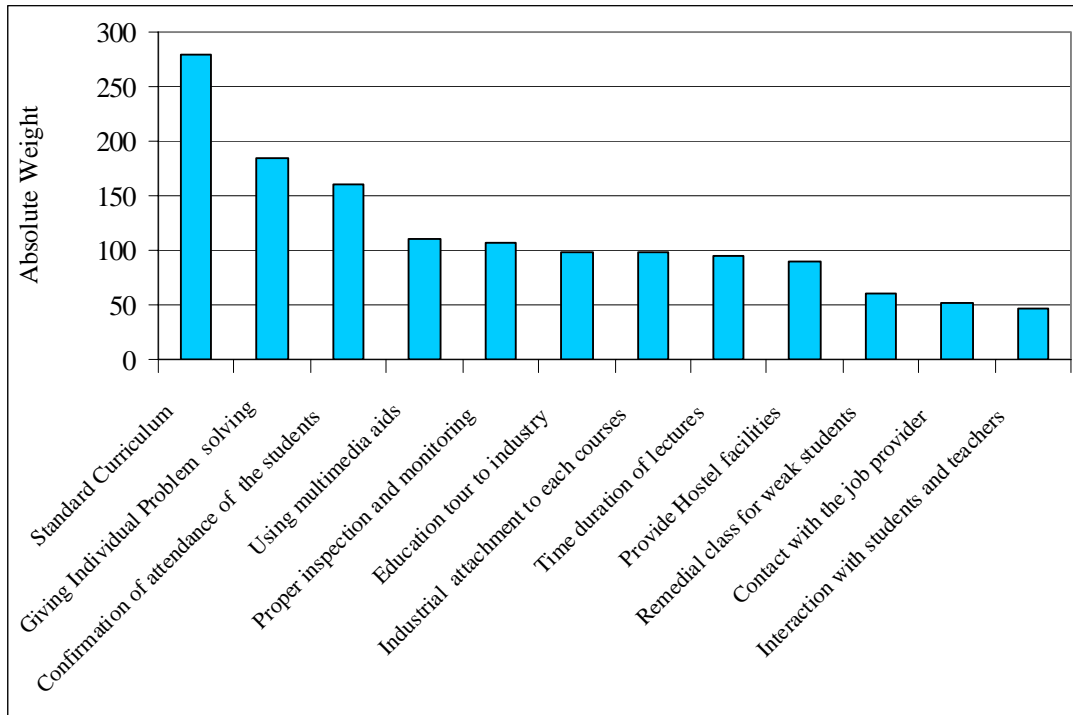
Fig 4.4 : Graphical representation of ranking of teaching techniques for the students of short course

The ranking are shown in the table below:

Table 4.3 : Ranking of teaching techniques for the students of short course

Rank	Teaching Techniques
1	Standard Curriculum
2	Giving Individual Problem solving
3	Confirmation of attendance of the students
4	Using multimedia aids
5	Proper inspection and monitoring
6	Education tour to industry
7	Industrial attachment to each courses
8	Time duration of lectures
9	Provide Hostel facilities
10	Remedial class for weak students
11	Contact with the job provider
12	Interaction with students and teachers

4.1.3.2 Analysis of data for the students of SSC vocational courses: Following steps are followed for analysis.

Step 1-list of the student requirements (WHATs):

Quality Function Deployment starts with a list of requirements of the students. This list is often referred as the WHATs that a student needs or expect in a particular service. The voices of the students are collected by surveying from two hundred fifty students. The students are selected from various trade courses like computer, Auto CAD, Refrigeration & Air condition, Catering etc. Twenty three student's requirements have been listed. The key requirements of the students are listed in the House of Quality. The students' requirements are described below:

01. Laboratory facilities
02. Workshop facilities
03. Teaching aids (like OHP, Projector)
04. Continuous assessment
05. Remedial Class for week student
06. Problem solving project for students
07. Group Discussion
08. Technical quiz
09. A good qualified teacher
10. Sincerity of a teacher
11. Regularity of a teacher
12. Exposing student to new technologies
13. Transport facilities
14. Library facilities
15. Seminar hall/Conference room
16. Canteen facilities
17. Hostel facilities
18. Back up facilities for power
19. Usages of Internet
20. Computer facilities
21. Interactive website of the Institution
22. Usage of learning Software
23. Arrangement of job fair

01. Laboratory facilities: It is one of the important requirements. Modernization of laboratories and creation of Labs and Workshops for new courses should be done properly.

02. Workshop facilities: The culture of seminars or workshops should be developed. This culture can play a vital role in case of job fair or internship program or alumni association.

03.Teaching aids(like, OHP,Projector) Establishment of Learning Resource Development Centers, Development/procurement of learning resources such as video films, multimedia and CAI packages should be done properly. Other learning resources such as laboratory manuals, learning packages and packages specific for the development of competencies are needed. Creation of Learning Resources storage facility for ready access to teachers and students and acquisition and installation of appropriate hardware for class room and self learning from audio-visual resources should be done.

04. Continuous assessment A well defined system of comprehensive regular and continuous assessment to be developed to include regular tests, laboratory work, assignments, student self-learning, student training in industry, student problem solving projects and other forms of student practices.

05. Remedial Class for weak student: Remedial class should be provided for the weak students to improve the overall quality of the students.

06. Problem solving project for students: The students have to be able to select the best solution to the problem and implement the solution. The student must be able to perform qualitative and quantitative analysis of a problem with the objective of understanding the problem and evaluating the alternative solutions to the problem.

07. Group Discussion: Group discussions are effective ways to achieve most educational objectives in tutorials.

08. Technical quiz: Students must appear in technical quiz program to improve themselves.

09. A good qualified teacher: A good qualified teacher is one of the most important demand vital for an educational institute. A good teacher can arise the thirst for knowledge within the students.

10. Sincerity of a teacher: A teacher must be sincere enough to It is also necessary to boost the moral of the students by motivating the students. All these aspects when carefully implemented and nurtured bring about a total turn around in the quality of education.

11. Regularity of a teacher: A teacher must be regular at his duty.

12. Exposing student to new tech: Undertaking research for creation of new knowledge and new technologies and undertaking consultancy projects for industry and community.

13. Transport facilities: Transport facilities must be provided to the students for industrial tour.

14. Library facilities Modernization and computerization of libraries strengthening libraries to meet requirements of research and consultancy works, services to community and industry. Establishment of Digital libraries in the institutions modernization and computerization of libraries

15. Seminar hall/Conference room: Conference room is needed to conduct the conference.

16. Canteen facilities : Canteen facilities must be provided to the students.

17. Hostel facilities: Living within the campus hostel a student can attend the class regularly and a teacher can monitor the students properly.

18. Back up facilities for power: A technical institute has lot of computers, electronic and mechanical devices. To operate these devices more power is needed. So back up facilities for power is needed to run the institute smoothly.

*19. Usages of Internet***:** Provision of Internet, campus networking and networking between institutions for enhancing access to and sharing of learning resources available in a cluster.

20. Computer facilities: For the technical education computer is a vital necessary. The global education system emphasizing on the increased application of computers in every aspect is the present demand. Improvement of computing facilities should be done within the institute.

21. Interactive website of Institution: If there is a website of an institute then it would be very easy for the student to see the various notice and circular.

22. Usage of learning Software: By using learning software a student can easily understand his study and he can evaluate himself.

23. Arrangement of job fair: Identification of employment opportunities for graduates through interaction with apex industry organizations. It can help a student to obtain easier access to job markets.

Step 2: Arranging the students' requirements or WHATS according to weight:

After getting a questionnaire, students input a value to each question. The marks were summarized and then the percentages of weight assigned by the students were calculated. These are shown in the table below.

Table 4.4: Percentage weight assigned by the students of SSC vocational course to each question of Students' requirements

Serial	Students Requirements	% Weight assigned by Students
1	A good qualified teacher	86.8
2	Sincerity of a teacher	85.2
3	Workshop facilities	82.6
4	Regularity of a teacher	80.2
5	Computer facilities	80.2
6	Laboratory facilities	79.6
7	Continuous assessment	78.8
8	Canteen facilities	77.8
9	Arrangement of job fair	77.6
10	Problem solving project for students	77.0
11	Technical quiz	76.4
12	Usage of learning Software	75.8
13	Group Discussion	75.4
14	Exposing student to new technologies	75.2
15	Back up facilities for power	75.2
16	Usages of Internet	74.2
17	Remedial Class for week student	74.0
18	Interactive website of the Institution	73.6
19	Teaching aids (like OHP, Projector)	73.4
20	Library facilities	73.4
21	Transport facilities	73.0
22	Seminar hall/Conference room	70.8
23	Hostel facilities	67.4

Step 3-: Observing the gap of students requirements between Importance to students and Actual performance of TTC :

The students are requested to assign a value to the Importance column and Actual performance column on the questionnaire sheet. Then the values are plotted into the graph. The graph shows the gap of students' requirements between the importance to students and the actual performance of TTC**.**
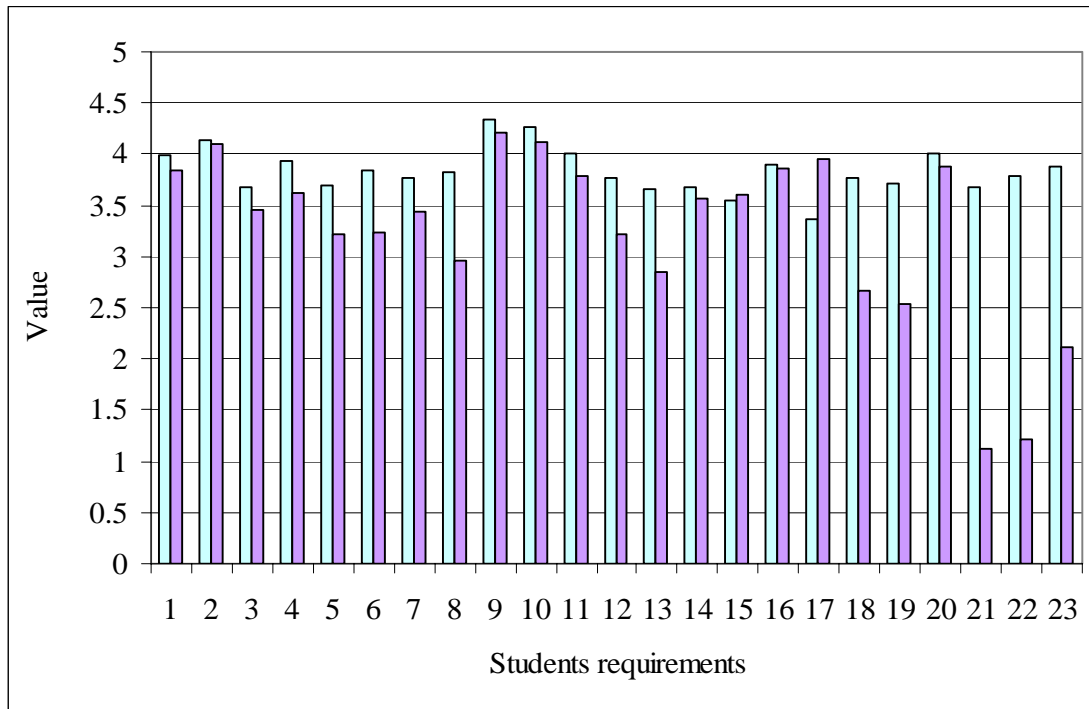
Fig 4.5 : Gap of students requirements between Importance to students and Actual performance of TTC for the students of SSC vocational course

Step 4:-list of the teaching techniques (HOWs):

The goal of the house of quality is to design or change the design of a service in a way that meets or exceeds the student expectations. The student's needs and expectations have been expressed in terms of the student requirements, the QFD team must come up with service element or teaching techniques (HOWs) that will affect one or more of the student requirements. The information on teaching techniques was collected from students. Each techniques of teaching must directly affect a student perception and are expressed in measurable terms. QFD team summarized the suggestions and combined different technique and the number was reduced. Then the summarized teaching techniques were incorporated in the House of Quality.

The teaching techniques fond for the students of SSC vocational are listed below:

1. Using multimedia aids

2. Time duration of lectures

3. Remedial class for weak students

4. Giving Individual Problem solving

5. Interaction with students and teachers

6. Education tour to industry

7. Proper inspection and monitoring

8. Confirmation of attendance of the students

9. Provide Hostel facilities

1. *Using multimedia aids*: The education can be made interactive to the students by using multimedia aids. A student can receive the lesson easily if it is conducted with the multimedia aids. Multi-media aids are also effective in developing communication skills and in enriching computer knowledge for analysis.

2*. Time duration of lectures*: The duration of lectures should be enough for the students to understand the topics completely. After conducting the class a teacher can get feedback from the students within the class room.

3. *Remedial class for weak students*: All the students are not same meritorious. Some students can understand easily and some students need time to understand. So, remedial class is needed for weak students.

4. *Giving Individual Problem solving*: As a technical graduate a student must solve lots of problem in his professional life. So,While studying in the TTC he must be given some problems related to his study and he must find out its solution.

5**. *Interaction with students and teachers***: Interaction with students is the best way to prepare for students' future careers and to develop students' interests in the subject.

Interaction with students is best for developing practical application skills and constant assessment is the most effective in preparing for examination.

6. *Education tour to industry*: Through education tour a student can learn practically how the people work with the machinery.

7. *Proper inspection and monitoring*: It is an important aspect for every sector to fulfill the quality of education. If proper inspection and monitoring is being done then a student must be conscious about his future career which is the primary motto of setting up the educational institute.

8. *Confirmation of attendance of the students*: Students do not want to attend the class regularly. So technical quiz, practical class must conduct regularly to confirm their regular attendance. For this, attendance marks should be imposed on them.

9. *Provide Hostel facilities*: To attend the class regularly hostel facilities should be provided to the students.

Step 5- develop a relationship matrix between WHATs and HOWs:

The next step in building a house of quality is to compare the student requirements and teaching techniques and determine their respective relationships. Tracing the relationships between the student requirements and the teaching techniques can become very confusing, because each requirement may affect more than one teaching techniques, and vice versa. For this reason, the relationship is divided into three categories – strong, medium and weak relationship. And if there is no relationship the intersection quadrant is remain blank. The relationship has been completed by QFD team. Prioritized students' requirements Relationship between requirements and techniques Students' (customer) requirements Prioritized technical descriptors Interrelationship between teaching techniques teaching techniques (Technical descriptors).

Importance to customer:

A focus group ranks each customer (students) requirements by assigning it a rating. Numbers 1 through 5 are listed in the importance to customer (student) column to indicate a rating 1 for least important and 5 for very important. In other words, the more important the students' requirements, the higher are the rating.

Target value:

This is an objective measure that defines values that must be obtained to achieve the technical descriptor. How much it takes to meet or exceed the students' expectations is answered by evaluating all the information entered into the house of quality and the selecting target values.

The rating of Relationship

■ -for Very Strong relationship (value = 9)

● - for Medium relationship (Value = 5)

O -for Weak relationship (Value = 1)

If there is no relationship then the value assigned is 0, and left blank.

Actual Performance:

This is the value assigned by the teachers and students to measure the present condition of TTC to fulfill the students requirements.

Absolute weight:

Finally, the absolute weight is calculated by multiplying the importance to customer to the relationship.

Absolute weight = Importance to customer *($\sum$ weight assigned to Relationship matrix)

Legend / How's / What's	1. Using multimedia aids	2. Time duration of lectures	3. Remedial class for weak students	4. Giving Individual Problem solving	5. Interaction with students and teachers	6. Education tour to industry	7. Proper inspection and monitoring	8. Confirmation of attendance of the students	9. Provide Hostel facilities	Importance to Students	Actual Performance of TTC
Legend ■ Very strong (9) ● Medium (5) ○ Weak (1)											
01. Laboratory facilities	●									3.98	3.84
02. Workshop facilities										4.13	4.10
03. Teaching aids (like OHP, Projector)										3.67	3.46
04. Continuous assessment		●					■	●		3.94	3.63
05. Remedial Class for week student		●		■	○		■	●		3.70	3.21
06. Problem solving project for students			●	■			●			3.85	3.23
07. Group Discussion								○		3.77	3.43
08. Technical quiz							○	○		3.82	2.96
09. A good qualified teacher		●		■	●					4.34	4.21
10. Sincerity of a teacher		○		●	●			●		4.26	4.12
11. Regularity of a teacher				○						4.01	3.78
12. Exposing student to new technologies						■				3.76	3.22
13. Transport facilities						■		●		3.65	2.85
14. Library facilities										3.67	3.56
15. Seminar hall/Conference room									○	3.54	3.60
16. Canteen facilities									●	3.89	3.86
17. Hostel facilities								■	■	3.37	3.95
18. Back up facilities for power	■								●	3.76	2.67
19. Usages of Internet										3.71	2.54
20. Computer facilities										4.01	3.87
21. Interactive website of the Institution										3.68	1.12
22. Usage of learning Software	■	●								3.79	1.22
23. Arrangement of job fair							●			3.88	2.11
Target Value	4	5	5	5	4	4	5	5	4		
Absolute Weight	88	57	45	132	47	67	111	116	72		
Relative Weight	4	7	9	1	8	6	3	2	5		

Relationship Symbol

Strong Positive ✔
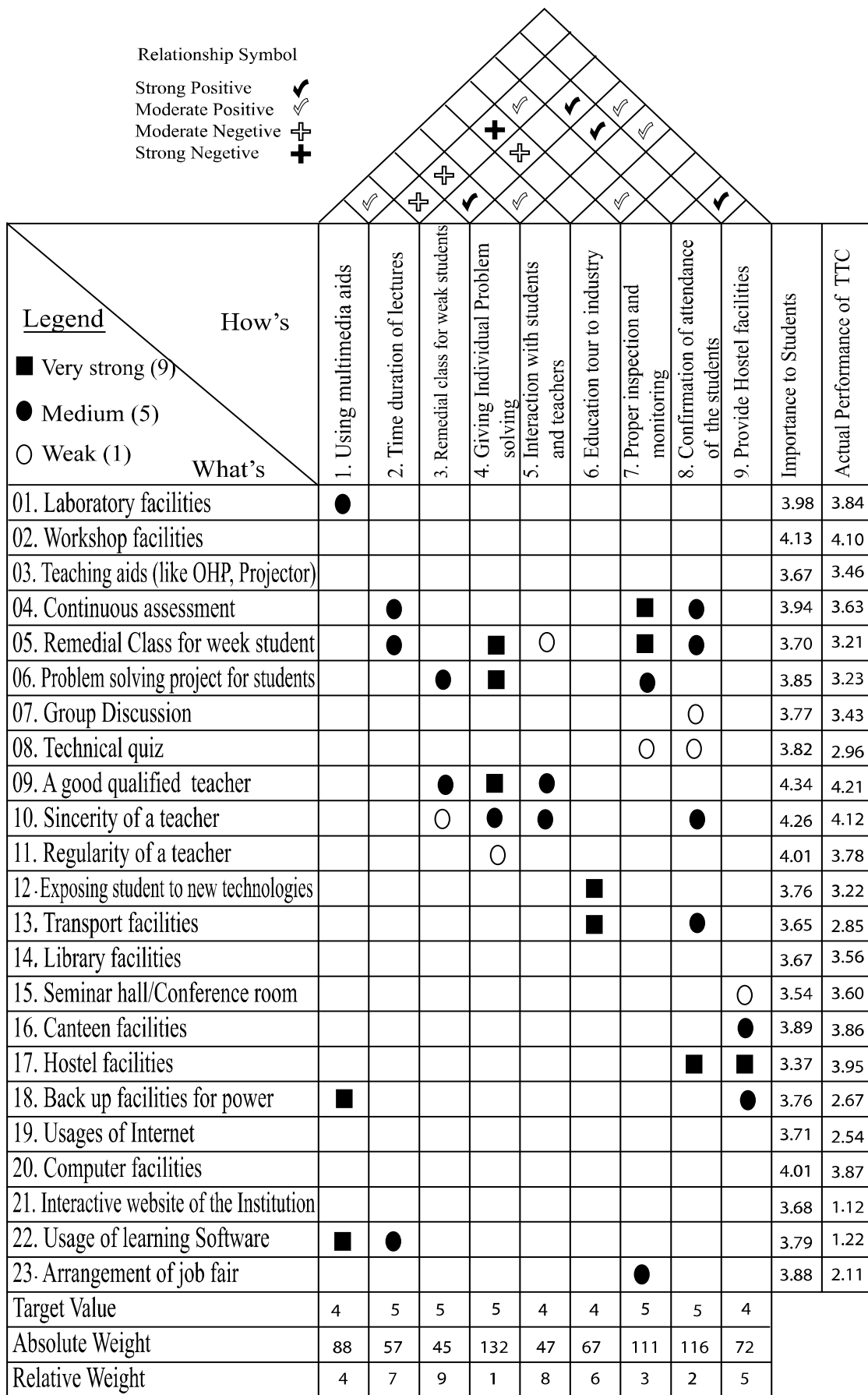Moderate Positive ✔
Moderate Negetive ➕
Strong Negetive ➕

Fig 4.6 : House of Quality for the students of SSC Vocational

Step 6:-competitive assessments:

The competitive assessments have been done by focus group (Focus group consists of One Director of BMET ,two principals ,two vice principals, two chief instructors and two senior instructors of TTC) using average rating.

Step 7:- develop prioritized teaching techniques (technical descriptor):

The QFD team identifies technical descriptors that are most needed to fulfill student requirements with respect to House of Quality. In the table below absolute weight of each teaching techniques and relative percentage weight are shown.

Table 4.5: Absolute weight and percentage weight of teaching techniques for
SSC vocational students

Hows	weight	Percentage weight
1. Using multimedia aids	88	12
2. Time duration of lectures	57	7.8
3. Remedial class for weak students	45	6.1
4. Giving Individual Problem solving	132	18
5. Interaction with students and teachers	47	6.4
6. Education tour to industry	67	9.1
7. Proper inspection and monitoring	111	15
8. Confirmation of attendance of the students	116	16
9. Provide Hostel facilities	72	9.8

Step 8:- Ranking the teaching techniques with respect to their absolute weight:
Graphical representation of ranking of teaching techniques for SSC vocational students are shown in the following figure.
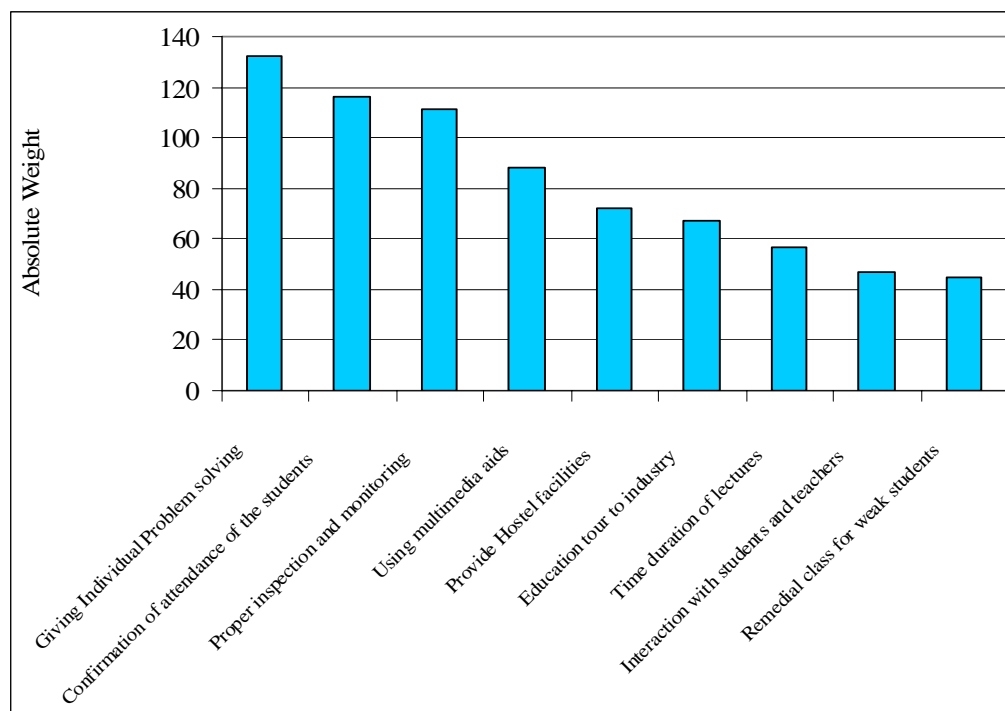

Fig 4.7: Graphical representation of absolute weight of teaching techniques for the students of SSC vocational course

The ranking are shown in the table below:

Table 4.6: Ranking of teaching techniques for the students of SSC vocational

Rank	Teaching Techniques
1	Giving Individual Problem solving
2	Confirmation of attendance of the students
3	Proper inspection and monitoring
4	Using multimedia aids
5	Provide Hostel facilities
6	Education tour to industry
7	Time duration of lectures
8	Interaction with students and teachers
9	Remedial class for weak students

4.2 Analysis of results

4.2.1 Analysis of result for the student of short course

In terms of the results for the teaching techniques of short course students it is observed (from table:4.5) that Standard Curriculum is the most effective technique according to its absolute weight. By giving emphasize on Standard Curriculum it is possible to uphold the image of the quality education of TTC. Curriculum should be standard enough to fulfill the demand of global labor market. So Labor market orientated courses should be offered. In the curriculum industrial training, continuous assessment should be included. The curriculum should be reviewed after a specific period of time to compete with globalization. The second most important teaching technique is Individual Problem solving. By giving emphasize on individual problem solving we can achieve the following five objectives. These objectives are:

• Developing analytical skills
• Developing problem solving skills
• Understanding the main concepts
• Developing specialized knowledge and
• Enriching computer knowledge for analysis.

The third important teaching technique is Confirmation of attendance of the students. If students attend regularly in the class they can hear class lecture regularly, attend the group discussion and appear in the technical quiz. These are important factors for a student to do better in the exam.

4.2.2 Analysis of result for SSC (Vocational) course

In terms of the results for the teaching techniques of SSC vocational students it is observed (from table:4.10) that, Individual problem solving is the most effective technique according to its absolute weight. The importance of individual problem solving has been discussed above. The second most important teaching technique is Confirmation the attendance of students. It is also discussed above.

The third important teaching technique is proper inspection and monitoring. It is one of the important aspects for the SSC vocational students. The age of SSC students are between 14years to 17 years. They need very much careful attention about their study. The interaction among the teachers and the students must be increased.

The deployment strategy is set on the basis of customer focus, technical features to fulfill their requirements and their relationship. The higher relative weight indicates giving the more concentration on the teaching techniques to satisfy the student's requirements. According to the relative weight of teaching techniques, the concerned authority can take initiative to improve the quality of the education of Technical Training Center

Chapter V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The utmost importance of education is universally accepted and cannot be denied. Educational institutions in general and technical institutions are required to provide the quality education that fulfills the needs and expectations of the students by enabling them to really serve the nation and thus strengthening the economy of the country. The universal recognition of QFD in education after industry highlights how important it is to raise the standards of education in educational institute in conformity with requirements of customers.

Quality function deployment provides the technical Training Center a means to understand customer needs and gives it strategic direction for continuous quality improvement. In this research it is found that to improve the quality of technical education in TTC some teaching techniques should be applied for both the short courses and SSC vocational courses. By implementing these teaching techniques the government can develop the quality of education of TTC. It will improve the quality of the students passing out from TTC and it will also help to produce skilled manpower in sufficient numbers to meet the needs of the economy of our country. Thus it can play a vital role for the industrialization of the country.

The adopted QFD methodology proved to be an effective tool for translating the student's requirements into teaching techniques in this research. This study and application of QFD is able to prompt the Technical Training Center to view the teaching techniques from a quality perspective. Despite its limitations and shortcomings, this paper presents a new approach to improve the quality of technical education in Technical Training Center. It is expected that the approaches and methodologies demonstrated in this paper will promote the application of quality management tools in technical education. It is also expected that this paper will stimulate more research in developing measures of teaching effectiveness and the evaluation of alternative teaching methods on teaching effectiveness.

5.2 Recommendations

Although the study successfully demonstrated how the QFD methodology can be used in identifying teaching techniques in achieving educational objectives, it cannot be claimed to have found the most effective methods of teaching. This is because of the following significant limitations in the study.

Students are considered as the prime customers but they are not the only customers for an institution of technical education. The final customers should be the employers of the graduates. Therefore, the measures of effectiveness must include views from these employers. The requirements of these customers should be used in developing the QFD matrix. To develop reliable measures of teaching effectiveness, focus group interviews and surveys must be conducted among employers and technical graduates in different disciplines at various TTC with a much larger sample size.

In future, there are many potential areas for applying this methodology for example, student admission process, design of specific courses, staff appraisal and promotion procedure, library books and materials acquisitions, etc. QFD can be a very powerful tool for the service operation.

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APPENDIX

Questionnaire for the students of short courses

| Name: | Name of the course: | Batch: | Name of TTC : |

N.B: In the left column there are 30 factors and in the right side of the questionnaire there are two column consisting Importance to students and performance of TTC. The values are given from Very poor to Very high (1-5). If it is not applicable then the value is 0.Give Tick mark.

List of Students Requirements	Importance					Performance of TTC					
	very Poor	Low	Medium	High	Very High	very Poor	Low	Medium	High	Very High	N/Applicabl
	1	2	3	4	5	1	2	3	4	5	0
01. Laboratory facilities											
02. Workshop facilities											
03. Teaching aids(ex OHP,Projector)											
04. Availability of scholarship											
05. Course duration											
06. Exam system											
07. Continuous assessment											
08. Remedial Class for week student											
09. Problem solving project for students											
10. Group Discussion											
11. Technical quiz											
12. Games and Sports											
13. Cultural Activities											
14. A good qualified teacher											
15. Sincerity of a teacher											
16. Regularity of a teacher											
17. Exposing student to new tech.											
18. Transport facilities											
19. Library facilities											
20. Seminar hall/Conference room											
21. Canteen facilities											
22. Hostel facilities											
23. Back up facilities for power											
24. Usages of Internet											
25. Computer facilities											
26. Interactive website of Institution											
27. Usage of learning Software											
28. Industrial Attachment											
29. Arrangement of job fair											
30. Education Tour to industry											

Questionnaire for the students of SSC Vocational

| Name: | Name of the course: | Batch: | Name of TTC : |

N.B: In the left column there are 23 factors and in the right side of the questionnaire there are two column consisting Importance to students and performance of TTC. The values are given from Very poor to Very high (1-5). If it is not applicable then the value is 0.Give Tick mark.

List of Students Requirements	Importance					Performance of TTC					
	very Poor	Low	Medium	High	Very High	very Poor	Low	Medium	High	Very High	N/Applicabl
	1	2	3	4	5	1	2	3	4	5	0
01. Laboratory facilities											
02. Workshop facilities											
03. Teaching aids (like OHP, Projector)											
04. Continuous assessment											
05. Remedial Class for week student											
06. Problem solving project for students											
07. Group Discussion											
08. Technical quiz											
09. A good qualified teacher											
10. Sincerity of a teacher											
11. Regularity of a teacher											
12. Exposing student to new technologies											
13. Transport facilities											
14. Library facilities											
15. Seminar hall/Conference room											
16. Canteen facilities											
17. Hostel facilities											
18. Back up facilities for power											
19. Usages of Internet											
20. Computer facilities											
21. Interactive website of the Institution											
22. Usage of learning Software											
23. Arrangement of job fair											