



## Improvement and evaluation Quality of an engineering institute through Quality Function deployment approach

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**Abstract**—Quality Function Deployment (QFD) is one of the Total Quality Management (TQM) techniques which can be useful for expansion and plan improvement. This research work develops an organization for quality in an engineering institute on the basis of assessment. A relationship matrix is developed between five recognized groups of ‘degree of Quality’ and ten sets of ‘Enablers’ in an engineering institute. It additionally outlines a QFD model based on interrelationship and internal relationship between degree of Quality, Enablers and customers. The wholly developed based on the QFD matrix are utilized for quality planning and monitoring. A survey consisting of 14 items was used to collect data from the respondents. A self designed questionnaire was used for data collection. The data was analyzed using the techniques of QFD on higher education institutes. On the basis of these feedback, a house of quality is developed, which highlighted the major concerned areas of quality improvements in teaching and also highlighted some benchmarks where other institutions are more productive.

**Keywords:**— Quality Function Deployment, Total Quality Management.

### 1. INTRODUCTION

QFD is one of the victorious approaches for attaining off line quality. It is an important communication vehicle. The Japanese use what they call Quality Function Deployment (QFD) to plan the quality related aspects of products. Developed in 1966, the concept was first brought to the attention of U.S. companies by Yoji Akao in 1983. Total Quality Management has been used effectively in a variety of organization viz., health care organizations, government agencies, educational institutes, banks, library, transportation facility etc. The continuous pressure from the various stakeholders makes the survival of these agencies extremely difficult specifically educational institutions. Development of the educational institutes depends on the surroundings, working method, and finally the approval of the customers. The viewpoint of these TQM principles underlines the requirement of fulfillment and assurance at all levels. Top management commitment helps in the development of an institute wide culture where the impact can be realized.

Quality Function Deployment (QFD) is one of effective tools which understand customer perspective and transform it to the capabilities of the organization. It can be defined as a system for scheming a

product or service based on customer demands and involving all members of the organization[1]. It helps to determine opportunities that can be developed effectively to achieve total customer satisfaction. QFD can be considered as requirement of TQM. In this current period of globalization customers look for the standards and environment which will satisfy their needs. QFD is a vital pillar for achieving TQM. Total quality management (TQM), as this model is now called, spreads later to service companies such as banks and insurance companies, and eventually to nonprofit organizations such as health care, government, and education institutions. TQM models, based on the teachings of quality gurus, generally involve a number of “principles” or “essential elements” such as top management’s leadership, teamwork, customer focus, employee involvement, training, continuous improvement tools and several other elements, which are all required for successful TQM implementation[2].

### **Characteristics of QFD**

QFD is a quality system that implements elements of Systems Thinking (viewing the development process as a system) and Psychology (understanding customer needs, what 'value' is, and how customers or end users become interested, choose, and are satisfied, etc [3].

QFD is a quality method of good Knowledge or Epistemology (how do we know the needs of the customer? how do we decide what features to include? and to what level of performance?

QFD is a quality system for strategic competitiveness; it maximizes positive quality that adds value; it seeks out spoken and unspoken customer requirements, translates them into technical requirements, prioritizes them and directs us to optimize those features that will bring the greatest competitive advantage.

Quality Function Deployment (QFD) is the only comprehensive quality system aimed specifically at satisfying the customer throughout the development and business process -- end to end.

### **QFD Process**

The QFD process involves constructing a matrix that is entitled ‘The House of Quality’. The matrix displays customer’s needs and wants (What the Customer wants) against the proposed technical solution (How do we achieve it). Customer weightings are applied to prioritize the most important features, and a relationship matrix is used to evaluate interdependencies between the ‘what’s’ and the ‘How’s’. The correlation matrix above the ‘How’s’ further evaluates all technical interdependencies. The results of the relationship matrix, in turn, highlight the most important elements of the new product, so the designers can know which technical aspects of the product matter the most to the customer [4].

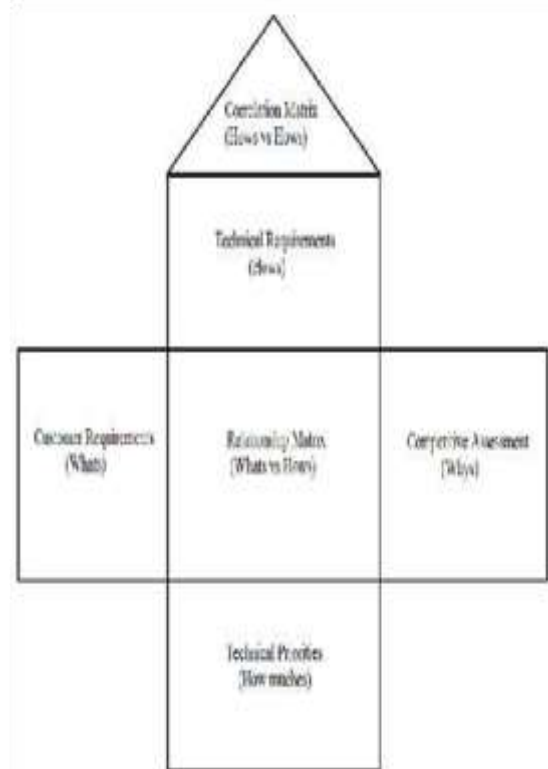


Figure 1: Shows the basic structure of the House of Quality

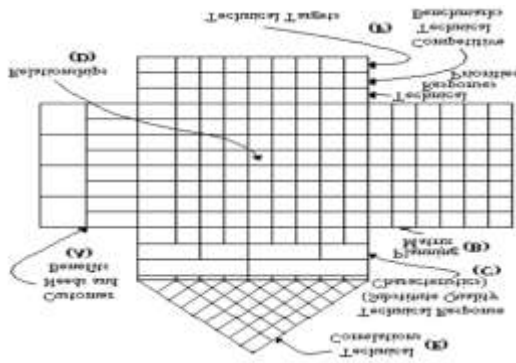


Figure 2: The House Of Quality

There are nine distinct steps that need to be completed to fill the "House of Quality". Each step will fill in one crucial area in the "House of Quality". While some QFD implementers may have more (or less) than nine steps, all of these steps must be completed to complete the House of Quality[5].

- Step 1:** Customer / Non-customer requirements
- Step 2:** Prioritization / Importance Rating
- Step 3:** Technical Design Specifications
- Step 4:** Relationship Matrix
- Step 5:** Competitor's Product Analysis / Rating
- Step 6:** Target Rating / Improvement Factor
- Step 7:** Overall Customer Importance
- Step 8:** Design Requirement Importance
- Step 9:** Trade-offs and Synergies

## 2. MATERIAL AND METHODS

### 2.1 Frame Work Model

Research process consists of series of actions or steps necessary to effectively carry out research and the desired sequencing of these steps. The Research methodology for this paper is shown below through flow chart. The

questions for any organization are how to obtain the innovative solutions or information for how to manage decision-making in a way that ensures the best possible results. These issues apply to the strategy for housing design. The search of a balance between external and internal inputs for the academic and administration phase was one of the goals of this study. Whatever method is used to parameters and develop a solution for the improvement, its success depends on how the organization assimilates and manages the client's requirements. For various problems occurs identified in institutes, various lean tools have been proposed for effective utilization of resources. Moreover, it is an efficient methodology for communication and participation. In this case, it needs group members to work.

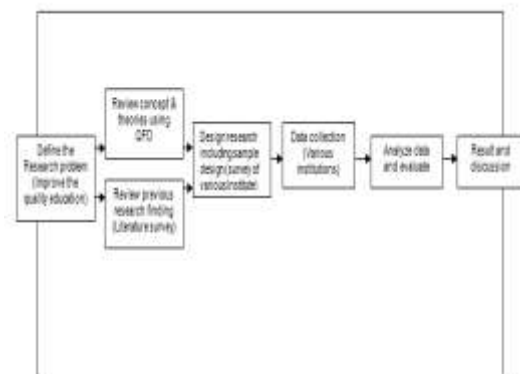


Figure 5: The Frame work modal for Improving quality

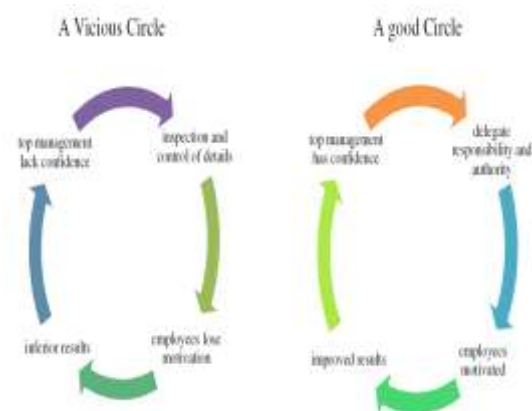


Figure 6: QFD analysis is a step-by-step process.

## 2.2 Analytical method

Education by applying QFD the various steps are

**Step 1:** Determining the voice of the customer (customer needs)

The voice of the customer is required to begin a QFD process, which can be obtained on the basis of experiences with the customer or on survey report.

**Step 2:** Determining the priority structure of customer needs and preparing the competitive evaluations of customer needs. The customer plays an important role in determining the relative position of the organization with respect to that of its competitors for each customer need. This competitive assessment of customer needs can be accomplished through survey of customers, which includes questionnaire survey, direct interviews, telephonic interviews and interaction through e-mail.

**Step-3:** Develop the customer portion of QFD matrix. The horizontal portion of the QFD matrix is concerned to the information related to customer. The list of customer needs, priority rating and competitive assessment of customer needs are occupied with a proper order in this customer portion.

**Step-4:** Develop the Technical portion of QFD matrix. The vertical portion of QFD matrix is related to the technical data. Once the customer needs are identified, then QFD team can establish appropriate design requirements that would satisfy those needs. The team for obtaining the target ratings for each design requirement conducts competitive technical assessment. Inter relationships for customer needs and design requirements are established, which are placed at the middle of the technical portion of the QFD matrix. The co-relationship of the design requirements can be examined.

As a result, the QFD matrix is referred as the House of Quality. Column weights can be calculated, by using the customers' importance level in conjunction with weights assigned to the relationship symbols. The resultant number provides a method of judging the relative importance of each of the design requirements. Column weights can serve as an index for highlighting those design requirements that have the largest relative effect on the product. These column weights are entered at the bottom of the technical portion of the QFD matrix.

**Step 5:** Analyze the QFD matrix once this QFD matrix is completed, the analysis stage begins. The chief focus should be made on the appropriate design requirements to obtain the complete satisfaction of customer needs in order of final ranking. To fulfill each design requirement, all the necessary steps to carryout are analyzed.

## 2.3 Research Design

A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine significance to the research purpose with economy in procedure. A Research design may broadly be applied into this paper is as pursue.

## 2.4 Sample Design

(a) A sample design is a definite plan for obtaining a sample from a given strength of institute. It refers to the technique or the procedure the researcher would adopt in selecting items for the sample. The syllabus will be designed by considering the inputs such as industry requirements, technological developments and students' needs.

(b) After identifying this, the next step is to determine the aims and objectives of the courses and to decide about the intended knowledge and skills to be developed in the students. This would helps to decide about the design of teaching methodology,

student's evaluation methods, students grading pattern and identify the resources needed for teaching learning process.

(c) This decision will lead to the preparation of instructional material and syllabus implementation process. A feedback will be collected from the industries and students and further the process will be continued once again from the beginning. This is a continuous improvement of syllabus design and development process.

(d) The model of syllabus delivery process helps in providing exact framework for the delivery of the newly designed and developed syllabus in the engineering college. The above model explains how the syllabus is delivered in the college. The input of the system is designed and developed syllabus. First block of the model houses the course plan, time table, faculty allotment and teaching materials. The next step or block in the model is controlling and monitoring of teaching and learning process. After establishing excellent teaching and learning environment the next step is to maintain the process on a continuous basis. These three blocks are executed under the supervision and guidance of standards and procedures of quality management objectives of the organization. These three blocks are supported with various resources such as classroom facilities, laboratory set ups, infrastructures, faculties, library and computers. The output of the model is the results achieved. The loop of the model is closed with a feed back to the input.

### **2.5 Collection and Source of Data:**

While making this project the sources used for the collection of data are as follows:

- Primary data
- Secondary data

### **2.6.a. Primary Data:**

In contrast, those data, which are collected at first hand, either by the researcher or by someone else especially for the purpose of the study is known as primary data. Sources of Primary Data are Questionnaire from the concerned quality.

### **2.6.b. Secondary data:**

Any data, which have been earlier for some other purpose, are Secondary data in the hands of the marketing researcher (as where applicable for present study).

#### **Sources of secondary data:-**

- Record of organization.
- Organization magazines.
- Organizational details form internet.
- Database of organization.

#### **Available information from secondary data:-**

- Numbers of employees of organization.
- Salary and incentive plans for the personnel.
- Strength of students
- Transportation service
- Libraries books availability
- Sports facility
- Fees structure

**Data Collection** For the purpose, data after collection has to be presented in the form of tables, diagrams and graphs. It is only after presentation that data can be analyzed, interpreted and inferences can be drawn. The liker scale has been used for getting the responses through questionnaire. A Questionnaire of 35

questions has to be prepared from different Institute of quality dimensions of education for purpose of obtaining information regarding opinion of the employees, staff and students. These questions were asked from various students, staff and other employees in the campus of institutes. Questionnaire were send and distributed up to 500 sheet out of those questionnaire received only 30% of the sheets back that is almost 150 sheets. Out of those questionnaire 2% sheets were of no use because of incomplete nature.

We used 5 point scale, which are assigned to degree of satisfaction level of the respondent with regard to the requirement of the production lines.

1	2	3	4	5
Very least Important	Least Important	Impor- tant	Very Impor- tant	Most Important (On Priority)

The responses were collected and analyzed on the above mentioned 5 point scale. We used weighted score to form Quality matrix.

The customer wants are identified and determined through the survey. These wants are the primary requirements of the customer, namely students and it is shown on the left side of the house of quality; they are communication skills, subject knowledge and creative ability. These wants are further identified through various secondary requirements. They are fluency in language, writing skill, presentation skill, oral communication skill, group discussion, use of technical words and persuasion skill in communication skill requirements. Core subject, fundamental subject, mathematics, interdisciplinary

subject, computer language, technical skill and depth of subject knowledge is the requirement of subject knowledge. Thinking ability, idea generation, practical skill, conceptualization skill, innovative ability and reasoning skill in creative ability requirement.

In the next step the team evaluated each of the customer requirements against process attributes targets. In the relationship matrix of the house, the team evaluated how well its design will meet customer needs and the relationship weightage between what's and how's is given. In the roof of the house, the team developed the relationship between the attributes of process. In the next step the team developed importance ratings for its design attributes in the bottom row of the table. This was done by assigning values (5 for strong relationship, 3 for medium relationship and 1 for weak relationship) to each entry in the relationship matrix and then multiplying each of these values by customer importance ratings. These values in our importance ratings now provides a ranking of how to proceed with process design, with the highest values being the most critical to a successful process which satisfies the customer by providing their needs or requirements.

The QFD process is achieved by QFD matrix called the 'House of Quality' (HOQ). The dimensions of 'quality' are to be shown on one side of the matrix and 'processes' identified on the other side. The processes which affected quality in an institute are:

- Finance
- Total Involvement
- Co-operation
- Stakeholders Participation
- Course content/Design of syllabus
- Sustainability
- Learning Environment

- Partnership/teamwork
- Innovative Culture
- Placement
- Staff Appraisal
- Discipline

According to the definition provided for each enabler, the type of relationship between the enablers and dimension of quality was investigated. The most commonly used categories of 'strong', 'medium', 'weak' and no relationship with the values of 9, 3, 1 and 0 respectively were applied. In order to rank the specified enablers according to students, staff and employers. The importance rating given by each group were considered in the Table.

### 2.7 Mathematical model for result Analysis

The relationship matrix is where the team determines the relationship between customer needs and the company's ability to meet those needs. An HOQ typically contains information on Customer requirements (CRs), relative importance of the CRs (Liang-Hsuan Chen et al. 2003), Design Requirements (DRs) for satisfying the CRs, relationships between CRs and DRs, and correlations between DRs. In conventional QFD applications, a cell (i, j) in the relationship matrix of HOQ (i.e., i-th row and j-th column of HOQ) is assigned 1, 3, 9 to represent a weak, medium, or strong relationship between i-th CR (called CR<sub>i</sub>) and j-th DR (called DR<sub>j</sub>), respectively. The absolute and relative importance's of DRs are computed using the relative importance of CRs and the relationship ratings (i.e., 1-3-9) (Liang-Hsuan Chen et al., 2003)

For each DR, the absolute importance rating is computed as:

$$AI_j = \sum_{i=1}^m W_i R_{ij}, \dots\dots\dots(1)$$

Where AI<sub>j</sub> = absolute (technical) importance rating of DR<sub>j</sub>, j = 1, ..., n,

W<sub>i</sub> = degree of importance (i.e., importance rating) of CR<sub>i</sub>, i = 1, ..., m,

R<sub>ij</sub>= relationship rating representing the strength of the relationship between CR<sub>i</sub> and DR<sub>j</sub>.

The absolute importance rating can then be transformed into the relative importance rating, RI<sub>j</sub>, as

$$RI_j = \frac{AI_j}{\sum_{k=1}^n AI_k}.$$

The larger RI<sub>j</sub> is, the more important DR<sub>j</sub> is. Thus, without consideration of any other constraints (e.g., cost and time), DRs should be incorporated into the product of interest in the order of their relative importance rating to achieve more customer satisfaction.

### 2.8 House of Quality.

The complete house of quality is as shown in below Table. This table show the Institutes rating according the students, employers and staff . The quality dimension are :-

1. Organization & Governance.
2. Financial Resources.
3. Physical Resources.
4. Teaching Learning Processes.
5. Supplementary Process

### 2.9 Table: QFD matrix for Quality dimensions and Enablers

#### Co-relationship Relationship

Positive 9- Strong, 3- Medium,

X- Negative 1- weak, 0- No relation

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Quality Dimension	Characteristics Codes	Importance rating (CR <sub>i</sub> )	No. of Enablers ( RIj )												
Organization & Governance		Students	Staff	E m - ployers	1	2	3	4	5	6	7	8	9	10	
	Top Management Commitment	0.31	0.26	0.27	3	9	3	1	9	3	0	0	1	1	
	Education Policy	0.05	0.06	0.12	0	3	0	3	9	1	1	3	0	0	
	Monitoring	0.45	0.13	0.05	3	3	3	1	1	3	3	3	3	1	
	Leadership	0.43	0.25	0.10	1	9	3	3	9	3	1	1	0	3	
	Self Assessment	0.35	0.15	0.53	3	1	3	1	0	0	3	1	3	0	
	Strategic Planning	0.29	0.12	0.24	1	3	1	0	1	0	3	3	1	1	
Financial Resources	Fund	0.59	0.23	0.07	1	3	0	1	9	0	0	0	1	1	
	Expenditure per students	0.67	0.06	0.29	0	0	1	3	9	1	0	3	0	0	
	Fee structure	0.34	0.13	0.28	1	3	0	1	9	0	0	0	1	0	
	Cost of course	0.43	0.35	0.34	1	0	0	0	9	3	0	0	0	1	
	Income Source	0.68	0.15	0.34	0	0	3	0	9	0	0	0	1	0	
Physical Resources	Computers	0.41	0.35	0.17	3	9	3	0	9	9	1	0	3	3	
	Infrastructure Building	0.19	0.13	0.24	0	1	0	1	9	1	0	0	3	0	
	Library space & Management.	0.12	0.03	0.21	3	3	9	9	3	9	1	0	1	1	
	Auditorium	0.02	0.02	0.03	1	3	1	3	3	0	3	1	1	3	
	Health Finances	0.04	0.12	0.04	1	3	0	1	9	0	1	1	3	0	
	Hostel mess	0.09	0.02	0.04	3	0	3	3	9	0	0	1	1	3	
	Class room offices	0.11	0.12	0.09	1	3	1	3	1	3	1	0	0	3	
	Sports Complex	0.04	0.06	0.12	3	1	3	1	1	1	3	3	3	1	
Transportation	0.05	0.07	0.21	3	3	3	3	1	1	1	9	9	3		
Teaching Learning Processes	Organization Culture	0.01	0.15	0.08	3	9	3	9	3	9	3	1	9	3	
	Quality Assurances& Audit	0.06	0.07	0.06	9	9	9	3	9	3	1	9	3	9	
	Communication Indoor Motion	0.06	0.03	0.04	3	3	1	1	1	1	3	3	1	1	
	Courses Delivery	0.24	0.15	0.04	3	3	3	9	1	3	9	1	3	1	
	Course / Study material	0.19	0.13	0.02	1	3	3	3	3	9	3	9	3	1	
	Information technology & multi media	0.05	0.04	0.12	1	3	1	3	1	3	9	1	3	3	
	Quality in teaching learning	0.23	0.16	0.32	9	3	3	3	1	3	3	3	3	3	
	Students Satisfaction	0.38	0.23	0.36	9	3	9	3	0	1	3	3	9	1	
Supplementary Process	Industry Institute Instruction	0.08	0.01	0.22	1	1	3	3	0	3	3	3	1	9	
	R & D Culture	0.44	0.32	0.04	1	3	0	9	1	1	0	3	3	0	
	Journal available	0.08	0.25	0.04	1	1	1	3	1	0	1	1	9	3	
	Market orientation / Focus	0.08	0.05	0.09	3	0	3	3	0	1	3	3	1	0	
	Alumni	0.04	0.05	0.02	3	1	3	1	0	3	9	1	3	3	
	Quality of service	0.26	0.24	0.34	3	3	3	1	1	3	9	9	3	1	
Weight age															
Students (AIj)					16.6	23.4	18.1	17.6	41.9	18.5	13.2	14.7	16.6	09.2	
Staff (AIj)					13.5	17.2	10.8	12.1	22.3	12.4	09.3	09.4	13.6	07.2	
Employer AIj)					14.0	14.9	15.4	12.1	23.4	11.7	12.0	12.3	14.3	08.3	
Total (RIj)					14.7	18.5	14.8	13.9	29.2	14.2	11.5	12.1	14.9	08.2	
Ranking					5	2	4	7	1	6	9	8	3	10	



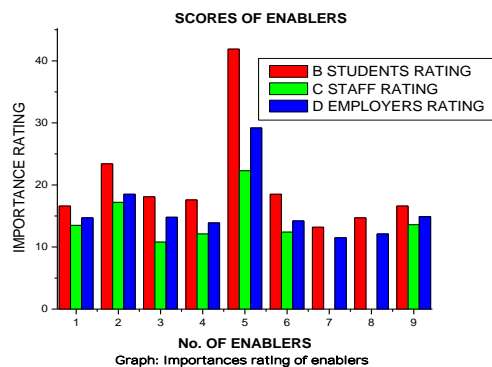
### 3. RESULT AND DISCUSSION

From the house of quality, on the basis of calculation the result of the QFD application shows very high score for 1st enablers; it can be attributed to the fact that finance resources and organization & Governance are the most important aspect from the customer point of view for each process.

The team determines how the organization is going to translate those customer wants into process design and process attribute targets. These are classroom teaching, practical sessions and library facility. These how's are entered across the top portion of the house of quality. These characteristics are further identified as teachers, curriculum, facilities, interactions, teaching aids and evaluation in classroom teaching. Project work, case study, industrial training, live demonstration, field training and apprenticeship are the primary procedure of practical works. Books, journals and magazines, Internet facilities, timings of the library, accessibility of the library books and periodicals and news papers availability in the library facility.

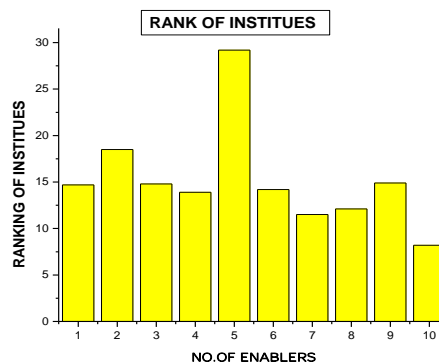
The implementation of QFD in education system show the rating of students, staff and employers according to quality dimension of 10 enablers. The following graphs show scores of enablers and ranking of institute. We use QFD in education system for improving the quality of education.

**Graph 1:** shows importance rating of enablers with respect to students, staff and employers. No. of enablers 5 show the highest rating given out by the students, staff and employers because of strong financial resources, top management commitment, better education policy.



Graph 1: Importance rating of students

**Graph 2:** shows ranking of institutes with respect to students, staff and employers. No. of enablers 5 show the highest rating given out by the students, staff and employers because of strong financial resources, top management commitment, better education policy.



Graph 2: Rank of institutes

The above graph show the qualities of educational institutes are depends on different parameters, the rating and ranking of enables improved by improving the quality of parameters.

### 4. CONCLUSION

QFD is a helpful tool to realize and investigate the student's needs and opportunity, later to transfer them into improvement of quality education. In this thesis, it is tried to focus on the importance of the rating assigned to student's requirement in institution to improve the quality of education. It is a system to be implemented in education field in

institution, QFD does not system to replace the existing organization system by any means, but rather support the organization's system. It is tried to provide a step-By-Step approach to do that and we also showed how consistency in the QFD team's judgment could be tested.

The quality dimensions and enablers identified show the fundamental requirement and their relationship. The framework developed with the application of QFD in an educational institute will help in establishing the present improvement and set priorities for future scope of improvement. The utmost advantage of implementing the QFD approach in an educational institution is that it considers both physical and intangibles aspects, and results can be utilized to have academic reforms in any educational institute. In the present work importance rating is calculated by pair wise comparison, this further opens the scope of future research by having a survey among the stakeholders and finding out the actual importance rating/ranking and validating those results with the present one. The educational institutions, which provide to the human resources development component of the above sectors, have yet to realize the impact of market forces. Especially, the technical institutions are expected to set an example in propagating quality awareness, teamwork, and optimization of productivity and manage the competitive environment and encourage team spirit among all concerned.

QFD can help to identify key product or process concerns with respect to customer requirements. QFD uses the work "backwards" towards design specifications. This is different from the current means of designing, where specifications are usually set first and then the process advances forward until the product is formed. Sometimes the end result is functional, but not necessarily what the customer wants. QFD is simply a planning tool. It begins

with market research that identified just what the customers like, which is called the Voice of the Customer (VOC). It is through the QFD process that the VOC is translated into system and curriculum requirements.

QFD is a tool for continuous improvement and problem solving. The QFD analysis in syllabus development of engineering education and the models of syllabus design and delivery will definitely help the academic administrators to implement in their syllabus development process. The implementations of QFD for improving the service quality of education system are studied thoroughly. Complete literature study for QFD's application in education sector is studied in detail. Gathering voice of customer is a very important task in QFD implementations. The various customers in education system are reviewed

Quality of higher education is its ability to produce a steady flow of people with high intelligence and commitment to learning that will continue the process of transmission and advancement of knowledge concerned areas of quality improvements in teaching and also highlighted some benchmarks where other institutions are more productive.

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