UNIT-4

TQM TOOLS AND TECHNIQUES-II

4.1 QUALITY CIRCLES

What is quality circle?

- A quality circle is also known as Quality control Circle (QCC), is a small, voluntary group of employees and their supervisor, comprising a team of about 6 to 10 members from within same work area ding smaller works, that meet regularly to solve problems relating to their job scope or work place.
- In other words, a quality circle is a small group of people who meet together on a regular basis to identify, analyze and solve quality, cost reduction or any other problem in their work area, leading to improvement in their total performance and enrichment of their work life.
- Quality circle is a participative management system in which workers make suggestions and improvements for the betterment of the company.
- Other names of quality circles are small groups, action circles, excellence circles, human resources circles, and productivity circles.

History of Quality circles:

- Quality circles where first established in Japan in 1961 and Prof. Kaoru Ishikawa has been credited with their creation.
- The movement of quality circle in Japan was coordinated by the Japanese Union of Scientists and Engineers (JUSE).
- The use of quality circles then spread beyond Japan. Quality circles have been implemented even in educational sectors in India and QCFI(Quality Circle Forum Of India) is promoting such activities.

Concept Of Quality Circle(Philosophy Of quality circle)

The concept of quality circle is primarily based upon recognition of the value of the workers as a human being, as some one who willingly activises on his job, his wisdom, intelligence, experience, attitude and feelings. The quality circle respects human dignity and motivates employees at gross root levels to use their brain power along with their physical effort.

Quality circle concept has the following three major attributes:

1.Quality circle is a form of participation management.
2. Quality circle is a human resource development technique.
3. Quality circle is a problem solving technique.

Objectives of Quality Circles

- There are number of objectives that can be accomplished in the quality circle program. the objectives of quality circle program is given below

1. Self development
2. Mutual development
3. Quality
4. Communication
5. Waste reduction
6. Job satisfaction
7. Cost reduction
8. Productivity
9. Safety
10. Problem solving
11. Team building
12. Link all People
13. Involvement
14. Participation
15. Reduce absenteeism

The below table presents objectives of quality circle program.

S.NO	Objectives of quality circles
1	To promote job involvement
2	To create problem solving capabilities
3	To improve communication
4	To promote leadership qualities
5	To promote personal development
6	To develop[a greater awareness for cleanliness
7	To develop greater awareness for safety
8	To improve morale through closer identity of the employee objectives with organization's objectives.
9	To reduce errors
10	To enhance quality
11	To inspire more effective teamwork
12	To build an attitude of problem prevention
13	To promote cost reduction
14	To develop harmonious manager, supervisor and worker relationship
15	To improve productivity
16	To reduce downtime of machines and equipment
17	To increase employee motivation

Characteristics of quality circles

Some of the important characteristics of quality circles are as follows:

i. The optimum number of employees in any quality circle is between 6 to 10.

ii. The quality circle should have a homogeneous group where participation members must be from within the same department or work area.

iii. The participation of quality circle members should be voluntary. No compulsion or pressure is to be brought on employees to join or not to join the quality circle.

iv. The members of quality circle should meet regularly once in a week for an hour after their working hours or during working hours to discuss the problems related to their work and find solutions to the solutions.

v. The members of the quality circle should themselves to identify the problems through various techniques such as brainstorming cause-effect diagram, pareto analysis, histograms, etc.

vi. Quality circles address the two types of problems:

(a) Those concerned with the personal being of the worker(such as working conditions, safety, work relations, house keeping, etc)

(b) Those concerned with the well-being of the company (such as quality and productivity related problems)

Vii The members of quality circle should be trained in statistical problem solving tools so that they can identify, analyze and resolve work related problems.

Viii Training and quality control activities must be carried out on company time.

Ix Final recommendations of the quality circle must be acceptable to management before they are made effective

Structure Of Quality circle

- A quality circle has an appropriate organizational structure for its effective and efficient performance. It varies from industry to industry, organization to organization.
- A typical structure of quality circle is depicted in figure below

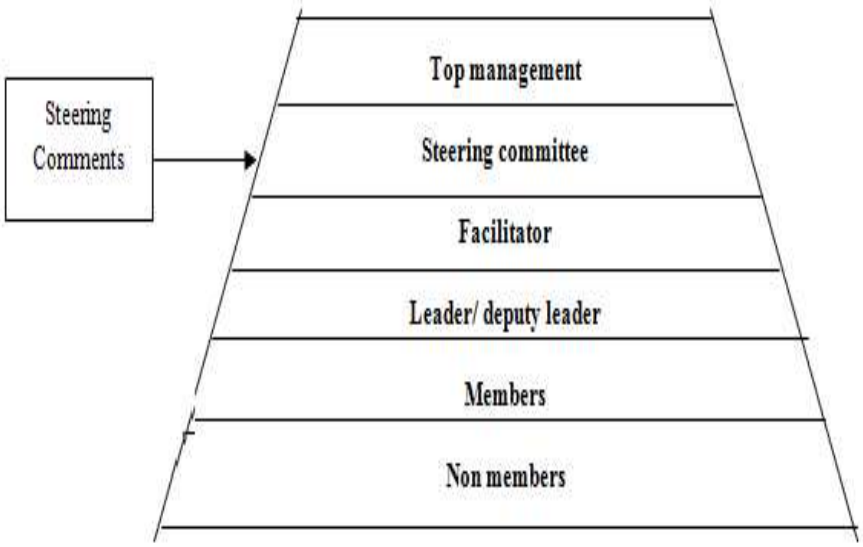


Figure: QC structure

Elements of Quality circle

The structure of quality circles consists of the following statements

1. Top management
2. Coordinator
3. Steering committee
4. Facilitator
5. Leader
6. Members
7. Non-Members

1. Top management

- Though not directly a part of a formal quality circle structure, top level management influences the successful implementation of the concept.
- A quality council collects information about the program and reports it to the Managing director. The top management has to convey its policy of quality to its employees and encourage them to form quality circles.
- It should extent its support and more importantly make it visible so that even, workers in the lowest level know what the top management is doing for them.
- It should also be lenient enough to financially support quality circle projects.

2. **Coordinator**
    - A senior manager acts as a coordinator. He arranges steering committee meetings and is responsible for proper documentation of various activities.
    - He organizes training programs whenever needed.
    - Overall, he is responsible for conducting seminars, presentations, and case studies and publishing periodicals to ascertain that the work of the quality circle is recognized.
3. **Steering committee**
    - A steering committee is a group of members working under the chairmanship of the CEO with functional heads as members.
    - The members of steering committee are responsible for proper implementation of the quality circle in their respective areas. They make the facilitators under them accountable to them. The CEO reviews the reports of the members activities and makes suggestions.
4. **Facilitator**
    - A senior person in a specific area acts as a facilitator. He bears the responsibility to catalyze and motivate the quality circles.
    - He acts as a guide or mentor for effective operation of quality circles.
    - Further, he also elucidates the functioning of the quality circles in his area in steering committee meetings.
5. **Leader/ Deputy leader**
    - The members of the circle chose a leader with due care and consensus. As the leader shapes the circles effectiveness, training him is vital.
    - A good leader should have the ability to motivate members of the team, conduct meetings, and coordinate efforts apart from involving all the members in the quality philosophy. He should strive to avert conflicts and ensure quality oriented teamwork.
6. **Members**
    - Members of a circle should not be forced to join a quality circle, instead they should join of their own interest.
    - They need to have an understanding of the functioning of quality circles.

- They should encourage other employees to participate in the movement, zealously involve themselves in the quality improvement programs, implement solutions and give presentations effectively.

7. Non -Members

- Non-members are important because they support circle members externally

  Also, if they realize the benefits of forming circles, they will willingly participate in the activities. Hence, non-members are often considered prospective members.

Though quality circles essentially comprise a small group of workers, the involvement of all employees of an organization at some point is critical. Following a structural hierarchy will ensure a smooth flow of the circle's activities.

Roles and responsibilities of quality circle elements

The roles and responsibilities of the various members and committee of a quality circle programme are summarized below

1. Role of quality circle members
   - Attend all possible meetings
   - Offer views, opinions and ideas freely and voluntarily in problem solving
   - Participate actively in the group process
   - Contribute to find solutions to problems
   - Contribute to implementing solutions
   - Attend training seriously with a receptive attitude
   - Assist leader/ deputy leader in circle activities.
2. Roles of quality circle leader
   - Conducts meetings regularly
   - Moderates in meeting
   - Involves all the members
   - Keeps the cohesiveness of the group
   - Makes the necessary facilities for enabling quality circle to perform without constraints
   - Takes the team towards the goal
   - Takes acre of:
     I. Task behavior of the group
     II. Team maintenance
     III. Disruptive or negative behavior to the management
   - Presents solutions/ suggestions to the management
   - Keeps the circles informed on the status of previously submitted suggestions.

- Trains the members in various problem solving techniques.

3. Roles of facilitator

- Coordinates the work of several quality circles through leaders
- Serves as a resource for the circle
- Works closely with steering committee
- Trains members by assisting leaders whenever required
- Arranges management presentations of his circles
- Coordinates and monitors all activities

4. Roles of coordinator

- Registers the circle
- Interacts with all
- Convenes steering committee meetings
- Maintains records, organizes systematic documentation
- Arranges management presentation
- Organizes various training programmes, including exposure programme
- Arranges presentation of case studies in sister units
- Publishes periodicals
- Organizes six monthly, annual conventions, develops facilities for the programmes
- Arranges periodical survey
- Helps in deputing people for seminar, convention, outside convention, presentation etc.
- Prepares a budget for the functioning of quality circle
- Helps in solving problems encountered in the implementation of quality circle.

BENEFITS OF QUALITY CIRCLES

The potential benefits of quality circles can be presented under three categories. They are

1. Quality circles effects on individuals characteristics

I. QCs enable the individual to improve personal capabilities
II. QCs increase the individuals self respect
III. QCs help workers change certain personality characteristics

2. Quality circles effects on individuals relations with others

I. QCs increase the respect of the supervisor for the workers
II. QCs increase workers understanding of the difficulties faced by supervisors
III. QCs increase management's respect for workers

3. Quality circles effects on workers and their attitudes toward the company

   I. QCs change some workers negative attitudes
   II. QCs reduce conflict stemming from the working environment
   III. QCs help workers to understand better the reasons why many problems cannot be solved quickly
   IV. QCs instill in the worker a better understanding of the importance of the product quality.

4.2 QUALITY FUNCTION DEPLOYMENT

QPD is a systematic and organized approach of taking customer needs and demands into consideration while designing new products and services.

QPD focuses on the voice of the customer. So QFD is sometimes called as customer driven engineering.

Definition:

QFD is a system for translating customer requirements in to appropriate requirements at every stage, from research through product design and development to manufacture, distribution, installation and marketing sales and service.

Objectives of QFD

- To identify the true voice of the customer and to use this knowledge to develop products which satisfy customers.
- To help in the organization and analysis of all the pertinent information associated with the project.

The voice of customer:

QFD begins with marketing to determine what exactly the customer desires from a product. The various sources for determining customer expectations are focus groups, surveys complaints, consultants and standards.

House of Quality:

The House of quality is a primary planning tool used to translate the voice of customer into design requirements that meet specific target values.

Structure of house of quality:

The structure of QFD looks like the structure of a house. Hence it is called the 'House of quality'.

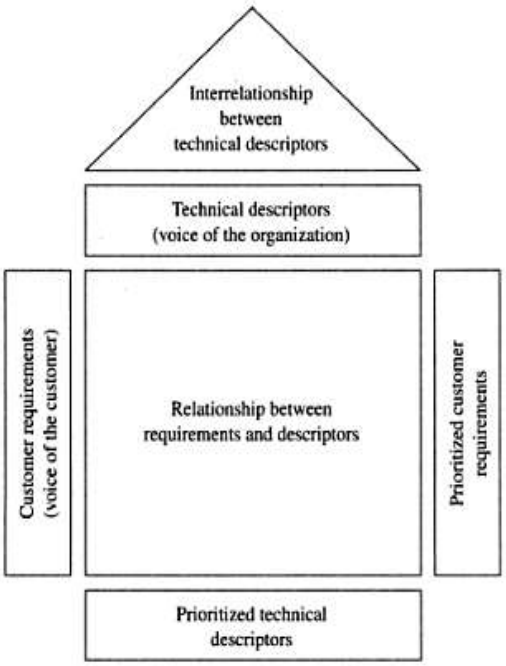


Figure: House of quality

The part of house of quality are described as follows

Exterior walls of the house	Customer requirements	Right side wall	List of the voice of the customer
		Left side wall	Prioritized customer requirement (Planning matrix)
Second floor of house	Technical descriptor (Voice of the organization) Engineering characteristics Design constraints and parameters		
Interior walls of the house	Relationship between the customer requirements and technical descriptors.		
Roof of the house	Interrelationship between technical descriptors		
Foundation of the house	Prioritized technical descriptors		

This is the basic structure for the House of quality. Once this format is understood, any other QFD matrices are fairly straight forward.

Building a house of quality:

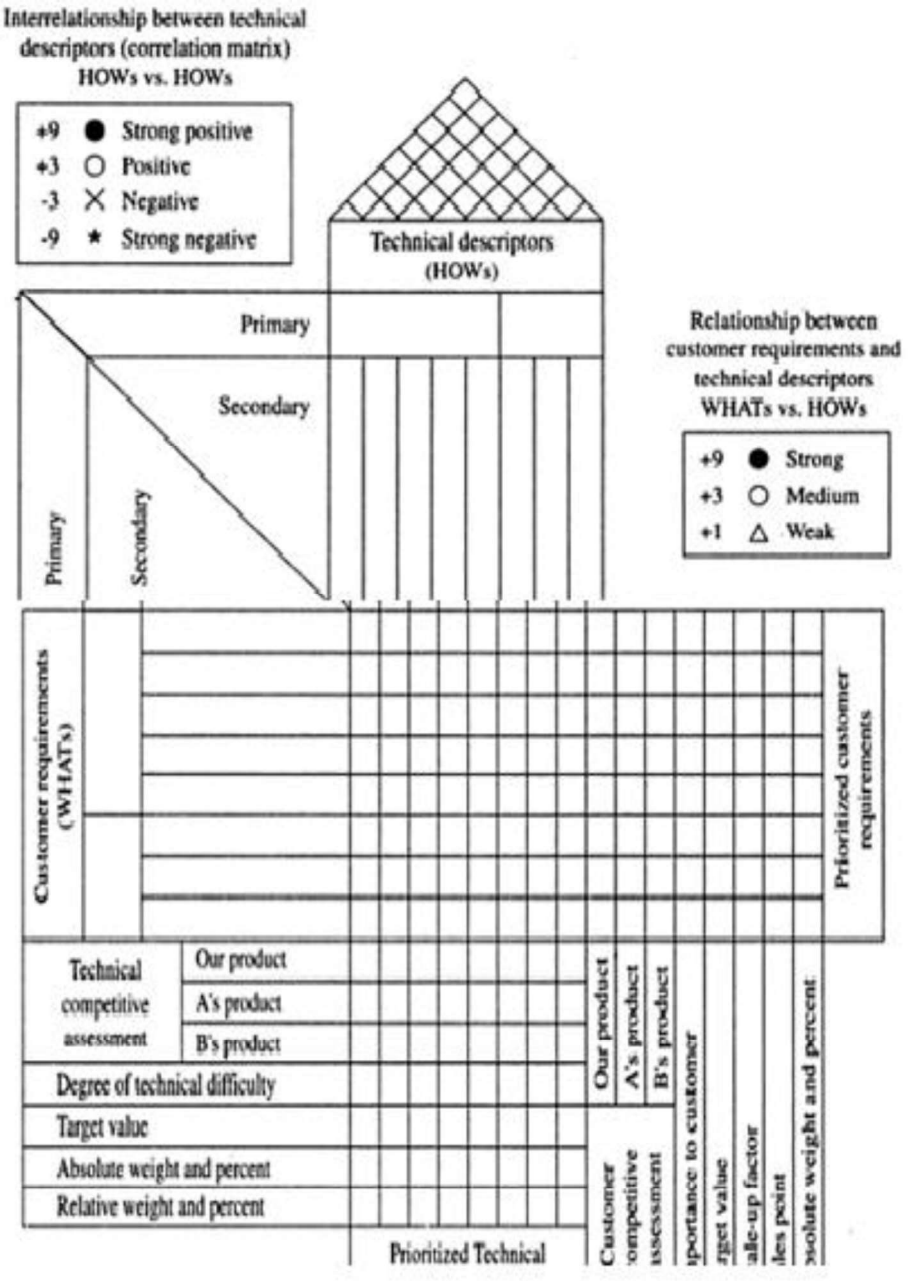


Figure: basic house of quality matrix

Building the House of quality consists of 7 steps. They are,

Step1: Identify customer requirements(WHATS)
Step2: Identify the technical descriptors (HOWS)
Step3: Develop a relationship matrix between WHATS and HOWS
Step4: Develop an inter relationship matrix between HOWS
Step5: competitive assessments
Step6: Develop prioritized customer requirements
Step7: Develop prioritized technical descriptors.

The house of quality helps marketing to understand the customer needs. Moreover it gives top management the needful strategic direction.

1.**List customer requirements(WHATS)**

- Define the customer and establish full identification of customer wants & dislikes.
- Measure the priority of these wants and dislikes using weighting scores.
- Summarize these customer wants into a small number of major wants supported by a number of secondary & tertiary wants.

2. Lists technical descriptors (HOWS)

- Translate the identified customer wants into corresponding 'HOWS' or design characteristics.
- Express them interns of Quantifiable technical parameters or product specifications.

3. Develop a relationship matrix between WHATS and HOWS

- Investigate the relationship between the Customer's Expectations (WHATS) and the technical descriptors

(HOWS)

- If a relationship exists, categories it as strong, medium or weak.

4. Develop an inter relationship matrix between HOWS

- Identify any interrelationship between each of the technical descriptors.
- These relationships are marked in the correlation matrix by either positive or negative. Here a positive correlation represents a strong relationship and a negative correlation represents a weak relationship.

5. Competitive Assessments

- Compare the performance of the product with that of competitive products.
- Evaluate the product and note the strong & weak points of the product against its competitors product according to the customer.
- This competitive assessment tables include two categories: Customer assessment and technical assessment.

6. Develop prioritized customer requirements

- Develop the prioritized customer requirements corresponding to each customer requirements in the house of quality on the right side of the customer competitive assessment.
- These prioritized customer requirements contain columns for importance to customer, target value scale up factor, scale point and an absolute weight.

7. Develop Prioritized technical descriptors

- Develop the prioritized technical descriptors corresponding to each technical descriptors in the house of quality below the technical competitive assessment
- These prioritized technical descriptors include degree of technical difficulty, target value and absolute and relative weights.

QFD process

- The QFD matrix(house of quality) is the basis for all future matrices needed for the QFD method.
- It is necessary to refine the technical descriptors further until an actionable level of details is achieved.
- The process is accomplished by creating a new chart in which the HOWS (technical descriptors) of previous chart became the WHATS(customer requirements) of the new chart
- This process continues until each objectives is refined to an actionable level.
- The HOWMUCH (Prioritized technical descriptors) values rare usually carried along to the next chart to facilitate communication

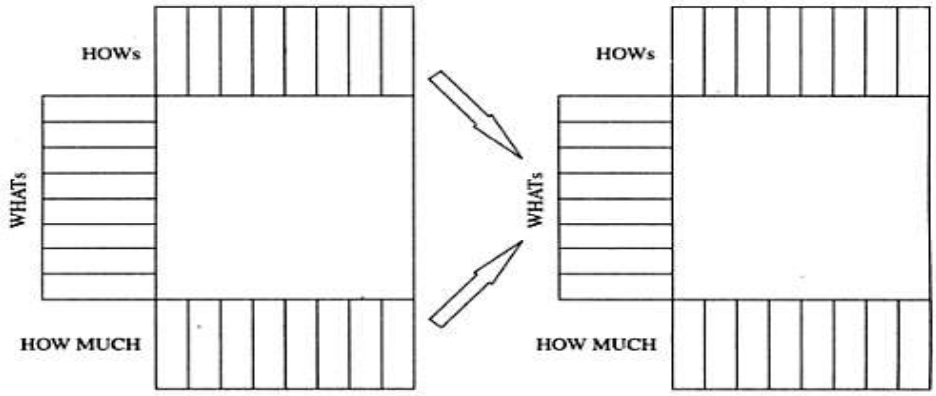


Figure: Refinement of the QFD chart

An example of the complete QFD process from the beginning to the end is shown in figure. There are 4 phases of QFD process

1.Product planning

- Centered around the house of quality
- Defines customer wants in relation to the product.

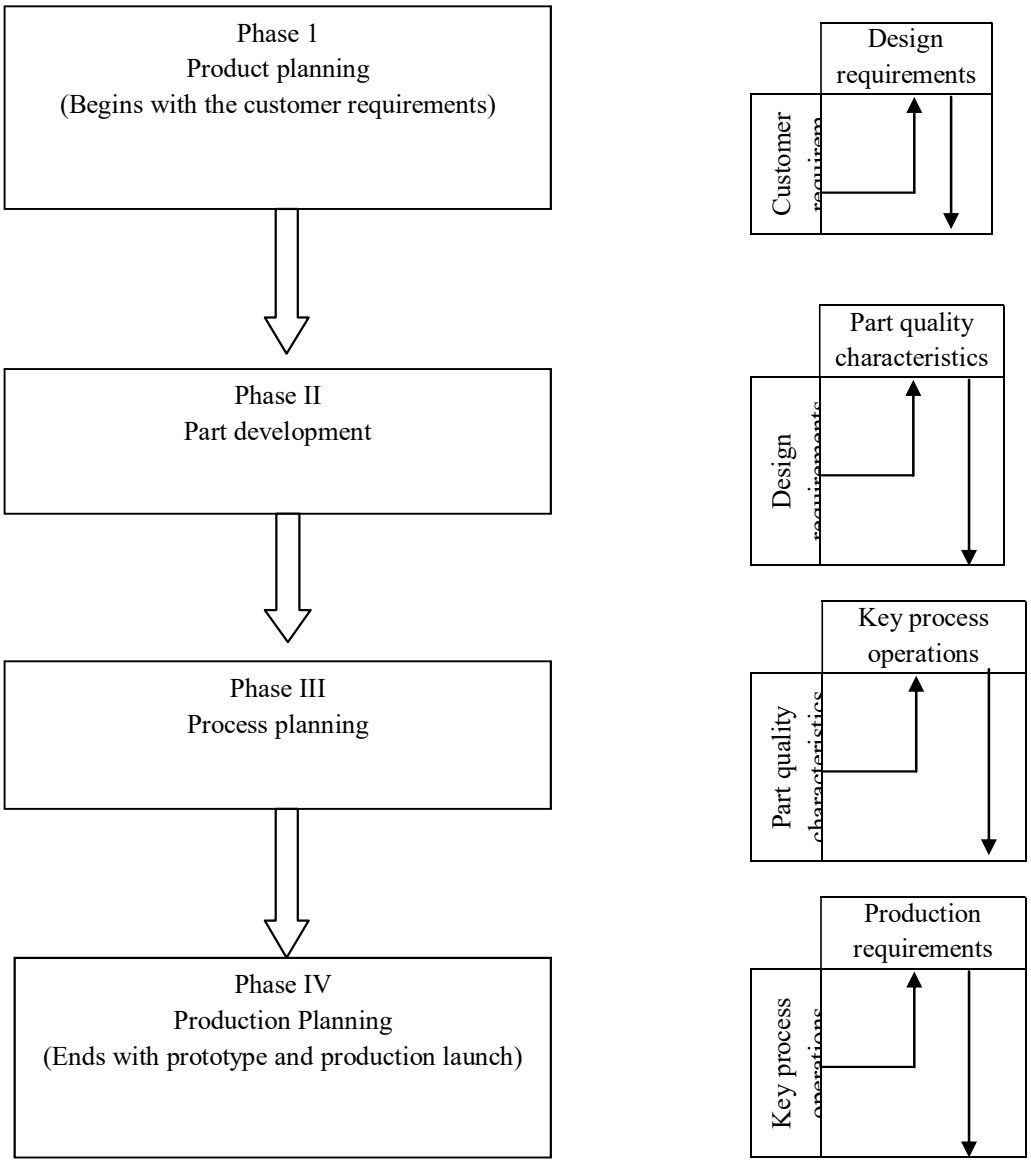


Figure: The QFD process

2. Part development

- Product engineering functions
- Design characteristics are transferred to part characteristics

3. Process planning

- Moves form design to manufacturing operations.
- Process for improvements is developed.
- Involves floor level personnel.

4. Production planning

- Employees on the floor contribute knowledge.
- Employee activities interact to achieve expectation

Benefits of QFD

QFD was originally implemented to reduce start- up costs. Organizations using QFD have reported a reduced product development time.

Improves customer satisfaction

The entire exercise of QFD is based on the voice the customer. The customer requirements are covered into Product & process characteristics, customer satisfaction is desired.

Reduces implementation time

The product is made available to the customer at the earliest possible time due to drastic reduction in rework and redesign.

Promotes frame work

This happens due to proper communication of the voice of the customer to all levels/ functions in the organization eliminate misinterpretations and misunderstandings.

Provides documentation

As all the data is documented , it can be effectively used for future design and process improvement.

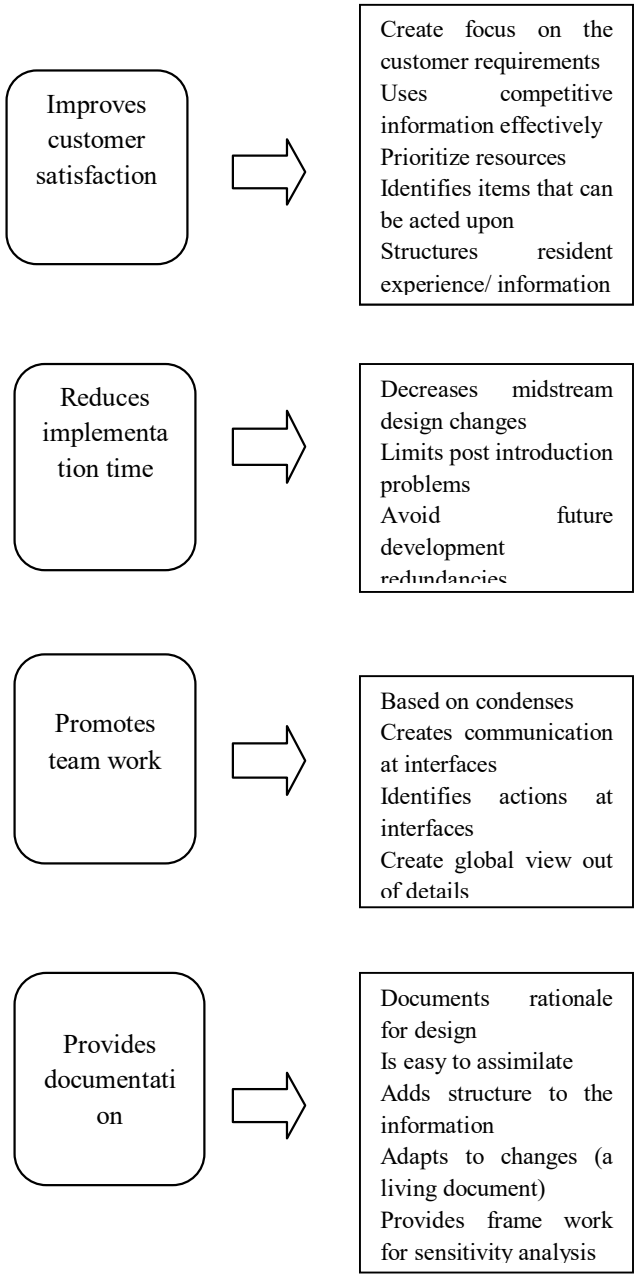


Figure: Benefits of QFD

4.3 TAGUCHI'S QUALITY LOSS FUNCTION

Taguchi has defined quality as the loss imparted to society from the time a product is shipped.

- Social losses include
  - Failure to meet customer requirements.
  - Failure to meet ideal performance
  - Harmful side effects

The loss-to- society concept can be illustrated by an example associated with the product of vinyl covers to protect materials from the element(figure)

- The figure shows three stages in the evolution of vinyl thickness

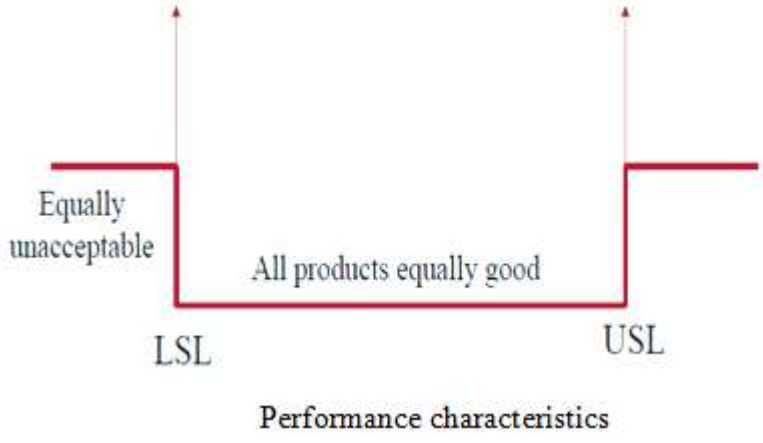
1.The process is just capable meeting the specifications(LSL &USL). It is on the target τ

2. After considerable effort, the production process was improved by reducing the variability about the target .

- 3.In an effort to reduce the production costs the organization decided to shift the target closer to the LSL.
- This action resulted in a substantial improvement by lowering the cost to the organization
- Out of specification is the common measure of quality loss. It implies that all product that meet specifications are good, whereas that do not are bad.

Nominal –the- best

Although Taguchi developed more than 68 loss functions, many situations are approximated by the quadratic function which is called the nominal-the- best type.



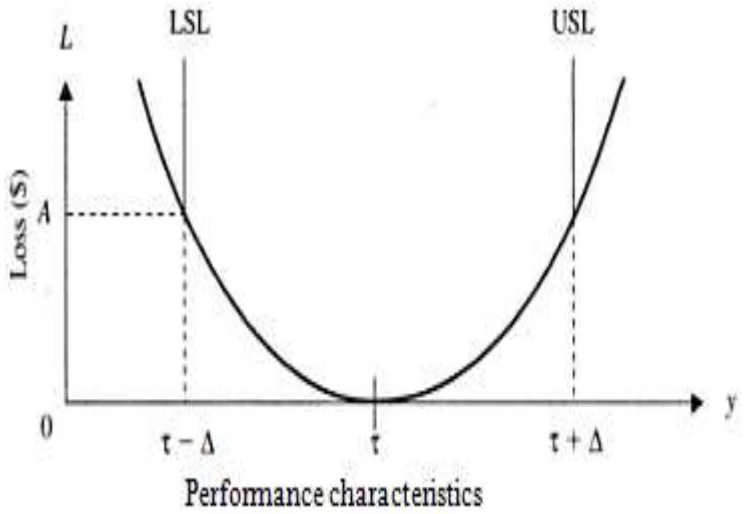


Figure: Taguchi's quadratic loss function for nominal –the- best

The quadratic function is shown in figure. In this situation, the loss occurs as soon as the performance characteristic, y, departs from the target τ. At τ, the loss is Rs. 0. At LSL (or) USL, the loss is Rs. A. The quadratic loss function is described by the equation

$$L = k (y - \tau)^2.$$

Where,
L- Cost incurred as quality deviate from the target
y- Performance characteristics
k-quality loss coefficient
τ -target

The loss coefficient is determined by setting $\Delta = (y - \tau)$, the deviation from the target. When Δ is the USL (or) LSL, the loss to the customer of repairing (or) discarding the product is Rs. A. Thus,

$$K = A / (y - \tau)2 = A / \Delta 2 .$$

Example:

If the specifications are 10±3 for a particular quality characteristics and the average repair cost is $230, determine the loss function. Determine the loss at y= 12

$K = A/\Delta^2 = 230/32 = 25.6$

Thus $L = 25.6(y-10)^2$ and at $y = 12$

$L = 25.6(y-10)^2 = 25.6(12-10)^2$

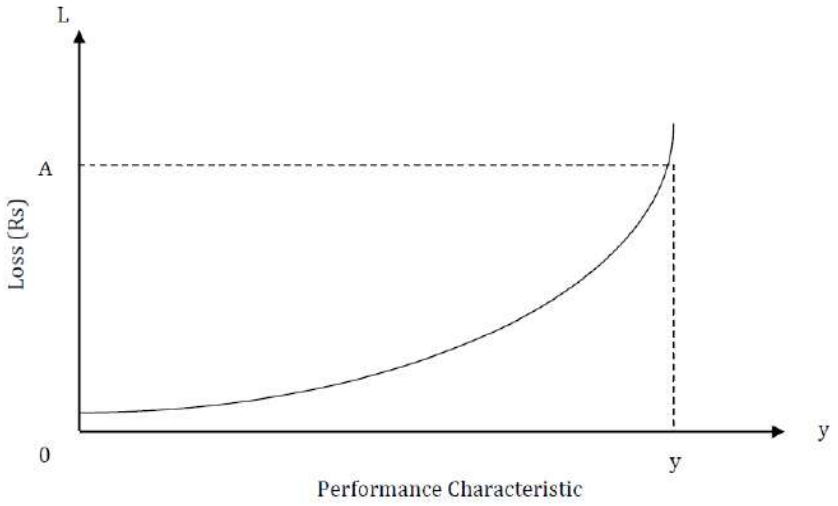
$= \$102.40$

Other Loss Function:

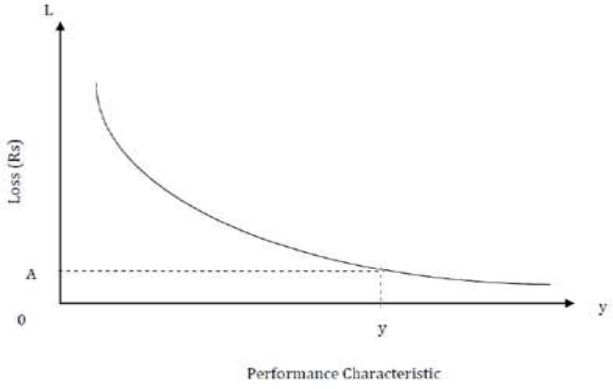
There are two other loss function that are,

- Smaller-the-better
- Larger-the –better

The target value for smaller-the-better is O and these are no negative values for the performance characteristics.



(a) smaller –the- better



(b) Larger- the –better

Figure: smaller –the- better and Larger- the –better Loss functions

The target value for larger-the-better is ∞ which gives zero loss. These are no negative values and the worst case is at y=0.

4.4 TOTAL PRODUCTIVE MAINTANANCE

TPM is keeping the current plants and equipment at its highest production level throughout cooperation of all areas of the organization.

Analyzing TPM into three words.

T(Total)- Everyone from maintenance and production area working together.

P(productivity)- Production of products serves that meet or exceed the expectation of the customer.

M(Maintenance)- Ensuring that the plant and equipment are kept in a conduction that matches which is better than its original conduction.

The Overall goals of TPM are:

1. maintaining and improving equipment capacity.
2. .maintaining equipment for life.
3. Using support from all areas of the operation
4. Encouraging input from all employees
5. Using teams for continuous improvement

Improvement teams

- One of the first steps for the team is to identify the current status
- Six major loss areas need to be measured and tracked.
- Downtime losses

1. Planned
   a) Start-ups
   b) Shift changes
   c) Coffee and lunch breaks
   d) planned maintenance shut downs
2. Planned downtime
   a) Equipment breakdown
   b) Change over's
   c) Lack of materials
3. Reduced speed losses

- Idling and minor stoppages
- Slow-downs

4. Poor quality losses
    - process non conformities
    - Scrap

Downtime losses are measured by equipment availability using the equation

$$A = \frac{T}{P} \times 100$$

Where

A-Availability

T-Operating time

P-Planned operating time

D-downtime

- Reduced speed losses are measured by tracking performance efficiency using the equation

$$E = \left(\frac{C \times N}{T}\right) \times 100$$

where

E- performance efficiency

C- Theoretical cycle time

N- Quality

Poor quality losses are measured by track the rate of quality products produced using the equation

$$R = \left(\frac{N - Q}{N}\right) \times 100$$

Where,

R- rate of quality products

N- processed amount

Q- non conformities

- Equipment effectiveness is measured as product of the decimal equivalent of the three previous materials using the equation

$$EE = A \times E \times R$$

Where,

EE =Equipment effectiveness

4.5 COST OF QUALITY

Quality costs are defined as those costs associated with the non- achievement of product /service quality as defined by the requirements established by the organization and its contracts with customers and society. Quality cost is a cost for poor product of service.

Quality cost is the cost to the company of not doing things right the first time. Quality cost is measure of the efficiency of an organizations work related to quality.

Quality cost are those categories of that are associated with producing, identifying, avoiding or repairing products that do not met its requirements.

Management techniques

Quality cost is used by the organization for its quality improvement, customer satisfaction increase market share & profit enhancement.

Quality cost identifies opportunities for quality improvement and establish funding. Once the quality correction has been completed, it will generate more money.

Quality cost identifies opportunities for quality improvement and generate funding. Quality cost is reduced on the cost of poor quality. So every rupee served on quality cost have a positive effective on profit.

Quality cost program is the identification of the hidden and buried cost in all functional areas.

ELEMENTS OF QUALITYCOST(Categories)

The following are the 4 major categories associated with quality management

1. Prevention Cost
2. Appraisal Cost
3. Cost of internal failures
4. Cost of external failures.

1. PREVENTION COST

Prevention cost are associated with preventing defects before they happen. They include redesigning the process to remove causes of poor quality, training the employees etc.

2. Appraisal cost

These are incurred in assessing the levels of quality attained by the operating system. They include the cost of detecting the defects.

As the preventive measures improve quality, appraisal costs decreases, because fewer resources are needed for quality inspections.

3. Internal failure cost

These results from defects that are discovered during the production of a product or service. The costs include the cost of producing the items that are scrapped, the cost of repairing, reworking, retesting etc;

This fall under two categories

i. Losses which are incurred if a defective item must be scrapped.

ii. Rework costs which are incurred if the item is re-routed to correct the defects.

4. External failure cost

They arise when a defect is discovered after the customer has received the product or service.

The cost includes warranty cost, the cost of product returns or recalls etc.

Sub categories	Explanation
Quality planning and engineering	These are costs incurred for creating quality plans, inspection plans, etc., and all activities of the quality assurance function. Those also include the cost of manuals and procedures to communicate these plans.
New product review	These are the quality costs incurred during the development and reproduction stages of a new product. It includes costs involved in the preparation of proposals, evaluation, and design with respect to quality etc.,
Product/ Process design	These are costs associated with the design of a product and selection of production methods with an aim of improving the quality of the product
Process control	These are costs associated with process control techniques in order to reduce variations and

	improve quality
Training	The cost incurred for conducting formal training programs to improve quality
Quality data acquisition and analysis	It is the cost associated with having a quality data system in order to collect data on product and process performance

Appraisal Costs

- Components and materials purchased are measured, evaluated and audited to make sure that it conforms to standards that have been set. Cost associated with these activities are termed as appraisal costs.
- The subcategories of these costs have been briefed below

Subcategories	Explanation
Inspection and test of incoming material	It is the cost associated with respect to inspection and testing of all vendor supplied items/ materials
Product inspection and test	These are cost of activities carried out for checking the product at various stages of manufacturing (including acceptance testing till the product is given to the customer) for assuring conformance to standards
Materials and services consumed	It is the cost associated with materials and products used in destructive tests
Manufacturing accuracy of test equipment	It is the cost associated with calibrating measuring instruments and maintaining them

Internal failure costs

- Internal failure costs are those costs incurred due to the failure of a product/ component or service before the product is delivered to the customer
- The subcategories of these costs have been briefed below

Subcategories	Explanation
scrap	If a defective product cannot be repaired economically, the net cost associated due to this is called scrap cost.
Rework	It is the cost involve in correcting nonconforming items so that it meets specifications
Retest	It is the cost associated with re inspection

	/ retesting of items on which rework has been carried out
Failure analysis	It is the cost incurred in finding the various causes of product failure.
Down time	It is the cost of idle time of production facilities due to the con-conformance of certain requirements for production such as non-conforming raw materials, etc
Down grading	It is the cost incurred due to the price difference between normal selling price and a selling price obtained for a product which has not met certain customer requirements

External failure costs

- External failure costs are those costs incurred due to failure of a product/ service after being supplied to the customer.
- The sub categories of these costs have been briefed below

Sub categories	Explanation
Complaint adjustment	It is the cost associated with investigation and adjustment of proven complaints
Returned product/ material	It is the cost associated with receiving, handling and replacement of the non-conforming products that are returned by customers
Warranty charges	It is the cost associated in rendering service to customers under warranty contracts
Liability costs	It is the legal compensation paid to customers due to the supply of non- conforming products

Use of quality cost information

Important uses are:

- To identify profit opportunities
- Used as an objective performance measure
- To identify waste, redundant systems and quality problems

Quality cost analysis

- The quality cost data has to be analyzed to make it meaningful

- It should be noted that quality cost analysis should include both of the following
  - Cost situation at the present time, and
  - Cost development over a period of time
  - The cost of quality matrix has been shown

	Design Engg.	Purchasing	Production	Finance	...	Total
Prevention Costs . . .					...	
Appraisal Costs . . .					...	
Internal failure costs . . .					...	
External Failure Costs . . .					...	
Total					...	

- Juran's classic model for optimum quality levels emphasizes that there is a trade off between quality and cost

  FC –Failure costs

  CA & P – Cost of Appraisal and prevention

  TQ_c –Total Quality costs

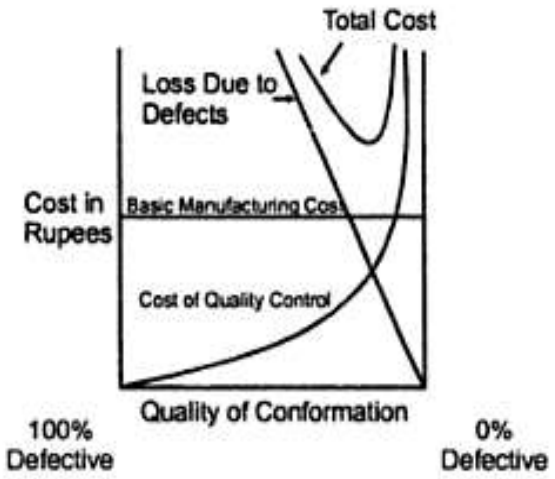


Figure: Quality cost- Traditional process

Optimum Quality cost

a) Failure costs

- This consists of both internal and external failure costs
- Failure cost = 0 when the product is 100% good
- Failure cost = ∞ when the product is 100% defective

b) Prevention cost

- Prevention cost – 0 when the product is 100% defective
- Prevention cost keeps increasing as perfection is kept as the target and approached

c) Total quality cost

- Total quality cost =[Failure cost] + [Prevention cost]

4.6 PERFORMANCE MEASURES

An important principle along with customer satisfaction, employee involvement, continuous process improvement and supplier partnership, refers to measuring the performance of entire organization. There are 6 basic technique for presenting performance measures.

1. Time series graph

This is commonly used and simple technique. This type of graph benchmarks the process and shows favorable & unfavorable trends in the measure.

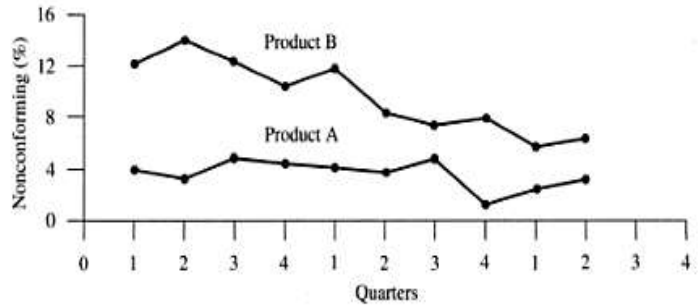


Figure: Time series Graph for percent Nonconforming

Here the Time is shown on horizontal axis & the performance measure on vertical axis.

2. Control chart

It is a graphical display of quality characteristics of a product Vs the sample number or lot number or batch.

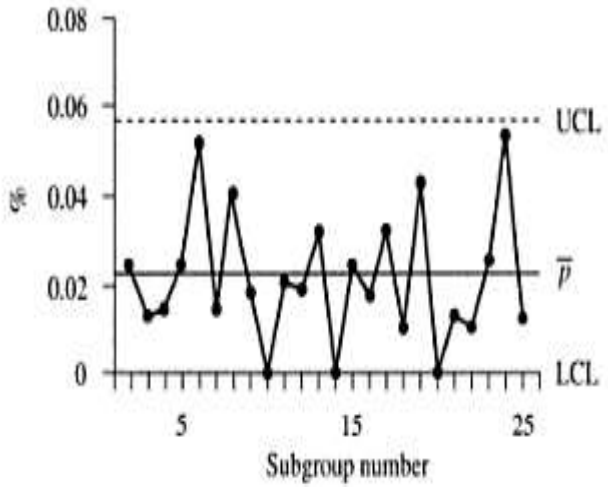


Figure: Control chart for percent nonconforming

Where, UCL (Upper Control Limit)
CL (Center Line)
LCL (Lower Control Limit)

The sample points may be denoted by dots. The successive sample points are connected with straight line segments. So that the pattern of variations can be analyzed easily.

If the process is in control, all points should fall within the control limits.

3. Taguchi's Quality loss function

In this technique, target, cost and specification are combined into one measurement.

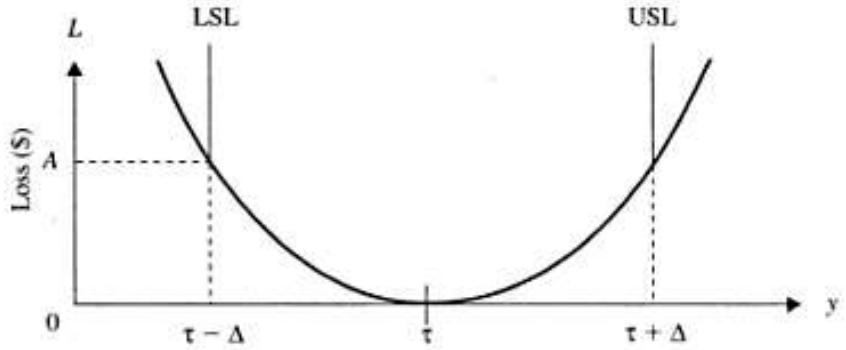


Figure: Taguchi's Quadratic loss function for nominal the best

4. Cost of poor quality

- It should be noted that money is the best way to attract the attention of top management
- If the quality cost are high, it implies that management is ineffective. Quality cost identify opportunities for quality improvement.
- Common techniques used to analyze quality cost are,
  - Trend analysis
  - Pareto analysis

5. Malcolm Baldige National Quality Award (MBNQA)

It is annual award for performance excellence. The award promotes the following

- Understanding of the requirements for performance excellence and competitiveness improvements.
- Sharing of information on successful performance strategies and
- Benefits derived from using these strategies

These awards are given each year in each of the following 5 categories.

I. Manufacturing
II. Service
III. Small business Health care and
IV. Education

This technique helps in continuous improvement and benchmarking