

COURSE MATERIAL
A.V.C.COLLEGE OF ENGINEERING, MANNAMPANDAL, MAYILADUTHURAI.

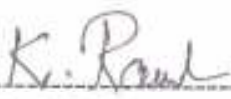


COURSE MATERIAL FOR TOTAL QUALITY MANAGEMENT


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Certificate

This is to certify that this course material for the subject **Total Quality Management (Mech)** covers the entire syllabus prescribed by Anna University, Trichy.


06/05/2018
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**SYLLABUS
TOTAL QUALITY MANAGEMENT**

UNIT-1 QUALITY**9**

Definition of Quality- Dimensions of Quality- Quality Planning-Quality Costs-Analysis techniques for quality costs- Basic concepts of total quality management- Historical review- Principles of TQM- Leadership- Concepts- Role of senior management- Quality council-Quality statements- Strategic Planning- Deming Philosophy- Barriers to TQM implementation.

UNIT-II TQM PRINCIPLES**9**

Customer satisfaction- Customer perception of quality- Customer complaints- Service quality- Customer retention- employee involvement- Motivation- Empowerment- Teams- Recognition and reward- Performance appraisal – Benefits- Continuous process improvement- Juran trilogy- PDSA cycle- 5S- Kaizen- Supplier partnership- Partnering- Sourcing- Supplier Selection- Supplier rating-Relationship development- performance measures- Basic concepts- strategy- Performance measure.

UNIT-III STATISTICAL PROCESS CONTROL (SPC)**9**

The seven tools of quality- Statistical fundamentals- Measures of central tendency and Dispersion- Population and sample- Normal curve- Control charts for variables and attributes- Process capability- Concept of Six sigma- New seven Management tools.

UNIT-IV TQM TOOLS**9**

Benchmarking- Reasons to benchmark- Benchmarking process- Quality Function Deployment(QFD)- House of quality- QFD process- Benefits- Taguchi quality loss function- Total productive Maintenance(TPM)- Concept- Improvement needs- FMEA- stages of FMEA

UNIT-V QUALITY SYSTEMS**9**

Need for ISO 9000 and other quality systems- ISO 9000:2000 quality systems-m Elements, implementation of quality system- Documentation- Quality auditing- TS 16949- ISO 14000- Concept- Requirements and benefits.

Total: 45**TEXT BOOKS :**

1. Besterfield, D.H., “ Total Quality Management”, 3rd Edition, Pearson Educaion, 2004.
2. Narayana, V. and Sreenivasan , N.S, “ Quality management- Concepts and tasks”, New Age international, 1996.

REFERENCES:

1. Evans, J.R. and Lidsay, W.M., “ The Management and control of Quality”, 5th Edition, South – Western (Thomson learning),2002.
2. Feigenbaum, A.V., “ Total Quality Management”, McGraw Hill, 1991.
3. Oakland., J.S., “ Total Quality Management, “ Butterworth- Hcinemann Ltd.,

UNIT – I

TOTAL	= Made up of the whole
QUALITY	= Degree of excellence in a product or service provided
MANAGEMENT	= Act, art or science /manner of handling, controlling, directing etc

Meaning

TQM is a structured system for satisfying internal and external customers and suppliers by integrating the business environment, continuous improvement and breakthrough with development, improvement and maintenance cycles while changing organizational culture.

THE DIMENSION OF QUALITY

Dimension	Meaning and Example
• Performance	Primary product characteristics such as the brightness of the picture
• Features	Secondary characteristics, added features, such as camera cell phone
• Conformance	Meeting specifications or industry Standards, workmanship
• Reliability	Consistency of performance over time, average time for the unit to fail
• Durability	Useful life, includes repair
• Service	Resolution of problems and complaints, ease of repair
• Response	Human - to – Human interface, such as the courtesy of the dealer.
• Aesthetics	Sensory characteristics, such as Exterior finish
• Reputation	Past performance and other intangibles, such as being ranked first

QUALITY PLANNING

Planning in the field of quality control must be geared fundamentally for delivering satisfactory product quality to the customer at minimum cost. These objectives are realized only by carefully planning the necessary quality procedures which establish the required operational detail.

- ◆ Establishing quality goals
- ◆ Identify the customers
- ◆ Determine the customer's needs
- ◆ Develop product features which response to the customers needs
- ◆ Develop processes that are able to produce the product features
- ◆ Establish quality controls
- ◆ Transfer the plans to the operating forces

QUALITY COSTS

The cost of poor quality can add to the other costs used in decision making, such as maintenance, production, design, inspection, sales and other activities. This cost is no different than other costs. It can be programmed, budgeted, measured and analyzed to help in attaining the objectives for better quality and customer satisfaction at less cost. A reduction in these costs (quality costs) will lead to increased profit.

◆ **Prevention Cost**

Cost incurred to avoid or minimize the failures

The various elements of prevention cost are given below.

1. Marketing / Customer / User cost.
2. Product/ service / Design Development cost.
3. Purchasing cost
4. Operations costs (manufacturing or service)
5. Quality administration costs.

◆ **Appraisal costs**

Costs involved in determining the degree of conformance to the quality requirements

These are the costs incurred by the organization for inspection and testing of the product in production process itself. In its widest sense, this cost includes all the checks done by people who are not titled inspectors. For example machinists, tools setters, supervisors etc routinely inspect the production process to ensure quality and this is the appraisal cost.

1. Purchasing appraisal cost
2. Operations (manufacturing or service) appraisal costs.
3. External appraisal costs.
4. Review of test and inspection data cost.
5. Checking labour cost.
6. Setup for test or inspection.
7. Laboratory acceptance testing cost.
8. Test and inspection of purchased material cost.
9. Quality audit cost.
10. Outside endorsement.
11. Fields testing costs.

◆ **Internal failure costs**

These are the costs incurred within the manufacturing organization. Costs associated with defects found before the customer receives the product or service. Typically these costs include scrap, rework or corrective operations etc.

1. Product or service design failure cost – internal
2. Purchasing failure costs.
3. Operation (product or service) failure costs.
4. Scrap costs
5. Rework cost.

6. Factory contact engineering cost.

◆ **External failure costs**

These are the costs incurred by the manufacturer after the product has been delivered to the customer. For example, cost of products or services rejected by the customer or recalled because of some defects will fall under this category.

1. Returned goods costs.
2. Product recall costs.
3. Complaints in warranty costs.
4. Complaints out of warranty costs.
5. Product liability costs.
6. Product service cost.
7. Penalties.
8. Customer goodwill
9. Lost sales cost.

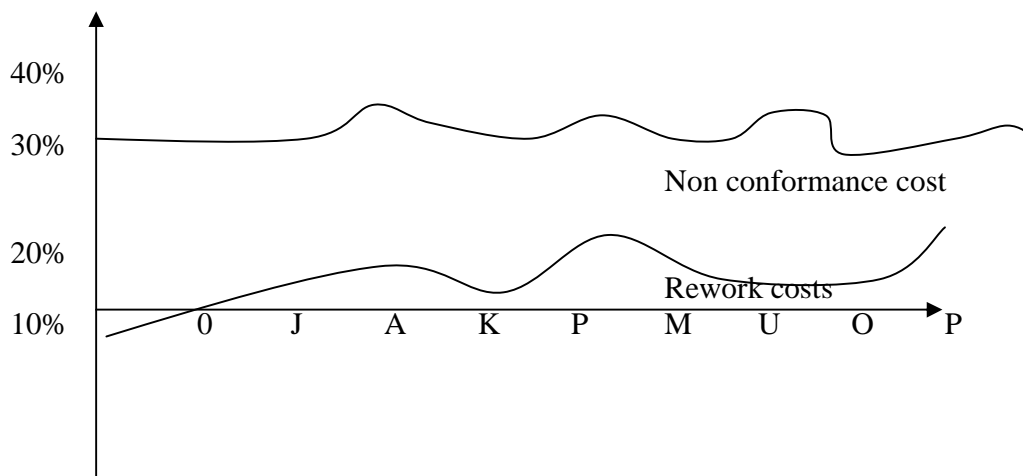
ANALYSIS TECHNIQUES FOR QUALITY COSTS

The frequently used quality costs analysis techniques are:

1. Trend Analysis
2. Pareto Analysis

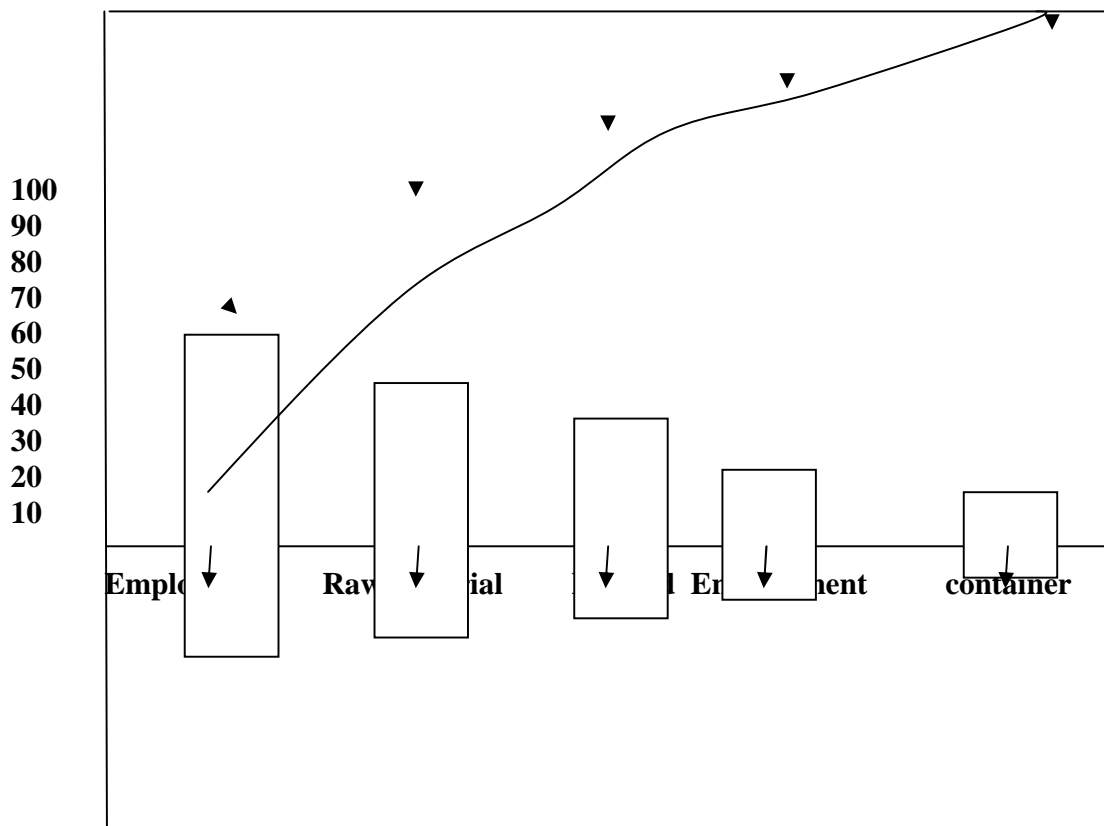
1. Trend Analysis.

- Comparing the present and past cost levels is the core of trend analysis. The information from the trend analysis is useful for the long range planning.
- The data can be taken from the monthly report.
- Trend analysis can be done on cost category, indices, products, departments, work centers, etc.
- Typically the past data on quality costs are plotted on a graph and using mathematical calculations one can forecast the quality cost trend which may be in the future, based on the past data's.



2. Pareto Analysis

- By this principle 80 percent of the major problems are due to 20 percent of the causes. (for example, i) few customers accounting for major sales, ii) a few type of problems accounting for major problem, iii) a few products accounting for majority of the profit)
- Vital causes for problems are identified; a major chunk of problems can be solved.
- Pareto diagram has few items that denote a substantial amount of the total.
- Pareto diagram can be established for quality costs by machine, defects, departments, category, etc.



BASIC CONCEPT OF TQM

1. A committed and involved management to provide long term, top to bottom organizational support.

It is useless to embark on a quality journey without the top management's commitment to quality. Top management must participate in the quality programme. They must also participate on quality improvement teams and also act as coaches to other teams

2. An un - wavering focus on the customer both internally and externally.

The employees of the organization in the first place. Managers must listen to the suggestions and recommendations made by the employees to improve quality. This aspect of listening to the voice of customers leads to the emphasis of design quality and defect prevention.

3. Effective involvement and utilization of the entire workforce.

TQM is everyone's responsibility in an organization. All workers in and organization must be oriented towards TQM and all personnel must be trained in TQM, statistical process control and other appropriate quality improvement skills.

4. Continuous improvement of the business and production process.

Continuous improvement refers to constant refinement and improvement of products, services and organizational systems to yield improved value to consumers.

Areas such as on-time delivery, scrap reduction, supplier management, customer satisfaction, etc. are good quality projects to begin continuous improvement.

5. Treating suppliers as partner

The traditional relationship between the buyer and the supplier has been adversarial in nature. Each tried to extract the maximum out of each other. There was lack of trust on each other.

To ensure good relationship with suppliers, frequent change of suppliers should be avoided and suppliers should be few in number so that true partnering can occur.

6. Establishing performance measures for the process.

Performance measure is an integral part of the quality process. If an organization cannot measure its progress, it is useless for it to go on a quality journey. Performance measures such as percentage of non conformance, absenteeism, customer satisfaction, etc., should be determined for each functional area.

HISTORICAL REVIEW

- The concept of specification of labour was introduced during the industrial revolution
- As a result a worker no longer made the entire product, only a portion. This change brought about a decline in workmanship
- Because productivity increased there was a decrease in cost, which result in lower customer expectations
- As products become more complicated and jobs more specialized, it became necessary to inspect product after manufacturing
- In 1942 W.A. Shewhart of Bell Telephone Laboratories developed a statistical chart for the control of product variables. This is beginning of SQC
- In some decade H.F. Dodge and H.G. Romig both of Bell telephone laboratories developed the area of acceptance sampling as a substitute for 100% inspection. It is recognized by 1942

- In 1946 the American society for Quality Control was formed. Now it is American Society for Quality
- In 1950 W. Edwards Deming who learned SQC from Shewhart, gave a series of lectures on statistical methods to Japanese Engineers
- Un 1954 Joseph M. Juran made his first trip to Japan and further he emphasized management's responsibility to achieve quality
 - By this concept the Japanese set the quality standard for the rest of the world
 - In 1960 the first quality circles were formed for quality improvement by Japanese workers
- By 19770's and 80's U.S. managers were making frequent trips to Japan to learn about the Japanese miracle
- In 1980's the automotive industry began to emphasizes statistical process control (SQC)
- Emphasis on quality continued in the auto industry in the year 1990's. when the Saturn automobile ranked first in customer satisfaction in 1996
- ISO 9000 became the world wide model for quality system

PRINCIPLES OF TQM

1. Customer focus
2. Leadership
3. Involvement of people
4. Continuous improvement/ long-term
5. Systematic improvement/ approach
6. Problem prevention
7. Quality as everyone's job
8. Mutually beneficial

LEADERSHIP DEFINED:

Leadership is interpersonal influence exercised in a situation and directed through communication process, towards the attainment of a specialized goal or goals. Thus leadership is a process of influencing the activities of an individual or a group for goal achievement in a given situation.

LEADERSHIP CONCEPT

Leadership requires in order to become successful as a leader , he needs an intimate and insightful understanding of human nature – the basic needs, wants and abilities people, a leader needs to know and understand the following;

1. People need both security and independence at the same time.
2. People are sensitive and do respond to external rewards or punishments. They are also strongly self-motivated.
3. Peoples sometime value a kind word of praise more than any monetary reward.
4. They trust their gut reaction more than statistical data.
5. A leader should simplify the task

ROLE OF SENIOR MANGEMENT

- Senior management must practice the philosophy of Management by Wandering around (MBWA). They should get out of the office and visit customers, departments, and plants within the organization and suppliers
- Encourage subordinates to write only important messages that need to be part of the permanent record.
- Senior management role is no longer to make the final decision, but to make sure the teams decision is aligned with the quality statement of the organization
- Problem solving and decision making to the lowest appropriate level by delegating authority and responsibility.
- Senior managers must stay informed on the topic of quality improvement by reading books and articles attending seminars and talking to other TQM leaders.
- The needed resources must be provided to train employees in the TQM tools and techniques, the technical requirements of the job and safety.
- Must be visibly and actively engaged in the quality effort by serving on teams, coaching teams and teaching seminars.
- They should lead by demonstrating, communicating, and re-in forcing the quality statements.
- They should spend about one third of their time on quality
- Senior managers are listening to internal and external customers and supplies through visits, focus groups and surveys.
- To create awareness of the importance of TQM and provide TQM results in an ongoing manner.
- Senior managers should be able to drive fear out of the organization, break down barriers, remove system roadblocks, anticipating and minimize resistance to change and in general change the culture.

QUALITY CIRCLE

Meaning

Quality council is composed of the chief executive officer, the senior managers of the functional areas, such as design, marketing, finance, production and quality and a coordinator or consultant. Individual selected for the coordinated position should be bright young person with execution potential.

Objectives of quality council:

- To raise the quality consciousness in the organization through seminars, study tours and using forms of promotion.
- To ensure effective functioning of the organization on the quality statement and plan.
- To encourage basic and applied research and development in the field of quality and dissemination of its results to the organization.
- To raise the level of training of personnel engaged in quality activities including the assessors and trainees.
- To facilitate upgradation of testing and calibration facilities and laboratories as well as to encourage the overall quality of the organization.

DUTIES OF QUALITY COUNCIL

- ❑ Develop with input from all personnel; the core values Vision statement, Mission statement, and Quality policy statement.
- ❑ Develop the strategic long term with goals and the annual quality improvement program with objectives
- ❑ Determine and continually monitor the cost of poor quality.
- ❑ Create the total education and training plan.
- ❑ Determine the programme measures for the organization.
- ❑ Continually determine those projects that improve the process.
(internal and external customers)
- ❑ Establish or revise the recognition and reward system to account for the new way of doing business.

QUALITY STATEMENT

In addition to the core values and concepts, the quality statement includes the Vision statement, Mission statement and Quality policy statement. Once developed, they are occasionally revised and updated. They are part of the strategic planning process, which included goals and objectives.

VISION STATEMENT

The vision statement is a clear declaration of what an organization aspires to be in the future (in long term). Its purpose is to provide a platform for the managers for thinking strategically. A vision statement is usually an ideal condition, that might never be reached but that will inspire the people to achieve.

Example: “THE HAPPIEST PLACE ON EARTH” - Disney Theme park.

MISSION STATEMENT

The mission statement answers the following questions. Who we are, who are the customers, what we do and how we do it. This statement is usually one paragraph or less. It is easy to understand and describe the functions of the organization. It provides a clear statement of purpose for employees, customers and supplies.

EXAMPLE: BEN & JERRY'S ICE CREAM – MISSION STATEMENT

PRODUCT MISSION: TO make, distribute and sell the finest quality natural ice cream and related products in a wide variety of innovative flavors made from Vermont dairy products.

QUALITY POLICY STATEMENT

QPS serve as a guide for everyone in the organization. This statement clarifies the employees about how the products and services must be provided to the customers. The CEO of the company writes quality policy statement after a careful study and analysis of the feedback from the workforce. Finally the quality council must approve the statement.

EXAMPLE:

**Meet the requirements of the customers (both internal and external)
Go ahead competition
Complete utilization of the entire workforce.**

STRATEGIC PLANNING

Organizations are finding that strategic quality plans and business plans are inseparable. The strategic planning is three to ten years and short term planning is one year or less. It consists of goals and planning.

SEVEN STEPS TO STRATEGIC PLANNING.

- 1. Identification of customer needs.**
 - 2. Determination of customer positioning**
 - 3. Predict the future.**
 - 4. Gap analysis.**
 - 5. Closing the gap.**
 - 6. Aligning the plan to the mission and vision.**
 - 7. Implementation of the plan.**
-
- 1. Identification of customer needs.**
 - This steps provides a focus on customer satisfaction.
 - Their needs and wants have to be identified and satisfied.

- The profiles of the customers are identified. Questions like who are our customers? Will they change in future? What will they want in future?

2. Determination of customer positioning

- The planners determine where the organization wants to be in relation to the customers.
- Expand the customer base products or services.
- Products with poor quality performance should be removed or eliminated and replaced by better ones.
- The organization needs to concentrate its efforts on areas of excellence

3. Predict the future

- Predict the future conditions that will affect their product or service
- Using effective tools for analyzing and predicting future
- Some products or services have become absolute because it failed to foresee the changing technologies.
- The managers in the organization anticipate a change in the first place, and then they can make necessary arrangements by making investments on resources and be prepared to take on the future.
- The rate of change is continuously increasing.

4. Gap Analysis

- The planners to identify the gaps between the current state and future state.
- The present position of the organization in the market in relation to competition, profits, customer satisfaction employee satisfaction, etc. to the intended position.
- If any there is gap identified future strategies must be formulated taking this gap in to consideration.

5. Closing the Gap

- After gap analysis plans must be formulated to reduce or close the strategic gap.
- To close the gap by establishing goals and responsibilities.
- All stakeholders should be included in the development of the plan.

6. Alignment

- It must be aligned with the mission, vision, and core values and concepts of the organization.

7. Implementation

- a. Resources must be allocated to collecting data, designing changes and overcoming resistance to change.
- b. To monitoring activities to ensure that progress is being made.

- c. Monitoring by the steering committee and periodical assessments are required for an effective and speedy implementation.

THE DEMING PHILOSOPHY

In 1950 he taught SPC concepts and the importance of quality to the leading CEO's of Japanese industry. He developed **the following fourteen points as a theory for management for improvement of quality** productivity and competitive position.

1. Create and publish the aims and purposes of the organization

- ✓ Organization must develop a long term view at least 10 yrs
- ✓ Plan to stay in business by setting long range goals
- ✓ Resources must be allocated for research, training and continuing education to achieve the goals
- ✓ Innovation is promoted to ensure that the product or services does not become absolute
- ✓ Organizational philosophy is developed to send the message that everyone is part of the organization

2. Learn the new philosophy

- ✓ Organization must seek never-ending improvement and refuse to accept non-conformance.
- ✓ Customer satisfaction is the number one priority
- ✓ The organization must concentrate on defect prevention rather than defect detection.
- ✓ Everyone should be involved in the quality journey and change his or her attitude about quality
- ✓ Supplier must help to improve quality
- ✓ Share the information relative to customer expectations

3. Understand the purpose of inspection

- ✓ Mass inspection is costly and unreliable it is replaced by statistical techniques
- ✓ It is required for self and supplier
- ✓ Mass inspection is managing for failure and defect prevention is managing for success.

4. Stop awarding business based on price alone

- ✓ Awarding business based on the low bid, because price has no meaning without quality
- ✓ To examine how customer expectations are affected and provide feedback to the supplier regarding the quality

5. Improve constantly and forever the system

- ✓ Management must have take more responsibility for problems by actively finding and correcting problems
- ✓ So that quality and productivity are continually and permanently improved and costs are reduced.
- ✓ The focus is preventing problems before they happen.
- ✓ Responsibility is assigned to teams to remove the causes of problems and continually improve the process.

6. Institute training

- ✓ Employee must be oriented
- ✓ Management must allocate resources to train employee to perform their jobs
- ✓ Everyone should be trained in statistical methods and monitor the need for further training.

7. Teach and institute leadership

- ✓ Improving supervision is management's responsibility
- ✓ Training in statistical methods
- ✓ Supervisors not focusing on negative fault findings,
- ✓ He create positive supportive
- ✓ Communication must be clear from the top management to supervisor and to operators

8. Drive out fear, create trust and create a climate for innovation.

- ✓ By providing workers with adequate training, good supervision and proper tools to do the job as well as removing physical dangerous.
- ✓ When people are treated with dignity fear can be eliminated and people will work for the general good of the organization.
- ✓ This climate will provide ideas for innovations and improvement.

9. Optimize the efforts of teams, groups, and staff areas.

- ✓ Barriers internally like levels of management among department within department etc.
- ✓ Barriers externally like with customers and suppliers
- ✓ The barriers exist because of poor communication, ignorance of the organization mission, completion, fear and personal grudges.
- ✓ To overcome these attitudes need to be changed communication channel opened, project teams organized, training for teamwork.

10. Eliminate exhortations for the work force

- ✓ Exhortations that ask for increased productivity without providing specific improvements methods
- ✓ They do not produce a better product or service, because the workers limited by the system

- ✓ Improvements in the process cannot be made unless the tools and methods are available.

11. a) Eliminate numerical quotas for the work force

- ✓ Instead of quotas, management must learn and institute methods for improvements.
- ✓ Quotas and work standards focus on quantity rather than quality.
- ✓ Quotas should be replaced with statistical method of process control.

b.) Eliminate management by objectives

- ✓ Management must learn the capabilities of the processes and how to improve them
- ✓ Management by numerical is an attempt to manage without knowledge of what to do

12. Remove barriers that rob people of pride of workmanship

Loss of pride in workmanship exists throughout organization because

- ✓ Workers do not know how to relate the organization mission
- ✓ They are being blamed for system problems
- ✓ Poor designs lead to the production of “Junk”
- ✓ Inadequate training is provided
- ✓ Inadequate or inefficient equipment is provided for performing the required work.

13. Encourage Education and self-improvement for everyone

- ✓ What an organization needs is people who are improving with education
- ✓ A long term commitment to continuously train and educate people must be made by management
- ✓ Everyone should be retained as the organization requirements change to meet the changing environment

14. Take action to accomplish the transformation

- ✓ Management has to accept the primary responsibility for the never ending improvement of the process.
- ✓ Management must be committed, involved and accessible if the organization is to succeed in implementing the new philosophy.

BARRIERS / OBSTACLES IN IMPLEMENTATION OF TQM

➤ **Lack of management commitment**

The management commitment should be clearly communicated both verbally and in action to the organization.

If the workers feel that the management is doing only the talking about no action is initiated on TQM then they too will lack necessary commitment and motivation to implement TQM principles.

- **Inability to change organizational culture**

The past culture should be unlearned and the new culture should be learnt. This gives rise to enormous resistance to change from the employees. It is very difficult for an organization to make a culture change.
- **Improper planning**

When planning for TQM all the constituents' should be involved in the development of the implementation plan and any modification that occur as the plan evolves. Rapid planning will ensure that the TQM fails.

Planning should be done on the customer front, employee's front and the supplier front.
- **Lack of continuous training and education**

Training and education is an ongoing process for everyone in the organization. The training needs of the employees must be determined and a plan should be developed to satisfy those needs.

Training and education are most effective when senior management conducts the training programme based on the principles of TQM
- **Incompatible organizational structures and isolated individuals and department**

Lack of co ordination and difference of opinion among departments and individuals in an organization will create implementation problems.

The use of multifunctional teams can help to break this barrier.

Restructuring of the organization may be needed to make the organization more responsive to the needs of the customers.
- **Ineffective measurement techniques and lack of access to data and results**

In order to improve the process, one has to measure the present position. Mechanisms to measure the present position should be available in the organization.

Once the measurement is done the data should be made available to the necessary mangers to make decisions.

Any clogging of data to the managers will become a barrier to TQM implementation.
- **Playing inadequate attention to internal and external customers**

Organizations have to understand the changing needs and expectations of the customers both internal and external.

Effective feedback mechanisms that provide data for decision making are necessary for this understanding.

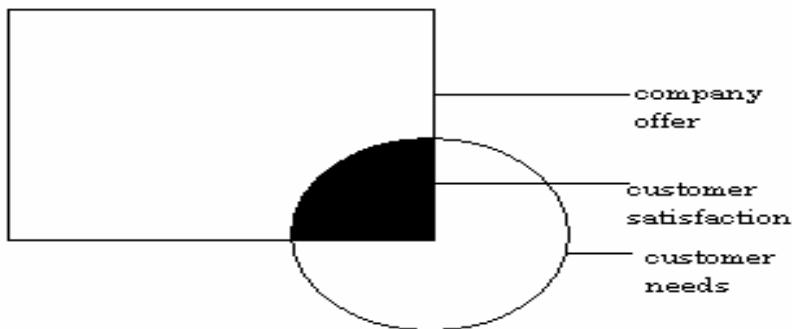
One way to overcome this is to give the right people in the organization, a direct access to the customers.
- **Inadequate use of empowerment and teamwork**

Individuals should be empowered to make decisions and take responsibility to make decisions that affect the efficiency of the process of production.

Teams should be formed and need to have proper training. The team's recommendations should be adopted whenever possible.

UNIT – II
CUSTOMER SATISFACTION

CUSTOMER SATISFACTION MODEL:



CUSTOMER:

A customer can be defined as one who purchases a product or service. There are two distinct type of customer.

Customer satisfaction is achieved when their expectations are matched by what is offered to them by the organization. It is important for the organization to listen to the voice of the customers to ensure that is marketing, production, R&D, distribution and service truly meet the expectations of the customers.

There are two distinct types of customers; they are external and internal customers.

A) External Customers:

External customers can be defined as the one who purchases the product of the organization for end usage or for reselling or to use the product in his production process as raw material.

B) Internal customers:

Internal customers are the employees of the organization. As far as the top management in concerned they have an obligation to keep internal customers satisfied.

CUSTOMER PERCEPTION OF OUALITY:

An American society for quality (ASO) survey on end user perception of important factors that influenced purchases showed the following ranking.

1. Performance
2. Features
3. Service
4. Warranty
5. Price
6. Reputation

1. PERFORMANCE

- Performance of the product is the “fitness” the product or service by the customer at the time of sale.
- It indicates that the product can be used as such without any further modification.
- Availability, which is the probability that a product will operate when needed.
- Reliability is the consistent performance of the product every time is used

- Maintainability which is the ease of keeping the product operational is also important.

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2. FEATURE

Features are the secondary characteristics or added facilities available with the core product.

FOR EXAMPLE:

Primary function of an automobile is transportation where as stereo system is a feature.

3. SERVICE:

- Service is emerging as a method for organizations to give the customer added value.
- The product may work fine but if the service which is attached to the product is not managed properly then it will lead to customer dissatisfaction.

FOR EXAMPLE:

Purchase of Air conditioner, the seller has to come to your home to install and run the A/C machine. After that he must come and service the A/C with regular interval and in case of any problem immediately come and repair the problem.

4. WARRANTY:

The warranty encourages customer to buy a product a service by reducing the risk of the purchase decision.

5. PRICE:

Customer is willing to pay a higher price to obtain value. he evaluating product and services against those of its competitors who provides the greatest value.

6. REPUTATION:

Find organizations by our overall experience with them.

Customer satisfaction is based on the entire experience with the organization not just the product.

FEEDBACK:

- Customer feedback must be continually solicited and monitored. Customer continually changes. They change their minds, their expectations and their supplies. Customer feedback is not a one-time effort it is a ongoing and active probing of the customer's mind.

IT ENABLES THE ORGANIZATION:

- Discover customer dissatisfaction.
- Discover relative priorities of quality.
- Compare performance with the competition.
- Identify customer's needs.
- Determine opportunities for improvement.

TOOLS USED:

1. COMMENT CARD –attach with warranty card.

Comment cards are simple cards usually in the form of prepaid postage card which can be attached with the product manual or the warranty card. or just included with the product the time of purchase.

2. **Survey.**

It is more effective and also popular tool for obtaining opinions and perceptions about an organization and its products and services.

Customers are asked to furnish the answers related to the quality of the product and service.

3. **Focus group.**

The focus group is like an in depth interview, except that it involves a group rather than an individual. It is a group interview that tries to stimulate people to talk freely about the products. In a typical focus group, a few customers are invited to attend a group discussion at a central interviewing location.

4. **Toll-free telephone numbers.**

Toll free phone numbers (1600 – in India, /800/888 in US) are an effective technique for receiving customer feedback. Organizations can respond faster and more cheaply to a complaint on receiving a complaint call.

5. **Customer visits.**

Company personnel visiting customers at their place will provide valuable information and feedback on the product.

6. **The Internet**

Web home pages and e-mails have become very popular these days that they are fast replacing the conventional methods of feedback mechanism.

Customers also find it very easy and cheaper to provide feedback to the supplier.

Using customer complaints:

Every single complaint should be accepted, analyzed and acted upon for its represents.

Information on customer dissatisfaction is received into the organization at the highest level, thereby providing a fast response.

Complaints can be seen as opportunity to obtain information and provide a positive service to the customers.

Activities of the customer complaints:

- Investigate customer's experiences by actively soliciting feedback both positive and negative and then acting it promptly.
- Develop procedures for complaint resolution.
- Analyze complaints but understand that complaints do not always fit in to neat categories.

- Survey response is received a senior manager should contact the customer and strive to resolve them.
- Establish customer satisfaction measures and constantly monitor them.
- Provide a monthly complaint report to the quality council for their evaluation and improvements.

SERVICE QUALITY

CUSTOMER SERVICE is the set of activities an organization used to win and retain customer's satisfaction. It can be provided before during or after the sale of the product or exits on it's own.

ELEMENTS OF CUSTOMER SERVICE:

ORGANIZATION:

1. Identify each market segment.
2. Write down the requirements.
3. Communicate the requirements.

CUSTOMER CARE:

4. Meet the customer expectations.
5. Get the customer point of view.
6. Deliver what is promised.
7. Make the customer feel valued.
8. Respond to all the complaints.
9. Over respond to the customer.
10. Provide a clean and comfortable customer reception area.

COMMUNICATION:

11. Optimize the trade-off between time and personal attention.
12. Minimize the number of contact points.
13. Provide pleasant knowledgeable and enthusiastic employees.
14. Write documents in customer friendly language.

FRONT-LINE PEOPLE:

15. Serve them as internal customer.
16. Hire people who like people.
17. Give them the authority to solve the problem.
18. Challenge them to develop better methods.
19. Be sure they are adequately trained.
20. Recognize and award performance.

LEADERSHIP:

21. Lead by example.
22. Listen to the front-line people.
23. Strive for continuous process involvement.

CUSTOMER RETENTION

Whether retail or industrial customer, are constantly watching out for better cheaper products and when a competitor is able to offer the product better, that the customers usually switch.

Any organization should develop a very personal relationship with individual customers, so that they do not switch over to the competitors.

CUSTOMER RETENTION represents the activities that produce the necessary customer satisfaction that creates customer loyalty, which actually improves the bottom line.

EMPLOYEE INVOLVEMENT

TQM requires everybody's involvement in the process and everyone should feel that the company belongs to them. Employee involvement results in improved quality and productivity.

MOTIVATION:

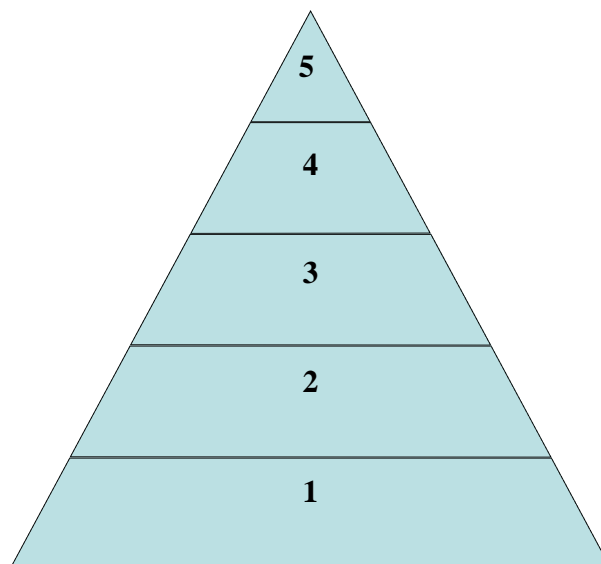
MEANING/DEFINITION:

1. Motivation is a process that starts with a physiological or psychological deficiency or need that activates behavior or a drive that is aimed at a goal or an incentive.
2. Motivation is the result of processes internal and external to the individual that arouse enthusiasm and persistence to pursue a certain course of action.

THEORIES OF MOTIVATION:

MASLOW THEORY

According to this theory every individual is depicted as a wanting organism with a desire to rise from one level to another level in the society. Maslow suggests five levels for every individual with differing needs at every level.



1. Basic or physiological needs

The first need of a person is physiological in nature. physiological needs are the necessities for survival. Once this need is satisfied, they no longer act as motivators for the employee. These factors when available are taken for granted and employees look for the next level as motivators.

2. **Security or safety needs.**

Employees now strive to achieve the next level which is safety needs. These needs include safe place of work and job security, which are very important for employees.

3. **Social needs.**

Since a man is social being, he has a need to belong and to be accepted by the various groups. When social needs are dominant, a person will strive for meaningful relationship with others. He gets a fear of being rejected.

Conversely when an individual has an opportunity to be a part of a group by feeling important and needed will motivate that person.

4. **Esteem needs.**

Self esteem needs are concerned with self respect, recognition, self worth and feeling of being unique.

5. **Self-actualization.**

Individuals in an organization must be given the opportunity to go as far as their abilities will take them. Many organizations have a policy of promoting employees from within. This motivates employees to contribute their maximum to the organization.

HERZBERG'S TWO-FACTOR THEORY:

He identified that people were motivated by recognition, responsibility, achievement and job advancement. He labels these factors as motivation.

He also identified that bad feelings were associated with low salary, minimal fringe benefits. Power working environment and ineffective supervision.

These factors were labeled as dissatisfaction or hygiene factor

It should note that the presence of extrinsic (hygiene factors) results in dissatisfaction, but the absence of motivating factor does not make employee dissatisfied.

EMPLOYEE

MOTIVATION	DISSATISFACTION (HYGINE FACTOR)
Recognition	Poor salary
Responsibility	Ineffective leadership
Achievement	Poor working environment
Job advancement	Poor policies

EMPOWERMENT**MEANING:**

Employee empowerment is making a person completely responsible for a particular task; the individual who is empowered becomes the process owner.

In the empowerment the individual in given complete authority required to execute the process and ownership is created.

Condition:

- Everyone should understand the need for change in culture and attitude.
- The system must change to the new paradigm.
- People should be provided with necessary resources.

Empowerment is an environment in which people have the ability the confidence and the commitment to take the responsibility and ownership to improve the process and initiate the necessary steps to satisfy customer requirements within well-defined boundaries in order to achieve organizational values and goals

TEAMS

T-together E-everyone A-achieve M-more

A team is defined as a group of people working together to achieve common objectives or goals.

Teamwork is the cumulative actions of the team during which each member of the team subordinates his individual interests and opinions to fulfill the objectives or goals of the group.

TYPES OF TEAM

1. Process improvement team.

Here, five to six members from various disciplines of the organization are brought together to solve a problem. Usually the scope of the team is limited to the work unit.

The life cycle of the team is usually temporary. The team is disbanded after the problem (process improved) is solved.

2. Cross-functional team.

Here the team is constituted by the number of different functional areas such as production, engineering, marketing, finance, e etc. it may also include customers and suppliers.

3. Natural team.

This type of team is not voluntary in nature as it was with other teams. Here all members of the work unit are in the team and the manger is also part of the team.

4. Self-management work groups.

They are an extension of natural work team without the supervisor. These teams are the essence of the empowered organization. These teams not only do the work but also manage it.

STAGES OF TEAM DEVELOPMENT:

1. Forming.

- Forming is the fist and beginning stage of the life cycle of a team.

- A facilitator is appointed by the quality council and he meets with the senior management to charter the path the solution of the problem should take.
- Once team is assembled, a meeting is called and the facilitator briefs the problem to the team, and then determines the type of training the team members may need and identify an appropriate team leader.

2. Storming.

- In this stage all members of the team are fully aware of the quality problem they are faced with.
- They will be interested in proving themselves by exhibiting their individual skills.

3. Norming.

- In this stage members have understood each other well. Everyone knows each others strengths and weakness and capabilities and limitations.
- The roles of the members are clearly defined, mission and objectives are clear and the course to be taken to solve the problem is also clear.

4. Performing.

- In this stage, the team members have understood the project better and begin performing by diagnosing and solving problems and choosing and implementing changes.

BARRIES OF TEAM PERFORMING:

1. Poor training for the group members.
2. Improper reward schemes.
3. Lack of planning.
4. Lack of management commitment in monitoring the team program.
5. Poor communication.
6. Too many members in team.

Role of team leader:

1. Ensure the smooth and effective operation of the team.
2. Handling and assigning the responsibilities.
3. Good record keeping.
4. Preparing and presenting the report.
5. Prevents other members from dominating.
6. Use positive interpersonal dominating.
7. Serve as a contact point between the team and qty council.
8. Monitors the status and accomplishments of member assuming firmly completion of assignments.
9. Prepares the meeting agenda i.e. time, date, location.

Role of team member:

1. Contributes best.
2. Sharing knowledge.
3. Listen carefully and ask question.
4. Negotiate important points.
5. Supports the decisions of the team.
6. Trust support concern for other team members.
7. Understands and is committed to team objectives.
8. Respects and is tolerant of individual differences.
9. Acknowledges and worker through conflict openly.
10. Carries out assignments between meetings such as connecting data observing charting data and returning report.
11. Gives honest sincere appreciation.

Recognition and reward:

Recognition and reward are basic motivational tools used to motivate employees to encourage them to maintain and improve their present level.

- Publicly acknowledging the contributions of an individual is called recognition.
- This acknowledgement may be in the form of a certificate or a verbal praise.
- On the other hand the rewards are tangible such as cash reward, gold coins etc
- Reward can be delayed but the recognition of the contributions must be done immediately.

Purposes:

1. Reward system reminds the continual improvement required for the TQM journey.
2. Serves as a platform for encouraging the super performances.
3. Serve as a goal for the employee.
4. Serve as a morale booster.

Performance appraisal

Performance appraisal is the judgment of employee's performance in the organization.

Performance appraisal is defined to show the employees how they are doing. This serves as a basis for promotion, salary increases etc those who are rated poorly should be allowed to undergo special counseling and skill up-grading programmer.

It should help people to assess themselves and improve.

Appraisal format:

1. **Ranking**- compares employees by ranking from highest to lowest.
2. **Narrative**- gives a written description of employee's strength and weakness.
3. **Graphic**-indicate the major duties performed by the employees and rate each duty with a scale, which is usually from 1(poor) to 5(excellent).
4. **Forced choice**-places each employee's in a category with a predetermined percentage for example excellent 10%, very poor 25%, grave 30%, fair 25%, poor10%.

BENEFITS

1. PROMOTION
2. SALARY INCREASE
3. BONUS
4. INCENTIVES
5. IDENTIFYING TRAINING NEEDS
6. IMPROVING SKILLS OF THE EMPLOYEE'S
7. TO IMPROVE EMPLOYEE PERFORMANCE
8. TO RATING THE CUSTOMERS.

CONTINUOUS PROCESS IMPROVEMENT

CPI is the care of TQM. CI in the business process as well as production process is desired for the growth of the organization.

CPI is possible by

1. Making all process effective and adaptive.
2. Accepting the change in the customer requirements and tuning ourselves to meet demand.
3. Improving the productivity by eliminating waste.
4. Permanently eliminating the 'non-value adding activities'.
5. Our self with the best player in the field.
6. Using advanced tool like DOE (design of experiments), SPC, quality function development etc .

JURAN'S TRILOGY

Juran's trilogy consists of three managing process quality planning, quality control and quality improvement.

Quality planning:

The quality planning starts with identifying external customers of a business.

- Identify who are the customers.
- Determine the needs of those customers
- Translate those needs into the business possibility
- Develop a product that can respond to those needs
- Optimize the product features so as to meet the organizations needs and customer's needs.

Quality Improvement

- Develop a process which is able to produce the Product.
- Optimize the process.

Quality control:

- Prove that the process can produce the product under operating conditions with minimal inspection.
- Transfer the process to operations.
- The quality control involves checking the products produced with specification.

QUALITY IMPROVEMENT STRATEGIES

1. REPAIR:

There are two levels of repair.

- a) In the first level the team or an individual working in the process identifies the problem and eliminates the root cause of the problem. This brings in permanent solution for the problem.
- b) In the next level the faulty product reaches the customer. The customer then indicates that he has received a bad product and the product is either replaced or repaired. This is temporary solution to the problem.
- c) It is important to note that the repair strategy will not make the process better than the original design.

2. CONTINUOUS IMPROVEMENT/ REFINEMENT:

Refinement is doing things a little bit, faster, better, easier, or with less waste.

It is the process products and services are required to keep the quality improvement process alive. But management may fail to notice the small improvement and influence fail to reward the improvement efforts. This will result in dissatisfaction and loss of involvement.

3. INNOVATION:

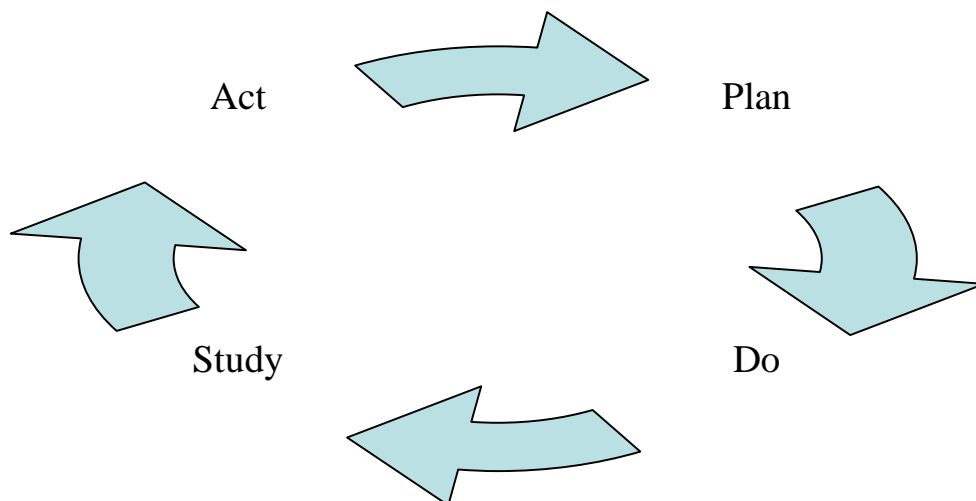
The processes and products by innovative methods.
For example: automation of process.

4. PARADIGM SHIFT (RE-INVENTION):

When a company understands that the existing processes cannot ensure the customer satisfaction it is better to reinvent the process.

PDSA CYCLE

STEWART developed the plan-do-check-act (PDCA) cycle and late Deming modified it to plan-do-study-act (PDSA) cycle.



Plan: By management. **Do:** By the operator. **Study:** quality manager **Act:** management

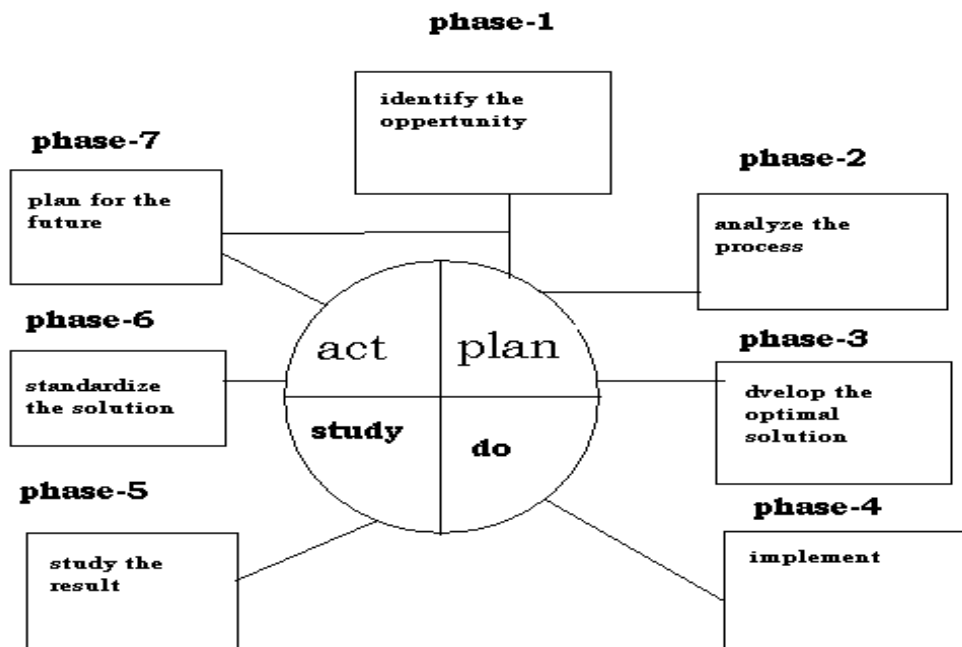
- Plan**
- It is important to establish the stage of the change to be introduced.
 - Plan on how you are going to collect the information about the differences that occur after the implementation of the plan.
 - What is to be done and how to achieve.

- Do:**
- Put the plan into practice.
 - There may be changes that should only be measured over long periods.
 - Record any unexpected event, problems and other observations. Start analyzing the data.

- Study**
- Review and reflect on the data collected in the previous step
 - Find out whether there has been any improvement in the process.
 - Did your expectations match the reality of what happened?
 - Find out what could have been done differently.

- Act**
- Carry out an amended version of what happened during the “Do” stage and measure any differences

PROBLEM SOLVING METHOD FOR PROCESS IMPROVEMENT.



5s-concept**1. Seiko (Proper arrangements)**

- This is the proper identification of materials, equipments and tools, data and information which are necessary or not necessary,.
- Provide the necessary space for the required or necessary items which you require to perform the necessary task.

2. Seiton (orderliness)

- Each equipment, data or anything should be placed in its appropriate and unique place.
- So that a simple eraser or pencil can be found at the same place every time by everybody in the organization.
- This reduces confusion and avoids wastages of time.
- The place in which it is stored should be easily accessible and appropriate.

3. Seiso (Cleanliness)

- The shop floor should be free of wastage, oil spills, cotton wastes etc.,
- The tools also should be clean, the machines should be clean and the entire organization should be free from dirt and any unexpected objects lying around.
- Keep the work place clean and make data and information easily available and constantly updated in order to support decision making.

4. Seiketsu (personal cleanliness).

- A person should be clean and his cloths should be clean. Only a clean person can be conscious about keeping his workplace clean and neat.
- Moreover unclean person present a work situation were co-workers become uncomfortable to work in.
- Personal cleanliness automatically creates a favourable condition at work place for physical and mental health, free from dirt, pollutants etc.

5. Shitsuke (Discipline).

- This may not only be the jobs related to the organization but also personal work.
- Job discipline is the habit and skill development to perform the job according to standards, to observe company rules and policies at all times.
- This habit of discipline is developed as a result of excusing mental, moral and physical strength.

KAIZEN

The philosophy that defines management role in continuously encouraging and implementing small improvements involving everyone.

It is the process of continuous improvement in small increments that make the process more efficient, effective, under control and adaptable.

Improvements are usually that make the accomplished at little or no expenses without sophisticated techniques or expensive equipment. It focuses on simplification.

Kaizen is possible only when the management is able to hear the workers. It requires an effective communication in both the directions.

KAIZEN REQUIRES THE USE OF THE FOLLOWING:

1. The data about value adding and non-value adding activities.
2. The knowledge about various types of waster (Muda). Over production, delay, transportation, processing, inventory, wasted motion and defective parts.
3. Documentation of the operating procedure.
4. Principles of time study.
5. Following the 5s concept.
6. Fewer inventories – use JIT.
7. Mistake proofing- to prevent or detect errors.
8. Effective use of teams to solve problems and to improve the performance.

SUPPLIER PARTNERSHIP

The relationship between customer (company) and the supplier. Customer and supplier have the same goal to satisfy the end user. Both the customer and the supplier have limited resources they must have work together as partners to maximize their return on investment.

Principles of customer-supplier relations:

1. Both the customer and supplier are responsible for the quality control.
2. Supplier and customer should be independent of each other.
3. The customer must communicate to the supplier about his requirements.
4. There should be agreement with respect to quality, price, mode of delivery and payment mode.
5. The supplier should supply quality materials that will result in customer satisfaction.
6. Provisions for the easy settlement of the disputes.
7. Mutual exchange of information.

PARTNERING

Meaning:

Partnering is a long-term commitment between two or more organization for the purpose of achieving specific business goals and objectives by maximizing the effective of each participants resources.

Benefits:

1. Improve quality.
2. Increased efficiency.
3. Lower cost.
4. Opportunity for innovation.
5. Continuous improvements of product and services.

KEY ELEMENTS OF PARTNERING:

1. LONG-TERM COMMITMENT:

- Long-term commitment provides the needed environment for both partners to work toward continuous improvement.

- Problems require time to solve or process need constant improvement.
- Each partner contributes its unique strength to the processes.
- Investment in new equipment or systems may be required.
- These must be a to far organization involvement from the CEO to the workers.

2. TRUST:

- Mutual trust forms the basis for a strong working relationship.
- Open and frequent communication avoids misdirection and disputes while strengthening the relationship.
- The parties should have access to each other business plans and technical information.
- They may share or integrate resources such as training activities, administration systems and equipment.
- Both parties become mutually motivated when win-win solution not rather than win-lose solution.

3. SHARED VISION:

- Shared goal and objectives ensure a common direction and must be aligned with each parties.
- Employees of both parties should think and act for their common good.
- Understand each other's business so that equitable decision are made
- Sharing of business plan.

SOURCING

SOURCING is the process of identifying the suppliers for the items required by an organization for produce or manufacturing the product. There are three types of sourcing

1. Sole sourcing:

- The organization is forced to use only one supplier.
- Only one organization producing the item.

2. Multiple sourcing:

- Two or more suppliers are available for the required item.
- It eliminates dependency.
- Usually these suppliers are chose in term of price, quality and delivery.
- It will result in better quality low cost and better service.
- If there is a strike going on in one of the supplier's company the manufacturer need not wait for him.

3. Single sourcing:

- Though there are number of suppliers available for a particular commodity selecting a single vendor for the organization to supply the item is called single sourcing.
- It results in long-term product.

Supplier Selection

The company before going for selecting a supplier should finalize on “Make or Buy” decision. The following questions must be answered before proceeding with the suppliers.

1. How critical is the item to the final product/ service
2. Is it possible to produce the item internally? Do we have technology to produce it? If not, can we develop it?
3. Are there any specialized suppliers for the item? Or can we develop such a supplier?

Finally the decision is made to outsource, the following points must be considered for evaluating the suppliers.

- a. The supplier’s ability to understand the management philosophy of the organization.
- b. The technical expertise available now and the ability to cope up with the future technical requirements.
- c. The supplier’s ability to consistently supply the raw materials that meet the specifications of the purchaser.
- d. The supplier’s ability to meet the demand and ability to increase the volume of production when demanded.
- e. The credibility of the supplier in maintaining the corporate secrets.
- f. System of delivery and communication systems available with the supplier.
- g. The track record of the supplier with the company.

Supplier Rating.

To assess the performance of the suppliers with respect to quality, speed of delivery, and service, the supplier rating is done. Supplier rating is the process of categorizing the suppliers on the basis of quality, prompt delivery, and services.

1. Supplier rating enables the company to obtain an overall rating of the supplier performance.
2. It ensures complete communication with customers on all the key areas.
3. It enhances the customer- supplier relationship by providing an objective feedback of the supplier’s performance.
4. It provides the supplier’s with a factual record of mistakes, so that the suppliers can eliminate them in future.

For example

Supplier Rating System. - Scorecard.

	Performance Characteristics				
Supplier	Quality (40-Marks)	Prompt Delivery (20-Marks)	Communication system (20-Marks)	Product Technology (20-Marks)	Total Marks (for 100 – Marks)
Supplier –A	35	15	12	20	82
Supplier - B	30	20	19	10	79
Supplier - C	25	13	17	10	65

The above clearly show - the supplier –A having more score comparing with the B and C. so it is conclude that the supplier –A is good performance.

RELATIONSHIP DEVELOPMENT

Sustaining the relationship with the suppliers is important after initiating the customer supplier partnering process. To keep the relationship alive and growing the following activities are carried out.

1. Inspection

The purpose of this inspection process is to gain confidence in each other's performance and finally automating the inspection activity. There are four phase in the inspection process.

- a. 100% inspection
- b. Sampling inspection
- c. Audit
- d. Identity Checks.

2. Training

It is always better to educate the suppliers on what we expect from them and what quality means to us in the business process. This is possible by allowing the suppliers to undergo training programmes conducted by the senior officials at customer's sites.

3. Team Effort

In all the possible areas the teams must involve officials from the suppliers side also. This will enhance the understanding of the suppliers and their role in the business process will be clear to them.

The team meeting must be arranged at both the customer and the supplier premises.

4. Recognition

The customer should recognize the supplier's performance by awarding them with a place in the preferred suppliers list. A certificate of contribution to the business must be given to them. This recognition will surely develop the relationship between the customer and the supplier

PERFORMANCE MEASURES

Performance measures are used to assess the performance of all those involved in the process. Measures play an important role in the success or failure of an organization. An organization without performance measures is like a pilot of plane trying to locate the position and moving forward without proper instruments.

Basic Concepts

Performance measures are used to carry out one or more of the following objectives.

1. Identifying the business trends
2. To identify the processes that requires improvement
3. Determine the profit and loss due to a process
4. To calculate the gap between the actual and desired performance.
5. To gather information for assessing the individuals and teams.
6. To aid the decision making process with correct data and information.
7. To assess the performance of the company.

TYPICAL MEASUREMENTS

S: No	Element	Performance Measures
01	Human Resources	Absenteeism, employee satisfaction, training cost and time per employee, number of accidents due to an employee, number of complaints about an employee, number of suggestions received from each employee, etc.
02	End User Satisfaction	Number of complaints received and rectified, time taken to solve the problems, customer satisfaction index, etc.
03	Manufacturing Process	Process capability of each machine, over the time , usage of SPC charts, machine downtime etc,
04	R&D	Development time for a product development Process, number of constructive improvements made in an year by the department, expenditure, etc
05	Suppliers Performance	Quality of delivered goods, promptness, service etc.,
06	Marketing	Expenditure on training the sales force, new customers list, lost customers list, number of product enquiry calls per week and successful sales per week, etc,
07	Administration	Profit per employee, number of errors made in the business transactions per day etc.,

UNIT – III

STATISTICAL PROCESS CONTROL (SPC)

What is SPC?

- SPC stands for Statistical Process Control
- SPC does not refer to a particular technique, algorithm, or procedure
- SPC is an optimization philosophy concerned with continuous process improvements, using a collection of (Statistical) tools for
 - a.) Data and process analysis
 - b.) Making inferences about process behaviour
 - c.) Decision making
- SPC is a key component of total quality initiatives
- Ultimately SPC seeks to improve profits by
 - Improving product quality
 - Improving productivity
 - Streamlining process
 - Reducing wastages
 - Reducing emission
 - Improve customer service, etc.

SEVEN TOOLS OF QUALITY

• FLOW CHARTS

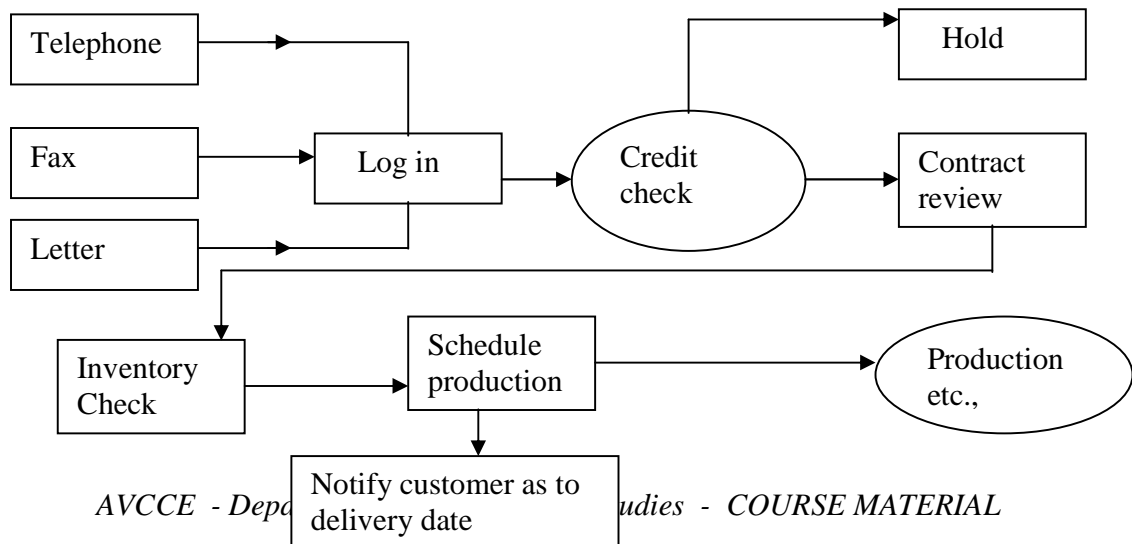
It shows the process of work i.e. the flow of material or information through a sequence of operations. These diagrams show the flow of the product or services as it moves through the various processing operations.

The diagram makes it easy to visualize the entire system, identify potential trouble spots and locate control activities.

Improvements can be accomplished by changing, reducing combining or eliminating steps.

For Example

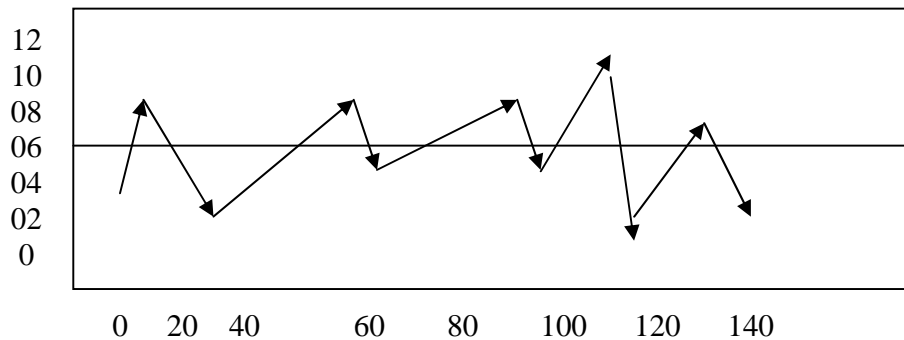
Flow diagram for an order entry activity



- **RUN CHARTS**

Run charts are simply plots of process characteristics against time or in chronological sequence. They do not have statistical basis, but are useful in revealing.'

- Trends
- Relationship between variables.



- **PARETO CHARTS AND ANALYSIS**

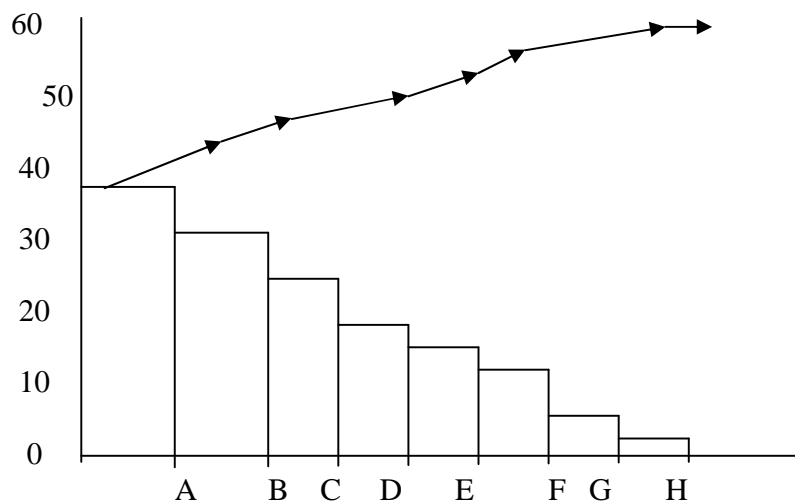
The 20% rule

Vilfredo Pareto (1848-1923)

- 80% of the wealth in Italy was held by 20% of the production
- 20% of customers accounted for 80% of sales
- 20% of parts accounted for 80% of cost.. Etc.

Pareto principles states that

- PARETO charts show the most frequently occurring factors
- Analysis of pareto charts help to make best use of limited resources by targeting the most important problems to tackle.



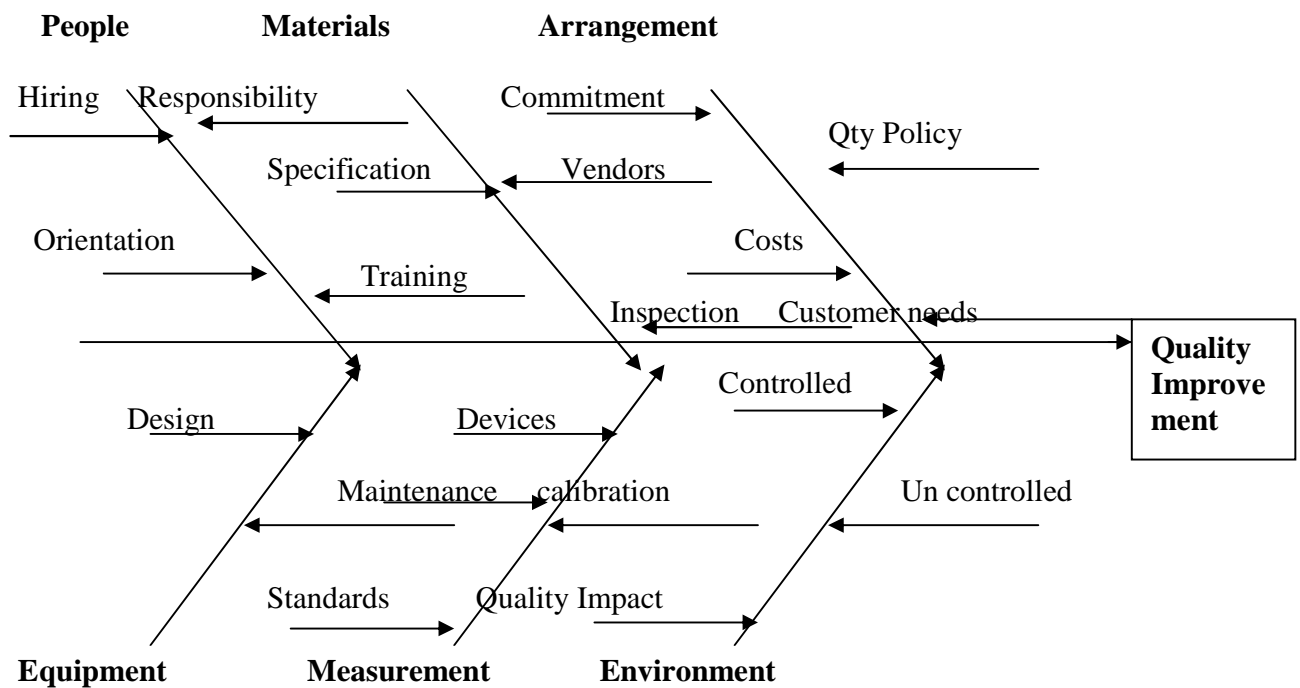
- CAUSE AND EFFECT DIAGRAMS**

It was developed by Dr. Kaoru Ishikawa in 1943 and is sometimes referred to as an Ishikawa diagram or a fishbone diagram because of its shape.

A cause and effect diagram is a picture composed of lines and symbols designed to represent a meaningful relationship between an effect and its causes.

This tool helps to organize problem-solving efforts by identifying all the factors that might have caused the problem. During brain storming sessions, this diagram is used to organize the ideas generated.

A typical cause-and-effect diagram is shown. The diagram shows the various elements (cause) that would have caused cracks on the surface, after the finishing process.



- HISTOGRAM DIAGRAMS**

A histogram is a graph that displays the distribution of data. A histogram is also known as 'frequency distribution diagram'. It is constructed from the data collected in a frequency table. A frequency table is a chart that divides the range

of data into several equal sections to compare the frequency of occurrence in each section.

Uses of histogram

A histogram is used to show clearly where the most frequently occurring values are located and the data is distributed. It is also a tool for determining the maximum results. It enables the analyst to quickly visualize the features of a complete set of data.

Construction of histogram

A histogram may be constructed using the following steps:

1. After the data collection, count the number of data values collected.
2. Determine the range of the data. $\text{Range} = \text{Highest value} - \text{lowest value}$.
3. Divide the data values in groups or classes and count the number of values in each class. The following table shows the guidelines to divide the data values.

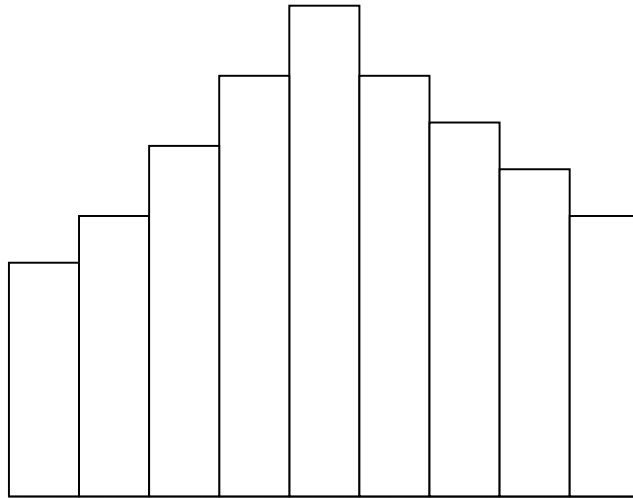
GUIDELINES TO FORM CLASSES

Number of values	Number of classes	Number of values	Number of classes
Less than 50	5-7	100-250	7-12
50-100	6-10	More than 250	10-20

4. Now determine the width of the classes
 $\text{Width of the classes} = \frac{\text{range}}{\text{Number of classes selected from the above table}}$
5. Draw a frequency table for all values.
6. Construct a histogram based on the frequency table. For that, mark the class limits on the horizontal axis and the frequency on the vertical axis.
7. Finally write the title and number of values on the diagram.

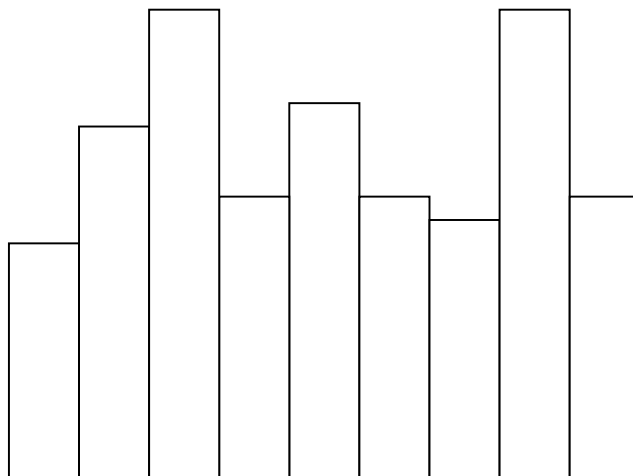
Types of histograms and their interpretations

The following patterns are very useful in the analysis of data.



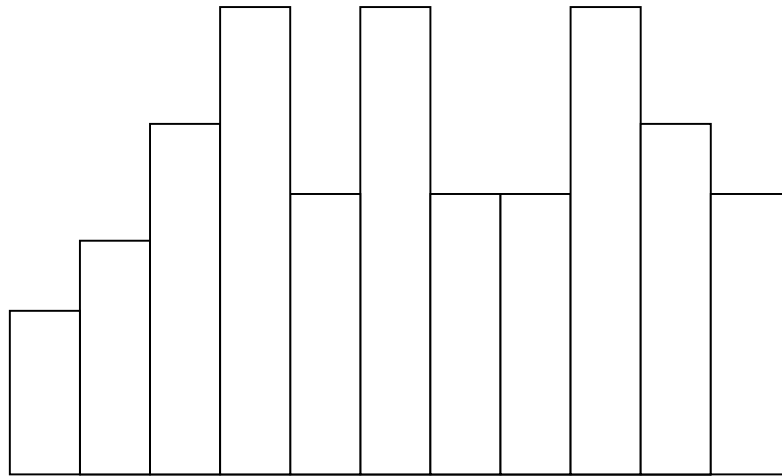
(a) Bell-shaped histogram

Bell-shaped	Symmetrical shape with a peak in middle representing a normal distribution.
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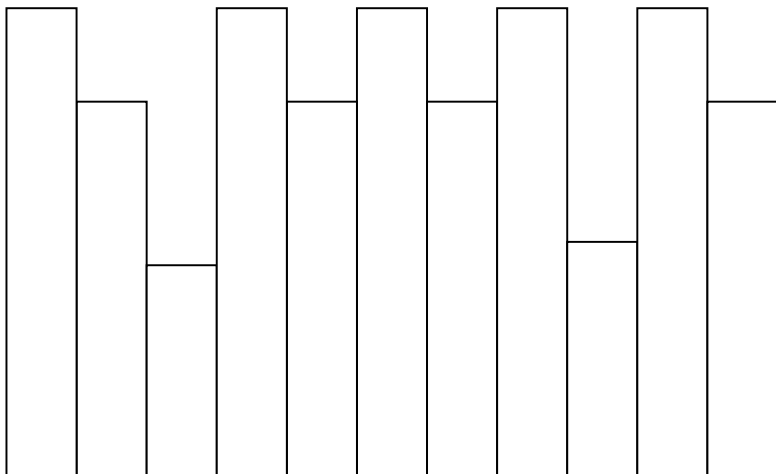
(b) Double-peaked histogram

Double-peaked	Two normal distribution with two peaks in middle indicating more than one distribution at work.
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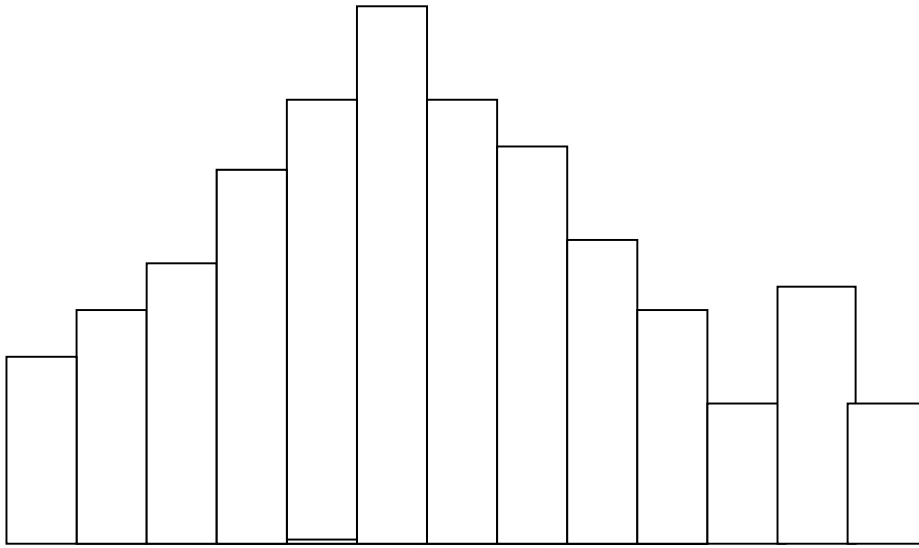
© Plateau

Plateau	Flat top, no distinct peak and tails indicating more than one distribution at work
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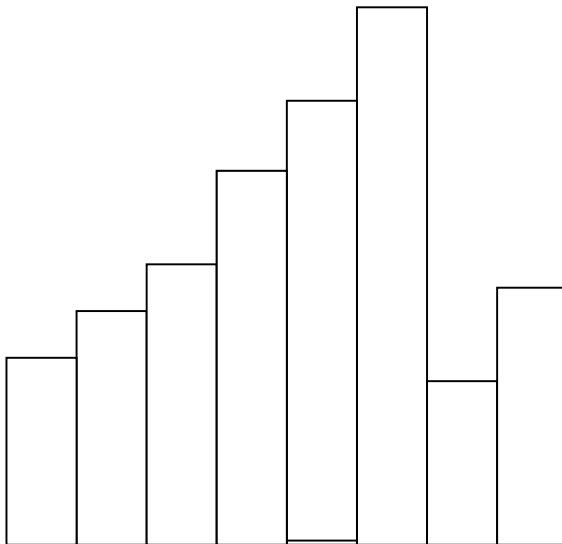
(d) Comb

Comb	Alternative peaks showing possible errors in data collection and analysis
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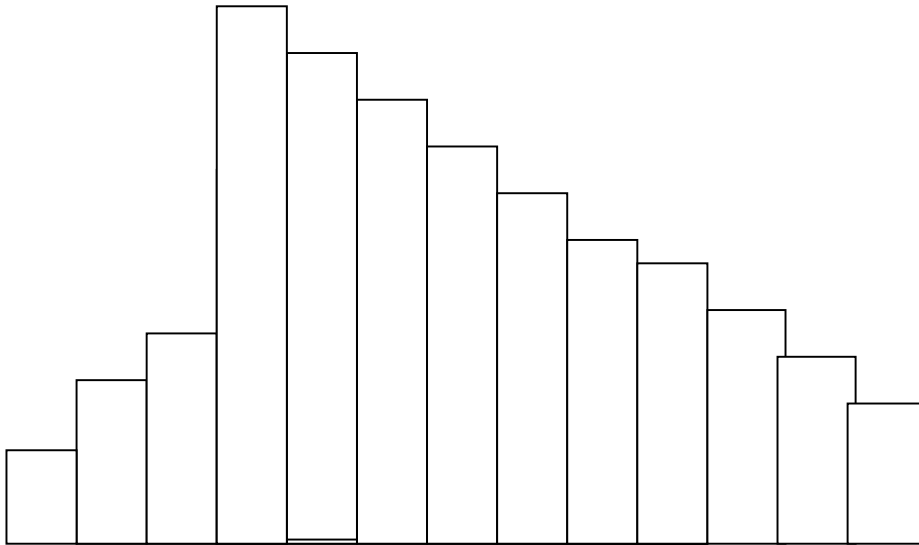
(e) Isolated peak

Isolated peak	Two normal distributions suggesting two processes taking place at the same time.
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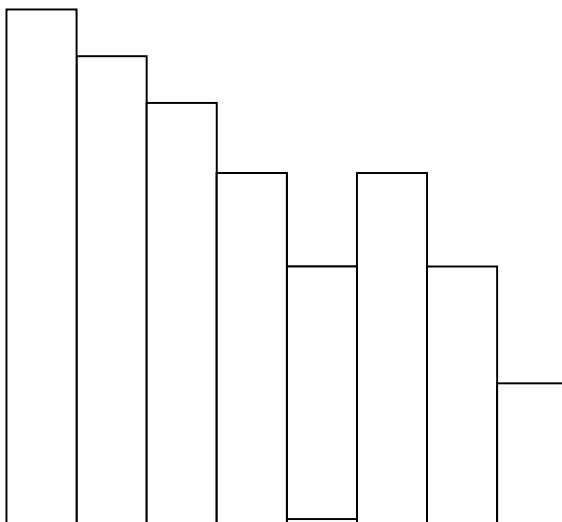


(f) Edged peak

Edged peak	A normal distribution curve with a large peak at one end indicating errors in data recording.
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**(g) Skewed**

Skewed	An asymmetrical shape positively or negatively skewed-usually reflecting limits in the specification on one side.
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Error!**(h) Truncated**

Truncated	An asymmetrical shape with a peak at the end. Usually being a part of a normal distribution with part of it having been removed.
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- **CHECK SHEET**

A check sheet is a form in table format prepared for recording data. Thus the necessary information can be recorded by making a check mark on the page. Check sheets are used in following ways:

1. Check sheets for recording data and making surveys
 - Defective item check sheet
 - Defect factor check sheet
 - Defect position check sheet
 - Process distribution check sheet
2. Inspection and validation check sheet

Product name...

Product no...

Process: publishing

DEFECTIVE ITEM CHECK SHEET

DAY

Defect	1	2	3	4	Total
A	IIII II	IIII I	II	I	16
B	IIII	IIII I	I	II	12
C	IIII	IIII IIII I	III	III	21
D	II	IIII I	II	IIII	13
Total	16	29	8	9	62

A-spelling mistakes

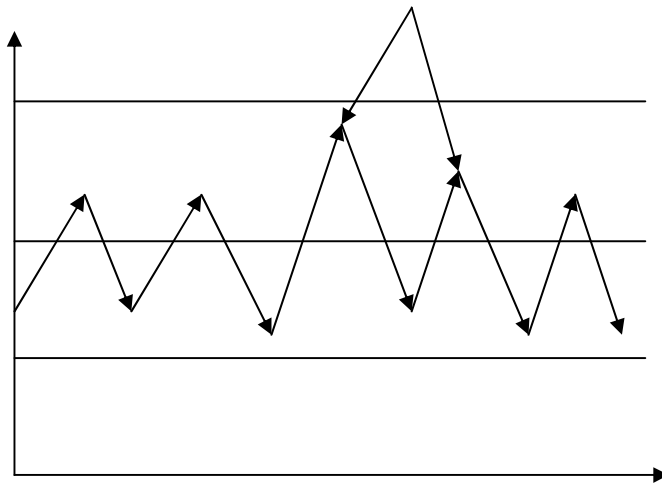
B-grammar mistakes

C-mistakes in the page numbers

D-punctuation marks

- **CONTROL CHARTS**

A control chart is used to monitor a process to see if the process output is random. It helps to detect the presence of controllable causes of variation. It can also indicate when a problem occurred and give insight into what might have caused the problem. Control charts are discussed in detail in the topic 'statistical process control'.



A control chart invented by WALTER A.SHEWRAT is the most widely used tool in statistical process control (SPC).

A control chart is a graph that displays data taken over time and variations of this data.

The control chart is based on a series of random samples taken at regular intervals.

The chart consists of three horizontal lines that remain constant over time: a centerline, a lower control limit (LCL), and an upper control limit (UCL).

The center is usually set at normal design value. The UCL and LCL are generally set at ± 3 standard deviations of the sample means.

If a sample drawn from the process lies inside these (UCL and LCL) limits, it means the process is in control. On the other hand, if the sample lies outside these limits, then the process is said to be out of control. So appropriate corrective action is necessary to eliminate the condition.

Types of control charts:

The two basic control charts are:

- (a) Control charts for variable-for measurable data such as time, length, temperature, weight, pressure etc.
- (b) Control charts for characteristics-for quantifiable data such as number of defects in a glass bottle (air bubbles), typing error in report, etc.

Uses of control charts

The purpose of a control chart is to identify when the processes has gone out of statistical control, thus signaling the need for some corrective action to be taken.

- **SCATTER DIAGRAMS**

Scatter diagram is a graph that shows the degree and direction of relationship between two variables. It can be useful in deciding whether there is a correlation between any two variables.

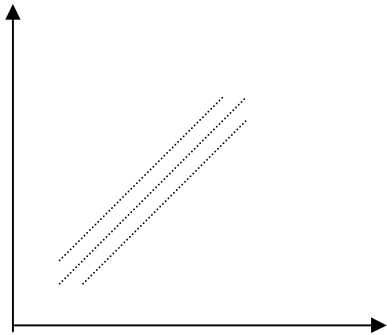
Relationship between the temperature and the number of errors committed per hour. High values of temperature correspond to high number of errors and vice versa. Higher values of speed correspond to low noise and vice versa.

The higher the correlation between the two variables, the lesser will be the scatter the points will tend to line up. On the other hand, if there were little or no relationship between two variables, the points would be completely scattered.

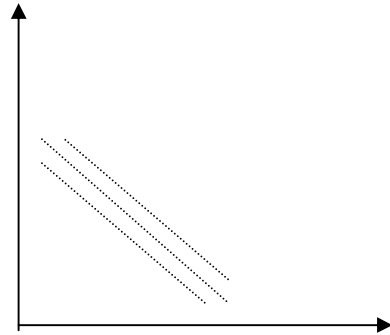
Uses of scatter diagram

- The purpose of scatter diagram is, therefore to display what happened to one variable to another variable is changed.
- This diagram is used to understand, why particular variations occur and how they can be controlled.

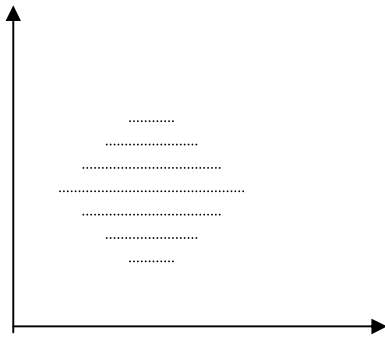
Types of scatter diagram



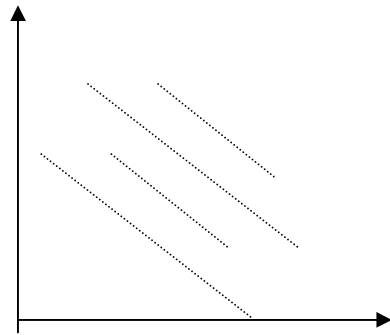
a) Positive correlation



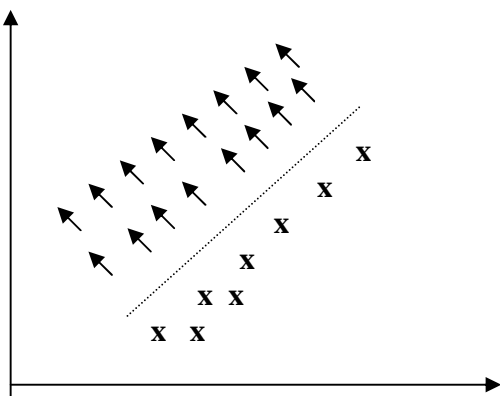
b) Negative correlation



c) No correlation



d) Negative correlation may exist



e) Correlation by stratification



f) curvilinear relationship

PROCESS CAPABILITY

Process capability compares the output of an in-control process to the specification limits by using capability indices. The comparison is made by forming the ratio of the spread between the process specifications (the specification “width”) to the spread of the process values, as measured by process standard deviation units (the process “width”)

SIX SIGMA

Six-sigma strategy can be used in an organization to achieve incredible levels of efficiency. The defects can be brought down to a level of 3.4 parts per million. This level is with a shift of 1.5σ . If the process can be centered properly the value can be still smaller (i.e. two defects per billion).

The objective of the six-sigma quality is to reduce process output variation so that \pm six standard deviations lie between the mean and the nearest specification limit.

THE NEW SEVEN MANAGEMENT AND PLANNING TOOLS

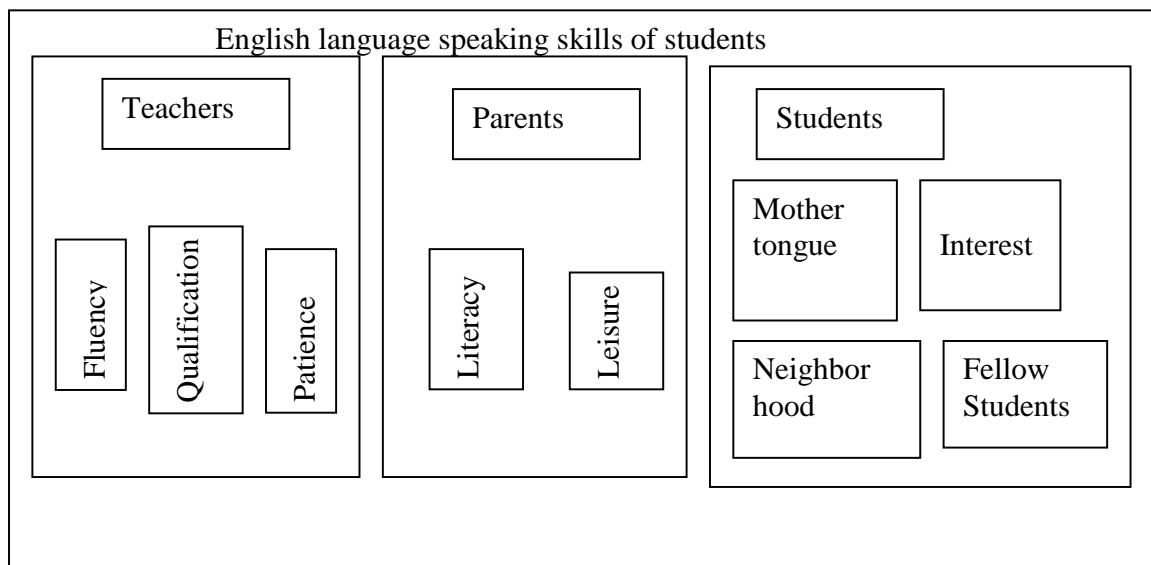
The advanced tools that are used to manage cross functionality include the seven new QC tools also known as the “Seven Management and Planning Tools” or 7 MP Tools in the US.

1. Identify a system owner and team members for each critical system.
2. Describe the system under study
3. Identify all subsystems that contribute to the critical system
4. Define the interdependencies of the subsystems
5. Prioritize the subsystems as to their contribution to the critical system
6. Develop a detailed “as is” description of the critical system. This includes identifying the interfaces between all system components as well as expanding the level of detail for major contributing subsystems.
7. Identify obvious system deficiencies
8. Identify possible causes of system deficiencies
9. Establish “basic line” measures for the system and major subsystems
10. Assess the performance of the system and major subsystems
11. Develop a “should be” description of the system and subsystems
12. Recommended changes to improve system and subsystem performance.

THE NEW SEVEN MANAGEMENT AND PLANNING TOOLS ARE:

- **AFFINITY DIAGRAMS**

In affinity diagrams large volumes of data is gathered and organized. Ideas, opinions, and facts relating to a problem are grouped. A sequence or pattern formation is the main aim. This is mainly used in addressing issues such as customer dissatisfaction etc. affinity diagram are tools for verbal data. Its applications are to organize into groups a large number of ideas, opinions about a particular topic.

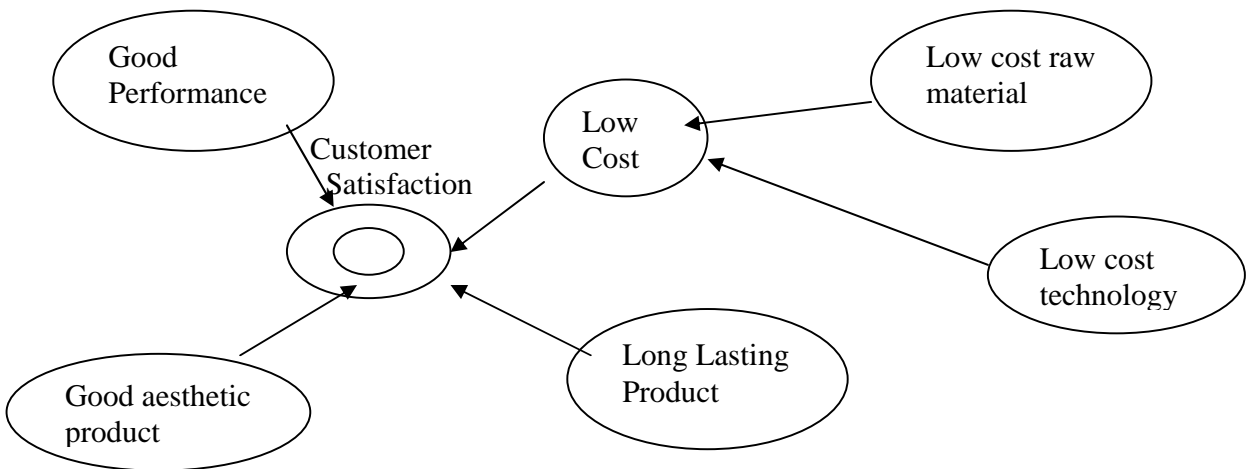


Example of an affinity diagram drawn to improve the English language speaking skills of students.

-
- **INTER RELATIONSHIP DIAGRAM**

The relationship between causative factors and then main issue is established. This tool helps us in identifying the relationship between different factors, which cause a problem or issue.

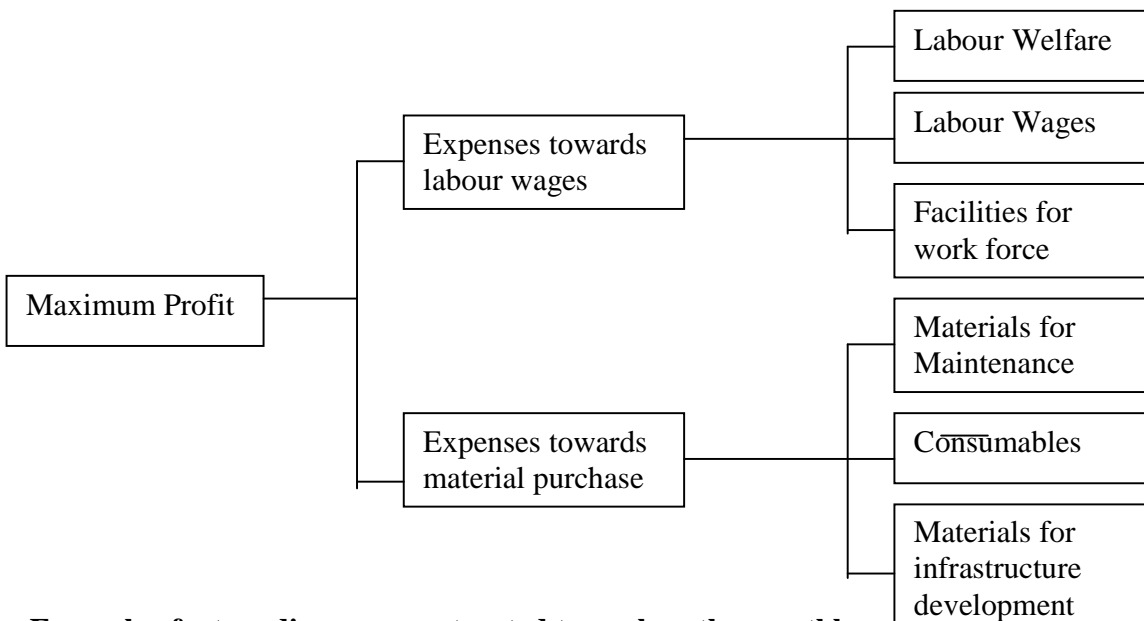
It also helps in determining the interrelationship between these factors. This tool is used to identify the major causes, which help in solving a problem on the basis of logical analysis and linkage of causes associated with the problem.



Example of a relationship diagram drawn to improve customer satisfaction.

- TREE DIAGRAM

Tree diagram is listed as a tool for non- numerical data. It is used to show the relationship between an issue and its component elements. Therefore a tree diagram breaks down the issue into its component elements. This is a tool for operational planning after initial diagnosis of issues.



Example of a tree diagram constructed to analyze the monthly outgoings of a company

- MATRIX DIAGRAM

A matrix diagram consists of a set of columns and rows. The intersections of these rows and columns are checked for determining the nature and strength of the problem. These help us to arrive at the key ideas and determining the relationship and an effective way of perusing the problem,

- **MATRIX DATA ANALYSIS**

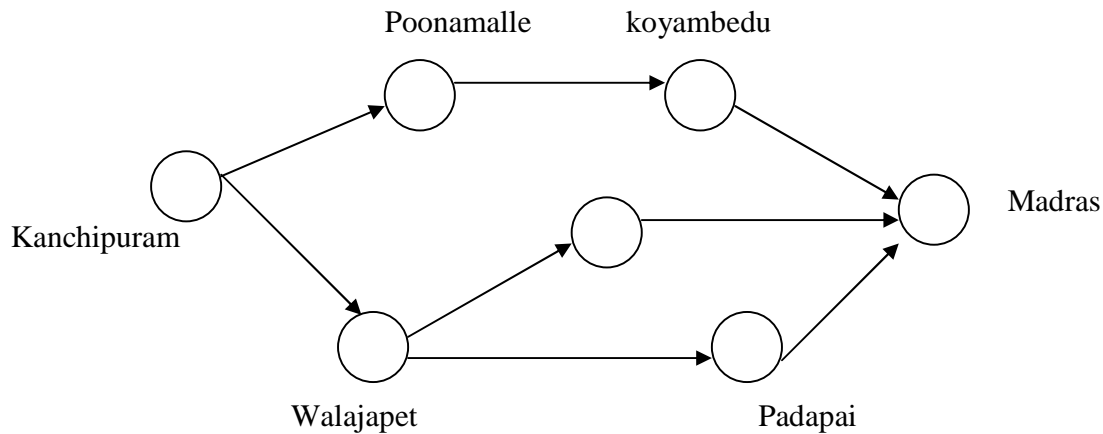
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Matrix data analysis

- **PROCESS DECISION PROGRAMME CHART**

It is method, which maps out conceivable events and contingencies that can occur in any implementation plan along with appropriate counter measures. This tool is used to plan each possible chain of events that need to occur when the problem or goal is unfamiliar one. This is a qualitative tool.

Thus PDPC is useful whenever uncertainty exists in a proposed implementation plan.

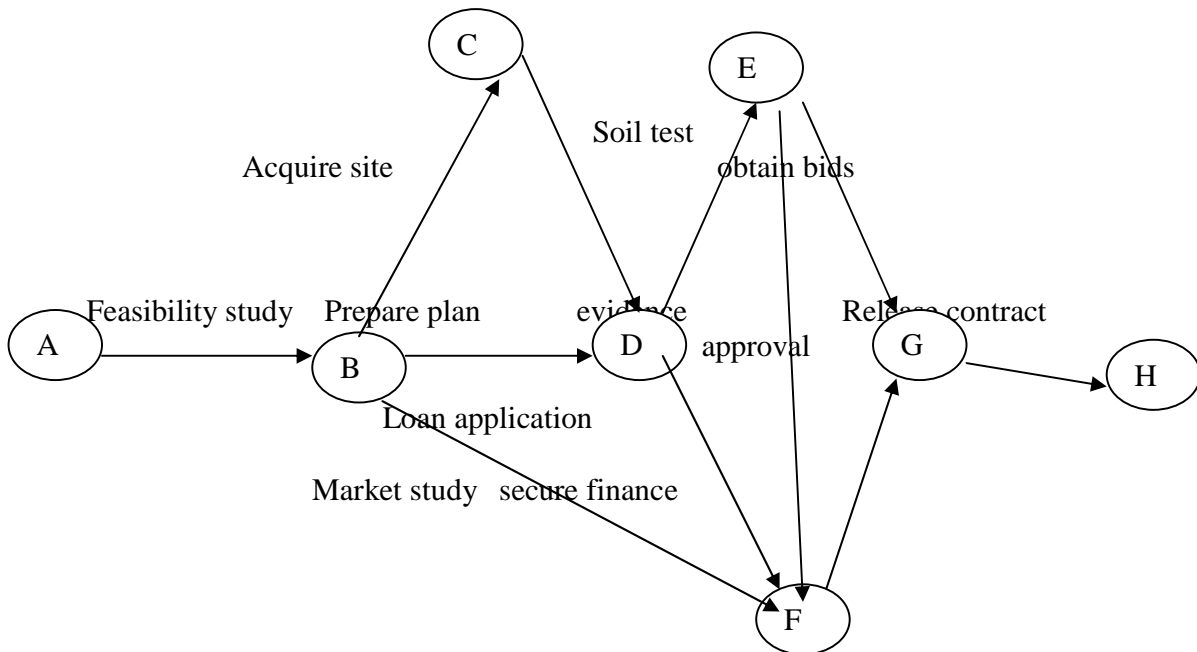


Example of process decision programme chart for commuting between Kanchipuram and Madras

- ARROW DIAGRAM

Arrow diagram is tool to plan the most appropriate schedule for the completion of a complete task and its related sub-task. It projects likely completion time and monitors all sub tasks adherence to necessary schedule.

The total work or task is sub- broken down to sub tasks or activities. The sub tasks and the total work is linked by arrows and a diagram is constructed to depict the activities.



Arrow diagram of list of activities in a construction firm

- Measures of Central Tendency and dispersion,
- Population and sample,
- Normal curve,
- Control charts for variables and attributes
- Population and sample
- Process capability

Problems and solutions

UNIT-IV TQM TOOLS

BENCH MARKING

Introduction

Benchmarking involves management identifying the best firms in their industry, or any other industry where similar processes exist, and comparing the results and processes of those studied (the "targets") to one's own results and processes to learn how well the targets perform and, more importantly, how they do it

Bench marking is the comparison of the processes and systems of a given business function across companies. It is a way for managers and employees to compare their functional performance to that of other companies. It can be defined as

- Measuring your performance against that of best in-class companies
- Analyzing how (methods) the best achieve their performance level.
- Using the information as the basis for evaluating your own targets, strategy and applications.
- Involvement and improvements are not limited to employees. In some cases, customers and suppliers are involving group problem solving.

DEFINITION

“Bench marking is the process of identifying, understanding, and adapting outstanding practices from organizations anywhere in the world to help your organization improve its performance”.

The following is an example of a typical benchmarking methodology:

1. Identify your problem areas –

Because benchmarking can be applied to any business process or function, a range of research techniques may be required. They include: informal conversations with customers, employees, or suppliers; [exploratory research](#) techniques such as [focus groups](#); or in-depth [marketing research](#), [quantitative research](#), [surveys](#), [questionnaires](#), re-engineering analysis, process mapping, quality control variance reports, or financial ratio analysis. Before embarking on comparison with other organizations it is essential that you know your own organization's function, processes; base lining performance provides a point against which improvement effort can be measured.

2. Identify other industries that have similar processes –

For instance if one were interested in improving hand offs in addiction treatment he/she would try to identify other fields that also have hand off challenges. These could include air traffic control, cell phone switching between towers, transfer of patients from surgery to recovery rooms.

3. **Identify organizations that are leaders in these areas –**

Look for the very best in any industry and in any country. Consult customers, suppliers, financial analysts, trade associations, and magazines to determine which companies are worthy of study.

4. **Survey companies for measures and practices –**

Companies target specific business processes using detailed surveys of measures and practices used to identify business process alternatives and leading companies. Surveys are typically masked to protect confidential data by neutral associations and consultants.

5. **Visit the "best practice" companies to identify leading edge practices –**

Companies typically agree to mutually exchange information beneficial to all parties in a benchmarking group and share the results within the group.

6. **Implement new and improved business practices –**

Take the leading edge practices and develop implementation plans which include identification of specific opportunities, funding the project and selling the ideas to the organization for the purpose of gaining demonstrated value from the process.

Types of benchmarking

- **Process benchmarking –**

The initiating firm focuses its observation and investigation of business processes with a goal of identifying and observing the best practices from one or more benchmark firms. Activity analysis will be required where the objective is to benchmark cost and efficiency; increasingly applied to back-office processes where outsourcing may be a consideration.

- **Financial benchmarking –**

Performing a financial analysis and comparing the results in an effort to assess your overall competitiveness and productivity.

- **Benchmarking from an investor perspective-**

Extending the benchmarking universe to also compare to peer companies that can be considered alternative investment opportunities from the perspective of an investor.

- **Performance benchmarking –**

Allows the initiator firm to assess their competitive position by comparing products and services with those of target firms.

- **Product benchmarking** –

The process of designing new products or upgrades to current ones. This process can sometimes involve reverse engineering which is taking apart competitors products to find strengths and weaknesses.

- **Strategic benchmarking** –

Involves observing how others compete. This type is usually not industry specific, meaning it is best to look at other industries.

- **Functional benchmarking** –

A company will focus its benchmarking on a single function to improve the operation of that particular function. Complex functions such as Human Resources, Finance and Accounting and Information and Communication Technology are unlikely to be directly comparable in cost and efficiency terms and may need to be disaggregated into processes to make valid comparison.

- **Best-in-class benchmarking** –

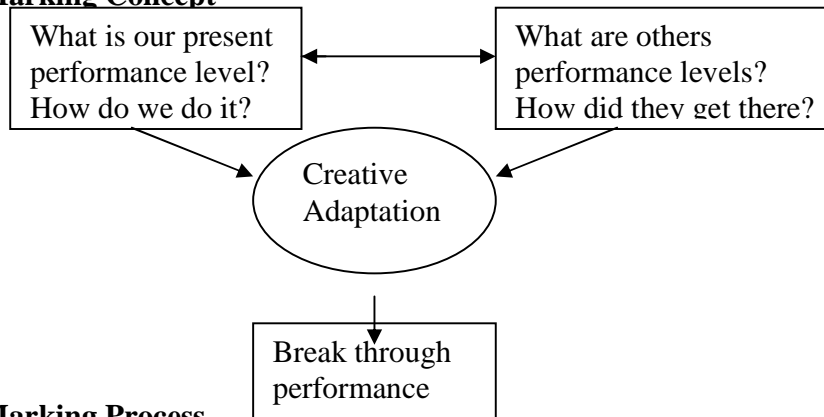
Involves studying the leading competitor or the company that best carries out a specific function.

- **Operational benchmarking** –

Embraces everything from staffing and productivity to office flow and analysis of procedures performed

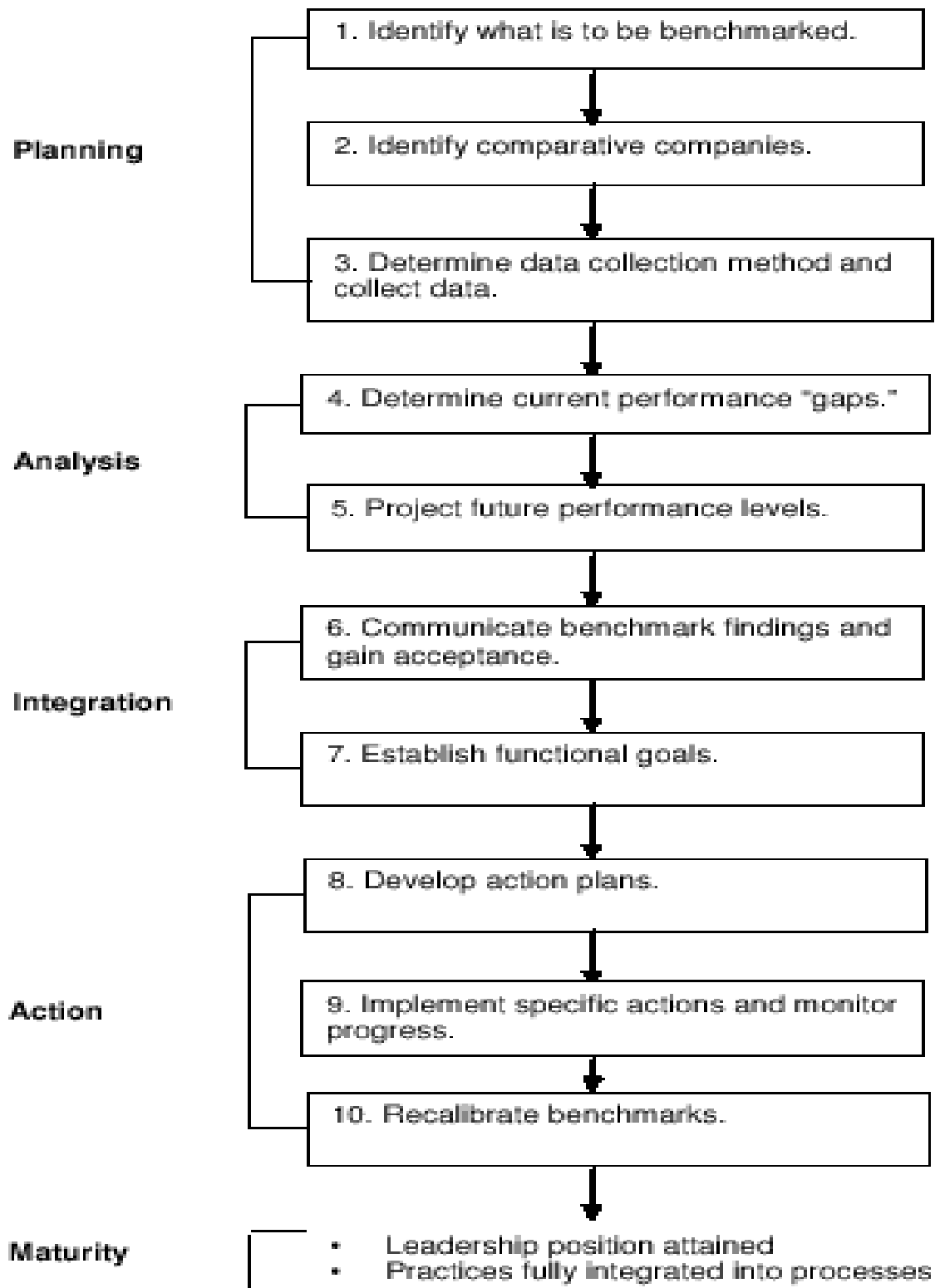
Reasons to Bench Marking

- Its aims at a goal setting process to facilitate comparison with the best
- To measure the relative performance of the organization.
- To analyze and determine how the best company has achieved its performance level so that the same strategy can be followed.
- The information can be used to relatively evaluate or rank our targets and strategies presently followed.
- It aims at searching for industry best practices

Bench Marking Concept**Bench Marking Process**

The benchmarking process consists of five phases:

1. Gap analysis between our own company practices and other superior practices
2. Assimilating and understanding the prevalent best practices in industries to find out “What must be changed”
3. Recognizing and identifying the “bench marking partner” and studying there best practices.
4. Executing and implementing bench marked practices at our own unit to achieve the target.
5. Evaluating the results and outcomes to determine where we stand after implementing the changes.



Planning.

The essential steps are those of any plan development: what, who and how.

- **Earmark what is to be benchmarked?**
- **Identifying the best competitor**

Determine the data collection method and the start collecting data

- **What is to be benchmarked?** Every function of an organization has or delivers a “product” or output. Benchmarking is appropriate for any output of a process or function, whether it’s a physical good, an order, a shipment, an invoice, a service or a report.
- **To whom or what will we compare?** Business-to-business, direct competitors are certainly prime candidates to benchmark. But they are not the only targets. Benchmarking must be conducted against the best companies and business functions regardless of where they exist.
- **How will the data be collected?** There’s no one way to conduct benchmarking investigations. There’s an infinite variety of ways to obtain required data – and most of the data you’ll need are readily and publicly available. Recognize that benchmarking is a process not only of deriving quantifiable goals and targets, but more importantly, it’s the process of investigating and documenting the best industry practices, which can help you achieve goals and targets.

I. Analysis.

The analysis phase must involve a careful understanding of your current process and practices, as well as those of the organizations being benchmarked. What is desired is an understanding of internal performance on which to assess strengths and weaknesses.

Ask:

- Is this other organization better than we are?
- Why are they better?
- By how much?
- What best practices are being used now or can be anticipated?
- How can their practices be incorporated or adapted for use in our organization?

Answers to these questions will define the dimensions of any performance gap: negative, positive or parity. The gap provides an objective basis on which to act—to close the gap or capitalize on any advantage your organization has.

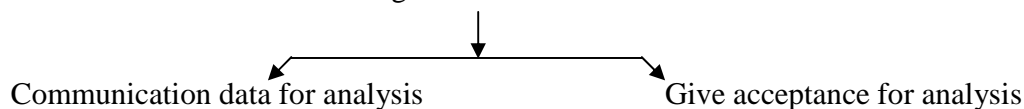
II. Integration.

Integration is the process of using benchmark findings to set operational targets for change. It involves careful planning to incorporate new practices in the operation and to ensure benchmark findings are incorporated in all formal planning processes.

Steps include:

- Gain operational and management acceptance of benchmark findings. Clearly and convincingly demonstrate findings as correct and based on substantive data.
- Develop action plans.
- Communicate findings to all organizational levels to obtain support, commitment and ownership.

1. Communicate benchmark findings and gain acceptance.
2. Establish functional goals



III. Action.

Convert benchmark findings, and operational principles based on them, to specific actions to be taken. Put in place a periodic measurement and assessment of achievement. Use the creative talents of the people who actually perform work tasks to determine how the findings can be incorporated into the work processes.

Any plan for change also should contain milestones for updating the benchmark findings, and an ongoing reporting mechanism. Progress toward benchmark findings must be reported to all employees.

IV. Maturity.

Maturity will be reached when best industry practices are incorporated in all business processes, thus ensuring superiority.

Tests for superiority:

- If the now-changed process were to be made available to others, would a knowledgeable businessperson prefer it?
- Do other organizations benchmark your internal operations?

QUALITY FUNCTION DEPLOYMENT

- It is a structured method that is intended to transmit and translate customer requirements, that is, the
- **Voice of the Customer**
- Through each stage of the product development and production process, that is, through the product realization cycle.
- These requirements are the collection of customer needs, including all satisfiers, excitors/delighters, and dissatisfies.

QFD is systematic and organized approach of taking customer needs and demands into consideration while designing new products and services (or while improving existing products and services)

QFD focuses on the ‘ **voice of the customer** ’ i.e. customer expectation or requirements. That’s why QFD is sometimes as “**Customer Driven Engineering**”

Definition

Quality Function Deployment may be defined as a system for translating consumer requirements into appropriate requirements at every stage, from research through product design and development, to manufacture, distribution, installation and marketing sales and services.

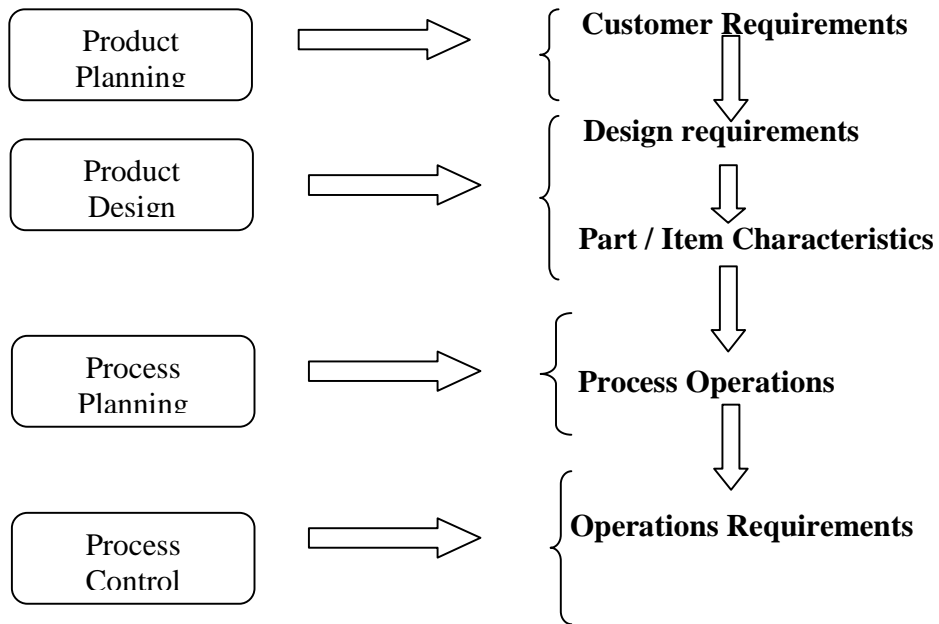
Objectives

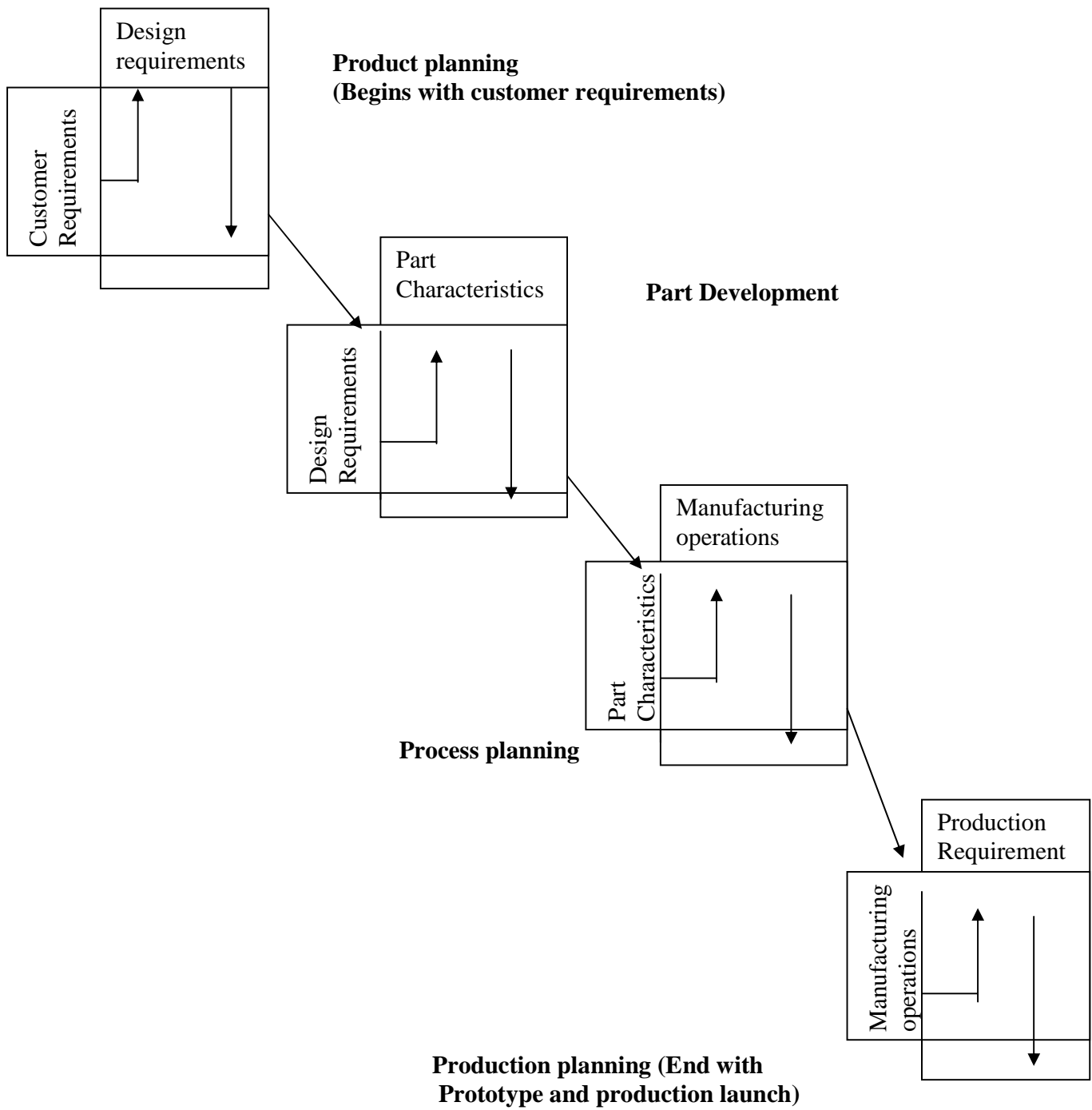
- To identify the true voice of the customer and to use this knowledge to develop products which satisfy customers
- To help in the organization and analysis of all the relevant information associated with the project.

In short the QFD aims at translating the customer voice (or) requirements into products specifications

QFD PROCESS

QFD is a team based management tool. Here customer expectations are used to drive the product development process. In a typical QFD application, a cross functional team creates and analysis a matrix linking customer wants and needs to a set of product and service designs metrics that the company can then measure and control.





Phase-I

Product planning

- ❖ List of customer requirements (What's)
- ❖ List technical descriptors (How's)
- ❖ Develop a relationship matrix between What and How
- ❖ Develop an interrelationship matrix between How's
- ❖ Do competitive assessments
- ❖ Develop prioritized customer requirements'
- ❖ Develop prioritized technical descriptors

Phase- II

Part Development

- ❖ Deploy QFD process down to sub- components level both in terms of requirements and characteristics
- ❖ Deploy the component deployment chart. Relate the critical sub-component control characteristics

Phase – III

Process Planning

- ❖ Develop the relationship between the critical characteristics and process used to create the characteristics
- ❖ Develop the control plan relating critical control to critical processes

Phase-IV

Production planning

- ❖ Tabulate operating instructions from process requirement
- ❖ Develop prototype and do testing
- ❖ Launch the final product to the market.

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

- **Customer driven:**
The focus is on customers' wants, not what the company thinks the customer wants. 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.

- **Documentation:**

A knowledge base is built as the QFD process is implemented. A historical record of the decision-making process is developed

BENEFITS OF QFD

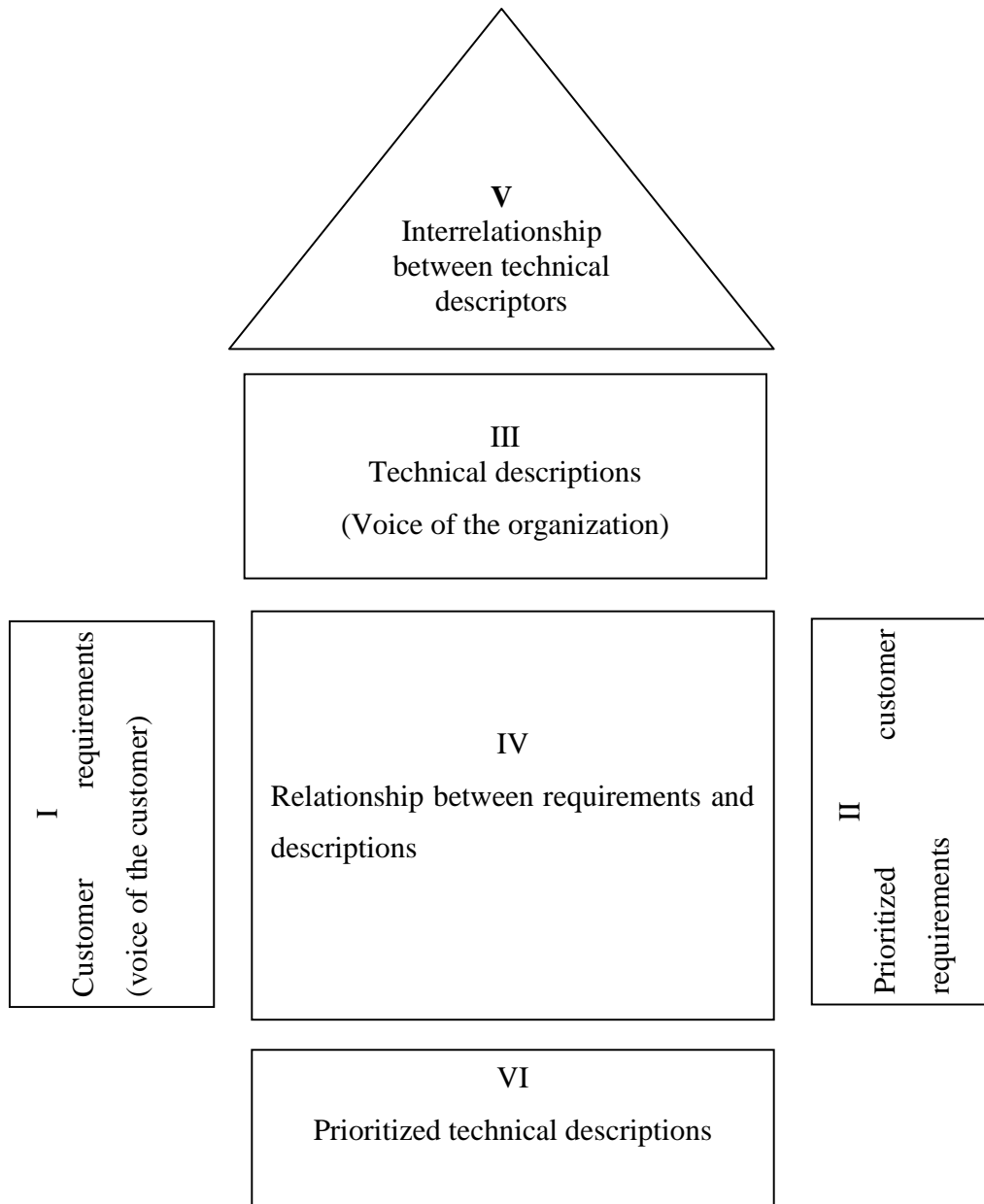
- ▶ Promotes better understanding of customer demands
- ▶ Improve customer satisfaction
- ▶ Promotes team work
- ▶ Facilitates better understanding of design interactions
- ▶ Concentrates on design efforts
- ▶ Introduce new design to the market faster.
- ▶ Breaks down barriers between functions and departments

HOUSE OF QUALITY (Tools of QFD)

House of Quality is a graphic tool for defining the relationship between [customer](#) desires and the firm/product capabilities. It is a part of the [Quality Function Deployment](#) (QFD) and it utilizes a [planning matrix](#) to relate what the customer wants to how a firm (that produce the products) is going to meet those wants. It looks like a House with a "[correlation matrix](#)" as its roof, customer wants versus product features as the main part, competitor evaluation as the porch etc. It is based on "the belief that products should be designed to reflect customers' desires and tastes"^[1]. It also is reported to increase cross functional integration within organizations using it, especially between [marketing](#), engineering and manufacturing.

- The primary planning tool used in the **QFD** is the “**HOUSE OF QUALITY**”
- The House OF Quality converts the voice of the customer into product design characteristics
- QFD uses a series of matrix diagrams also called ‘**QUALITY TABLES**’ that resemble connected houses.

Basic structure of House of Quality



The house of quality has six sections

Section –I

Customer Requirements

- ✓ The exterior walls of the house are the customer requirements

- ✓ On the left hand side, the voice of the customer i.e, what the customer expect from the product is listed.

Section – II
Prioritized Customer Requirements

- ✓ On the right hand side, the prioritized customer requirements or planning matrix are listed
- ✓ Some of the listed items include customer bench marking, customer importance rating, target value, scale up factor and sales point.

Section –III
Technical Descriptors

- ✓ The second floor, or ceiling of the house contains the technical descriptors
- ✓ Product design characteristics, expressed in engineering terms, are located in this ceiling

Section – IV
Relationship Matrix

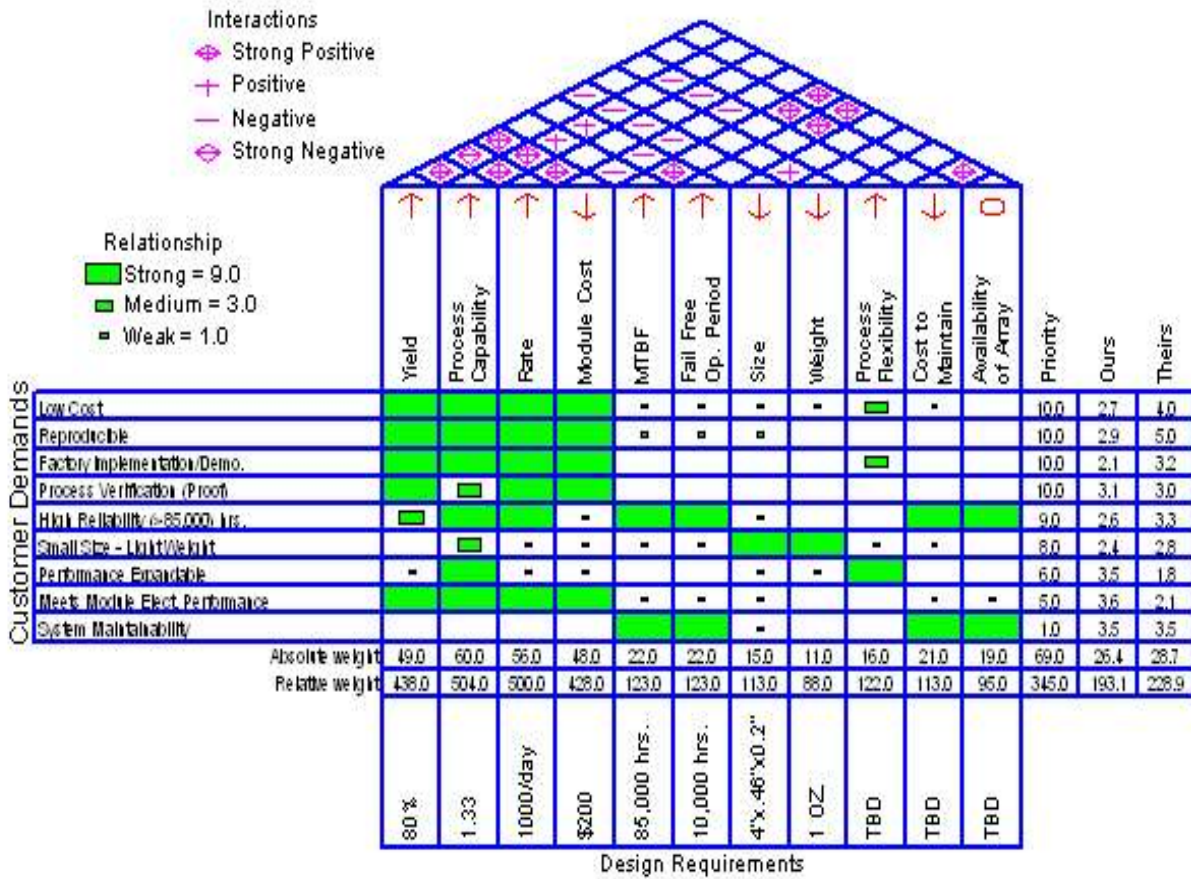
- ✓ The interior walls of the house are the relationship between customer requirements and technical descriptors.
- ✓ The relationship matrix correlates customer requirements with product characteristics

Section – V
Trade –Off Matrix

- ✓ The root of the house is the interrelationship between technical descriptors.
- ✓ Trade –off between similar and /or conflicting technical descriptors are identified.

Section – VI
Prioritized Technical Descriptors

- ✓ The foundation of the house is the prioritized technical descriptors
- ✓ Some of the items included are the technical benchmarking, degree of technical difficulty, and target value.



"a minimal loss at the nominal value, and an ever-increasing loss with departure either way from the nominal value." - W. Edwards Deming

The quality loss function is based on the work of electrical engineer, Genichi Taguchi. This view disagrees with the traditional (goalpost) view. The quality loss function recognizes that products falling between specific limits are not all equal. The four following statements summarize Taguchi's philosophy.

1. We cannot reduce cost without affecting quality.
2. We can improve quality without increasing cost.
3. We can reduce cost by improving quality.
4. We can reduce cost by reducing variation. When we do so, performance and quality will automatically improve.

- ❑ Taguchi defines Quality as “the loss imparted by the product to society from the time the product is shipped.”
- ❑ LOSS = Cost to operate, Failure to function, maintenance and repair cost, customer satisfaction, poor design.
- ❑ Product to be produced “being within specification”

<u>Taguchi's</u>	<u>Traditional</u>
When a product moves from its Target will cause the loss even if the product lies or not within Limits	There is Good or Bad Products only as per Limits

Taguchi's Vs Traditional Approach

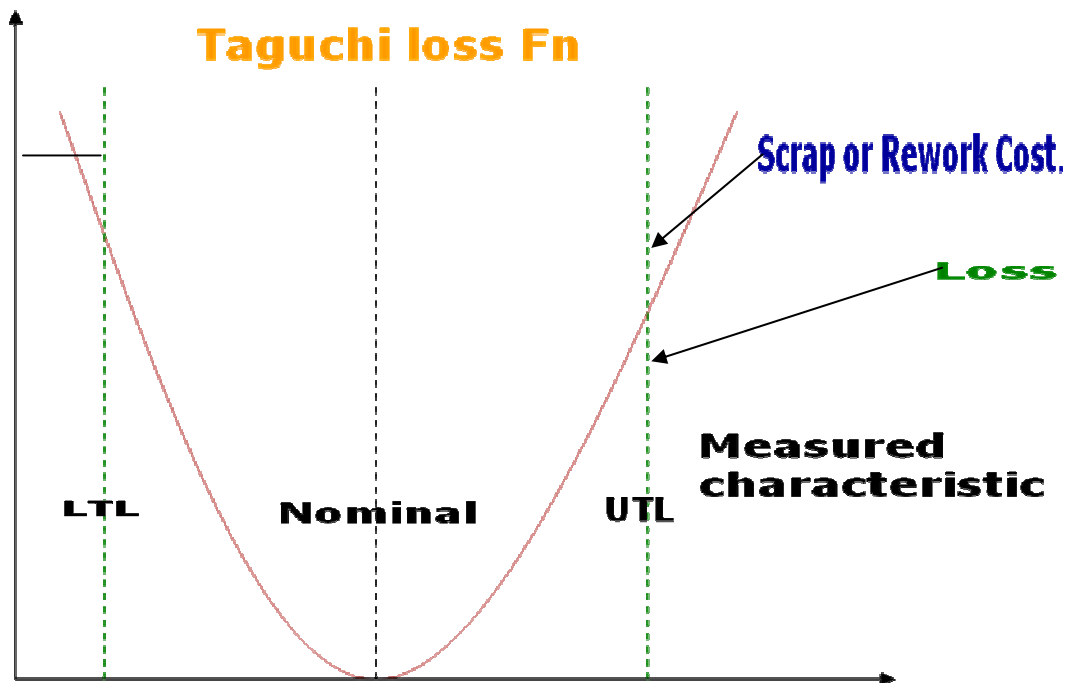
Taguchi's Loss Function

- ❖ Taguchi's defines quality as “the loss imparted by the product to society from the time the product is shipped”
- ❖ This loss includes costs to operate, failure to function, maintenance and repair costs, customer dissatisfaction, injuries caused by poor design and similar costs.
- ❖ Defective products/ parts that are detected, repaired reworked, or scrapped before shipment are not considered part of this loss
- ❖ The essence of the loss function is that whenever a product deviates from its target performance, it generates a loss to society. This loss is minimum when performance is right on target, but it grows gradually as one deviates from the target.
- ❖ Therefore the loss function philosophy says that for a manufacturer, the best strategy is to produce as close to the target as possible, rather than aiming at “being with in specifications”

Taguchi's Quadratic Quality Loss Function

- ❑ **Quality Loss Occurs when a product's deviates from target or nominal value.**
- ❑ **Deviation Grows, then Loss increases.**
- ❑ **Taguchi's U-shaped loss Function Curve**

Taguchi's U-shaped loss Function Curve



Formula to find Taguchi's Loss Fn

Taguchi uses Quadratic Equation to determine loss Curve

$$L(x) = k(x-N)^2$$

Where $L(x)$ = Loss Function,

$k = C/d^2$ = Constant of proportionality,

where C – Loss associated with sp limit

d - Deviation of specification from target value

x = Quality Features of selected product,

N = Nominal Value of the product and

$(x-N)$ = Tolerance

Problem

A part dimension on a power tool is specified as 32.25 ± 0.25 . Company records show ± 0.25 exceeded & 75% of the returned for replacement. Cost of replacement is Rs.12,500. Determine k & QLF

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MAINTENANCE

Maintenance is defined as the management, control, and execution and quality assurance of activities, which ensure the achievement of optimum availability and performance of a plant in order to meet business objectives.

Types of Maintenance

- ❖ **Corrective or breakdown maintenance**
It implies that repairs are made after failure of machine or equipment.
- ❖ **Scheduled or routine breakdown**
It is a stitch-in-time procedure aimed to avoiding breakdowns
- ❖ **Preventive maintenance**
It is carried out before the failure arises (or) prior to the equipment actually breakdowns. E.g. Overhauling & Periodic upkeep.
- ❖ **Predictive maintenance**
Equipment Condition evaluated periodically and maintenance carried out.

TOTAL PRODUCTIVE MAINTENANCE

TPM is a partnership between the maintenance and production organization to improve product quality, reduce waste, reduce cost, increase equipment availability and improve maintenance state.

- Total productive maintenance (TPM) is the systematic execution of maintenance by all employees through small group activities
- The dual goals of TPM are zero breakdowns and zero defects.
- TPM improves equipment efficiency rates and reduces cost. It also minimizes inventory costs associated with spare parts.
- TPM is concerned with the fundamental rethink of business processes to achieve improvements in cost, quality, speed etc.

OBJECTIVES OF TPM

1. To improve equipment effectiveness.
2. To achieve autonomous maintenance
3. To plan maintenance
4. To train all staff in relevant maintenance skills
5. To Zero Breakdowns

WHAT ARE THE 6 BIG LOSSES?

- | | |
|-------------------------------|--|
| 1. Breakdown | - Long interruptions, expensive repairs |
| 2. Setup and changeover | - Taking much longer than needed |
| 3. Idling and minor stoppages | - Hard to quantify, add up to big losses |
| 4. Reduced speed | - Equipment cycle times have gradually deteriorated |
| 5. Defects and rework | - Quality losses and unhappy customers |

6. Start up losses

- **Too long to get to steady state after a Change.**

CONCEPT OF TPM

- ❖ TPM is that everyone from the operator to top management is responsible for maintenance activities
- ❖ Under TPM operators no longer limit themselves to simply using the machine and calling the technician when a breakdown occurs. Operators can inspect, clean, lubricate, adjust and even perform simple calibrations on their respective equipment.
- ❖ In TPM management should also show interest in data concerning equipment uptime, utilization and efficiency.
- ❖ Everyone understands that zero breakdowns, zero defects and maximum productivity are goals to be shared by everyone under TPM
- ❖ TPM cannot implement overnight. Normally it takes an organization at least two years to set and effective TPM system in place.
- ❖ Activities carried out in small teams with specific tasks. Every level in the overall organizations must be represented by a team or more

TWELVE STEPS FOR TPM DEVELOPMENT

1. Announce top management about the decision to introduce TPM
2. Launch education and campaign to introduce TPM
3. Create organization to promote teams
4. Establish basic TPM policies and goals
5. Formulate basic TPM policies and goals
6. Hold TPM kick off
7. Improve effectiveness of each piece of equipment
8. Develop an autonomous maintenance programme
9. Develop a scheduled maintenance program for the maintenance department.
10. Conduct training to improve operation and maintenance skills
11. Develop early equipment management program
12. Perfect TPM implementation

BENEFITS OF TPM

- ✓ Increased equipment productivity
- ✓ Improved equipment reliability
- ✓ Reduced equipment downtime
- ✓ Increased plant capacity
- ✓ Extended machine line.
- ✓ Lower maintenance and production costs
- ✓ Approaching zero equipment – caused defects
- ✓ Improved teamwork between operators and maintenance people.
- ✓ Enhanced job satisfaction
- ✓ Improved return on investment
- ✓ Improved safety

FAILURE MODE AND EFFECT ANALYSIS

Introduction

- **Failure Mode Effect Analysis is an analytical technique that goes in for combining Technology and Experience of people to identify foreseen failures in a product or process and planning to eliminate the Failure.**

MEANING

Failure mode and effect analysis (FMEA) also known a risk analysis is a preventive measure to systematically display the causes, effects and possible actions regarding observed failure.

The objective of **FMEA** is to anticipate failures and prevent them from occurring. FMEA prioritise failures and attempts to eliminate their causes.

FMEA is an engineering technique used to define, identify and eliminate known and/ or potential failures, problems, errors which occur in the system, design process and service ‘ before they reach the customers’

TYPES OF FMEA

Major Classification

- **Design FMEA**
- **Process FMEA**

Sub Classification

- **Equipment FMEA**
- **Maintenance FMEA**
- **Service FMEA**
- **System FMEA**

1. Design FMEA

- ✓ Design FMEA involves the analysis of the potential failures of product or service due to component or subsystem unreliability
- ✓ Design FMEA is to establish priorities based on expected failures and severity of those failures.

2. Process FMEA

- ✓ Process FMEA involves a failure analysis of a manufacturing process.
- ✓ The process FMEA is used primarily to identify areas of critically of control and to emphasize the design and more reliable.

FAILURE RATE

- Products follow a pattern of failure.
- There is no information about the reliability (i.e. Failure) of the product.
- Failure Rate is a constant is known period of failure can be found out using Exponential Distribution

$$Rt = e - \lambda t \quad Rt = \text{Reliability of survival}$$

$$Rt = e - t / \theta \quad t = \text{Time for operation without failure}$$

$$\lambda = \text{Failure rate } \theta = \text{Mean time to Failure}$$

BENEFITS OF FMEA

- Improve product/process reliability and quality
- Increase customer satisfaction
- Early identification and elimination of potential product / process failure modes.
- Prioritize product /process deficiencies
- Capture engineering/ organizational knowledge
- Document and track the actions taken to reduce risk
- Provide focus for improved testing and development.
- Minimize late changes and associated cost.

FMEA PROCEDURE

1. Describe the product/process and its function

2. Create a block diagram of the product/ process:

It shows the relationship of components and establishes a structure, which the FMEA can be developed.

3. Complete the header of the FMEA form worksheet.

Changing team leader, team members if it's needed

4. List product/process function

5. Identify failure modes

A failure mode is defined as the manner in which a component, subsystem, system, process, etc., could potentially fail to meet the design purpose.

Examples of potential failure modes include- corrosion, torque, fatigue, deformation, cracking, electrical short or open and hydrogen embitterment.'

6. Describe the potential failure effects:

A failure effect is defined as the result of a failure mode on the function of the product/process as perceived by the customer

Examples of failure effects include: injury to the user, impaired operation, poor appearance, odors, noise and degraded performance.

7. Establish the numerical ranking for the severity of the effect.

8. **The CLASS column** is used to classify any special product characteristics for components, sub-systems, or systems that may require additional process controls.

9. Identify the potential causes/ mechanisms of failure.

Example:- improper torque applied, improper operating conditions, improper alignment, excessive loading etc.,

10. Enter the probability factor.

A numerical weight should be assigned to each cause that indicates how likely that cause. (i.e., probability of the cause causing)

11. Identify current control

12. Determine the likelihood of deduction

The likelihood of detection is also based on a 1 to 10 scale, with 1 being the certain of detection and 10 being the absolute uncertainty of detection.

13. Review Risk Priority Number (RPN)

The risk priority number is defined as the product of Severity(S), Occurrence (O), and detection (D) rankings

$$\text{i.e., RPN} = \text{Severity} \times \text{Occurrence} \times \text{Detection}$$

14. Determine the recommended actions

15. Assign responsibility and a target completion date for these actions. This makes responsibility clear cut and facilitates tracking

16. Indicate actions taken..

17. Update the FMEA as the design or process changes, the assessment changes or new information becomes known.



UNIT-V

QUALITY SYSTEMS

International Organization for Standardization (ISO) was established in 1946 in Geneva, Switzerland.

International Organization for Standardization (ISO) define the term quality systems as follows:

“The quality systems are the organizational structures, responsibilities, procedures, processes and resources for implementing quality management.”

ISO -9000 and ISO- 14000

The ISO 9000 family primarily concerned with “quality Management”. This means what the organization does to fulfill.

- The customers quality requirements
- Applicable regulatory requirements, while aiming to
- Enhance customer satisfaction and
- Achieve continual improvements of its performance in pursuit of these objectives.

The ISO 14000 family primarily concerned with “environmental management”. This means what organization does to?

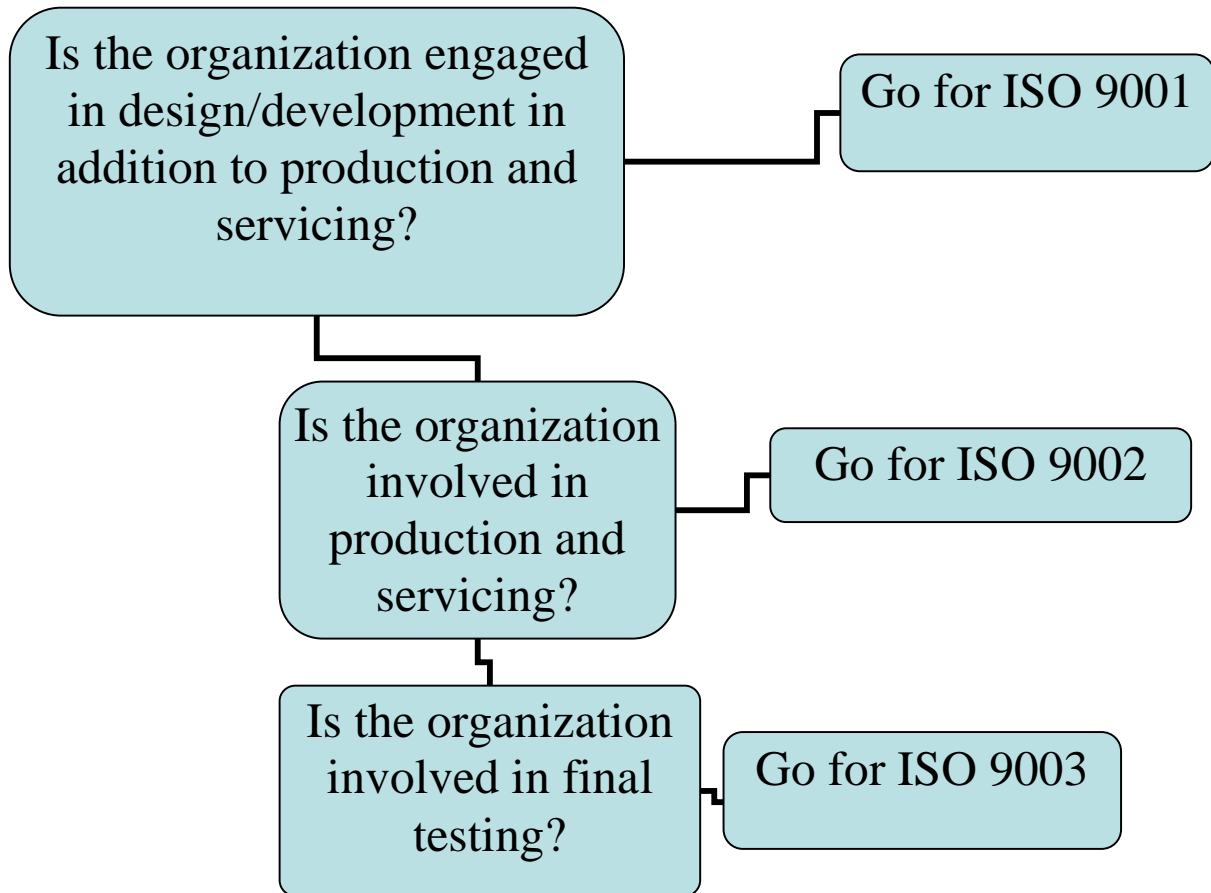
- Minimize harmful effects on the effect on the environment caused by it activities, and to
- Achieve continual improvement of its environmental performance.

Reasons for implementing a Quality System that conforms to an ISO standard

- Improved employee involvement (average gain is 100%)
- Improved housekeeping (average gain is 140%)
- Improved decision making based on facts and data (average gain is (5%)
- Improved customer satisfaction (average gain is 55%)
- Improved safe working (gain is 45%)
- Reduced customer complaints (about40%)
- Reduced inspection efforts (about 45%)
- Reduced quality cost (about 50%)

SELECTION OF ISO STANDARDS:

An organization can use the decision tree for selection of ISO standards

ELEMENTS OF CLAUSES OF ISO 9000:
(QUALITY SYSTEM REQUIREMENTS):

The elements of ISO 9000 must be understood for their successful implementation in an organization. The following are the twenty elements of quality managements.

1. MANAGEMENT RESPONSIBILITY:

- The management should define and documents its quality policy and objectives.
- The responsibility, authority and interrelations of all employees should be clearly defined.
- The management should provide adequate resources for internal verification activities.
- The management should nominate management representative such as quality director or quality manager to coordinate the quality activity.
- The management must periodically review the effectiveness of the quality system and keep record of the same.

2. QUALITY SYSTEM:

- The organization should document, establish and maintain a quality system.
- The documentation of quality system includes preparation of quality manual, procedures, process work instructions, workmanship standards, drawing specifications and relevant quality records.

3. CONTRACT REVIEW:

- This element states that the customer's requirements (the contract) should be formally reviewed to ensure that the supplier is capable in terms of both technical and organizational requirements.
- The records of those reviews should be properly maintained.

4. DESIGN CONTROL:

- This element requires that the design process should be documented and planned correctly.
- Both the design inputs(like specifications) and the design outputs(like drawings) should be identified and documented.
- The supplier shall review the designs to ensure that the outputs meet the input requirements and that any changes to the designs are properly controlled.

5. DOCUMENT CONTROL:

- The ISO 9000 quality management system is totally documented system.
- This element explains the method of documentation, approval and issue of all quality documents.
- The various documents include quality manual, quality system procedures, work instructions quality plans and quality records.

6. PURCHASING:

- This clause addresses relating to assessment of subcontractor, purchasing data, verification of purchased components, materials and procedures there of are specified.
- The suppliers must have4 procedures for maintaining list of approved sub contractors, deleting sub contracting etc.
- This clause on purchasing/sub-contracting is applicable to raw materials, purchased components, sub-contracted components which are likely to affect the product.

7. PURCHASER SUPPLIED PRODUCT:

(Control of customer supplied product)

- In many situations the customer supplies various products. For example, in construction work, the customer may supply cement and steel. This clause explains how a system has to be laid down for inspection, storage and usage of customer-supplied products.
- This also lays down the responsibility for preventing damage or loss and the same to be recorded and reported to the customer.

8. PRODUCT IDENTIFICATION AND TRACEABILITY:

- This clause lays down the requirement for the product or services to be correctly identified throughout the production process.
- Trace ability means the method by which the item can be identified.

9. PROCESS CONTROL:

- This clause specifies that the supplier shall identify and plan the production and installation processes, which directly affect the quality.
- According to this clause, each process has to be performed under controlled conditions. Controlled conditions mean the following:
 - i. Quality system procedure (QSP) to describe how each process is carried out.
 - ii. Compliance with relevant codes/ standards and quality plans
 - iii. Monitoring and control of specified process parameters and product characteristics.
 - iv. Approval of process as specified in quality system.
 - v. Maintaining workmanship standards in terms of representative samples, sketches, photographs, details write ups etc.,
 - vi. Continuous monitoring to ensure continuing process capability.

10. INSPECTIONS AND TESTING

- **Receiving inspection and testing** – to ensure the quality while at the time of receiving the products from purchaser.
- **In-process inspection and testing** – to ensure the quality at the time of processing of the product/ services
- **Final inspection and testing** – to ensure the quality at final stage (Finished product) of the product/ services.

11. INSPECTION, MEASURING AND TESTING EQUIPMENT (IMTE)

- Identify the measurements to be made and the accuracy required.
- Selecting appropriate inspection, measuring and test equipments
- Calibrating the measuring equipments and test devices.
- Maintaining calibration records for inspection, measuring and test equipments.

12. INSPECTION AND TEST STATUS

- This clause explains how the systems should be laid down to indicate that the product has been inspected and tested and conforms or does not conform to specifications at various stages or production.

13. CONTROL OF NON CONFORMING PRODUCTS

- This clause lays down how action should be taken that does not conform to specifications.
- This control includes identification, documentation, evaluation, segregation and disposal of non-conforming product.
- This part of the standard is sometimes referred to as the calibration section.

14. CORRECTIVE AND PREVENTIVE ACTION

- This clause explains the systems for removing actual and potential non-conformities.
- Corrective action includes effective handling of customer complaints investigation of the cause of non-conformity and its removal.
- Prevention action is taken to ensure that non-conformity does not occur. This is done by continuous study and analysis of various sources of information.

15. HANDLING, STORAGE, PACKING PRESERVATION AND DELIVERY

- This clause explains how the supplier ensures that there is no degradation of quality of product due to handling, storage, preservation, and delivery at different stages of production.

16. CONTROL OF QUALITY RECORDS.

- The records of the performance of the quality system (contract review, sub contractor assessment, test records, calibration data etc.,) should be established and maintained.
- These records are essential for assessment of the effectiveness of the quality system by the internal/ external certification audits and management reviews.

17. INTERNAL QUALITY AUDIT

- This clause describes the self-evaluation mechanism. These are carried out by the suppliers own people trained for the purpose.
- These audits are used to verify the effectiveness of the quality system.
- The audit result should be documented and reported to the concerned managers to take any identified corrective action.

18. TRAINING

- This clause describes how training needs of personnel are identified, organized, implemented and monitored.
- Appropriate records of all training should be maintained.
- Training pertains to professional training as well as training for maintenance and implementation of quality system.

19. SERVICING

- This clause explains how servicing will be planned and executed wherever it is a specified requirement.
- Record of service provided should.

20. STATISTICAL TECHNIQUES

- This clause describes that the organization has to identify the most useful statistical techniques (such as pareto analysis, histograms, PERT, etc.,) for its operations.

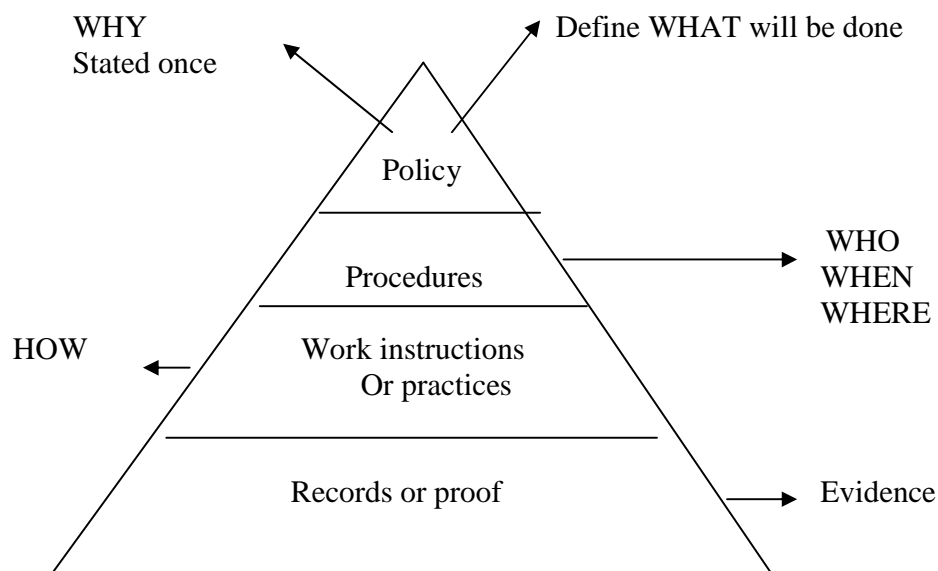
IMPLEMENT OF QUALITY SYSTEMS (STEPS TO REGISTRATION)

1. Top management commitment.
2. Appoint the management representative
3. Awareness
4. Appoint an implementation team.
5. Training
6. Time schedule
7. Select element owners.
8. Review the present system
9. Write the documents
10. Install the new systems
11. Internal Audit
12. Management Review
13. Pre assessment
14. Registration
15. Award of ISO 9000 certificate.

DOCUMENTS TO BE PREPARED

1. Quality Policy Manual.
2. Quality System procedures (QSPs)
3. Work Instructions (Wis)
4. Records/ Formats/ Forms

the above system documentation can be viewed as a hierarchy containing four levels as shown in the below diagram.



1. QUALITY POLICY MANUAL

- Quality policy manual is the first level of documentation. This is the documentation that defines “what will be done “ and “Why”.
- The policy manual communicates the quality policy and objectives of an organization.
- This manual is a living document. Because it reflects the current system being followed in the organization.

2. QUALITY SYSTEM PROCEDURES

- These procedures describe the methods that will be used to implement and perform the stated polices.
- These procedures define who should perform specific tasks, when the task should be done, and where documentation will be made.
- These procedures are confidential documents of the organization and therefore need not be revealed to outsiders.

3. WORK INSTRUCTONS

- It gives details of flow individual work processes (for example, machining welding, casting etc.,) are carried out within a company.
- It also specify how the work should be done; who should undertake the work and what records are to be maintained.
- The work instructions should be written by the employee who performs the task.

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