

Unit-I - INTRODUCTION

Introduction.

Quality is generally used with reference to the end use of the product. For example, one could argue that this leather wallet is a high quality one. How we can judge that? The high quality wallet will have durable, soft leather, precise stitching, and a long lifespan.

In a contrast, a low quality wallet may use cheap materials, have poor stitching, and wear out quickly. The difference lies in the materials, craftsmanship and overall durability.

Quality is a relative term. The quality is defined as the fitness for use or purpose at the most economical level.

Quality is a judgement by customers or users of a product or service. That is quality is a customer determination, not an engineer's determination or a manager's determination.

Quality is the extent to which the customers or users believe the product or service exceeds their needs and expectations.

Quality does not mean an expensive product; it is fitness for use of the customer.

Quality Chain Reaction.

The Deming quality chain Reaction is depicted in the following figure 1.

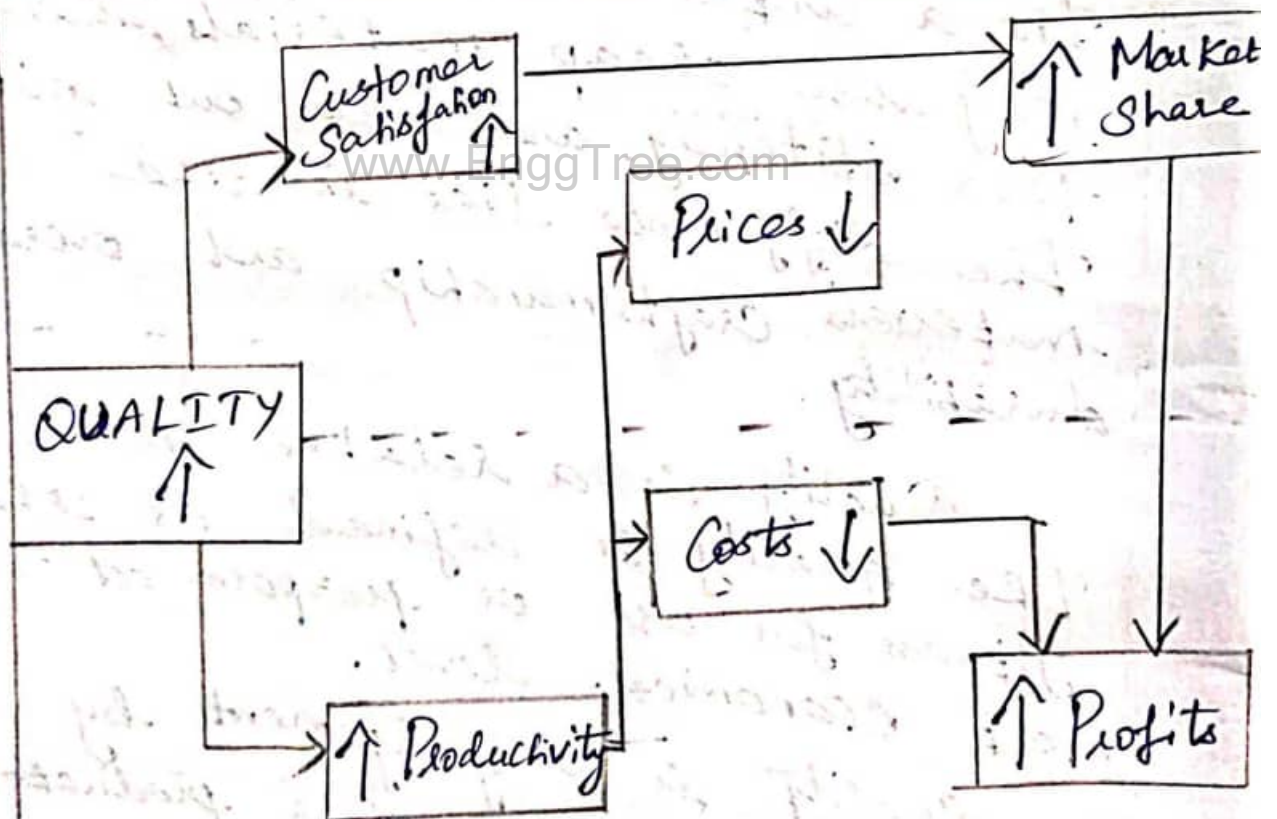


Figure 1. Deming's Quality Chain reaction.

Japanese Chain reaction is another view of the above quality chain reaction depicted in figure 2. Clearly explain the importance of quality in any organisation.

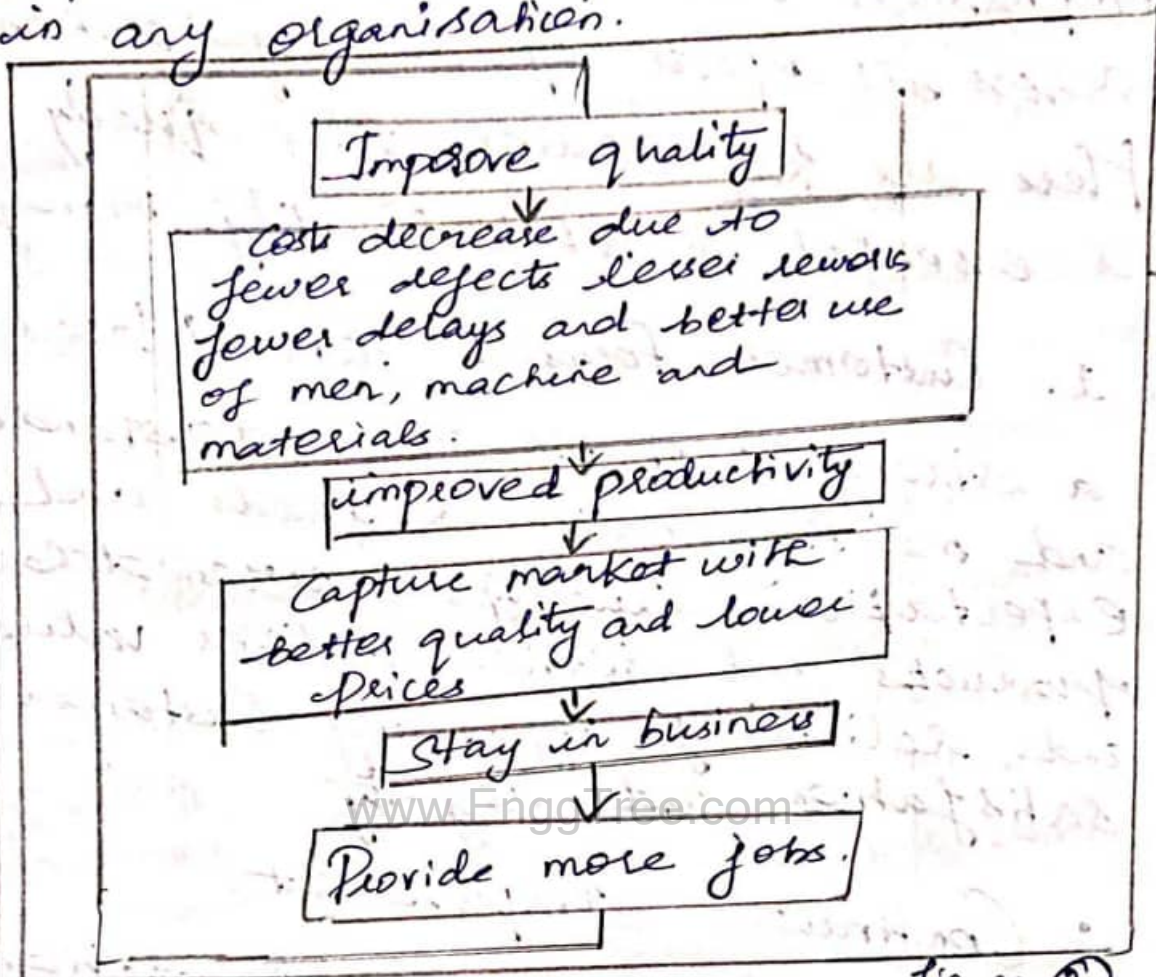


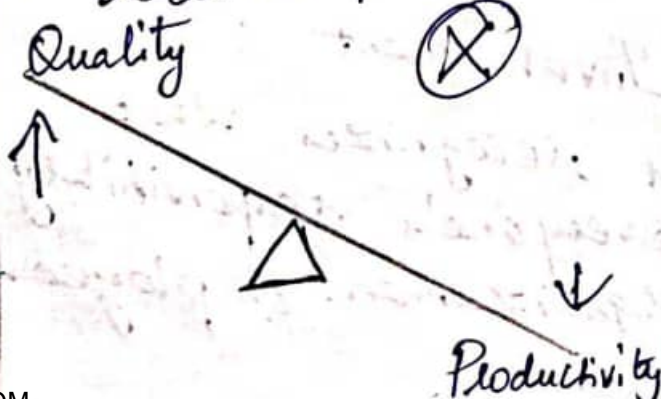
Figure 2

Quality Vs Productivity

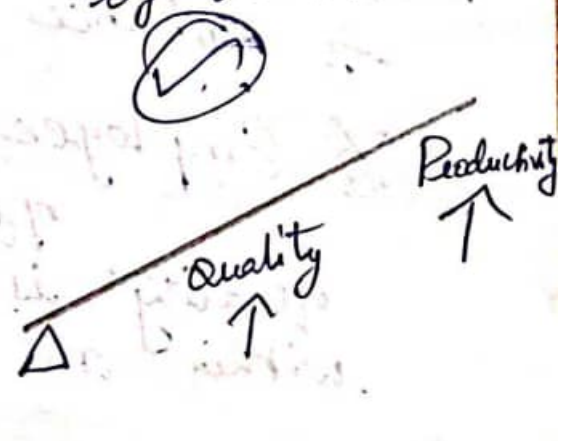
Figure 3 depicts the two views in the relationship between quality and productivity.

Figure 3

(a) Out model (Cold view)



(b) Modern view of relationship



Need for Quality :

Total Quality Management (TQM) emphasizes the need for quality across all aspects of an organization. Here are key reasons why quality is essential in Total Quality Management.

1. Customer Focus : TQM Places a strong emphasis on understanding and meeting customer needs and expectations. Quality ensures that products and services deliver value and reliability, fostering customer satisfaction and loyalty.

2. Continuous Improvement :

Quality is the foundation of Continuous improvement in TQM. By consistently striving for higher quality standards, organizations can identify and eliminate inefficiencies, reduce waste and optimize processes to enhance overall performance.

3. Employee Involvement :

TQM recognizes that quality is everyone's responsibility within an organization. Employees

are empowered to contribute to quality improvement initiatives, fostering a culture of collaboration, innovation, and accountability.

4. Cost Reduction: Implementing TQM principles leads to reduced costs associated with defects, rework and customer complaints. By focusing on quality at every stage of production reduces cost.

5. Competitive Advantage: Consistently delivering high-quality products or services gives a competitive edge in the market. It can differentiate a company from its competitors and attract more customers.

6. Reputation and Brand Image: Consistently delivering quality builds a strong reputation and positive brand image. This enhances trust among stakeholders, including customers, suppliers, and investors.

7. Legal and Regulatory Compliance: Meeting quality standards ensures compliance with legal and regulatory requirements, avoiding penalties and lawsuits.

Overall, the need for quality in TQM is foundational to achieving organizational excellence, sustainability, and long-term success in a competitive business.

Evolution of Quality

The history of quality management is as old as industry itself. Table 1 depicts a brief outline of how the quality concepts have evolved starting from 19th Century.

Time	Events
Until the 1960's.	
Prior to the 20th Century	Quality is an art. Demands overcome potential Production An era of workmanship.
F. Taylor 1900s	The Scientific approach to management resulting in rationalization of work and its break down leads to greater need for standardization, inspection and supervision.
Shewart 1930's	Statistical beginnings and study of quality control. In Parallel studies by R.A. Fisher on experimental design. The

beginning of Control charts at Western electric in U.S.A.

Late 1930's	Quality standards and approaches are introduced in France (Dunmore) and Japan. Beginning of SQC, reliability and maintenance Engineering.
1942	Seminal work by Deming at the ministry of war in U.S.A on quality control and sampling. Working group setup by Tuar and Dodge on SQC in U.S. Army. Concepts of acceptance sampling devised.
1944	Dodge and Deming Carried out seminal research on acceptance sampling.
1945	Founding of the Japan Standard Association.
1946	Founding of the ASQC (American Society of quality Control).
1950	Visit of Deming in Japan at the invitation of K. Ishikawa.
1951	Quality Assurance increasingly accepted.

1954 TQC in Japan (Feigenbaum and Juran) :
book published 1956.

1957 founding of European
organisation for the control
of quality (France - AFNOR,
Germany, Italy, Holland, England)

After the 1960's.

1961 The Martin Co. in U.S.A.
Introduces the Zero-defects
approach, while developing and
producing perishing Missiles (Crosby).
Quality motivation is starting
in the U.S. and integrated
programmes begun.

1962 Quality Circles are started
in Japan.

1964 Ishikawa publishes book on
Quality Management.

1970 Ishikawa publishes the book
on the basics of quality Circles
and the concept of Total
Quality is affirmed and
devised.

1970
to
1980 Just-In-Time and Quality
become crucial for competitiveness.
A large number of U.S.
and European corporations are

beginning to appreciate the advance of Japan's industries. Taguchi popularises the use of environmental design to design robust systems and products.

1980 +

facing the rising sun challenge in quality management. Development and introduction of FMSs ^(Financial management software system) and greater dependence on supplier contracts.

Growth of economic based on quality control information software packages.

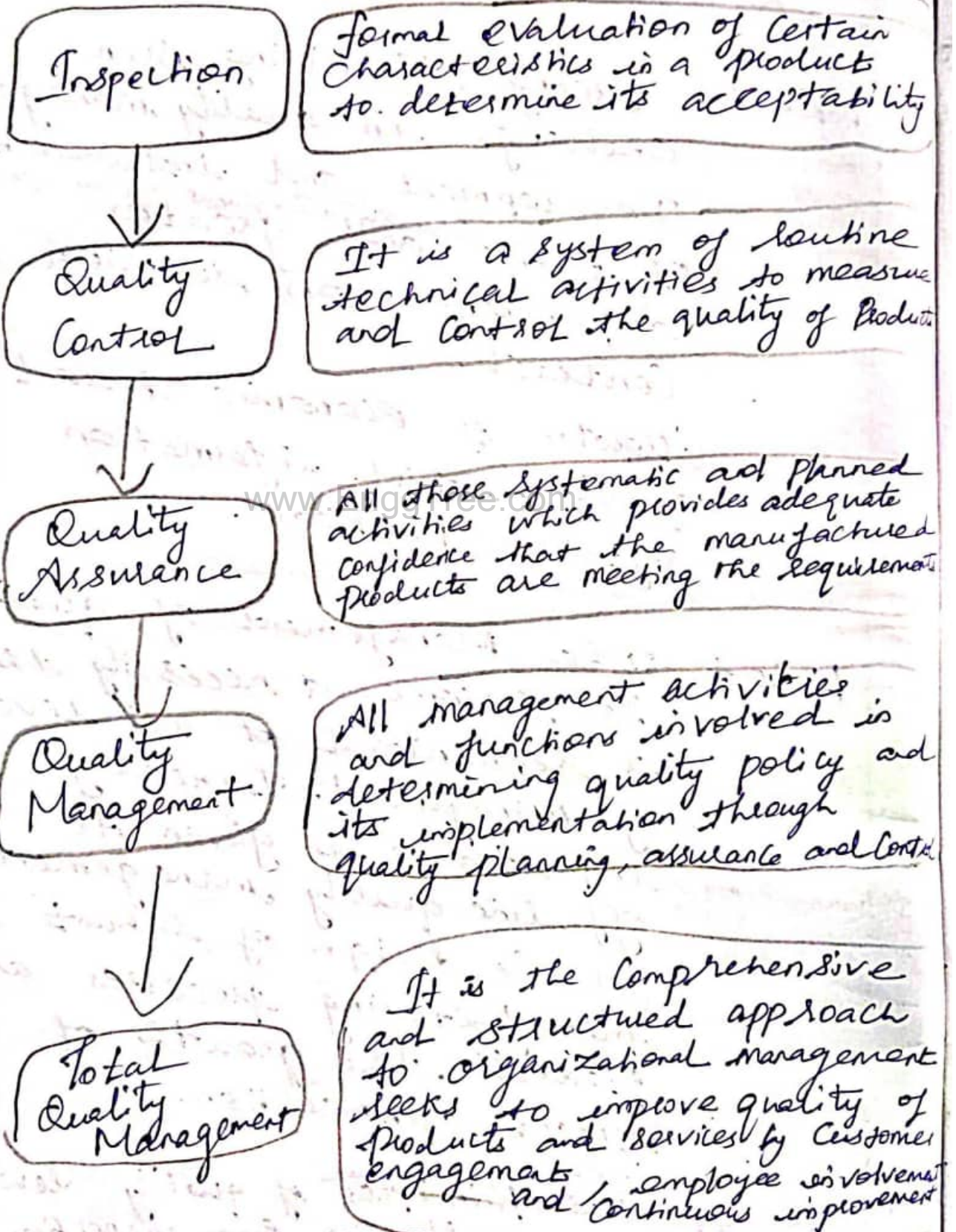
1990 +

The Management of quality has become a necessity that is recognized at all levels of management. Increasing importance is given to off-line quality management for the design of robust manufacturing processes and products. The growth of process optimization.

The Principles of quality developed over the years starting from inspection, quality control, quality assurance, quality

management and total quality management: figure 4. depicts this evolution in a hierarchical format.

Quality evolution.



Definition of Quality

Quality refers to the ability of a product or service to consistently meet or exceed customer expectations. In simple terms, quality means getting what you pay for and quality is ~~also~~ customer satisfaction and quality is ~~fit~~ fitness for use.

Quality has been defined in various ways by many authors and some of the important definitions of quality are given below.

1. Quality is fitness for use - Juran.
2. Quality is conformance to requirements - Crosby.
3. Quality is a predictable degree of uniformity and dependability; at low cost and suited to the market. - Deming.
4. Quality is the minimum loss imparted by a product to society from the time the product is shipped. - Taguchi.
5. Quality is in its essence, a way of managing the organisation. - Feigenbaum.

6. Quality is Correcting, and preventing loss, not living with loss. - Hoshin.

7. The universally accepted definition of quality which is provided by international organisation for standardization (ISO), is as follows: "Quality is the totality of features and characteristics of a product or service, that bear on its ability to satisfy stated and implied needs of the customer."

Dimensions of quality

Quality has many dimensions. The dimensions of quality are nothing but the various features/aspects of product or service by using which the customer may evaluate the quality of the product or service.

The dimensions of quality is presented separately under two categories as:

1. Dimensions of product quality
2. Dimensions of service quality.

Dimensions of Product Quality

The quality of a product can be evaluated by customers using nine dimensions/aspects of the product. The nine dimensions of product quality are presented in figure (5).



S.No	Dimension & Meaning	Example
1.	Performance. Performance refers to how well a product performs its intended function or task. It focuses on the primary purpose and operational characteristics of the product.	A high performance smartphone would handle multitasking smoothly, take clear photos, processing speed, battery life, camera quality and overall responsiveness to user interactions.

2. Features:

Features are additional characteristics that enhance the utility or attractiveness of a product beyond its basic function.

facial recognition, waterproofing, wireless charging capability. these are the features of the mobile phone.

3. Conformance:

Conformance measures how well the product meets established standards and specifications.

Products manufactured with ISO Certification ensure they conform to international quality standards.

4. Reliability

Reliability relates to the consistency of performance over time and under varying conditions.

A reliable car starts reliably in all weather conditions and rarely breaks down unexpectedly.

5. Durability

Durability refers to the lifespan of the product and its ability to withstand wear, pressure or damage.

For instance, the low durability of a low priced mobile phone can be considered as 2-3 years.

6. Serviceability
Serviceability is the ability to repair a product quickly and easily. It is the resolution of problems and complaints on the product.

A printer that allows easy replacement of ink cartridges or parts is considered serviceable.

7. Responsiveness
Responsiveness is a measure of how well the manufacturer of the product is able to adapt to the changing needs of the customer.

The development of the multi-sim mobile phone is an example of responsiveness of the manufacturer to satisfy the customer ~~in the~~ ⁱⁿ changing the needs of the customer.

8. Aesthetics
Aesthetics refers to the sensory appeal of the product, including its visual design, tactile feel, and overall attractiveness.

The mobile models with slim in size, the flip flap design, touch screen, coloured finish attract more customers.

9. Reputation
Reputation is nothing but the perceived quality. It is the subjective

A luxury brand handbag is perceived to be of higher quality due to its brand image and craftsmanship.

assessment
resulting from
image, advertising,
or brand names.

Though it is desired to have a product that can be excellent in all three dimensions, it is practically very difficult to design and manufacture a product that can be excellent in all dimensions. Since these dimensions are independent to each other, a product can be excellent in few dimensions and average or poor in other dimensions. Therefore, the product quality is usually evaluated by using a few of the dimensions of quality.

Dimensions of Service Quality:

The various dimensions of Service quality are presented in figure ⑥



1. Tangibles:

Tangibles refer to the physical evidence of the service, including facilities, equipment, personnel, and communication materials.

Example: When visiting a restaurant, tangibles include the cleanliness and ambiance of the dining area, the appearance and demeanor of the waitstaff, the quality of the tableware and utensils, and the clarity and attractiveness of the menu. A well-maintained, clean, and aesthetically pleasing environment with courteous and well-groomed staff contributes positively to the perception of service quality.

2. Reliability:

Reliability refers to the ability of the service provider to perform the promised service dependably and accurately.

Example: Consider a courier service that promises next-day delivery of packages. If they consistently deliver packages on time without damage

they are considered reliable.

3. Responsiveness:

Responsiveness relates to the willingness and readiness of staff to help customers and provide prompt service. It involves timely assistance and attentiveness to customer needs.

Example: A Customer calls a tech support hotline with an issue. The responsiveness dimension is met if the support agent answers promptly, listens actively, and provides timely solutions.

4. Assurance:

Assurance refers to the knowledge, competence and courtesy of employees and their ability to convey trust and confidence. It involves instilling a sense of trust and security in customers.

Example: In a healthcare setting, assurance is demonstrated when doctors and nurses communicate effectively, show empathy towards patients, and demonstrate expertise.

in their field.

5. Empathy: Empathy involves understanding and caring for customers' needs and concerns. It relates to personalized attention and treating customers as individuals.

Example: A hotel staff member shows empathy by remembering a guest's preferences for room amenities and addressing any specific requests promptly and courteously.

Definitions of Total Quality Management. TQM has been defined in various ways. Some of the important definitions of TQM are given below:

"TQM is the management approach of an organisation, centered on quality based on the participation of all its members and aiming at long-term success through ~~for~~ customer satisfaction and benefits to all members of the organisation and to society".

- ISO

"TQM is an integrated organisational approach in delighting Customers (both internal and external) by meeting their expectations on a continuous basis through everyone involved with the organisation work on continuous improvement in all products services and processes along with proper problem solving methodology."

- Indian Statistical Institute.

"TQM is a people focused management system that aims at continual increase in Customer satisfaction at continually lower cost. TQM is a total system approach (not a separate area or programme) and an integral part of high level strategy. It works horizontally across functions and departments, involving all employees, top to bottom, and extends backwards and forwards to include the supply chain and the Customer Chain."

Characteristics of TQM:

* TQM is a management philosophy to guide a process of change.

* TQM is a Customer-oriented management system.

* TQM ^{is a teamwork} ~~starts at the top~~, it requires organization-wide involvement.

* TQM ^{starts at the top} ~~starts at the top~~, it requires the leadership of the top management and continuous involvement.

* TQM calls for Planning

* TQM is a strategy for continuously improving performance at all levels and in all areas of responsibility.

* TQM ^{is about} achieving results by ^{product} ~~product~~ based approach.

* TQM recognises internal Customer supplier relationship.

* TQM considers suppliers as part of the organisation's processes.

* TQM aims to instill a prevention not an inspection ethic.

* TQM emphasizes the importance of measurement.

* TQM inter-links and integrates the various sub-systems of the organisation.

* TQM aims at meeting the dynamic needs of the Customer and creates a loyal and diversified Customer base.

Basic Concepts of TQM.

A successful TQM programme requires the following six basic concepts.

1. Top Management Commitment
Top Management should participate and completely involve in the total quality programme. They should ensure their complete commitment to the approach through management meetings, Company magazines or newsletters. Also top management should make sure that everybody within the organization from top to bottom is communicated about the TQM Programme.

2. Focus on the Customer
Achieving Customer satisfaction is the heart of TQM. Customers include both internal and external Customers. So focus on the Customer is the key for any TQM Programme.

3. Effective involvement and utilisation of the entire work force: This concept is sometimes referred as 'principles of employees involvement' or 'respect for people'.

TQM is a team work. Total quality recognises that each person is responsible for the quality of his work and for the work of the group. All persons must be trained in TQM, statistical process control (SPC), and other appropriate quality improvement skills. So that they can effectively participate on quality ~~teams~~ teams.

4. Continuous improvement: TQM is based on the quest for progress and improvement. TQM believes that there is always a better way of doing things, way to make better use of the Company's total quality resources, a way to be more productive. For this purpose various quality tools and techniques may be used.

5. Treating Suppliers and partners:
Since the supplier influence the Company's quality, therefore a Partnering relationship should be developed between the management and suppliers.

6. Establishing performance measures for the process:

As we know, Quantitative

data are necessary to measure the continuous quality improvement activity. Therefore performance measures such as uptime, productivity, sales turnover, absenteeism, ~~Perfee~~ Percent non conforming, Customer satisfaction, etc should be determined for ~~the~~ each functional area. These results can be used for further improvement activities.

Gurus of TQM.

There are a number of writers whose work dominates the quality movement. Their ideas and approaches have stood the test of time and have come to form a body of accepted knowledge to lead and advise their own movement in quality. They have become known as 'gurus'.

Many of the gurus appear to present different theories of quality management. In reality they are all thinking the same language but they use different dialects.

There have been three groups of gurus since the 1940's.

Early 1950's Americans who took the message of quality to Japan.

Late 1950's Japanese who developed new concepts in response to the Americans

1970's-1980's Western gurus who followed the Japanese industrial success.

The most quality gurus and the main years of their work are given below.

1. Walter Shewhart (1920's - 1940's)
2. W. Edwards Deming (Post world war II through 1980's)
3. Joseph M. Juran (Post world war II through 1980's)
4. Philip Crosby (1980's)
5. Armand Feigenbaum (1970's - 1980's)
6. Kaoru Ishikawa (Post world war II through 1980's)
7. Genichi Taguchi (1960's - 1980's)
8. Shigeo Shingo (Post world war II through 1980's)

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7. Genichi Taguchi (1960's - 1980's)
8. Shigeo Shingo (Post world war II through 1980's)

9. Masaaki Imai (1980's)

Together these great thinkers have had a tremendous impact on the management and control of quality, and the way company operate. In the following we shall present a brief overview of the Contributions of Deming, Juran and Crosby to the quality. It is beyond our scope to go into great detail on the gurus, their philosophies, teachings and tools. (I) W. Edwards Deming.

Deming's Contributions.

Deming's Contributions can be grouped under the following four topics

1. Deming's 14 point on route to quality.
2. Deming Cycle (PDCA Cycle).
3. Seven deadly diseases of Management.
4. System of profound knowledge.

1. Deming's 14 points.

(1) Create constancy of purpose toward improvement of product and

Service, with the aim to become competitive and to stay in business, and to provide jobs.

(2) Adopt the new philosophy.

We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change.

(3) Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.

(4) End the practice of awarding business on the basis of price tag. Instead minimize total cost. Move toward a single supplier for any one item, on a long-term relationship of loyalty and trust.

(5) Improve constantly and forever the system of production and service, to improve quality and productivity and thus constantly decrease costs.

(6) Institute training on the job.

(7) Institute leadership. The aim of supervision should be to help people and machines and gadgets to do a

better job. Supervision of management is in need of overhaul, as well as supervision of production workers.

(8) Drive out fear, so that everyone may work effectively for the company.

(9) Break down ~~B~~ barriers between departments. People in research, design, sales and production must work as a team, to foresee problems of production and in use that may be encountered with the product or service.

(10) Eliminate slogans, exhortations and targets for the work force which ask for zero defects and new levels of productivity. Such exhortations only create adversarial relationships. Since the bulk of the causes of the low quality and low productivity belong to the system and thus lie beyond the power of the work force.

(11) Eliminate work standards on the factory floor. Substitute leadership. Eliminate management by objectives. Eliminate management by numbers.

numerical goals substitute leadership.

(12) Remove barriers to pride of workmanship. The responsibility of supervisors must be changed from sheer numbers to quality. Remove barriers that rob people in management and in engineering of their right to pride of workmanship. This means, for example, abolishment of annual or merit rating and of management by objectives.

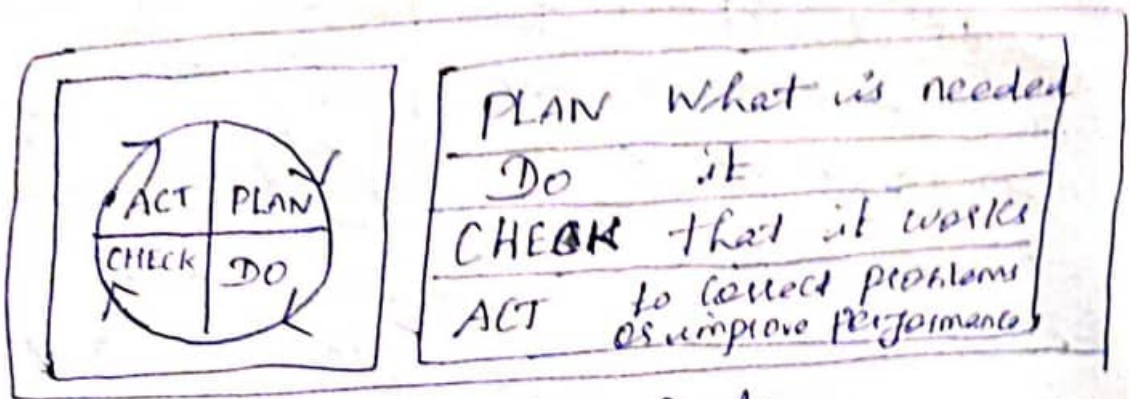
(13) Institute a vigorous program of education and self-employment. self-improvement.

(14) Put everybody in the Company to work to accomplish the transformation. The transformation is everyone's job.

2. Deming Cycle (or PDCA cycle).

The following figure illustrates Deming Cycle. Deming encouraged a systematic approach to problem solving and promoted the widely known Plan, Do, Check, Act (PDCA) Cycle. The PDCA cycle

is also known as the Deming Cycle or Deming Wheel, although it was developed by a colleague of Deming, Dr. Walter A. Shewart.



The Deming Cycle.

It is a universal improvement methodology, the idea is to constantly improve and thereby reduce the difference between the requirements of the customer and the performance of the process.

The Cycle is about learning and ongoing improvement, learning what works and what does not in a systematic way; and the cycle repeats; after one cycle is complete, another is started.

3. Seven deadly diseases of Western management.

The implementation of Deming's 14 points can transform the western style of management.

This transformation can fully materialize only when certain bad practices, called by Deming unforgivable sins or deadly diseases (DD) are eliminated. ^{The following} Table presents his seven deadly diseases (DD) of western management.

Seven deadly diseases of management

- | |
|---|
| 1. Lack of Consistency of purpose |
| 2. Emphasis on short term profits |
| 3. Reliance on performance appraisal and merits |
| 4. Staff mobility |
| 5. Reliance on financial figures |
| 6. Excessive medical costs |
| 7. Excessive legal costs |

4. System of Profound Knowledge.

The system of profound knowledge, or management by positive co-operation, is described by Deming. The four ingredients (or elements) of the system of profound knowledge that is necessary to learn and practice are given

in the following table.

1. Appreciation for a System :
The need for managers to understand the relationships between functions and activities and that the long term aim is for everyone to win - employees, Shareholders, Customers, Suppliers and the environment.

2. Knowledge of Statistical theory:
Knowledge and understanding of Variation, Process Capability, Control Charts, interactions and loss functions.

3. Theory of Knowledge: As all plans require prediction Based on historical information, the theory must be understood before it can successfully be copied.

4. Knowledge of Psychology:
The understanding of human interactions, how people are motivated and what disillusion them.

Four elements of System of
Profound Knowledge.

(II). Joseph M. Juran.

Juran's Contributions

Juran's Contributions Can be studied under the following topics.

1. Internal Customer
2. Cost of quality
3. Quality trilogy
4. Juran's 10 Steps for quality improvement

5. The breakthrough Concept.

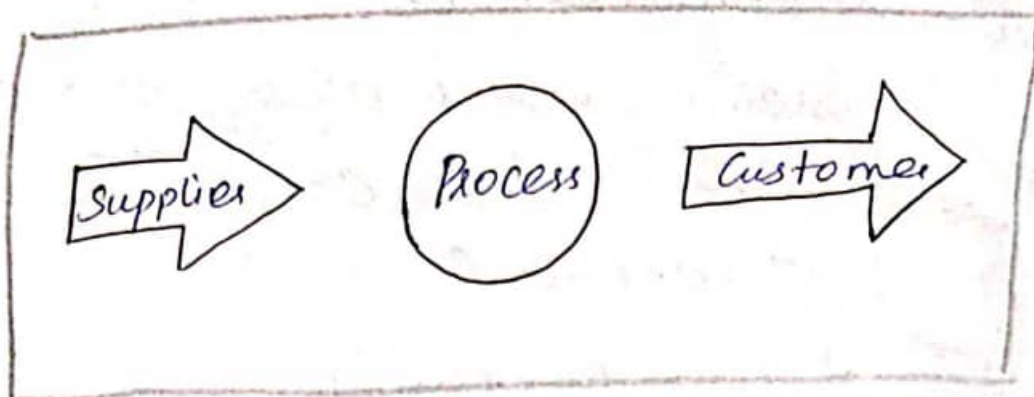
1. Internal Customer

Juran realised that the Customer was not just the end customer and that each person along the chain has an internal customer. Each person along the chain, from product designer to final user, is a supplier and a customer.

In addition, the person will be a process, carrying out some transformation or activity.

Therefore Juran maintained that at each stage was a "three role

model." supplier, process and Customer as shown in figure



Juran's "three role model"

2. Cost of Quality

Juran Classified the Cost of Quality into three Classes as:

(i) Failure Costs: Scrap, rework, Corrective actions, warranty claims, Customer Complaints, and loss of Customer.

(ii) Appraisal Costs: Inspection, Compliance Auditing and investigations.

(iii) Prevention Costs: Training, Preventive auditing, and process improvement implementation.

Juran demonstrated the potential for increased profits that would result if the costs of poor quality could be reduced.

3. Juran's Quality Trilogy.

Juran views quality as fitness for use. He also believes that roughly 80% of quality defects are management controllable. Thus management has the responsibility to correct this deficiency.

Juran divides quality management into three parts. They are given below.

1. Quality Planning: Objectives are to determine quality goals; to form implementation planning; to do resource planning; to express goals in quality terms; and to create the quality plan.

2. Quality Control: Objectives are to monitor performance; to compare objectives with achievements and to act to reduce the gap.

3. Quality improvement: Objectives are to reduce waste, to enhance logistics; to improve employee morale; goals.

to improve profitability and to satisfy customers.

The entire concepts of Juran's quality trilogy can be summarised as shown in Table ①

Table ① Juran's quality trilogy.

1. Quality Planning.

Identify the Customers.

Determine the Customer's needs

Develop product features

Establish quality goals

Develop a process

Prove process capability

2. Quality Control

Choose control subjects (what to control)

Choose units of measurement

Establish measurement

Establish standards of performance

Measure actual performance

Interpret the difference.

Take action on the difference.

3. Quality Improvement.

Prove need for improvement

~~Organise~~
~~Identify~~ to guide the projects

~~Organise~~

Identify specific projects for improvement.

Organise for diagnosis - for discovery of Causes

Diagnose to find the Causes

Provide remedies

Prove that remedies are effective under the operating conditions

Provide for control to hold gains.

4. Juran's 10 steps for Quality improvement.

Juran proposed 10 steps for quality improvement.

1. Build awareness of the need and opportunity for improvement.

2. Set goals for improvement

3. Organise to reach the goals.

4. Provide training
5. Carry out projects to solve problems.
6. Report progress
7. Give recognition.
8. Communicate results
9. Keep score
10. Maintain Momentum by making annual improvement part of the regular systems and processes of the company.

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5. The Breakthrough Concept.

Like the Deming Cycle, Juan's breakthrough concerns itself with the product/service life cycle. In essence, this splits it up into areas: the "journey from symptom to Cause" and "the journey from Cause to remedy."

(III) Philip Crosby.

Crosby's Contributions :

Crosby is known for his following contributions.

1. Four absolutes of quality
2. fourteen steps to quality management; and
3. Crosby's quality vaccine.

1. Crosby's Absolutes for Quality Management.

Crosby proposed four absolutes of quality for his quality improvement process.

First Absolute: The definition of quality is conformance to requirements, not goodness.

Second Absolute: The system for causing quality is preventive, not appraisal.

Third Absolute: The performance standard must be zero defect, not 'that's close enough'.

Fourth Absolute: The measurement of quality is the price of non-conformance, not indexes.

2. Crosby's Fourteen steps for Quality Improvement.

Crosby has laid down 14 steps for implementing the quality improvement process in an organisation. His 14 steps are presented in the following.

Step:-1 Establish and ensure management commitment.

Step:-2 form quality improvement teams (QITs) for quality improvement process planning and administration.

Step:-3 Establish quality measurements.

Step:-4 Evaluate the cost of quality and explain its use as a management tool to measure waste.

Step:-5 Raise quality awareness among all employees.

Step:-6 Take actions to correct problems identified through previous steps.

Step:-7 Establish a Zero defects Committee and programme.

Step:-8 Train Supervisors and managers on their role and responsibilities in the quality.

Step:-9 Hold a Zero defects ^{management} ~~commitment~~ ^{programme}. Commitment¹.

Step:-9 Hold a Zero defects day to reaffirm management Commitment.

Step:-10 Encourage individuals and group to set improvement goals.

Step:-11 Obstacle reporting (i.e., encourage employees to communicate to management any obstacles they take in ~~attending~~ ^{attaining} their improvement goals).

Step:-12 Recognise and appreciate all participants.

Step:-13 Establish quality councils to discuss quality matters on a regular basis.

Step:-14 Do it all over again to demonstrate that the improvement Process never ends.

2. Crosby's Quality Vaccine

In the Crosby style the "Vaccine" is explained as medicine for management to prevent poor quality. The five sections of vaccine that cover the requirements of total quality management are presented in Table 2.1.

Table 2.1. five sections of Crosby's quality Vaccine

~~Step~~ Section 1- Integrity Treat quality seriously throughout the whole business organisation from top to bottom. That the Companies future will be judged on its performance on quality.

Section 2- Systems. Appropriate measures and systems should be put in place for quality costs, education, quality. Performance, review, improvement and Customer satisfaction.

Section 3- Communication The communication systems are of paramount importance to communicate requirements and specifications and improvement opportunities around the organisation. Customers and operators know what needs to be put in place to improve and listening to them will give you the edge.

Section 4- operations : Work with and develop suppliers. Processes should be Capable and improvement Culture should be the norm.

Section 5- policies Must be clear and consistent throughout the business.

Contributions of other Gurus in a brief Manner

Walter Alfred Shewart

Shewart offered Statistical Control Charts and he known for the PDCA to manage the effects of the Variations.

Masaki Imai : He propounded the Kaizen Concept for his Continuous improvement.

Armond V. Feigenbaum
He introduced the Industrial Cycle and Hidden plant. Also he explained about the crucial elements of total quality

Kaoru Ishikawa

He known for the Ishikawa or fishbone diagram, he promoted the use of quality Circles and emphasized ~~that~~.

~~Quality~~ the importance of internal Customer satisfaction.

Genichi Taguchi He proposed quality loss function and product development stages.

Shigeo Shingo He explained and introduced the Zero Quality Control (ZQC) poka-yoke. (or error proofing) and JIT related Concepts.

TQM Framework

TQM is an umbrella under which the management includes everything that it considers important for its success. Most of the elements are common to all TQM programmes and the list of elements can be divided into the two groups. These two groups are

1. TQM principles and Practices
2. TQM tools and techniques.

TQM Framework

Managing the entire organisation so that it excels in all dimensions of products and services that are important to the customer

Contributions of Quality Gurus
(Contributions of Deming, Juran, Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi, Shingee, Stewart etc)

TQM Elements

I. TQM Principles and Practices

A. People and Relationships

1. Leadership

- * Quality Council
- * Quality Statements
- * Strategic planning

2. Customer focus

- * Customer Complaints
- * Customer retention

3. Employee involvement

- * Empowerment
- * Team and teamwork
- * Recognition and reward
- * Performance appraisal

4. Suppliers partnership

- * Sourcing
- * Supplier selection/rating

B. Approach

1. Continuous Process improvement

- * Juran Trilogy
- * PDCA cycle
- * Kaizen
- * 5S Housekeeping

2. Innovation

3. Management by fact

C. Performance Measures

1. Quality costs
2. Quality awards

II. TQM Tools and Techniques

1. Seven Tools of quality

- * flow chart
- * Check sheet
- * Histogram
- * Pareto diagram
- * Cause and effect diagram
- * Scatter diagram
- * Control chart

2. New Seven Management Tools

- * Affinity diagram
- * Relationship diagram
- * Tree diagram
- * Matrix diagram
- * Matrix data analysis diagram
- * Decision tree
- * Arrow diagram

3. Six Sigma process Capability

4. Benchmarking
5. failure Mode and Effect (FMEA) Analysis
6. Quality Circles (QC)
7. Quality function Deployment (QFD)
8. Total preventive Maintenance
9. Taguchi Methods
10. Sampling Plans
11. Experimental Design
12. Quality Management System
 - * ISO 9000 Series of Standard
13. Environmental Management System
 - * ISO 14000 series of Standards.

Barriers to TQM

(Implements or obstacles to TQM Implementation)
The various roadblocks in implementing TQM are

1. Lack of management Commitment
2. Lack of faith in and support to TQM activities among management Personnel.
3. Failure to appreciate TQM as a Cultural revolution. In other words, inability to change Organisational Culture.
4. Misunderstanding about the Concept of TQM
5. Improper Planning
6. Lack of employees Commitment.
7. Lack of effective communication.
8. Lack of continuous training and education.
9. Lack of interest or incompetence of leaders.
10. Ineffective measurement techniques and lack of access to data and results.
11. Non application of proper tools and techniques.

12. Inadequate use of empowerment and team work.
13. Inadequate attention to internal and external customers.
14. Delay or non-implementation of quality improvement team's recommendations.

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Benefits of TQM

Tangible benefits

- * Improved product quality
- * Improved productivity
- * Reduced quality costs
- * Increased market and customers
- * Increased profitability
- * Reduce employee grievances.

Intangible benefits

- * Improved employee participation
- * Improved teamwork
- * Improved working relationships
- * Improved customer satisfaction
- * Improved communication
- * Enhancement of job interest
- * Enhancement of problem-solving capacity
- * Better company image.

Unit - II - TQM PRINCIPLES

Leadership - Deming Philosophy -
 Quality Council - Quality statements and
 Strategic planning - Customer satisfaction
 - Customer perception of quality, feedback
 Customer complaints, service quality,
 Kanoo model and Customer retention -
 employee involvement - motivation;
 Empowerment, - Team and Teamwork,
 Recognition & Reward and performance
 Appraisal - Continuous process
 improvement - Juan Trilogy - PDCA Cycle -
 5S - and Kaizen Supplier partnership -
 partnering supplier selection - Supplier
 rating and Relationship Development.

Leadership: Unit - II

Leadership is the process of influencing others towards the accomplishment of goals. Leader triggers the will to do, show the direction to a higher standard, the building of man's personality beyond its normal limitations.

Behaviours of Quality Leaders.

Successful quality leaders tend to demonstrate the 12 characteristics or behaviours. They are

1. The Customers first: Quality leaders give primary importance to both the internal and external customers and their needs. Leaders should listen to customers; actively seek their opinion on the value of the products/services; develop a close link with customers; seek joint improvement activity; and lead the handling of complaints.

2. Value People: Quality leaders take care of the development of people's skill and capabilities. They enable people to be responsible for the result of their work.

They monitor, appraise and recognize people's performance.

3. Build Supplier partnership: Quality leaders clarify quality to suppliers; audit their capabilities; give feedback; discuss improvements; and support them where needed. They recognize quality improvements made by suppliers and encourage joint improvement action.

4. Empower people: Quality leaders train and coach the people, rather than directing and supervising them.

5. Demonstrate involvement/commitment:

Quality leaders continually demonstrate their commitment to quality.

6. Strive for excellence: Quality leaders emphasize continuous improvement rather than maintenance. They strictly believe the statement 'There is always room for improvement'.

7. Explain and deploy policy:

Quality leaders explain the quality policy to all involved. They set stretching targets and

deploy these to business processes to the functions within the organisation, and to suppliers.

8. Promote teamwork
~~Improve Communication~~:

Quality leaders promote multidisciplinary teamwork; create involvement; and active participation of everyone.

9. Improve Communication:

Quality leaders continually improve Communications. They establish channels of communication, which are reliable and accessible to everyone in the organisation.

10. Benchmark Continuously:

Quality leaders learn from problems. They continuously do benchmarking and create new learning effects through innovation.

11. Establish System:

Quality leaders establish organisational systems to support the quality effort.

12. Encourage Collaboration:

Quality leaders encourage collaboration rather than competition. They emphasize the importance of

Collaboration among and within functional areas, departments or work centres.

Requirements of Effective leadership

five core leadership skills required for effective leadership are

- (i) Vision
- (ii) Empowerment
- (iii) Intuition
- (iv) Self understanding
- (v) Value Congruence

(i) Vision: Vision is crucial for leaders during times of change. Leaders recognise the radical organisational changes taking place today as opportunities to achieve total quality.

(ii) Empowerment: Leader empower employees to assume ownership of problems or opportunities and to be proactive in implementing improvements and making decisions in the best interests of the organisation.

(iii) Intuition: leaders usually follow their intuition. They must be prepared to make

difficult decisions even in the face of uncertainty and change and anticipate the future.

(iv) Self - understanding: Self-understanding requires the ability to look at one's self and then identify relationships with employees and within the organisation. It requires an examination of one's weaknesses as well as strengths.

(v) Value Congruence:

Value Congruence occurs when leaders integrate their values into the company's system. Values are basic assumptions and beliefs about the nature of the business, mission, people and relationships of an organization. Values include trust and respect of individuals, openness, teamwork, integrity and commitment to quality.

Deming's Philosophy:

As in Unit 1

Quality Council :

A quality Council is a team to provide overall direction for achieving the total quality culture.

A quality Council is a team formed in the organisation with an objective of building quality into the culture of the organisation.

In other words, quality Council helps to build quality into the culture and to provide overall direction.

The quality Council is composed of

- (i) the ~~the~~ Chief executive officer (CEO)
- (ii) the senior managers of the functional areas such as design, marketing, finance, production and quality and
- (iii) a quality Council Coordinator or Consultant.

Objectives of Quality Council :

The objectives of the quality Council are

1. To raise the quality consciousness

is the organisation through seminars, study tours, and using other forms of promotion.

2. To ensure effective functioning of the organisation on the quality statement and plan.

3. To encourage basic and applied R&D in the field of quality and dissemination of its results to the organisation.

4. To raise the level of training of personnel engaged in quality activities including the assessors and trainees.

5. To facilitate upgradation of testing and calibration facilities and laboratories as well as to encourage the overall quality of the organisation.

Duties of Quality Council:

The duties of the Quality Council are listed in the following.

1. To establish the core values and quality statements. Quality statements include vision statement

mission statement and quality policy statement.

2. To establish the strategic long-term plan with goals and annual quality improvement program with objectives.

3. To plan the training and education programmes

4. To determine and monitor the cost of poor quality.

5. To perform and monitor the performance measures for each functional area of the organisation

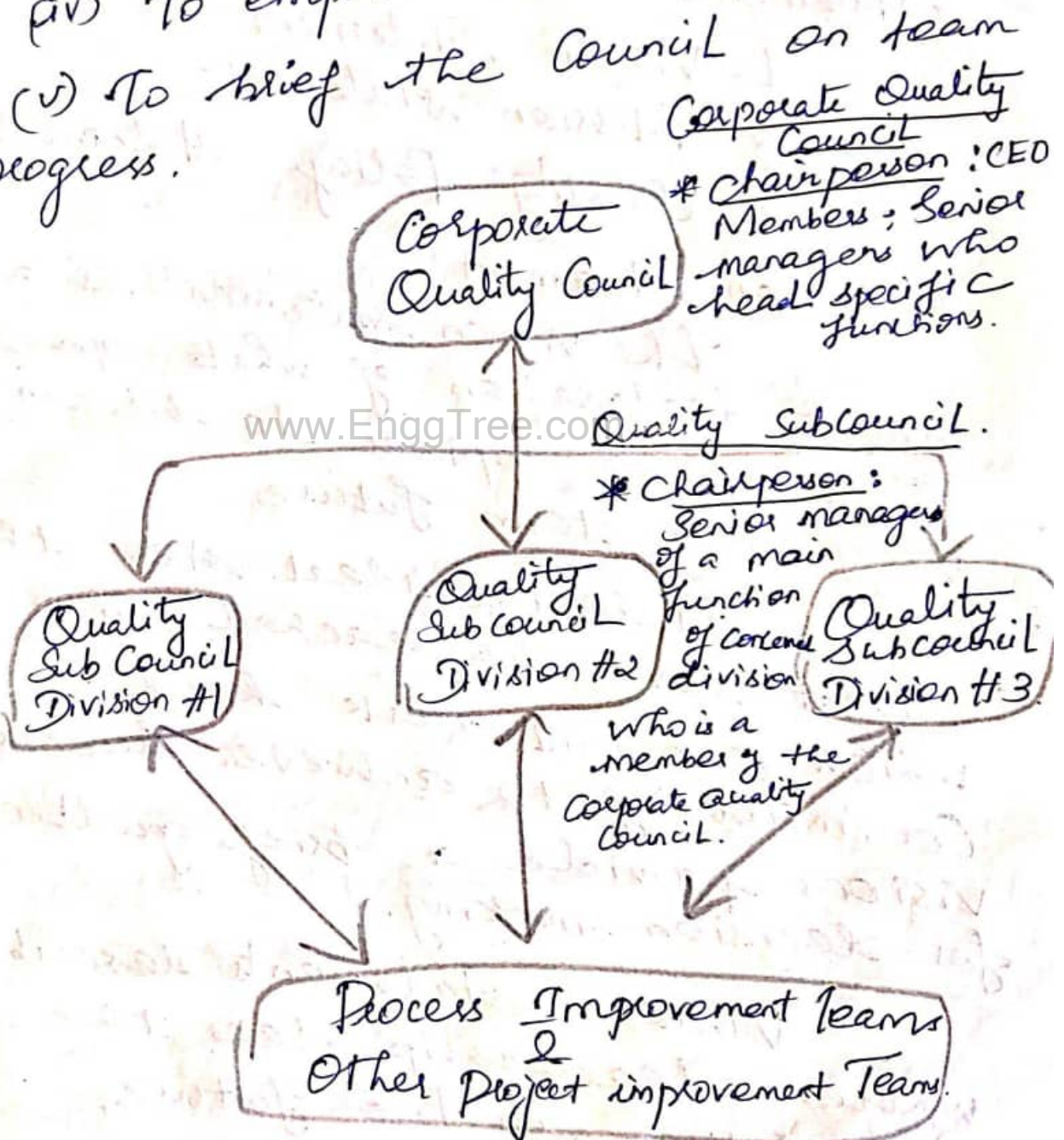
6. To determine continually those projects that improves the processes particularly those that affect external and internal customer satisfaction.

7. To establish multifunctional project and departmental teams and monitor their progress.

8. To establish/revise the recognition and reward system periodically.

Responsibilities of the Quality Council Coordinator.

- (i) To develop two-way trust
- (ii) To propose team requirements to the Council
- (iii) To share Council expectations with the team
- (iv) To empower the team
- (v) To brief the Council on team progress.



Thus Quality Councils are the instruments for creating the idea of never ending improvement. In other words it is the driver for the TQM engine.

Quality Statements

Quality statements are established by the quality council to provide overall direction for achieving the total quality ~~structure~~ culture.

Three elements of quality statements are

1. Vision Statement
2. Mission statement
3. Quality Policy statements.

1. Vision Statement:

The vision statement is a short declaration of what an organisation aspires to be in the very long term future.

It is the ideal state that might never be reached, but on which one will work hard. Continuous to achieve. Successful visions provide a brief guideline for decision-making.

Vision statements describes where leadership sees the organisation in the future.

A vision describes aspiration for the future, without specifying

the means that will be used to achieve those desired ends

Examples of vision statements:

1. "To help our clients meet their goals through our people, services and solutions."

- Infosys International Incorporated

2. Apollo's vision for the next phase of development is to 'Touch a Billion Lives'.

- Apollo Hospitals.

3. Preparing young minds to contribute to the betterment of the global society - Indian Institute of Management (IIM) Trichy.

Each of the above vision statements offers a very different view of the direction and character of the organisation. Each statement conveys a general image to customers and employees of where the organisation is headed.

Thus for the organisation, the vision statement provides a clear picture of where it is headed and why it is going there.

2. Mission Statement:

The Mission statement, is usually one paragraph, describes the function of the organisation. It provides a clear statement of purpose for employees, customers and suppliers.

The mission statement answers the following questions: Who we are? Who are the customers? What we do? and how we do it?

The key elements of a mission statement are as follows.

* Obligation to Stakeholders:

The most important stakeholder and the relative emphasis placed on meeting the needs of various stakeholders.

* Scope of the business: The areas in which the company will compete defined by the customers served, the functions provided, and the technology employed.

* Sources of Competitive advantage:

The skills that the company will develop/leverage to achieve its vision and a description of how the company intends to excel in creating customers.

Value and Competitive advantage.

* View of the future:

The anticipated regulatory, competitive and economic environment in which the company must compete.

Examples of mission statements:

1. "To enhance the wealth generating capability of an enterprise in a globalizing environment, delivering superior and sustainable stakeholder value"
- ITC Limited.

2. "Infosys International Inc.' is dedicated to providing the people, services and solutions our clients need to meet their information technology challenges and business goals."
- Infosys International Inc

3 Quality Policy Statements:

The Quality Policy is a guide for everyone in the organisation as to how they provide products and service to the customers. It is used as a guide to managerial action.

It should be written by the CEO with feedback from the workforce and be approved by the quality council.

A quality policy is an important requirement of ISO 9000 quality systems. ISO 9000, the international standard for quality assurance, requires a quality policy as a declaration of intent to meet the needs of customers.

Example:-

1. Reliance is committed to meeting customer requirements through continual improvement of its quality management systems. Reliance shall sustain organization excellence through visionary leadership and innovative efforts.

- Reliance industries limited

2. Parle products limited will strive to provide consistently nutritious and quality food products to meet customers' satisfaction by using quality

materials and by adopting appropriate processes.

To facilitate the above we will strive to continuously train our employees and to provide them an open and participative environment.

— Parle Products Limited.

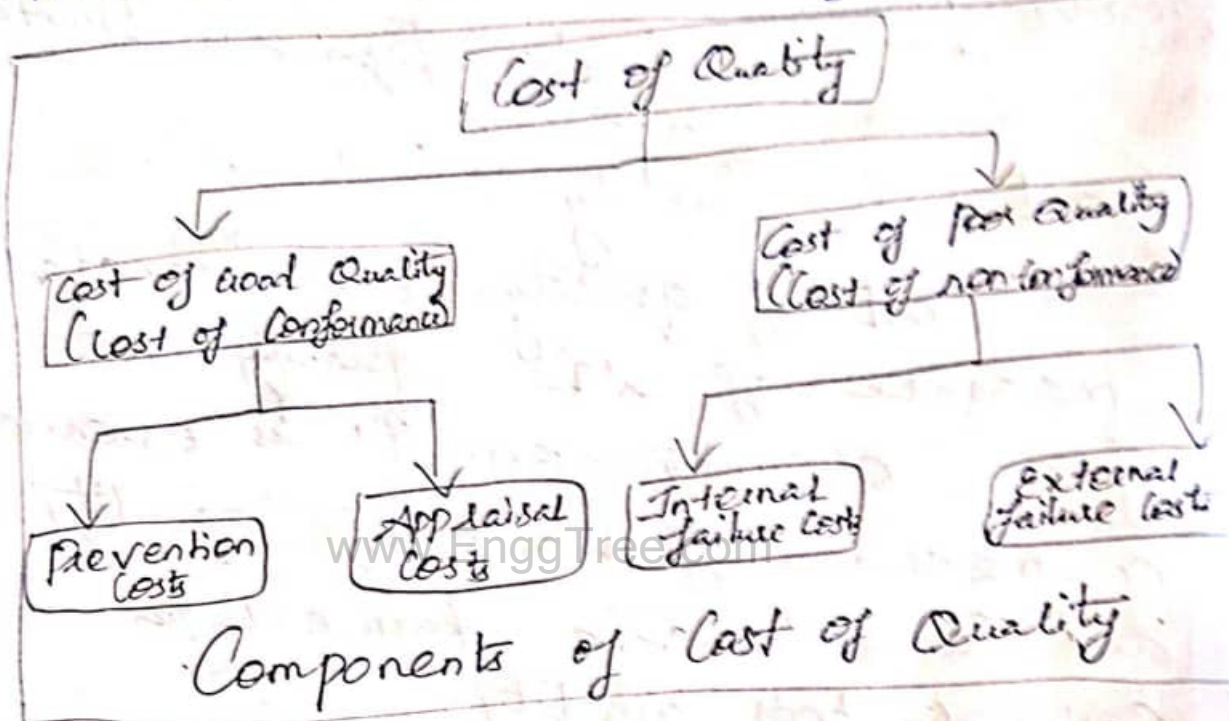
Cost of Quality.

Cost of quality is a financial measure of the quality measure of an organization. It is essentially a measure of lack of quality and can also be termed as Cost of poor quality.

The cost of quality isn't the price of creating a quality product or service. It's the cost of NOT creating a quality product or service.

Every time work is redone, the cost of quality increases. So the cost of quality refers to any cost that would not have been expended if quality were perfect.

COQ is primarily used to understand, analyze and improve the quality performance. COQ can be used as a standard measure to study organization's performance and can be used as a benchmarking indices.



$$\begin{aligned}
 \text{Cost of Quality} &= \left\{ \text{Prevention Costs} \right\} + \left\{ \text{Appraisal Costs} \right\} + \left\{ \text{Internal failure costs} \right\} \\
 &\quad + \left\{ \text{External failure costs} \right\}
 \end{aligned}$$

Strategic Planning.

Strategic planning sets the long term direction of the organisation in which it wants to proceed in future. This is depicted in the following.



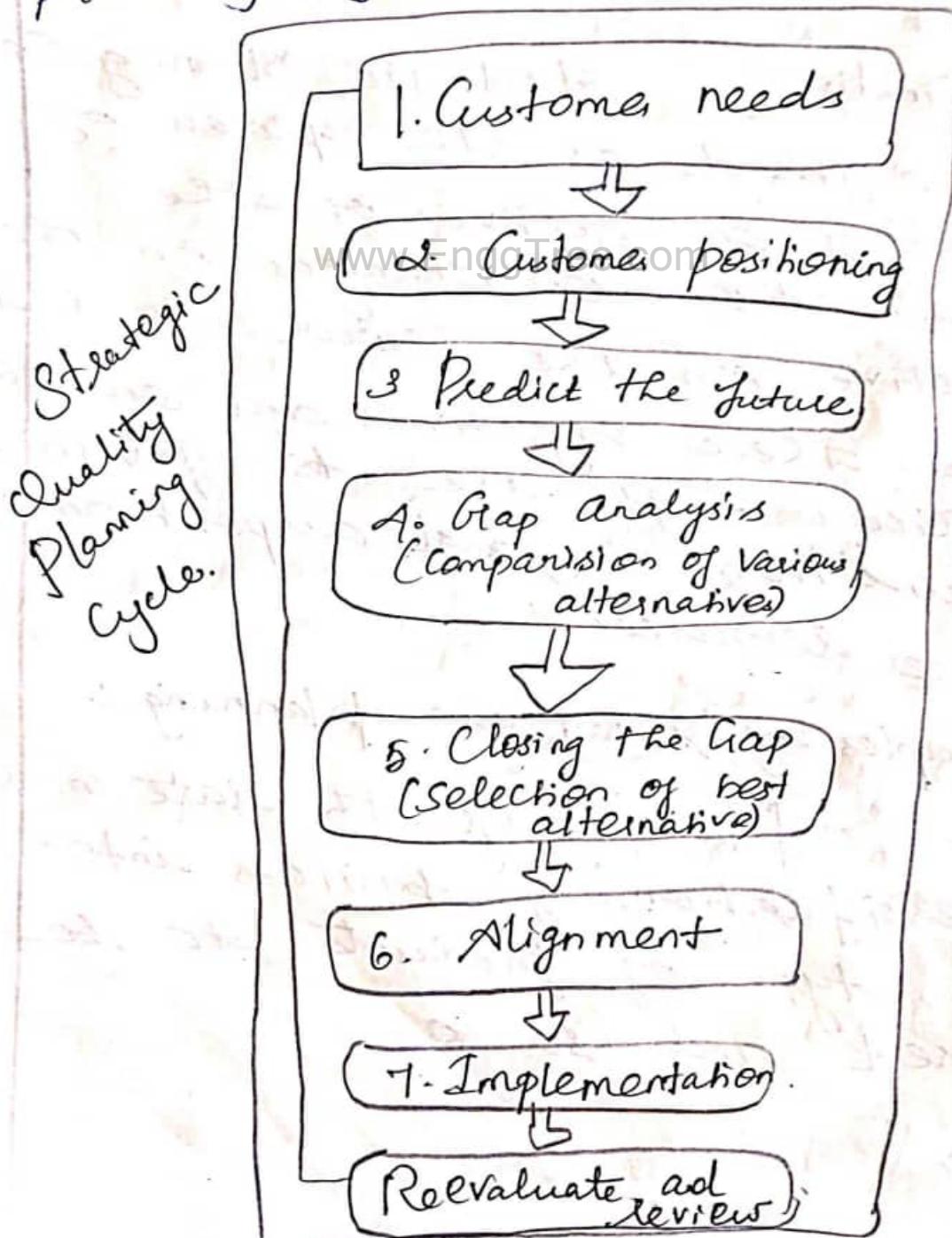
Definition: Strategic planning can be defined as the process of deciding on objectives of the organisation, on changes on these objective, on the resource used to attain these objectives and on the policies that are to govern the acquisition, use, and disposition of these resources.

Examples of strategic planning :-

Planned growth rate in sales, diversification of business into new lines, type of products to be offered and so on.

Strategic Quality Planning Process.

In order to integrate quality with strategic planning process, a systematic and sequential procedure has to be adopted. There are seven basic steps to strategic process planning. The following figure summarises the Strategic Planning Cycle.



Step:-1 Identification of Customer Needs

The basic step is the identification of customers and their wants and needs. An organisation must seek its customers' requirements, expectations and ~~assess~~ assess future trends before developing a strategic plan.

Step:-2 Determination of

Customer positioning

The second step requires the planners to determine its positioning with regards to its customers. Various alternatives such as whether the organisation should give up, maintain or expand market position should be considered. In order to become successful, the organisation should concentrate and consolidate its position in its area of excellence.

3. Predict the future :

Next, the planners must predict future conditions that will affect their product, or service. To help predicting the future the tools such as demographics

Economic forecasts and technical assessments or projections may be used.

Step:-4 Gap Analysis.

In this step, the planners must identify the gaps between the current state and the future state of the organisation. This concept is also known as Value Stream mapping. For identifying the gaps, an analysis of the core values and concepts and other techniques may be used.

Step:-5 Closing the Gap

Now the planners should develop a specific plan to close the gap. This process is also termed as process improvement.

By assessing the relative importance and relative difficulty of each gap, planners can close the gap.

Step:-6 Align the plan with the mission and vision.

Now the revised plan should

be aligned with the mission, vision and Core Values and Concepts of the organisation.

Organisation should embrace quality as an essential ingredient in their vision, mission and objectives.

Step:-1 Implementation of the Plan :-

In order to implement the action plan, resources must be allocated to collecting data, designing changes and overcoming resistance to change. Also the planners should monitor and assess the result of the strategic plan.

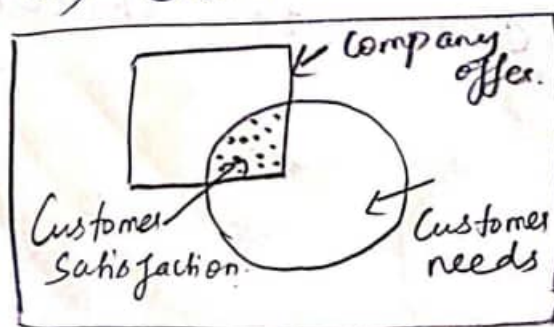
Since quality is a continuous improvement process, one has to reassess and renew the strategic plans periodically. So it is a cyclic process as shown in the figure.

~~Customer~~ Customer Satisfaction Model.

As emphasised so far, in today's buyers market the Customer is the king. Even the definition of quality, 'quality is what Customer wants', emphasises on the Customer requirements. In other words, quality is a measure of Customer satisfaction.

Customer Satisfaction Model:

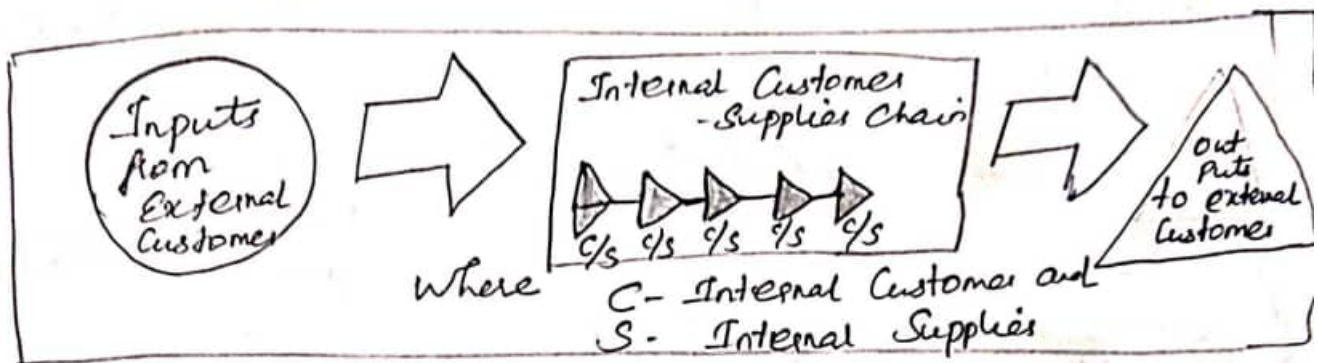
The following figure shows the Tebent's model of Customer satisfaction. In the following figure the Customer's need are represented by the Circle, and the square represents the product or service offered by the Company. The intersection portion, shown with dots, is perceived as the Customer satisfaction. So it is understood that the Company should strive for increasing the intersection portion.



Customer Satisfaction Model.

Customer Supplier chain

In order to achieve the total customer orientation, TQM requires the better customer supplier relationship. The following figure shows the model of customer supplier chain



Customer Supplier Chain

All processes require inputs, which are provided by the internal or external suppliers. Similarly, all processes deliver outputs, which are used by internal or external customers. The figure shows everyone inside the company as a supplier and customer at the same time. Each unit is considered as a customer by the previous unit and as a supplier for the next unit.

Customer Perception of Quality

An American Society for Quality (ASQ) survey ranked the customer perceptions in the following order:

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

1. Performance :-

* Performance involves "fitness for use". It indicates that the product and service is ready for the customer's use at the time of sale.

Other Considerations include:

1. Availability: It is the probability that a product will operate when needed.

2. Reliability: It is freedom from failure over time.

3. Maintainability: It is the ease of keeping the product operable.

2. Features :-

* features are secondary characteristics of the product or

Service.

* for example, the primary function of a cell phone is for communication, whereas other facilities such as calculator and alarm are features of the cell phone.

3. Service:

* Customer service is an intangible in nature. Intangible characteristics are those traits that are not quantifiable, but it contributes greatly to customer satisfaction.

* Organizations objective is to provide good quality of the product to the customer at the right time, even though the customers are not complaining about their service.

4. Warranty:

* The product warranty represents an organization's public promise of a quality product. In other words, it represents a public commitment to guarantee a level of service sufficient to satisfy the customer.

* A warranty forces the organization to focus on the customer's definition of product and service quality. It also forces the organization to develop a corrective action system.

* In present scenario, the warranty attracts and builds the market. It encourages customers to buy a service by reducing the risk of the purchase decision. Hence it generates more sales from existing customers by enhancing loyalty.

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5. Price:

* Nowadays customer is willing to pay a higher price to obtain value. Also customers expect high quality products at the lower price.

* Customers are preferring the organisations who are providing the greatest value for their money. For this purpose, customers are constantly evaluating all the organisations.

* In our highly competitive environment, each customer's concept of value is continually changing.

In order to overcome this challenge the organisations should identify, verify and update each customer's perception of value in relation to each product and service regularly.

6. Reputation:- * It is obvious that customers are willing to buy products or service from a known, trusted and reputed organisation. The total customer satisfaction is based on, not only with the product, the entire experience with the organisation. * Thus reputation of a firm brings the market to them. So organisation should strive for customers for life.

Customer feedback:-

Customer feedback refers to the informations, opinions, and insights that customers provide about their experiences with company's products, services or overall brand. This feedback is a vital source of data for businesses, as it helps them understand customer needs, preferences, and areas where they

may need to improve. In the context of Total Quality Management (TQM) Customer feedback is a key element in the continuous improvement process.

Types of Customer feedback :

1) Direct feedback :

* Surveys and Questionnaires
Structured forms where customers are asked specific questions about their experience, satisfaction and suggestions for improvement.

* Interviews and Focus groups :
In depth discussions where customers provide detailed feedback on their experiences and opinions.

* Online Reviews and Ratings :
Customers publicly share their experiences and rate products or services on various platforms like google, yelp or social media.

2) Indirect feedback :

* Social Media Mentions :
Unsolicited feedback

that customers post on social media, which can provide insights into their experiences and perceptions.

* Customer Behaviour: Analyzing how customers interact with products, services, or websites can offer feedback on what works well and what doesn't (e.g.: website navigation patterns, purchase frequency).

* Support Requests: Issues raised by customers through customer service channels can highlight areas where the product or service may be falling short.

Importance of Customer feedback

- 1) Improvement of products and services: Feedback helps companies identify flaws, issues or areas for enhancement in their offerings, leading to better products and services that meet customer needs.

- 2) Customer satisfaction:
By listening to feedback and making necessary changes

Companies can increase customer satisfaction, which in turn can lead to higher customer loyalty and retention.

3) Innovation: Customers often provide ideas and suggestions that can inspire new products, services or features driving innovation within the company.

4) Brand Reputation: Engaging with customer feedback, especially on public platforms, allow companies to manage their reputation by addressing concerns and demonstrating responsiveness.

5) Competitive Advantage: Companies that effectively use customer feedback to continuously improve can gain a competitive edge by consistently meeting or exceeding customer expectations.

How to collect customer feedback:

* Online Surveys: Sent via email or integrated into websites

* feedback forms : Available on websites, apps, or at physical location.

* Social Media : Monitoring and responding to comments, reviews and mentions.

* Customer service interactions : Capturing feedback during support call, chats or emails.

* Loyalty programs : Engaging loyal customers in providing feedback through rewards or incentives.

Customer Complaints

A customer complaint is any communication a customer has with a company in which 'displeasure' is expressed.

A customer complaint may be defined as an expression of dissatisfaction with a product/service either orally or in writing, from an internal or external customer.

Why is Customer Complaint Necessary?

Customer Complaint is required:

(i) To discover customer dissatisfaction.

- (ii) To identify Customer's needs.
- (iii) To discover relative priorities of quality
- (iv) To compare performance with the competition
- (v) To determine opportunities for improvement.

Sources for Customer Complaint.

Customer complaints are mainly either related to product itself or related to after-sales-service. Some of the sources of ~~loss~~ cost customer complaints are listed below.

1) Customer Complaints Related to Product Itself:

- * Product is defective/non functioning
- * Product is unreliable
- * Product did not meet the basic requirements.
- * Customer expectation was higher than what the product could deliver.
- * Frequent breakdown of product
- * Product has defective parts
- * Product provided with defective accessories.

2) Customer Complaints Related to After-Sales - Service:

- * Service department responding to the problem.

* Speed of response to a Complaint Call.

* Basic behaviour and Courtesy of the service person.

* Competence of the Service Personnel.

* Product Complaint not resolved even after repairs.

The understanding of these potential sources for customer complaint is essential for building the complaint redressal strategy.

Common Customer feedback Collection Tools:

Customer feedback Collection tools include:

1. Surveys and Questionnaires:

These can be distributed online, via email, or in person. Tools like Google forms, Survey Monkey, and Typeform are popular for creating and distributing surveys.

2. Customer Interviews:

Direct conversations with customers to gather in-depth insights.

about their experiences and expectations.

3. Feedback forms: Often embedded on websites or apps, these allow customers to provide feedback at various touchpoints.

4. Net Promoter Score (NPS): A metric used to gauge customer loyalty by asking how likely they are to recommend the company or product to others.

5. Social Media Monitoring: Tools like Hootsuite and Sprout Social help track and analyze customer feedback shared on social media platforms.

6. Online Reviews:

Monitoring reviews on platforms like Google reviews, Yelp, and Amazon to gather customer opinions.

7. Customer Support interactions:

Analyzing data from customer service calls, emails, and chats can provide valuable feedback.

8. Focus Groups: Small groups of customers discuss their experiences and provide detailed feedback in a moderated setting.

9. Website Analytics: Tools like Google Analytics track user behavior on a website, indirectly providing feedback on usability and content effectiveness.

10. Suggestion Boxes: Physical or digital boxes where customers can leave anonymous feedback or suggestions.

Service Quality (or Customer Service)

Customer service is the set of activities an organisation uses to satisfy the customers and their needs.

The service can be provided at

- (i) before the sale of the product
- (ii) during the sale of the product
- (iii) after the sale of the product

~~* Though the *~~ Elements of Service Quality:

I. Organization

1. Identify each market segment
2. Write down the requirements
3. Communicate the requirements
4. Organize processes
5. Organize physical spaces.

II. Customer Care

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

III. Communication

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

IV Front line people

17. Hire people who like people
18. Challenge them to develop better methods.
19. Given them the authority to solve problems.
20. Serve them as internal customers.
21. Be sure they are adequately trained
22. Recognize and reward performance

V Leadership.

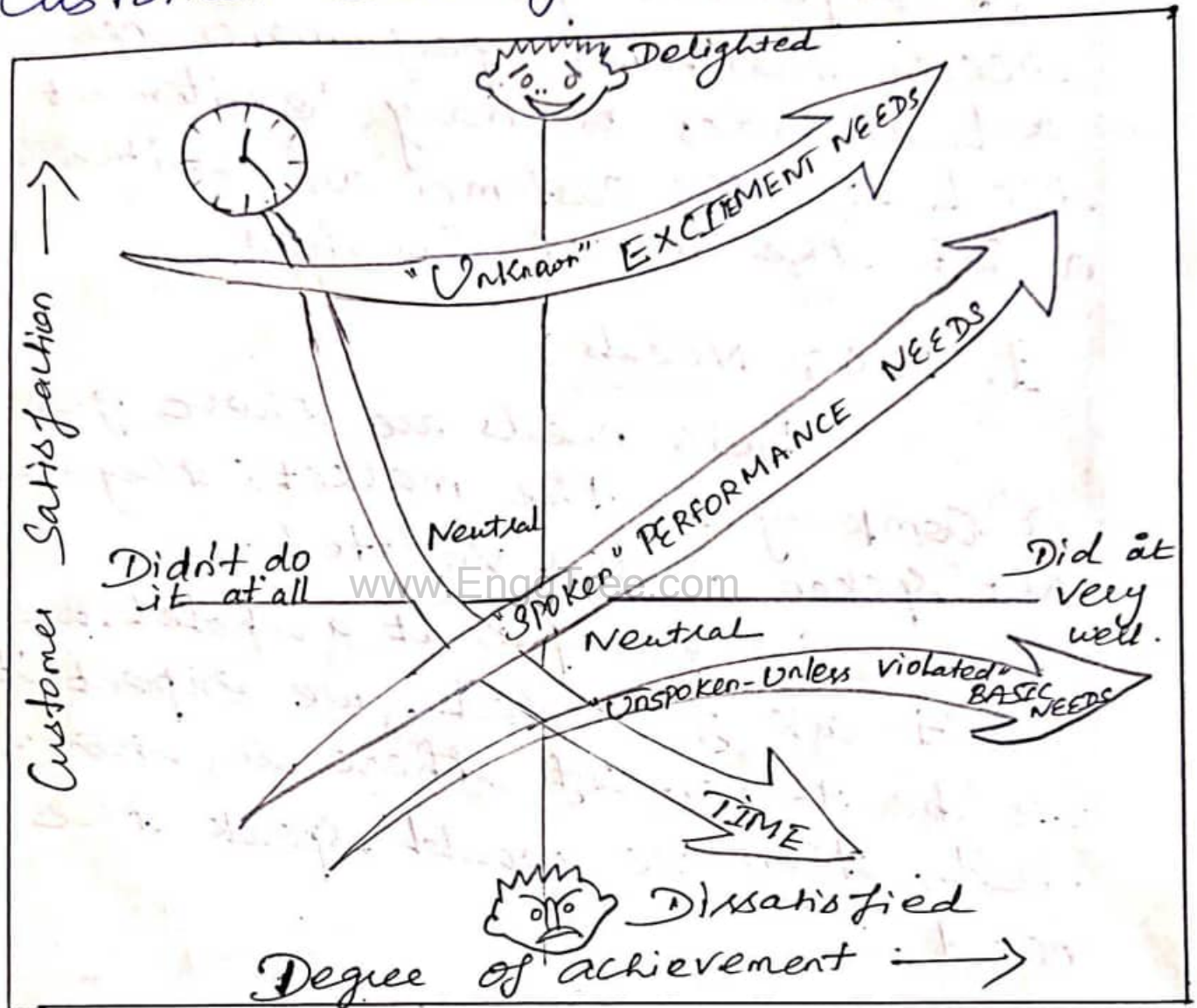
23. Lead by example.
24. Listen to the front line people.
25. Strive for continuous process improvement.

Kano Model of Customer Satisfaction.

(Understanding Customer needs)

The Kano Model is a useful tool in understanding customer needs. The Kano model of

Customer satisfaction classifies product attributes based on how they are perceived by customers and their effect on customer satisfaction.



Kano model.

The Kano model is useful for

- * identifying customer needs
- * determining functional requirements
- * Concept development; and
- analysing competitive products

The Kano model shown in figure categorises customer needs into

Three Categories.

1. Basic Needs
2. Performance needs
3. Excitement needs.

A Competitive product meets basic needs, maximises performance needs, and includes as many 'excitement' need of the customer as possible at a cost the market can bear.

1. Basic Needs :

Basic needs are those get a company in the market; they are not spoken unless violated.

For example, at a hotel, we don't ask for a bed, we expect it to be there. If there is no bed, then we would speak the need.

2. Performance Needs :

Performance needs are known as those that keep a company in a market. They are spoken by the customer and considered when purchasing decisions are made.

Performance needs make the customer happy or unhappy, and the customer's happiness is proportional to how well the performance needs are met.

For example, customers would be willing to pay more for a car that provides them with better fuel economy.

3. Excitement Needs:

Excitement needs are those that afford the greatest opportunity in terms of becoming a market leader or innovator.

Like basic needs, ~~excitement~~ excitement needs are unspoken, but unlike basic needs which are expected and known, excited needs are beyond customer expectations. Thus the excitement reasons are generally unknown and difficult to uncover. If an excitement need is fulfilled in any way, then there is movement on the curve towards increased customer satisfaction. For example, the table top wet grinders with "tilting" facility that enhanced the comfort of the users.

Customer Retention :

Customer retention is the process of retaining the existing customers. It is obvious that customer retention is more powerful and effective than customer satisfaction.

Customer Care can be defined as every activity which occurs within an organisation that ensure that a customer is not only satisfied but also retained.

The following research findings will enable us to understand the real significance of customer retention. The important research findings are:

- * Over 60% of an organisation's future revenue will come from existing customers.

- * A 2% increase in customer retention has an equivalent impact upon profitability as a 10% reduction in operating costs.

- * Up to 96% of unhappy customers do not inject complains. But they

are three times more likely to communicate a bad experience to other customers than a good one.

* 91% of the unhappy customers will never purchase goods and services from you again.

* If you make an effort to remedy customers' complaints 82 to 95% of them will stay on with you.

* It costs 5 times as much to attract a new customer as it costs to keep an old one.

Thus the customer retention is more essential than attracting new customers.

* Customer retention represents the activities that produce the necessary customer satisfaction that creates customer loyalty.

* Customer retention can be improved by obtaining customer feedback and by measuring customer satisfaction.

Customer feedback is obtained from customer satisfaction surveys, focus groups, interviews, and observations. Customer satisfaction should be measured by using

the hard measures of cash registers receipts, market share, the level of customer retention, and the number of referrals from customers.

Customer retention really moves the customer satisfaction to the next level called customer delight.

Employee Involvement

Employee involvement is the backbone of a TQM movement. An effective TQM effort requires the total involvement from every person at all levels in the organization. Employee involvement leads to meet the organization goals and objectives. It also improves the quality and productivity at all levels of the organization.

Some of the important aspects of the employee involvement

1. Employee motivation
2. Employee empowerment
3. Team and teamwork

4. Recognition and reward schemes.

5. Performance appraisal.

1. Employee Motivation:

According to Scott, motivation means a process of stimulating people to accomplish desired goals.

In simple words, motivation is the process of influencing people inner drives and action towards certain goals and committing their energies to achieve these goals.

Importance of Motivation

* Motivation improves employee involvement.

* Motivation promotes job satisfaction and thus reduces absenteeism and turnover.

* Motivation helps in securing a high level of performance and hence enhances efficiency and productivity.

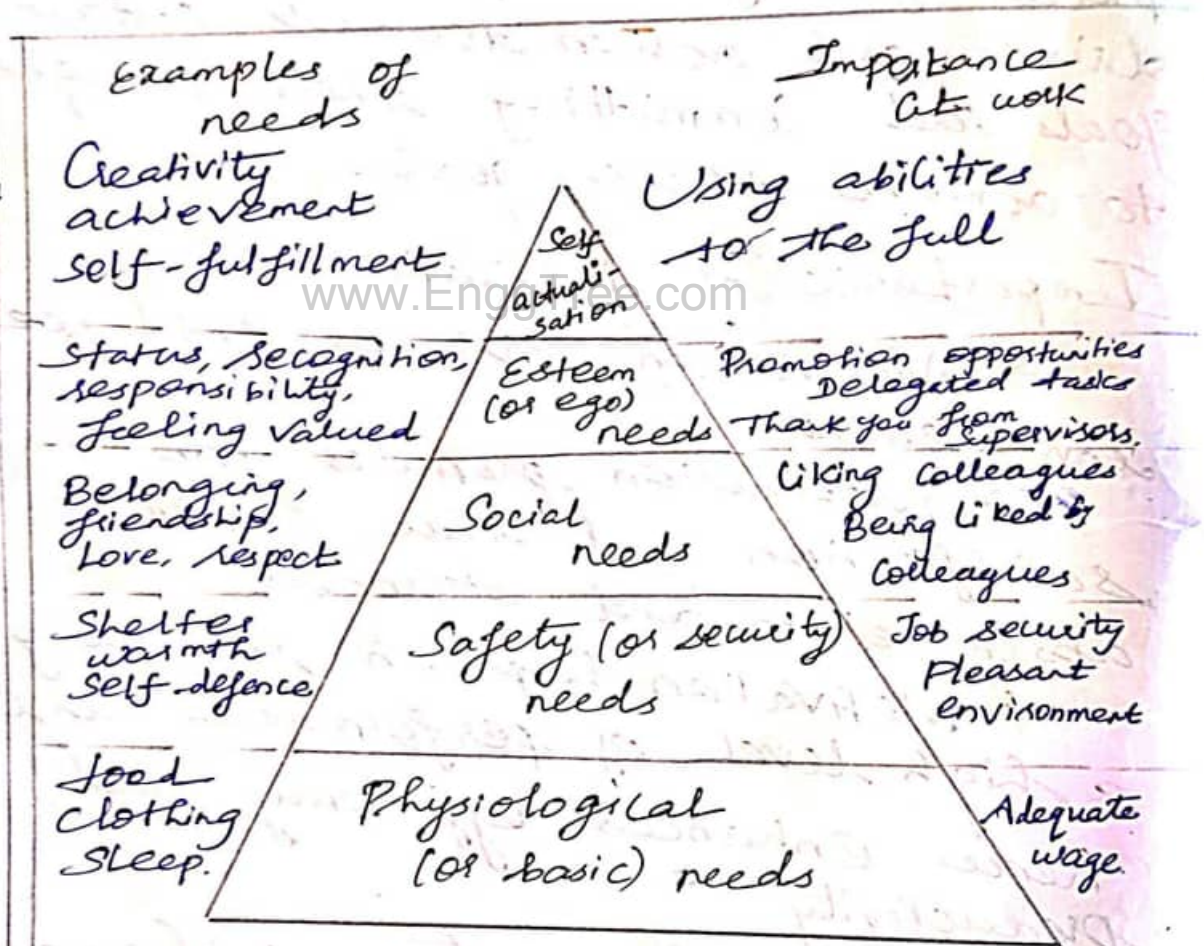
* Motivation creates a congenial working atmosphere in the organisation and thus promotes interpersonal cooperation.

Theories of Motivation:

I. Maslow's Hierarchy of Needs

The five basic needs are

- (i) Physiological needs
- (ii) Safety needs
- (iii) Social needs
- (iv) Esteem needs
- (v) Self actualisation needs



Maslow's hierarchy of needs.

The first three needs also known as lower level needs, can be satisfied by monetary and non-monetary compensations.

But last two needs, also known as higher level needs, can be satisfied through participation in decision making process, delegation of authority and responsibility, more freedom, self development etc.

Hierarchy of human needs and forms of quality motivation.

Maslow's list of human needs	Usual forms of Quality motivation
Physiological needs	Opportunity to increase earnings by a bonus for good work.
Safety needs	Job security
Social needs	Appeal to the employee as a member of the team he & she must not let the team down
Esteem needs	Appeal to pride of workmanship, to achieving a good score. Recognition through awards, publicity, etc
Self fulfillment needs	Opportunity to propose creative ideas and participate in creating creative planning.

II. Herzberg's Two factor theory.

Herzberg's two factor theory is also called motivation-hygiene theory.

This theory is based on two factors.

1. Motivation factors or satisfiers
2. Hygiene factors or dissatisfiers

Various motivation factors and hygiene factors are listed in the table.

Motivation factors	Hygiene factors
Achievement Recognition The work itself Responsibility Advancement and growth	Supervisors Working Condition Interpersonal relationship Pay and security Company policy and administration

According to Herzberg, maintenance or hygiene factors are necessary to maintain a reasonable level of satisfaction among employees. These factors do not provide satisfaction to the employees but their absence will dissatisfy them. Therefore these factors are called dissatisfiers.

On the other hand, motivational factors create satisfaction to the workers at the time of presence but their absence does not cause dissatisfaction.

It can be noted that Herzberg's dissatisfiers are roughly equivalent to Maslow's lower levels, and the motivators are similar to the Maslow's upper levels.

Thus the knowledge of motivation is required for any organisation to understand the utilisation of employee involvement.

Employee Empowerment

Definition:

Empowerment is an environment in which people have the ability, the confidence and the commitment to take the responsibility and ~~own~~ ownership to improve the process and initiate the necessary steps to satisfy customer requirements within well defined

boundaries in order to achieve organisational values and goals.

General Principles for Empowering Employees

Tell people what their responsibilities are.

Give them authority equal to the responsibility assigned to them.

Set standards of excellence.

Provide them with training that will enable them to maintain standards.

Give them knowledge and information.

Provide them with feedback on their performance.

Trust them and create trustworthiness in the organisation.

Allow them to fail but guide them and counsel them when needed.

Treat them with dignity and respect.

Conditions to Create the Empowered Environment.

1. Everyone must understand the need for change.
2. The system needs to change to the new paradigm.
3. The organisation must provide information, education and skill to its employees.

Characteristics of Empowered

Employees.

They feel responsible for their own task.

They are given a free hand in their work.

They are well trained, equipped, Creative and Customer oriented.

They balance their own goals with those of the organisation.

They are critical, have self esteem, and are motivated.

They are challenged and Encouraged.

They monitor and improve their work continuously.

They find new goals and change challenges.

Therefore it is important to empower individuals and teams at all levels of the organisation to achieve the continuous improvement process.

Teams and Team Work

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Definition:

A team can be 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.

Benefits of Teamwork:

The benefits of teamwork include

- (i) Improved solutions to quality problems
- (ii) Improved ownership of solutions
- (iii) Improved communications.
- (iv) Improved integration.

Types of Teams:

1. Process Improvement Team.

Process improvement team focuses its attention on improvements of a process which is already operating at a satisfactory ^{level} with agreed to tolerances.

2. Cross functional Team

At the top management level, the cross functional teams are formed by certain organisations which are very successful in solving complex problems involving functions of various departments.

3. Natural work Teams:

Team comprise of all the members of the work unit and the team members are not volunteers; they ^{are} selected by

management. Manager is also a part of the team and he is selecting the projects to be improved.

4. Self directed / self managed work Teams.

A self managing team is a group of individuals who work together continuously. These teams plan, execute and control their work to achieve a defined output. The team consists of members from the work unit except supervisor.

Characteristics of successful team

1. Sponsors: The sponsor is a person from the quality council to provide support to the organisation.
2. Team Charter: A team Charter is a document that defines the team's mission, boundaries, the background of the problem, the team's authority and duties and resources.

3. Team Composition: The size of the team should not exceed ten members except in the case of natural work teams or self directed teams.

4. Training: The team members should be trained in the problem solving techniques, team dynamics and communication skills.

5. Ground Rules:
The team should have separate rules of operation and conduct.

6. Clear Objectives:
The objective of the team should be stated clearly.

7. Accountability: Periodic status report of the team should be given to the quality council.

8. Well defined Decision procedures:
The decision should be made clearly at the right time by the team.

9. Resources: The adequate information and necessary tools should be given to the team whenever needed.

10. Trust : Management must trust the team to perform the task effectively.

11. Effective problem solving:

Problem solving methods are used to make the effective decision.

12. Open Communication:

Everyone feels free to speak in the team whatever they are thinking, without any interruptions.

13. Appropriate Leadership:

Leader is a person who leads the team, motivates the team and guides the team in a proper direction.

14. Balanced Participation:

Everyone in a team should be involved in the team's activities by voicing their opinions, lending their knowledge and encouraging other members to take part.

15. Cohesiveness : Members should be comfortable working with each other and act as a single unit, not

as individuals or subgroup

Stages of Team Development.

1. **Forming Stage**: When a team is created, it consists of group of individuals and team work does not exist at this stage. Team's purpose, members' roles, acceptance of roles, authority and process of functioning are learnt in the formation process.

2. **Storming Stage**: Initial agreements and role allocations are challenged and re-established at this stage of team development. At this stage, hostilities and personal needs often emerge which may be resolved.

3. **Norming Stage**: During norming stage of team development, formal and informal relationships get established among team members. Openness and cooperation have been observed as signs of team's behaviour.

4. **Performing Stage**: At this stage, the team starts operating in successful manner. Trust openness,

healthy conflict and decisiveness of a group's performance can be reached at this stage.

5. Maintenance stage: At this stage, the performance of teamwork at the earliest stage will be maintained for some period of time.

6. Evaluating stage:

At this stage, team's performance is to be evaluated in view of the set targets.

Barriers to Team Progress:

1. Insufficient training
2. Incompatible demands and compensation
3. First line supervisor resistance
4. Lack of planning
5. Lack of management support
6. Access to information systems
7. Lack of union support
8. Project scope too large
9. Project objectives are not significant
10. No clear measures of success
11. No time to do improvement work.

Recognition and Reward :-

Recognition is a process whereby management shows acknowledgement of an employee's outstanding performance.

Reward is a tangible one, such as increased salaries, Commission, Cash bonus, gain sharing etc, to promote desirable behaviour.

Why Should one Recognize the employees.

- * improve employee morale
- * Show the Company's Appreciation for better performance
- * Create Satisfied workplace
- * Create highly motivated workplace
- * Reinforce behavioural patterns
- * Stimulate creative efforts.

Types of Rewards

Intrinsic rewards : These are related to feelings of accomplishment or self worth.

Extrinsic rewards : These are related to pay or compensation issues.

Intrinsic rewards

1. Non monetary forms of recognition to acknowledge achievement of quality improvement goals

2. Celebrations to acknowledge achievement of quality improvement goals.

3. Regular expressions of appreciation by managers and leaders to employees to acknowledge achievement of quality improvement goals.

4. 360° Performance appraisals - feedback from co workers, Subordinates or

Customers is incorporated into performance appraisals

5. Formal suggestion system available for individuals to make quality improvement suggestions.

6. Developmental based performance appraisals

7. Quality based promotions.

Extrinsic rewards

1. Profit Sharing

2. Gain Sharing

3. Employment security

4. Compensation time

5. Individual based performance systems.

6. Quality based performance appraisals.

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Ways to Recognize people.

1. Send letters to improve team members when they establish a team, thanking them for their involvement.
2. Develop a 'behind the scenes' award specifically for those whose actions are not usually in the lime light, make sure such awards are in the lime light.
3. Create a best ideas of year booklet and include everyone's picture name and description of their best ideas.
4. Feature the quality team of the month and put their picture in a prominent place.
5. Honour peers who have helped you by recognising them at your staff meetings.
6. Let people attend meetings, committee etc, in your place when you are not available.
7. Involve teams with external and suppliers, sending them on appropriate visits to solve problems.

and look for opportunities.

8. Invite a team for coffee or lunch at any time, not necessarily when you need them for something.

9. Create a visibility wall display information, posters, pictures, thanking individual employees and their teams, and describing their contributions.

10. When you are discussing an individual's or group's ideas with other people, peers or higher management, make sure that you give ~~of~~ them credit.

11. Mention someone's outstanding work or ideas during your own meetings and at meetings with your peers and management.

12. Take interest in employees' development and set up appropriate training and experience to build on their initiatives.

13. Get your team's pictures in the Company newspaper newsletter.

14. Write a letter to praise to people to recognise their specific contributions and accomplishments.

Send a copy to your boss.

15. Ask people to help with a project you consider to be especially difficult but which provides real challenge.

16. Send a team to special seminars, workshops or meetings outside that cover topics they are especially interested in.

17. Ask your boss to send a letter of acknowledgement and thanks to individuals or groups that are making significant contributions.

18. Honour outstanding contributions with awards which are formally presented and publicised.

19. Have a stock of small gifts to give to people on the spot whom you catch doing things right.

20. Promote or nominate for promotion, those people who contribute most to improvement over a period of time.

Performance Appraisal

Performance Appraisal is a systematic and objective assessment or evaluation of performance and contribution of an individual.

It is a systematic and objective way of judging the relative worth of an employee in performing his task.

Need for performance appraisal.

- * To identify employees for salary revision, promotion, transfer, demotion and lay-off

- * To take an organisational inventory people, skills and potential for comparing it with its needs.

- * To determine training and development needs of the employees.

- * To motivate employees by providing feedback on their performance levels.

- * To know personal strengths and weaknesses of different

individuals.

* To establish a basis for research and reference for personnel decisions in future.

* To guide the individual to plan job and personal objectives and to help him in Career planning.

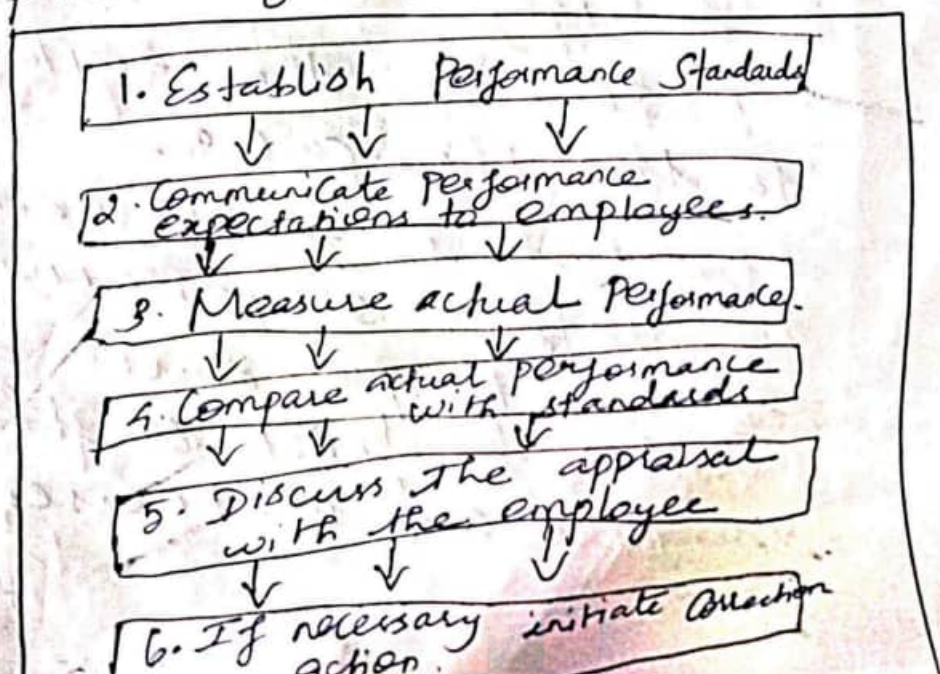
* To validate the selection procedures.

* To improve communication in an Organisation.

* To make the supervisors and executives more observant of their subordinates.

Process of performance appraisal
(Steps in development of Appraisal system).

There are six steps in the development of appraisal system.



Benefits of Performance Appraisal.

The Performance appraisal benefits are as follows.

1. It Provides useful feedback to the employee, supervisor and personnel specialists and ~~follows~~ allows them to take corrective measures to improve performance further.

2. It helps in determining the pay adjustments increments and bonuses as it rates the merit of the employee.

3. It provides basis for employee promotion, transfer or demotion.

4. It helps in determining individuals training and developmental needs and in designing training programmes accordingly.

5. It helps the employee to plan their career.

6. It helps in evaluating the staffing or personnel department procedures and provides feedback on their strengths and weaknesses.

7. It may provide information on some external factors such as family circumstances, health, financial or personal matters that may be affecting the performance.

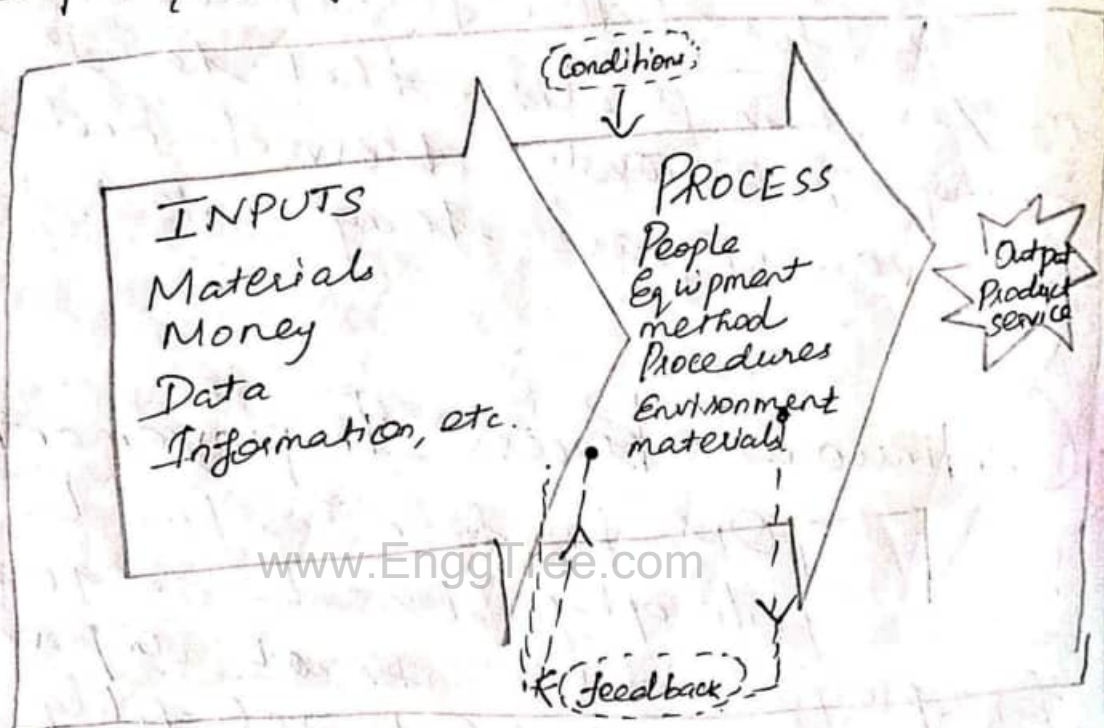
8. It puts a sort of pressure on people for better performance. It makes him realise that he is being continuously observed and his improvements are being noted.

Continuous Process Improvement.

TQM has been defined as a philosophy based on quest for progress and continual improvement in the areas of cost, reliability, quality innovation, efficiency and business effectiveness. TQM is a continuous learning process which never stops. It is a cyclic, iterative and never ending activity. Also, TQM has been described as an approach for continuously improving the quality of goods and services delivered through the participation of all levels and functions of the organisation.

In this chapter, we shall discuss different Continuous process improvement approaches, such as TQM Trilogy, PDCA Cycle, Kaizen and 5S Concept, in detail in the following sections.

Input / Output Process Model.



Turan's Quality Trilogy:

Turan divides quality management into managerial processes. They are.

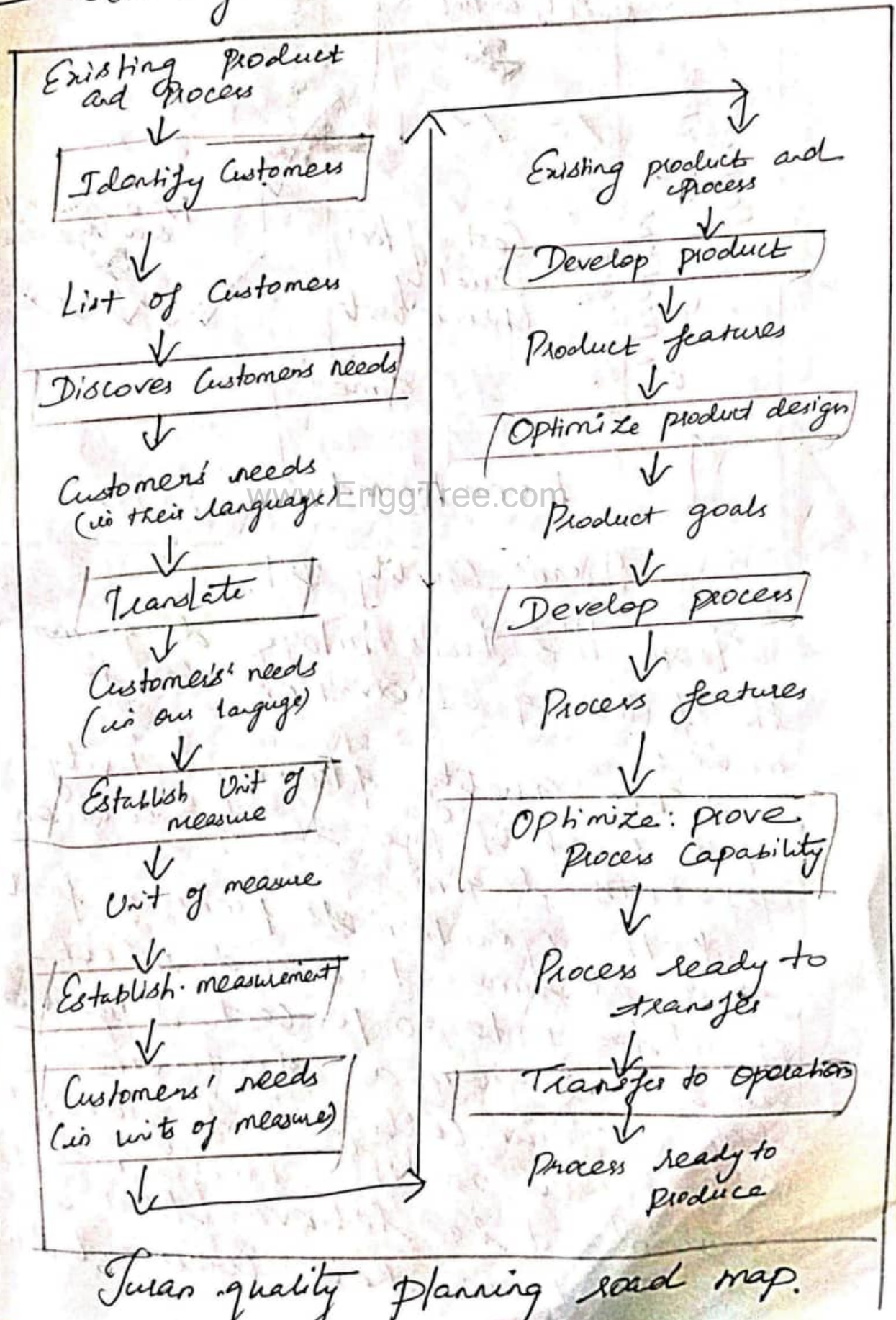
1. Quality planning
2. Quality Control
3. Quality improvement.

The above three organisation wide processes are the constituents of Turan's Quality trilogy.

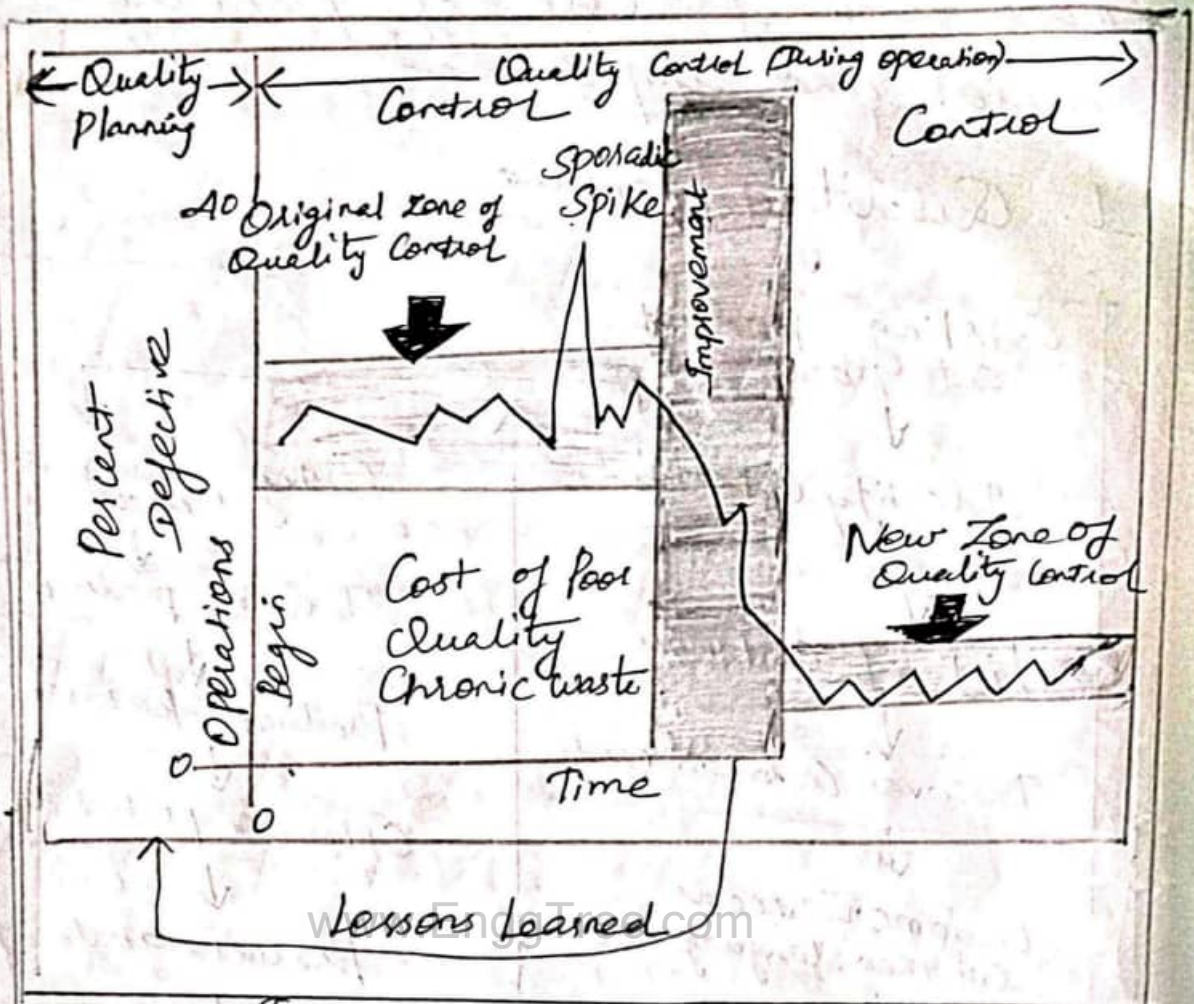
Turan's quality trilogy

means 'managing for quality is achieved by the use of the three managerial processes of planning, control and improvement'

1. Quality Planning



Juran Trilogy Diagram.



Juran's Quality Trilogy

From the Juran's trilogy diagram, the following observations can be made:

- * The quality planning activity starts much before the production operations begin.
- * The operation to produce products starts at time $t=0$ and there could be up to 20 per cent defectives in this region as shown in figure. Juran calls this region of high defects as the chronic waste region and he believes that the defects might have occurred due

to errors in the planning process. Through quality control process, a large number of defects are identified and corrected.

* In the chronic waste region. Sometimes the defects could be very high say 40 percent as shown in figure and this is called sporadic spike. Juran believes that sporadic spike occurs because the quality control is not strictly followed. Obviously such spike is not desirable and may cause inconvenience to the customers and the organisation.

* Due to quality improvement initiatives over the time, a new zone of quality control reached. This gain was through the third process namely quality improvement. Now the percent defectives may reach 5 percent. This achievement is due to quality improvement action initiated by the organisation. Once the performance stabilizes at the new zone of quality control, the quality plan has to be updated.

In figure, Juran has

made clear distinction between sporadic waste and chronic waste. The sporadic waste can be identified and corrected through quality control; whereas the chronic waste requires an improvement process. It is also clear that Juran's trilogy is a cyclic and never ending continuous process improvement approach.

PDSA cycle (or Deming Wheel)

The basic plan -

Do - Study - Act cycle was originally developed by Walter A. Shewart. But it was popularised by Edward Deming and that's why it is often called the Deming cycle or Deming wheel. It is an effective continuous improvement technique.

What is PDSA cycle?

PDSA stands for Plan, Do, Study, Act. It is a model for testing ideas that you think may create improvement.

It is an extremely practical, common sense based approach

that is easy to understand

It can be used to test ideas for improvement quickly and easily based on existing ideas, research, feedback, theory, review audit, etc.

It encourages starting with small changes, which can build into large improvements in the service through successive quick cycles of change.

It is a universal improvement methodology. The idea is to constantly improve and thereby reduce the difference between the requirements of the customer and the performance of the process.

The cycle is about learning an ongoing improvement; learning what works and what does not in a systematic way; and the cycle repeats; after one cycle is complete, another is started.

Phases of PDCA Cycle.

Phases

Description.

1. Plan

* Define the problem
* Analyse the causes and draft an action plan for solving the problem.

- * Determine the quality objectiveness objectives and the critical factors.

- * Define the performance indicators.

- * Collect and analyze the necessary process data.

- * Generate possible solutions.

- * Select the most feasible solution and work it out

2. DO

- * first, implement the plan on a limited scale or conduct an experiment to test the proposed improvement. Collection of data is hereby essential.

Train all involved employees in the use of quality improvement methods and techniques.

Describe the process which is considered for improvement and form project teams to lead the process.

3. Check & Evaluate the trial project with the performance indicators.

- * Verify whether the improvement has been successful or not

4. Act * Act to implement proven improvements. The Choices are introduce the plan, adjust or reject it.

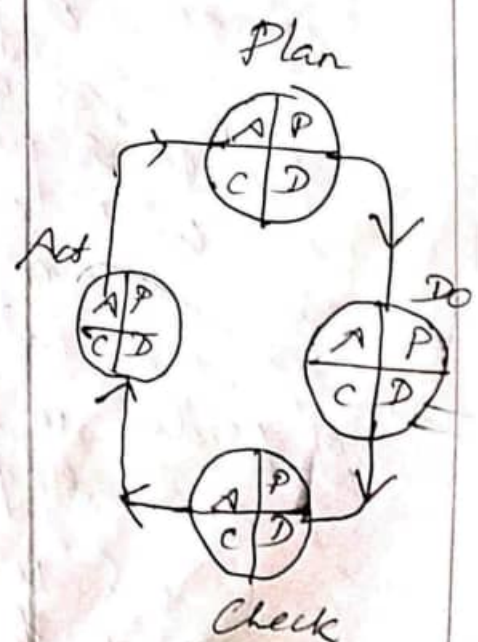
* The improvements are documented in standard procedures so all employees are well informed on how to handle ~~the~~ in future.

* Usually, the cycle will be repeated under the different circumstances and conditions to test how consistent the results are.

Continuous Process improvement cycle using PDCA.



The PDCA cycle



Applying PDCA to its phases

Benefits of the PDCA Cycle.

1. Daily routine management - for the individual and/or the team.
2. Problem Solving Process
3. Project Management.
4. Continuous development.
5. Vendor development
6. Human Resource development.
7. New product development.
8. Process trials.

5S

The 5S Practice is a house keeping technique used to establish and maintain a productive and quality environment in an organisation.

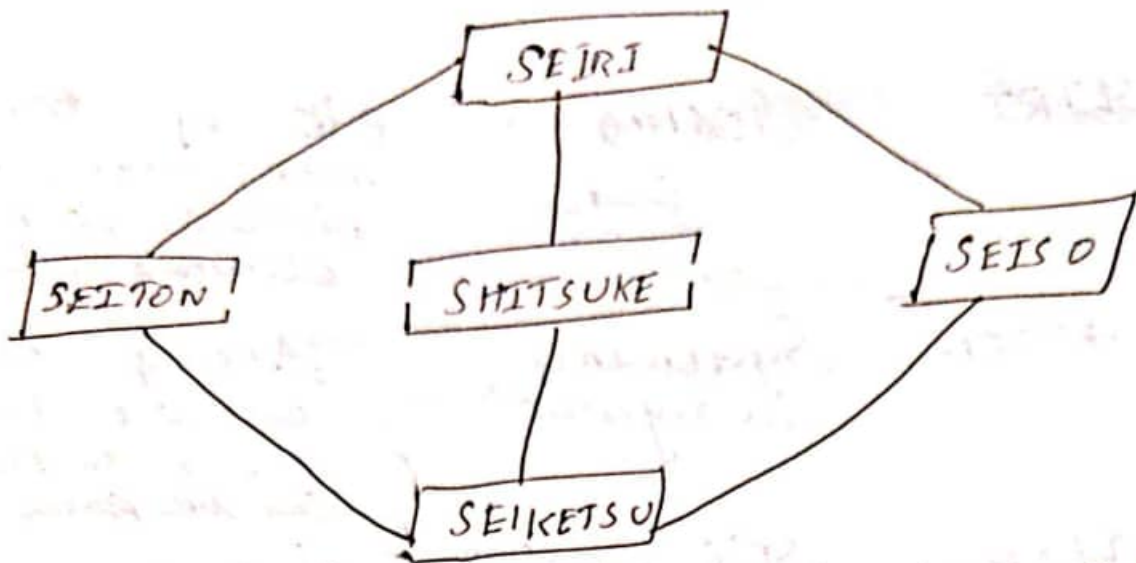
A well organized work place results in a safer, more efficient and more productive operation. It boosts the morale of the workers, promoting a sense of pride in their work and ownership of their responsibilities.

5S was invented in Japan. It stands for five Japanese words that ~~the~~ start with the letter 'S': SEIRI, SEITON, SEISO, SEIKTSU, SHITSUKE

Meaning of '5s' elements.

Japanese Term	English equivalent	Meaning in Japanese Context.
1. SEIRI	Sorting (Sort) Out	Separate out all unnecessary things in order, sort and eliminate them.
2. SEITON	Systematic Arrangement (set in order or grouping)	Arrange the essential things in order, so that they can be easily accessed.
3. SEISO	SPIC and span. Super cleaning eg. inspection	clean the work place, everything without fail.
4. SEIKETSU.	Standardizing	standardizing the way of maintaining cleanliness. (procedures)
5. SHITSUKE	Self discipline Just say	Practice five s' daily. Make it a way of life. This also means commitment. audit

Relationship Between Various 5S.



5S is an easy way to restore and sustain an ideal environment at work place. www.EnggTree.com

Objectives of 5S

1. To create a neat and clean work place.
2. To systemise day to day working.
3. To improve work efficiency.
4. To standardize work practices
5. To improve work discipline.
6. To improve the quality of work and products.

Details of 5S.

1. SEIRI : SORTING.

SEIRI denotes action to identify and sort out all items into necessary and unnecessary items and discard all unnecessary items.

Consequences of not following SEIRI

- (i) The wanted is hard to find when required.
- (ii) More space is demanded.
- (iii) Unwanted items cause misidentification.
- (iv) Misidentification causes errors in operation.
- (v) Maintenance cost of the equipments increases.

Examples of unwanted items :

(i) At factory floor : Machines to be scrapped, rejected materials, expired goods, broken tools, pallets, bins, trolleys, old notices; Scrap heaps outside; etc.

(ii) At office: Broken pens; useless papers; old diaries; broken furniture, etc.

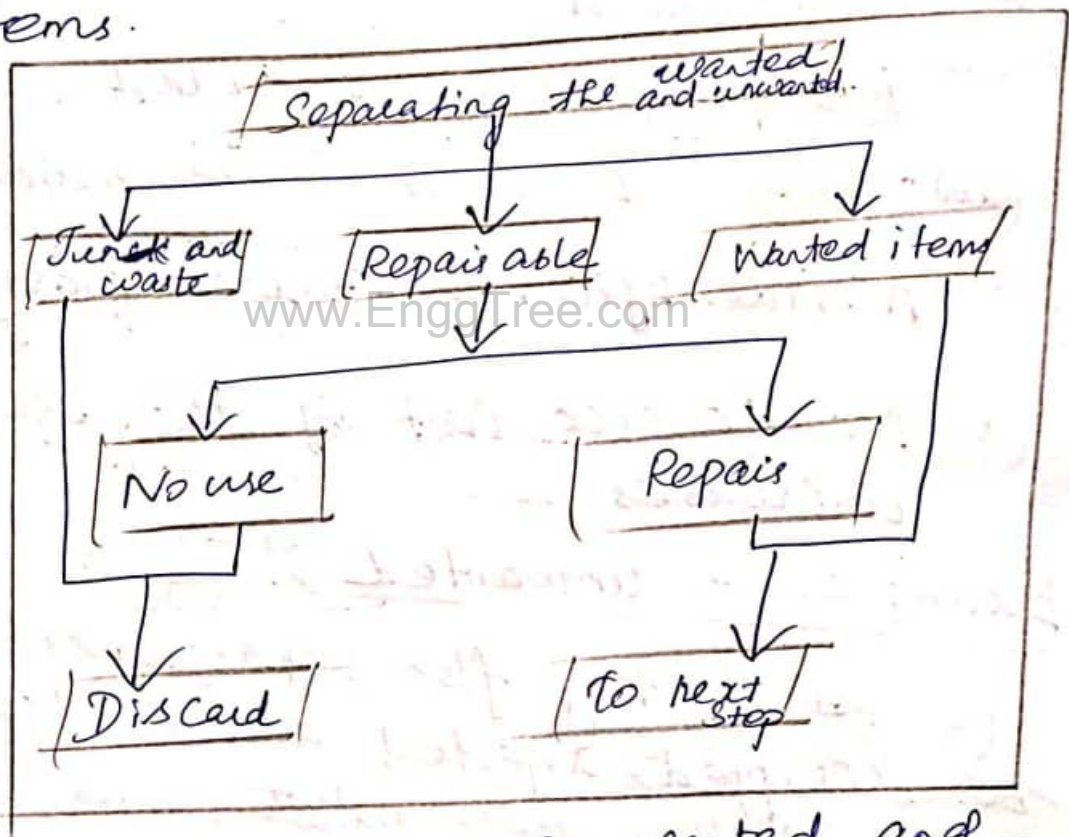
(iii) At home:- Broken toys; old clothes, broken suitcases, useless fans, etc.

How to practice Seiri?

1. Separate the wanted and the unwanted, as shown in the figure. Classify everything by frequency of use. Apply the sorting criteria depicted in figure.

2. Always repair the repairable items immediately.

3. Throw away unwanted items.



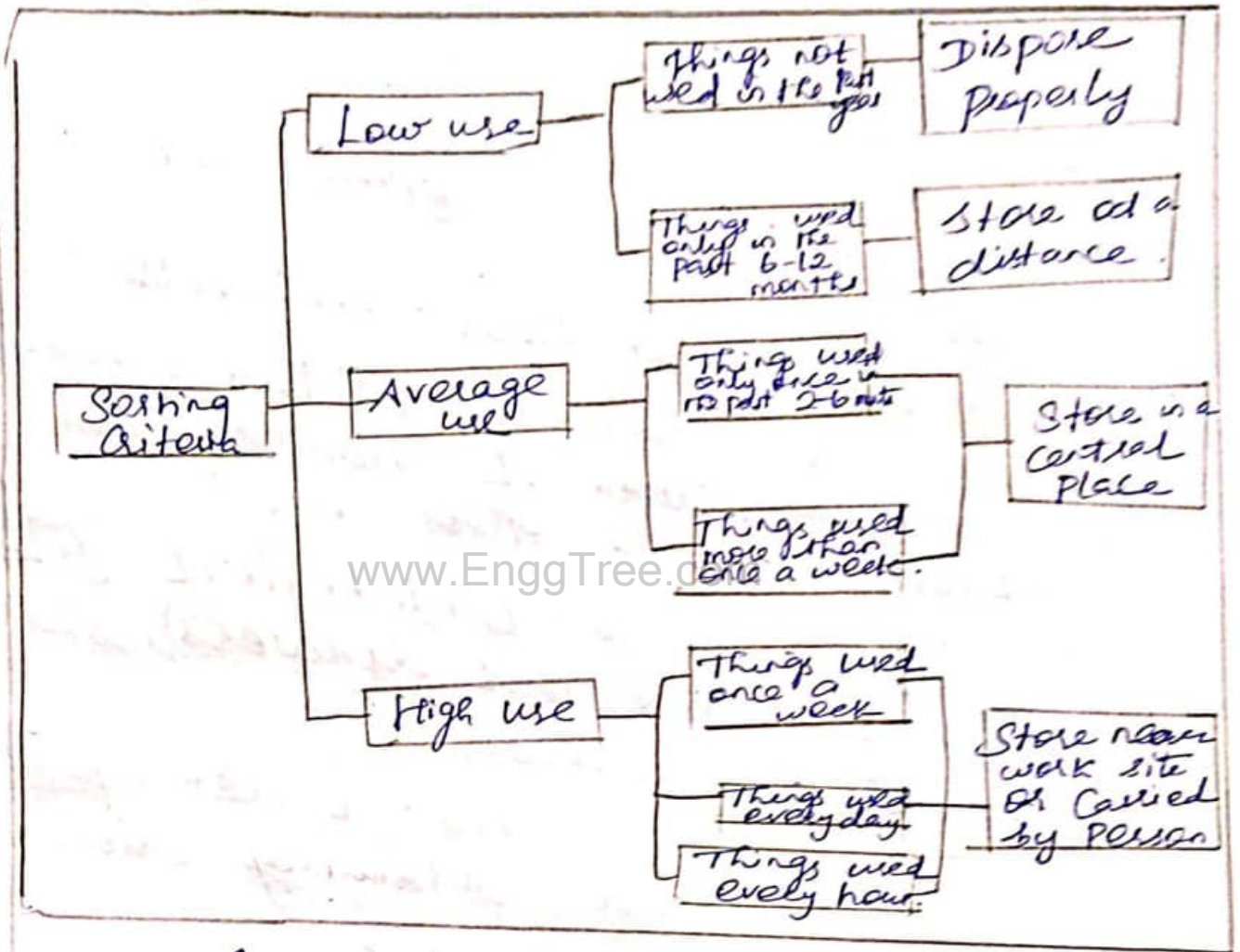
Separating the wanted and unwanted.

A. Develop a clear and well-understood policy of disposal of broken, unrepairable or unwanted items.

B. Make a clear plans for getting rid of waste or dirt or

leakages, either by action at the source to prevent its generation.

6. Have a system of specifying the life of each file and destroy the unwanted files



Sorting and evaluation criteria.

2. SEITON: Systematize.

Seiton means to arrange everything in proper order so that it can be easily picked up for use. A place for everything and everything in its place.

Consequences of not practising SEITON on the shop floor:

1. Things are seldom available when needed.
2. Items are 'lost' in stores.
3. Visual control of the shop floor is not possible.

Some examples of ~~SEITON~~ ^{SEITON} not in Practice.

- (i) At factor floor: unlabelled tool crib, clustered shelves, lockers, stores on clear location system, things on the floor; etc.
- (ii) At office: Unlabelled file cabinet, clustered drawers, shelves, book-cases, tables.
- (iii) At home: no orderly arrangement - in drawing room or kitchen or anywhere.

How to Practice SEITON?

1. Designate locations.
 - * Assign a specific place for each item based on how often you use it.
 - * Tools and equipment that are used frequently should be stored close to the workspace.

2. Use Labels and Visual Aids:

- * Label storage spaces clearly to indicate what belongs there.
- * You can also color code areas to enhance visual organisation.

3. Implement a logical flow:

- * Organize items in the order in the order in which they are used.

* This will reduce time spent searching for tools and streamline workflow.

4. Minimize Clutter

Only essential items should be in the workplace. Non essential tools or materials should be stored elsewhere to reduce Clutter.

5. Regular audits:

Conduct periodic checks to ensure that everything is still in its proper place, and adjust the organization system as needed.

3. SEISO : SHINE.

SEISO means to clean the workplace thoroughly so that there is no dust/dirt/snap anywhere.

Consequences of not practising SEISO are.

1. Mist machines are affected by dust and dirt. Their performance may go down, they may wear out faster. The costs can be huge.

2. Dust and dirt on products, materials, packing boxes will almost certainly affect either their performance quality or at least their aesthetic quality.

3. A dusty and dirty place is unpleasant to work in.

Some examples of poor SEISO:

(i) At factory floor: Dirty machines, dust on products, parts, raw materials, dirty jigs, fixtures, moulds, dusty walls, soots, littered floor etc..

(ii) At office: Dusty table and furniture, dirty office equipment, typewriter, photo copiers, computers

littered floor, etc.

How to practice SEISO?

1. Sweeping inside the lines is the responsibility of people working in that line. This includes cleaning of machines, tooling, bins, pallets etc.

2. Packing bags, rejects, spilled powders, paper, etc. must not be allowed to first drop on the floor and then swept out of the lines and cleared later by sweeping staff.

3. Oil and other liquid spills should not take place but if they do they must be cleared and the stains removed.

4. Inaccessible parts like roofs, high walls must be swept out.

5. Outside the buildup area, sweeping and washing must be kept up regularly.

6. Toilets should be kept clean and well supplied.

4. SEIKETSU: STANDARDISE.

SEIKETSU means maintaining a high standard of workplace organisation and house keeping at all times.

It always aims at maintaining the standard level of cleanliness, hygiene and visual control.

Consequences of not practising

SEIKETSU:

(i) Dual standards yield multiple results.

(ii) Multiple results lead to conflicts and confusions.

(iii) Rework increases.

(iv) Rework increases the basic cost of the finished product without any value addition.

How to Practice SEIKETSU?

1. Colour coding.
2. Fool proofing
3. Responsibility labels.
4. Wire management.
5. Inspection marks
6. Prevention of dusts, dirt, noise and vibration.

7. I-Can-do-it - blindfolded.
8. One Point lessons
9. Visual Control signs.

While doing SEIKETSU keep in mind.

- * The standards should be arrived unanimously.
- * Always keep the standards flexible to changes and improvement.
- * Standards should be known to all and displayed.

5. SHITSUKE : SELF DISCIPLINE.

SHITSUKE denotes self discipline, especially with regard to safety rules and punctuality.

5S means everything in its place. People must also be in their place, at the right time in the right attire.

It is management's responsibility to train people to practice 5S with discipline to acquire the habit and to keep it.

Consequences of not practising SHITSUKE:

- (i) If discipline is not practiced the first 4S would backslide.
- (ii) Lack of SHITSUKE means not following the standards, then all activities related to quality and safety will be affected.

How to practice SHITSUKE?

1. All employees must be trained in all aspects of 4S. This must be done through class-room, actual practice and also by well illustrated instructions and displays.
2. Supervisors must correct wrong practices everyday, on the spot.
3. If all members of an office or workshop are not present when they are supposed to be, it is poor 5S. punctuality is the backbone of 5S.
4. Timeliness also applies to preparation of reports, filling out the charts, etc.
5. Wearing appropriate safety wear at all times is essential.
6. Name plates should be worn.

Factors in Implementing '5S'

The following factors are required for any organisation to implement 5S concept successfully.

1. Participation by all: 5S Programme should be understood and practiced by all employees. Linkage with productivity, quality, Cost, delivery, safety, and Customer Satisfaction should be clear to everyone.

2. Top management Commitment:
The CEO along with Senior management team needs personally committed practice and supervise the programme. Without their deep commitment, no 5S can be successful.

3. Should be Self sustaining:
Banners, slogan posters and new tutors should be fully utilised to draw attention of everyone in the company. Basic in-house training and introduction to model companies would provide them the necessary skills.

4. Review the Programme: Every month, a group of people selected from different areas of responsibility should tour the plant, evaluate each zone according to certain criteria of house keeping principles.

Benefits in Implementing '5S'

1. Work place becomes clean and better organized. It becomes proud place to work.
2. Results in good Company image and generates more business.
3. Shop floor and office operations become easier and safer.
4. People become disciplined.
5. Contribute to productivity, quality and employee morale.
6. Better quality awareness.
7. More usable floor space.
8. Lesser time wasted in material handling.
9. Lower Cost of production.
10. Better preventive maintenance.

11. High employee involvement.
12. Lesser accidents.
13. More time for improvement activities.

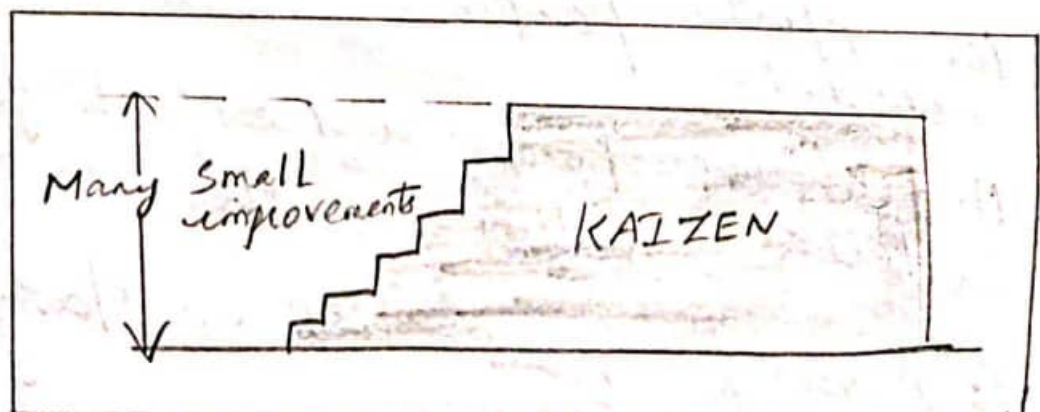
KAIZEN.

What is Kaizen?

Kaizen is a Japanese word which means continuous improvement or improvement over improvement.

It is the process of continuous improvements in small increments that make the process more efficient, effective, controllable and adequate.

In Kaizen (Japanese philosophy), improvements are accomplished gradually, i.e. improvements in small increments.

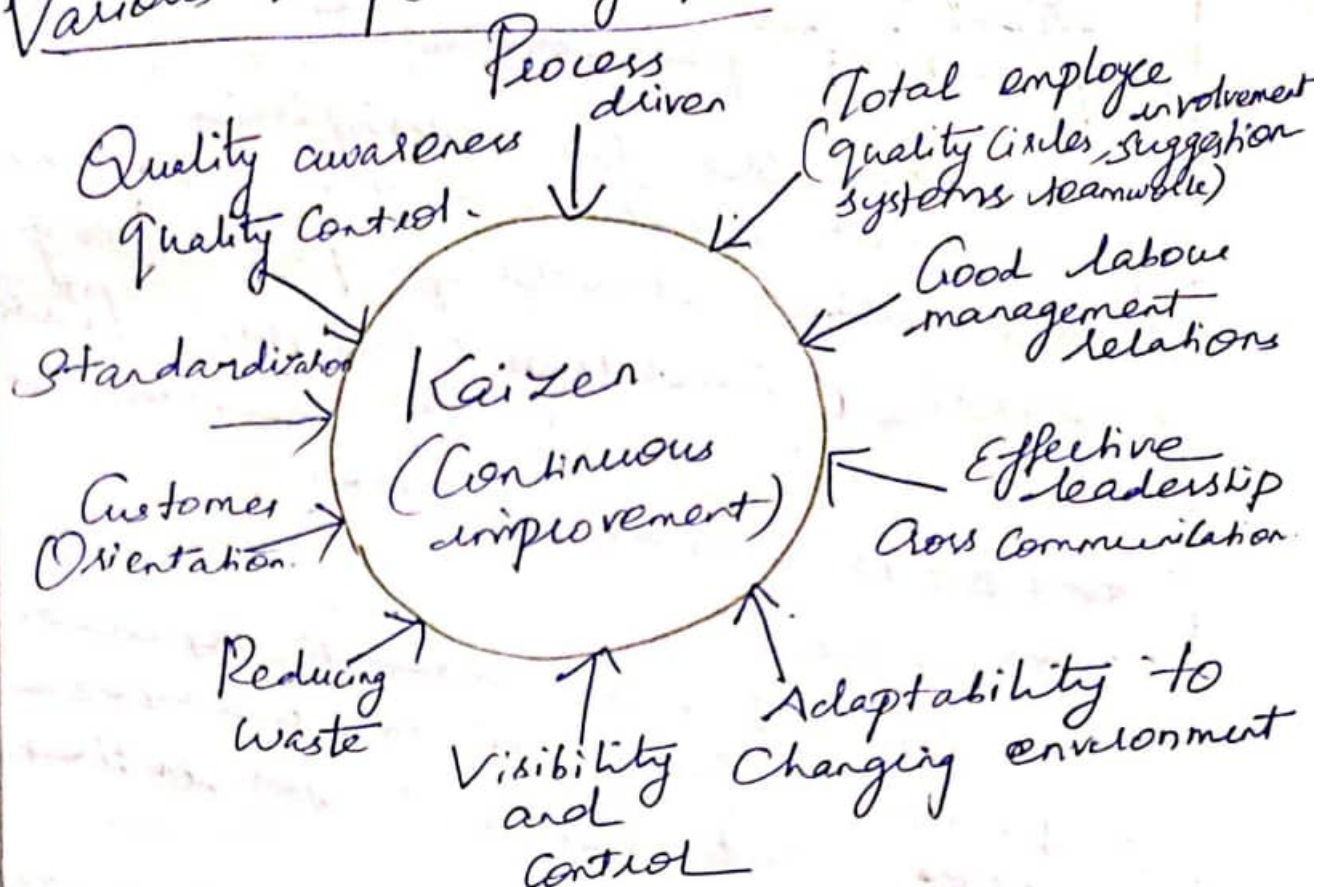


Comparison between Kaizen and TQM

Kaizen.

	Kaizen.
1. Effect	Long-term and long lasting but undramatic.
2. Pace	Small steps.
3. Time frame	Continuous and incremental.
4. Change	Gradual and constant.
5. Involvement	Everybody.
6. Approach	Collectivism, group efforts, Systems approach.
7. Mode	Maintenance and improvement.
8. Spark	Conventional know-how and state of the art.
9. Practical requirements	Requires little investments but great effort to maintain maintain it.
10. Effort orientation	People.
11. Evaluation Criteria	Process and efforts for better results.
12. Advantage	Works well in slow-growth economy.

Various Aspects of Kaizen.



Various aspects of Kaizen philosophy.

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Features of Kaizen :

1. Value added and non value added work activities.
2. Muda, which refers to the seven classes of wastes. Wastes are Over production, delay, transportation, Processing, inventory, wasted motion, defective parts.
 (Production organization)
3. Principles of motion study and the use of all technology.
4. Principles of materials handling and use of one-piece flow.
 (lean manufacturing)

5. Documentation of standard operating procedures.

6. The 5S for workplace organisation, which are five Japanese words that mean proper arrangement (SEIRI), orderliness (SEITON), Personal cleanliness (SEISO), Standardisation (SEIKETSU) and Discipline (SHITSUKE).

7. Visual management by means of visual displays that everyone in the plant can use for better communication.

8. Just in time principles to produce only the units in the right quantities, at the right time and with the right resources.

9. Poka-yoke ^{error proofing} to prevent or detect errors.

10. Team dynamics, which include problem solving, communication skills and conflict resolution.

Role of People in Implementing Kaizen

1. Top management must be committed to introducing Kaizen.

as a company strategy.

2. The executive just below top management must formulate and carry out kaizen goals according to guidelines from top management.

3. Supervisors, like everyone else, must use kaizen in their activities.

4. Workers must be involved in kaizen through the suggestions systems and small group activities.

Supplier Partnership.

In recent years, there are number of forces that have changed supplier relations,

They are

1. Deming's philosophy,
2. Just-In-Time Concept,
3. Kaizen or Continuous improvement.

4. ISO 9000 Quality management system and
5. Supply chain Management.

Principles of Customer / Supplier Relations

Ishikawa's 10 principles for Customer/supplier relations.

1. Both the Customer and the Supplier are fully responsible for the control of quality.
2. Both the Customer and the Supplier should be independent of each other and respect each other's independence.
3. The Customer is responsible for providing the supplier with clear and sufficient requirements so that the supplier can know precisely what to produce.
4. Both the Customer and the Supplier should enter into a non-adversarial contract with respect to quality, quantity, price, delivery method and terms of payments.
5. The supplier is responsible for providing the quality that will satisfy the Customer and submitting necessary data upon the Customer's request.

6. Both the Customer and the Supplier should establish in the methods to evaluate the quality of the product or service to the satisfaction of both parties.

7. Both the Customer and the Supplier should establish in the contract the method by which they can reach an amicable settlement of any disputes that may arise.

8. Both the Customer and the Supplier should continually exchange information, sometimes using multi functional teams, in order to improve the product or service quality.

9. Both the Customer and the Supplier should perform business activities such as procurement, production and inventory planning, clerical work and systems so that an amicable and satisfactory relationship is maintained.

10. When dealing with business transactions, both the Customer and the Supplier should always have the best interest of the end user in mind.

Supplier Partnering

Partnering is defined as continuing relationship between a buying firm and supplying firm, involving a commitment over an extended time period, an exchange of information, and acknowledgement of the risks and rewards of the relationship.

The relationship between Customer and Supplier should be based upon trust, dedication to common goals and objectives and an understanding of each party's expectations and values.

Benefits of Partnering

The benefits of Partnering include:

- (i) improved quality
- (ii) increased productivity
- (iii) increased market share

- (iv) Reduced Cost
- (v) increased efficiency
- (vi) increased opportunity for innovation and
- (vii) Continuous improvements of products / services.

Key elements of Partnering.

1. Long term Commitment :

Long-term commitment provides both customer and supplier the much needed environment to achieve the planned objectives. Because to set up and solve the problem of continuous improvement, both parties may require the sufficient time.

2. Trust : Mutual trust between two parties forms the basis for a strong working relationship. Trust enables the partners to effectively combine their resources and knowledge. It results in a win-win situation for both partners.

3. Shared Vision. Both the customer and supplier have the common goal i.e. to satisfy the

End users. In order to ensure this goal, both parties should share and understand their goals and objectives. This concept is also known as mutual strategic planning.

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Supplies selection:

Usually suppliers are selected based on their performance in terms of cost, quality, and delivery reliability. In addition, supplier criteria includes factors such as management compatibility, goal congruence and strategic direction of the supplier firm.

Stages in Supplies Selection and Evaluation.

1. Survey stage: In survey stage.

based on the information available through catalogues, advertisements, brochures, etc, a list is drawn up for further investigation.

2. Enquiry stage: In enquiry stage a detailed analysis is made after obtaining required information.

Standard enquiry forms are sent to the vendors, requesting them to furnish information. This may be followed by plant visit if necessary to have first hand details.

The vendor's present customers may be enquired regarding his performance, promptness in delivery, etc.

3. Negotiation and Selection Stage:

During the enquiry stage itself, many of the vendors might have been dropped from the original list as unsatisfactory.

The remaining vendors may be called for direct negotiations to discuss various terms and conditions like payment terms, discounts, supply procedures, quality control procedures, etc.

As a result of this a final list of approval vendors is drawn up.

4. Experience stage: In this stage, the performance of the supplier is evaluated mainly on basis of quality and promptness in delivery.

A history card is maintained for each vendor. The card contains information likes date of supply of ~~to~~ materials of by vendor, inspection procedure adopted, acceptance or otherwise of the lot supplied.

frequent rejections may upset the production schedule in the buyer's Company and result in heavy losses, hence such vendors might be dropped from the list.

Similarly the ~~date~~ late deliveries may cause stoppages in production, otherwise large inventories may have to be carried in stock. Both the situations are not desirable and

hence such vendors are also reviewed for continuance as suppliers.

Ishikawa's ten Conditions for selection and evaluation of suppliers

1. The Supplier should understand and appreciate the management philosophy of the organisation.
2. The supplier should have a stable management system.
3. The supplier should maintain high technical standards and have the capability of dealing with future technological innovations.
4. The supplier should provide those raw materials and parts required by the purchaser and those suppliers meet the quality specifications.
5. The supplier should have the capability to produce the amount of production needed.
6. The supplier should be accessible in terms of transportation and communication.

7. The Supplier should not breach the Corporate secrets.

8. The Supplier should be sincere in implementing the Contract provisions.

9. The Supplier should have an effective quality system and improvement program such as ISO/9000.

10. The Supplier should have a track record of customer satisfaction and organization credibility.

Supplier Rating:

A Supplier Rating System, also referred as a scorecard system, is used to obtain an overall rating of supplier performance. It is analogous to student's progress report.

Usually supplier rating is based on quality, price, performance and production capability.

Objectives of Supplier Rating:

The customer rates supplier in order to:

* to obtain an overall rating of supplier performance

* ensure complete communication with suppliers.

* Provide each supplier about the details of problems for collective action. and

* Maintain and improve the partnering relationship between the customer and the supplier.

Supplier Rating :

Item	Rated by:					Date :
	Maximum Points	Supplier A	Supplier B	Supplier C	Supplier D	Supplier E
Period :						
Location :						
Quality Performance		Actual Points	Actual Points	Actual Points	Actual Points	Actual Points
I Quality						
(i) Quality Personnel						
(ii) Quality Procedure						
(iii) Concern for quality						
(iv) Concern history						
II Price						
(i) Price quality						
(ii) Price negotiation						
(iii) Financial ability						
III Performance						
(i) Technical						
(ii) Delivery history						
(iii) Technical Assistance						
IV Production Capability						
(i) Production Capacity						
(ii) Manufacturing equipment						

5.0 = Very good

2.0 = Poor

4.0 = Good

1.0 = Very Poor

3.0 = Average

0 = Negative

A model supplier's standard.

Relationship development

This topic relationship development refers to maintaining and improving the growth of the Customer Supplier relationship.

1. Inspection:-

1. The four phases of quality Inspection are (i) 100% inspection (ii) Sampling inspection. (iii) Inspection audit (iv) Identify check.

2. In 100% inspection phase all the items supplied by the supplier are inspected. If the customer is satisfied with supplier in this phase for a period of time, then he gains confidence that initiates him to do sampling inspection rather than 100% inspection.

3. If the customer gains in this sampling inspection, then the customer changes to auditing the supplier's performance.

4. At this audit phase, the Customer has complete in the Supplier and initiates identity checks.

5. The fourth ^{and} final phase occurs when both the Customer and Supplier perform only identity checks.

2. Training:

1. Both Customers and Suppliers should be trained in quality teamwork and other management aspects.

2. Usually Customers invite the Suppliers to attend their seminars, workshops, courses, exhibition, etc.

3. The training methods could improve the two parties relationship.

3. Team Approach.

1. Customer-supplier teams should be established in all the functional areas.

2. Suppliers should be called for the team meetings of customers. Team meetings should occur at both partners workplace

3. It may help in understanding each other's processes.

4. Recognition

1. The customers can recognise the suppliers by awarding them non-monetary and/or monetary rewards.

2. This reward and recognition concept will certainly improve the customer supplier relationship.

Unit-III Seven traditional tools of Quality.

Statistical tools	Purpose
1. Flow Chart	for depicting the essential steps of a process by using standard symbols.
2. Check Sheet	For systematic data gathering, by tabulating the frequency of occurrence.
3. Histogram	for graphically displaying the frequency distribution of the numerical data.
4. Pareto diagram	For identifying the vital few causes that account for a dominant share of quality loss.
5. Cause and effect diagram	for identifying and analysing the potential causes of a given problem.
6. Scatter diagram	for depicting the relationship between two variables.

7. Control Chart

for identifying process variations and signalling corrective action to be taken.

1. Flow Chart:

A flow chart also known as process flow chart, flow diagram and process deployment is a diagrammatic view of the various steps in sequential order that form an overall process in an organisation.

Flow charts are used in the quality management for depicting the steps of a process in an easily understandable form by using standard systems symbols.

In other words, the flow chart is a simple mapping tool that shows the sequence of actions within a process, in a form that is easy to read and communicate.

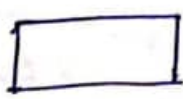
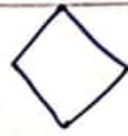
Uses:

→ To document and analyse the connection and sequence of events in a process.

→ It is used to create an integrated understanding of the activities that are performed and

The relationship between the different process steps.

Construction:

Symbol	Name	Meaning
	Terminator.	for indicating the start or end of the flow process chart
	Action (rectangle)	for indicating process or activity or task or operation
	Decision (Diamond)	for indicating a decision
	Arrows.	for indicating the direction of flow of the process
	Link.	for indicating a link to another page or another flow chart.

The ~~above~~ standard symbols used for constructing the flow process chart are presented in the ^{above} table.

The various steps involved in constructing a flow chart are given below.

1. Decide on the process to be investigated.

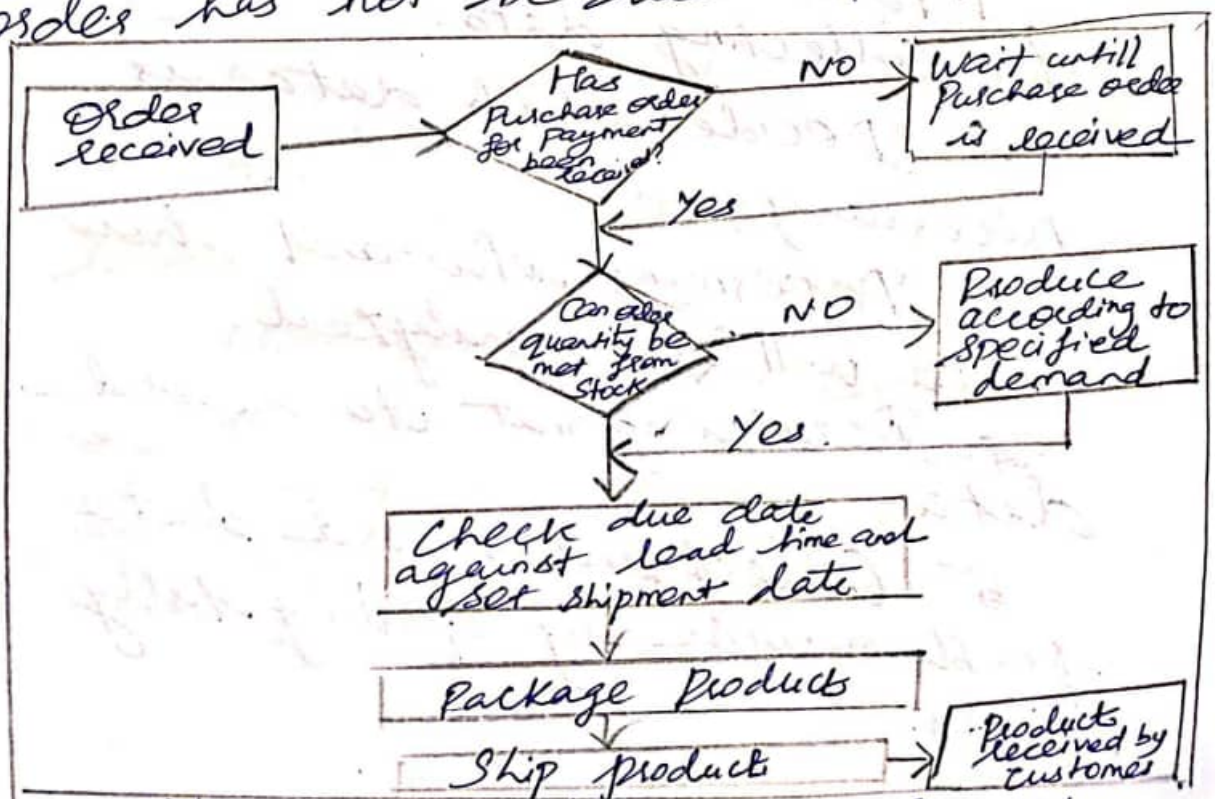
2. Define the Start, the end and the borders of the process.

3. List the steps in the process by determining the activities, decisions, inputs and outputs of the process.

4. Draw the chart placing the process steps in the order of their sequence using the standard symbols in Table.

5. Compare the flow chart with the actual process.

Eg:- The below figure illustrates a simple flow chart for processing incoming orders. The flowchart identifies where delays can occur for example, when a purchase order has not been received.



flowchart for processing incoming orders.

2. CHECK SHEET.

A check sheet also known as tally sheet, is a form for systematic data gathering and registering to get a clear view of the facts.

It is used to keep track of how often something occurs.

The form of the check sheet is tailored for each situation application.

Uses:

→ To indicate the frequency of a certain occurrence.

Construction:

A checklist may be constructed using the following steps.

1. Formulate the objective for collecting data.

2. Decide which data is necessary.

3. Determine who and how data will be analyzed.

4. Draw a format to record data.

5. Collect and record data problem-wise by putting tally lines.

6. Start Counting by tallying on the list: I, II, III, IIII, $\overline{\text{N}}$ represent the numbers 1, 2, 3, 4, and 5 respectively.
7. Mark on the list the total number of facts, which were noticed.

Types of check sheets:

1. Process distribution Check sheet:
This check sheet is used to collect on process variability.
2. Defective item Check sheet:
This check sheet is intended to specify the variety of defects occurring together with their frequency of occurrence.
3. Defect location Check sheet:
This check sheet is intended to identify where defects occur on the product.
4. Defect factor Check sheet:
This check sheet is used to monitor the input parameters in a process that might affect the incidence of defects.

Eg! A Xerox making machine Company notices a sudden increase in complaints about poor quality photocopies. To analyse these complaints, the Causes of defects are traced using a Check Sheet, as shown in figure.

Causes of defects	Types of defects				Total
	Missing Pages	Muddy Copies	Pages out of Sequence	Show through	
Humidity				1	11
Machine Jams				1	3
Toner			1		8
Conditions of Original	1			1	10
Total	6	14	7	5	32

3. Histogram.

A Histogram is a bar chart/diagram showing a distribution of Variable quantities or Characteristics. It is a graphical display of

the frequency distribution of the numerical data

The data are displayed as a series of rectangles of equal width and varying heights.

Uses:-

→ 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 process results.

→ It enables the analyst to quickly visualize the features of a complete set of data.

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Construction:-

1. After the data collection, count the number of data values collected.

2. Determine the range of the data.

Range = Highest Value - Lowest Value

3. Divide the data values in groups or classes and count the number of values in each class.

The below table shows the guidelines to divide the data values.

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

4. Now determine the width of the class.

$$\text{Width of the Class} = \frac{\text{Range}}{\text{Number of classes selected from the above table.}}$$

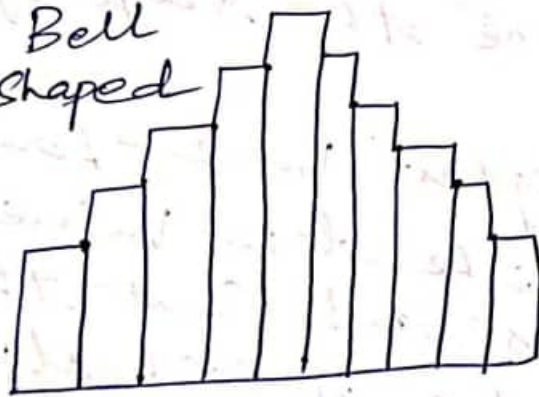
5. Draw a frequency table for all the values.

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.

(a) Bell Shaped



(b) Double peaked



(c)

Plateau



(d) Comb



(e) Isolated Peak



(f) Edged Peak



(g) Skewed



(h) Truncated



Eg: Company X manufactures small resistors with a resistance value of 100 ohms. Recently, the Company has receiving numerous Complaints from their Customers about these resistors. The value of the resistance has been deviating from the design value. A team of workers was selected to investigate the deviation in the resistance values. As a starting point, the team decided to construct a histogram to see the extent of variation in the resistance value. A sample of 50 resistors from the production line was taken for the construction of histogram. The sample's resistance values are listed in Table below.

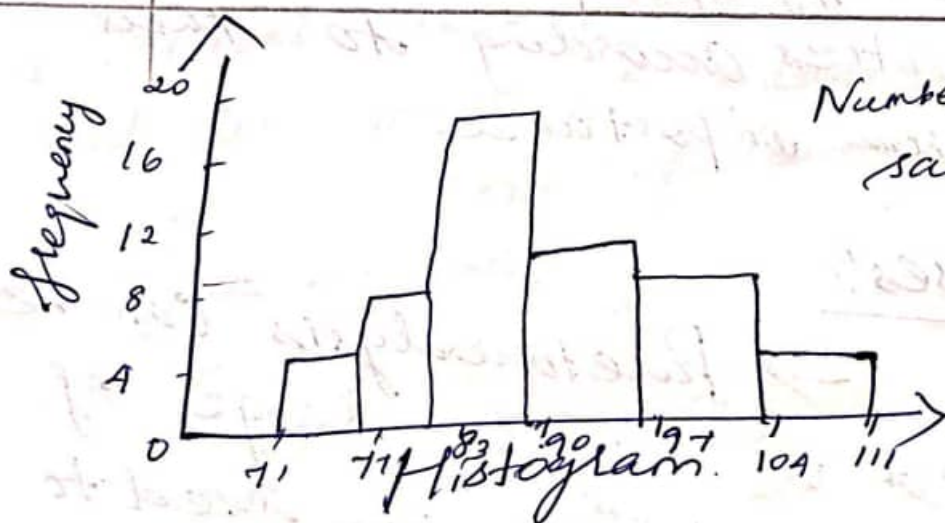
Resistance value for 50 resistors.

85	87	84	100	81	83	91	76	76	90
82	90	108	79	94	110	89	74	100	85
88	86	89	90	86	90	100	99	74	91
85	101	80	92	85	100	81	85	79	84
79	83	85	90	100	91	107	85	77	100

Sol:

1. Data Collection
2. Range of fifty data points =
Highest value - lowest value
 $= 110 - 74 = 36$.
3. Number of classes is 6
4. Width of the class
 $= \text{Range} / \text{Number of classes}$
 $= 36 / 6$
5. Construct the frequency table.

Class	boundaries	Tally	Total
1	71-77		5
2	78-83		8
3	84-90		18
4	91-97		9
5	98-104		7
6	105-111		3



4. Pareto Diagram

A Pareto diagram is a diagnostic tool commonly used for separating the vital few causes that account for a dominant share of quality loss.

This tool is used to single out the 'vital few' from the 'trivial many'.

The Pareto diagram is based on the Pareto principle which states that a few of the defects accounts for most of the effects.

Pareto analysis is also called as 80/20 rule and as ABC analysis. It means only 20% of problems account for ~~most~~^{80%} of the effects.

This analysis is a method of classifying items, events or activities according to their relative importance.

Uses:

→ Pareto analysis can be used in a wide range of situations where one need to

prioritise problems based on its relative importance.

It can be used as a risk assessment technique from activity level to system level.

Construction:

1) Obtain data, using a check sheet or brainstorm.

2) Arrange the data in descending order starting from the largest category to smallest.

3) Calculate the total and percentage of the total that each category represents.

4) Compute the Cumulative Percentages.

5) Draw a bar chart with two vertical axes. Along the left vertical axis, mark the measured values for each cause, starting from zero till the total number of causes. The right vertical axis should have the same height and should go from 0 to 100%. This axis displays the

Cumulative percentages. List the different kinds of causes along the horizontal axis, from the left to right in descending order of frequency or costs.

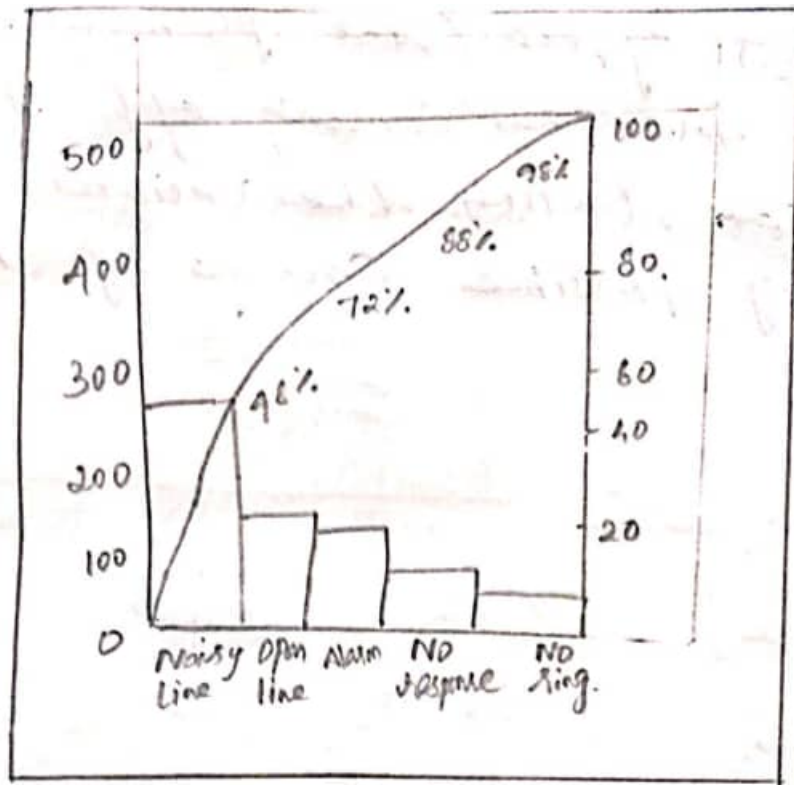
6. Draw a bar above each item whose height represents the number for that cause.

7. Plot a cumulative percentage line.

8. Now draw a horizontal line from 80% (on the right vertical axis) to the left till the point of intersection with the cumulative line, and then draw a vertical line from this intersection downwards till the horizontal axis. Left from this intersection point are the 20% of causes, which causes 80% of the damages.

Eg: Construct a pareto diagram for reports of troubles with telephones.

The below figure shows that the noisy lines and open lines account for 72% of the telephone trouble reports. So one need to concentrate more on these two points for further improvement.



5. Cause and Effect diagram.

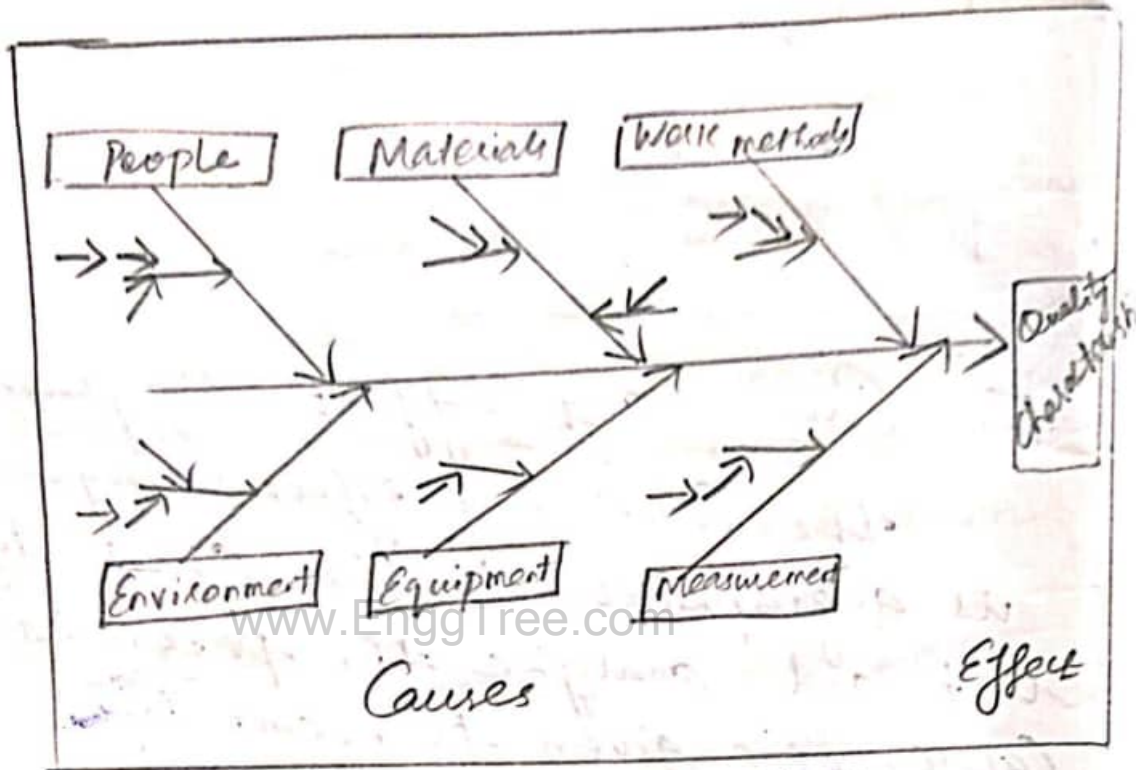
The Cause and effect diagram is a graphical tabular chart to list and analyze the potential causes of a given problem.

The Cause and effect diagram is also called the fishbone diagram because of its appearance and the Ishikawa diagram after the man who developed it in 1943.

The following figure illustrates the basic structure of a cause and effect diagram:

As shown in the following figure the diagram consists of a central stem leading to the

~~As~~ effect (the problem), with multiple branches coming off the stem ~~can~~ listing the various groups of possible causes of the problem.



Cause and effect diagram.

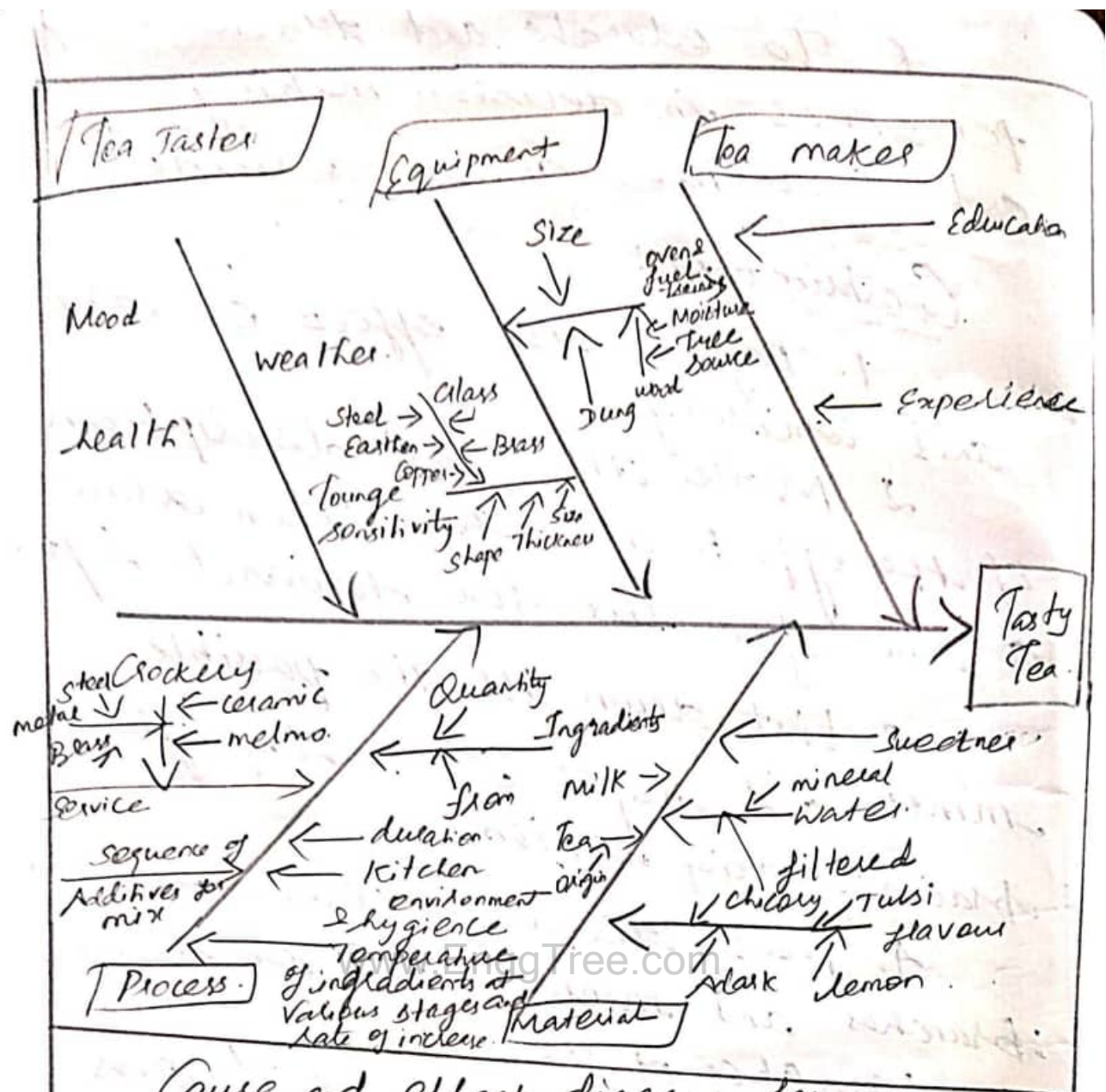
- Uses:
1. The CE diagram unlimited in research, manufacturing, marketing, office operations, services and so forth.
 2. The CE diagrams are used:
 - * To analyse cause and effect relationships.
 - * To facilitate the search for solutions of related problems.
 - * To standardize existing and proposed operations.

* To educate and train personnel in decision-making and corrective-action activities.

Construction:

1. Define the effect clearly and concisely.
2. Mark the short description of the effect in a box. Then draw a line from this box towards left.
3. List down all the possible minor and major causes through a brainstorming session.
4. Mark the major causes on the branches and minor causes on the sub-branches of the CE diagrams.
5. Look for possible solutions for these causes.
6. Introduce the changes.

The following diagram shows the Cause and effect diagram for preparation of tasty tea.



Cause and effect diagram for preparation of Tasty Tea.

6. Scatter diagram.

The Scatter diagram is a simple graphical device to depict the relationship between two variables. It is the graphical component of regression analysis.

A scatter diagram is composed of a horizontal axis containing the measured values of one variable.

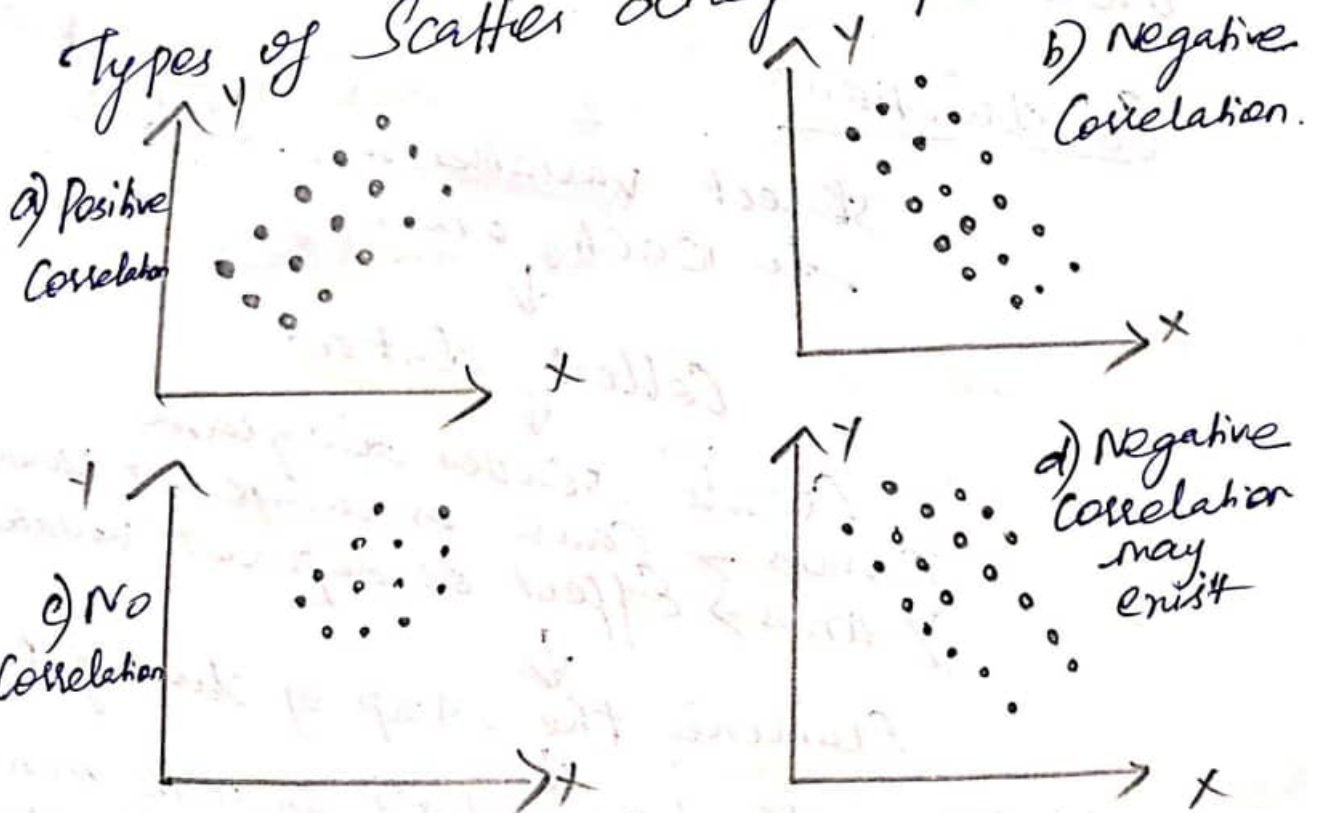
and a Vertical axis, representing the measurement of the Variable.

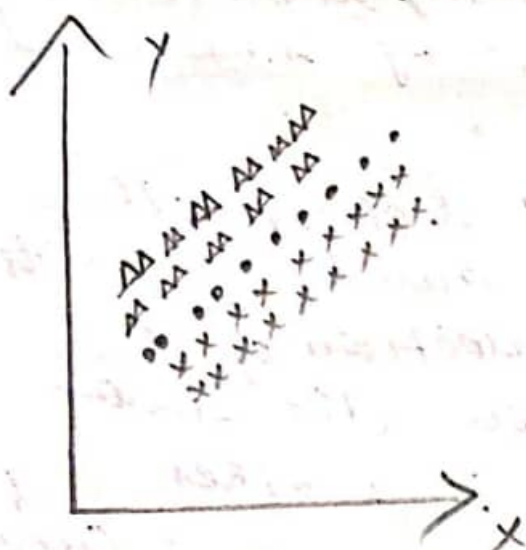
This diagrams displays the paired data as a cloud of points. The density and direction of the cloud indicate how the two variables influence each other.

Although this diagram cannot prove that one variable causes the other, but they do indicate the existence of a relationship as well as the strength of that relationship.

These diagrams often used as follow ups to a cause and effect analysis to determine whether a stated cause truly has impact on the quality characteristics.

Types of Scatter diagram patterns.





(e) Correlation by Stratification.



(f) Curvilinear relationship.

Uses:

* The Purpose of the Scatter diagram is to display what happens to one variable when another variable is changed.

* This diagram is used to understand, why, particular variations occur and how they can be controlled.

Construction:

Select variables are related to each other



Collect data.



Create scatter diagram
 X-axis → Cause or independent variable
 Y-axis → Effect or dependent variable

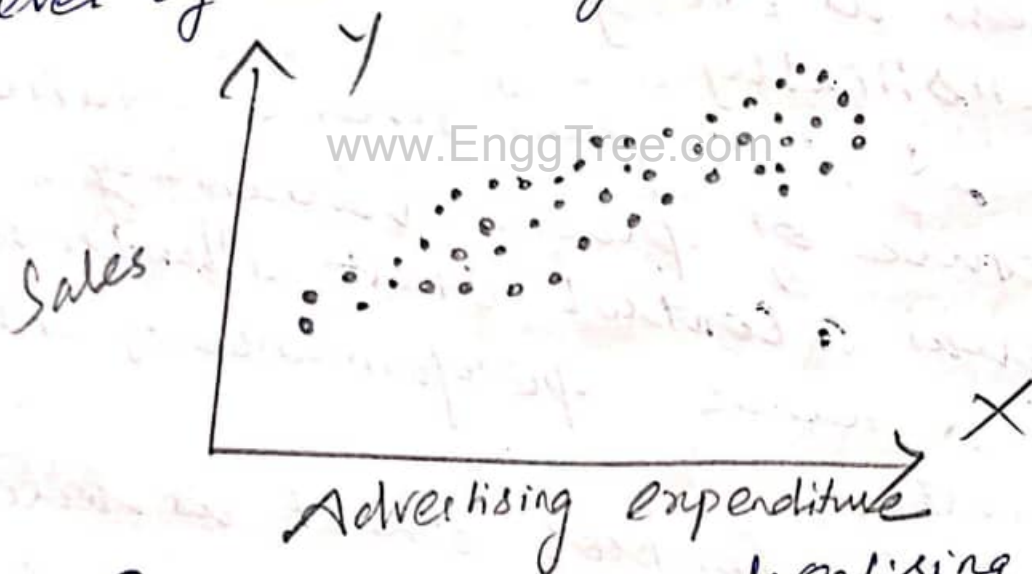


Examine the shape of cloud of points



Determine the type and strength of the mutual relationships.

Example: An Organisation investigates the relationship between the advertising expenditure and its product sales. The scatter plot can be drawn between the advertising expenditure and the company sales as shown in figure. The following figure indicates the strong positive relationship between the variables. Thus the company sales tend to increase with the increase in the level of advertising expenditure.



Scatter plot of advertising expenditure vs. sales.

7. Control Chart

A Control Chart, invented by Walter A. Shewart is the most widely used tool in statistical process control.

The Control Chart is a graph that displays data taken over time and the variations of this data.

The Control chart can be used to check whether the process is being controlled statistically.

A histogram gives a static picture of process variability, whereas a Control Chart illustrates the dynamic performance of the process.

The Control chart is based on a series of random samples taken at regular intervals. The general form of the Control Chart is given below.

The Chart consists of three horizontal lines that remain constant over time: a Center, a lower control limit and an

upper control limit. The center is usually set at the 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 otherhand, if the sample lies ~~either~~ 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 chart.

The two categories of Control chart are

1. Control charts for variables:
- for measurable data such as time, length, temperature, weight, pressure, etc.

2. Control charts for Characteristics:
for quantifiable data such as number of defects, typing errors in a report, etc.

Uses:

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

It is used to show the sources of variations and to eliminate them in order to statistically control the process.

It is also used to evaluate process stability and to decide when to adjust the process.

Construction:

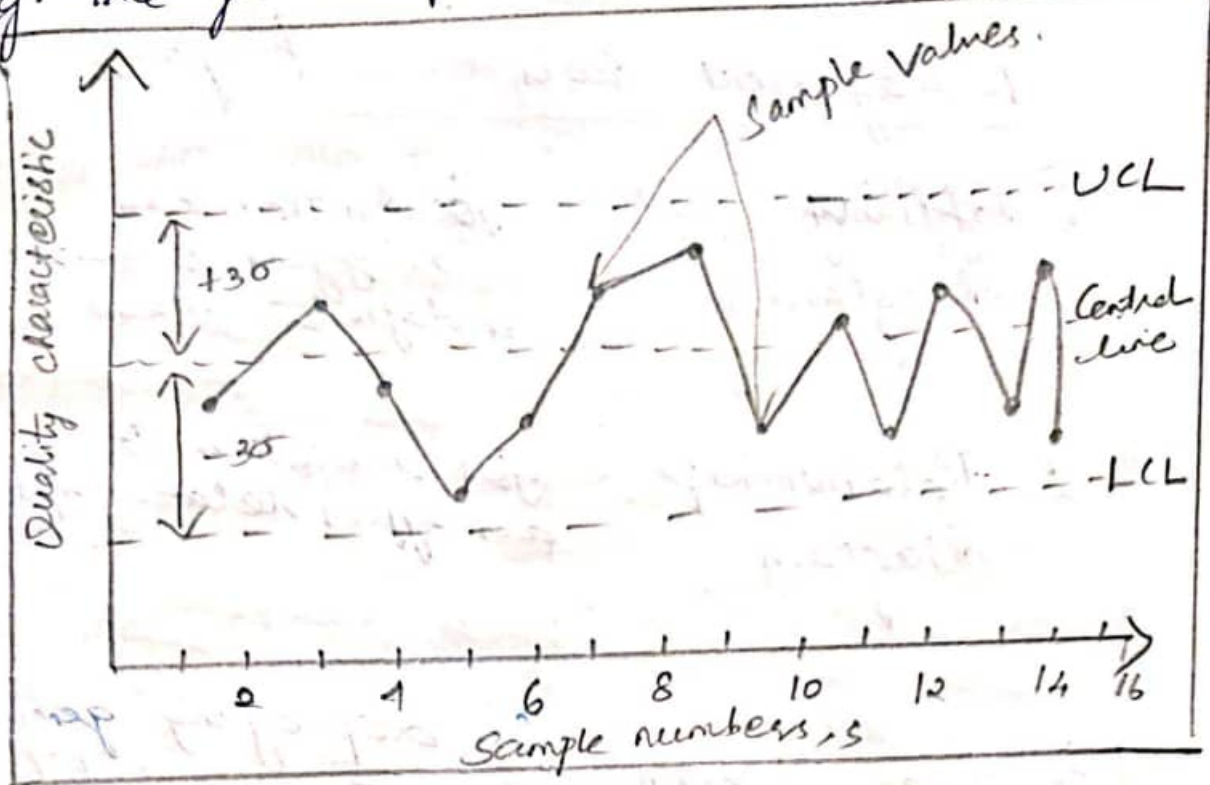
* Plot data points of the measured process variable on the y-axis and time or sequence of samples on the x-axis.

* Calculate and draw the center line as the average value of the data points.

* Calculate the upper control limit and lower control limit which represent the acceptable range of variation.

* Interpret the chart to detect outliers or trends indicating instability.

Eg: The general form of the control chart



Merits

- 1) Simplicity
- 2) Effective problem identification.
- 3) Visualization of Data.
- 4) Data Driven Decision making.
- 5) Versatility.
- 6) Cost-effective.
- 7) Enhances team Collaboration.

Demerits

- 1) Limited Analytical depth.
- 2) Time Consuming
- 3) Requires accurate data.
- 4) Can Become Complex.
- 5) Subjectivity
- 6) Not suitable for dynamic analysis.
- 7) Requires Basic Training

New Seven Management Tools.

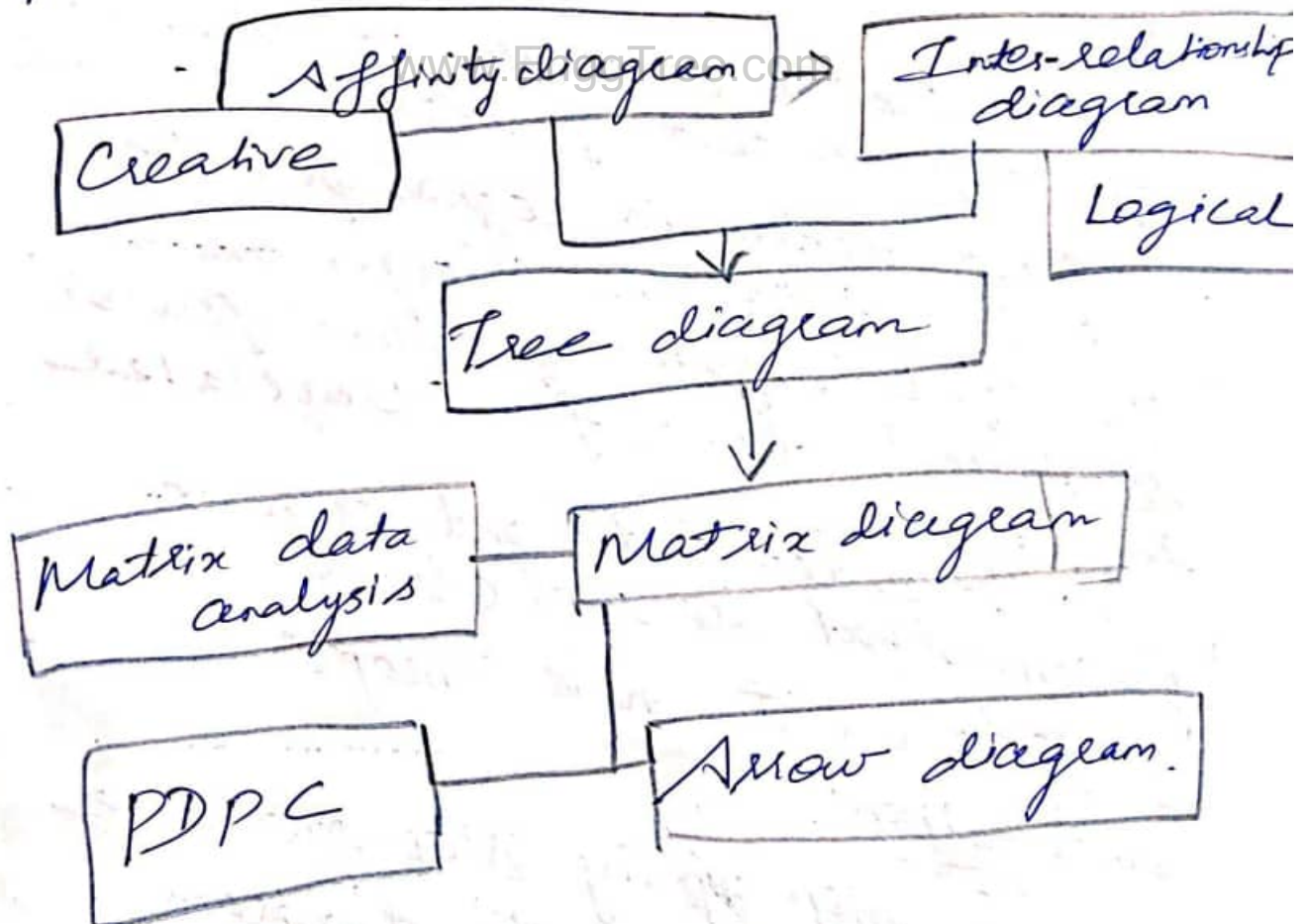
Management Tools	Purpose.
1. Affinity (KT) diagram.	for synthesizing, classifying, organizing indefinite ideas.
2. Relationship diagram.	for isolating cause and effect relationships.
3. Tree diagram.	for deploying general concepts into details.
4. Matrix diagram.	for correlating in a logical form, in order to evaluate, select and decide.
5. Matrix data analysis.	for quantifying relationships.
6. Decision tree	for identifying alternative.
7. Arrow diagram.	for Planning.

New Seven Management Tools:

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These qualitative tools, also known as 'Seven Management tools' are helpful for the managers, (i) to organise large amounts of non quantitative data (ii) to Create hypotheses. (iii) to clarify inter relationships. (iv) to establish priorities.

Since these seven tools are interrelated, figure shows the order in which these tools can be used to understand a problem.



1. Affinity diagram.

An affinity diagram is a tool to collect a large amount of verbal expressions (ideas, opinions, observations, etc.) and organise them in groups according to natural relationships between individual items.

Affinity diagram is also referred to as a KJ diagram, after its inventor Jiro Kawakita.

Affinity diagram is a special kind of brainstorming tool.

Uses:

- * To provide a visual representation of large amount of ideas.
- * To determine logical priorities.
- * To extract the large amount of useful information from few or scattered data from unrelated ideas.
- * To understand and organize problems that are not clear.
- * To create new concepts.

Construction:-

The step by step procedure for drafting an affinity diagram.

1. Define Problem
2. Generate ideas
3. Record ideas as cards
4. Display Cards in random order
5. Arrange Cards in grouping
6. Create headers for groupings
7. Draw the affinity diagram.

Example: A large supplier of food was interested in getting an ideas of what the consumers thought characterized the ordinary daily meal. He started the study by setting up a focus group of eight persons. Within the group, the members were distributed according to occupation, education and family situation.



2. Relationship diagram.

The relationship diagram is a tool for finding causes to a problem.

The basic logic behind the tool is the same as those of the Cause and effect diagram.

The relationship diagram not only clarifies the relationship between Cause and effect but also between the various causes.

It is a graphical representation of all factors in a complicated problem system or situation.

Uses:

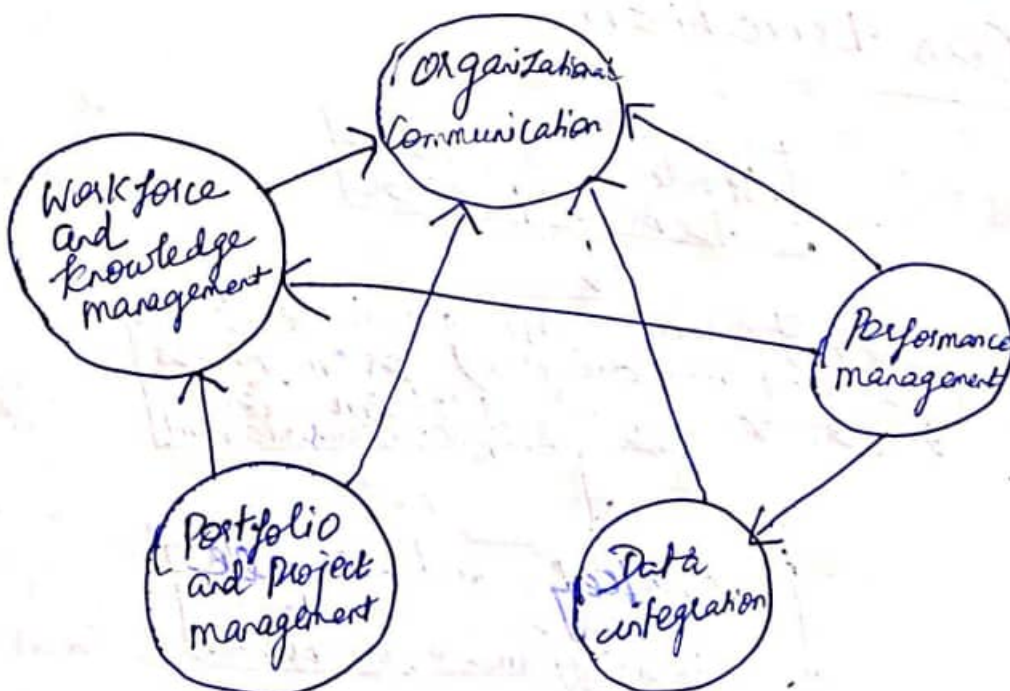
The purpose of the relationship diagram is to generate a visual representation of the relations between an effect and its causes as well as the interrelationship between the different causes of the problem.

This tool can be used to

- (a) Identify key problem from a list of important problems
- (b) Identify the root cause of existing problems.
- (c) Identify key factors needed to make a decision.

Construction:

1. Identify and decide the effect of the problem. Write it in the Centre of a board and enclose it in a dark bordered rectangle.
2. Conduct brainstorming to identify the immediate causes of effect. Note down these causes in rectangle around the centre dark rectangle.
3. Connect these immediate causes to the effect by connecting the rectangles of the causes to that of the effects with a line. The line has an arrow pointing towards the effect.
4. The element of the rectangle with the most outgoing arrows will indicate the root causes. Those one with the most incoming arrows will be key outcomes or results.



3. Tree Diagram

A tree diagram systematically breaks down a topic into elements, and shows the logical and sequential links between these elements.

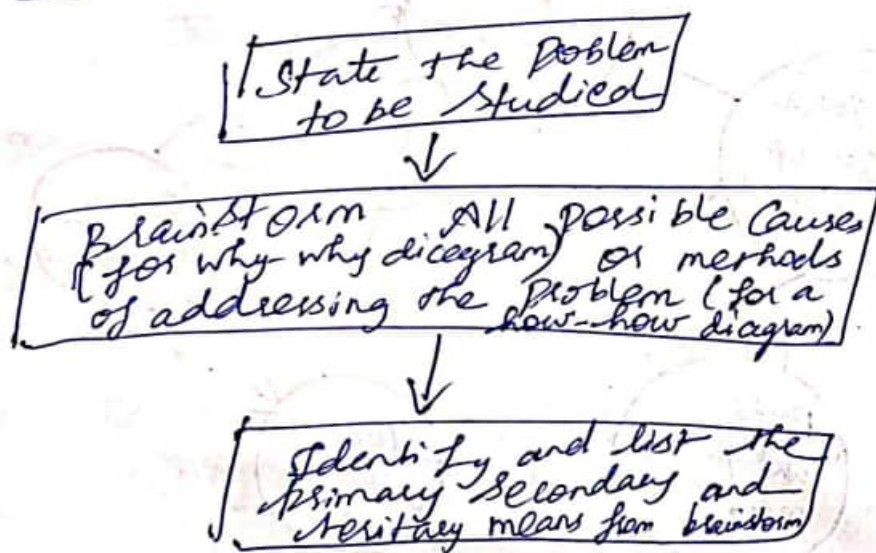
The tree diagram systematically outlines the complete spectrum of paths and tasks that must be carried out to achieve a goal.

Uses:

The Purpose of the tree diagram is to explore the ways and means to achieve the objective, develop a list of alternative means and to present them in visual understandable form.

It helps to develop a systematic, step by step, strategy to achieve an objective.

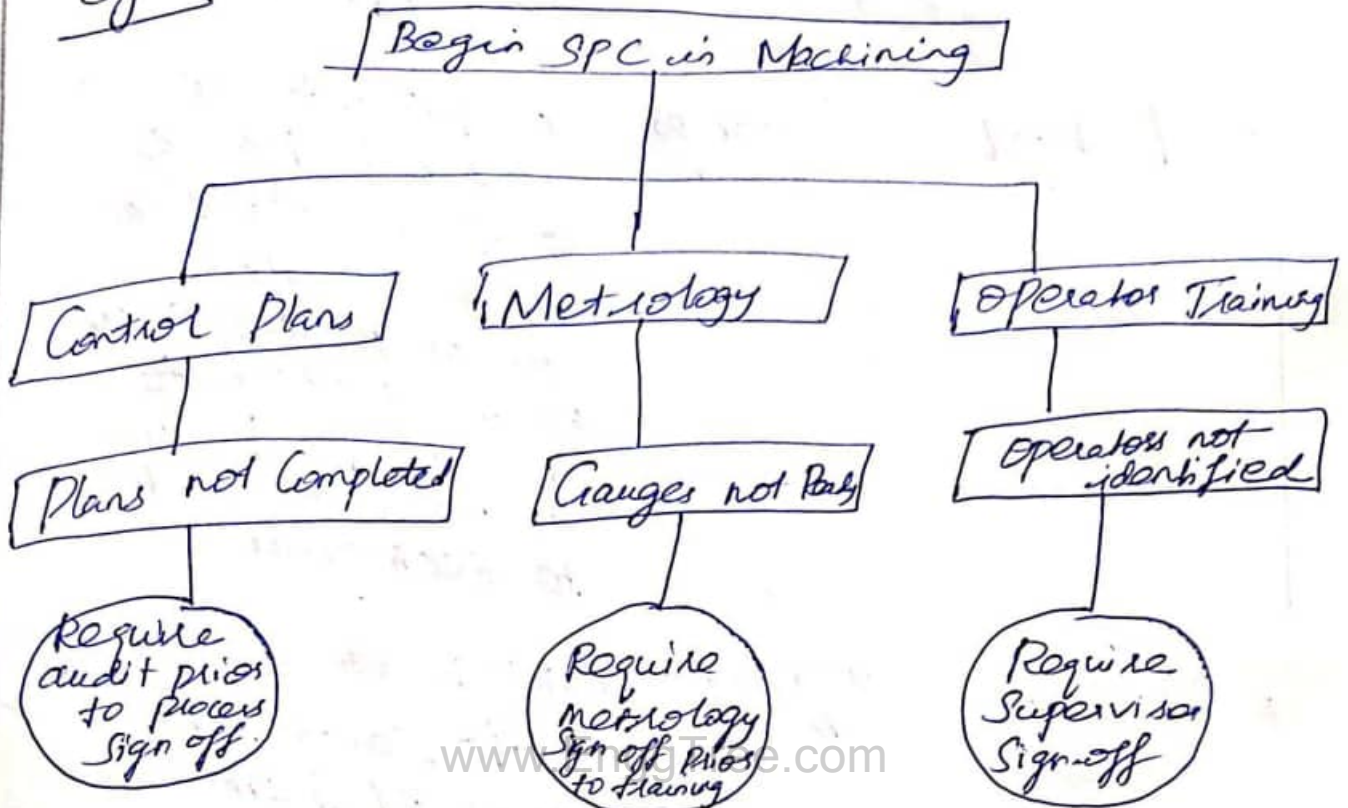
Construction:



↓

Arrange and rearrange the elements in proper order in boxes

Eg-1



4. Matrix Diagram.

A matrix diagram is a tool that is used to systematically organise information that must be compared on a variety of characteristics in order to make a comparison, selection or choice.

It is a tool which depicts the relations between two, three or four sets of factors in the form of a table or a matrix.

Matrix diagram, sometimes referred as a ~~quality~~ 'quality table' is the starting point in building a house of quality

Types of Matrix diagrams.

1. L-Shaped 2 groups * $A \leftrightarrow B$ ($A \leftrightarrow A$)

	1A	1B	1C
2A	Δ	0	⊙
2B	⊙	⊙	Δ
2C			⊙

Variable 2

← Variable 1 To relate two groups of items to each other

2. T Shaped 3 groups

* $B \rightarrow A \leftrightarrow C$
but not $B \leftrightarrow C$

* To relate three groups of items.
groups B and C are each related to A. Groups B and C are not related to each other.

3. Y-Shaped 3 groups

Variable 1	2A	2B	3A	3B	3C	3D
1A	⊙	⊙				
1B	⊙	⊙				
1C	⊙	⊙				
1D	⊙	⊙				

* $A \leftrightarrow B \leftrightarrow C \leftrightarrow A$
* To relate three groups of items each group is related to the other two in a circular fashion.

4. C-Shaped 3 groups

Variable 1	2A	2B	3A	3B	3C	3D
1A						
1B						
1C						
1D						

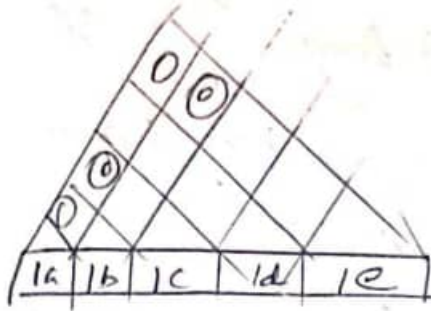
* 3-D
* To relate three groups of items all together simultaneously in 3-D

5. X-Shaped 4 groups

Variable 1	2A	2B	3A	3B	3C	3D
1A	Δ	0	3A			
1B	0	Δ	2A			
1C	⊙	⊙		1A	1B	1C
1D	⊙	⊙		2A	Δ	0
2A	Δ	Δ	Δ	2C		

* $A \leftrightarrow B \leftrightarrow C \leftrightarrow D \leftrightarrow A$
but not
 $A \leftrightarrow C$ or $B \leftrightarrow D$
* To relate four groups of items each group is related to two others in a circular fashion.

6. Roof shaped / group $\& A \leftrightarrow A$ When also $A \leftrightarrow$ is L or T.



$\&$ To relate one group of items to itself. It is usually used along with on L or T-shaped matrix

Types of matrix diagrams.

- ① Primary relationship
- Secondary relationship
- △ Minor relationship.

www.EnggTree.com

Uses:

The matrix diagram is used to show relations between individual items in two sets of factors.

For example, this diagram can be used to understand relations between customer satisfaction and product characteristics, between complaints and product groups, between complaints and geographical regions, between a product's performance in the market and promotional inputs into it and so on.

Constructions:

1. first decide on the two sets of factors to be compared.
2. Place the main factors (say features) vertically on the left hand side of the matrix and the dependent factors (say characteristics) horizontally on top of the matrix.

3. In the main body of the matrix, place appropriate symbols at the intersecting square boxes denoting the relationship between the two factors.

4. Now score relationships and select most important relationship for analysis.

5. Matrix Data Analysis Diagram.

A matrix data analysis diagram (MDAD) is very much similar to a matrix diagram with a difference that numerical data is used instead of symbols indicating the existence and strength of relationship.

It is the only tool among the new seven management tools which uses numerical data and produces numerical results.

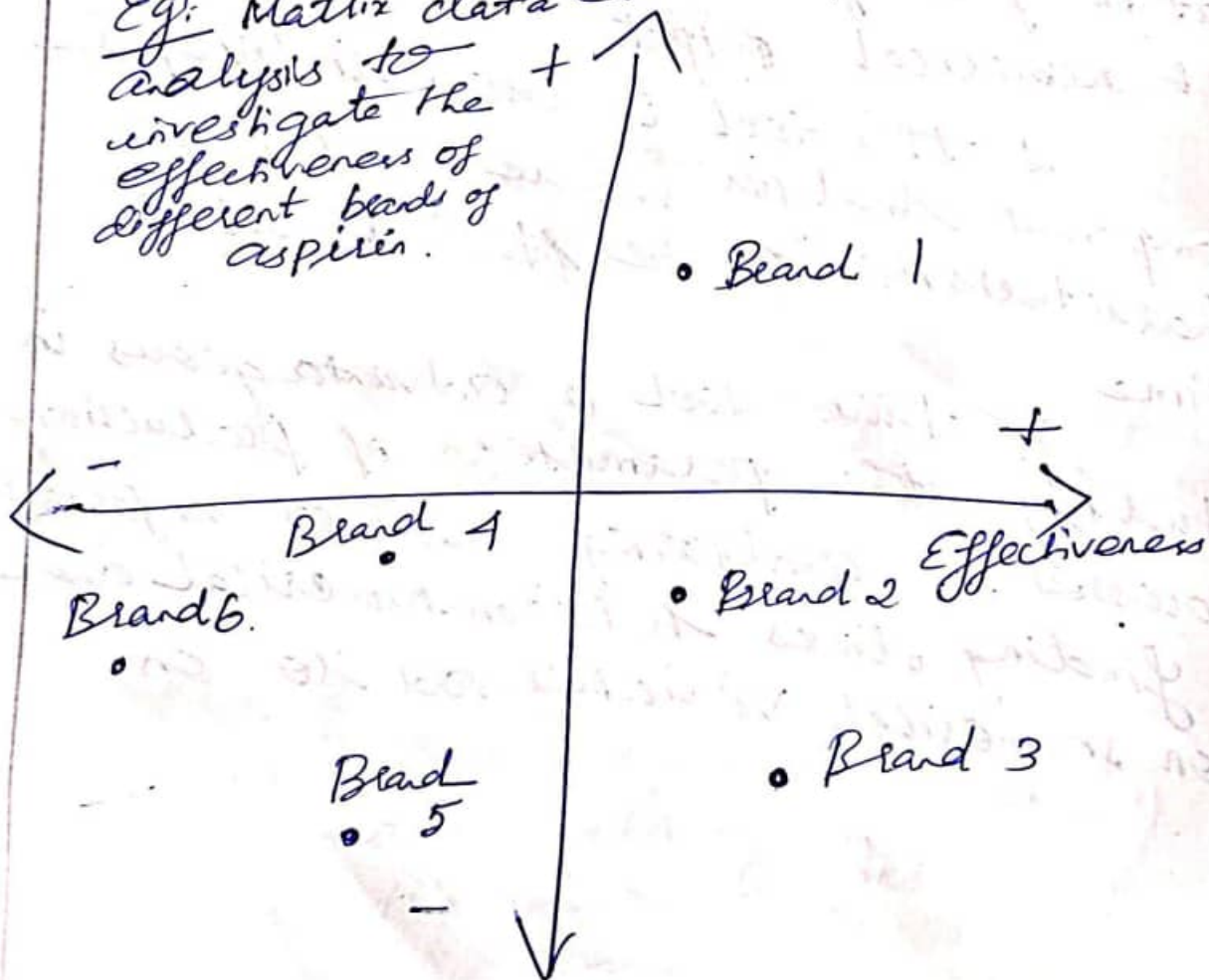
Uses: 1. The Purpose of matrix data analysis diagram is to present numerical data about two sets of factors in a matrix ~~form~~ form and analyse it to get numerical output.

2. This tool is used in Principal Component Analysis where only two characteristics can be studied at a time.

3. This tool is advantageous in studying the parameters of production processes in analyzing market information, in finding links between numerical and non-numerical variables and so on.

Construction:

Eg: Matrix data stomach upset analysis to investigate the effectiveness of different brands of aspirin.



6. Process Decision Programme Chart (PDPC) or Decision Tree

A Process decision Programme Chart also known as Decision tree, is a planning tool to outline every conceivable and likely occurrence in any planning.

The PDPC forces proactive thinking on what can go wrong with one's plan and what would one do to overcome the effect of such adverse occurrences.

Uses:

* The PDPC is useful when one wants to plan all possible chains of events that might occur during a project.

* This tool is particularly used in new product development, building and equipment, and data processing programs.

* This tool is widely used in decision making when the task is new, complex and unique.

Construction: ~~The~~

1. first, prepare a normal flow chart of the process with all

expected events as steps in the chart.

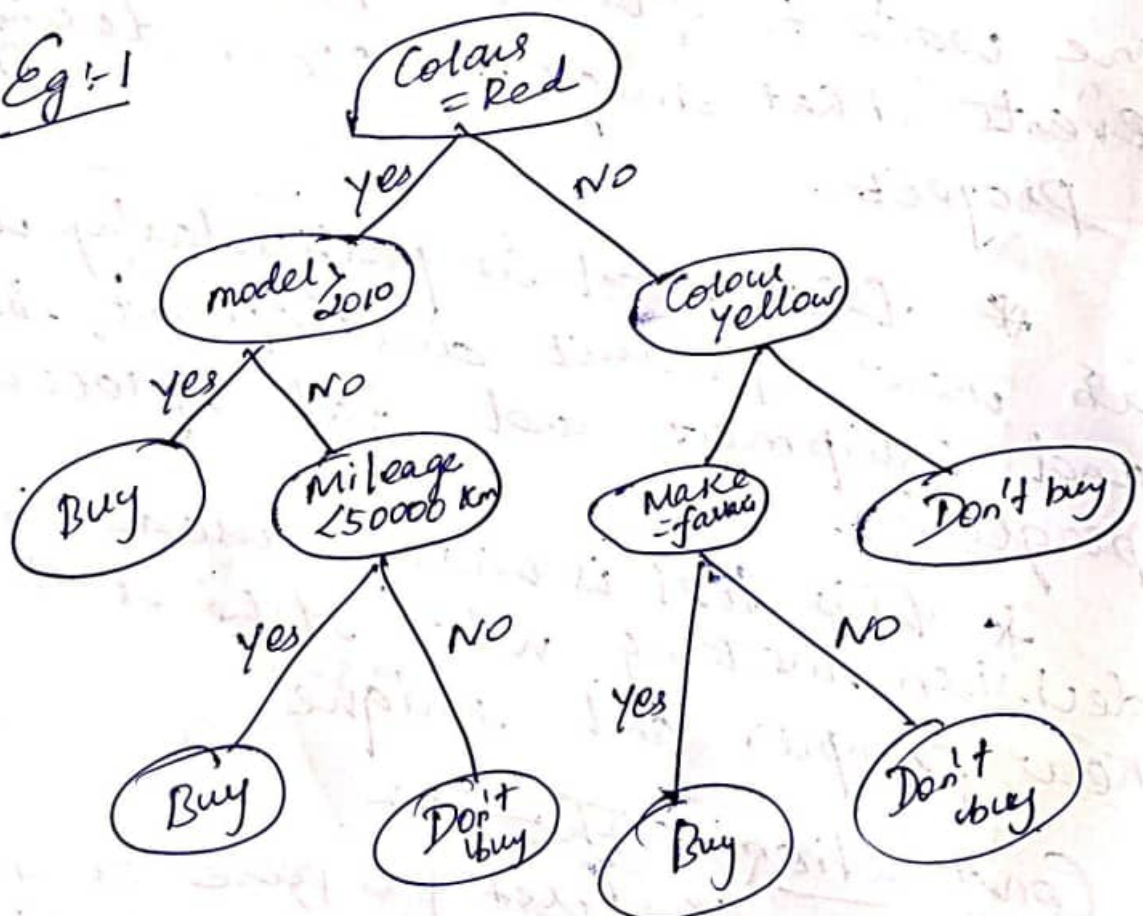
2. Identify the various possibilities of the process not going as per the plan due to any abnormal occurrences.

3. Write these occurrences on the flow chart through branching at appropriate locations.

4. Now identify the ways and means to counter the effects due to abnormal occurrences.

5. Write these ~~other~~ counter measures in rectangles connecting the corresponding abnormal occurrence on one side and the process objective on the other.

Eg:-1



1. ARROW DIAGRAM.

1) An arrow diagram also known as the activity network is a graphic description of the sequential steps that must be completed before a project can be completed before a project. Can

2) The PERT (Program evaluation and Review technique) and CPM (Critical path method) charts are the best known arrow diagrams.

3) It is a planning tool that determines the critical path of a process or a project.

Uses:

* To show the paths to complete a project.

* To find the shortest time possible for the project

* To display graphically simultaneous activities.

The arrow diagram is indispensable for long-term projects, such as the construction of a plant or the development of new products.



Construction:

Identify and list each activity to be done in the project

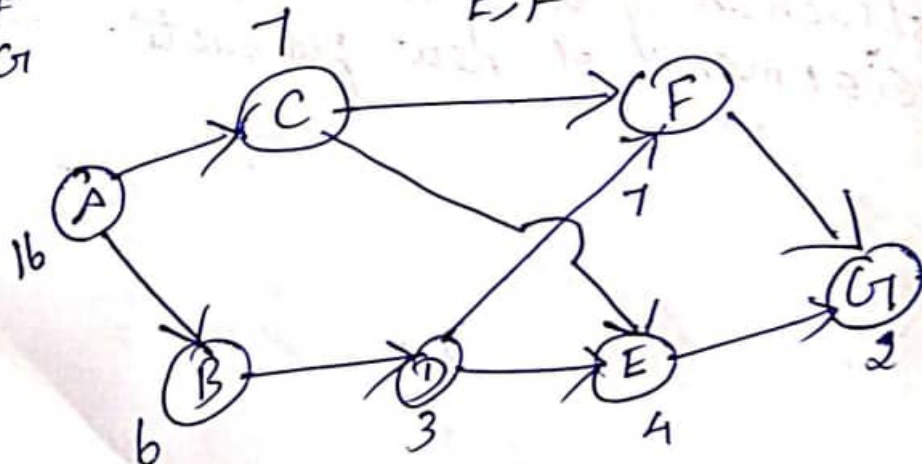
Determine the sequence of activities.

Construct a network reflecting the Precedence Relationships

Write the activity time under arrow leading from it

Eg:-1 Construct CPM network for the following data.

Activity	Immediate predecessors	Time in weeks
A	-	16
B	A	6
C	A	7
D	B	3
E	C, D	4
F	C, D	7
G	E, F	2



The Six Sigma Principle.

Definition: Six Sigma is defined by GE as 'a vision of quality which equates with only 3.4 defects per million opportunities (DPMO) for each product or service transaction and strives for perfection.

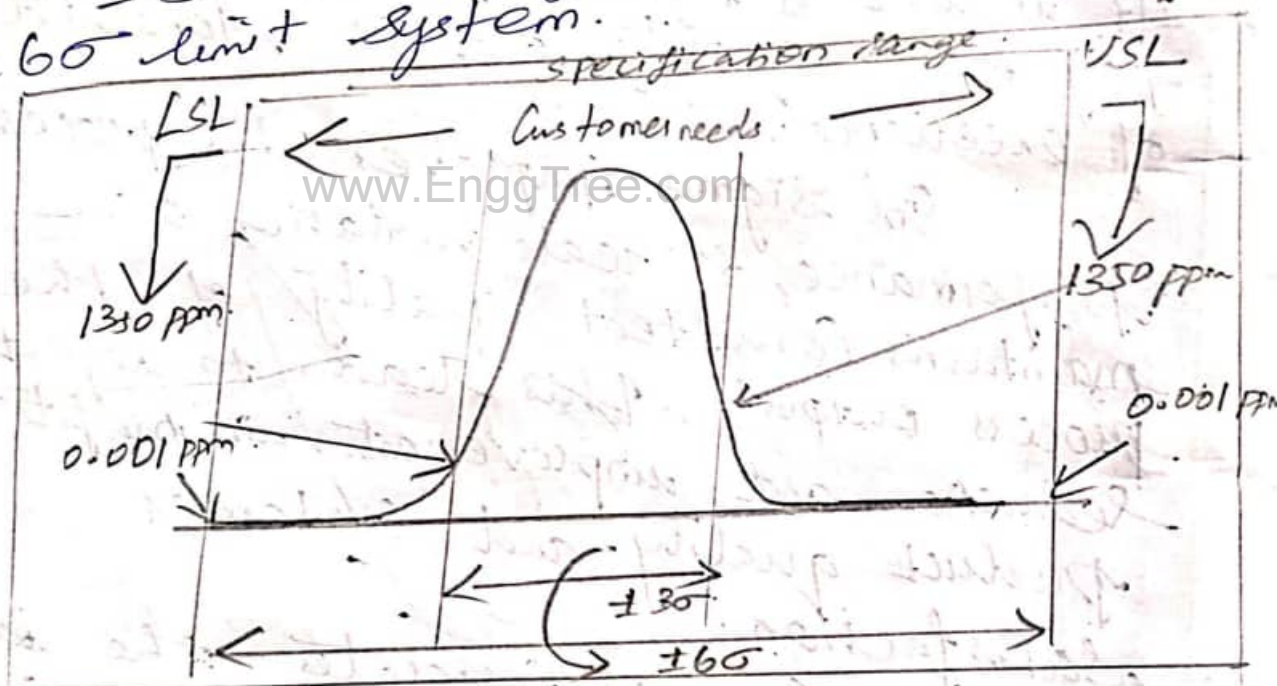
Six Sigma is a systematic method for process and product improvement and for measuring performance variation. It is also a metric for evaluating performance quality and a standard of excellence.

Six Sigma improves the process performance, decrease variation and maintain consistent quality of the process output. This leads to defect reduction and improvements in profits product quality and customer satisfaction.

Six Sigma incorporates the basic principles and techniques used in business; statistics and engineering.

Why do we need 6 σ Sigma?

The 6 σ Sigma is nothing but an extension of the control limits from $\pm 3\sigma$ limit to the $\pm 6\sigma$ limit. The chance of a part going outside the control limits from the $\pm 3\sigma$ is 27 parts in 10000 and that of $\pm 6\sigma$ is 3.4 parts per million. This means that the probability of the parts produced going outside the control limit is much higher in the $\pm 3\sigma$ limit system than in the $\pm 6\sigma$ limit system.



The concept of 6 σ Sigma

Process Capability

Normal distribution curve illustrates 3 σ and 6 σ parametric compliance.

$$C_p = \frac{\text{Design width}}{\text{Process width}} = \frac{USL - LSL}{UCL - LCL}$$

Six Sigma Process

The ^{Six} Sigma methodology is described by the acronym DMAIC. In DMAIC, D is Define, M is measure, A is Analyze, I is Improve and C is Control.



Step: 1 Define.

Activities.

- * Identify Project, champion and Project owner
- * Determine Customer requirements and Critical to quality's (CTQ's)
- * Define Problem, objective, goals and benefits.
- * Define Stakeholder / resource analysis
- * Map the Process
- * Develop project plan

Quality Tools:-

- * Project Charter and Plan
- * Effort / impact analysis
- * Process mapping
- * Tree diagram.

Step 1: 2

- Activities:
- * Determine operational definitions
 - * Establish performance standards
 - * Develop data collection and sampling plan.
 - * Validate the measurements
 - * measurement system analysis
 - * Determine process capability and baseline

Quality Tools:

- * quality function deployment
- * Measurement systems Analysis.
- * Check Sheet
- * process Capability

Step 1: 3

Activities:

- * Benchmark the process or Project
- * Establish Casual relationships using data
- * Analysis of the Process map
- * Determine root Causes using data.

Quality Tools:

- * Statistical analysis of data
- * Cause and effect or event diagram.
- * Histogram
- * Pareto diagram
- * Run Chart
- * Scatter graph

Step-4 ImproveActivities:

- * develop solution alternatives
- * Assess risks and benefits of solution alternatives.
- * Validate solution using a pilot
- * Implement solution
- * Determine solution effectiveness using data.

Quality Tools:

- * Design of Experiments
- * Brainstorming
- * FMEA
- * Risk assessment.

Step-5 ControlActivities:

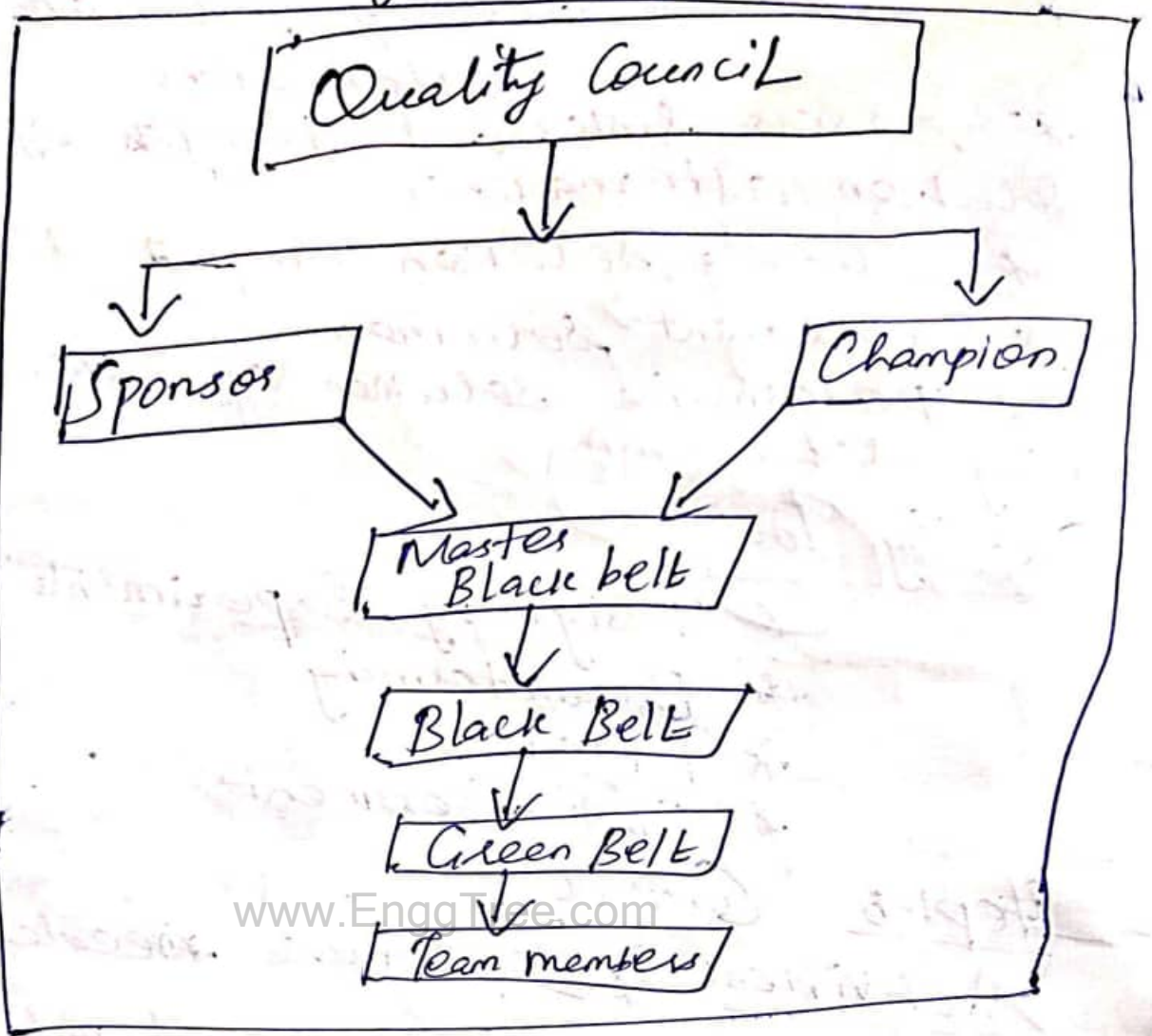
Controls

- * Determine needed controls
- * Implement and validate controls.
- * Develop transfer plan
- * Realize benefits of implementing solution.
- * Close project and communicate results.

Quality Tools:

- * Statistical Process Control
- * Out of Control Action Plan
- * Design Changes to eliminate the defects.

Six Sigma Organization.



1. Quality Council

- * It is the apex body formed by heads at the functions with its Chairman as the CEO or the MD.
- * The apex council controls and periodically reviews the entire six sigma activity, including project identification, performance of the project teams, and the effectiveness of the solutions and their implementation.

2. Sponsor

* The Sponsor sponsors the project, reviews and monitors its progress on a day to day basis and ensures the implementation of the improvement suggestions.

3. Champions

* Champion is a senior executive with significant overall business responsibility.

* He provides the vision and business decisions and the leadership for the six sigma activities.

* He may not be part of any specific project, but he is available for the expert help.

4. Master Black Belts

* A master black belt is an expert in six sigma technique and application.

* He plays a key role in training and coaching black belts.

* His responsibilities include participating in the project reviews and monitoring all six sig sigma projects.

5. Black belts:

* A black belt is a process improvement team leader who is trained and Certified in six sigma methodology and tools.

* He is responsible for successful project execution.

* His responsibilities include using the DMAIC methodology to create breakthrough in performance, reporting progress to the champion/monitor black belts and providing excellent project management.

6. Green Belts

* Green belts are similar to black belts but they do not have a full time role.

* They are the project heads or process owners. They execute six sigma project as part of their normal jobs.

4. Team members:

* The team member is a fresher initiated to the six sigma project.

* They focus on day-to-day work assist green belts.

Advantages of Six Sigma:

* Improved Customer satisfaction

* Improved quality, efficiency and Cost of products sold.

* Creation of Self sustaining infrastructure.

* Standardization.

Scope of Six Sigma Principle

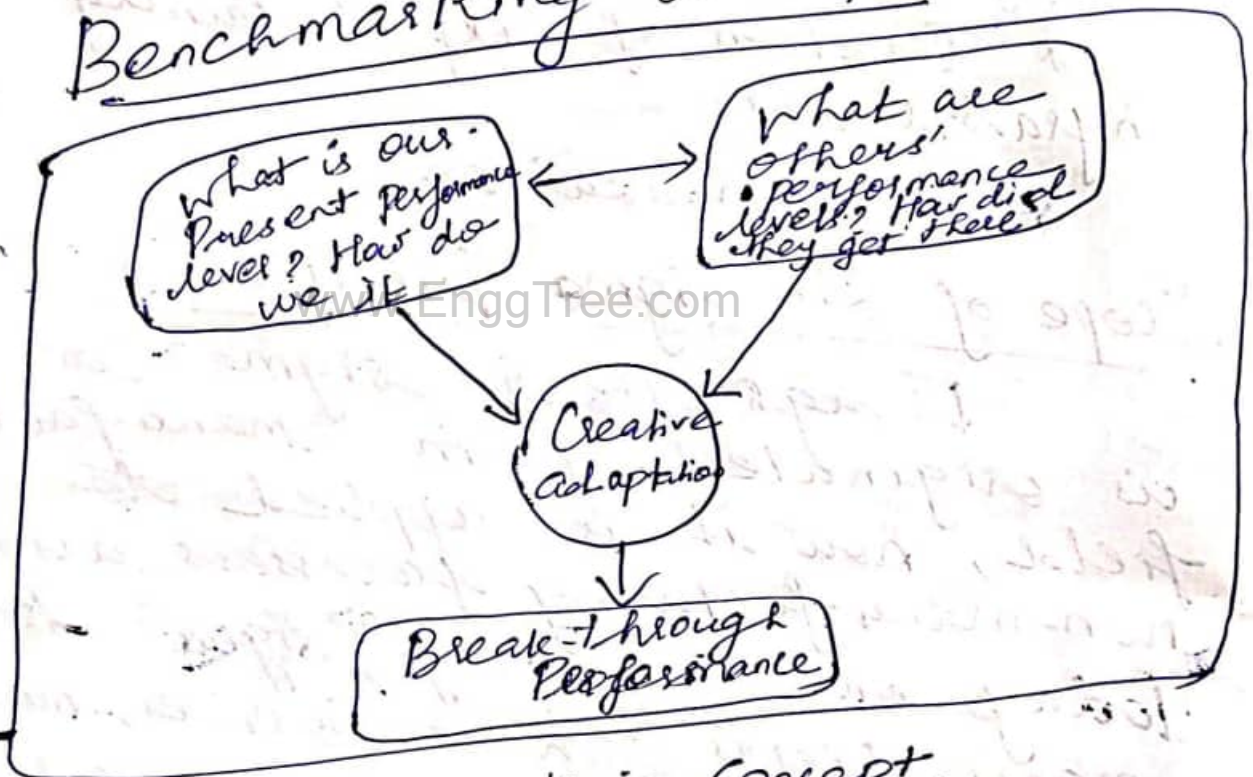
Though the six sigma concept is originated from manufacturing field, now it is applied to non-manufacturing processes also.

Today one can apply ^{Six}sigma to many fields such as services, medical and insurance procedures, call centres, etc.

Bench Marking

American Productivity and Quality Centre (APQC) has defined the benchmarking as the process of identifying, understanding and adapting outstanding practices and processes from organisations anywhere in the world to an organisation to improve its performance.

Benchmarking Concept



Benchmarking Concept.

Reasons to Benchmark:

1. Benchmarking aims at a goal setting process to facilitate comparison with the best.
2. It aims at motivating and stimulating company employees towards the goal of continuous quality improvement.

3. It aims at external Orientation of the Company.
4. It aims at identifying a technological break-through.
5. It aims at searching for industry best Practices.

Benchmarking Process.

Phase I.: Planning

The Planning Phase involves three steps: To identify

- (i) what is to be benchmarked
- (ii) to whom or what shall we compare
- (iii) how will the data be collected.

Step:-1 What can be benchmarked

* Benchmarking can be applied to any business or product process.

* During this step, determine which functions, tasks, processes, or activities within the own organisation will be subjected to benchmarking

* Appoint a benchmark team that will pilot the activity within the organization.

* In this stage, formulate the project goals, determine the data to be collected; and prepare a

Tentative list of questions.

Step 2 To whom or what shall we compare.

* Identify the world class or leading edge companies that have a similar product or process.

* Important criteria for the selection of benchmark partners are

(i) The partners should be outstanding regarding the benchmark subject.

(ii) Competitiveness of activities

(iii) availability of reliable information about the partners.

Phase II Analysis

Step 1-4 Determine the current performance gap

* Determine the gap between the performance level of the organisation and that of its benchmark partner.

* After the data is gathered, measured, and analysed, compare these to the data of the own organisation. Based on this, determine the current performance gap between the own organisation and that of the benchmark partner.

* Document the differences in underlying working methods and

the Causes of the differences in performance.

Step: 5 Project future performance levels.

* The gap is a projection of performance. Therefore the performance will change as industry practices change. So keeping the future in mind, project the performance levels.

Phase III Integration.

Step: 6 Communicate benchmark findings and gain acceptance

* Demonstrate the benchmark findings to the management for their acceptance.

* Communicate the benchmark findings to all organizational levels to obtain support, commitment and ownership.

Step: 7 Establish functional goals:

On the basis of communicated data and acceptance of analysis, establish the functional goals and achieve them through the benchmarking process.

Phase IV Action.

Step: 8 Develop action plans.

* Transform the functional goals into concrete action plans.

* The action plans should answer the following questions: When, Should, which action, with which, goal be implemented? How can changes successfully implemented? Who does that? In which way? Who is responsible for the implementation of the different actions.

Step: 9 Implement specific actions and monitor the progress.

* This step relates to the execution of improvement actions and introduction of changes.

* Constantly monitor the implementation of actions for successful execution.

Step: 10 Recalibrate benchmarks.

* The updating may require the recalibration of the competitive benchmarking data.

Since benchmarking is a continuous quality improvement tool, recalibrate the benchmarks again and again.

Phase V Maturity

Step: 11 Attain the leadership position

Step: 12 Integrate practices into the process.

Criticisms of benchmarking.

1) Stifles Innovation: Relying on benchmarking might limit creativity and innovation, as companies may focus too much on replicating others' success rather than pioneering new solutions.

2) Context differences: What works for one company may not work for another due to differences in organizational culture, resources, market conditions and customer ~~base~~ base. Benchmarking ignores these contextual ~~man~~ nuances.

3) Short term focus: Benchmarking can lead organizations to prioritize short term improvements over long term strategic goals, focusing on catching up with competitors rather than forward looking innovation.

4) Risk of Imitation: Instead of driving meaningful improvement, some companies may blindly copy practices without fully understanding why those practices worked for the benchmarked company, leading to misapplication.

5) Overemphasis on Metrics

Benchmarking can cause companies to focus too heavily on numerical comparisons rather than qualitative improvements, potentially missing the bigger picture of customer satisfaction or process optimization.

6) Resource Intensive!

Benchmarking can require significant time effort, and resources to gather relevant data, analyze it and implement changes. This may not always result in a proportionate return on investment.

7. Ethical Concerns:

Some argue that benchmarking can encourage competitive intelligence practices that may border unethical, particularly if it involves proprietary or confidential information.

Pitfalls of Benchmarking

Benchmarking is based on learning from others, rather than developing new and

improved approaches. Since the process being studied is there for all to see, therefore a firm will find that benchmarking cannot give them a sustained competitive advantage.

Although, helpful, benchmarking should never be the primary strategy for improvement.

If all industries employ the benchmarking approach, it will lead to stagnation of ideas, strategies, best industry practices, etc. So benchmarking should never be substitute for innovation.

It must be a mere improvement tool.

Failure Mode and Effect Analysis

Defn: failure mode and effect analysis, also known as risk analysis, is a preventive measure to systematically display the causes, effects, and possible actions regarding observed failures.

The objective of FMEA is to anticipate failures and prevent them occurring. FMEA prioritises failures and attempts to eliminate

Types of FMEA

The several types of FMEA include

1. System FMEA - Analyzes components subsystem and main system in early stage of design.
2. Design FMEA - Analyzes the products/parts before they are released to manufacturing.
3. Process FMEA - focuses on manufacturing and assembly processes.
4. Service FMEA - analyzes service industry processes before they are released to impact the customer.
5. Equipment FMEA
6. Maintenance FMEA

7. Concept FMEA
8. Environmental FMEA.

However in practice; all the above types can be broadly categorised into two types. They are.

1. Design FMEA

Design FMEA involves the analysis of the potential failures of product or service due to component or subsystem unreliability.

2. Process FMEA

Process FMEA involves a failure analysis of a manufacturing process.

Benefits of FMEA

1. Improve product / Process reliability and quality.
2. Increase customer satisfaction.
3. Early identification and elimination of potential product/process failure modes.
4. Prioritize product / process deficiencies.
5. Capture Engineering / Organisation Knowledge.
6. Minimize late changes and associated cost.
7. Document and track the actions taken to reduce risk.

Inputs for preparation of FMEA

1. People Inputs: The FMEA methodology is a team effort. The FMEA team should have assembly engineer, manufacturing engineer, materials engineer, quality engineer, service engineer, suppliers and the customer.

2. Data Inputs:- The data inputs needed to prepare FMEA are product and process specifications, reliability data, customer priority data, process variability data, process descriptions and inspection data.

Stages of FMEA

Stage 1:- Specifying Possibilities

- (i) functions
- (ii) Possible failure modes
- (iii) Root Causes
- (iv) Effects
- (v) Detection/prevention.

Stage 2 Quantifying Risk.

- (i) Probability of Cause
- (ii) Severity of effect
- (iii) Effectiveness of control to prevent Cause.

(iv) Risk priority number.

Stage 3 Correcting High risk Causes.

- (i) Prioritizing work
- (ii) Detailing action
- (iii) Assigning action responsibility
- (iv) Check points on completion.

Stage 4 Re-evaluation of Risk

- (i) Recalculation of risk priority number.

FMEA Procedure:

1. Describe the product/process and its function
2. Create a block diagram of the product/process.
3. Complete the FMEA form worksheets.
4. List Product/Process functions
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.

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.

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

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

9. Identify the Potential Causes / mechanisms of failure.

A failure cause is defined as a design weakness that may result in a failure.

10. Enter the probability factors.
Occurrence is the chance that one of the specific causes/mechanisms will occur.

11. Identify Current Controls.

12. Determine the likelihood of detection (D).

Detection is an assessment of the likelihood that the current controls will detect the cause of the failure mode or the failure mode itself.

13. Review Risk Priority Number.

$$(RPN) \quad RPN = \text{Severity} \times \text{Occurrence} \times \text{Detection} \\ = (5) \times (10) \times (10).$$

14. Determine recommended action(s)
 Determining recommended action(s) to address potential failures that have a high RPN.

These actions may include specific inspection, testing, re-labelling, selection of parts and materials, redesign of the items, monitoring mechanisms, and performing preventive maintenance.

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

16. Indicate actions taken.

After these actions have been taken, re assess the severity, occurrence and detection and review the revised RPN's.

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

FMEA: Number

Page _____ of _____ prepared by _____

item	Design / Process	Responsibility	Prepared by
Model Number / Year		Key date	FMS date(orig)

Core Steam

[illegible]

Design/Process FMEA: form

p-chart

$$p = \frac{np}{n}$$

p = fraction defective

np = Number of defectives

n = Number of items inspected in the subgroup

Control limits for p-chart

$$\bar{p} = \frac{\sum np}{\sum n}$$

Control line or Central line $CL_p = \bar{p}$

Upper Control limit, $UCL_p = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

Lower Control limit, $LCL_p = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

np-chart

Control line or Central line

$$CL_{np} = n\bar{p}$$

Upper Control limit $UCL_{np} = n\bar{p} + 3\sqrt{n\bar{p}(1-\bar{p})}$

Lower Control limit $LCL_{np} = n\bar{p} - 3\sqrt{n\bar{p}(1-\bar{p})}$

$\bar{p}$ = Average fraction defective

$$= \frac{\sum np}{\sum n}$$

n = Number of items inspected in subgroup

Example:-1 (p chart).

In a factory producing spark plug the number of defective found in inspection of 20 lots of 100 each, is given below.

Lot No,	Number of defective	Lot no,	Number of defective
1	05	11	04
2	10	12	07
3	12	13	08
4	08	14	03
5	06	15	03
6	04	16	04
7	06	17	05
8	03	18	08
9	03	19	06
10	05	20	10

(i) Construct the appropriate control chart and state whether the process is in statistical control.

(ii) Determine the sample size when a quality limit not worse than 9% is desirable and a 10% bad product will not be permitted more than three

times in thousand.

Soln: Since the problem is related to defectives having constant sample size, therefore the construction of p -chart will be appropriate.

(a) To find control limits of p -chart

$$\bar{p} = \frac{\text{Total number of defectives}}{\text{Total number of items inspected}}$$

$$= \frac{120}{20 \times 100} = 0.06.$$

$$\text{Control limit} = \bar{p} = 0.06.$$

$$\begin{aligned} UCL_{\bar{p}} &= \bar{p} + 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \\ &= 0.06 + 3 \sqrt{\frac{0.06(1-0.06)}{100}} \\ &= 0.1309. \end{aligned}$$

$$\begin{aligned} LCL_{\bar{p}} &= \bar{p} - 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \\ &= 0.06 - 3 \sqrt{\frac{0.06(1-0.06)}{100}} \\ &= -0.0109. \end{aligned}$$

(b) To draw the p -chart, we need to calculate the fraction defective for each sample.

times in thousand.

Soln: Since the problem is related to defectives having constant sample size, therefore the construction of p-chart will be appropriate.

(a) To find control limits of p-chart

$$\bar{P} = \frac{\text{Total number of defectives}}{\text{Total number of items inspected}}$$

$$= \frac{120}{20 \times 100} = 0.06.$$

$$\text{Control limit} = \bar{P} = 0.06.$$

$$UCL_{\bar{P}} = \bar{P} + 3 \sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$$

$$= 0.06 + 3 \sqrt{\frac{0.06(1-0.06)}{100}}$$

$$= 0.1309.$$

$$LCL_{\bar{P}} = \bar{P} - 3 \sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$$

$$= 0.06 - 3 \sqrt{\frac{0.06(1-0.06)}{100}}$$

$$= -0.0109.$$

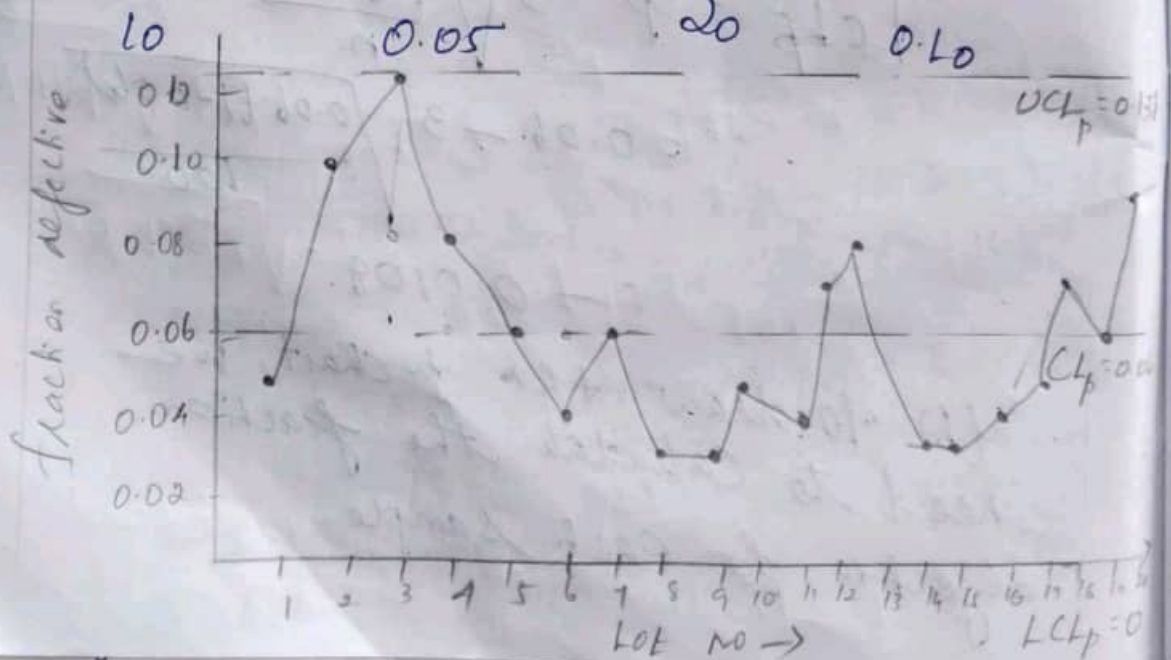
(b) To draw the p-chart, we need to calculate the fraction defective for each sample.

fraction defective

= $\frac{\text{Number of defectives in the sample}}{\text{sample size}}$

Corresponding sample size

Lot no	fraction defectives	Lot no	fraction defectives
1	$\frac{5}{100} = 0.05$	11	0.04
2	0.1	12	0.07
3	0.12	13	0.08
4	0.08	14	0.03
5	0.06	15	0.03
6	0.04	16	0.04
7	0.06	17	0.05
8	0.03	18	0.08
9	0.03	19	0.06
10	0.05	20	0.10



Now the p-chart can be drawn as shown in the figure.

The process is in control, since all the points lie inside the control limits.

(C) To find new sample size
We know that the probability that a defective worse than 9% defective quality will not be permitted is more than 3 times in thousand is corresponding to 3 σ limits.

$$\bar{P} + 3\sigma_p = 0.09$$

$$0.056 + 3 \sqrt{\frac{0.056(1-0.056)}{n}} = 0.09$$

$$n = 333$$

Example:-2 (np-chart)

In the manufacture of connecting led assembly, the number of defectives found in the inspection of 15 samples of 50 items in each sample are given in the following table.

Sample no	1	2	3	4	5	6	7	8	9	10
Member of defective	8	7	5	4	8	7	9	21	12	10

Sample no	11	12	13	14	15
Member of defective	9	8	16	15	17

(i) Determine the trial control limits. Construct the np-chart and State whether process is in control.

(ii) If any goes outside the control limits, determine the revised control limits eliminating that point.

Solution: (i) To find trial control limits for np-chart.

from the given data,

total number of defective

$$= \sum np = 8 + 7 + 5 + 4 + \dots + 17 = 156$$

Total number of items inspected,

$$\sum n = 15 \times 50 = 750$$

$$\bar{p} = \frac{\sum np}{\sum n} = \frac{156}{750} = 0.208$$

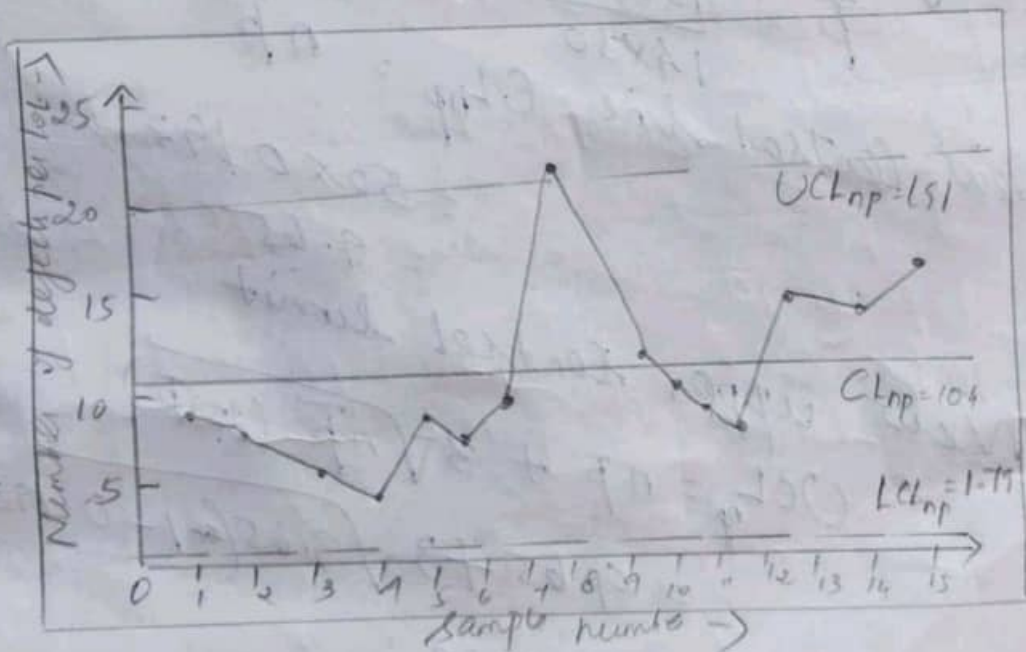
The Central line, $CL_{np} = n\bar{p} = 50 \times 0.208$
 $= 10.4$

Upper Control limit, $UCL_{np} = n\bar{p} + 3\sqrt{n\bar{p}(1-\bar{p})}$
 $= 10.4 + 3\sqrt{10.4(1-0.208)}$
 $= 19.01$

Lower Control limit, LCL_{np}
 $= n\bar{p} - 3\sqrt{n\bar{p}(1-\bar{p})}$
 $= 10.4 - 3\sqrt{10.4(1-0.208)}$
 $= 1.79$

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To construct the np chart



np-Chart

The np-Chart can be drawn as shown in figure above

To state whether the process is in control: It can be observed from the np-chart that the sample number 8 falls above the UCL.
 $\therefore$ The process is not in statistical control.

(ii) To find the revised control limits

Eliminating sample number 8, the new value of fraction defective is given by

$$\bar{p} = \frac{156-21}{14 \times 50} = 0.193$$

$$\begin{aligned} \text{New central line } CL_{np} &= n\bar{p} \\ &= 50 \times 0.193 \\ &= 9.65 \end{aligned}$$

New upper control limit

$$\begin{aligned} UCL_{np} &= n\bar{p} + 3\sqrt{n\bar{p}(1-\bar{p})} \\ &= 9.65 + 3\sqrt{9.65(1-0.193)} \\ &= 18.02 \end{aligned}$$

New lower control limit

$$\begin{aligned} LCL_{np} &= n\bar{p} - 3\sqrt{n\bar{p}(1-\bar{p})} \\ &= 9.65 - 3\sqrt{9.65(1-0.193)} \\ &= 1.28 \end{aligned}$$

Now all the points fall within control limits, so the process is in statistical control.

C-chart

Control limits for C-chart

Let C = Number of defects and

n = Number of samples.

Then, Average number of defects,
 $\bar{C} = \frac{\text{Total number of defects in all samples}}{\text{Total number of samples}}$

$$\bar{C} = \frac{\sum C}{n}$$

Control limit or Central line, $CL_C = \bar{C}$
 Upper control limit, $UCL_C = \bar{C} + 3\sqrt{\bar{C}}$
 Lower control limit, $LCL_C = \bar{C} - 3\sqrt{\bar{C}}$

Eg:-3 (C-chart)
 The following table shows the number of point defects on the surface of a bus body on March 2010.

Body Number	Number of defects	Body Number	Number of defects
1	13	11	17
2	15	12	11
3	19	13	7
4	8	14	11
5	6	15	14
6	17	16	6
7	7	17	16
8	9	18	10
	3	19	2
	23	20	6

U-chart. When the subgroup size varies from sample to sample, then the u-chart is used.

Control limits for u-chart
In u-chart the control limits will vary from sample to sample.

$$\bar{u} = \frac{\text{Number of defects in a sample}}{\text{Number of units in a sample}} = \frac{c}{n}$$

Control limit or central line,

$$CL_u = \bar{u}$$

Upper control limit, $UCL_u = \bar{u} + 3\sqrt{\frac{\bar{u}}{n}}$

Lower control limit, $LCL_u = \bar{u} - 3\sqrt{\frac{\bar{u}}{n}}$

~~The for~~
Eg:- A (u-chart). The following data shows the number of defects per lot in 15 successive lot of 5 radio sets each.

Lot Number	Number inspected	Number of defects	Number of defects per unit
1	5	3	0.60
2	5	2	0.40
3	5	1	0.20
4	5	2	0.40
5	5	6	1.20
6	5	1	0.20
7	5	3	0.60
8	5	2	0.40
9	5	0	0.00
10	5	0	0.00
11	5	0	0.00
12	5	0	0.00
13	5	0	0.00
14	5	1	0.20
15	5	2	0.40
	$\Sigma n = 75$	$\Sigma c = 23$	

(i) Plot the u-chart based on the above data

(ii) Suppose the reasons for out of control points are known and can be eliminated, then what will you suggest the control limits for future production.

Soln: In this case either a C-chart or u-chart can be used. But this problem is solved using a u-chart

Average number of defects per unit, $\bar{u} = \frac{\sum c}{\sum n}$

$$\frac{12.3}{45} = 0.31$$

Control limit or centre line

$$CL_u = \bar{u} = 0.31$$

Upper control limit, UCL_u

$$= \bar{u} + 3\sqrt{\frac{\bar{u}}{n}}$$

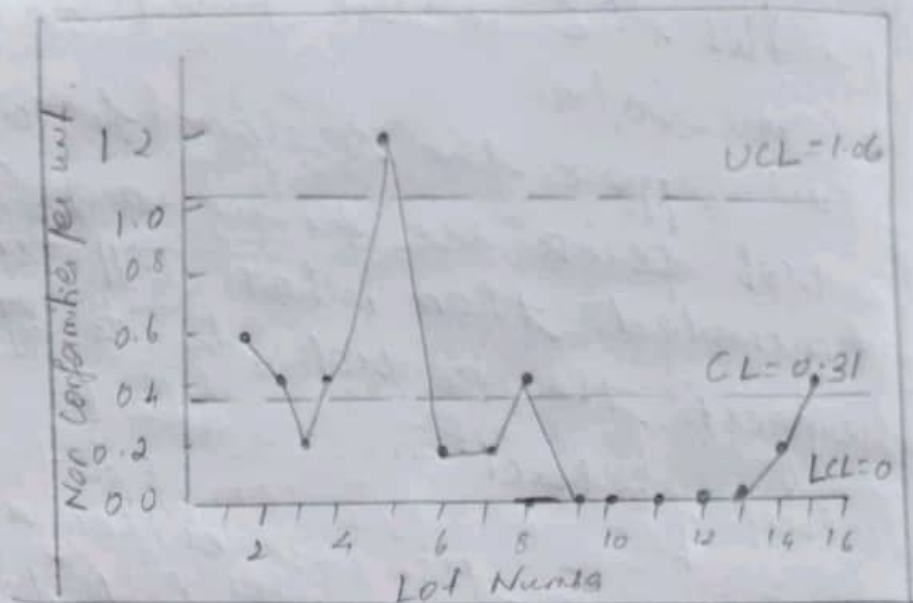
$$= 0.31 + 3\sqrt{\frac{0.31}{5}}$$

$$= 1.06$$

Lower control limit,

$$LCL_u = \bar{u} - 3\sqrt{\frac{\bar{u}}{n}}$$

$$= 0.31 - 3\sqrt{\frac{0.31}{5}} = -0.437 \leq 0$$



(b) To find the revised control limits.

From the control chart, it can be seen that lot number 5 is above UCL. So lot number 5 is out of control. Eliminating the lot number 5, the new $\bar{u}$ can be obtained for future production.

$$\therefore \bar{u} = \frac{23-6}{15-5} = \frac{17}{10} = 0.24$$

Then, control limit or Centre line $CL_u = \bar{u} = 0.24$.

Upper control limit,

$$UCL_u = \bar{u} + 3\sqrt{\frac{\bar{u}}{3}}$$

$$= 0.24 + 3\sqrt{\frac{0.24}{3}}$$

$$= 0.90$$

Lower Control Limit

$$LCL_u = \bar{u} - 3 \sqrt{\frac{\bar{u}}{3}}$$

$$= 0.24 - 3 \sqrt{\frac{0.24}{5}}$$

$$= -0.42 = 0.$$

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Unit - IV

Quality Circles

Definition: A Quality Circle (QC) also known as Quality Circle is a small voluntary group of employees their supervisors comprising a team of about 6 to 10 members from within same work area or doing similar works, that meet regularly to solve problems relating to their job scope or workplace.

Objectives of Quality Circles.

1. To Promote job involvement
2. To create problem solving Capability
3. To improve Communication
4. To Promote leadership qualities
5. To promote personal development
6. To develop a greater awareness for cleanliness.
7. To develop greater awareness for Safety.
8. To reduce errors
9. To enhance quality
10. To promote the Cost reduction.
11. To improve productivity
12. To increase employee motivation.

13. To build an attitude of problem prevention.

Characteristics of Quality Circles.

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

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

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

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

(v) The members of the quality circle should themselves identify the problems through various techniques such as brainstorming, Cause-effect diagram,

Pareto analysis, histograms, etc.

(vi) Quality Circles address two types of problems

(a) those concerned with the personal well-being of the worker.

(b) those concerned with the well-being of the company.

(vii) The members of the quality Circle should be trained in statistical and other problem solving tools so that they can identify, analyse and resolve work related problems.

(viii) Training and quality control activities must be carried out on company time.

(ix) Final recommendations of the quality Circle must be acceptable to management before they are made effective.

Structure of Quality Circle



Elements of Quality Circle

1. Top management:

(*) Though not directly a part of formal Quality Circle structure, top level management influences the successful implementation of the concept.

(*) A quality Council collects the information about the program and reports it to the managing director.

(*) It should extend its support and more importantly make it visible so that even workers in the lowest level know what the top management is doing for them.

2. Coordinator:

(*) A senior manager acts as a Coordinator. He arranges steering Committee meetings and is responsible for proper documentation of various activities.

(*) Overall, he is responsible for conducting seminars, presentations, and case studies and publishing periodicals to ascertain that the work of the quality circle is recognized.

3. Steering Committee

(*) A steering Committee is a group of members working under the chairmanship of the CEO with functional head as members.

(*) The members of steering Committee are responsible for proper implementation of quality circle.

in their respect areas. The CEO reviews the reports of the members activities and make suggestions.

4. facilitator!

(*) A senior person in a specific area acts as a facilitator. He bears the responsibility to catalyze motivate the quality circles.

(*) He acts as a guide or mentor for effective operation of quality circle.

(*) further he also elucidates the functioning of quality circles in his area in steering committee meetings.

5. Leader / Deputy leader.

(*) The members of the circle choose a leader with due care and consensus. As the leader shapes the circle's effectiveness, training him is vital.

(*) He should strive to avert conflicts and ensure quality oriented teamwork.

6. Members

(*) Members of a circle should not be forced to join a quality circle instead they should join of their own interest.

(*) They should encourage other employees to participate in the movement. Zealously involve themselves in the quality improvement programs, implement solutions and give presentations effectively.

7. Non Members:

(*) Non members are important because they support circle members externally.

(*) Also if they realize the benefits of forming circles, they will willingly participate in the activities.

Roles and Responsibilities of Quality Circle Elements.

1. Roles of Quality Circle Members.

- (*) Attend all possible meetings
- (*) offer views, opinions and ideas freely and voluntarily in problem solving
- (*) Participate actively in the group process
- (*) Attend training seriously with a respectful attitude.
- (*) Contribute to implementing solutions.

2. Roles of Quality Circle Leader.

- (*) Conducts meeting regularly
- (*) Involves all the members.
- (*) keeps the cohesiveness of the group.
- (*) Takes the team towards the goal.
- (*) Takes Care of
 - (i) Task behaviour of the group.

- (ii) Team maintenance
- (iii) Disruptive or negative behaviour to the management.

3. Roles of facilitator.

- (*) Coordinates the work of several quality Circles through leaders
- (*) Serves as a resource for the Circle.
- (*) Works closely with steering Committee.

- (*) Trains members by assisting leaders whenever required.
- (*) Maintains Circle records.
- (*) Evaluates Circle activities.

A. Roles of steering Committee:

- (*) Meets regularly once in two or three months.
- (*) Takes important decisions at the organizational level.
- (*) Give guidelines and directions.
- (*) Attend management presentations and get-togethers
- (*) Reviews periodically the progress
- (*) Ensures adequate training, ^{opportunities}
- and Recognizes the Contributions of the facilitator, leaders and members.

5. Roles of Coordinator

- (*) Registers the Circle
- (*) Interacts with all
- (*) Convenes steering Committee meetings.
- (*) Arranges management presentation.
- (*) Prepares a budget for the functioning of Quality Circle.
- (*) Help in solving problems encountered in the implementation of quality circle.

Process of Quality Circle operation.

1. Problem identification
2. Problem selection
3. Problem Analysis
4. Generate Alternate solutions
5. Select the most appropriate solution.
6. Prepare plan of action.
7. Present solution to management
8. Implementation of solution.

Benefits of Quality Circles.

1. Quality Circles effects on individuals
- ### Characteristics.

- (*) QC's enable the individual to improve personal capabilities
- (*) QC's increase the individuals' self respect.

(*) Qc's help workers change certain personality characteristics.

2. Quality Circles' effects on individuals' relations with others

(*) Qc's increase the respect of the supervisor for the workers

(*) Qc's increase workers understanding of the difficulties faced by supervisors.

(*) Qc's increase management's respect for workers.

3. Quality Circles' effects on workers and their attitude toward the company.

(*) Qc's change some worker's negative attitudes.

(*) Qc's reduce conflict stemming from the working environment.

Gains of Quality Circles:-

Tangible gains

- Better quality
- Productivity improvement
- Higher safety
- Greater cost of effectiveness
- Better Housekeeping
- Increased profitability

Intangible gains

- Enriched quality of work life
- Attitudinal changes
- Harmony, mutual trust
- Better human relations
- Participative culture
- Human resource development

Limitations of Quality Circles:-

1. Participation is not always voluntary in all cases.
2. Participation fades away if lacks the top management's support.
3. No involvement of trade unions.

Quality Function Deployment.

QFD 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 service.

Objectives of QFD.

The objectives of QFD are

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

Capturing the voice of the customer.

Sources of capturing the customer expectations include:

- 1) Direct Discussions or interviews
- 2) Customer surveys.

- 3) Market Surveys
- 4) Trade Trials
- 5) focus groups
- 6) Customer visits
- 7) Consultants
- 8) Observation
- 9) Warranty data
- 10) Customer audits
- 11) Customer Complaints
- 12) field reports.
- 13) Standards.

House of Quality

The primary planning tool used in 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, as shown in figures.

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) 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 benchmarking, 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 relationships between Customer requirements and technical descriptors.

(*) This relationship matrix correlates customer requirements with product characteristics.

Section V : Trade off Matrix

(*) The roof of the house is the interrelationship between technical descriptors.

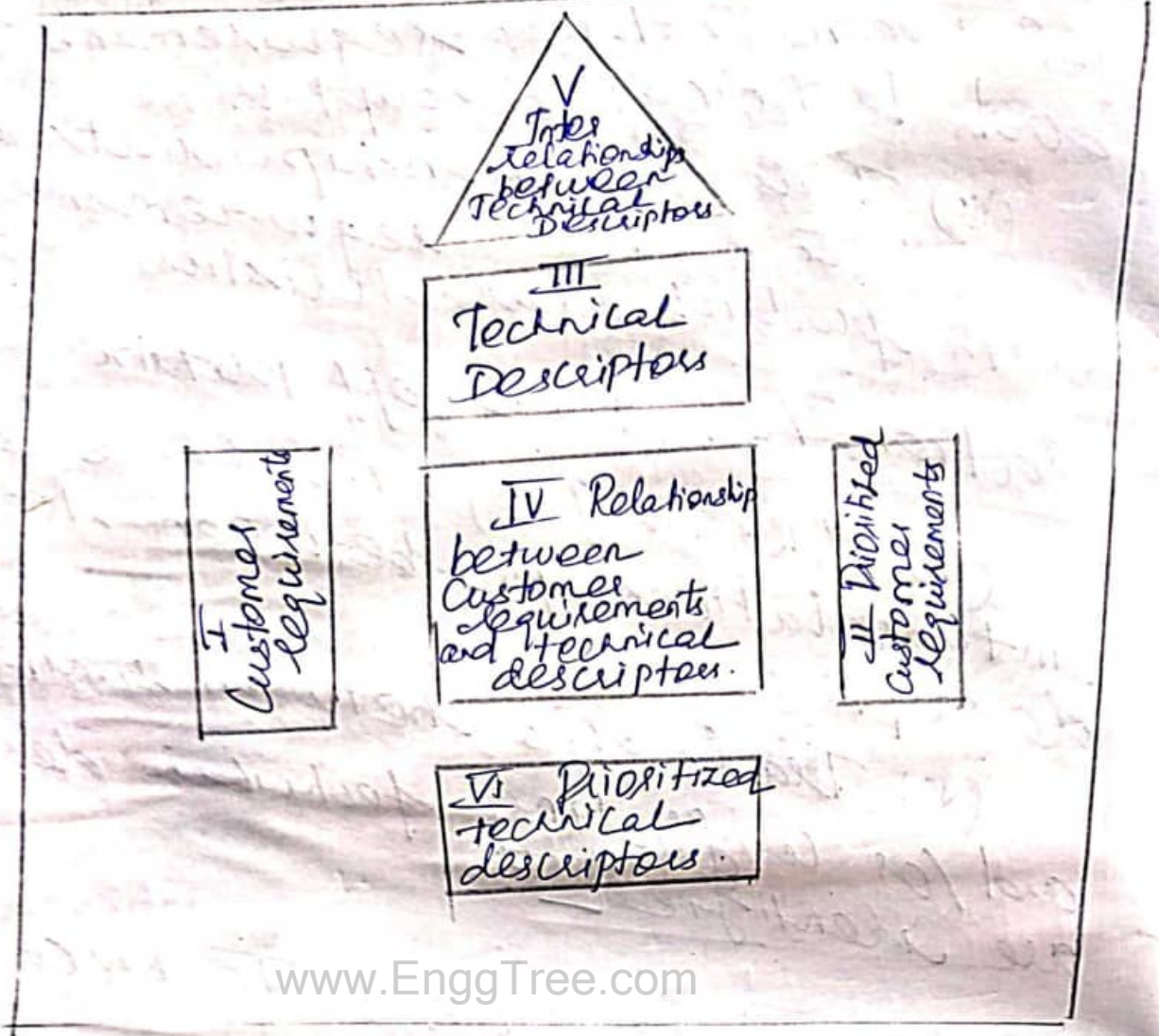
(*) Trade offs between similar and/or conflicting technical descriptors are identified.

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.

The detailed basic house of quality matrix is given below;



QFD Methodology:-

Step:-1 List Customer requirements (WHATs)

* Define the Customer and establish full identification of Customer wants and dislikes.

* Measure the priority of these wants and dislikes using weighing scores.

Step:-2 List Technical Descriptors (HOWs)

* Translate the identified Customer wants into corresponding

How's or design characteristics.
Express them in terms of
quantifiable technical parameters
or product specifications.

Step 3 Develop a Relationship matrix
Between WHAT's and How's

(*) Investigate the relationships
between the customer's expectations
and technical descriptors

(*) If a relationship exists,
Categorise it as strong, medium,
or weak.

Step 4 Develop an Interrelationship
matrix between How's

(*) Identify any interrelationships
between each of the technical
descriptors.

Step 5 Competitive Assessment
(*) Compare the performance
of the product with that of
Competitive products.

* Evaluate the product and
note the strong and weak points
of the product against its
competitor's product according to
the customer.

This Competitive Assessment tables ~~is~~ include two categories: Customer assessment and technical assessment.

Step: 6 Develop prioritized Customer requirements.

(*) Develop the prioritized Customer requirements corresponding to each customer requirement in the house of quality on the right side of the Customer Competitive assessment.

Step: 7 Develop prioritized Technical Descriptors.

(*) Develop the prioritized technical descriptors corresponding to each technical descriptor in the house of quality below the technical competitive assessment.

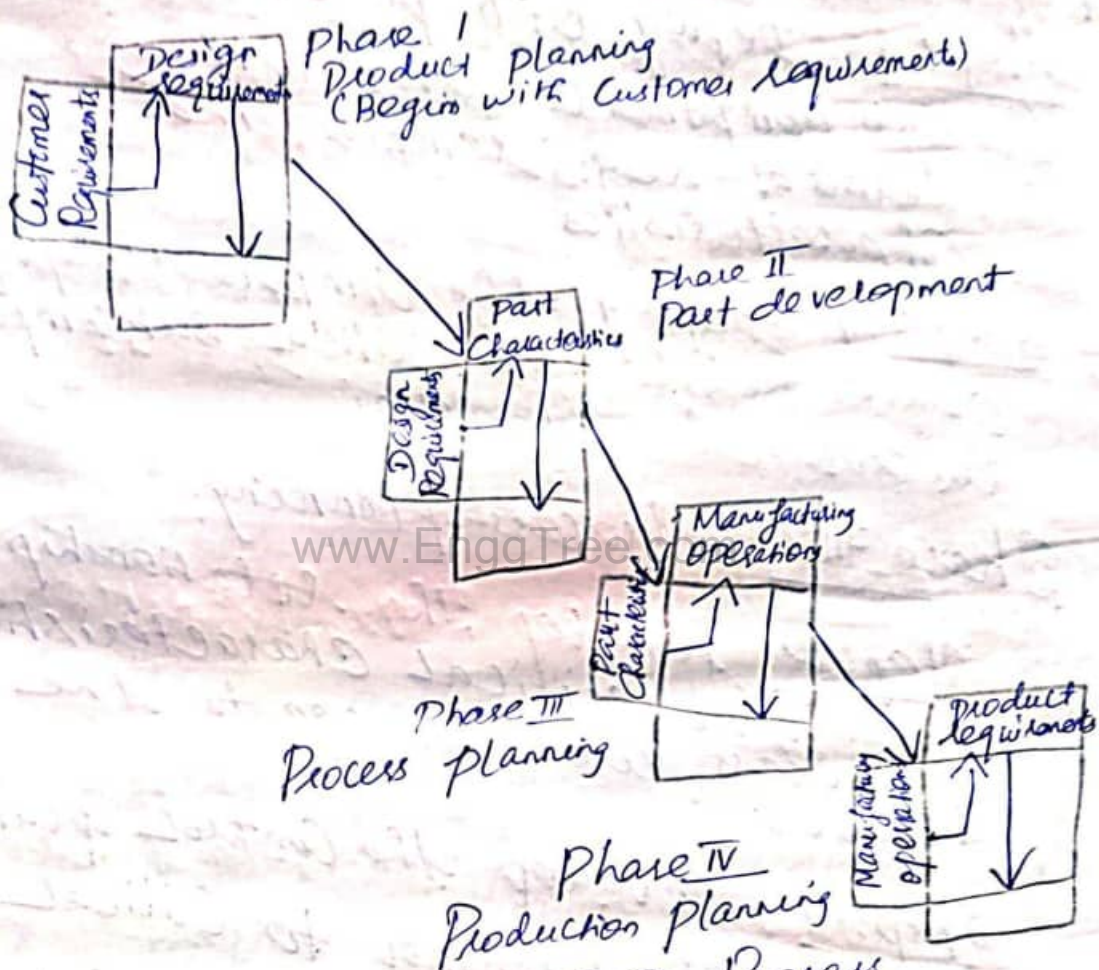
(*) These prioritized technical descriptors include degrees of technical difficulty, target value and absolute and relative weights.

QFD PROCESS

These are the four phases of product development

- (i) Product planning
- (ii) Part development
- (iii) Process planning
- (iv) Production planning

The QFD Process



Steps in the QFD Process.

Phase I

Product Planning

- Step 1: List Customer requirements (WHAT's)
- Step 1.2 List technical descriptors (HOW's)
- Step 1.3 Develop a relationship matrix between WHAT's and HOW's
- Step 1.4 Develop an interrelationship matrix between HOW's

- Step:-5 Do competitive assessments
- Step:-6 Develop prioritized customer requirements
- Step:-7 Develop prioritized technical descriptions.

Phase II: Part Development

- Step:-8 Deploy QFD process down to sub components level both in terms of requirements and Characteristics.

- Step:-9 Deploy the Component deployment chart. Relate the Critical sub component Control Characteristics

Phase III: Process Planning

- Step:-10 Develop the relationship between the critical Characteristics and process used to create the Characteristics.

- Step:-11 Develop the Control plan relating critical Control to Critical processes.

Phase IV: Production Planning

- Step:-12 Tabulate operating instructions from process requirements

- Step:-13 Develop prototype and do testing

- Step:-14. Launch the final product to the market.

Benefits of QFD

- * Promotes better understanding of Customer demands
- * Improve Customer satisfaction
- * Promotes teamwork.
- * facilitates better understanding of design interactions.
- * Involves manufacturing in the design process
- * Concentrates on design effort
- * Reduces the overall costs of design and manufacture.

Tangible Benefits

- Significant reduction in start-up and Engineering cost by 30%.
- Elimination of most late engineering changes
- Early identification of high risk areas
- Up-front determination of product process requirements
- More efficient allocation of resources.

Intangible Benefits

- Improves Customer satisfaction
- facilitates multidisciplinary teamwork
- Provides a basis for improvement planning
- Establishes and maintains documentation.
- Creates a transferable storehouse of engineering knowledge

Taguchi's Quality Loss function

Taguchi defines quality as "the loss imparted by the product to society from the time the product is shipped"

The essence of the loss function concept 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.

Taguchi's Approach Vs Traditional Approach.

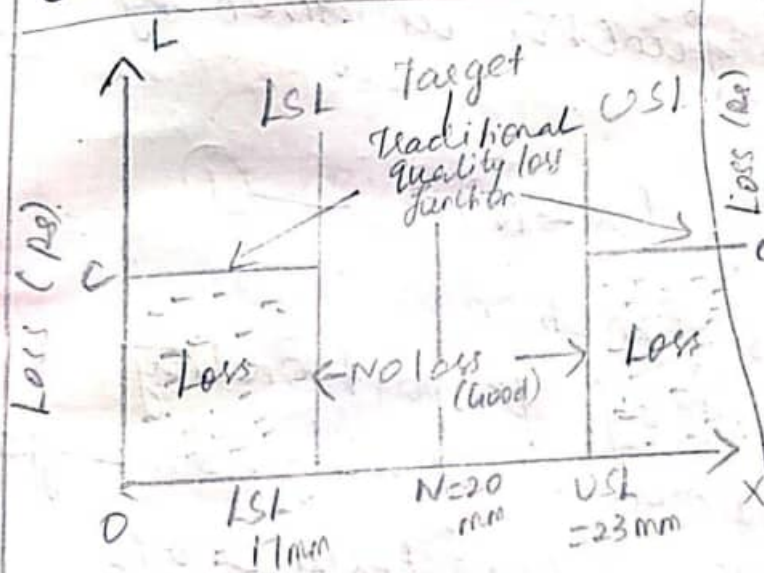
Consider two products and one is within the specified limits and the other is just outside of the specified limits. In the traditional approach, the product within the specified limits is considered as good product while the outside the specified limits is considered as bad product.

Taguchi disagrees with

this traditional approach. He believes that when a product moves from its target value, that move causes a loss, no matter if the move falls from its target value, that move causes a loss, no matter if the move falls outside or inside the specified limits.

Traditional Approach

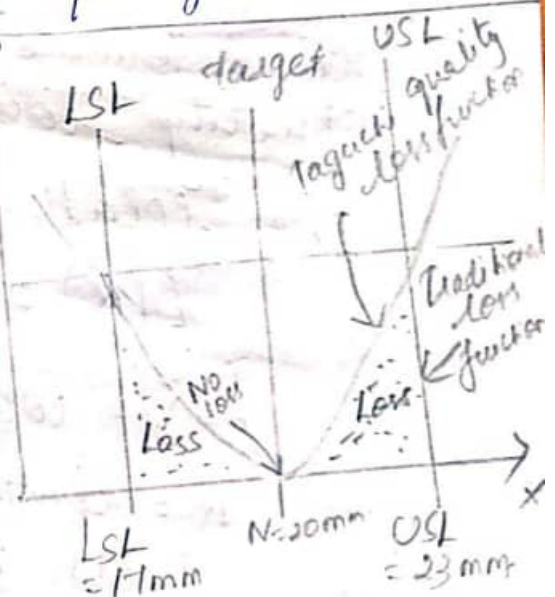
In traditional approach, the product within the specified limits is considered as good product, while the outside the specified limit is considered as bad product.



Performance Characteristic

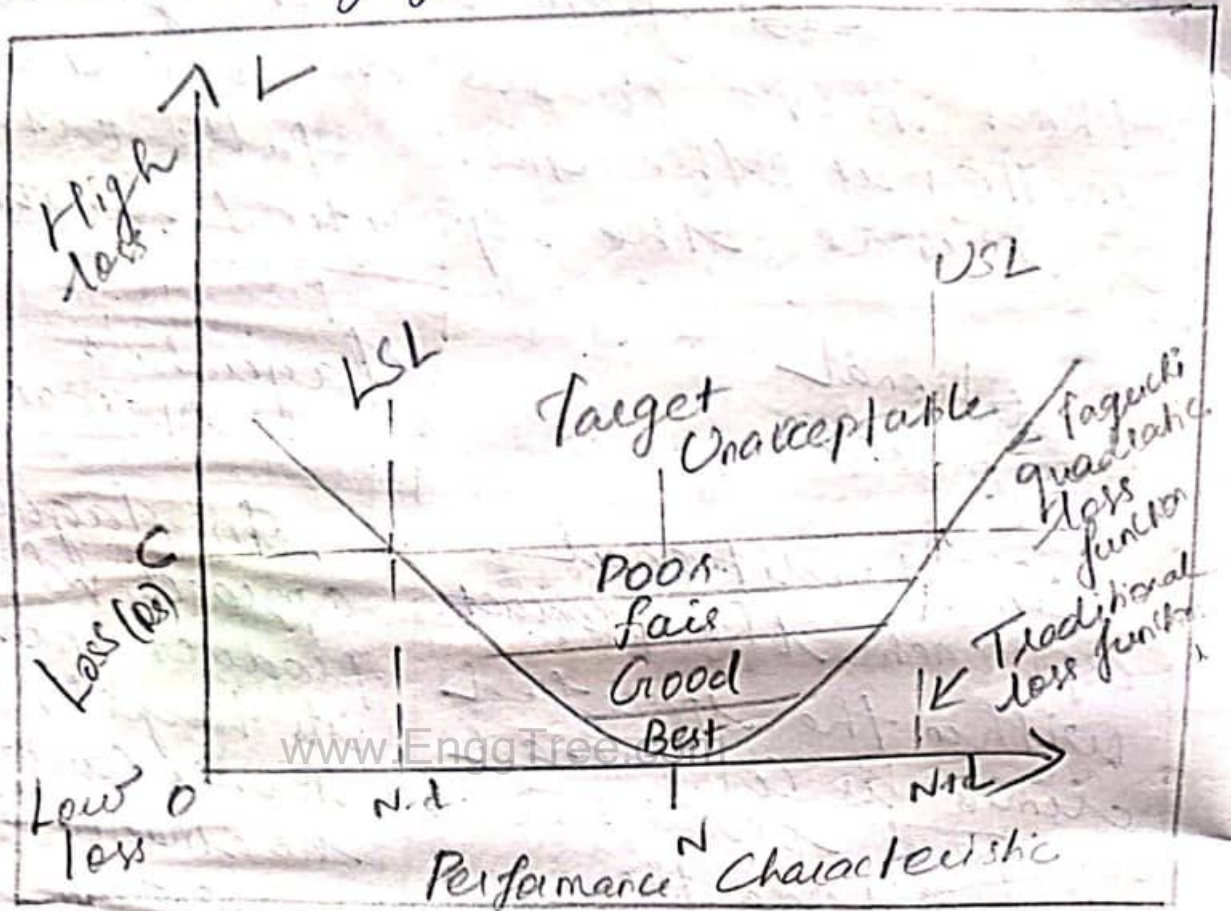
Taguchi's Approach

In Taguchi's approach, when a product moves from its target value, that move causes a loss, no matter if the move falls inside or outside the specified limits.



Performance Characteristic

If the deviation grows, then the loss increases. The Taguchi's U-shaped loss function curve is shown in figure.



Taguchi uses a quadratic equation to determine this curve. The quality loss function is given by the relation.

$$L(X) = K(X - N)^2 \quad \text{--- (1)}$$

$L(X)$ = loss function.

K = Constant of proportionality
also known as quality loss coefficient

X = Quality characteristic of
Selected product.

N = Nominal (or target) value of the chosen product and
 $X - N$ = Tolerance.

Determination of 'k' :-

To estimate the loss, the value of quality loss coefficient (k) should be determined first.

Let $d = X - N$ = Deviation of the specification from the target value.

When d is at LSL or USL, the loss to the customer is Rs. C .

Now from (1), we can write Quality loss function:

$$k = \frac{C}{d^2}.$$

C = loss associated with the specification limit, and

d = Deviation of the specification from the target value.

In fact, the value of k determines the slope of quality loss function.

Total Productive Maintenance

Defn: The Productive Maintenance (TPM) is a holistic approach to equipment maintenance that strives to achieve perfect production (i.e. product without any breakdowns, small stops or slow running, defects and accidents.)

TPM emphasizes proactive and preventive maintenance to maximize the operational efficiency of equipment.

The Similarities between TQM and TPM are given below

- Total Commitment to the program by top management is required in both programmes.
- Employees must be ~~prepared~~ empowered to initiate corrective action.
- A long term outlook must be accepted, as TPM may take a year or more to implement and is an on-going process.
- Also changes in employee attitude toward their job

responsibilities must take place.

TPM Concepts:

The Eight Pillars of TPM:

1. Autonomous Maintenance

- Operators take ownership of routine maintenance tasks, such as cleaning, lubrication and inspection.
- Reduces equipment downtime and fosters operator engagement.

2. Planned Maintenance

- Scheduled maintenance activities to prevent ~~unscripted~~^{unexpected} failures.
- Focuses on optimizing equipment lifespan and minimizing costs.

3. Quality Maintenance

- Prevents defects through regular checks and calibrations.
- Aims to maintain production quality at optimal levels.

4. Focused Improvement

- Continuous efforts to eliminate losses and inefficiencies.

- Encourages teams to collaborate on solving problems.

5. Early Equipment Management

- Involves maintenance staff during the design phase of new equipment.

- Ensures ease of maintenance and optimal performance from the start.

6. Education and Training

- Develops skills for operators and maintenance personnel.
- Promotes shared knowledge for effective teamwork.

7. Safety, Healthy and Environment

- Ensures workplace safety and environmental responsibility
- Focuses on creating a healthy and hazard-free work environment.

8. TPM in Office Areas:

- Extends TPM Principles to administrative functions.

- Streamlines processes and reduce waste in non-production areas.

2. Six Big Losses

TPM targets the reduction of these six major types of equipment related losses.

- Equipment failures : Breakdowns Causing downtime
- Setup and Adjustments : Time lost during production changeovers.
- Idling and Minor Stops : Small interruptions or delays.
- Reduced speed : Operating below optimal speed.
- Quality Defects : Producing items that need rework or are scrapped.
- Startup losses : Inefficiencies during the initial phase of production.

3. Goals of TPM

- Achieve Zero breakdowns, zero defects, and zero accidents
- Improve Overall Equipment Effectiveness which includes:
 - * Availability : Uptime of machines
 - * Performance : Running speed compared to ideal speed
 - * Defect-free production rate.

Overall Equipment Effectiveness

- Measures of TPM.

The TPM efforts are measured by the factor called overall equipment effectiveness (OEE)

Calculation of OEE.

Six Big Loss.

1. Breakdowns
2. Setup and Changeover.

$$\rightarrow \text{Availability} = \frac{\text{Loading time} - \text{Down time}}{\text{Loading time}} \times 100$$

3. Idling and minor stoppages.
4. Reduced Speed.

$$\rightarrow \text{Performance efficiency} = \frac{\text{Theoretical cycle time per unit} \times \text{Number of units}}{\text{operating time}}$$

5. Defects and rework
6. Startup losses

$$\rightarrow \text{Rate of quality products} = \frac{\text{Produced quantity} - \text{Defect quantity}}{\text{Produced quantity}} \times 100$$

Overall equipment effectiveness

$$= \text{Availability} \times \left\{ \text{Performance Efficiency} \right\} \times \left\{ \text{Rate of quality products} \right\}$$

Benefits of TPM.

- (i) Increased equipment productivity
- (ii) Improved equipment reliability
- (iii) Reduced Equipment downtime
- (iv) Increased plant Capacity
- (v) Extended machine life
- (vi) Lower maintenance and production costs
- (vii) Approaching Zero Equipment Caused defects
- (ix) Enhanced job satisfaction.
- (x) Improved return on investment
- (xi) Improved safety.

Difference between TPM and TQM.

Total Productive Maintenance (TPM) and Total Quality Management (TQM) are both methodologies aiming at improving efficiency and quality in organizations. However, they focus on different aspects of organizational performance. Here's a comparison.

Aspect	TPM	TQM
Focus	Equipment and machinery performance	Overall product, service quality and customer satisfaction.
Objective	Minimize equipment downtime, improve reliability and enhance productivity.	Eliminate defects and improve processes to meet customer needs.
Scope	Primarily maintenance and production operations	Organization-wide involving all departments.
Key Principle	Preventive maintenance and production operations	Organization-wide involving all departments. Continuous improvements and total customer focus.
Tool Used	Autonomous maintenance planned maintenance - OEE	Quality Circles Statistical process control (SPC) - Benchmarking.
Implementation	focused on maintaining and improving equipment through proactive and preventive strategies	Implemented by improving processes, reducing waste, and ensuring quality at every stage.

Employee Role: Operators are trained to perform basic maintenance tasks.

Employees are encouraged to participate in quality improvement initiatives.

End Goal: Achieve Zero breakdowns, Zero defects, and Zero accidents.

Achieve customer satisfaction through consistent quality.

Key differences

1. Core focus: TPM centers on maintaining and optimizing equipment, while TQM focuses on delivering high quality products or services.

2. Implementation Area: TPM is more operational and technical, whereas TQM is strategic and spans all organizational functions.

3. Primary Goal: ~~TPM~~ TPM aims for Zero losses in equipment related areas; TQM targets Zero defects and customer delight.

Improvement needs.

Identifying improvement needs is a critical step in continuous improvement methodologies like TPM and TQM. Here's how to approach and address improvement needs.

Categories of Improvement Needs

1. Operational Efficiency
 - Reduce waste
 - Improve work flow and processes.
 - Optimize equipment utilization and maintenance.
2. Quality
 - Minimize defects in products or services.
 - Standardize processes to ensure consistent outcomes.
 - Enhance compliance with Quality Standards (eg:- ISO).
3. Customer Satisfaction
 - Gather and act on customer feedback.
 - Improve product or service delivery times.
 - Enhance user experience and value.
4. Employee Engagement
 - Provide better training and resources.

- Foster a culture of collaboration and ownership.
- Address job satisfaction and workplace issues.

5. Safety and Sustainability

- Improve workplace safety protocols
- Reduce environmental impact
- Comply with regulatory and ethical standards.

Steps to Identify Improvement Needs

1. Assess current performance
 - Use performance metrics like key performance indicators (KPIs), Overall Equipment Effectiveness (OEE), or customer satisfaction scores.
2. Gather Data and feedback
 - Collect input from employees, customers, and stakeholders.
 - Use surveys, audits and reviews to identify pain points.
3. Analyze processes.
 - Use tools like root cause analysis, Pareto charts or fishbone diagrams to pinpoint issues.
4. Benchmark Against Standards.
 - Compare performance to industry standards or competitors.

5. Prioritize Issues:-
 • focus on high-impact areas that align with organizational goals.

Performance Measures
 Performance measures indicates the measurement of success in an organisation.

Objectives:-
 1. To establish baseline measures and reveal trends
 2. To determine which processes need to be improved
 3. To indicate process gains and losses.

4. To compare goals with actual performance.
 5. To provide information for individual and team evaluation.
 6. To provide information to make informed decisions.
 7. To determine the overall performance of the organization.

Performance indicators
 1. Customers
 • number of Customers' Complaints
 • number of warranty claims

- number of suggestions per employee
- number of suggestions implemented
- % returns by customers.

2. Production

- $\text{Productivity} = \frac{\text{Output}}{\text{input}} = \frac{\text{result}}{\text{costs}}$
- $\text{labour productivity} = \frac{\text{result}}{\text{labour costs}}$
- $\text{Capital productivity} = \frac{\text{result}}{\text{capital costs}}$
- $\text{material productivity} = \frac{\text{result}}{\text{material costs}}$
- revenue growth.

3. Suppliers

- Service rating
- On-time delivery
- quality performance
- SPC charts
- billing accuracy
- average lead time
- just-in time delivery target.

4. Research and development

- new product time to market
- time needed to launch a new product
- design change orders
- Cost estimating errors.
- % of sales from new products.

5. Human Resources

- % personnel turnover
- % absence due to illness
- employee satisfaction index
- number of training hours per employee
- number of active teams
- number of suggestions/grievances

6. Marketing Sales

- Sales growth
- Market growth
- % delivery completed
- Sales expense to revenue
- new customers
- Sales income to number of sales people
- order accuracy

7. Administration

- revenue growth
- revenue per employee
- expense to revenue
- Cost of poor quality
- % of payroll distribution on time
- invoicing speed

Requirements (or Criteria) of the Performance measures.

1. Simple : Performance measures should be simple and understandable to the users.

2. few in number : Instead of using many performance measures, it is preferable to use few number of key measures.

3. Developed by users : performance measures should be developed by the users so that to ensure ownership of the measures.

4. Relevance to Customers : While selecting measures, one should select the measures which are more relevant to measures.

5. Improvement : Performance measures should focus on continuous improvement, prevention and corrective action.

6. Cost : Cost related performance measures should be preferred to better understand the financial position of the firm.

7. Visible : The performance measures selected/used should be

transparent and visible to all the employees.

8. Timely: The performance measures should be time-based, preferably measures should be based on hourly, daily, or weekly rather than monthly or quarterly.

9. Aligned: A comprehensive set of measures and indicators tied to customer and organisational performance requirements provide a way to align all activities with organisational goals.

10. Results: The results of the performance measures should balance the interests of all stakeholders - customers, employees, stockholders, suppliers, and the community.

Performance measures presentation.

1. Time series trend graph
2. Control charts
3. Capability index.
4. Taguchi's loss function
5. Cost of poor quality
6. Quality awards.

Cost of Quality

As in Unit 1 (TQM).

BPR

Business process Reengineering is a management ~~at~~ in Total Quality Management is an approach focused on fundamentally rethinking and redesigning business processes to achieve significant improvements in performance, efficiency and quality. BPR goes beyond incremental improvements by seeking radical changes in processes, often leveraging technology and streamlined work flows to optimize end-to-end operations.

Key Aspects of BPR in TQM.

1. Focus on processes, Not Tasks
 - BPR emphasizes looking at entire processes rather than individual tasks. This means identifying core business processes and reengineering them for maximum efficiency and quality.
2. Customer Centric Approach.
 - Like TQM, BPR centers on delivering value to the customer.

By redesigning processes, companies can improve response times, increase product or service quality and better meet customer needs.

3. Elimination of Non Value added Activities.

- BPR identifies and removes steps or activities that do not add value, reducing waste and streamlining the workflow.

4. Use of Technology:

- Technology plays a critical role in BPR, enabling automation, better data management and enhanced communication, which can lead to faster and more accurate processes.

5. Empowerment of teams:

- In BPR, employees are often empowered with greater responsibility and authority, as streamlined processes may require cross-functional knowledge and decision making closer to the action.

6. Performance Metrics.

- Both TQM and BPR use

performance metrics to track progress. In BPR these metrics help ensure that reengineered processes meet quality, efficiency, and customer satisfaction goals.

Relationship between BPR and TQM

While TQM focuses on continuous improvement, BPR seeks breakthrough improvements by redesigning processes ~~to~~ from the ground up. Both approaches share the ~~goal~~ goal of enhancing quality, but BPR is more radical, aiming for ~~transforming~~ transformational change to meet TQM's overarching quality objectives.

Taguchi Quality loss function

1) In the specifications are 10 ± 2 for a particular quality characteristic and the average repair cost is Rs 200 determine the loss function.

Given specification 10 ± 2 , $C = \text{Rs } 200$
 Soln: Taguchi's quality loss function

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

$$K = \frac{C}{d^2} \quad C = \text{loss associated with the specification limit} = 200 \text{ Rs.}$$

$d = \text{deviation of the specification from the target} = 2.$

$$K = \frac{200}{2^2} = 50$$

When, nominal value $N = 10$ $x = 11$, the loss is given by
 (Target value)

$$L(x) = 50(11 - 10)^2 = 50.$$

$$L(x) = 50.$$

2) A Certain part dimension on a power garden tool is specified as 32.25 ± 0.25 mm. Company repair records indicate that if the ± 0.25 mm tolerance is exceeded, there is a 75% chance that the product will be returned for replacement. The cost associated with replacing the product is estimated to be Rs 12500. Determine the Constant 'K' in the Taguchi' loss function for these data Also write QLF.

Soln: specification 32.25 ± 0.25 , $d = 0.25$ mm
 $p = 75\%$ replacement cost = 12500

To find:

(i) k

(ii) QLF

$$C = 0.75 \times 12500 = 9375$$

$$k = \frac{C}{d^2} = \frac{9375}{(0.25)^2} = \text{Rs } 150,000$$

$$L(x) = 150,000 (x - N)^2$$

Eg: 5 The Taguchi quadratic loss function for a particular component via a piece of earthmoving equipment is $L(x) = 2520 (x - N)^2$, where x = the actual value of a critical dimension and N is the nominal value. If $N = 162.00$ mm determine the value of the loss functions for the tolerances ~~at~~ (a) ± 0.25 mm and (b) ± 0.15 mm.

Soln:

$$L(x) = 2520 (x - N)^2; \quad N = 162.00$$

Tolerance $(x - N)$

$$a) \quad L(x) = 2520 (0.25)^2$$

$$\text{Rs} = 15750$$

$$b) \quad L(x) = 2520 (0.15)^2$$

$$= 5670$$

Unit - V

Quality Management System.

Introduction:

International Organisation for Standardisation (ISO) defined the term quality system as follows

"The quality system is the organisational structure, responsibilities, procedures, processes and resources for implementing quality management."

The quality system should function in such a manner as to provide proper confidence that

(i) the system is well understood and effective

(ii) the products or services actually do satisfy customer expectations

(iii) the emphasis is placed on problem prevention rather than dependence on detection after occurrence.

A quality system involves

(i) How methods and process description;

- (ii) Who - responsibilities and authorities.
- (iii) When - records and evidence
- (iv) Where - identification and traceability.

Benefits of ISO Registration.

ISO registration provides numerous benefits for organizations across various industries. Some key advantages include:

1. Enhanced quality and Consistency
 - Ensures consistent quality in products or services by adhering to standardized processes.
 - Promotes continuous improvement in operations and outputs.
2. Increased Customer Satisfaction
 - Builds trust and confidence among customers due to adherence to international standards.
3. Market Competitiveness
 - Act as a competitive advantage in bidding for contracts, especially in global markets.
 - Provides recognition as a reliable and professional organisation.

4. Improved efficiency and productivity
 - Streamlines processes by identifying and eliminating inefficiencies
 - Encourages a culture of process optimization and waste reduction
5. Compliance with Regulations
 - Helps organizations comply with national and international legal and regulatory requirements
 - Reduces the risk of legal penalties and fines
6. Global Recognition
 - ISO Certification is recognized worldwide, making it easier to expand into new markets
 - Demonstrates adherence to globally accepted standards.
7. Better Risk management
 - Helps identify potential risks and implement preventive measures.
 - Improves overall risk awareness and resilience.
8. Employee engagement and morale
 - Encourages employee participation in maintaining quality standards.

- Provides clear guidelines, roles and responsibilities enhancing job satisfaction.
9. Stronger, supplier relationships
 - Strengthens trust with suppliers, leading to more reliable partnerships.
 10. Cost Savings
 - Reduces waste, errors, and rework resulting in lower operational costs.
 - Ensures efficient use of resources, boosting profitability.

ISO 9001 Requirements

1. Scope
Tell what organisation, location, process, product and so on covered.
2. Normative reference
Normative reference are other standards which by being listed constitute provisions of the ISO 9001 standard.
3. Terms and definitions
For the purpose of this international standard, the terms and definitions given in ISO 9000 apply.

4. Quality management System.

Provides general requirements for the QMS and defines documentation requirements.

5. Management Responsibility

Defines the requirements top managers must perform to ensure the effectiveness of the QMS.

It includes specific requirements for

- Management Commitment
- Customer focus
- Quality policy
- Planning
- Responsibility, authority, Communication
- Management review

6. Resource management.

Defines the requirements Companies must meet to provide adequate resources to implement and maintain the QMS to continually improve its effectiveness.

It includes specific requirements for

- Provision of resources
- Human Resources
- Infrastructure
- Work environment.

7. Product realization

• Defines requirements for processes related to product realization

It includes specific requirements for

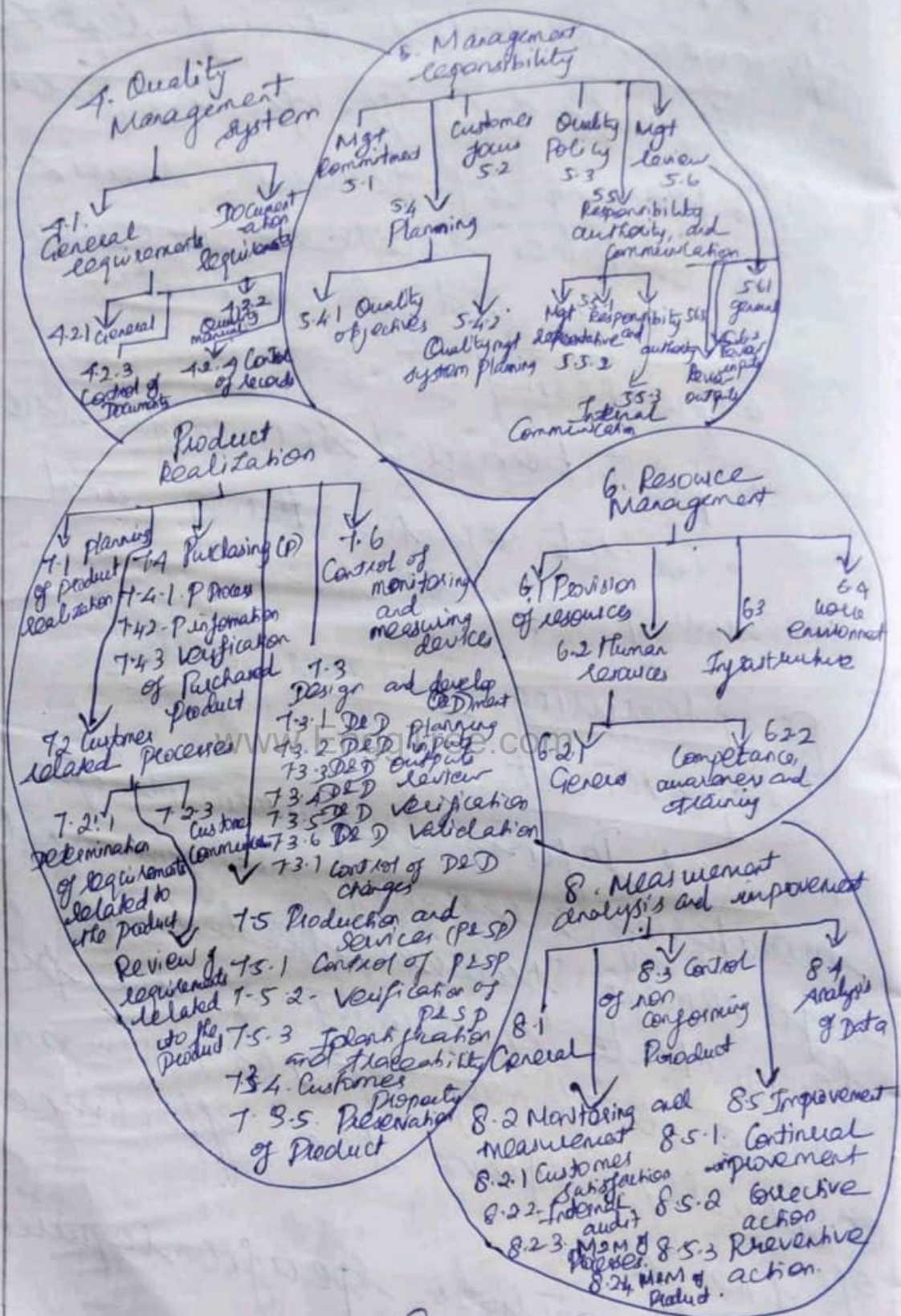
- Planning of product realization
- Customer related processes
- Design and development
- Purchasing
- Production and service provision
- Control of monitoring and measuring devices.

8. Measuring analysis and improvement

• Defines requirements for monitoring, measuring, analysis and improvement processes needed to demonstrate conformity of the product, ensure conformity of the QMS and continually improve the effectiveness of the QMS.

It includes specific requirements for

- measuring
- monitoring and measurement.
- Control of nonconforming product
- Analysis of data
- Improvement.



Various Causes & Sub Clauses of ISO 9001 requirements.

Implementation.

Step: 1 Top management Commitment

- The most important step in implementing a quality system is to get the full support of upper management.

Step: 2 Appoint the management representative

- The management representative is responsible for coordinating the implementation and maintenance of the quality system. Also he is the contact person for all parties involved in the process both internal & external.

Step: 3 Awareness.

- Since the implementation of the quality system requires involvement of all members in the organisation, the members should understand the process and implication of ISO program.

Step: 4 Appoint an Implementation Team.

- This team should identify the QMS processes and their sequence and interaction.

Step: 5 Training

- This activity can be accomplished through in-house training programs, seminars, workshops etc.

Step:-6 Time schedule:-

- This time frame will vary depending on the size ^{and type} of organisation.

Step:-7 Select element owners.

- Each owner has the option of selecting a team to assist in the process.

Step:-8 Review the present system

- This activity is a gap analysis and can be performed by the element owners and their teams or by an external consultant.

Step:-9 Write the Documents

- This documentation of work instructions should be done by the employee who performs the job.

Step:-10 Install the new system.

- The policies, procedures and work instructions should be integrated into the day to day workings of the organisation.

Step:-11 Internal Audit

- This step ensures that the system is working effectively and to provide management with information for the comprehensive management review.

Step:-12 Management Review
The management review should be conducted in order to determine the effectiveness of the system.

Step:-13 Reassessment
The Reassessment is an optional step. If a good job has been done on the previous steps, then reassessment is not necessary.

Step:-14 Registration.
The application for registration should also include supplying the registrar with the policy and procedure manuals for their review.

Step:-15 Award of ISO 9001 Certificate
After accepting the application and setting a time frame for registration, the registrar will review the quality system documentation.

Documentation:

Necessity for Documentation

It is understood that the proper documentation is the pre-requisite for implementing quality system.

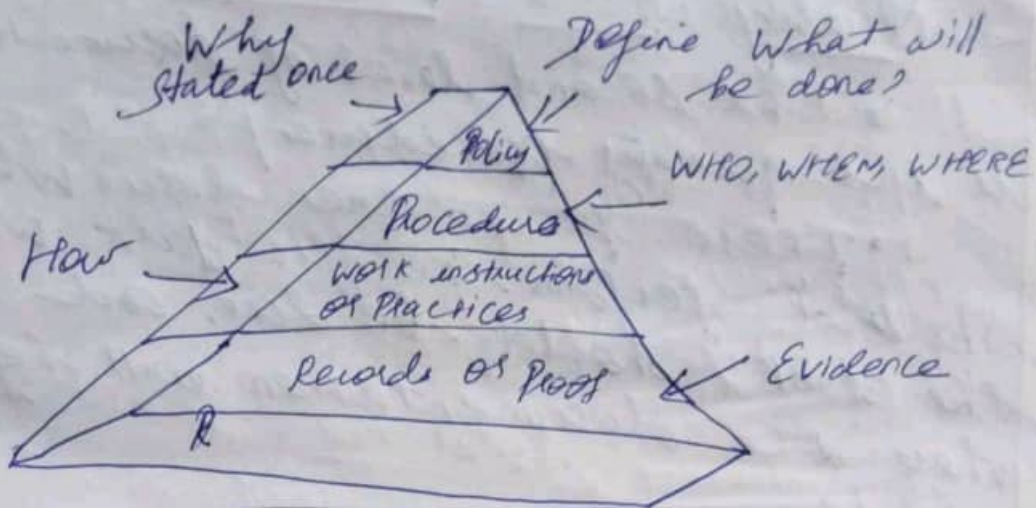
The documentation serves as a reference for the management, the staff, and other agencies whose involvement is essential for implementation of the quality system.

Advantages of having a documented quality system:-

Documentation:

- (a) serves as a reference
- (b) brings about clarity of objectives and targets
- (c) provides standardisation in work procedures.
- (d) brings about consistency in operations.
- (e) develops confidence amongst employees.
- (f) generates customer's confidence
- (g) provides a basis for continual improvement.

Documents to be prepared



Document Contents

Level 1 - statements of the quality policy and objectives.

Level-2 - Description of the activities needed to implement in the system.

Level:-3 - Detailed work documents.

Level:-4 Results of implementing the quality system.

The documentation Pyramid

1. Quality Policy manual:

- Quality policy manual is the first level of documentation.
- The policy manual communicates the quality policy and objectives of an organisation.
- This manual is a living document, because it reflects the current system.

being followed in the organisation.

2. Quality System Procedure:

- The second level of documentation is the quality procedure.

- These procedures define who should perform specific task, when the task should be done, and where the documentation will be made.

3. Work Instruction

- The third level of documentation is generally company specific.

- Work instructions should 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.

4. Records / Formats / Forms.

- Records provide evidence of activity having been performed in compliance with quality system procedure.

- Records are used to provide traceability of actions taken on a specific product or batch of products.

Benefits of Documentation.

- (i) Documentation regularises the method of performing the day-to-day activities.
- (ii) It provides formats for standardising practices.
- (iii) It facilitates trouble shooting for tracing back on the processes.

Internal Audits

Internal audits are systematic evaluations conducted within an organization to assess its processes, systems and controls. They aim to ensure compliance with established policies, procedures and regulations and to identify areas for improvement. Internal audits are a critical component of Total Quality Management as they help maintain and improve organizational performance.

Objectives of Internal Audits

1. Compliance: Verify adherence to internal policies, legal regulations and industry standards.

2. Risk Management: Identify risks and recommend controls to mitigate them.

3. Process Improvement: Highlight inefficiencies and suggest enhancements to optimize processes.

4. Quality Assurance: Ensure the organization meets customer expectations and quality standards.

5. Performance Measurement: Evaluate the effectiveness of existing processes and systems.

Steps in the internal Audit process:

1. Planning:

- Define the scope and objectives of the audit.
- Develop an audit plan and checklist.
- Communicate the schedule to relevant departments.

2. Execution:

- Collect data through observations, interviews and document reviews.
- Evaluate compliance with standards and policies.

3. Reporting:

- Summarize findings in an audit report.

- Highlights areas of non compliance, risks and improvement opportunities.

4. follow-up:

- Ensure corrective actions are implemented.
- Conduct re-audits if necessary to confirm improvements.

Benefits of Internal Audits in TQM:-

- Promotes a culture of continuous improvements.
- Identifies inefficiencies and waste in processes.
- Enhances employee awareness of quality and compliance standards.
- Provides management with actionable insights for decision-making.

Registration:

ISO 9001 registration refers to the process of obtaining certification to the ISO 9001 standard which an organization's Quality Management system is independently audited and certified to meet the ISO 9001 standard. Here's detailed guide to the registration process.

Steps for ISO 9001 registration

1. Preparation and Planning

- understand the standard
- Gap analysis
- Top management commitment

2. Develop or update the QMS.

- Document processes: Create or update policies, procedures and work instructions to align with ISO 9001.
- Define Scope! clearly define what parts of the organization or processes will be included in the QMS.
- Train Employees
- Address Risks and opportunities.

3. Implement the QMS

- Put the documented processes into action
- Monitor performance and collect data to ensure compliance with ISO 9001.
- Ensure internal audits and corrective actions are part of the routine.

4. Select a Certification Body.

- Accreditation: Choose a Certification body accredited by an internationally recognized accreditation organization.

- Reputation: Ensure the body has experience in your industry and is credible.

5. Stage 1 Audit: Documentation

Review

- The Certification body reviews your QMS documentation to verify it aligns with ISO 9001.
- Non Conformities it found, must be addressed before moving to stage 2.

6. Stage 2 Audit: On site Assessment

- The Certification body conducts an on-site audit of your processes and operations.
- Thus verify the QMS is implemented effectively and meets ISO 9001 requirements.
- Any non-conformities identified during this stage must be resolved.

7. Certification Decision

- If the audit is successful, the Certification body issues an ISO 9001 Certificate valid for three years.

8. Surveillance Audits

- Annual or semi annual audits are conducted to ensure

The QMS continues to comply with ISO 9001.

9. Recertification.

- After three years, a full audit is conducted to renew the Certification.

Costs of Registration.

ISO 9001 registration costs depend on:

- The size and complexity of the organization.
- The scope of Certification
- The certification body chosen
- The level of QMS maturity before registration

Benefits of registration:

- Demonstrates your commitment to quality.
- Improves Customer Confidence and Satisfaction.
- Enhances operational efficiency and Compliance
- Open doors to new markets and contracts requiring ISO 9001 Certification.

ISO 9000 Series of Standards

ISO 9000: Series of Standards.

ISO 9000:2005 - Quality Management Systems: Fundamentals and Vocabulary.

Scope

- Provides information about the Concepts and Vocabulary used in the other two Standards.
- The Standard serves as a reference to support the interpretation of the ISO 9001:2008 requirements.

ISO 9001:2008 - Quality Management System requirements.

Scope:

- Provides the requirements that Organisation must meet in order to achieve Certification.
- ISO 9001 is the standard in this family that may be used for registration or Certification.

ISO 9004:2009 - Quality Management Systems: Guidelines for performance improvement.

- Provides guidelines for those Companies wishing to go beyond ISO 9001:2008.

ISO 9001:2008 - Establishes a quality management that not only meets customer

requirements but also focuses on improving performance.

- ISO 9004 is not a requirement and does not lead to certification.

Sector: The ISO 9000 series of standards can apply across a wide range of sectors, as it provides a universal framework for quality management. However, specific sectors and industries often adapt ISO 9000 principles to their particular requirements. Here are a few examples.

1. Manufacturing: In this sector, ISO 9001 is commonly used to ensure consistent product quality, enhance efficiency, and reduce waste in production processes. Many suppliers and manufacturers require ISO 9001 certification to demonstrate quality compliance.

2. Healthcare: Hospitals, clinics, and healthcare providers adopt ISO standards to ensure patient safety, improve service quality, and comply with regulatory requirements. The ISO 9001 standard helps healthcare

Organizations optimize processes and maintain high standards.

3. Construction: Construction Companies use ISO 9001 to manage quality in building projects, meet regulatory standards, and improve client satisfaction. It helps them keep consistent practices across various projects and subcontractors.

4. Automotive: The automotive industry has a specific standard based on ISO 9001 called IATF 16949 which combines quality management with industry specific requirements to improve product quality, efficiency, and safety in car manufacturing.

5. Information Technology: Software development, IT service providers and tech companies use ISO 9001 to maintain quality in product development, testing and customer support. It helps these organizations ensure consistent service delivery.

6. Education: Educational institutions apply ISO 9001 to enhance administrative processes, improve student satisfaction, and establish systems for continuous improvement.

7. Food and Beverage: Food safety standard like ISO 22000 combine quality and safety requirements, integrating the ISO principles to ensure high quality safe food products for consumers.

8. Logistics and Transportation. Companies in this sector implement ISO standards to ensure reliable consistent delivery of goods and improve customer satisfaction with tracking, handling and timing.

Specific Standards

1. ISO 9000:2015 - Quality Management Systems. Fundamentals and Vocabulary.

2. ISO 9001:2015 - Quality Management Systems - Requirements.

3. ISO 9004:2018 - Quality Management - Quality of an organisation - Guidance to Achieve Sustained Success.

4. ISO 19011:2018 - Guidelines for Auditing Management Systems.

5. ISO 10001:2018 - Quality Management - Customer Satisfaction - Guidelines for Codes of Conduct for Organizations.

6. ISO 10002:2018 - Quality Management - Customer Satisfaction - Guidelines for Complaints Handling in Organizations.

7. ISO 10003:2007 - Quality Management - Customer Satisfaction - Guidelines for dispute resolution External to organizations.

8. ISO 10004:2018 Quality Management - Customer Satisfaction - Guidelines for ~~Quality Plans~~ Monitoring and measuring.

9. ISO 10005:2018 - Quality management - Guidelines for quality plans

10. ISO 10006:2017 - Quality Management - Guidelines for quality management in projects.

11. ISO 10007:2017 - Quality Management - Guidelines for Configuration management
12. ISO 10008:2013 - Quality management - Customer Satisfaction - Guidelines for Business - to - consumer Electronic Commerce Transactions.
13. ISO 10015:2019 - Quality Management - Guidelines for Competence management and people development.

AS 9100:

AS9100 is a quality management system standard specifically developed for the aerospace, aviation, and defense industries. It is based on the ISO 9001 standard but includes additional requirements to address the unique demands and safety requirements of these industries. The AS 9100 standard was established by the International Aerospace Quality Group (IAQG) and is widely recognized by aerospace manufacturers, suppliers, and regulators worldwide.

TS16949.

The global automotive industry demands world class levels of product quality, productivity and competitiveness as well as continual improvement. To achieve this goal, many vehicle manufacturers insist that suppliers adhere to strict technical specifications laid out in a quality management standard for suppliers to the automotive sector, known as TS16949.

The standard is applicable to any organization within the automotive supply chain that manufactures and/or adds value to parts for supply to the automotive industry.

TL9000:

TL9000 is a quality management system standard, specifically designed for the telecommunication industry. It builds on ISO 9001 requirements but includes additional telecom-specific criteria to address the unique needs and challenges of telecommunications.

Service providers and suppliers. The Standard was developed by the QuEST forum in 1998 to improve performance and quality across the telecom supply chain.

ENVIRONMENTAL MANAGEMENT SYSTEM.

Introduction:

- After the success of the ISO 9000 series of quality standards, the International Organization for Standards (ISO) has developed a comprehensive set of standards for Environmental ~~Management~~ management which is known as ISO 14000 Series in 1992.

- The ISO 14000 standards are a set of norms for environmental management system either at organisation and process level or product level.

- The series of ISO 14000 standards are designed to cover:
 - (i) Environmental management Systems.

- (ii) Environmental auditing
- (iii) Environmental performance evaluation.
- (iv) Life cycle assessment
- (v) Environmental aspects in product standards.

The overall objective of ISO 14000 Environmental management standard is to encourage environmental protection and pollution prevention while taking into account the economic needs of society.

The ISO 14000 series of standards enables a company to improve environmental management voluntarily.

ISO 14000 Series standards:

1. ISO 14001:1996 Environmental management Systems - specifications with guidance for use

- Give the elements that organisations are required to conform to get registration Certificate.

2. ISO 14004 : 1996 - Environmental management systems - Guidelines on principles, systems and supporting techniques.

— Provides supplementary material. It is only for information and not used for registration.

3. ISO 14010 : 1996 - Guidelines for Environmental Auditing - General principles on environmental auditing.

— Provides information for internal and external auditing.

4. ISO 14011 : 1996 - Guidelines for Environmental Auditing - Audit Procedures - Auditing of environmental management systems.

— Provides information on how to plan and conduct an audit.

5. ISO 14012 : 1996 - Guidelines for Environmental Auditing - Qualification Criteria for environmental auditors.

— Covers information on auditor qualification, training, and personal attributes and skills.

6. ISO 14031: 1999

- Guidelines on Environmental Performance Evaluation.
- Helps the organisation to meet the requirements of ISO 14001, monitoring and measuring.

7. ISO : 14020 : 2000

- Environmental labeling - Basic principles for All Environmental labeling.
- Provides guidance on the goals and principles that should be used in all labeling programs.

8. ISO 14021: 1999

- Environmental labeling - Self declaration of Environmental claims: Terms and conditions.
- Ensures that this type of labeling is accurate, Verifiable and not deceptive.

9. ISO 14022: 1999

- Environmental labeling symbols.
- Provides a standard set of symbols for use by organisations.

- ## 10. ISO 14023: 1999 - Environmental labeling - Testing and Verification methodologies.
- Provides information on

the appropriate methods to use to confirm the guidelines of the product.

11. ISO 14024:1999 - Environmental labeling - Practitioner programs: Guiding principles, Practices, and Certification procedures for multiple Criteria programs.

— Establishes criteria for third party labeling of seal programs.

12. ISO 14040:1997 - Life cycle Assessment - Principles and framework.

— Provides an overview of the practice, applications and limitations of the cycle assessment.

13. ISO 14041:1998 : Life cycle Assessment - Goals and definition/ Scope and Inventory Analysis.

— Provides guidelines for the Preparation, Conduct and Critical review of the life cycle inventory analysis.

14. ISO 14042:2000 : Life cycle Assessment - Impact Assessment

— Intended to use the results of the inventory analysis

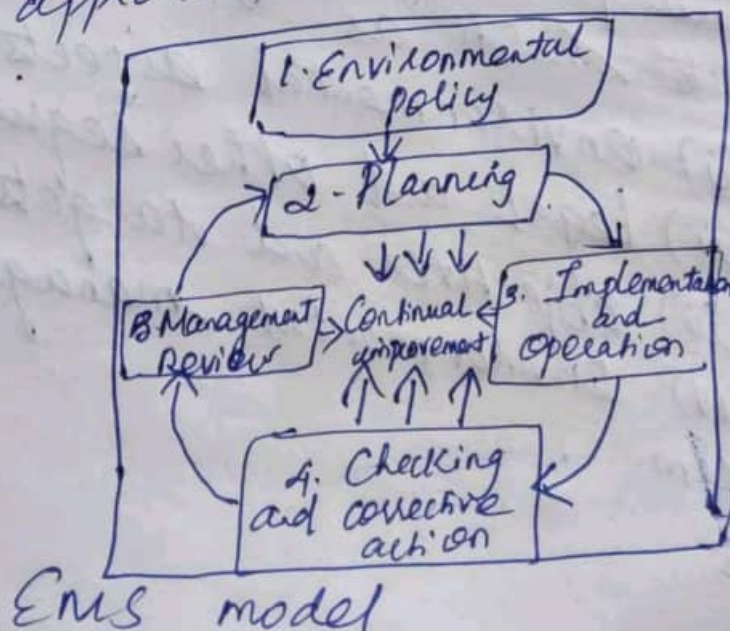
to evaluate the significance of potential environmental impacts.

15. ISO 14043:2000

- Life Cycle Assessment Improvement Assessment
Provides information to improve the total environmental performance of a product system.

Concepts of ISO 14001

As discussed earlier, ISO 14000 series of standards can be applicable to all types and sizes of the organisations and to accommodate diverse geographical, cultural and social conditions. The basic approach to Environmental management system (EMS) is depicted in the below figure. EMS approach is based on PDCA cycle.



The EMS model consists of the following five stages

1. Environmental policy
2. Planning
3. Implementation and operation
4. Checking and corrective action
5. Management review

Step 1-1 Environmental Policy

The environmental policy should address the following issues.

- Prevention of pollution.
- Creating a framework for setting objectives.
- Communication requirements with stakeholders.
- Education and training for environment.

Step 1-2 Planning

This planning stage contains four elements such as

- (i) environmental aspects
- (ii) legal and other requirements
- (iii) objectives and targets
- (iv) environmental management program.

- The environmental aspects of an organisation's activities, products and services should be identified in order to determine the environmental impact.

- The organisation should identify and have access to all legal and other requirements to which it subscribes.

- The organisation should establish and maintain the objectives and targets at each relevant function and level.

- The organisation should establish and maintain a program(s) for achieving the objectives and targets.

Stage 3: Implementation and Operation.

This stage contains seven elements such as.

- (i) Structure and responsibility
- (ii) Training awareness and Competency
- (iii) Communication.
- (iv) EMS documentation.
- (v) document Control
- (vi) Operational Control
- (vii) Emergency preparedness and response.

- Roles, responsibilities and Authorities should be defined, documented and communicated for all personnel affecting the EMS.
- Training needs should be evaluated on a regular basis to ensure their effectiveness.
- The EMS implementation requires proper communication with all stakeholders.
- The organisation should establish and maintain information in paper or electronic form to describe the core elements of the system.
- Procedures should be established and maintained to control all EMS documents.
- Procedures should be formed to identify and respond to potential accidents and emergency situations.

Stage 4: Checking and Corrective Action

This stage contains four elements such as

- (i) monitoring and measuring
- (ii) non-conformance and corrective and preventive action
- (iii) records
- (iv) EMS audit.

- The organization should monitor and measure the key characteristics of its objectives and activities in order to assess its performance in meeting environmental operations and targets.
- Procedures should be established to define responsibility and authority for (i) handling and investigating non conformance; (ii) initiating corrective and preventive action.

- The organization should establish procedures for the identification, maintenance, and disposition of environmental records, such as training, audits, equipment calibration and reviews.

- EMS audit should be carried out to ensure that the EMS conforms to plans.

Stage 5: Management Review

- Management should review and revise the system in order to ensure the continuing suitability, adequacy and effectiveness of the EMS.
- The management must evaluate the feedback data and make improvements to the system.

Thus EMS implementation is based on PDCA cycle.

Requirements of ISO 14001.

ISO 14001 Standard consists of four sections and an information annexure.

The four sections of ISO 14001 are

Section 1 : Scope

Section 2 : Normative reference

Section 3 : Definitions

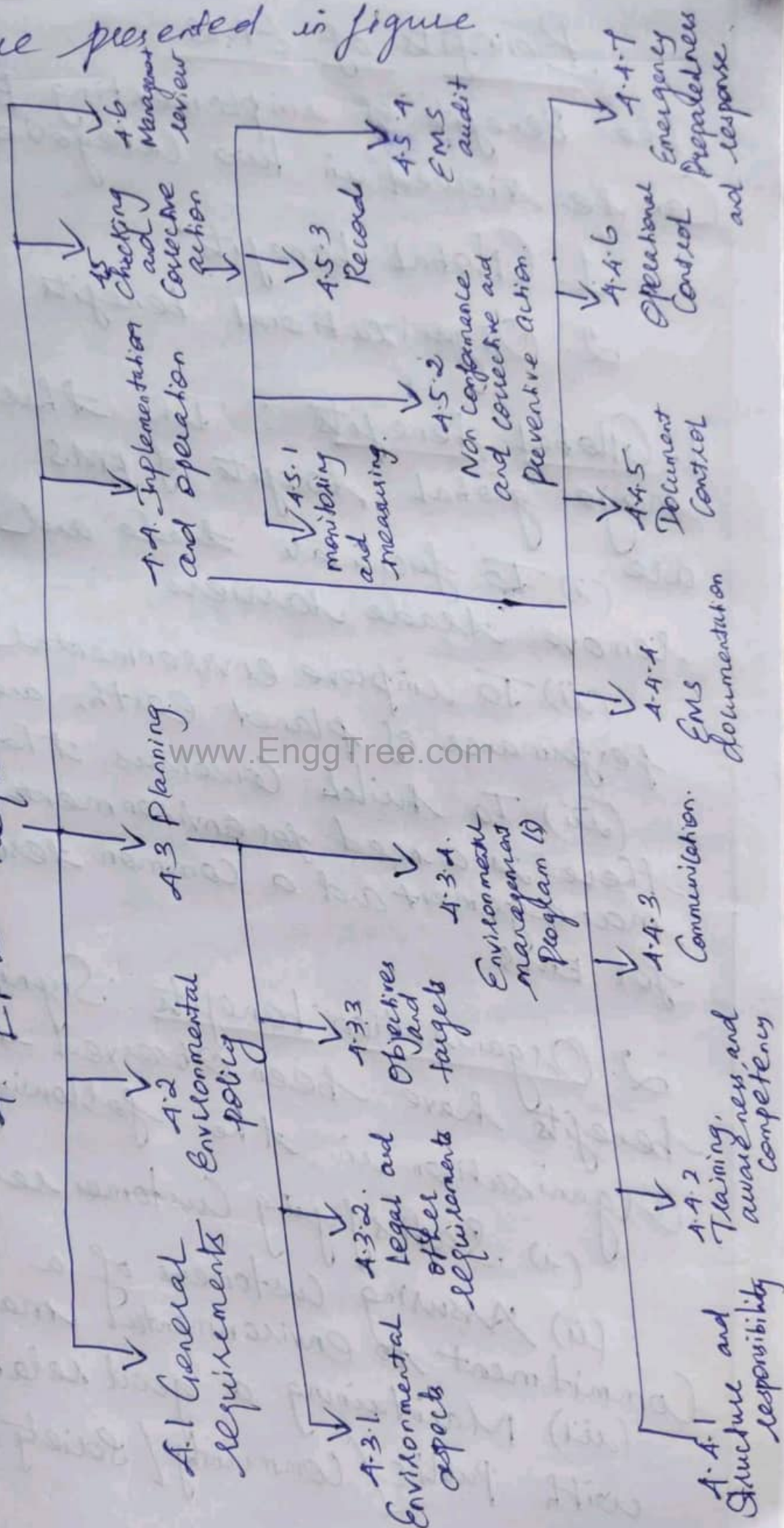
Section 4 : EMS requirements

The EMS requirements are given below.

The section 4 consists of 6 clauses and has a total of 18 requirements. The clauses and sub-clauses of EMS requirements:

are presented in figure

A. EMS Requirements.



Benefits of EMS.

The Benefits of implementing EMS can be viewed in two categories.

1. Global benefits
2. Organizational benefits

1. Global benefits : The three major global benefits of EMS are

- (i) To facilitate trade and remove trade barriers.
- (ii) To improve environmental performance of planet earth, and
- (iii) To build consensus that there is a need for environmental management and a common terminology for EMS.

2. Organisation benefits : Significant benefits have been observed in the organisation in the following ways.

- (i) Satisfying customer requirements
- (ii) Assuring customers of a commitment to environmental management.
- (iii) Maintaining a good relationship with Public/Community/Society.

- (iv) Improving access to capital by improving the confidence of the investors.
 - (v) Satisfying insurance criteria and obtaining insurance at reasonable cost.
 - (vi) Increasing market share that results from a competitive advantage.
 - (vii) Reducing incidents that result in liability.
 - (viii) Facilitating the attainment of permits and authorization.
 - (ix) Conserving input resources.
 - (x) Improving industry / government relations.
 - (xi) Improving teamwork.
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