Lecture Note on
Subject: INDUSTRIAL ENGINEERING & MANAGEMENT
Code TH – 1
Branch: Mechanical Engineering
Name of Faculty: - Er Litu Behera

Syllabus

1.PLANT ENGINEERING:

1.1 Selection of Site of Industry.
1.2 Define plant layout.
1.3 Describe the objective and principles of plant layout.
1.4 Explain Process Layout, Product Layout and Combination Layout.
1.5 Techniques to improve layout.
1.6 Principles of material handling equipment.
1.7 Plant maintenance.
1.7.1 Importance of plant maintenance.
1.7.2 Break down maintenance.
1.7.3 Preventive maintenance.
1.7.4 Scheduled maintenance.

2. OPERATIONS RESEARCH:

2.1 Introduction to Operations Research and its applications.
2.2 Define Linear Programming Problem,
2.3Solution of L.P.P. by graphical method.
2.4 Evaluation of Project completion time by Critical Path Method and PERT (Simple problems)
2.5Explain distinct features of PERT with respect to CPM.

3. INVENTORY CONTROL:

3.1 Classification of inventory.
3.2 Objective of inventory control.
3.3 Describe the functions of inventories.
3.4 Benefits of inventory control.
3.5 Costs associated with inventory.
3.6 Terminology in inventory control
3.7 Explain and Derive economic order quantity for Basic model. (Solve numerical)
3.8 Define and Explain ABC analysis.

4. INSPECTION AND QUALITY CONTROL:

4.1Define Inspection and Quality control.

4.2Describe planning of inspection.

4.3 Describe types of inspection.

4.4 Advantages and disadvantages of quality control.

4.5 Study of factors influencing the quality of manufacture.

4.6 Explain the Concept of statistical quality control, Control charts (X, R, P and C - charts).

4.7 Methods of attributes.

4.8 Concept of ISO 9001-2008.

4.9.1 Quality management system, Registration /certification procedure.

4.9.2 Benefits of ISO to the organization.

4.9.3 JIT, Six sigma,7S, Lean manufacturing

4.9.4 Solve related problems.

5. PRODUCTION PLANNING AND CONTROL

5.1 Introduction

5.2 Major functions of production planning and control

5.3 Methods of forecasting

5.3.1 Routing

5.3.2Scheduling

5.3.3 Dispatching

5.3.4 Controlling

5.4 Types of production

5.4.1 Mass production

5.4.2 Batch production

5.4.3 Job order production

5.5 Principles of product and process planning.

Chapter - 07
Inspection and Quality Control

7.1 Definition of Inspection & Quality Control :-

Inspection :- An item or product which is manufactured, is required to perform certain functions. The act of checking wether a component actually does so or not is called inspection.

→ In other words, Inspection means checking the acceptability of manufactured product.

→ Inspection measures the qualities of a product or service in terms of ~~product~~ predecided standards.

Objective of Inspection :-

(i) Inspection separates defective components from non-detective ones and thus ensures the adequate quality of products.

(ii) Inspection locates defects in raw materials and flaws in processes which otherwise cause problems at the final stage. For example, detecting the parts not having proper tolerances during processing itself, will minimize the troubles arising at the time of assembly.

(iii) Inspection prevents further working being done on semi-finished products already defected as spoiled.

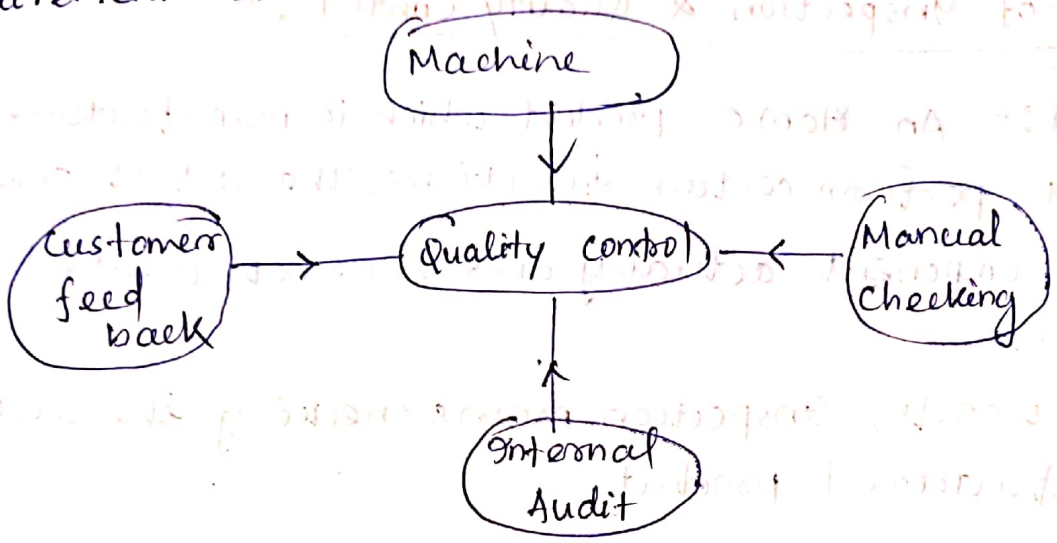
(iv) Inspection makes sure that the product works and it works without hurting anybody i.e its operation is safe.

(v) Inspection detects sources of weakness and trouble in the finished products and thus checks the work of designers.

(vi) Inspection buils up the reputation of the concern as it helps reducing the number of complaints from the customers.

Quality Control :-

- Quality control is a procedure or set of procedures intended to ensure that a manufactured product or performed service adheres to a defined set of quality criteria or meets the requirements of the clinet or customer.



Objective of Quality Control :-

(i) Improvement of quality of products
(ii) Reduction of scrap and rework
(iii) Efficient use of man and machines
(iv) Decreased inspection costs
(v) Scientific evaluation of quality and production.
(vi) Quality caution at all levels
(vii) To decide about the standards of quality of a product that is easily acceptable to the customer.
(viii) To check the variation during manufacturing
(ix) To prevent the poor quality product reaching to customer

Types of Inspection :-

(a) Roving or patrolling or floor inspection
(b) Fixed inspection
(c) Key point inspection
(d) Final inspection

(a) Roving or Patrolling or Floor Inspection :-

- The inspector walks round on the shop floor from machine to machine and checks samples of the work of various machine operators or workers.
- Floor inspection helps catching errors during process itself i.e before the final production is ready.
- → It is more effective and desirable because the work need not be transported to a centralized place.

(b) Fixed Inspection :-

- The work is brought at intervals for inspection to check.
- Fixed inspection discovers defects after the job has been completed
- Fixed inspection is used when inspection equipments and tools cannot be brought on the shop floor.
- It is a sort of centralized inspection, the worker and the inspector do not come in contact with each other; thus it eliminates any chances of passing a doubtful product.

(c) Key point Ispection :-

- Every product has a key point in its process of manufacture. A key point is a stage beyond which either the product requires an expensive operation or it may not be capable of rework
- Inspection at a key point segregates and thus avoids unnecessary further expenditure on poor and subsequent substandard parts which are likely to be rejected finally.

(d) Final Inspection :-

- The final inspection of the product may check its appearance and performance.
- Many destructive and nondestructive inspection and test methods such as tensile, fatigue, impact testing etc. and ultrasonic inspection, x-ray radiography, etc respectively are available for final inspection of the products manufactured.
- Final inspection is a centralized inspection and it makes use of special equipments.

Statistical Quality Control :- (SQC)

→ A quality control system performs inspection, testing and analysis to conclude whether the quality control when statistical techniques are employed to control quality or to solve quality control problems.

→ Statistical quality control makes inspection more reliable and at the same time less costly. It controls the quality level of the outgoing products.

Factors influencing the quality of manufacture :-

(i) Market :- Because of technology advancement, we could see many new products to satisfy customer wants.

- Market for the product must exist before quality of the product is emphasized by management. It is unless to talk about the quality when the market for the product is lacking e.g. there is no demand for woolen garment in the hot climate

(ii) Money :- Most important factor affecting the quality of a product is the money involved in the production itself.

- In the present day of tough and cut throat competition, companies are forced to invest a lot in maintaining the quality of products.

(iii) Materials :- To turn out a high quality product, the raw material involved in production process must be of high quality.
- Selection of proper materials to meet the desired tolerence
(iv) & limit is also an important consideration.

(iv) Management :- Quality control and maintenance programmes should have support from top management. If the management is quality consious rather than merely quality conscious, organisation can maintain adequate quality of products.

(v) Men / People :- People employed in production in designing the products must have knowledge and experience in their respective areas.

(vi) Machines and Methods :- To maintain high standards of quality companies are investing in new machines and following new ~~prod~~ procedures and methods these days.

Control Charts :-

- Control charts are based on statistical sampling theory, according to which an adequate sized sample drawn, at random, from a lot represents the lot.
- Control chart is a graphical presentation of the collected information. The information pertains to measured or otherwise judge quality characteristics of the items or the samples.
- A control chart detects variations in the processing and warns if there is any departure from the specified tolerance limits.

Advantages of Control Chart :-

- It indicates whether the process is in control or out of control.
- It determines the process variability & detects the unusual variations taking place in a project.
- It ensures the product quality level.

(iv) It provides information about the selection of process & setting of the tolerance limit

- It builds up the reputation of the organisation through customer satisfaction.

Types of Control charts :-

(i) $\bar{X}$ chart
(ii) R chart
} variables or measurement chart

(iii) P chart
(iv) C chart
} Attribute chart

(i) $\bar{X}$ Chart :-

- It shows changes in process average and is affected by changes in process variability.
- It is a chart for the measure of central tendency.
- It shows erratic or cyclic shifts in the process.
- It detects steady progress changes like tool wear.
- It is the most commonly used variables chart.

(ii) R Chart :-

- It controls general variability of the process and is affected by changes in process variability.
- It is a chart for measure of spread.
- It is generally used along with an $\bar{x}$ chart,

Plotting of $\bar{x}$ & R chart :-

A good number of samples of items coming out of the machine are collected at random at different ~~time~~ intervals of time and their quality characteristics are measured.

- For each sample, the mean value and range is found out. For example if a sample contain 5 items, whose diameters are d_1, d_2, d_3, d_4 & d_5 the sample average.

$$\bar{X} = \frac{d_1+d_2+d_3+d_4+d_5}{5}$$

And, range R = Maximum diameter − Minimum diameter

A number of samples are selected and their average values and range are tabulated.

Example:-

Sample No. (sample size-5)	$\bar{X}$	R
1	7.0	2
2	7.5	3
3	8.0	2
4	10.0	2
5	9.5	3
6	11.0	4
7	11.5	3
8	4.0	2
9	3.5	3
10	4.0	2
	$\Sigma\bar{X} = 76$	$\Sigma R = 26$

Average of $\bar{X}$, $\bar{\bar{X}} = \frac{\Sigma\bar{X}}{\text{No. of samples}}$

Average of R, $\bar{R} = \frac{\Sigma R}{\text{No. of samples}}$

Therefore, $\bar{\bar{X}} = \frac{76}{10} = 7.6$

$\bar{R} = \frac{26}{10} = 2.6$

For $\bar{X}$ chart; Upper control limit (UCL) $= \bar{\bar{X}} + A_2\bar{R}$

Lower control limit (LCL) $= \bar{\bar{X}} - A_2\bar{R}$

For R chart; Upper control limit, UCL $= D_4\bar{R}$

Lower control limit, LCL $= D_3\bar{R}$

The values of various factors (like A_2, D_4 & D_3) based on Normal distribution can be found from the following table

Sample size	A_2 Limit Average	D_3 Range lower limit	D_4 Range upper limit
2	1.88	0	3.27
3	1.02	0	2.57
4	0.73	0	2.28
5	0.58	0	2.11
6	0.48	0	2.00
8	0.37	0.14	1.86
10	0.31	0.22	1.78
12	0.27	0.28	1.72

→ Values of A_2, D_3 and D_4 for sample size 7, 9 & 11 can be determined by taking the mean value of sample sizes 6 & 8, 8 & 10 and 11 & 12 respectively.

→ Sample size in this problem is 5, therefore $A_2 = 0.58$,
$D_3 = 0$
$D_4 = 2.11$

Thus for $\bar{x}$ chart; Upper control limit, $UCL = \bar{\bar{x}} + A_2\bar{R}$

$= 7.6 + (0.58 \times 2.6)$

$= 7.6 + 1.51$

$= 9.11$

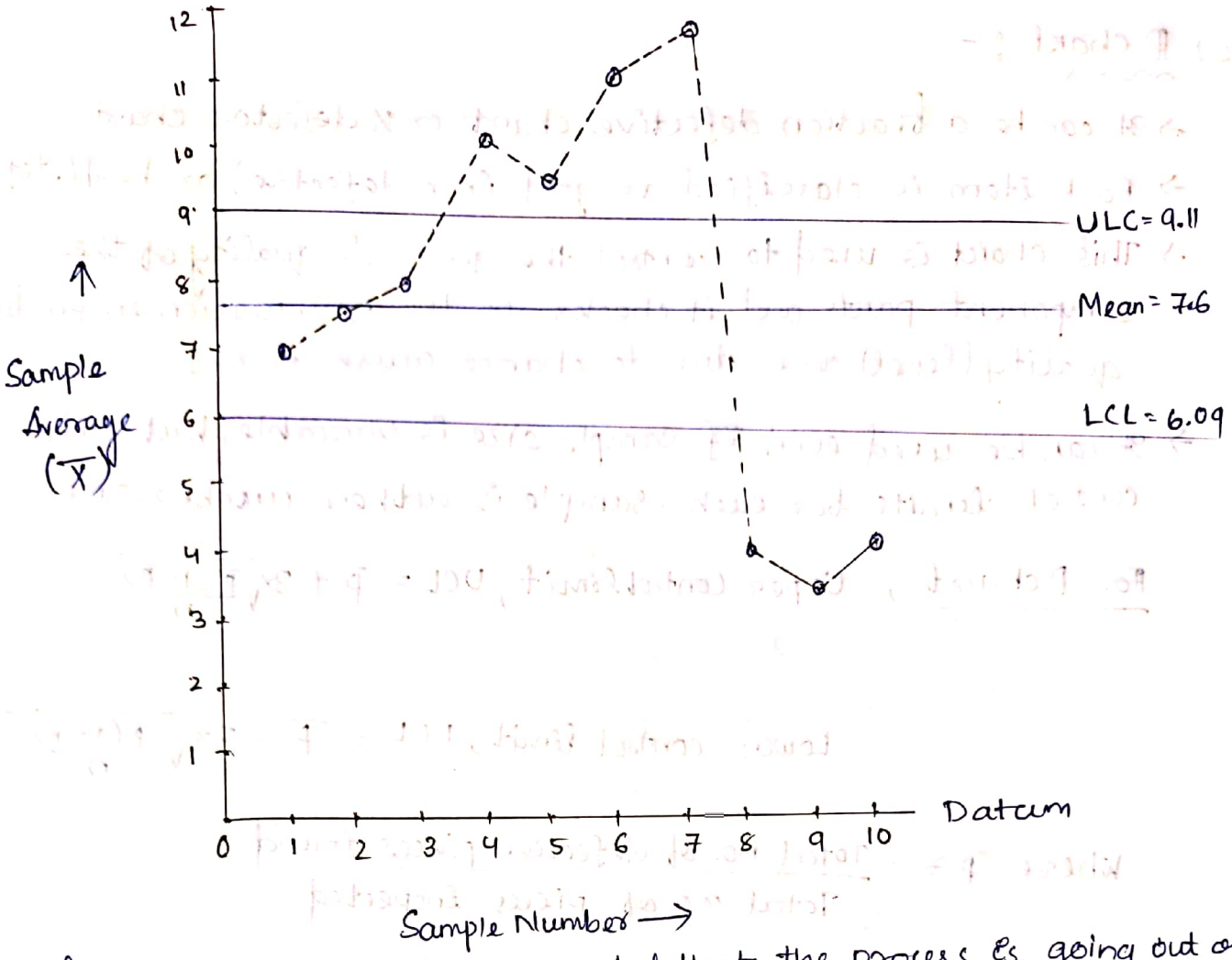
Lower control limit, $LCL = \bar{\bar{x}} - A_2\bar{R}$

$= 7.6 - 0.58 \times 2.6$

$= 6.09$

For R chart; $UCL = 2.11 \times 2.6 = 5.48$

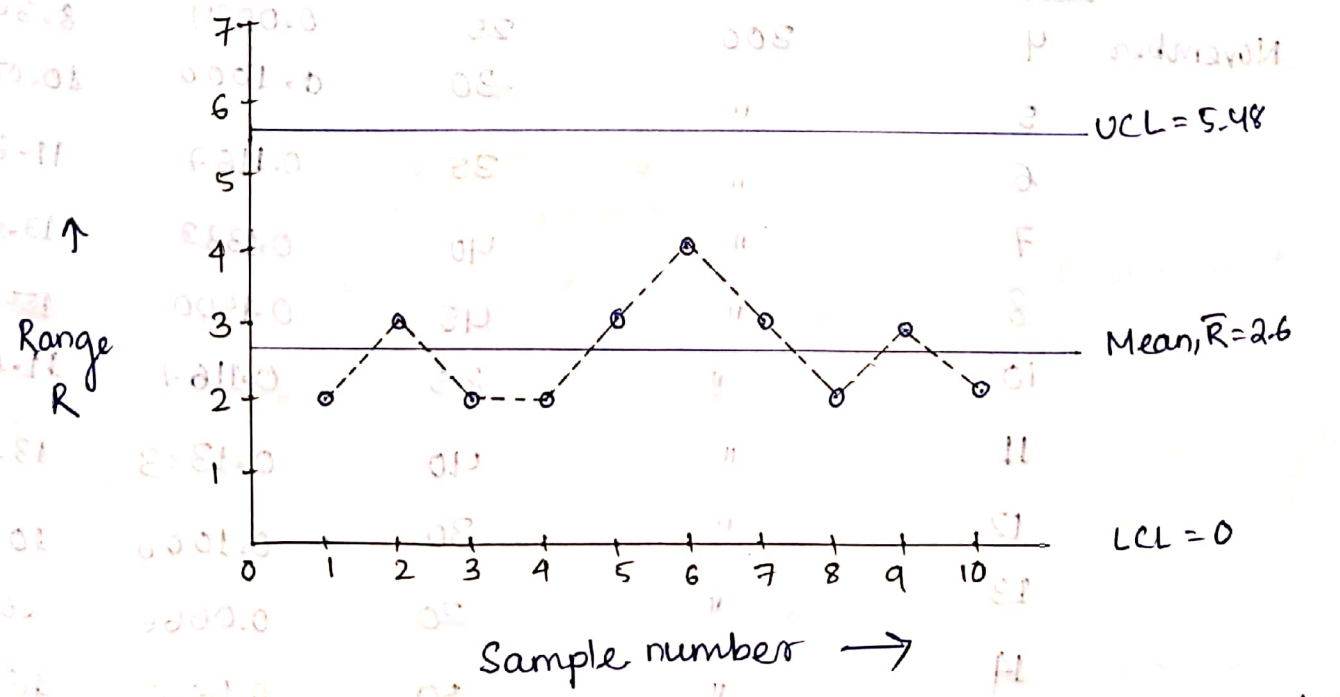
$LCL = D_3 \times \bar{R} = 0 \times \bar{R} = 0$



So from the $\bar{x}$ chart, it is concluded that the process is going out of control from the 4th sample onwards.

For R chart :- $UCL = D_4\bar{R} = 2.4 \times 2.6 = 5.48$ $\quad \bar{R} = \text{Mean} = 2.6$

$LCL = D_3\bar{R} = 0 \times 2.6 = 0$



→ From the R-chart it is concluded that all the range values are under control

(c) P chart :-

→ It can be a fraction defective chart or % defective chart

→ Each item is classified as good (non defective) or bad (defective)

→ This chart is used to control the general quality of the component parts and it checks if the fluctuation in product quality (level) are due to chance cause alone.

→ It can be used even if sample size is variable, but calculating control limits for each sample is rather cumbersome.

For P chart, Upper Control limit, $UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

Lower control limit, $LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

Where $\bar{p} = \frac{\text{Total no. of defective pieces found}}{\text{Total no. of pieces inspected}}$

Example

Date	Number of pieces inspected (a)	Number of defective pieces found (b)	Fraction defective p = (b)/(a)	% defective 100p
November 4	300	25	0.0834	8.34
5	"	30	0.1000	10.00
6	"	35	0.1167	11.67
7	"	40	0.1333	13.33
8	"	45	0.1500	15.00
10	"	35	0.1167	11.67
11	"	40	0.1333	13.33
12	"	30	0.1000	10.00
13	"	20	0.0666	06.66
14	"	50	0.1666	16.66
Total number of days = 10	Total = 3000	Total = 350		

For P-chart upper control limit, $UCL = \bar{p} + 3 \times \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

Lower control limit, $LCL = \bar{p} - 3 \times \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$\because \bar{p} = \frac{\text{Total no. of defective pieces found}}{\text{Total no. of pieces inspected}} = \frac{350}{3000} = 0.1167$

And n = number of pieces inspected every day = 300

Therefore, $UCL = \bar{p} + 3 \times \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$= 0.1167 + 3 \times \sqrt{\frac{0.1167(1-0.1167)}{300}}$

$= 0.1167 + 3 \times 0.01852$

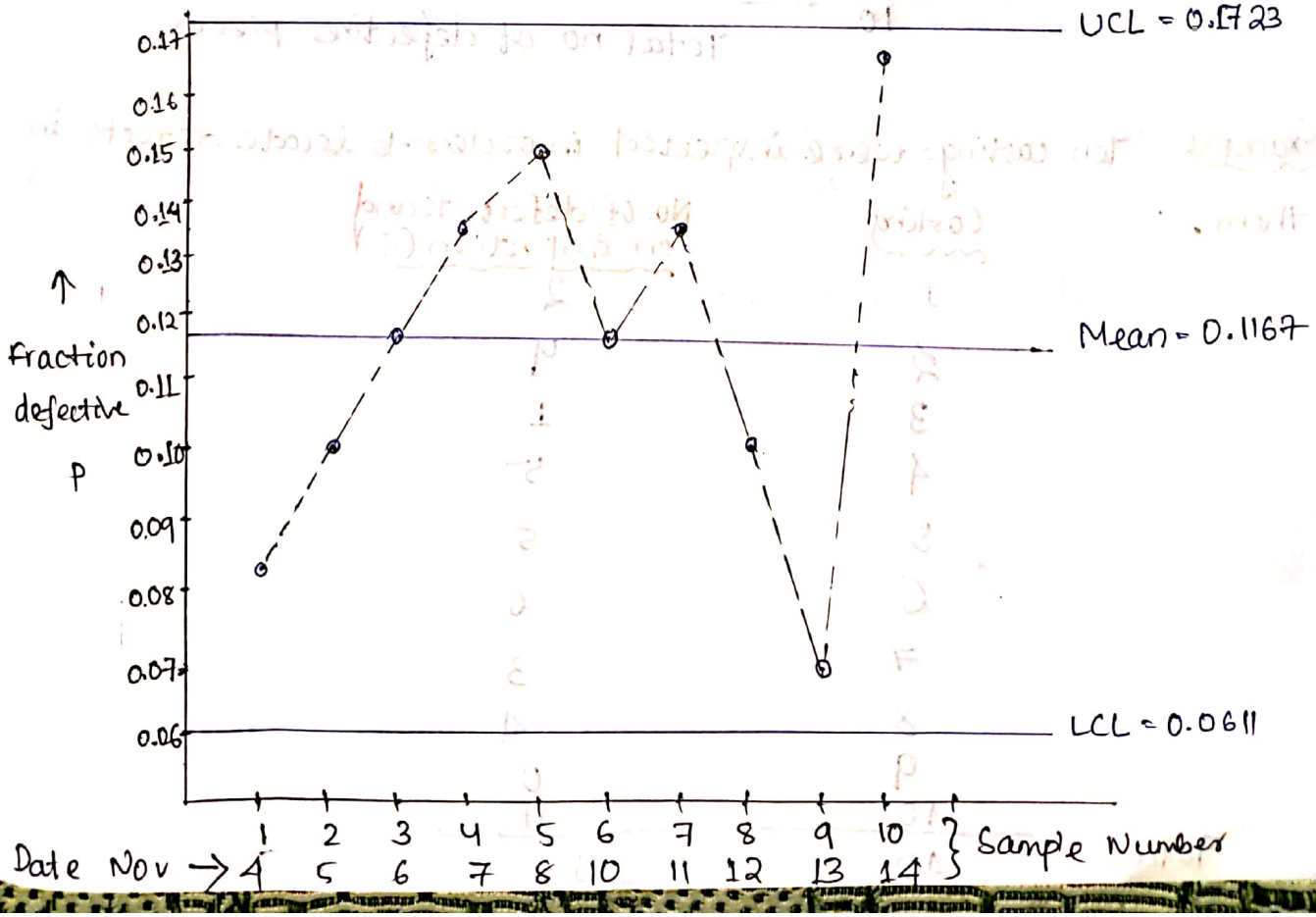
$= 0.17226 \approx 0.1723$ (Approximate)

$LCL = \bar{p} - 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$= 0.1167 - 3 \sqrt{\frac{0.1167(1-0.1167)}{300}}$

$= 0.1167 - 3 \times 0.01852$

$= 0.06114 \approx 0.0611$ (Approx)



It can be visualised that all the points lie within the control limit and hence the process.

(d) C - Chart

1. It is the control chart in which number of defects in a piece or sample are plotted.
2. It controls number of defects observed per unit or per sample.
3. Sample size is constant
4. The chart is used where average number of defects are much less than the number of defects which would occur otherwise if everything possible goes wrong.
5. The C chart is preferred for large and complex parts

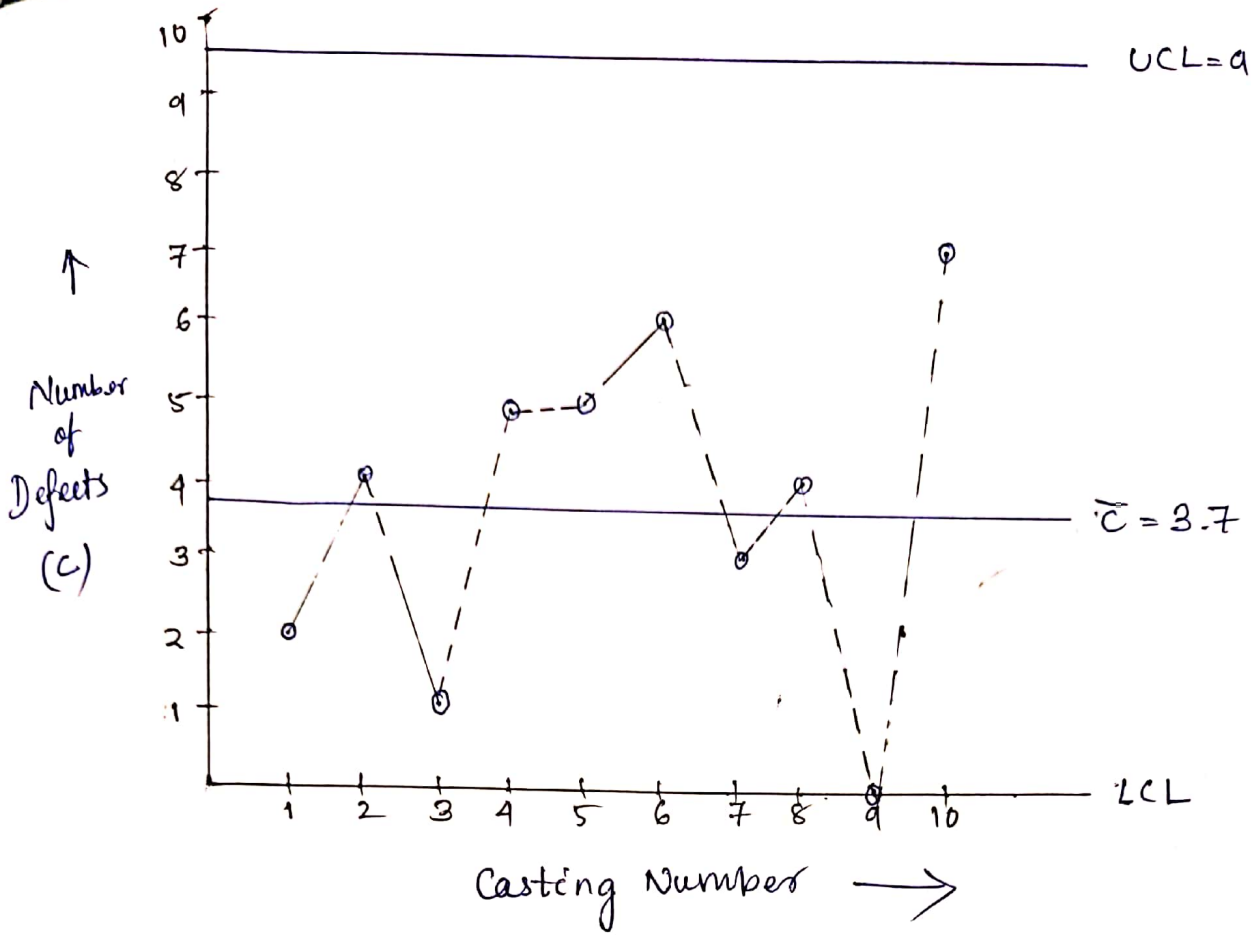
* Upper control limit, $UCL = \bar{c} + 3\sqrt{\bar{c}}$

Lower control limit, $LCL = \bar{c} - 3\sqrt{\bar{c}}$

Where $\bar{c} = \frac{27}{10}$ Total No. of defects found on inspection / Total no. of defective pieces

Example Ten castings were inspected in order to locate defects in them.

Casting	No. of defects found on inspection (C)
1	2
2	4
3	1
4	5
5	5
6	6
7	3
8	4
9	0
10	7
Total 10	37



Therefore, $\bar{c} = \frac{\text{Total no. of defects found on inspection}}{\text{Total no. of defective pieces}}$

$= \frac{37}{10} = 3.7$ (Mean)

Upper control limit, $UCL = \bar{c} + 3\sqrt{\bar{c}} = 3.7 + 3\sqrt{3.7} = 9.472$

Lower control limit, $LCL = \bar{c} - 3\sqrt{\bar{c}} = 3.7 - 3\sqrt{3.7} = -2.072 \approx 0$

⇒ It is concluded that since all the values of 'c' lie with in the control limit and hence the process.

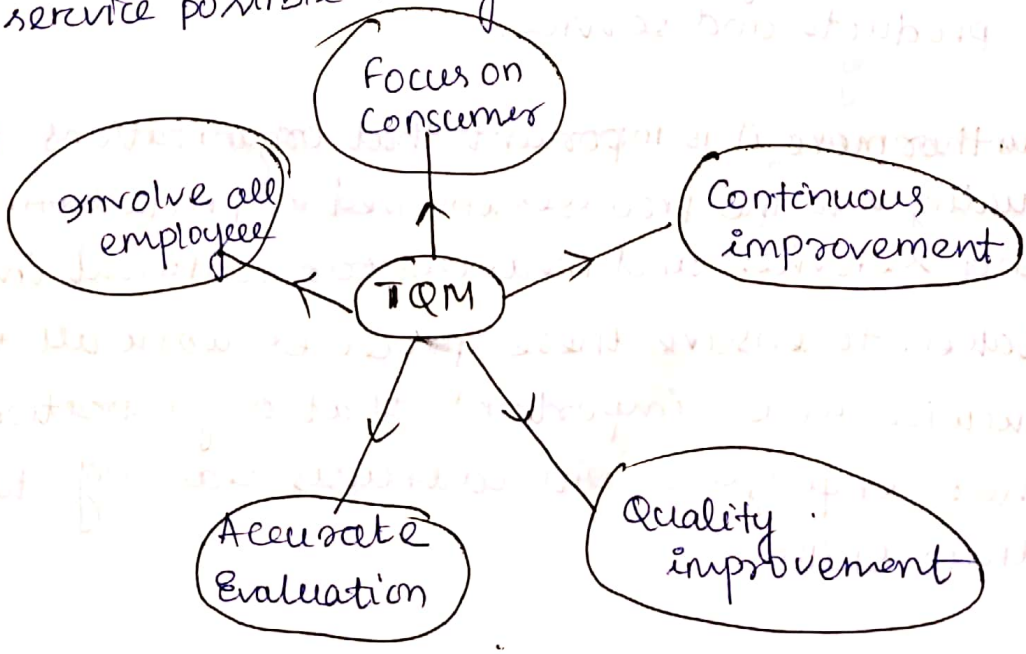
[∵ Lower control limit is negative & thus has been taken as zero]

Chapter-08 Contemporary Quality Management Concept

8.1 Total Quality Management (TQM)

Meaning and Definition :- Total Quality management provides the concept that ensures continuous improvement in an organisation.

- The philosophy of TQM stresses on a systematic, integrated and consistent approach involving everyone and everything in an organisation.
- It aims at using all people in multifunctional teams to bring about improvements from within the organisation. Everyone associated with the organisation is fully involved in continuous improvement.
- Total Quality management is an approach to improving the effectiveness and flexibility of business as a whole. It is essentially a way of organising and involving the whole organisation, every department every activity, every single person at every level.
- TQM is a strategic approach to produce the best product and service possible through constant innovation.



Principles of TQM :-

- With increased competion and market globalization, TQM principles and practices are now becoming more and more important for the leadership and management of any organization.
- Therefore for organizations that seek to continually improve their performance over a long term, focus on customers and address the needs of all other stakeholders, these total quality management principles will serve as a guide in the right direction.

Principle -1 : Customer Focus

- This principle stresses that an organization should understand its customers; what they need and when they need it while trying to meet and exceed their expectations.
- A such, revenue is increased, and waste reduced when a business seeks opportunities to satisfy its customers.

Principle-2 Leadership

- Good leaders help to unite an organization and give people a sense of direction. They create and nurture an environment where everyone's views are given careful consideration.
- Therefore without clear leadership, an organization loses its direction.
- This principle establishes that leaders are ~~clear~~ fundamental in setting clear goals and objectives and ensuring that employees are actively involved in achieving there objectives.

Principle-3 People involvement :-

- People are the essence of any organization's existance.
- Research has shown that when people understand the importance of their contribution and role in an organization, they become innovative, eager to participate and creative in organization's objective.
- It helps to bridge the gap of communication between mangement & employees.

Principle-4 Process Approach

- This principle states that an organization achieves its desired result when related resources and activities are managed as a process.
- Therefore this approach stresses efficiency, effectiveness, consistency & understanding.

Principle-5 System Approach to management

This principle stresses that several processes are managed simultaneously in an ~~organization~~ organized system. This makes the system much more effective and greater than the sum of its individual parts.

Principle-6 Continuous improvement

This principle states that continual change should be an active business objective. By doing so, Organizational flexibility increased ability to embrace new opportunity & improved performance are achieved.

Concept of Total Quality Management

(i) Continuous improvement of Quality :-

- Foremost among TQM concepts is the idea of continuous improvement of quality.
- The underlying aim of TQM is to improve the quality of products and services in any organization. By so doing, productivity, employability and customer service are improved.

(ii) Focus on the customer :-

- The customers are the internal and external recipients of an organization's products.
- Therefore the needs of customers and their desires define quality for the organization.

(iii) Operations improvement

- Every work done in an organization follows a chain or process. These processes account for 80-85% of the quality of work and productivity of employees.
- This concept establishes that work progress and processes should be studied through individuals or teams, to identify complexities or lapses.

(iv) Human Resources :-

- These concepts of TQM are committed to employee learning & development. So these require that management trust that well-trained staff can do the jobs assigned to them properly.
- In addition, human resource development includes providing the training required in a quality improvement work environment as well as extensive education to help employees keep up-to-date on their jobs.

ISO 9000

- ISO 9000 is a family of standards and guidelines related to the Quality Management system (QMS). It sets the requirements for the assurance of quality and for the mangement's involvement.
- When an organization demonstrates conformity to ISO 9000 to an independent resistar fiom, the register can to certify the organization. Registration provides assurance to customers worldwide that products or services from the organization can be expected to consistenty meet customer requirements.

- The ISO 9000 QMS is based on eight principles from Total Quality management system.

(i) Customer focus :- Understanding the customer's needs, meet the customer's requirements & strive to exceed the customer expectation.

(ii) Leadership :- Establish unity of purpose and organizational direction and provide an environment that promotes employee involvement and achievement of objectives.

(iii) Involvement of People :- Take advantage of fully involved employees using all their abilities for the benifit of the organization.

(iv) Process Approach :- Recognize that things accomplished are the results of process and that processes along with related activities and resources must be managed.

(v) System Approach to Management :-

The multiple interrelated processes that contribute to the organization's effectiveness are system and should be managed as a system.

(vi) Continual Improvement :- Continual improvement should be a permanent objective applied to the organization and to its people, process, system and products.

(vii) ~~Factual~~ Factual Approach to Decession making :-

Decisions a must be based on the analysis of accurate relevant and reliable data & information.

(viii) Mutually Beneficial Supplier Relationship :-

Both the organization and suppliers benefiting from one another's resources and knowledge results in value of for all.

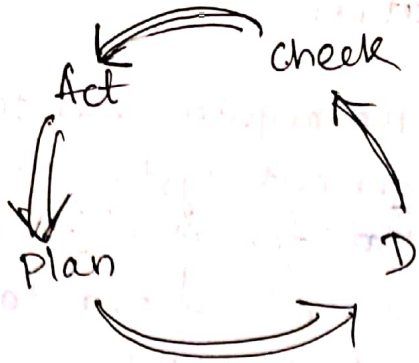
Iso 9000's Operating principle

(i) Plan :- Establish objective & develop the plans to achieve them

(ii) Do :- Put the plans in to action.

(iii) Check :- Measure the results of the action ; that is planned action working or were the objectives met

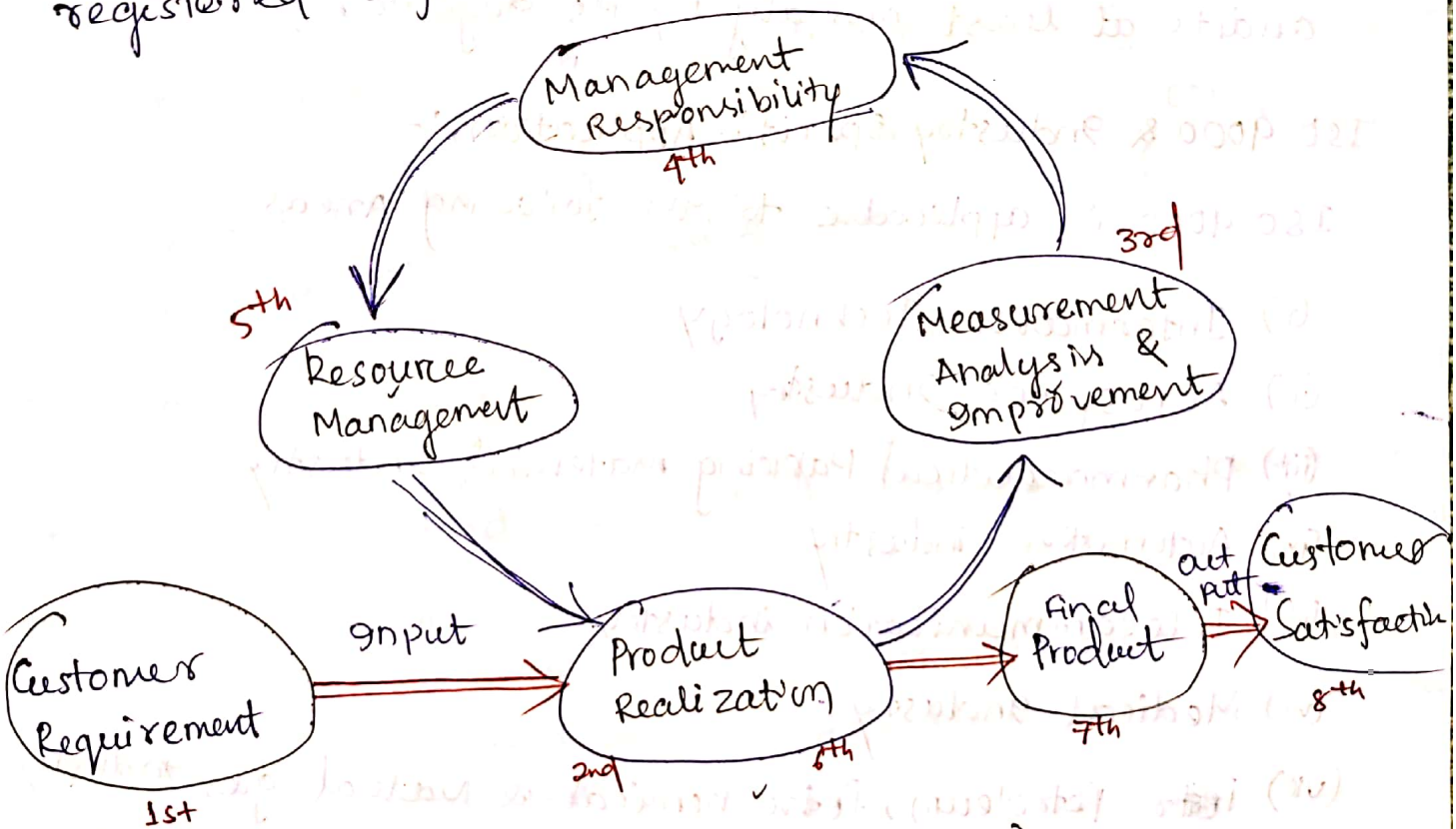
(iv) Act :- Learn from the results of the third (check step), make any necessary changes to the plans and ~~reapet~~ repeat the cycle.



(ISO 9000 operation prineiple)

2MD

- **Aim of ISO 9000** :- The original aim of ISO 9000 is to ensure that the product or services provided by registered organizations were consistenly fit for their intended purposes.
- The ISO 9000 raised the standard's aim to a new level i.e customer focus & continual improvement along with the other six quality management prineiples that have been incorporated into the standard, are intended to make registered organizations more competitive.



(Fig :- ISO 9000 process Approach)

ISO 9000 Applied to Organization

The ISO 9001 lay down the requirements for what an organization's Quality management system must do, The organization determines that for itself and if seeking registration, employs an accredited registar firm to verify its conformance to ISO 9001

- Once the organization registered, must apply to QMS (Quality management system) to its operations according to the standard and exactly as the QMS states.
- And is also continually assess the effectiveness of the QMS & make changes to improve it and conduct periodic internal QMS audit.
- Then it submit to external (3rd party) surveillance audits at least annualy by its registar.

ISO 9000 & Industry Specific Applications :-

ISO 9000 is applicable to the following Areas

(i) Information Technology
(ii) Aerospace industry
(iii) Pharmaceutical Packing Material industry
(iv) Automotive industry
(v) Telecommunication industry
(vi) Medical industry
(vii) Petroleum, Petrochemical & Natual gas industry

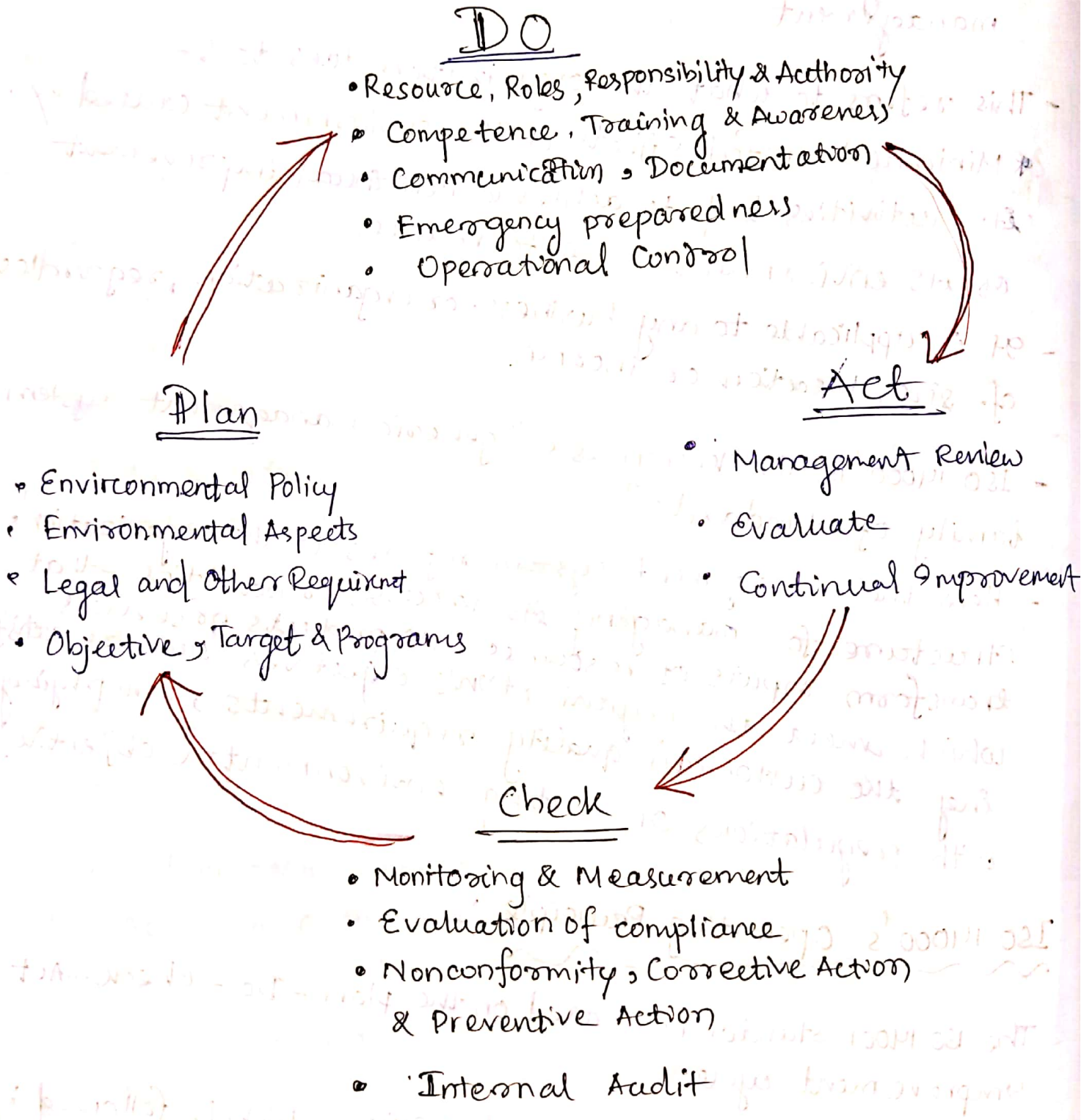
ISO 14000 :-

- The designation "ISO 14000" is a general term referring to a family of standards concerned with environmental management
- This refers to what the organization does to :-
  * Minimize harmful effects on the environment caused by its activities and to achieve continual improvement of its environmental performance.
- It is applicable to any business or organization, regardless of size, location or income.
- ISO 14000 is also known as a "generic management system family of standards".
- Here the management system refers to the organizations structure for managing its processes or activities - that transform inputs of resources into products or services which meet the organization's objectives such as satisfying the customer's quality requirements, complying with regulations or meeting environmental objective.

ISO 14000's Operating Principle :-

- The ISO 14001 standard is based on the plan - Do - Check - Act - improvement cycle.
- It begins with the enviormental policy, which is followed by planning, implementation and operation. checking & corrective action & management review.
- Plan :- What you will do?
  Do :- According to the plan.
  Check :- to see if you did what you planned.

Act – change or improve the part of your plan or Do that did not give you the results you intended.



Evolution of ISO 14000

- ISO 14000 is a set of rules and standards created to help companies reduce industrial waste & environmental damage.
- the ISO 14000 ~~certified~~, series of standards was introduced in 1996 by the International Organization for Standardization (ISO) and most recently revised on in 2015.

- Overview of the ISO 14000 family of standards

ISO 14001 :- It is the world's most recognized framework for environmental management system (EMS) that helps organizations both to manage better the impact of their activities on the environment & to demonstrate sound environmental management.

* ISO 14001 : 2015 : Environmental Management systems Requirements with guidance for use.

- ISO 14004 : which complements ISO 14001 by providing additional guidance and useful explanations.

* ISO 14004 : 2016 :- ~~Envi~~ General guidelines on principles, systems and support technique.

* ISO 14005 : 2019 :- Guidelines for a flexible approach to a phased implementation.

- ISO 14007 : Determining environmental costs and Benefitits.
- ISO 14008 : Monetary valuation of environmental impacts from specific emissions and use of natural resources.
- ISO 14006 : 2011 :- Environmental management system guidelines for incorporating ecodesign.
- ISO 14009 : EMS guidelines for applying the ISO 14001 framework to environmental aspects and environmental condition by environmental topic areas.

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- ISO 14004 : which complements ISO 14001 by providing additional guidance and useful explanations.

* ISO 14004 : 2016 :- ~~Envi~~-General guidelines on principles, systems and support technique.

+ ISO 14005 : 2019 :- Guidelines for a flexible approach to a phased implementation.

- ISO 14007 : Determining environmental costs and Benefitits.
- ISO 14008 : Monetary valuation of environmental impacts from specific emissions and use of natural resources.
- ISO 14006 : 2011 :- Environmental management system guidelines for incorporating ecodesign.
- ISO 14009 : EMS guidelines for applying the ISO 14001 framework to environmental aspects and environmental condition by environmental topic areas.

ISO 14010 to ISO 14015 :- Environmental Auditing & Related Activities

ISO 14020 to ISO 14024 – Environmental labeling

ISO 14031 & ISO 14032 – Environmental performance Evaluation

ISO 14040 – ISO 14043 :- Life cycle Assessment

ISO 14050 – Terms & Conditions

ISO 14064 – Green house gas accounting & verification

Implication of ISO 14000

- The ISO 14001 standard provides specific requirements for an Environment Management system (EMS) and focuses on Environmental Protection.

= An effective ESM provides many benifits to the implementing organization, its customers and stakeholders and to regulators including :

- i- reduced environmental risk
  ii- Proactive environmental management
  (iii) improved employee environmental awareness and performance.
  (iv) increased operating efficiency and cost effectiveness

JIT (Just In Time)

The main focus of JIT is to identify and correct the obstacles in the production process. It shows the hidden problems of inventory.

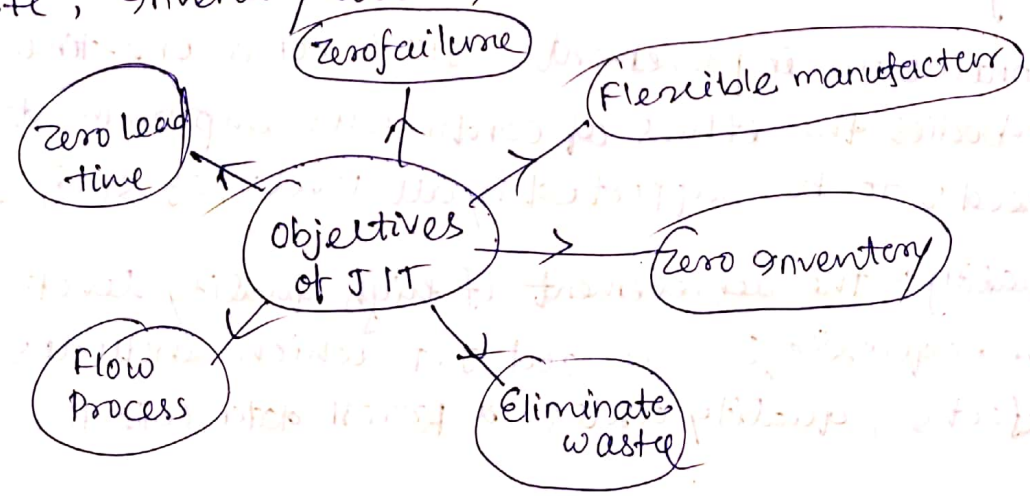
- JIT method prevents a company from using excessive inventory and smooth on production operations.
- JIT is a philosophy of manufacturing based on planned elimination of waste & continuous improvement of productivity.

History :- It is evolved in Japan after world war II as a result of their diminishing market share in the auto industry.

* Toyota motor company first to implement fully functional & successful JIT system in 1970's

Function of JIT :- Zero inventory
Zero lead time
Zero failure

* **Eliminating waste :-** There are 7 types of waste. waste from overproduction, waste of waiting time, transportation waste, inventory waste, waste from product defects.



JIT

Def^n of JIT:- The Just-in-time (JIT) inventory system is a management strategy that minimizes inventory & increases efficiency.

or In other words, JIT is an inventory management method where by materials, goods and labours are scheduled to arrive or be replenished exactly when needed in production process.

- JIT can be summarized as a system of eliminating waste and achieve excellence in an entire organization. The sole purpose of JIT is to eliminate waste.

Elements of JIT:-

(i) Automation & Autonomation:- means "to build in a mechanism to prevent mass production of defective work in machines or product lines." The autonomous machine ensures that 100% good units flow to the subsequent process in an uninterrupted manner.

(ii) Bufferstock Removal:- constant elimination of buffer stocks is emphasized to highlight production problems previously shielded by high inventory levels.

(iii) Computer integrated manufacturing:- The use of computers to automate manufacturing operations such as changing the type & ~~quadit~~ quantity of products through minimal changes

(iv) Continuous improvement:- JIT is not a one-time effort, it embodies the ethics of continuous improvement which needs to be supported by all levels of staff.

(v) Quality:- The achievement of high quality levels is a prerequisite of successful JIT which includes zero defects, quality circles & process data collection.

- Smooth Production :- Production smoothing enables the system to adapt smoothly to the variation in customer demand by gradually changing the frequency.

Benefits of JIT

- Improved competitive position,
  - " Worker efficiency
  - " equipment efficiency
- Increased flexibility
  - " teamwork
  - " profit margin
  - " quality & Productivity
- Less Scrap
- Lower overhead
- Reduce inventory & labour requirements.
  - " Production lead time.
- Closer Relationship with suppliers.

Disadvantages

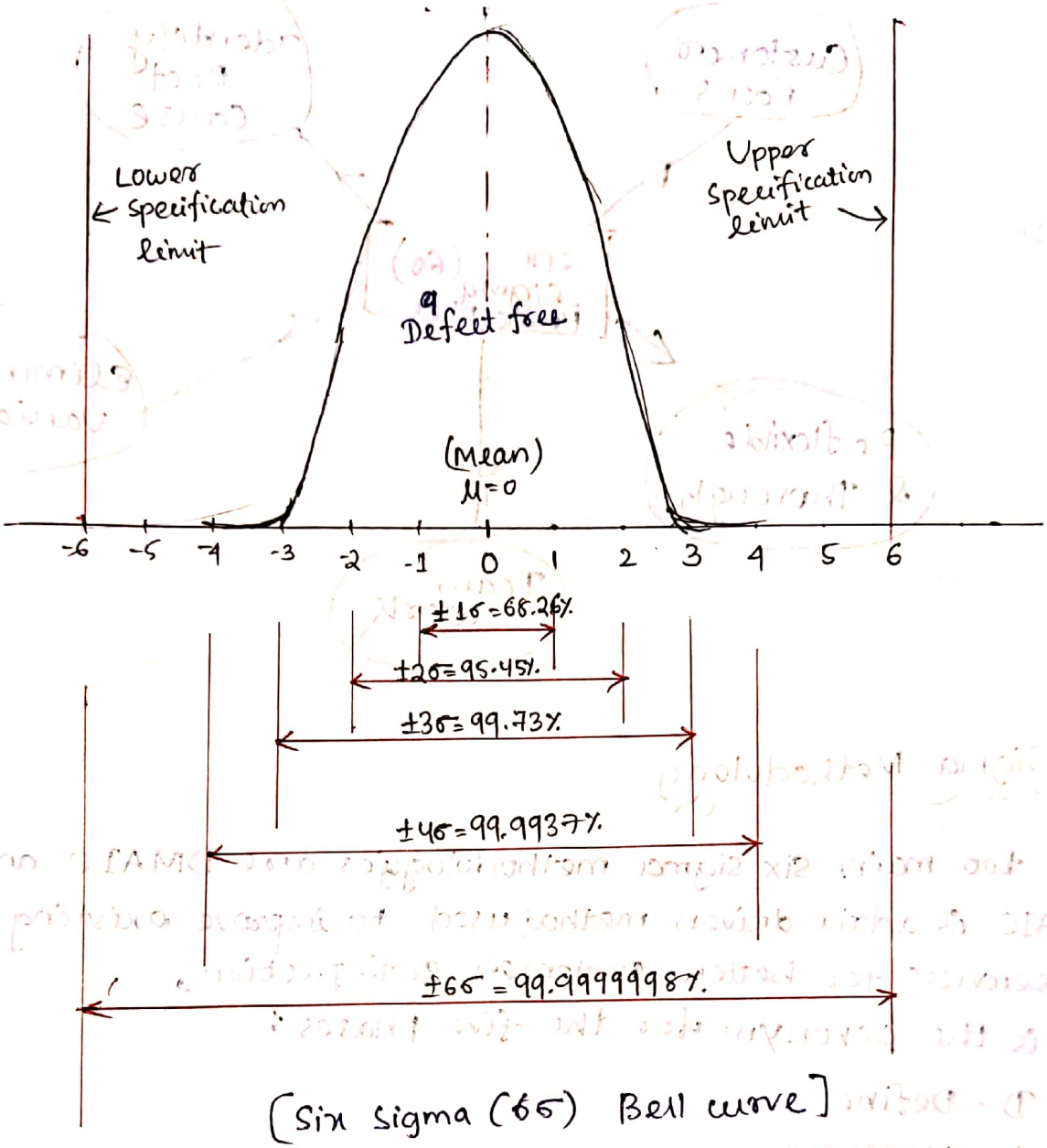
- Production may be stopped if suppliers are delayed
- Sales may be lost if not meeting customer demands
- Increased ordering & admin cost
- Depending on the efficiency of supplier.
- Less time for quality control on arrival of materials.

Six Sigma :- (6σ)

- Six sigma is a ~~deep~~ disciplined, statistical-based, data driven approach and continuous improvement methodology for eliminating defects in a product, process or service.
- It was developed by Motorola for the first time during 1980s.

- Sigma(σ) represents the population standard deviation which is a measure of the variation in a data set collected about the process.
  of a defect is defined by specification limits, separating good from bad outcomes of a process - mean (average) i.e six standard deviations from the nearest specification limit.

- Six sigma comes from the bell curve used in statistics where one sigma symbolizes a single standard deviation from the mean.
  of the process has six sigmas, three above and three below the mean, the defect rate is classified as "extremely low"



[Six sigma (6σ) Bell curve]

Principles of Six Sigma

Six sigma success is based on five key ~~point~~ principles.

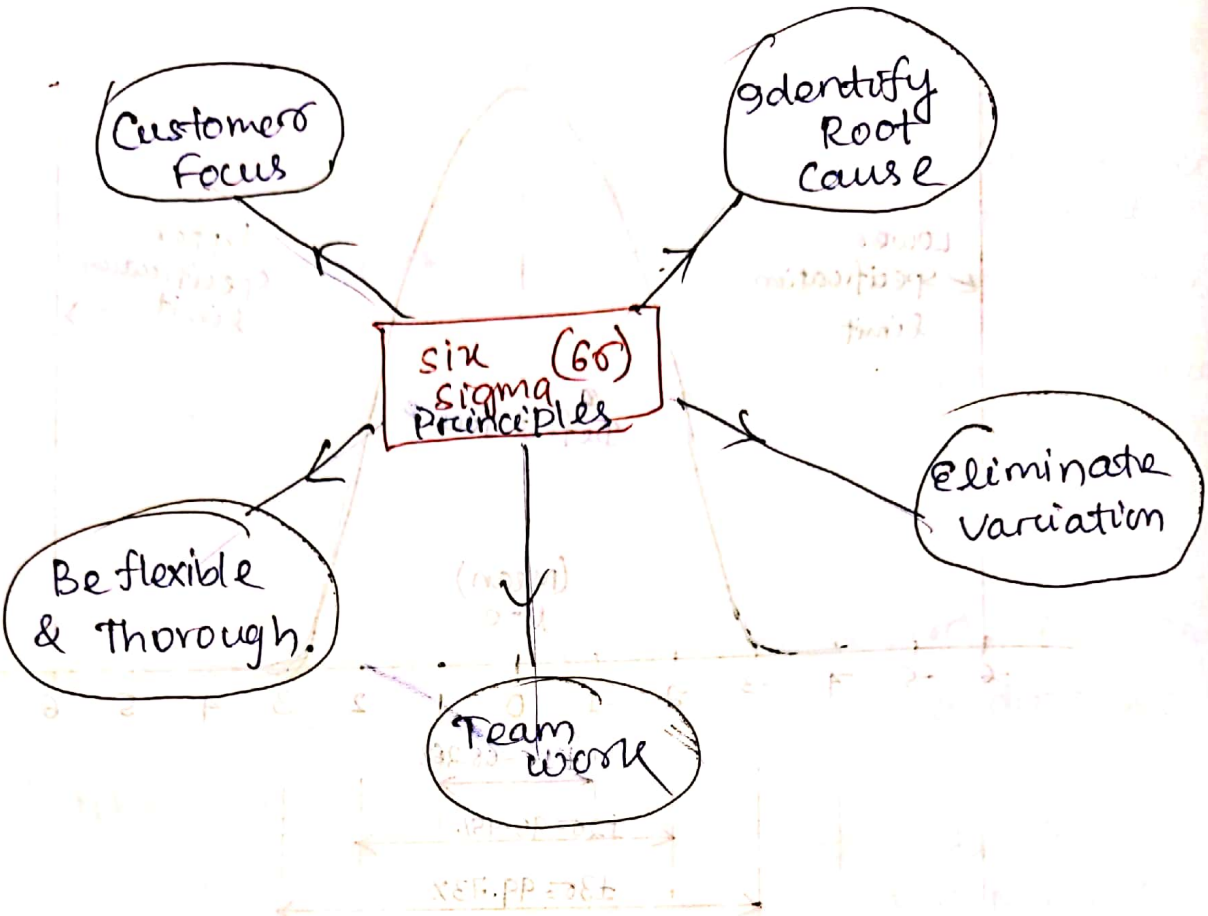
i- Focusing on customer requirements

ii- Using extensive measurement and statistical analysis to understand how work gets done and to identify the root cause of problems (variations)

(iii) Being proactive in eleminating variation & continually improving the process.

(iv) Involving people in six sigma cross-functional teams.

(v) Being Flexible & thorough.



Six Sigma Methodology

- The two main six sigma methodologies are DMAIC and DMADV.
- DMAIC is a data driven method used to improve existing products or services for better customer satisfaction.

It is the acronym for the five phases:

D - Define
M - Measure
A - Analyse
I - Improve
C - Control

- DMAIC is applied in the manufacturing of a product or delivery of a service.

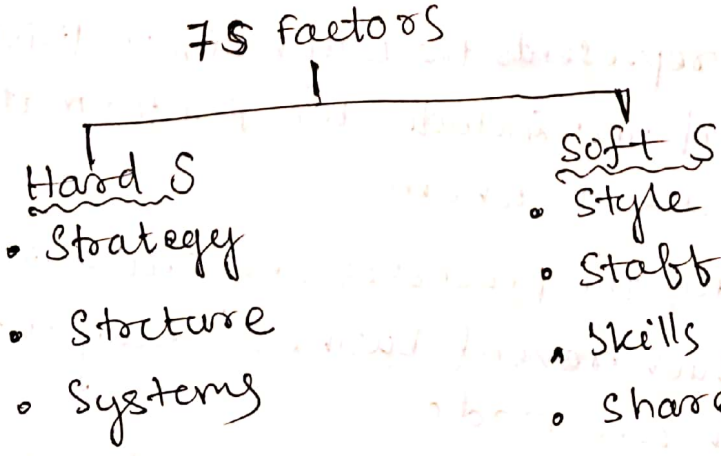
* DMADV is a part of the Design for six sigma process used to design or re-design different processes of product manufacturing or service delivery.

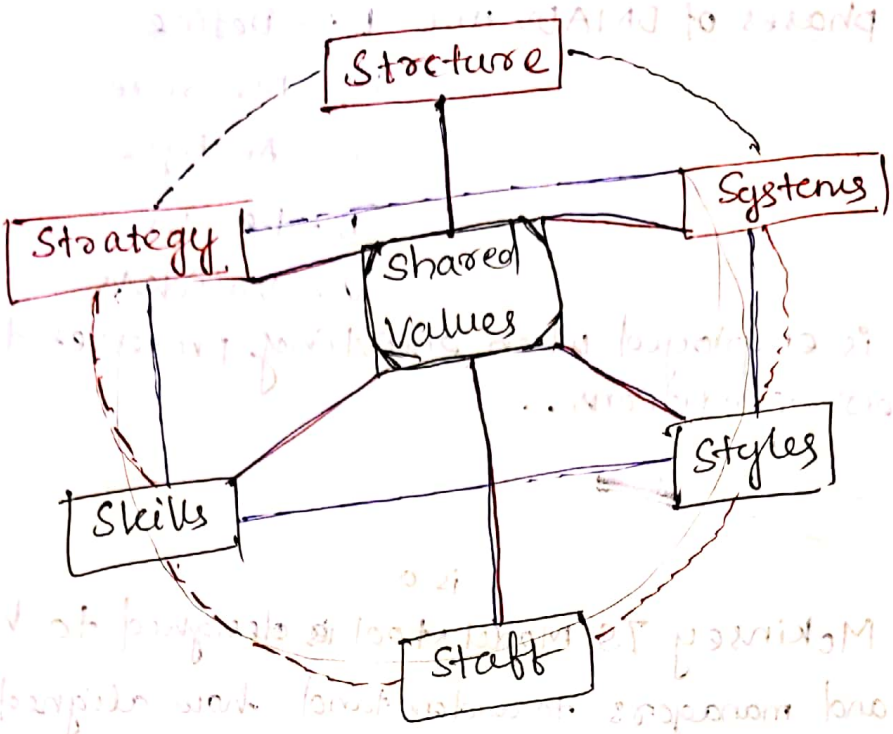
The five phases of DMADV are D - Define
M - Measure
A - Analyse
D - Design
V - Validate

- DMADV is employed when existing processes donot meet customer conditions..

* 7S

- 7S or Mckinsey 7S Model is a tool is designed to help business owners and managers to understand how aligned their organization is and how it can be improved.
- Mc kinsey 7S model was developed in 1980s by Mckinsey consultants which analyzes firm's organizational design by looking at 7S key internal elements :- Strategy, Structure, Systems, Shared values, Style, Staff and Skills
- The goal of the model is to show how 7S of the company can be aligned together to achieve effectiveness in a company & its objectives.
- The 7S are interconnected with eachother and divided into two parts. ie one is Hard S and another Softs





- Strategy, structure and systems are hard element that are much easier to identify and manage when compared to soft elements.
- On the other hand, soft areas although harder to manage, are the foundation of the organization and are more likely to create the sustained competitive advantage.

Strategy :- is a plan developed by a firm to achieve sustained competitive advantage and successfully complete in the market.

Structure :- represents the way business divisions and units are organized and includes the information of who is accountable to whom.

System :- are the processes and procedures of the company which reveal business' daily activities and how decision are made.

- Systems are the area of firm that determines how business is done and it should be the main focus

for managers during organizational change.

Skills :- are the abilities that firm's employees perform very well. they also include capabilities and competences.

Style :- represents the way, company is managed by top-level managers, how they interact, what action do they take & their value.

Shared values :- are the core of McKinsey 7s model They are the norms and standards that guide employee behavior & company actions and thus are the foundation of every organization.

Staff :- element is concerned with what type & how many employees an organization will need & how they will be recruited, trained, motivated & rewarded.

Lean Manufacturing :-

- Lean manufacturing is a methodology that focuses on minimizing waste within manufacturing systems while simultaneously maximizing productivity.
- The benefits of lean include reduced lead times, reduced operating costs and improved product quality to name just a few.

- The five Lean Manufacturing Principles

(1) Identify Value :- The first lean principle, identifying value, is also the 1st step in the journey to become lean.
- This step requires businesses to define what customer value and how their products or services meet those values. i.e Designing of products.

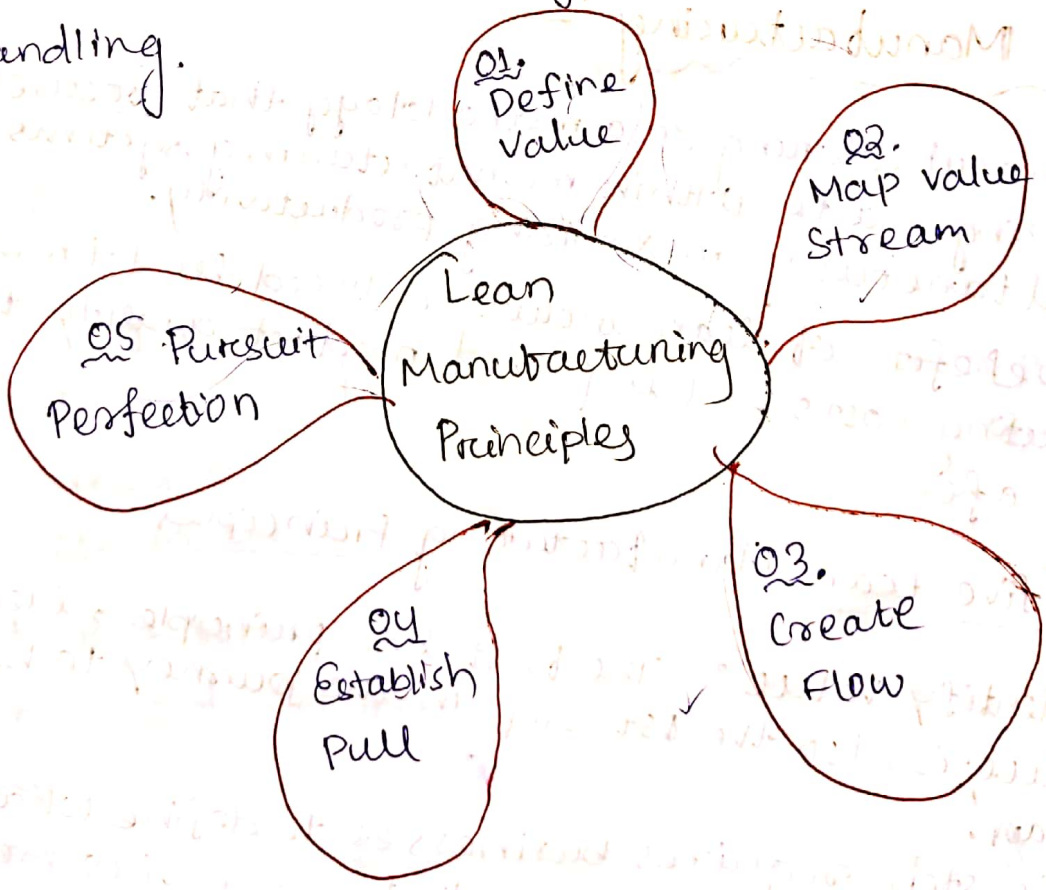
(2) Map the Value Stream :-

A value stream is the complete lifecycle of a product, which includes the product's design, the customer's use of the product & the disposal of the product.

- That is mapping of entire product flow to minimize steps that don't add value.

(3) Create Flow :-

- Efficient product flow requires ~~to~~ items to move from production to shipping without interruption and can be achieved by strategically organizing the work floor.
- A well organized work floor will result in reduced production time, inventory size and material handling.



(04) Establish Pull :- closely related to creating flow, the fourth lean principles requires businesses to use a pull-based production system.

- Traditional production system use a push system, which starts with purchasing supplies & proceeds by manufacturing process, even though there is not an order. and it leads to result in large inventories. & significan amount of work-in-process.
- A pull system, however, pulls a customer's order from the shipping department then prompts new items to be manufactured.
- Using a pull system, busines will; increase output reduce inventories, eliminate overproduction.

05 Pursuit Perfection :-

The final lean manufacturing principle requires companies to seek perfection. It is often one of the most difficult principles to successfully apply in workplace.

- Seeking perfection requires companies to continuously improved their practices and often requires a shift in the workplace culture.