GOVERNMENT POLYTECHNIC, DHENKANAL

Programme: Diploma in Mechanical Engineering

Course: Industrial Engineering and Management (Theory)

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UNIT1:PLANT ENGINEERING

SELECTIONOFSITEOFINDUSTRYOFPLANTLOCATION

- Firstwehavetodefineindustrybeforeselectingitslocationofsite.
- Anindustryofplantisanorganizationwhichproducesrow-materials, goods of services using men, materials, money and machinery.
- Atthetimeofsettingupofanindustrysuitablesitehastobeselected.
- Selectionofsiteinvolvestwomajoractivities.
- 1.Toselectapropergeographicregion.
- 2.Selectionofaspecificsitewithintheregion.

Factors affecting plant location:-

- **Nearnesstorawmaterial:**-

  Itwillreducethecostoftransportingrawmaterialfromthevendor's endtothe plant, this factor is essentialforselectionof sitefor sugar, cement, jute and cotton textile industries.

- **Transportfacilities:**–

  A lot of money is spent both in transporting the raw material and the finished goods speedy transport facilities ensure timely supply of raw materials to the company and finished goods to the customers, There arefivebasicmodesofphysicaltransportationair,road,rail,waterand pipe line.

- **Nearnesstomarket:-**

  Itreducesthecostoftransportationaswellasthechancesofthe finished products getting damaged and spoiled in the way.

Availabilityoflabour:-

- Suitable labour force, of right kind, of adequate size (number), and atreasonable rates
- With its proper attitude towards work are a few factors which governplant location to major extent.
- Thepurposeofthemanagementistofacelessboycotts,strikesorlockout and achieve lower labour cost per unit of production.

Availabilityoffuelandpower:–

- Steelindustriesarelocatednearsourceoffuel(coal)tocutdownfuel transportation costs.
- Electricpowershouldremainavailablecontinuouslyinproperquantity and at reasonable rates.

Availabilityofwater: -

Depending on the nature of the plant, water should be available in adequatequantityandshouldbeofproperqualitywaterisessentialfor paper and chemical industries.

Climaticcondition:–

Climategreatlyinfluencehumanefficiencyandbehavior.Forexampletextile mills require humidity. Moreover certain industry require a specific climatic condition ventilating and air conditioning, climate of the region doesn't present much problem of Course control of climate needs money and increases the cost of the product.

Financialandotheraids:–

- Certainstatesgiveaidsasloans,feedmoney,machinery,builtupsheds etc. to attract industrialist.

Land:-Topography,area,theshapeofthesite,cost,drainageandother facilities, the probability of floods, earthquakes etc.

- Influencetheselectionofplantlocation.

Communityattitude

- Communityattitudetowardstheirworkandtowardstheprospective industries cab make or mar the industry.
- SuccessofanindustrydependsontheattitudeofthelocalPeople whether they want to work or not.

Supportingindustries

- Allindustrieswillnotmakeallthecomponentsandpartsbyitselfandit subcontracts the work to vendors

SocialInfrastructures:–

Availabilityofcommunityfacilitieslike

1. Housingfacilities
2. Recreationalfacilities
3. Educationalfacilities
4. Medicalfacilitiesaretobeconsidered.

Lawand taxation

Thepoliciesofthestategovtandlocalbodiesconcerninglabourlaws,building codes, safety etc. are the factors that demand attention.

PLANTLAYOUT

- Plantlayoutmeansthedispositionofthevariousfacilities(equipments, material,manpoweretc)andservicesoftheplantwithinthe areaofthe site selected previously.
- It begins withthe designof the factory building and goes upto the locationandmovementofaworktable.Allthefacilitieslikeequipments, raw materials, machinery, tools, fixtures, workers etc are given a proper place.
- Plant layout is a plan of anoptimumarrangement of facilities including personnel, operating equipment, storage space, material handling equipmentandallothersupportingservicesalong withthedesignofbest structure to contain all these facilities.

OBJECTIVEOFPLANTLAYOUT:-

- Materialhandlingandtransportationisminimizedandefficiently controlled.

- Bottlenecksandpointsofcongestionsareeliminatedsothattheraw material andsemi finishedgoods movefastfrom oneworkstationto another.
- Workstationsaredesignedsuitablyandproperly.
- Suitableplacesareallocatedtoproductioncentersandservicecenters.
- Movementsmadebytheworkersareminimized.
- Waitingtimeofsemifinishedproductsisminimized.
- Workingconditionsaresafer,betterandimproved.
- Increasedflexibilityofchangesinproductdesignandforfuture expansion.
- Utilizationofcubicspace(length,widthandheight).
- Theseareimprovedworkmethodsandreducedproductioncycletimes.
- Plantmaintenanceissimpler.
- Increasedproductivityandbetterproductqualitywithreducedcapital cost.
- Agoodlayoutpermitsmaterialstomovethroughtheplantatthe desired speed with the lowest cost.

PRINCIPLESOFPLANTLAYOUT:-

- **Principleofintegration:**

Agoodlayoutisonethatintegratesmen, materials,machinesand supporting services and other in order to get the optimum utilization of resources and maximum effectiveness.

- **Principleofminimummovementsandmaterialhandling:**

Thefacilitiesshouldbearrangedsuchthatthetotaldistancestravelledbythe men and materials should be minimum and as far as possible straight line movement is preferred. It is better to transport materials in bulk rather thanin small amounts.

- **Principleofsmoothandcontinuousflow:**

A good layout makes the materials to move in forward direction towards the completionstage.Bottlenecks,congestionpointsandbacktrackingshouldbe removed by proper line balancing techniques.

- **Principleofcubicspaceutilization:**

The good layout utilizes both horizontal and vertical space. Besides using the floor space of a room the ceiling height is also utilized. Boxes and bags containingrawmaterialorgoodscanbestackedoneabovetheothertostore more items in the same room.

- **Principleofsafety,securityandsatisfaction:**

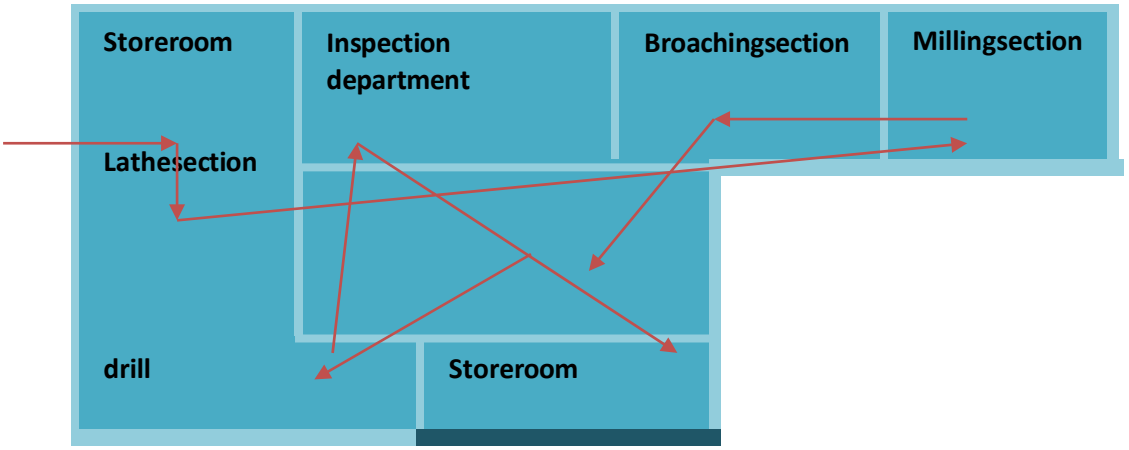
Workingplacesmustbesafe,wellventilatedandfreesafeworkspacefrom dust, noise, fumes, odours, and other hazardous conditions, increases the operating efficiency of the workers and improve their morale.

- **Principleofmaximumflexibility:**

Thegoodlayoutisonethatcanbealteredwithoutmuchcostandtime.The machinery is arranged in such a way that the changes of the production process can be achieved at least cost or disturbance.

1. PROCESSLAYOUT(FUNCTIONLAYOUT)

- The layout is recommended for batch production. All machines performing similar type of operations are grouped at one location in the process layout. Ex-all lathes, milling machine kept at one place.
- Thearrangementsof facilitiesaregroupedtogetheraccordingtotheir functions.



Advantages:

I. Wideflexibilityexistsduringallotmentofworktoequipmentandworkers.

II. Betterutilizationofequipments.

III. Lowerinvestmentsonaccountofcomparativelylessno.Ofmachineare used.

IV. Betterproductqualitybecausetoattendonetypeofmachine.

V. Varietiesofjobscomingasdifferentjobordermaketheworkmore challenging and interesting.

VI. Workersinonesectionareoneaffectedbythenatureofanother section.

Disadvantages:

I. Forthesameamountofproduction,morespaceisrequired.

II. Automaticmaterialshandlingisdifficult.

III. Morematerialsinprocessremaininqueueforfurtheroperation.

IV. Completionofsameproducttakesmoretime.

V. Work-in-processinventoryislarge.

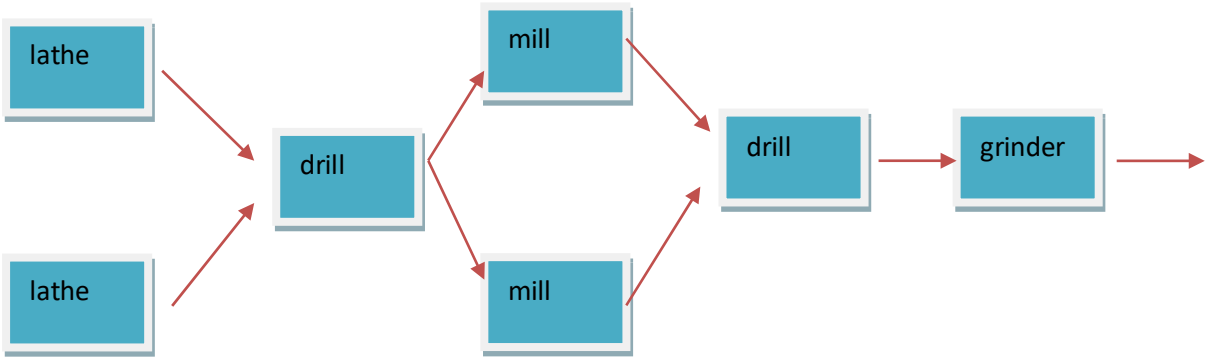
VI. Productionplanningandcontrolisdifficult.

VII. Rawmaterialshavetotravellargerdistancesforbeingprocessedto finished goods. Thus increases cost.

VIII. Itmeansmoreinspectionsanddifferentco-ordination.

2. Productlayout(linelayout)

- Thevariousoperationsonrawmaterialsareperformedinasequence and the machines are arranged in the sequence in which the raw materials will be operated upon.



Advantages:

I. Lessspacerequirementsforthesamevolumeofproduction.

II. Automaticmaterialshandling,lessmovements,socostisreduced.

III. Lessinprocess inventory.

IV. Productcompletesinlessertime.

VI. Simplifiedproduction,planningandcontrol.

VII. Smoothandcontinuousworkflow.

VIII. Lessskilledworkerscanlearnandserveandservethepurpose.

Disadvantage:

I. Lackof flexibility.

II. Excessiveidletimeduetoslowest machine.

III. Moremachinestobepurchasedandkeptwhichrequirehighcapital investment.

IV. Oneinspectorhastoattendano.ofmachineinaproductionline.

V. Itisdifficulttoincreaseproductionbeyondthecapacitiesofthe production lines.

2. COMBINATI0NLAYOUT:-

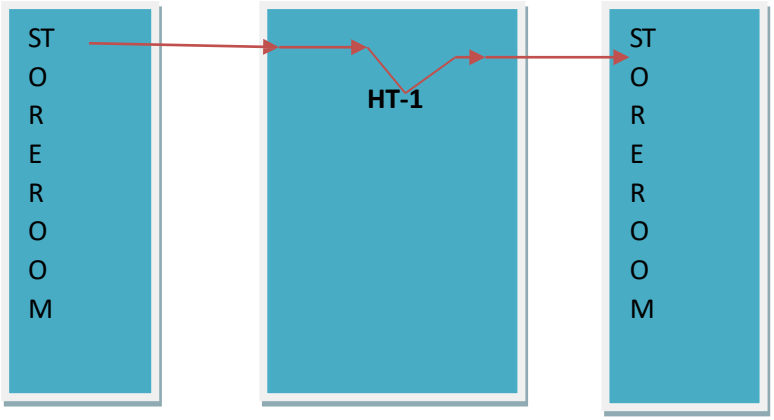
Thisiscalledthemixedtypeoflayoutusuallyaprocesslayoutiscombined with the product layout.

Ex-refrigeratormanufacturingusesacombinationlayout.

Manufacturing various components ⇒ process

Layout for assembly of component ⇒ product

Layout



EX-files,hacksaw,circularmetalsaws,woodsaws

TOOLS&TECHNIQUESUSEDTOIMPROVEINDUSTRIALLAYOUT

Therearе6tools&techniquesusedforlayoutplanning.

- Operationprocesscharts
- Flowprocesscharts
- Processflowdiagram
- Machinedatecards
- Templates
- Scale models

Operationprocesscharts:

- Manufacturingprocessisdividedintoseparateoperationwithhelp of operation process chart.
- Thischartrepresentsbasicactivitiesrequiredforproducing product.

Flowprocesscharts:

- This chart is a graphical representation of all production activities occurring on the shop floor.

- It provides complete information for the analysis & improvement of plant operation as a whole on the basis of this analysis operations may be combined, rearranged or eliminated.
- Thischartusedtoverifyefficiencyofanewlayout.

Processflowdiagram:

- Thisdiagramisusedtosupplementtheflowprocesschart.
- It is the diagram of building plan representing graphically the relativepositionof productivemachinery storagespace,gangways & path followed by men or materials.
- Ithelpinimprovinglayout.

Machine date cards:

- Thesecardgivecompletespecificationofeachmachinetobe installed showing its capacity, space & other requirements, foundation method of operation, maintenance & handling devices of machine.

Templates:

- After studying the flow process chart, process flow diagram & machine data card a floor plan is prepared by firing aria occupied by each item (machine, benches, racks, material handling equipment) to be erected on the shop.
- The thick sheets of cardboard, plywood or plastic on same scale pieces of sheet are cut to represent various item which are to be housed in the plants & placed on floor at suitable locations.
- These templates are arranged in such a way so as to provide best layout.

Scalemodels:

- Inthistools,insteadoftemplates,3Dscalemodelis utilized.
- Thesemodelswood,plasticormetal.
- Seriesofadditionalinformationabouttheheight&oftheprojected components of machine are obtained.

PrinciplesofMaterialHandlingEquipment.

In an organization, a considerable amount of material handling is donemanually or through automated process.

ObjectivesofmaterialHandlingare:

1. Itshouldbeabledetermineappropriatedistancetobecovered.
2. Facilitatereductioninmaterialdamageastoimprovequality.
3. Reducemanufacturingtime.
4. Improvematerialflowcontrol.
5. Improveproductivity&efficiency.
6. Betterutilizationoftime&equipment.

PrinciplesofmaterialHandling:

1. OrientationPrinciple:--Studyofallavailablesystemrelationships before moving towards preliminary planning.
2. Planning principle: -- It produce a plan includes basic requirements,desirable alternates & planning for contingency.
3. SystemPrinciple:--Itintegrateshandling&storageactivities,whichis cost effective into integrated system design.
4. UnitloadPrinciple:--Handleproductinaunitloadaslargeaspossible.
5. SpaceutilizationPrinciple:--effectiveutilizationofallspace.
6. StandardizationPrinciple: -- standardizationofhandlingmethods&equipments.
7. Ergonomic Principle: -- Recognizes human capabilities & limitation by design effective handling equipment.
8. EnergyPrinciple
9. EcologyPrinciple
10. Mechanization Principle: -- Mechanization of handling process wherever possible to encourage efficiency.
11. FlexibilityPrinciple:--Method&equipmentwhicharepossibleto utilize in all types of condition.
12. SimplificationPrinciple:--Byremovingunnecessarymovements.
13. Gravityprinciple:--Usegravityprincipleinmovementof goods.
14. Safetyprinciple.
15. Systemflowprinciple:--Integrationofdataflowwithphysicalmaterial flow.
16. Layoutprinciple:--Encouragespreparationofoperationalsequenceof all systems.
17. Costprinciple:--Costbenefitanalysis.
18. Maintenance principle: -- Encourages preparation of plan for preventive maintenance.
19. Obsolescenceprinciple:--Encouragepreparationofequipmentpolicy as to enjoy appropriate economic advantage.

Plantmaintenance:

Plant maintenance consists of a set of activities by which the machinery, buildings and services are always ready to perform their functions at optimum return on investment.

In other words the main objective of plant maintenance is to achieve minimum breakdown and to keep the plant in good working condition at the lowest possible cost.

Importanceofplantmaintenance:

(i) The importance of plant maintenance varies with the type of production of the plant.

(ii) In a flow production factory, a single fault in a line will cease the activities of different work station of that line as well as may stop the activities of other production line.

Thisresultsaninevitablelossof production.

(iii) An un-properly maintained plant will demand expensive repairs at a particular time as all machines and other facilities including buildings will need to be maintained to function properly.

(iv) Plantmaintenancehasavitalroleinproductionmanagementbecause plant breakdown creates problems such as :

- Lossinproductiontime
- Reschedulingofproduction
- Damageofin-processmaterial
- Temporaryworkshortages
- Needfor overtime
- Needforsubcontractingwork

TypeofMaintenance:

(a) Correctiveorbreakdownmaintenance
(b) Scheduledmaintenance
(c) Preventivemaintenance
(d) Predictivemaintenance

CorrectiveorBreakdownmaintenance:

In corrective or breakdown maintenance the repair of the equipment is done only whenthe equipment fails to perform its normal duty, e.g. an electric motor will not start.

Breakdown maintenance practice is economical for those equipments whose down time and repair cost is less compared to overhead cost of production by adopting any other type of maintenance.

Breakdown type of maintenance involves little administrative work, few records and a comparative small staff.

Thereisnoplannedinterferencewithproductionprogrammes.

This type of maintenance is quite suitable for small factories.

DisadvantagesofBreakdownMaintenance:

(i) If breakdown occurs at the time when the equipment has to be operated to fulfil the supply of demand then the situation leads to hurried maintenance.
(ii) Reductionofoutput.
(iii) Increaseschancesofaccidentsandprovideslesssafetyworkplace.
(iv) Resultsdirectlossofprofit.
(v) Breakdownmaintenancepracticecannotbeemployedforthoseplant itemswhichareregulatedbystatutoryprovisions,forexample:cranes, lifts, hoists and pressure vessels.

ScheduledMaintenance:

Inscheduledmaintenancethecausesofequipmentbreakdownhasbeen analyzed and some maintenance work has been planned to be taken up at a scheduled time to minimize the possibility of breakdown of the equipment.

Inthistypeofmaintenance,lubricationoverhaulingofmachines,clearing of water and other tanks, white-washing of buildings are conducted.

Preventivemaintenance:

Inpreventivemaintenance,inspectionplaysakeyrole.

Usingsuitablestatisticaltechniquesthefrequencyofinspectionhasbeen determined.

With the help of periodic inspection, the conditions which lead to production breakdown has been uncovered and the weak spots of all equipments have been repaired before breakdown of the equipment.

By this maintenance optimum productive efficiency and operational accuracy of the plant equipment has been obtained.

Themainobjectivesofpreventivemaintenanceis

(i) Toachievemaximumproductionatminimumrepaircost.
(ii) Toensuresafetyoflifeandlimbsofthe workmen.
(iii) Tomaintainthequalityoftheproduct.

However, a perfect coordination between production department and preventive maintenance personnel is highly essential for the success of the preventive maintenance practice.

UNIT2:OPERATIONRESEARCH

Optimizationtechniques:

The word optimization is from optimum which implies a point at which the conditionsarebestandmostfavorable.Anoptimumpointmayrepresentamaximum position or minimum position.

Methodforoptimizing:

a) Search
b) Differentialcalculus
c) Statisticalmethods
d) Linearprogramming
   i. Graphicalmethod
   ii. Transportationmethod
   iii. Simplexmethod
e) Queuingtheory
f) Dynamicprogramming

Applicationofoptimization:

Load allocation problems, component selection and dynamic, load sharing problems.

Operationresearch:

Operation research signifies research on operations. It is the organized applicationofmodernscience,mathematicsandcomputertechniquestocomplex military, government, business or industrial problems arising in the direction and management of large systems of men, materials, money and machines.

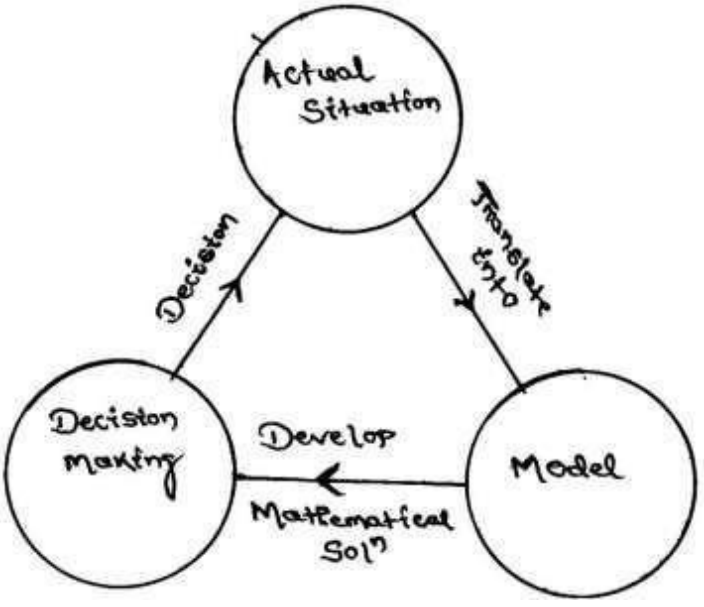
Methodology

1. Understand the actual real situation, capture the same and define theproblem
2. Formulateamathematicalmodel
3. Developamathematicalsolution
4. Interpret the solution and prepare the information in such a form that it is meaningful, and quantitative. Translate it in to adecision.
5. Implementthedecisiontotherealsituation.
6. Verifytheresults

Methodsofoperationresearch

Varioustechniquesusedtosolveoptimizationproblemsareasfollows:

1. Linearprogramming
    a) Graphicallinearprogramming
    b) Transportationmethod
    c) Simplexmethod
2. Waitlineorqueuingtheory
3. Gametheory
4. Dynamicprogramming



Linearprogramming

Linear programming is powerful mathematical technique for finding the best use of limited resources of a concern. Overall profit or minimum overall cost to minimize this technique can be used to maximize of a company.

LPcanbeappliedeffectivelyonly if

a) Theobjectivescanbestatedmathematically
b) Resourcescanbemeasuredasquantities(no.weightetc)
c) Therearetoomanyalternatesolutionstobeevaluatedconveniently
d) The variables of the problem bear a linear relationship i.e. doubling the units of resources will double the profit.

Problemsolvingisbaseduponthesystemoflinearequation:

Standardformoflinearprogrammingproblem:

Let$x_1, x_2, x_3 \ldots\ldots\ldots\ldots x_n$arethedecisionvariables.

Optimize(maximumorminimize)

$Z = c_1x_1 + c_2x_2 + \ldots\ldots\ldots\ldots\ldots + c_nx_n$(objectivefunction)

Subjecttoconstraints

$a_{11}x_1 + a_{12}x_2 + \ldots\ldots\ldots\ldots + a_{1n}x_n \leq b_1$

$a_{21}x_1 + a_{22}x_2 + \ldots\ldots\ldots\ldots + a_{2n}x_n \leq b_2$

. . . .
. . . .
. . . .

$a_{m1}x_1 + a_{m2}x_2 + \ldots\ldots\ldots\ldots\ldots + a_{mn}x_n \leq b_n$

$x_1, x_2, x_3 \ldots\ldots\ldots\ldots x_n \geq 0$(non-negativerestriction)

where$c_1, c_2, c_3, \ldots\ldots\ldots\ldots c_n$arecostorprofitcoefficients.

a_{ij}(i=1,2,3,… .....n)

(j=1,2,3,… ....n)

$b_1, b_2, \ldots\ldots\ldots\ldots\ldots b_m$arecalledrequirementoravailability.

LPPcansolvedbytwo methods.

1. Graphical method: when two decision variables are involved. This is simple.
2. Simplex method: useful for any no. of decision variable in theproblem and no. of constraints.

FormulationofLPproblem:

1. Fromthegivenproblem,identifythekeydecisionstobemade.
2. Identify the decision variables, whose values give the solution to theproblem.
3. Writetheobjectiveinthe quantitativetermsandexpress itas a function oflinear variables.
4. Studytheconstraintsandexpressthemasalinearequation.

Graphicalmethod:

Simple two dimensional linear programming problems can be easily and rapidly solved by this technique. This method can be easily be applied up to 3 variables.

Example1:AfurnituremanufacturermakestwoproductsX_1 &X_2 namelychair andtables.EachchaircontributesaprofitofRs20andeachtablethatofRs40. Chairs and tables from raw material to finished product, are processed in 3 sections S_1,S_2,S_3. In sectionS_1each chair (X_1)requires 1Hr andeachtable(X_2) requires 4 Hrs of processing. In section S_2, each chair requires 3 Hrs and each table 1 Hr and in section S_3 the times are 1 and 1 Hr respectively. The manufacturer wants to optimize his profits if sections S_1, S_2, S_3can be availed for not more than 24, 21 and 8 Hrs respectively.

ANS:

LetnoofChair=X_1 &
no ofTable = X_2

Thenthemathematicalmodelformaximizingnetprofitwillbe Maximum Z = $20X_1 + 40X_2$

	Maximum Chair	Table	Total
S_1	1	4	24
S_2	3	1	21
S_3	1	1	8

Subjectto:

$X_1+4X_2 \leq 24$
$3X_1 + X_2 \leq 21$
$X_1+ X_2 \leq 8\ X_1,$
$X_2 \geq 0$

Problem:

MaximizeZ=X+5Ywhen 5X +
6Y≤ 30
3X+2Y≤12 X,
Y ≥ 0
Firststep:converttheconstraintinequalitiestemporarily,intoequationsi.e. 5X +
6Y = 30 ---------- C_1
3X+2Y=12---------- C_2

Second step: Axes are marked on the graph paper and are labeled with variables Xand Y.

Thirdstep:Drawstraightlinesonthegraphpaperusingconstraintequations. We have to find two points to draw a straight line.

OnX axis the Y coordinate of the point will be zero andonY axis the X coordinateof the point will be zero.

UsingequationC_1twopointswillbefoundtheequationis5X+6Y=30

Here to findthe point on X axis Y =0

PuttingY=0intheequationwe have

5X+0=30

$\Longrightarrow$X =6

SothepointonXaxisis(6,0)

SimilarlytheXcoordinateofthepointon Yaxis=0

Putting X =0

wehave0+6Y=30

$\Longrightarrow$Y= 5

SothepointonYaxisis(0,5)joining(6,0) &(0,5) We will obtain one straight line named as C_1

SimilarlyequationC$_2$ willbesolvedandanothertwopointswillbeobtainedas follows

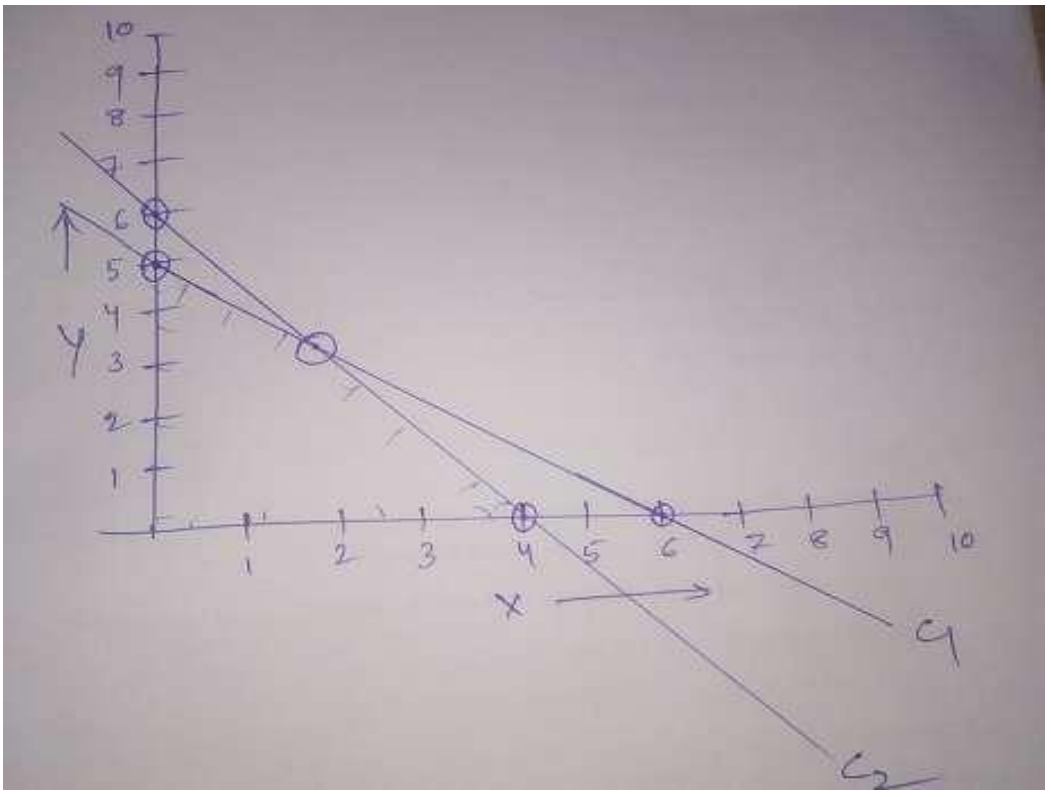
3X 0+ 2Y=12 $\Rightarrow$Y=6

Pointis(0,6)

And3X+2X0=12 $\Rightarrow$X=4

Pointis(4,0)

Joining(0,6)and(4,0)anotherstraightlineisobtained.



NETWORKANALYSIS

Itisasystemwhichplansprojectsbothlargeandsmallbyanalyzingtheproject activities. Projects are broken down to individual tasks or activities, which are arranged in logical sequence. A network diagram is constructed for visual presentation of the relationship between all the activities involved in the project. It haditsearlyrootsinWorldWarIIbutbecomesausefultoolforenhancingproduction maximizing profit and assuring quality of the product.

Projects:

Project is any task which has definable beginning and definable end. It is essential to manage effectively the projects through proper planning, scheduling and control as project requires a heavy investment, and is associated with risk and uncertainties.

Networkscheduling:

Itis a technique used for planning andscheduling large projects in the fieldof constructions, maintenance, fabrication and any other areas.

This technique is the method of minimizing the bottlenecks, delays and interruptionsbydeterminingthecriticalfactorsandcoordinatingvariousactivities.

There aretwobasic planning andcontroltechniques.Theyare CriticalPath Method (CPM) and Program Evaluation and Review Techniques (PERT).

ObjectiveofNetworkAnalysis:

1. Apowerfulcoordinatingtoolforplanning, schedulingand controllingof projects.
2. Minimizationoftotalprojectcostandtime.
3. Effectiveutilizationofresourcesandminimizationofeffectiveresources.
4. Minimizationofdelaysandinterruptionduringimplementationofthe project.

ApplicationofNetworkAnalysis(PERTandCPM):

1. Researchanddevelopmentprojects.
2. Equipmentmaintenanceandoverhauling.
3. Constructionprojects(building,bridges,dams)
4. Settingupnewindustries
5. Planningandlaunchingofnewproducts.
6. Designofplants,machinesandsystems
7. Organizationofbigprograms

Termsrelatedtonetworkplanningmethods:

Event(node):

An event is a specific instant of time which marks the start and the end of an activity. Eventconsumes neither time nor resources. Itis represented by a circle and the event no. is written within the circle.

Ex–startthemotor,loanapproved.

Activity:

Every project consists of a no. of job operations or tasks which are called activities. An activity is an element of project and it may be a process, a material handling or material procurement cycle.

Ex–installmachinery,arrangeforeignexchange.

Itisshownbyanarrowanditbeginsandendswithanevent.Anactivityis

normallygivenanamelikeA,B,Cetci.e.markedbelowthearrowandtheestimated time to accomplish the activity is marked above the arrow.

Activitiesareclassifiedas:

1. Criticalactivities:

   In a network diagram, critical activities are those which if consume more thantheirestimatedtimetheprojectwillbedelayed.Anactivityiscalledcritical if its earliest start time plus the time taken by it is equal to the latest finishing time. A critical activity is marked either by a thick arrow or (//).

2. Noncriticalactivities:

   Suchactivitieshaveprovision(slackorfloat)sothatevenifitheyconsume a specified time over and above the estimated time, the project will not be delayed.

3. Dummyactivities:

   Whentwoactivitiesstartatthesameinstantoftime,theheadeventsare joined by a dotted arrow and this is known as dummy activity. It does not consume time. It may be non-critical or critical. It becomes a critical activity when its EST = LFT.

Criticalpath:

Itisthatsequenceofactivitieswhichdecidethetotalprojectduration.It is formed by critical activities. A critical path consumes maximum resources. It isthelongestpathandconsumesmaximumtime.Ithaszerofloat.Theexpected completiondatecannotbemet,ifevenonecriticalactivityisdelayed.Adummy activity joining two critical activities is also a critical activity.

Duration:

Duration is the estimated or actual time required to complete a task or anactivity.

Totalprojecttime:

Itisthetimewhichwillbetakentocompletetheprojectandisfoundfrom the sequence of critical activities. It is the duration or critical path.

Earlieststarttime(EST):

It is the earliest possible time at whichactivity canstart andis calculatedby moving from first to last event in a network diagram.

Earliestfinishtime(EFT):

Itistheearliestpossibletimeatwhichactivitycanfinish.i.e.(EST+D)

Latestfinishtime(LFT):

It iscalculatedbymoving backward i.e.from last event tofirstevent ofthe network diagram. It is the last event time of the head event

Lateststarttime(LST):

Itistheleastpossibletimebywhichanactivitycanstart.

LST=LFT–durationof thatactivity

Floatorslack:

Slack is with reference to an event and float is with respect to an activity. It means spare time, a margin of extra time over and above its duration which a noncritical activity can consume without delaying the project.

Floatisthedifferencebetweenthetimeavailableforcompletingan activity and the time necessary to complete the same.

Therearethreetypeof float.

1. Totalfloat:
   Itistheadditionaltimewhicha non-criticalactivitycanconsumewithout increasing the project duration.
   TF=LST–ESTorLFT–EFTanditcanbe–ve.
2. Freefloat:
   Ifallthenoncriticalactivitiesstartasearlyaspossible,thetimeisthefree float.
   FF=ESToftailevent–ESTofheadevent–activityduration
3. Independentfloat:
   The use of independent float of an activity does not change the float in other activities. Independent float can be used to reduce the effort on a non-critical activity in order to apply the effort on a critical activity to reduce the project duration.

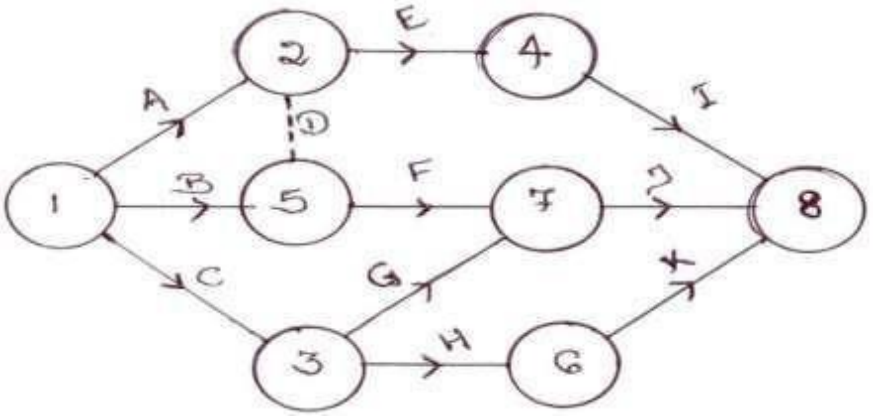
IF =EST of tail event –LFT of headevent – activity duration. If is negative,then taken as 0.

Numberingofevents(Fulkerson'srule):

1. The initial event which has all outgoing arrows with noincoming arrow isnumbered '1'.
2. Deleteallarrowscomingoutfromnode1.Thiswillconvertsomemorenodes into initial events number these events 2, 3 etc.
3. Deletealltharrowsgoingoutfromthesenumberedeventstocreatemore

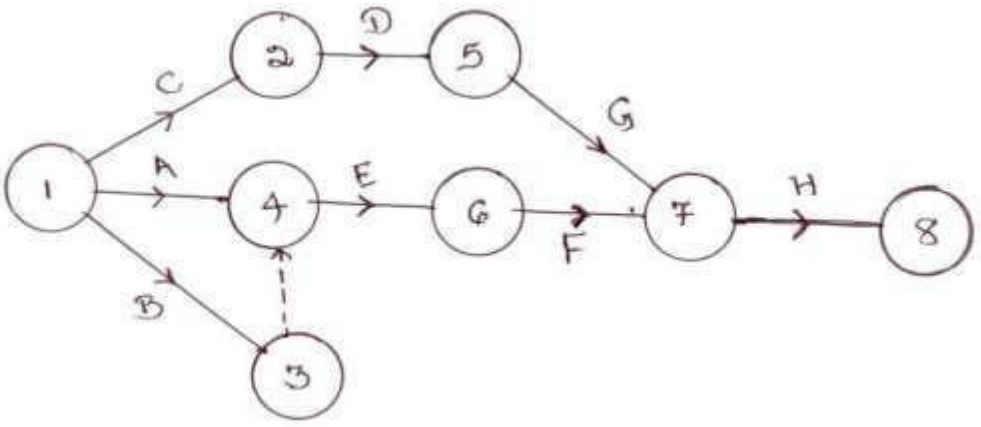
initialevents.Assignnextnumbertotheseevents.

4. Continueuntilthefinalorterminalnodewhichhasallarrowscomingin,with no arrow going out is numbered.



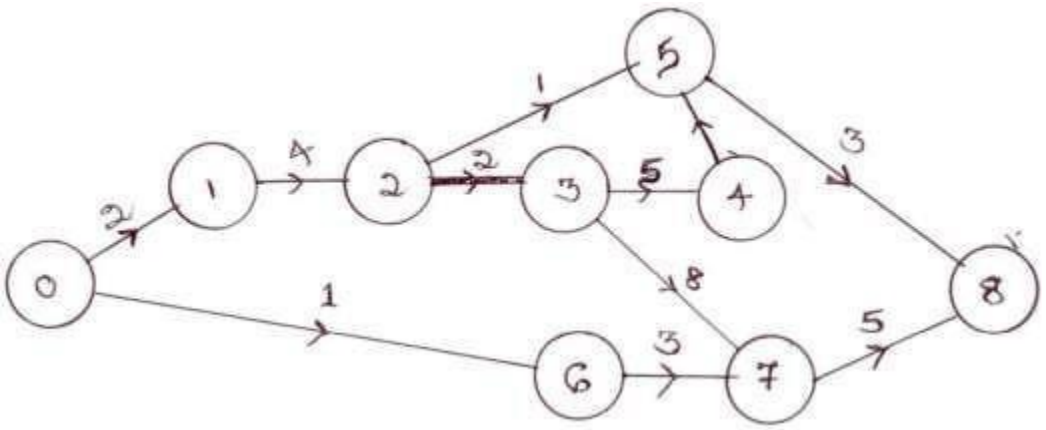
1. Constructthenetworkfromtheinformation.

Activity	Immediate predecessor	Time
A	------	6
B	------	10
C	------	14
D	C	6
E	A,B	14
F	E,D	6
G	D	4
H	F,G	4



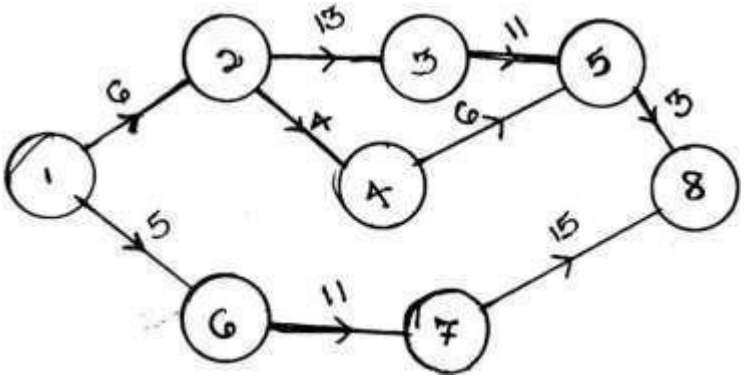
2. Constructthenetworkfromtheinformation.

Activity No.	Duration	Activity No.	Duration
0-1	2	0-6	1
1-2	4	3-7	8
2-3	2	6-7	3
3-4	5	5-8	3
2-5	1	7-8	5
4-5	1		



3. Constructthenetworkfromtheinformation.

Activity	Time	Activity	Time
1-2	6	3-5	11
1-6	5	4-5	6
2-3	13	6-7	11
2-4	4	5-8	3
------	----	7-8	15



CriticalPathMethod:

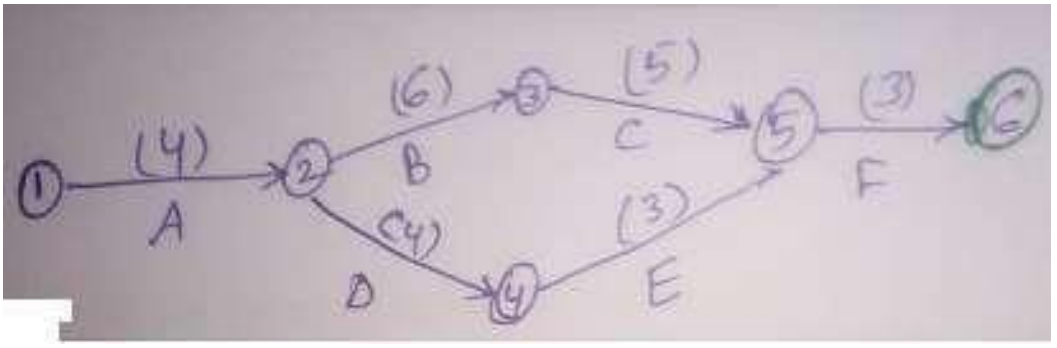
In the critical path method the activity times are known with certainty. For each activity EST and LST are computed. The path with the longest time sequence is called critical path. The length of the critical path determines the minimum time in which the entire project can be completed. The activities on the critical path are called critical activities.

Objective:

1. Determiningthecompletiontimefortheproject.
2. Earliesttimewheneachactivitycanstart.
3. Latesttimewheneachactivitycanstartwithoutdelayingthetotalproject.
4. Determiningthefloatforeachactivity.
5. Identificationofthecriticalactivitiesandcriticalpath.

Example:

A small engineering projectconsistsof 6activitiesnamelyA,B, C,D, E & F with duration 4, 6, 5, 4, 3 & 3 days respectively. Draw the network diagramandcalculateEST,LST,EFT,LFTandfloats.Markthecriticalpathand find total project duration



Activity	Duration(days)	EST	LST(LFT - D)	EFT(EST + D)	LFT	TF
A	4	0	0	4	4	0
B	6	4	4	10	10	0
C	5	10	10	15	15	0
D	4	4	8	8	12	4
E	3	8	12	11	15	4
F	3	15	15	18	18	0

Criticalpath=1-2-3-5-6

Totalprojectduration=4+6+5+3=18days

ProgrammeEvaluationReviewTechnique(PERT):

PERT takes into account the uncertainty of activity times. It is a probabilistic model with uncertainty in activity duration.

Itmakesuseofthreetimeestimates.

I. Optimistictime(t_0)
II. Mostlikelytime(t_m)
III. Pessimistictime(t_p)

I. Optimistictime(t_0):

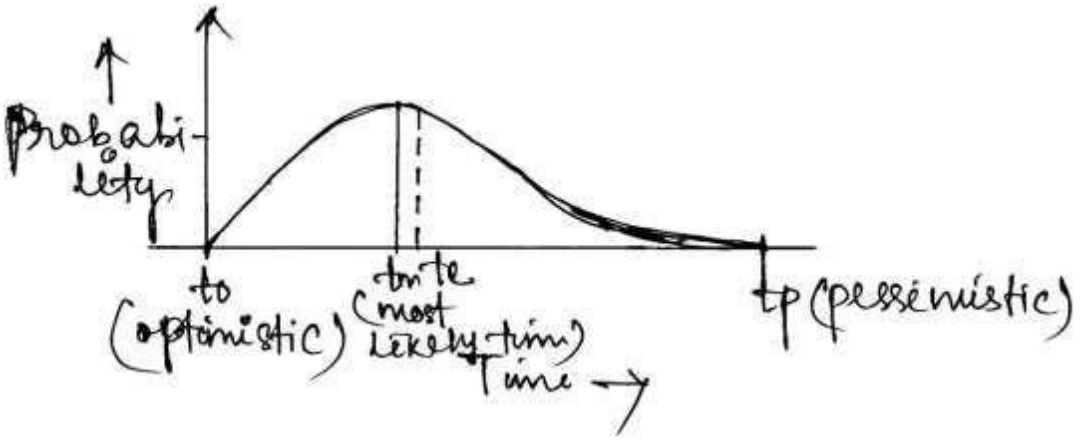
Itistheshortestpossibletimeinwhichanactivitycanbecompletedif everything goes perfectly without any complications.
It is an estimate of minimum possible time to complete the activity under ideal condition.

II. Pessimistictime(t_p):

Itisthelongesttimeinwhichanactivitycanbecompletedifeverythinggoes wrong.

III. Mostlikelytime(t_m);

It is the time in which the activity is normally expected to completeunder normal contingencies.



Accordingtothedistributioncurve

$$te = \frac{T_0 + 4t_m + t_p}{6}$$

Thestandarddeviationoftimerequiredtocompleteeachactivity.

$$\text{Standard deviation} = \frac{t_p - t_o}{6}$$

$$\text{Variance} = \frac{t_p - t_o}{6}^2$$

Standarddeviationofthetime$t_e$tocompletetheproject

Mean,variance,standarddeviation:

No.ofdaystakentodigacertainlengthoftrenchundervaryingcondition.

48	76	52	40	50
49	60	62	53	50
53	56	67	62	60
61	46	72	70	58

Meantimeoraveragetime=52.5days

Standard deviation for each entry:

48–52.5=-4.5

49–52.5=-3.5

.

.

Squarethevariation

$(-4.5)^2$=20.25

$(-3.5)^2$=12.25 .....soon

= 6.52

Square the deviations, add them and divide by no. of jobs to get variance. Square rating the variance standard deviation can be found.

Probabilityofcompletionoftheprojectwithinascheduledtime:

Time:
Theprobabilityofcompletionoftheprojectwithinscheduledis computedas

1. Calculate the mean of the event time (t_e) by adding the times of the activities along the critical path leading to the event.
2. Calculate the variance of the event time by adding up the variances of the activities onthecriticalpath.Takethesquarerootofthisvariancestoget T(standarddeviation)
3. Computestandardnormalvariate

$$Z = \frac{D - T_e}{S_t}$$

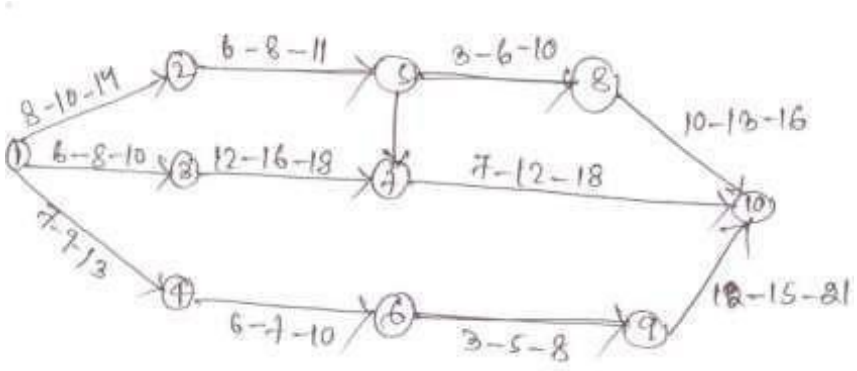
ForvalueofZfindthecorrespondingvalueofprobabilityfromthetable.

Standard Normal Distribution

Z	Probabilityofmeeting dueorscheduleddate	Z	Probability of meetingdueor scheduleddate
2.8	0.997	-0.2	0.421
2.6	0.995	-0.4	0.345
2.4	0.992	-0.6	0.274
2.2	0.986	-0.8	0.212
2.0	0.977	-1.0	0.159
1.8	0.964	-1.2	0.115
1.6	0.945	-1.4	0.081
1.4	0.919	-1.6	0.055
1.2	0.885	-1.8	0.036
1.0	0.841	-2.0	0.023
0.8	0.788	-2.2	0.014
0.6	0.726	-2.4	0.008
0.4	0.655	-2.6	0.005
0.2	0.579	-2.8	0.003
0.0	0.500		

1. ConstructthePERTnetwork.Findthecriticalpath.

ANS:



Thereare4pathsto reach1to10.

A⇒1-2-5-8-10

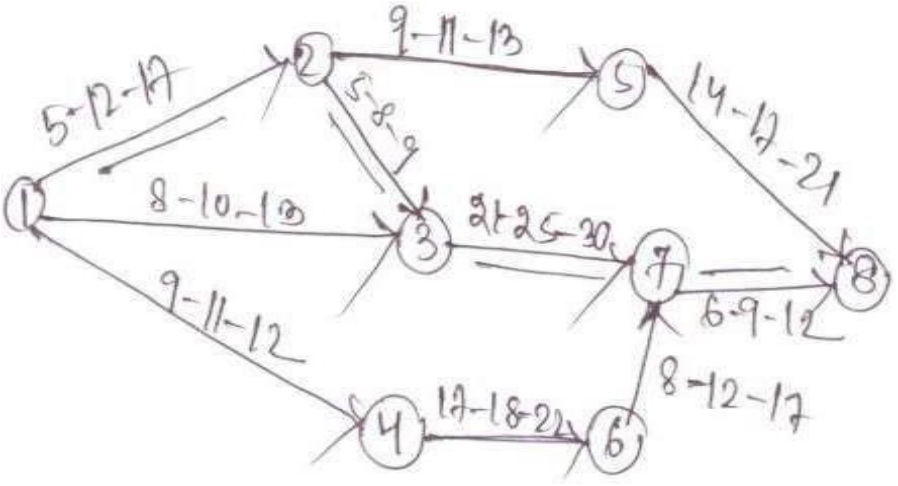
B⇒1-2-5-7-10

C⇒1-3-7-10

D⇒1-4-6-9-10

	Activity	t_0	t_m	T_p	T_e	Sum of t_e
PathA	1-2	8	10	14	10.33	37.67
	2-5	6	8	11	8.17	
	5-8	3	6	10	6.17	
	8-10	10	13	16	13	
PathD	1-4	7	9	13	9.33	37.34
	4-6	6	7	10	7.33	
	6-9	3	5	8		
	9-10	12	15	21		
PathC	1-3	6	8	10		35.84
	3-7	12	16	18		
	7-10	7	12	18		
PathB	1-2	8	10	14		37.84
	2-5	6	8	11		
	5-7	5	7	10		
	7-10	7	12	18		

Maximumtimeconsumedis37.84isthecriticalpath.SopathBisthecriticalpath.



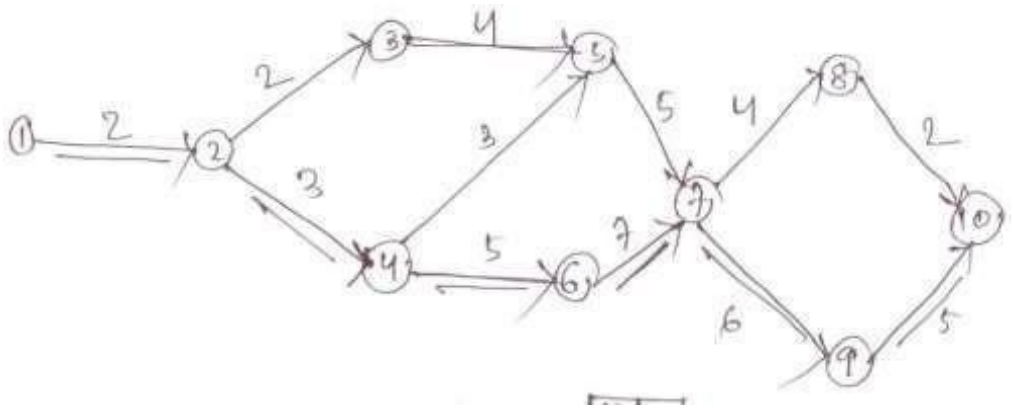
Example–2:

ConstructthePERTnetwork.Findthecriticalpathandvarianceofeach event. Find the project duration at 95 % probability.

Activity	Optimistic time	Pessimistic time	Mostlikely time
1-2	1	5	1.5
2-3	1	3	2
2-4	1	5	3
3-5	3	5	4
4-5	2	4	3
4-6	3	7	5
5-7	4	6	5
6-7	6	8	7
7-8	2	6	4
7-9	5	8	6
8-10	1	3	2
9-10	3	7	3

Solution:

Activity	t_o	t_p	t_m	t_e	Variance
1-2	1	5	1.5	2	4/9
2-3	1	3	2	2	1/9
2-4	1	5	3	3	4/9
3-5	3	5	4	4	4/9
4-5	2	4	3	3	1/9
4-6	3	7	5	5	4/9
5-7	4	6	5	5	1/9
6-7	6	8	7	7	4/9
7-8	2	6	4	4	4/9
7-9	5	8	6	6.16	1/4
8-10	1	3	2	2	1/9
9-10	3	7	3	5	4/9



Thecriticalpathis1-2-4-6-7-9-10.

Expecteddurationoftheproject=2+3+5+7+6.16+5=28.16days
Project variance = 4/9+4/9+4/9+4/9+1/4+4/9 = 89/36

$$Z = \frac{D - T_e}{S_t}$$

D=Expecteddurationoftheprojectfor95%probabilityofcompletion. Where
T_e= sum of most likely time of activities in the critical path.
S_t=Standarddeviation=√Projectvariance
From the table for 95% probability

Z =0.8289

D-28.16

$$\Rightarrow 0.8289 = \frac{\quad}{\sqrt{2.47}}$$

$$\Rightarrow D = 0.8289 \times \sqrt{2.47} + 28.16$$

$$= 1.30 + 28.16$$

$$= 29.46$$

Example-3:

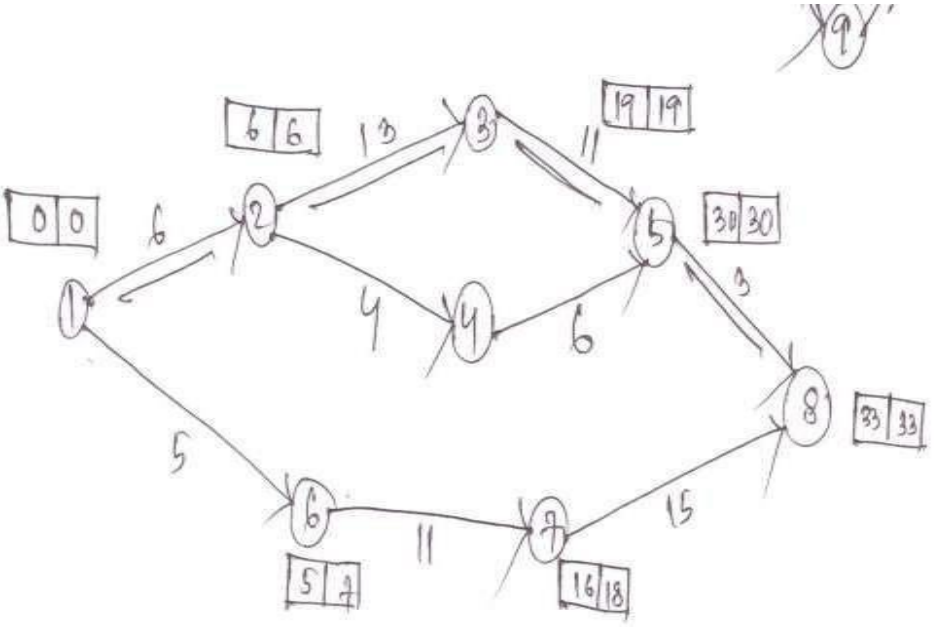
Asmall engineeringprojectconsistsofan activity.Threetimeestimatesfor each activity are given

a) Calculate values of expected time (t_e), standard deviation (s_t) and variance (v_t) for each activity.
b) Drawthenetworkdiagramandmark$t_e$oneachactivity.
c) CalculateESTandLFTandmark$t_e$oneachactivity.
d) Calculatetotalslackforeachactivity.
e) Indentifythecriticalpathsandmarkonthenetworkdiagram.
f) Findthelengthofcriticalpathsortotalprojectduration.
g) Calculatevarianceofcriticalpath.
h) Calculatethe probabilitythatthe jobsonthecritical pathwillbefinishedby the due date of 38 days.
i) Calculate the approx probability that the jobs on the next most critical path will be completed by the due date of 38 days.
j) Estimatetheprobabilitythattheentireprojectwillbecompletedbythedue date of 38 days.
k) Iftheprojectduedatechangesto35dayswhatistheprobabilityofnot meeting the due date.
l) Findtheduedatewhichhasaprobabilityof94.5%ofbeingmet.

Solution:

Activity	T_o	T_m	T_p	T_e	V_t
1-2	2	5	14	6	4
1-6	2	5	8	5	1

2-3	5	11	29	13	16
2-4	1	4	7	4	1
3-5	5	11	17	11	4
4-5	2	5	14	6	4
6-7	3	9	27	11	16
5-8	2	2	8	3	1
7-8	7	13	31	15	16



Activity	EST	LST	LST-EST
1-2	0	0	0
1-6	0	2	2
2-3	6	6	0
2-4	6	20	14
3-5	19	19	0
4-5	10	24	14
6-7	5	7	2
5-8	30	30	0
7-8	16	18	2

e) Criticalpathis1-2-3-5-8anditismarkedonthenetworkdiagram.

f) The length of the critical path or total project duration (T_e) is the sum of the duration of each critical activity = 6 + 13 + 11 + 3 = 33days

g) Varianceofthecriticalpathistwooftheeachcriticalactivity=4+16+4+1 =25

h) Theprobabilitythattheprojectwillmeetthescheduledorduedateis calculated from the

$$Z = \frac{D - T_e}{S_t}$$

$$Z = \frac{38 - 33}{5} = 1$$

WhereT_e=totalprojectduration

S_t=standarddeviation=√variance D =

Due or scheduled deviations

ForZ=1,probability=0.841

i) Thenextmostcriticalpathis1-6-7-8of31days.
Variance = 1+16+16 = 33

$s_t = \sqrt{33} = 5.74$

$$Z = \frac{D - T_e}{S_t} = \frac{38 - 31}{5.74} = 1.22$$

From the table

For Z = 1.22, probability = 0.888

j) To complete the project, there are three paths from first to last event,

a) 1-2-3-5-8 (33 days)

b) 1-2-4-5-8 (19 days)

c) 1-6-7-8 (31 days)

Path (b) involves much less time, so its probability of completing in 38 days is very high.

Paths (a) and (c) are independent of each other and the probabilities of paths (a) and (c) to complete in due time of 38 days are 0.841 and 0.888 respectively. Therefore the probability of heir both being completed in 38 days is = 0.841 X 0.888 = 0.7468.

k) Again $Z = \frac{D - T_e}{S_t} = \frac{35 - 33}{5} = 0.4$

From table for Z = 0.4 the probability of meeting due date is 0.655, and hence the probability of not meeting the due date

= 1 - 0.655 = 0.345

l) From table for the probability of 94.5% or 0.945, the value of Z = 1.6 $D - T_e$

And $Z = \frac{D - 33}{5}$, therefore $1.6 = \frac{D - 33}{5}$

And thus D = 41 days

<u>Difference Between PERT and CPM</u>

The fundamental network of PERT and CPM are though identical, yet there are (certain) differences in details as mentioned below:

	PERT	CPM

1.	A probabilistic model with uncertainty in activity duration. Expected time is calculated from t_o, $t_m$and t_p	A deterministic model with well-known activity (single) times based upon past experience. It assumes thattheexpectedtimeisactually thetimetaken.
2.	Anevent-orientedapproach.	Anactivity-orientedapproach.
3.	PERT terminology uses words like network diagram, events and slack.	CPM terminology employs works like arrow diagram, nodes, and float.
4.	Theuse of dummy activities is required forrepresentingthepropersequencing.	The use of dummy activities is not necessary.Thearrowdiagramthus becomesslightlysimpler.
5.	PERT basically does not demarcate between critical and non-critical activities.	CPMmarkscriticalactivities.
6.	PERT finds applications in projects where resources (men, materials and specially money) are always made availableasandwhenrequired.	CPM is employed to those projects where minimum overall costs is of primaryimportance.Thereisbetter utilizationofresources.
7.	Especiallysuitableindefenceprojects andR&Dwhereactivitytimescannot bereliably predicted	Suitableforproblemsinindustrial setting,plantmaintenance,civil constructionprojects,etc.

UNIT3:INVENTORYCONTROL

Introduction:

- To maximize profit and to establish reputation each industry has to focus on material planning. The materials which are procured and stocked to act as buffer for efficient operation of the system and the finished products which are stocked to meet the demand of the customer is termed as inventory.

  Inotherwordsinventorycanbedefined as

- Inventory is a detailed list of those movable items which are necessarytomanufactureaproductandtomaintaintheequipment and machinery in good working order.
- Itrepresents thoseitems whichare either stockedfor saleor theyarein the process of manufacturing or they are in the form of materials which are yet to be utilized.
  Ex–moneykeptintheshapeof HSStoolorbitMSrod.

Classificationofinventories:

1. Rawinventories(rawmaterials):
   - Raw materials and semi-finished products supplied by another firm which are raw items for present industry.
   - Raw materials are those basic unfabricated materials which havenotundergoneanyoperationsincetheyarereceivedfrom the suppliers. Ex – round bars, angles, channels, pipes etc
2. Work-in-progressinventories:
   - Semi-finishedproductsatvariousstoragesofmanufacturingcycle
   - The items or materials in partially completed condition of manufacturing
3. Finishedinventories:

   Theyarethefinishedgoodslyinginstockroomsandwaitingdispatch.
4. Indirectinventories:
   - The inventories refer to those items which do not form the part or the final product but consumed in the production process.

Eg–machinespares,oil,grease,spareparts,lubricants

- For proper operation, repair and maintenance during manufacturing cycle.

Functionsofinventories:

- Tostabilizeproduction
- Totakeadvantageofpricediscount
- Tomeetthedemandduringreplenishmentperiod
- Topreventlossoforders
- Tokeeppacewithchangingmarketconditions

Inventorycontrol:

- Keepingtrackofinventory
- Itisaplannedapproachofdeterminingwhattoorder,whentoorderand how much to order and how much to stock so that costs associated with buyingandstoringareoptimalwithoutinterruptingproductionandsales.
- Whenshouldanorderplaced
- Howmuchshouldbeorderedoreconomicorderquantity

Objectiveofinventorycontrol:

- Purchasingmaterialateconomicalpriceatpropertimeandinsufficient quantity as not to run slow
- Providingasuitableandsecurestoragelocation
- Tomaintaintimelyrecordofinventoriesofalltheitems
- Adefiniteinventoryidentificationsystem
- Adequateandresponsiblestoreroomstaff
- Suitablerequisitionprocedure
- Toprovideareservestock

Advantagesorbenefitsofinventorycontrol

- Onedoesnotfaceshortageofmaterials
- Materials of good quality andprocured in time minimized defect in finished goods.
- Delaysinproductionschedulesareavoided
- Productiontargetsareachieved
- Accuratedeliverydates
- Economyinpurchasing

Inventorycontrolterminology:

1. Demand:

   It is the no. of items (products) required per unit of time. The demand may be either deterministic or probabilistic in nature.

2. Ordercycle:

   Thetimeperiodbetweentwosuccessiveordersiscalledordercycle.

3. Leadtime:

   The length of the time between placing an order and receipt of items is called lead time.

4. Safetystock:

   It is also called buffer stock or minimum stock. It is the stock or inventoryneededtoaccountfordelaysinmaterialssupplyandto account for sudden increase in demand due to rush orders.

5. Inventoryturnover:

   If the company maintains inventories equal to 3 months consumptionit means thatinventory turnover is 4times a year i.e.theentireinventoryisusedupandreplaced4timesayear.

6. Reorderlevel:

   Itisthepointatwhichthereplenishmentactionisinitiated.When the stock level reaches ROL the order is placed for the item.

7. Reorderquantity:

   This is the quantity of material to be ordered at the reorder level. This quantity equals to the EOQ.

Costassociatedwithinventory

1. Purchase(orproduction)cost:

   Thevalueofanitemisitsunitpurchasingorproductioncost.

2. Capitalcost:

   The amount invested in an item is an amount of capital notavailable for other purchases.

3. Orderingcost:

   It is also known as procurement cost or replenishment cost or acquisition cost.

Twotypeofcosts-Fixedcostsandvariablecosts.

Fixed costs don't depend on the no. of orders whereas variable costs change

w.r.ttheno.oforders placed.

I. Purchasing:

The clerical and administrative cost associated with the purchasing, the cost of requisition material, placingtheorder,followup,receivingand evaluating quotations.

II. Inspection:

The cost of checking material after they are received by the supplier for quantity and quality and maintaining records of the receipts.

III. Accounting:

The cost of checking supply against a given level of hand and this cost vary in direct proportion to the amountofholdingandperiodofholdingthestockin stores.

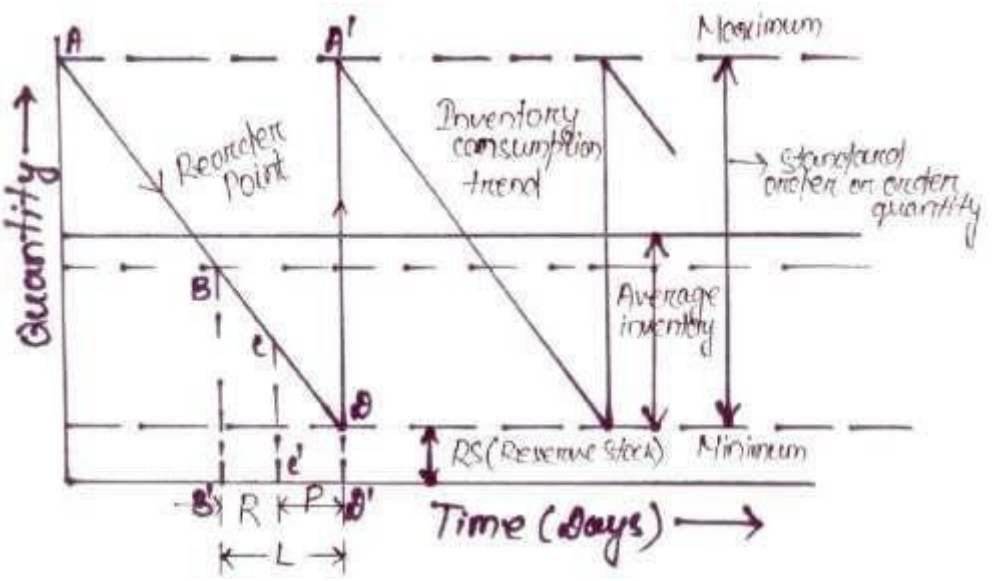
Thisincludes-

I. Storagecosts(rent,heating,lightingetc.)
II. Handling costs (associated with moving the items. Such as labour cost, equipment for handling)
III. Depreciation,taxesandinsurance
IV. Productdeteriorationandobsolescence
V. Spoilage,breakage

Economicorderquantity:

How much materials may be ordered at a time. An industry making bolts will definitely like to know the length of steel bars to be purchased at any one time. i.e. called EOQ.

An economic order quantity is one which permits lowest cost per unit and is most advantageous.



Starting from an instant when inventory OA is in the stores, it consumes gradually in quantity from A along AD at a uniform rate. We know it takes L no. of days between initiating order and receiving the required inventory. As quantityreachespointB,purchaserequisitionisinitiatedwhichtakesformBto CthatistimeR.fromCtoDistheprocurementtimeP.AtthepointDwhenonly resource stock is left, the ordered material is supposed to
reach and again the total quantity shoots to its maximum value i.e. the point A'(A=A')

Maximumquantity-OAistheupperormaxlimittowhichtheinventorycanbe kept in the stores at any time.

Minimum quantity- OE is the lower or minimum limit of the inventory which must be kept in the stores at any time.

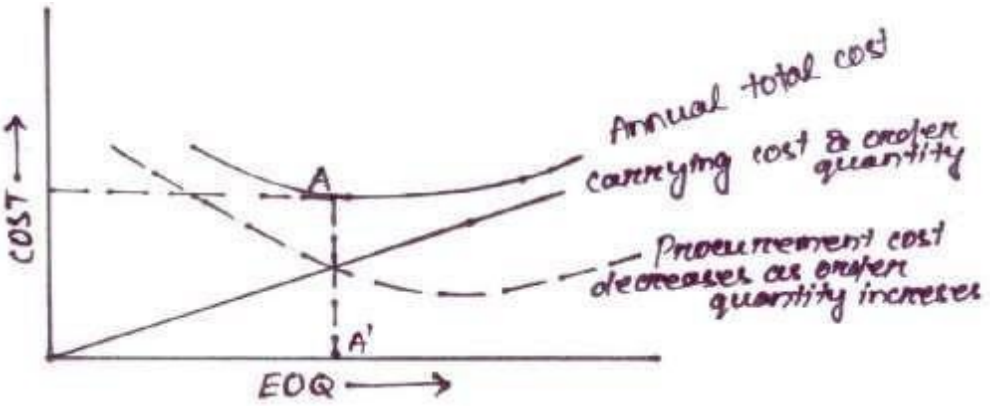
Standardorder(A'D) -Itis thedifference betweenmaximumandminimum quantityand is known as economical purchase inventory size.

Reorderpoint(B)-Itindicatesthatitishightime toinitiateapurchaseorderif notdonesotheinventorymayexhaust,evenreservestockutilizedbeforethe new material arrives.

FromB'toD'itis lead time and it may be calculated on the basis of past

experience. It includes-

a) Timetopreparepurchaserequisitionandplacingtheorder.
b) Timetakentodeliverpurchaseordertotheseller
c) Timeforsellertogetorprepareinventory
d) Timeforinventorytobedispatchedfromthevendor'sendandto reachthe costumer



Inventoryprocurementcost:

1. Receivingquotations
2. Processingpurchaserequisition
3. Followingupandexpeditingpurchaseorder
4. Receivingmaterialandtheninspectit
5. Processingseller'sinvoice

Procurementcostdecreaseasorderquantityincreases.

Inventorycarryingcost:

1. Interestoncapitalinvestment
2. Costofstoragefacility,up-keepofmaterial,recordkeeping
3. Costinvolvingdeteriorationandobsolescence
4. Costofinsurance,propertytax.

Carryingcostdirectlyproportionaltotheordersizeororderquantity

MathematicalderivationofEOQ:

LetQistheeconomiclotsizeorEOQ C is
the cost for one item.
Iisthecostofcarryinginventoryinpercentageperperiod P is
the procurement cost associated with one order
Uisthetotalquantityusedperperiod.Sayannually

$$\text{No.ofpurchaseorderstobefurnished} = \frac{\text{Totalquantity}}{\text{E.O.Q}} = \frac{U}{Q}$$

Totalprocurementcost=No.oforders×costinvolvedinoneorder $= \frac{U}{Q} XP$

Averageannualinventory= Q/2

Inventorycarryingcost=averageinventory×costperitem×costofcarrying inventory in % per period $= \frac{Q}{2} X C X I$

Totalcost(T)=a+b

$$= \frac{U}{Q} XP + \frac{Q}{2} X CXI$$

Tominimizethetotalcost,differentiateTwithrespecttoQandputitequaltozero. $\frac{dTd}{dQ} = \frac{U}{dQ} XP + \frac{Q}{2} XCXI = 0$

$$\Rightarrow -UPQ^{-2} + \frac{CI}{2} = 0$$

$$\Rightarrow \frac{UP}{CI}$$

$$\frac{\overline{\quad}}{Q^2} = \frac{\overline{\quad}}{2}$$

$$\therefore Q = \sqrt{\frac{2.\,U.\,P}{C.\,I}}$$

Problem-1:giventhat

I. Annualusage(U)=60units
II. Procurementcost(P)=Rs15perorder
III. Costperprice(C)=Rs100
IV. Costof carryinginventory(I) =
10 % Calculate EOQ.

Answer:

$$\therefore Q = \sqrt{\frac{2.U.P}{C.I}} = \sqrt{\frac{2X\ 60X\ 15}{100X.1}} = 13.41$$

$$\text{No.ofordersperyear} = \frac{60}{13.41} = 4.47 \sim 5$$

$$\text{SoE.O.Q} = \frac{60}{5} = 12(\text{rounded})$$

Problem-2:

The rate of use of a particular raw material from stores is 20 units per year. The cost of placing and receiving an order is Rs 40. The cost of each unit is Rs 100. The cost of carrying inventory in percent per year is 0.16 and it depends upon the average stock.

Determine the economic order quantity. If the lead time is 3 month, calculate the reorder point.

Answer:giventhat

U =

20units

P=Rs40

=Rs100/- I

= 0.16

$$EOQ = \sqrt{\frac{2UX\ P}{CX\ I}} = \sqrt{\frac{2X205X4010}{100X\ .164}} = 10$$

L=3months

Usein12months=20units

Usein3months==5units

∴ Recorderpointis5unitsinhand

Problem3:

Findeconomicorderquantityfromfollowingdata. Average annual demand = 30000 units
Inventory carrying cost = 12 % of the unit value per year

Cost of unit = Rs 2 /-

Costofplacinganorder=Rs70.

Answer:

Given,U=30000

I =12%
P=70/-
C=2/-

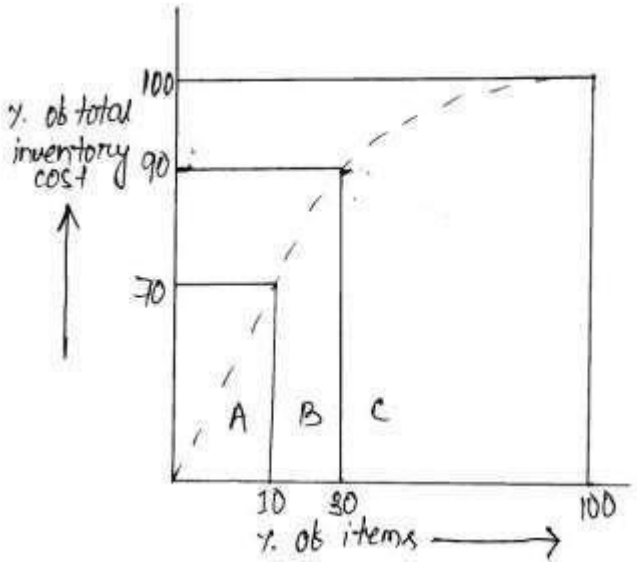
$$EOQ = \sqrt{\frac{2\ X\ U\ X\ P}{C\ X\ I}} = \sqrt{\frac{2X30000X70}{2X.12}} = 4183.3$$

$$\text{No. of orders} = \frac{30000}{4183.3} = 7.17 \sim 7$$

$$\text{EOQ} = \frac{30000}{7} = 4285.7 = 4286 \text{ (rounded)}$$

ABCanalysis:

ABCanalysishelpsdifferentiatingtheitemfromoneanotherandtells how much valued the item is and controlling it to what extent is in the interest of an organization.



1. A-items:

   A items are high valued but are limited or few in number. They need careful and close inventory control and proper handling and storage facilities should be provided for them.

   A items generally 70-80 % of the total inventory cost and 10 % of the total items.

2. B-items;

   B-items are medium valued and their umber lies in between A andCitems.Theyneedmoderatecontrol.Theyarepurchasedon the basis of past requirements.

   B-items generally 20-15 % of total inventory cost and 15-20 % of the total items.

3. C-items:

   C-items are low valued, but maximum numbered items. These items donotneed anycontrol.These are leastimportant items,

likeclip,allpins,washers,rubberbands.Norecordkeepingis done.
C-itemsgenerally10-5%ofthetotalinventorycostand
constitute 75 % of the total items

Advantage

I. Betterplanningandcontrol
II. Increaseinventoryturnover
III. Effectivemanagementandcontrol

Disadvantage

I. Periodicreviewtobedone

Procedure

1. IdentifyalltheitemsusedInindustry
2. Listalltheitemsaspertheirvalue.
3. Countthe no.ofhighvalued,mediumvaluedandlawvalueditems
4. Find the % of high, medium and low valued items High valued contribute – 70% of total inv. Cost Medium valued contribute -20% of total inv. Cost Low valuedcontribute-10%oftotalinv.Cost
5. A graph can be plotted between % of items and % of total inventory cost.

UNIT4:INSPECTION&QUALITYCONTROL

Inspectionaddstotheexpenditureofaproductionshop,butitisanintegral part of the production unit to control the quality of the product. In other words inspection and quality control create norms for standardization and result in interchangeability in the items.

Inspection is the art of comparing materials, processes and products with established standard.

- Itseparatesdefectivecomponentsfromnon-defectiveones.
- Itpreventsfurtherworkonspoiledinprocessproduct.
- Itcontrolworkmanshipofworker.
- Itbuildsindustriesreputationbymaintainingthequalityofthefinal product.
- Itpromoteseconomybypreventingexpenditureonpostsaleactivities.

PLANNINGOFINSPECTION:

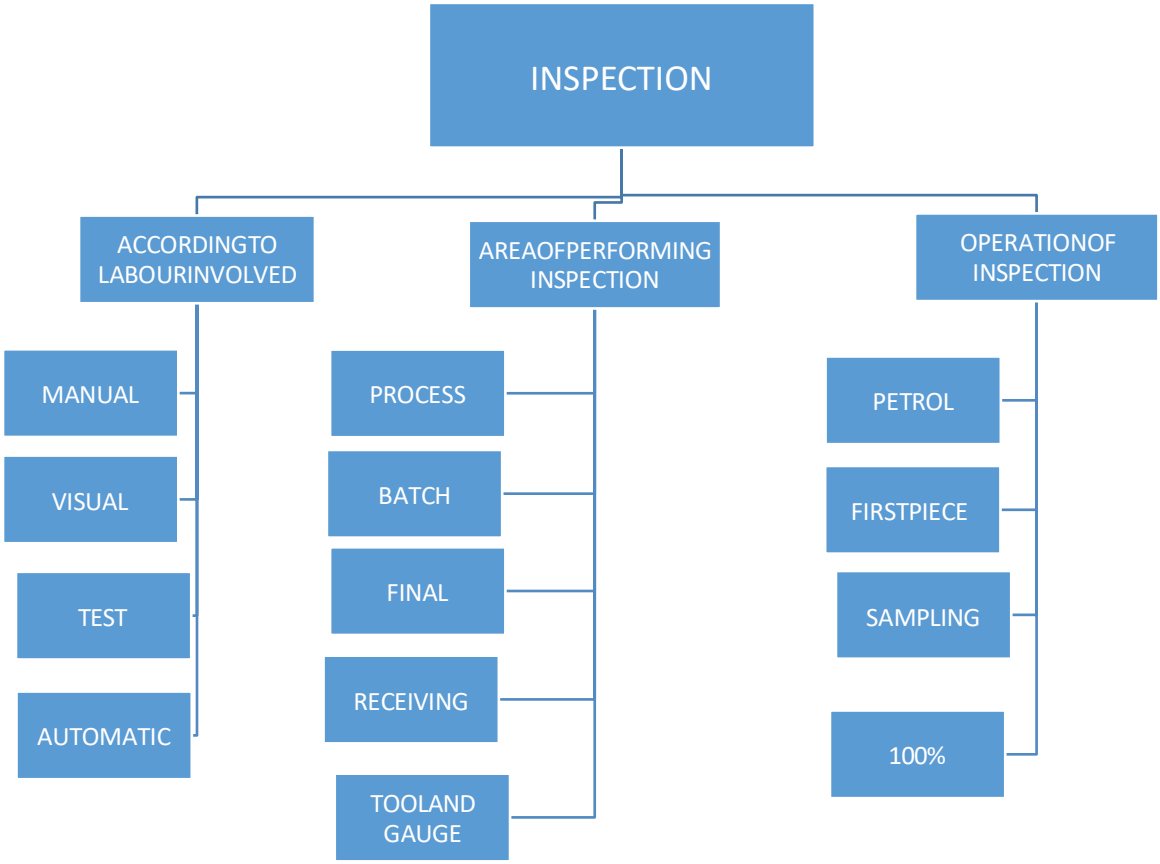
Planningofinspectionincludes

1. Placeofinspection
2. Timeofinspection
3. Methodofinspection
4. Degreeofinspectionconsideringtheallowedlimitofdeviationofthe final product.
5. Parameters which are to be measured and compared with standards.
6. Persons who will inspect at which location and will be responsible for measurement of which parameters.

In planning of inspection all above factors have to be considered and accordingly proper method of inspection is to be developed.

In the first phase of inspection, studying the processes involved in manufacturingandthequalitytobemaintaineddifferentparametershavechosen.
These parameters are treated as the variables to be studied in case of statistical analysis.

DESCRIBETYPESOFINSPECTION



Process/workinginspection

Theinspectionbeing carriedoutwhileinprocessare:

- Settingoflimitgaugesandcheckingthecorrectsettingofmachine.
- Checkingfrequentlyofthegaugesandlevelingthemsuitably.
- Inspectorshouldcheckproductsatdifferentintervaltoensurethatthey are being produced according to specifications.

Floor/PetrolInspection:

In this method a qualified inspector, keeps on patrolling on the shop floor constantly to keep an eye or inspect the part produced by machine immediately.

The floor inspection, keeps a constant check thereby discovering the faulty work as early as possible.

Theotheradvantagesareenlistedas:

- Spoilageofmaterialisprevented.
- Thefinalproductisalmostinspectedalready.
- Transportationisreduced.
- Reductioninlabourcost.
- Theinspectioncanhelpinremovingthetroublesindoingwork.

Besidestherearesomedisadvantagessuchas:

- Thetimeofinspectoriswastedinmovingfromoneareatoanother.
- The inspectionofproductioncannot be donewith moderncostly equipments. (difficult to carry on dirty floor)
- Itbecomesdifficulttokeepatrackofgoodorbadproducts.
- Duetodelayininspectionworkforanyreason,theworkmaybepiled up at the work stations.
- Highlyskilledandquickinspectorsarerequired.
- Personnel emotions can influences the inspector and he may favour some worker.

<u>Centralized/FixedInspection:</u>

In centralized inspection, he worker and inspector do not come face to face with each other but the work is brought to a fixed place such as inspection room. This type of inspection is best suited at place where the precision and costly equipment cannot be brought to the shop floor. However, the time taken in transporting the material to the inspection room can be reduced by location inspection room or inspection counter parallel to the flow of work through shop.

Themainadvantagesofthiscentralizedinspectionareasunder:

i) Asthereisnodirectcontactbetweenworkersandinspectorshence, the quality achieved is much better.
ii) Lessskilledinspectorscanbeengaged.
iii) Theautomationininspectioncanbedoneduetofixedplaceof inspection.
iv) Delicateinspectioninstrumentscanbeusedwithinaclosedroom.

v) Theshopfloorremainstidyandcleansothefinishedpartsaresent to inspection room to avoid piling up of finished part.

Thedisadvantagesofthistypeofinspectionareasunder:

i) Materialhandlingcostisincreased.
ii) The defects in jobsare detected afterthe completionofjob. Hence the critical point where the defect occur repeatedly cannot be amended immediately.
iii) More spoilage of the work due to non detection of defects at early stage.
iv) Morewastageoftimeduetodelayininspection room.
v) Extra scheduling, routing and dispatching work is done to include the inspection place.

RemedialandPreventiveInspection:

Preventive inspection lays emphasis on removing assignable variables by paying special attention to the accuracy of manufacturing process so that possibility of defects and waste is eliminated to the maximum possible extent.

Operative/StageInspection(Keypointinspection)

The inspection which takes placeat each stage or at the end of some functional operation.

IncomingorReceivingInspection:

Incoming inspection it examines everything coming into the plant e.g materials, parts, assemblies, equipments etc. the received material is generally checked for:

a) Requirementlaiddowninpurchaseorder
b) Damages,corrosion,cracksetc.
c) Testreportsincaseofrawmaterials.

SamplingInspection:

In sampling inspection a small number of parts are drawn which are representative of the entire load. The result of inspection of these samples judge the quality of whole lot.

Thepercentageof piecesto beinspected largelydependupon therequirementof the product and statistical experience.

CageInspection:

Thisisthelatestand advancedtypeofinspectioninwhichthemachinesare arrangedinacircleinsidewhichtheinspectionstaffremaininsideafence.Thepart afterworkedononemachineispassedto acorrespondinginspectorinsidea case. Ifthepartisproperwithinlimitsthenitisretainedwithinthecageotheritispassed back for rectification or rejection.

FirstpieceInspection:

InthistypeofinspectionthemachineusuallyautomaticorCNCissettothe parameters and only first four or five pieces are inspected. If any of them is found defective then the parameters are changed accordingly. Otherwise it is assumed that working conditions remaining same, the whole lot or batch of production will be correct to the specification.

PilotPieceInspection:

This type of inspection is almost similar to the first piece except that the product is passed through a series of machine performing entire sequence of operations. Now each machine and their tools are checked and adjusted or replaced.Thisiscontinueduntilaperfectpieceisproduced.Thisgivesanindication of a good production to start.

FunctionalInspection:

After the completion of assembly, it is checked for its functioning i.e it will withstandtheworkingconditionsimposeduponitwhileperformingitsfunctione.g the functional testing of a locomotive boiler to ensure its designed power production.

EnduranceInspection:

This is the time based inspection imposed to test the duration for which an assembly will perform its function satisfactorily.

ToolInspection:

In addition to the inspection of material, the inspection of tool, jigs and fixtures and gauge is also necessary to eliminate the wrong processes. It is based on the principle that the proper tools result in proper product. This types of inspectionis verymuchnecessaryforCNCor automaticmachines. Thescrapingof old, obsolete and worn out tools should be replaced immediately.

FACTORSINFLUENCINGTHEQUALITYOFMANUFACTURE:

The following nine M's directly affect the quality of products and services, and thus these must be thoroughly recognized and dealt with.

i) Market for products , services
ii) manpower
iii) materials
iv) money
v) management
vi) machinesandmethod
vii) motivationofemployees
viii) modern information approaches
ix) mountingproductsneeds.

1. Market Demand: It occurs as per customers demand for a particular product type, quality and quantity.
2. Manpower:Bothforqualitydesignsandforproductionofqualitygoods right type of men with required knowledge are essential.
3. Materials: Due to pressure on production cost and quality requirements, it becomes necessary to work with wide variety of materials having right specification.
4. Money: Increased competition, more mechanization and lower profit margins have made scrap and rework losses as very serious. Cost of maintenance and improvement of quality have increased to a great extent. Money crunch touches the quality.
5. Management:Withoutmanagement'sinterestandactiveco-operation there can be no adequate quality.
6. MachinesandMethods:Manufacturingequipmenthavebecomemore complex in order to meet high volume of production and high level of quality goals. The machines and technologies required are highly sensitive to meet quality goals.
7. Motivation of employees: A motivated worker can produce better qualityproductsandhecanalsoincreaseandbettertheproduction

rate.Themotivationoftheemployeescanbedonebyfinancial(Bonus, increments etc) or non- financial (Praising etc) benefits.

8. Moderninformationapproaches:Byimplementingmoderninformation approaches to the various production and Marketing process the quality of products can be improved.
9. Mounting product needs: The right operation at right time in the production process can also improve quality of products.

Controlcharts(X,R,P,andC–charts)

1. X-Charts:Thechartisbasedonthemeasurementdatainsteadofdata that arisesimply from classification andcounting. Sample size can be smalleralso. It isconstructedtoshowthefluctuations of the means of samplesaboutthemeanoftheprocesses.Thischartwillhelptheuser in tracking down the assignable causes.

   Thecontrolcharthasthefollowingadvantages:

   1. Itshowschangesinprocessaverageandisaffectedbychangesin process variability.
   2. Itisachartforthemeasureofcentraltendency.
   3. Itshowserraticorcycleshiftsintheprocess.
   4. Itdefectssteadyprogresschanges,liketoolwear.
   5. Itisthemostcommonlyusedvariableschart.
   6. WhenusedalongwithRchart:
      a. It tells when to leave the process alone and when to chaseand go for the causes leading to variation.
      b. Itsecures information in establishing or modifying processes specifications or inspection procedures and

   c.Itcontrolsthequalityofincomingmaterial.

   7. X andRcharswhenusedtogetherformapowerfulinstrumentfor diagnosing quality problems.

   ThecontrollimitsofXchartaregivenas:

   Upper control limit (UCL) $= \overline{\overline{X}} + A_2 \overline{R}$

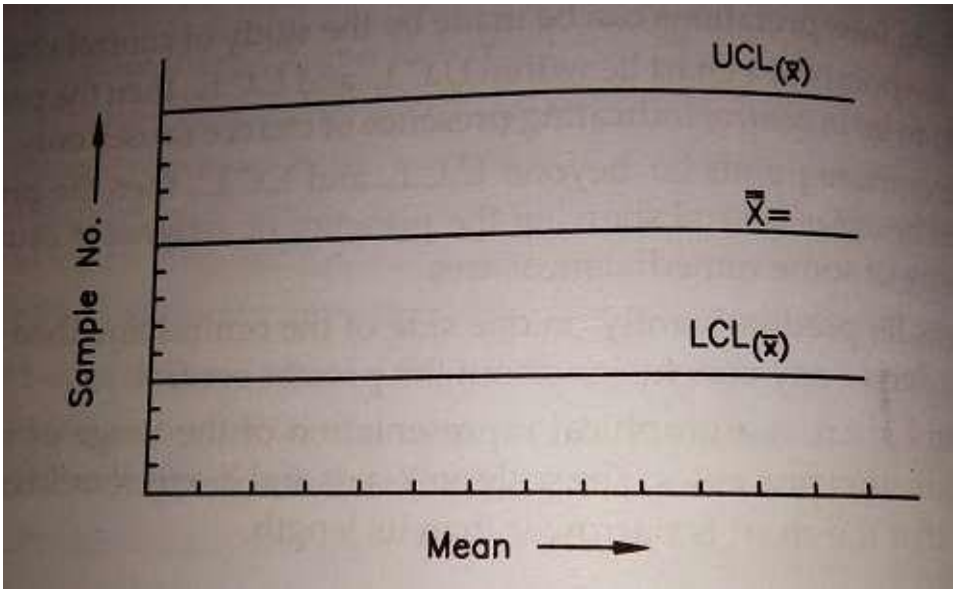
   Central line (CL) $= \overline{\overline{X}}$

   Lowercontrollimit(LCL)$= \overline{\overline{X}} - A_2 \overline{R}$

   Where,$\overline{\overline{X}}$=mean(average)ofsamplemeans

   $$= \frac{\Sigma \overline{X}}{n} = \frac{\overline{X}_1 + \overline{X}_2 + \overline{X}_3 + \ldots\ldots \overline{X}_n}{n}$$

=arithmeticmeanofX_1,X_2,X_3etc.



R = Range = Difference between the largest observed data and he smallest observed data.

$=X_H-X_L$

$$\bar{R} = \frac{\Sigma R}{n} = \text{mean(average)ofrange}$$

$$= \frac{R_1+R_2+R_3+\ldots\ldots R_n}{n}$$

A_2=Chartfactorformeanchart.

2. R chart: It is used to show fluctuations of the ranges of the samples about the average range R. This control general variability of the process and affected by the changes in variability. It is a char for measure of spread. It is generally used along with an X chart.

ThecontrollimitsforRchartaregivenas:

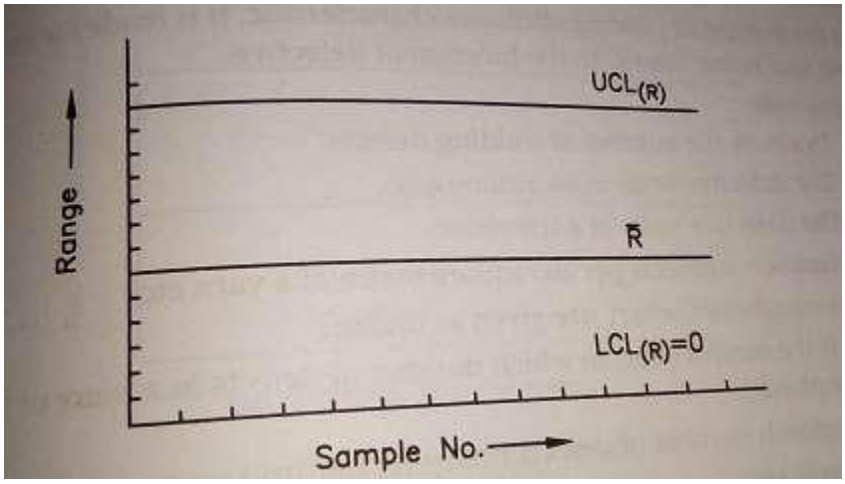
Upper control limit (UCL) = $\bar{D}_4\bar{R}$

Lowercontrollimit(LCL)=$D_3\bar{R}$

Where ,R = Average of sample ranges

D_4=controlfactorforUCLofR-chart

D_3=controlfactorforLCLorR-chart



ThevalueofD3andD4dependsonsamplesizechosenandtheirvalue are available from standard table.

Factorsfordeterminingthe3sigmacontrollimitsfor$\bar{x}$andRcharts

umber of observations in sub-group n	ctor for c chart, A_2	Factorfor Rchart	
		wercontrollimit D_3	ercontrollimit D_4
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
7	0.42	0.08	1.92
8	0.42	0.14	1.86

9	0.37	0.18	1.82
10	0.34	0.22	1.78
11	0.31	0.26	1.74
12	0.29	0.28	1.72
13	0.27	0.31	1.69
14	0.25	0.33	1.67
15	0.24	0.35	1.65
16	0.22	0.36	1.64
17	0.21	0.38	1.62
18	0.20	0.39	1.61
19	0.19	0.40	1.61
20	0.18	0.41	1.59

3.P-Chart:The chart showsthe variation in the fractiondefectivesof output.Italsoknown ascontrolchartfor “Go”and“NotGo”data. It is a tool for process quality control and hence it is quality control by attributes, sometimes it is also known as “control chart for attributes”. The P-chart have following advantages given as under:

a) Itcanbeafractiondefectivechartor%defectivechart(100P).
b) Eachitemisclassifiedasgoodorbad.
c) This chart is used to control the general quality of the component parts and it checks if the fluctuations in product quality (level) are due to chance cause alone.
d) Itcanbeusedevenifsamplessizeisvariablebutcalculatingcontrol limits for each sample is rather cumbersome.

P-chartisplottedbycalculatingthefractiondefectivefirstandthenthe control limits.

LotNo	SampleSize(a)	No.ofDefects(P)	Fraction Defectives P = ... a
1 2 3 4			

. . . . . .			

Totalno.ofitems,n=Totalno.oflotsXsamplesize He

control limits for P-chart are given as :

$$\text{Uppercontrollimit(UCL)} = \bar{P} - 3\sqrt{\frac{Pq}{n}}$$

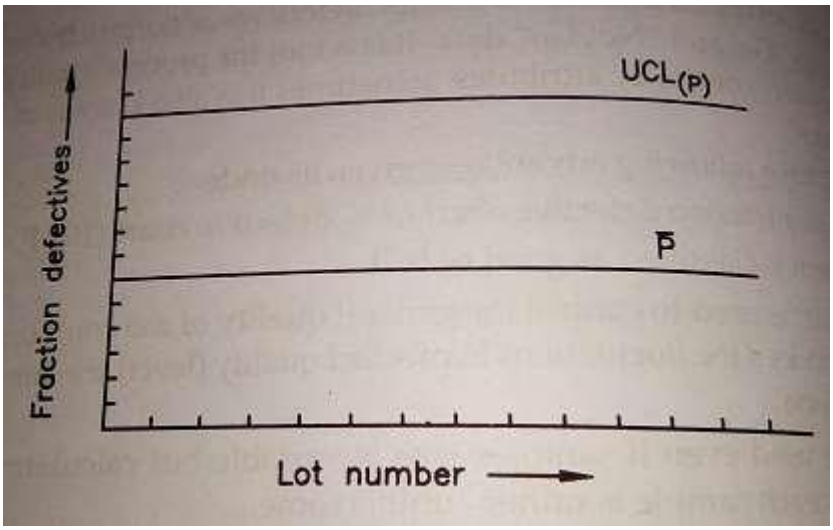
$$\text{Lowercontrollimit(LCL)} = \bar{P} - 3\sqrt{\frac{Pq}{n}}$$

WhereP=overallfractiondefective.

$$= \frac{\text{Totalnumberofitemsdefective}}{\text{Total number of items inspected}}$$

$q = (1-P)$

n=samplesize.



TheP-chartcanalsobepreparedinthefollowingtwoforms:

i) Numberofdefective(np)chart:

$$UCL = n\bar{P} + nX\ 3\sqrt{\frac{Pq}{n}}$$

$$LCL = nP - nX\ 3\sqrt{\frac{Pq}{n}}$$

ii) Presentdefectivechart:

$$UCL = 100\bar{P} + 100X3\sqrt{\frac{Pq}{n}}$$

$$LCL = 100P - 100X3\sqrt{\frac{Pq}{n}}$$

4. Cchart: It is the method of plotting attributes characteristic. It is made fornumberofdefectsperunitratherthanwiththefunctionofdefective. For example:
   a) Inaturn,thenumberofwelding defects.
   b) Thedefectiveunitsinanautomobile.
   c) Thedefectiveunitsinatelevision.
   d) Numberofdefectsper100squaremeterofayarnetc.

   TheadvantagesofC–chartaregivenas under:

   a) Itisthecontrolchartinwhichnumberofdefectsinapieceora sample are plotted.
   b) Itcontrolsnumberofdefectsobservedperunitorpersample.
   c) Samplesizeisconstant.
   d) The chart is used where average number of defective prices in a given sample, C chart takes in to account the number of defects in eachdefectivepieceorandagivensample.Adefectivepiecemay contain more than one defect.
   e) Whereas , P chart considers the number of defective pieces in a given sample, C chart takes into account the number of defects in eachdefectivepieceorandagivensample.Adefectivepiecemay contain more than one defect.
   f) Cchartispreferredforlargeandcomplexparts.
   g) Ithaslimiteduse.

ThecontrollimitsforCchartaregiven as:

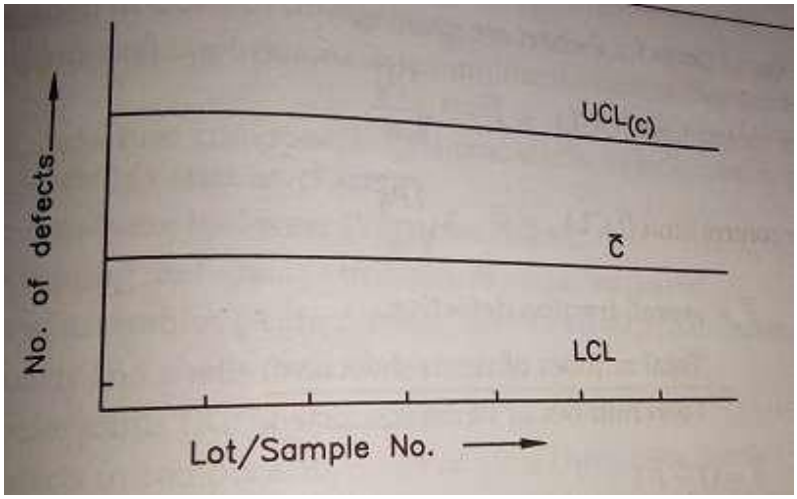
Upper control limit (UCL) $= \bar{C} + \sqrt{\bar{C}}$

Lower control limit (LCL) $= \bar{C} - 3\sqrt{\bar{C}}$

Where $\bar{C}$ = average number of defects per sample

$$= \frac{\text{Total number of defects in all the samples}}{\text{Total number of samples inspected}}$$

Lot/Sample Number	No. of Defects
1 2 3 4	
$\Sigma n =$	$\Sigma C =$



UNIT5:Productionplanningandcontrol

Production –Production are manufactured by the transformation of raw material into finished goods

Planning-planninglooksahead,anticipatespossibledifficultiesanddecidesin advance as to how the production is to be carried out.

Control- the control phasemakes sure thatprogrammedproduction is constantly maintained

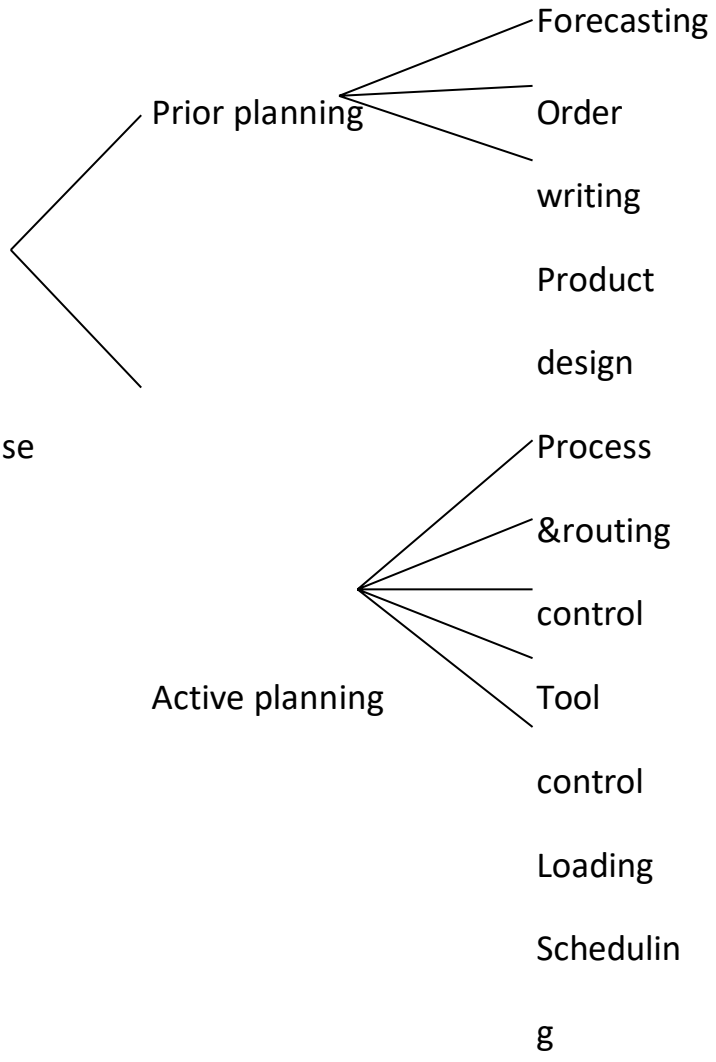
NeedforPPC-

- Toachieveeffectiveutilizationoffirmsresources
- Toachieve theproductionobjectiveswith respecttoquality, quantity, costand timeliness of delivery.
- Toobtain the uninterrupted productionflowin ordertomeetcustomers demand w.r.tqualityandcommitteddeliveryschedule.
- Tohelpthecompanytosupplyagoodqualityproductstothe customer on the continuous basis at competitive rates

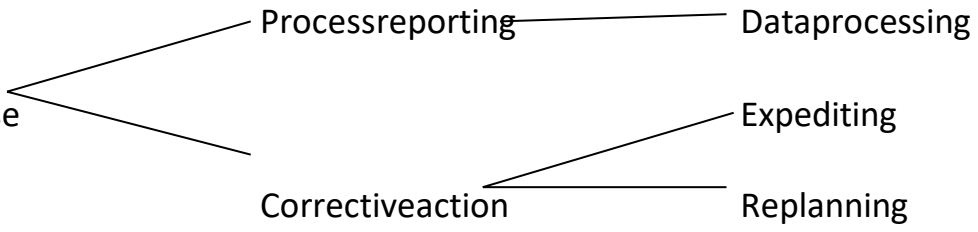
ObjectivesofPPC-

- Systematic planning of production activities to achieve the highest efficiency in production of goods
- Toorganizetheproductionfacilitieslikemachines,men,etc.to achievestated production objectives
- Optimumschedulingofresources
- Toconfirmtodeliverycommitments
- Materialsplanning&control
- Tobeabletomakeadjustmentsduetochangesindemandandrushorders

Functionsofproductionplanning&control



2. Actionphase ---------- Dispatching



a) Forecasting-estimationoftype,quantityandqualityoffuturework.
b) Orderwriting-givingauthoritytooneormorepersonstoundertakea

particularjob.

c) Product design- collection of information regarding specifications, bill of materials, drawings etc.
d) Process planning & routing- finding the most economical process of doing a work andthen deciding how & where the work will bedone
e) Material control-it involvesdetermining the requirementsand control of materials
f) Tool control- it involves determining the requirement and control of toolsused
g) Loading-assignmentofworktomanpowermachineryetc.

h) Scheduling- it is the time phase of loading & determines when and in what sequence the work will be required out. It fixes the starting as well as the finishing time for the job

i) Dispatching- it is the transition from planning to action phase. In this phase the worker is ordered to start the actual work.

j) Progressreporting-Dataregardingthejobprogressiscollected.
-It is interpretedby comparisonwiththe preset level of performance.

k) Corrective action- 1. Expanding means taking action if the progress reporting indicates deviation of the plan from the originally set targets
2. Replanning of the whole affair becomes essential, in case expediting fails to bring the deviated plan to its actual path

Processplanning-

Definitionandconcept

- Processplanningmeansthepreparationofworkdetailplan
- Sinceaprocessisrequiredtomanufactureaproduct,itisnecessary to plan the process
- PP is determining the most economical method of performing an operation or activity
- Processplanningcomesafterithasbeendecidedaswhatistobemade Process planning develops the broad plan of manufacture for the componentorproduct
- Process planning takes as its input the drawings or other specifications whichshowwhatistobemadeandforecastsororderswhichindicatethe product quantity to be manufactured

Informationrequiredtodoprocessplanning-

- Quantityofworktobedonealongwithproductspecification Quality of work to be completed
- Availabilityofequipments,toolsandpersonneletc.
- Sequenceinwhichoperationswillbeperformedontherawmaterial

- Namesofequipmentsonwhichtheoperationswillbeperformed
- Standard time for each operation
- Whentheoperationswillbeperformed

Process planning procedure-

1. Selectionofprocess
   - a process is necessary in order to shape, form, condition and join materials and components with the help of machines and labour in order to convert raw material into a finished product.
   - One shouldselect the most economical process andsequencethat satisfies the product specifications
   - Theselectionofprocessdependsupon

a) Currentproductioncommitments-
Its enough work has already been allocated to more efficient equipments,thecurrentworkmayhavetobepassedontolessefficient m/c s to complete the same in time

b) Deliverydate-
   - anearlydeliverydatemay
   - forcetheuseoflessefficientm/cs
   - rule out the use of special tools & jigs as they will take time for design and fabrication

c) quantitytobeproduced-Smallquantitywillnotprobablyjustifythehigh costofpreparationandefficientset-ups.Thus,theymaygavetobemade on less efficient machines and vice-versa.

d) Qualitystandards-Qualitystandardsmaylimitthechoiceofmakingthe product on a particular machine

2. Selectionofmaterial-
   - Material shouldbeof rightqualityand chemical composition as per the product specifications
   - Shape and size of material should restrict the scrap(i.e. material removed for getting the product shape)
3. Selectionofjigs,fixturesandotherspecialattachments
   These supporting devices are necessary
   - Togivehigherproductionrate
   - Toreducecostofproductionperpiece
4. Selectionofcuttingtoolsandinspectiongauges-
   Reduce production time
   - Inspectaccuratelyandatafasterrate

5. Maketheprocesslayoutindicatingeveryoperationandthesequencein

whicheachoperationistobecarriedout

6. Findsit-uptimeandstandardtimeforeachoperation

7. Manifest process planning by documents such as operation and route sheets, which gives information about the operations required, the preferred sequence of operations, auxiliary tools required estimated operationtimes

Routing

- taking from raw material to the finished product, routing decides the pathandsequenceofoperationstobeperformedonthejobformone machine toanother
- itdetermineswhatworkistobedoneandwhereandhowitwillbedone

Procedure

- the finished product is analyzed from the manufacturing stand point in order to decide how many components can be made in the plant and how many others will be purchased from the outside through vendors, bysubcontractingetc.make/buydecisionsdependsupontheworkload in the plant, availability of equipment and personnel to manufacture all components and the economy associated with making all components within the plant itself
- A parts list and a BOM is prepared showing name of the part, quantity, material specifications amount of materials required etc. The necessary materials thus can be produced
- From production standards m/c capacities, m/c characteristics and the operations which must be performed at each stage of manufacture are established and listed in proper sequence on an operation and route sheet. the place of operations is also decided
- Operation and route sheet are separate. An operation sheet shows everything about the operation, i.e. operation description, their sequence, type of machinery, tools, setup and operation times, where as a route sheet besides listing the sequence of operations and relation between operation and machine, also details the section and the m/c to whom the work will flow

Operationandroute sheet								
Component No. _____					Drawing _____			
Nameof component _____					Quality _____			
Material _____					To becompletedon ____			
Routing		Operation No.	Operation description	Tools required	Fixtures	Time		
Section	Machine					Set up	Operation	total

The difference between an operation sheet and a route sheet is that an operationsheetremainssameforthecomponentsittheorderis repeatedbut the route sheet may have to be revised it certain machines are already committed to other jobs.

- The next step is to determine the lot size or the number of components tobe manufactured in one lot or batch.
- Standardscrapfactorsandtheplaceswherescrapisverylikelyoccurare identified causes for points out of control limits are explored and corrected. The variables like workers, machinery and schedules may adjust to minimize scrap.
- The cost of the component is analyzed and estimated through the information obtain in steps. The costs consist of material and labour charges and other specific and general indirect expenses.

Scheduling:

- Schedulingmeanswhenandinwhatsequencetheworkwillbedone.It involvesdecidingastowhentheworkwillstartandinacertainduration of time how much work will be finished.
- It determines which order will be taken up on which machine and in which department by which operator.

Schedulingprocedureandtechniques:

Masterschedule:

Master schedule for the foundry shop Maximum production – 100 Hr Minimumproduction–8Hr			
Week-1	Week-2	Week-3	Week-4
15	15	20	15
25	25	12	10
20	28	32	
35			

- A master schedule resembles central office which possesses information about all the orders in hand.
- Astheordersarerecеived,dependingupontheirdeliverydatestheyare worked on the master schedule when the shop capacity is full for the present week the newly acquired orders are carried over to due next week and so on.
- A master schedule updated continuously.

Advantages:

- Itissimpleandeasytounderstand.
  It can be kept current.
- Itinvolveslesscosttomakeitandmaintain.
  It can be maintained by non-technical staff.
- A certain percentage of total weekly capacity can be allocated for rush orders.

Disadvantages:

- Itprovidesonlyoverallpicture.
- It does not give detailed information.

Applications:

- For the purpose of loading the entire plant.
- Inresearchanddevelopmentorganizations.
- Fortheoverallplanninginfoundries,computerentries,repairshopsetc.

Schedulingtechnique:

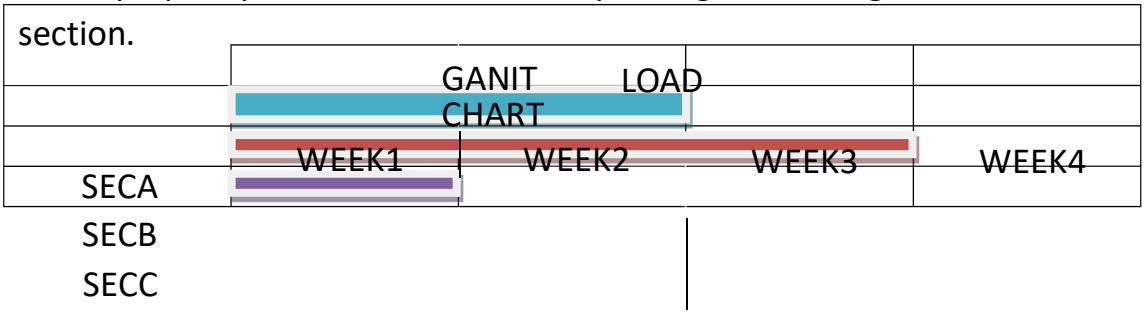
a)Perpetualschedule:

It is similar to master scheduling. It is simple and easy to understand.Itinvolveslesscostandcanbemaintainedbyclerical staff. The information is not clear when work will take place.

i. Preparationofloadanalysissheetfromtheordersinhand.

LOAD ANALYSIS SHEET			
	LOAD IN Hr/DAYS		
ORDER No.	SEC A	SECB	SECC
X-320	25	10	16
Y-210	10	15	10
Y-314	18	20	8
Z-150	8	25	------
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.

ii. Weeklycapacityofsectioniscalculatedbyaddingtotalloadagainsteach section.



Colorbarsareshowstheactualworkloadagainsteachsection.

Dispatching:

- Dispatchingisthephysicalhandingoverofamanufacturingordertothe operatingfacilitythroughthereleaseofordersandinstructions

previouslydevelopedplanofactivity(timeandsequence)establishedby the scheduling section of the production planning and control department.

- Dispatchertransmitsorderstothevariousshops.
- Dispatcher determines by whom the job shall be done and it coordinates production.
- Itcreatesadirectlinkbetweenproductionandsales.

Procedure:

The product is broken into different components and components into operations.AroutesheetforthepartChavingthreeoperationsonitis shown.

ROUTESHEETPARTC
MATERIAL
OPERATION-1
OPERATION-2
OPERATION-3

a) Storeissueorder:

Authorizestorestodeliverrequiredrawmaterial.

b) Toolorder:

Authorize tool store to release the necessary tools. The tools can be collected by the tool room attendant.

c) Joborder:

Instruct the worker to proceed with the operations and formsthe basis for worker's pay.

d) Timeticket:

Itrecordsthebeginningandendingtimeoftheoperationsand forms the basis for worker's pay.

e) Inspectionorder:

Notify the inspectors to carry out necessary inspections and report the quality of the component.

f) Moveorder:

Authorizedthemovementofmaterialsandcomponentsfromone facility to another for further operations.

Processcontrol:

It means trying to achieve the standards set i.e. a certain level of efficiencyoracertainvolumeofproductioninaspecifiedduration.Thesystem of progress control should be such that it furnishes timely, adequate and accurate information about the progress made, delays and under or overloading.

Steps:

a) Settingupasystemtowatchandrecordtheprogressoftheoperatingfacility.
b) Makingareportoftheworkprogressorworkaccomplishment.
c) Transmissionofreportto
   i. Controlgroupfornecessarycontrolaction
   ii. Accountinggroupforrecordingmaterialandlabourexpenditures.
d) Interpretationoftheinformationcontainedintheprogressreportby thecontrol group.
e) Takingcorrectiveactionif necessary.