MAR GREGORIOS COLLEGE
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DEPARTMENT OF COMMERCE
(ACCOUNTING & FINANCE)

SUBJECT NAME: **ELEMENTS OF OPERATIONAL RESEARCH**

SEMESTER: IV

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ELEMENTSOFOPERATIONSRESEARCH

SYLLABUS

OBJECTIVES

- ToFacilitatethisUnderstandingoftheConceptofOperationsResearch
- ToHelptheStudentstoUnderstandtheVariousTechniquesofSolvingProblems

OUTCOME:

- Understanding of the Concept of Operations Research and to Help the StudentstoUnderstandthe VariousTechniquesofSolvingProblems

UNITI:Introduction

OperationsResearch-Meaning-Definition-OriginandHistory-CharacteristicFeatures –Need-Scope–Steps-Techniques-Application-Limitations

UNITII:LinearProgrammingProblemLpp

Meaning- Requirements- Assumptions- Applications- Formulating Lpp –Advantages-LimitationsFormulatingLPModel(SimpleProblemsOnly)

UNITIII:MethodsOfLpp

ObtainingOptimalSolutionforLinearProgrammingProblem(LPP)-GraphicalMethod -Problems--SimplexMethodforTypeofLPPandforSlackVariableCase-MaximizationFunction-Minimization Function(SimpleProblemOnly)

UNITIV:TransportationProblems

Meaning –(Initial Basic Feasible Solution)Assumptions -Degenerate Solution -North -WestCornerMethod-LeastCostMethod-VogelsApproximationMethod-AssignmentProblems-Features-TransportationProblemVsAssignmentProblem-HungarianMethod(SimpleProblemsOnly)

UNITV:GameTheory

Meaning- Types ofGames- BasicAssumptions- FindingValue ofGame for PureStrategy-MixedStrategy-IndeterminateMatrixandAverageMethod-GraphicalMethod -Pure Strategy- Saddle Point Payoff Matrix Value of Game (Simple ProblemsOnly)

UNITI
Introduction

Operationsresearch meaning

Operationss research (OR) is an analytical method of problem-solving and decision-makingthat is useful in the management of organizations. In **operationss research**, problems arebrokendownintobasiccomponentsandthensolvedin**defined**stepsbymathematicalanalysis.

DefinitionofOperationsResearch.

It is the application of scientific methods, techniques and tools to problems involving theoperationss of a system so as to provide those in the control of the system with optimumsolutions to theproblems.

Characteristics(Features)ofOperationsResearch:

Maincharacteristics ofoperationssresearch (O.R.)arefollows:

(i) Inter-DisciplinaryTeamApproach:

This requires an inter-disciplinary team including individuals with skills in mathematics,statistics,economics,engineering,materialsciences, computeretc.

(ii) WholisticApproachtotheSystem:

While evaluatinganydecision,theimportantinteractionsandtheirimpactonthewholeorganisationagainstthefunctions originally involvedarereviewed.

(iii) MethodologicalApproach:

O.R.utilisesthescientificmethodtosolvetheproblem

(iv) ObjectiveApproach:

O.R. attempts to find the best or optimal solution to the problem under consideration, takingintoaccountthegoalsof theorganisation.

ScopeofOperationsResearch

1. Finance,Budgeting and Investment:

i. Cash flow analysis, long range capital requirement, investment portfolios, dividendpolicies,
ii. Claimprocedure,and
iii. Creditpolicies.

2. Marketing:
i. Productselection, competitiveactions,
ii. Numberofsalesmen,frequencies ofcallingon,and
iii. Advertisingstrategieswithrespecttocostandtime.

3. Purchasing:
i. Buyingpolicies,varying prices,
ii. Determinationofquantitiesandtimingofpurchases,
iii. Biddingpolicies,
iv. Replacementpolicies,and
v. Exploitationofnewmaterialresources.

4. ProductionManagement:
i. Physical distribution: Location and size of warehouses, distribution centres and retailoutlets,distribution policies.
ii. FacilitiesPlanning:Numberand locationoffactories,warehousesetc.Loadingandunloadingfacilities.
iii. Manufacturing: Production scheduling and sequencing stabilisation of production,employment,layoffs, and optimumproductmix.
iv. Maintenancepolicies,crewsize.
v. Projectschedulingand allocationofresources.
5. PersonnelManagement:
i. Mixesofageandskills,
ii. Recruitingpolicies,and
iii. Jobassignments.
6. ResearchandDevelopment:
i. AreasofconcentrationforR&D.
ii. Reliabilityandalternatedecisions.
iii. Determinationoftime-costtradeoffandcontrolofdevelopmentprojects.

LimitationsofOperationsResearch:

i. Thesedonottakeintoaccountqualitativeandemotionalfactors.
ii. Theseareapplicabletoonlyspecificcategories ofdecision-makingproblems.
iii. Thesearerequiredtobeinterpretedcorrectly.
iv. Due to conventional thinking, changes face lot of resistance from workers and sometimesevenfromemployer.
v. Modelsareonlyidealisedrepresentationofrealityandnotberegardedasabsolute.

TechniquesofOperationsResearch

TechniquesofOperationsResearch:

ImportanttechniquesofOperationsResearch arebeingdescribedhereunder:

(i) InventoryControlModels:

Operations Research study involves balancing inventory costs against one or more ofthefollowing costs:
i. Shortagecosts.
ii. Orderingcosts.

iii. Storagecosts.

iv. Interestcosts.

Thisstudyhelpsin taking decisionsabout:

i. Howmuchtopurchase.
ii. Whentoorder.
iii. Whethertomanufactureortopurchasei.e.,makeandbuydecisions.

The most well-known use is in the form of Economic Order Quantity equation for findingeconomiclotsize.

(ii) WaitingLineModels:

Thesemodelsareusedforminimisingthewaitingtimeandidletimetogetherwiththecostsassociated therewith.

Waitinglinemodels areoftwotypes:

(a) Queuingtheory,whichisapplicablefordeterminingthenumberofservicefacilitiesand/or thetiming ofarrivalsfor servicing.

(b) Sequencingtheorywhichisapplicablefordeterminingthesequenceoftheservicing.

(iii) ReplacementModels:

These models are used for determining the time of replacement or maintenance of item,whichmayeither:

(i) Becomeobsolete,or
(ii) Becomeinefficientforuse,and
(iii) Becomebeyond economicaltorepair or maintain.

(iv) AllocationModels:

Thesemodels areusedtosolvetheproblems arisingwhen:

(a) Therearenumberofactivitieswhicharetobeperformedandtherearenumberofalternati vewaysof doing them,

(b) Theresourcesorfacilitiesarelimited,whichdonotalloweachactivitytobeperformedinbest possible way. Thus these models help to combine activities and available resources so astooptimiseand getasolution to obtain anoveralleffectiveness.

(v) CompetitiveStrategies:

Such type of strategies are adopted where, efficiency of decision of one agency is dependenton the decision of another agency. Examples of such strategies are game of cards or chess,fixingofprices inacompetitivemarketwherethesestrategiesaretermedas “theory”.

(vi) LinearProgrammingTechnique:

These techniques are used for solving operations problems having many variables subject tocertain restrictions. In such problems, objectives are—profit, costs, quantities manufacturedetc.whereasrestrictionsmaybee.g.policiesofgovernment,capacityoftheplant,demandoftheproduct,availabilityofraw materials,water orpowerandstoragecapacityetc.

(vii) SequencingModels:

These are concerned with the selection of an appropriate sequence of performing a series ofjobs tobedoneonaservicefacilityormachineso as tooptimisesomeefficiencymeasureofperformanceof thesystem.

(viii) SimulationModels:

Simulationisanexperimentalmethodusedtostudybehaviourovertime.

(ix) NetworkModels:

Thisis anapproachtoplanning,schedulingandcontrollingcomplexprojects.

ApplicationsofOperationsResearch:

Thesetechniques areappliedtoaverywiderangeofproblems.

Hereonlysomeofthecommon applicationsarebeingmentioned:

(i) DistributionorTransportationProblems:

Insuchproblems,variouscentreswiththeirdemandsaregivenandvariouswarehouseswiththeir stock positions are also known, then by using linear programming technique, we canfind out most economical distribution of the products to various centres from variouswarehouses.

(ii) ProductMix:

Thesetechniques canbeappliedtodeterminebestmixoftheproducts foraplantwithavailableresources,so as togetmaximumprofitorminimumcostofproduction.

(iii) ProductionPlanning:

These techniques can also be applied to allocate various jobs to different machines so as togetmaximumprofitortomaximiseproductionortominimisetotalproductiontime.

(iv) AssignmentofPersonnel:

Similarly, this technique can be applied for assignment of different personnel with differentaptitudetodifferentjobssoas to completethetaskwithinaminimumtime.

(v) AgriculturalProduction:

We can also apply this technique to maximise cultivator's profit, involving cultivation ofnumberofitemswithdifferentreturnsandcroppingtimeindifferenttypeoflandshavingvariablefertility.

(vi) FinancialApplications:

Manyfinancialdecisionmakingproblems canbesolvedbyusinglinearprogrammingtechnique.

Someofthemare:

(i) To select best portfolio in order to maximise return on investment out ofalternative investment opportunities like bonds, stocks etc. Such problems aregenerallyfacedbythemanagersofmutualfunds,banksandinsurancecompanies

(ii) In deciding financial mix strategies, involving the selection of means for financing firm,projects,inventoriesetc.

Historyofoperationresearch

Operations Research (Operational Research, O.R., or Management science)includes agreat deal of problem-solving techniques like Mathematical models, Statistics and algorithmsto aid in decision-making. O.R. is employed to analyze complex real-world systems,generallywith theobjectiveofimproving oroptimizing performance.

Inotherwords,OperationsResearchisaninterdisciplinarybranchofappliedmathematicsandformal science which makes use of methods like mathematical modeling, algorithms statisticsandstatistics to reachoptimalornear optimalsolutions to complexsituations.

Itisusuallyworriedaboutoptimizingthemaxima(forinstance,profit,assemblylineperformance, bandwidth, etc) or minima (for instance, loss, risk, cost, etc.) of some objectivefunction. Operational Research aids the management to accomplish its objectives utilizingscientificmethods.

Based on the **history of Operations Research**, it is believed that Charles Babbage (1791-1871)isthefatherofOperationalResearchduetothefactthathis researchintothecostoftransportationandsortingofmailresultedinEngland's universalPennyPostin1840.

ThomasEdisonmadeuseofOperationalResearch,contributingintheantisubmarinewar,with his greatsideas,likeshieldsagainsttorpedo fortheships.

In 1947 -Janos Von Neumann published his work called "Theory of Games", thatprovided the basics Mathematicians to Linear Programming.At a later time, in 1947, heviewedthesimilitudeamongthemProgramminglinearproblemsandthematrixtheorythatdevelopedhimself.

In1939,mathematicalRussianL.Kantorovich,inassociationwiththemathematicalDutchmanT.Koopmans,developedthemathematicaltheorycalled"Linearprogramming",thanks to thatwentrewarded with theNobel.

In 1840.,It is believed that Charles Babbage is the father of the OperationalResearchduetohisresearchaboutthetransportation'scostsandsortingofmailrealizedfortheUniformPenny Postin inEngland

1941 and 1942, Kantorovich and Koopmans studied in independent ways theTransportProblemforfirsttime,knowingthistypeofproblemslikeproblemofKoopmans-Kantorovich.Forhissolution,theyusedgeometricmethodsthatarerelatedtoMinkowski'stheoremofconvexity.

In 1947,To notice the range of this new discipline, England created another groupsof the same nature in order to obtain optimal results in the dispute. Just like United States(USA),whenjoinedtheWarin1942,creatingtheprojectSCOOP(ScientificComputation Of Optimum Programs), where was working George Bernard Dantzig, who developed in1947theSimplex algorithm.

June 25, 1948.During the Cold War, the old Soviet Union (URRS), excluded ofthe Plan Marshall, wanted to control the terrestrial communications, including routesfluvial, from Berlin. In order to avoid the rendition of the city, and his submission to be apartofthedeutschecommunistzone,EnglandandUnitedStatesdecidedsupplyingthecity,orelsebymeansofescortedconvoys(thatwouldbeabletogiverisetonewconfrontations)or by means of airlift, breaking or avoiding in any event the blockage from Berlin. Secondoptionwaschosen, startingtheLuftbrücke(airlift)atJune25,1948.

May12,1949. ThiswentanotherfromtheproblemsinwhichworkedtheSCOOPgroup, in December of that same year, could carry 4500 daily tons, and after studies ofResearchOperations optimizedthesupplyingtogettothe8000~9000dailytons

in March of 1949. This cipher was the same that would have been transported forterrestrialmeans,for thattheSovietdecided tosuspendtheblockageatMay12, 1949.

AftersecondWorldWar,theorderofUnitedStates'resources(USA)(energy,armaments,andallkindofsupplies)tookopportunetoaccomplishitbymodelsofoptimization,resolvedintervening linearprogramming.

In 1952, The first result of these techniques was given at the year 1952, when aSEACcomputerfromwasusedNationalBureauofStandardsinwaytoobtaintheproblem´ssolution.Thesuccessattheresolutiontimewassoencouragingthatwasimmediately used for all kind of military problems, like determining the optimal heightwhichshouldflytheplanestolocatetheenemysubmarines,monetaryfoundsmanagementforlogisticsandarmament,includingtodeterminethedepthwhichshouldsendthechargesto reach the enemy submarines in order to cause the biggest number of casualties, that wastranslatedinaincreasein fivetimes in AirForce'sefficacy.

Duringthe50'sand60'sdecade,growstheinterestanddevelopingofOperational Research, due to its application in the space of commerce and the industry.Take for example, the the problem of the calculation of the optimal transporting plan ofsandofconstructiontotheworksofedificationofthecityofMoscow,whichhad10originspoints and 230 destiny. To resolve it, was used and Strena computer, that took 10 days inthe month of june of 1958, and such solution contributed a reduction of the 11 % of theexpenses in relationto originalcosts.

ModesofOR

Typesof Modelwithexamplesandsaythesimplifiedwaysforthebestmodel.

OperationsResearchModels:

Operations Research model is an idealised representation of the real life situation and represents one or more aspects of reality. Examples of operations research models are: a map,activity charts balance sheets, PERT network, break-even equation, economic orderingquantity equation etc. Objective of the model is to provide a means for analysing thebehaviourof thesystemfor improvingitsperformance.

ClassificationofModels:

Modelscanbeclassifiedonthebasisoffollowingfactors:

1. BydegreeofAbstraction:
i. Mathematicalmodels.
ii. Languagemodels.
2. ByFunction:
i. Descriptivemodels.
ii. Predictivemodels.
iii. Normativemodelsforrepetitiveproblems.
3. ByStructure:
i. Physicalmodels.
ii. Analogue(graphical)models.
iii. Symbolicor mathematicalmodels.

4. ByNatureofEnvironment:

i. Deterministicmodels.
ii. Probabilisticmodels.
5. BytheTimeHorizon:
i. Staticmodels.
ii. Dynamicmodels.

Characteristics ofaGoodModel:
i. Assumptionsshouldbesimpleandfew.
ii. Variablesshouldbeaslessaspossible.
iii. It should be able to assimilate the system environmental changes without change in itsframework.
iv. Itshould beeasy toconstruct.
ConstructingtheModel:
A mathematical model is a set of equations in which the system or problem is described. Theequations represent objective function and constraints. Objective function is a mathematicalexpressionsofobjectives(costorprofitoftheoperations),whileconstraintsare mathematicalexpressions of thelimitationson thefulfilmentof theobjectives. Theseexpressionsconsistofcontrollableanduncontrollablevariables.
Someofthecommon simplifications are:
i. Omittingcertainvariables.
ii. Aggregating(orgrouping)variables.
iii. Changingthenatureofvariables e.g.,consideringvariables as constantorcontinuous.
iv. Changingrelationshipbetweenvariablesi.e.,consideringthemaslinearorstraightline.
v. Modifyconstraints.

UNITII

LinearProgrammingProblem(LPP)

LinearprogrammingProblem (LPP)

Linear programming is an optimization technique for a system of linear constraintsandalinearobjectivefunction.An**objectivefunction**definesthequantitytobeoptimized,and the goal of linear programming is to find the values of the variables that maximize orminimizetheobjectivefunction.

Thiskindofproblemisperfecttouselinearprogrammingtechniqueson.

- Allofthequantifiablerelationships intheproblemarelinear.
- Thevaluesofvariablesareconstrainedinsomeway.
- Thegoalis tofindvalues ofthevariables thatwillmaximizesomequantity.

Meaningof graphical method

Graphicalmethodoflinearprogrammingisusedtosolveproblemsbyfindingthehighestorlowest point of intersection between the objective function line and the feasible regionon agraph.

LPPAssumptions

Thereareseveralassumptionsonwhichthelinearprogrammingworks,theseare:

1. **Proportionality:** The basic assumption underlying the linear programming is that any change intheconstraintinequalitieswillhavetheproportionalchangeintheobjectivefunction.

2. **Additivity:** The assumption of additivity asserts that the total profit of the objective function isdetermined bythesumofprofitcontributedbyeachproductseparately.
3. **Continuity:** Another assumption of linear programming is that the decision variables arecontinuous. This means a combination of outputs can be used with the fractional values alongwiththe integer values.
4. **Certainty:** Another underlying assumption of linear programming is a certainty, i.e. theparameters of objective function coefficients and the coefficients of constraint inequalities isknownwithcertainty.
5. **Finite Choices:** This assumption implies that the decision maker has certain choices, and thedecision variables assume non-negative values. The non-negative assumption is true in the sense,theoutputinthe productionproblemcannotbe negative.

Advantagesandlimitations(or)disadvantages:

LPhasbeenconsideredanimportanttoolduetofollowingreasons:

1. LPmakeslogical thinkingandprovidesbetterinsightintobusinessproblems.
2. Managercanselectthebestsolutionwiththehelpoflpbyevaluatingthecostandprofitof variousalternatives.
3. LP provides aninformationbaseforoptimumallocationofscarceresources.
4. LPassistsinmakingadjustmentsaccordingtochangingconditions.
5. LPhelpsinsolvingmulti-dimensionalproblems.

Limitations **(or)disadvantages:**

1. This technique couldnotsolve theproblemsinwhichvariables cannotbestatedquantitatively.
2. Insomecases,theresultsofLPgiveaconfusingandmisleadingpicture.
3. LPtechniquecannotsolvethebusinessproblemsofnon-linearnature.
4. Thefactor ofuncertaintyisnotconsideredinthistechnique.
5. Thistechniqueishighlymathematicalandcomplicated.

SimplestepsforGraphicalmethod

Step1:SettheObjectivefunction i.e. Maximisation of profit and Minimisation ofexpenses

Example $Z=12X1+16X2$

Step2:ConvertInequalityinto**Equality** byequation

$10X_1+20X_2=120$

$8X_1+8X_2=80$

SolvetheequationtakingwhenX1is0; whatisX2?

X_1	0	?
X_2	?	0

Step3:Plotbothequationon graphsheet

Step4:Findthefeasibleregionwhichis foundunderthetwoequationsforMaximisationProblems like the Region found above two equation are called Feasible region in case ofMinimisationProblems.

Step5:Findallthecornervalues

Step 6: Apply all the Corner values in the Objective Function ie Z=12X1

+16X2Whichis**Maximum** isthesolution for **Maximisation Problem**and

Whichis **Minimum**isthesolutionfor**Minimisation Problem**and

UNITIII
MethodsofLPP

Simplex Method

The **Simplex Method or Simplex Algorithm** is used for calculating the optimal solution tothelinearprogrammingproblem.Inotherwords,thesimplexalgorithmisaniterativeprocedure carried systematically to determine the optimal solution from the set of feasiblesolutions.

Whyintroduce slack variable

slack variable is a **variable** that is added to an inequality constraint to transform it into anequality. **Introducing** a **slackvariable**replacesaninequalityconstraintwithanequalityconstraintand anon-negativityconstrainton the **slack variable**.

feasiblesolutionmeaning

A **feasiblesolution** isasetofvaluesforthedecisionvariablesthatsatisfiesalloftheconstraints in an optimization problem. The set of all **feasible solutions** definesthe**feasible**region of theproblem.

basicfeasiblesolution

A**basicsolution**thatsatisfiesalltheconstraintsdefiningorinotherwords,onethatlieswithinis called a **basic feasible solution**. let Ax=b the system of the 'm' equation with 'n' unknownvariables.

LIMITATIONS OF LPPSIMPLEXMETHOD

1. SimplexmethodInvolvesunderstandingofmanyconceptualtechnicalaspects.Thesecannotbeunderstood byany managernotconversantwiththesubject.
2. Linear programming problems need lot of expertise, time and are cumbersome. Anumberofstepshavetobeadoptedtoproceedinasystematicmannerbeforeonecanarriveatthesolution.
3. Graphicsolutionmethodhaslotofapplicationsandisrelativelyshort andsimple.However, it has limitations and cannot be applied to problems with more than twovariables in theobjectivefunction.
4. SimplexmethodofLPPcanbeappliedtoproblemswithmorethantwovariablesintheobjectivefunction,theprocedureadopted is complicated andlong.
5. LPP does not lead to ‘a unique’ optimal solution. It can provide different types ofsolutions like feasible solution, infeasible solution, unbounded solution, degeneratesolutionetc.

SimplexMethod steps

Step1:SettheObjectivefunctionwithintroduction$S_1$and S_2 i.e.Maximisationofprofitand Minimisation of expenses

Example $Z=12X_1+16X_2+0S_1+0S_2$

Step2:Convert**Inequality** into**Equality** byequation

$\mathbf{10X_1+20X_2} + S_1 \mathbf{=120}$

$\mathbf{8X_1+8X_2} + S_2 \mathbf{=80}$

Step3:ConstructatableusingtheaboveobjectfunctionandinequalityConstraintvalues

			Key Column					
Cij	**Cj**	**12**	**16**	**0**	**0**	**Solution**	**Ratio**	
	BV	X1	**X2 Incoming**	S1	S2			
0	**S1 Outgoing**	10	20 KeyElemnt	1	0	120	120/20 = 6	**Key Row**
0	S2	8	8	0	1	80	80/8 = 10	
	Zj	**0**	**0**	**0**	**0**	**0**		

12 16 0 0

Step4:FindtheValuesofZj

Zj=CijxBij ieforX1 Column0x10=0 +0 x8 =0

X2 Column0x20=0 + 0 x8 =

0Step5:FindtheOptimality

ForMaximisationProblems $C_j - Z_j \leq 0$
ForMinimisationProblem $C_j - Z_j \geq 0$
Step6:IftheOptimalityisnotcome,goforNextIterationTablebythefollowingadditionalsetps

a) bringing **incoming variable** by selecting the **Maximum Column Value** (Cj-Zj), thatis **key column**
b) FindouttheRatioby= **Solution / CorrespondingColumnValue**
c) Select the least RowRatio, that Row is called **Key Row, that Row S Value is OutGoingVariable**
d) **FindtheIntersectionofboththeRowandColumn,thatVariableiscalledKeyElement**
e) FortheNextiterationfind outnewValueby thefollowing
1. intheKeyRow,findnew valueby = Key RowValue / CorrespondingKeyColumnValue

IntheNon **KeyRow**.,

FindtheNew Value=OldValue-Corr.KeyRow ValuexCorr.KeyColumnValue

KeyElement

Step7 RepeatFromtheStep3

UNITIV

TransportationandAssignmentProblems

ASSIGNMENT

Introduction

Theassignmentproblemisaspecialcaseoftransportationproblemwhereinthenumberofresources(origin) equalsnumberofactivities(destinations).Thecapacityanddemandvalueisexactlyoneunit i.e.onlyoneunitcanbesuppliedfromeachoriginandeachdestinationalsorequiresexactlyonlyoneUnit

OBJECTIVEASSIGNMENT PROBLEM

The **objectives** aloneareconsidered as fuzzy. The classical **assignmentproblem**referstoaspecialclassoflinearprogramming**problems**.Linearprogramming isoneofthemostwidelyused decision makingtoolfor solvingrealworld**problems**

Inshortlyinobjective

Objectives : The objective is to determine which origin should supply specific units to whichdestination.

STEPSofassignmentproblem

1. DeductROWMINIMUM fromalltheelementsineachrowforallrows.

2. From such reduced matrix, deduct COLUMN MINIMUM from all elements in each column forallthecolumns.

3. Tofindoptimalsolution,

CoverMAXIMUMNUMBEROFZEROSbydrawingMINIMUMNUMBEROFVERTICALORHORIZONTAL LINESwhichshouldbeequaltoorderofmatrix.

*** If the minimum number of lines are not equal to order of matrix (no optimal solution),uncovered elements are reduced by smallest element in uncoverd area and intersection element isadded with such smallest element (no change in the covered area).Repeat the same until you aregetting optimalsolution.

4. Makeoneassignmenttoleastpossiblezeroineachrow andineachcolumn.Subsequently,strikeoffotherzerosfoundinthesame rowandsame column.

*Leastpossiblezero=givingpreferencetoroworcolumnwhichhasminimumzero(s)

5. Addoriginalvaluesofassignmentslocatedplacestogettheresult.

Note:
1. Unbalanced problems :If the number of columns is not equal to number of rows, dummy columnshouldbe addedwithzeroelementsandvice versa.

2. Maximization case: If profit is given (usually cost is given), conversation of maximization problemintominimizationproblembydeductionofallelementsinallrows andcolumnsfromthelargevalueofthetotalelements.(Largest– Allothersmallestelements).

Hungarianmethod

The **Hungarian method**is a combinatorial optimization**algorithm** that solves the **assignment**probleminpolynomialtime andwhichanticipatedlaterprimal-dual**methods**.

WhatisDummyactivity?

a**dummy activity** is a simulated **activity** of sorts, one that is of a zero duration and is createdfor the sole purpose of demonstrating a specific relationship and path of action on the arrowdiagrammingmethod.

TRANSPORTATION

In the process of transportation of goods from one place to various distribution centers(origin) tovarious distribution centers(destination), transportation expenses are incurred. Some times it maybemoreduetorandomcalculation.Soinordertoavoidincreaseofcost intransportation,theleastcost isselected byapplying asuitable method.

NORTH-WESTCORNER METHOD:

The **North-West Corner Rule** is a method adopted to compute the initial feasible solution ofthe transportation problem. The name North-west corner is given to this method because thebasicvariablesareselected fromtheextremeleftcorner.

Least Cost Method

The **Least Cost Method** is another method used to obtain the initial feasible solution for thetransportationproblem.Here,the allocationbeginswiththecellwhichhasthe minimumcost.

Thelowercostcellsarechosenoverthehigher-costcellwiththeobjectivetohavetheleastcostof transportation.

Vogel'sApproximationMethod

The **Vogel'sApproximationMethod** or **VAM** isaniterativeprocedurecalculatedtofindouttheinitialfeasiblesolutionofthetransportationproblem.LikeLeastcostMethod,herealsotheshippingcostistakenintoconsideration,butina relativesense.

NORTH-WESTCORNER METHODSTEPS:

1. BeginfromNORTH-WESTCORNERCELL(UpperLeftHandCorner)ofthetransportationtable.

2. ALLOTtherespective RowTotal orColumnTotal, whichever isless, inthe North-WestCell.

*Side-by-side,correspondingtosuchroworcolumn,mentiontheremainingbalancetobeallotted.

3. StrikeofftherespectiveRoworColumnasasignoffull allotment (whichhasremainingbalance-zero)made.

4. SelectthenextNorth-WestCornerCellandrepeatthefirstthreestepsforremainingRowsandcolumnstill possible allotmentstobemade.

Note:But,thetotalallotment madeshouldbeequaltom+n-1inordertoget feasiblesolution.

5. Now, add all the values found by multiplying the transportation cost with allotment made tofindthetotaltransportationcost.

LEASTCOSTMETHODSTEPS:

1. ChoosetheLeastCostCell.

2. Allot therespective RowTotalorColumnTable,whicheverisless,intheLeast Cost Cell.

*Side-by-side,corresponding tosuchroworcolumn,mentiontheremainingbalancetobeallotted.

3. StrikeofftherespectiveRoworColumnasasignoffull allotment (whichhasremainingbalance-zero)made.
4. Select the next Least Cost Cell and repeat thefirst three steps for remaining Rows andcolumnstill possible allotmentstobemade.

Note:But,thetotalallotment madeshouldbeequaltom+n-1inordertoget feasiblesolution.

5. Now, add all the values found by multiplying the transportation cost with allotment made tofindthetotaltransportationcost.

VOGEL'sAPPROXIMISATIONMETHOD(VAM)STEPS:

1. Findoutthedifferencebetweentwoleastcostineachcolumnandineachrow.

2. Select the maximum difference among them and locate the lowest cell corresponding to themaximumdifference.

3. Allot therespective rowtotalorcolumntotalwhicheverislessinsuchlowest cost cell.

4. Strikeofftheroworcolumnorbothasasignofallotment fullymade.

5. Repeatthefirstfour stepsfortheremainingrowsandcolumnstillthepossibleallotmentsaremade.

6. Nowaddthevaluesfoundbymultiplyingthetransportationcostwithfullallotmentmadetofindout the totl transportation cost.*Generally, preference is given tominimum cost and possiblemaximumallotment.

MXIMISATIONCASE:

If profit is given (usually cost is given), conversation of maximization problem intominimization problem by deduction of all elements in all rows and columns from the large value ofthetotalelements.(Largest-Allothersmallestelements).

DEGENERACY:

In transportation problem, if total allotment is not equal to m+n-1, it is called degeneracy.Inthis case select the least unallotted (unallotted cell) and allot Epsilon (value close to zero or between0and1)insuchaleast unallotted cell.Theremaining stepsare sameaswefollowedearlier.

UNITV
GameTheory

Game Theory

Introduction

Gametheorywasdevelopedfordecisionmakingunderconflictingsituationswheretherearoneor moreopponents(players).

Definition:

It was developed by Prof. John Von Neumann and Oscar Morgenstern in 1928The games likechess, poker, etc. have the characteristics of competition and are played according to somedefinite rules. Game theory provides optimal solutions to such games, assuming that each oftheplayerswantstomaximizehisprofitorminimizehis loss.

Meaningsof strategy

Purestrategy-Itis adecision,inadvanceofallplays,always tochooseaparticularcourseof action.

Mixedstrategy-Itisadecision,inadvanceofallplays, to chooseacourseofactionforeachplay inaccordancewithsomeparticularprobability distribution.

Optimalstrategy: Thecourseofactionwhichmaximizestheprofitofaplayerorminimizes hisloss iscalledanoptimalstrategy.

Payoff: The outcomeofplayingagameiscalledpayoff.

Payoff matrix: When the players select their particular strategies, the payoffs (gains orlosses)can berepresented in theformofamatrix calledthepayoffmatrix.

Saddle point: A saddle point is an element of the payoff matrix, which is both thesmallest element in its row and the largest element in its column. Furthermore, the saddlepointisalsoregarded asanequilibriumpointin thetheoryof games.

Valueofthegame:Itreferstotheexpectedoutcomeperplaywhenplayersfollowtheiroptimalstrategy.

GAMETHEORYASSUMPTIONS

1. Therearefinitenumbers ofcompetitors.
2. Thereisconflictofinterestsbetweenthem.
3. Eachplayerhasavailablewithhimfinitecoursesofaction.
4. Players know all possible available choices but do not know which one is going to bechosen.
5. Playerssimultaneouslyselect theirrespectivecoursesofaction.
6. Thepayoffisfixedanddeterminedinadvance.

MERITSorSIGNIFICANCEorIMPORTANCE

1. **Helps in decision making**: Game theory develops a framework for analysingdecision-makings under the situations of inter-dependence of firms with existinguncertaintiesaboutthecompetitor’sreactionstoanycourseofactionadoptedby afirm.

2. **Provide scientific quantitative technique**: This theory outlines a scientificquantitativetechniquewhichcanbefruitfullyusedbyplayerstoarriveat anoptimalstrategy, given firm’sobjectives.
3. **Gives insight into situation of conflicting interests**: game theory gives insight intoseveral less-known aspects which arise in situations of conflicting interests. Forexample, it describes and explains the phenomena of bargaining and coalition-formation.

DemeritsorLimitations

1. **Unrealistic:** The assumption that the players have the knowledge about their ownpay-offsandpay-offsofothers isratherunrealistic.Hecanonlymakeaguess ofhisownand hisrivals’ strategies.
2. **More Complication:**As the number of maximiniand minimax show that thegaming strategies becomes increasingly complex and difficult. In practice, there aremanyfirmsinanoligopolysituationandgametheorycannotbeveryhelpfulinsuchsituation.
3. **NotPractical**:Theassumptionsofmaximumandminimaxshowthattheplayersarerisk-averseandhavecompleteknowledgethestrategies.Thesedonotseenpractical.
4. **No Secrecy: Rather** than each player in an oligopoly situation working underuncertain conditions, the players will allow each other to share the secrets of businessinordertoworkoutcollusion.Thus,themixedstrategies arealsonotveryuseful.