The Transportation Model

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2022-10-15

**Formulation of LP problem in “R”**

$$ \text{The objective function is } Min\hspace{.3cm} TC = 622(x\_11)+614(x\_12)+630(x\_13)+641(x\_21)+645(x\_22)+649(x\_23) $$

Subject to

$$\text{supply constraints}\\$$

$$\text{demand constraints}\\$$

$$\text{Non-Negativity constraint}\\$$

where

*activating the required package and creating the table*

library(lpSolve)  
tab <- matrix(c(22,14,30,600,100,  
 16,20,24,625,120,  
 80,60,70,"-","-"), ncol=5,byrow=TRUE)  
colnames(tab) <- c("warehouse1", "warehouse2", "warehouse3", "ProductionCost", "ProductionCapacity")  
rownames(tab) <- c("PlantA", "PlantB", "Demand")  
tab <- as.table(tab)  
tab

## warehouse1 warehouse2 warehouse3 ProductionCost ProductionCapacity  
## PlantA 22 14 30 600 100   
## PlantB 16 20 24 625 120   
## Demand 80 60 70 - -

#Creating dummy variables when supply and demand are not equal  
costs <- matrix(c(622,614,630,0,  
 641,645,649,0), ncol = 4, byrow = TRUE)  
colnames(costs)<-c("warehouse1","warehouse2","warehouse3","Dummy")  
rownames(costs)<-c("PlantA","PlantB")  
costs<-as.table(costs)  
costs

## warehouse1 warehouse2 warehouse3 Dummy  
## PlantA 622 614 630 0  
## PlantB 641 645 649 0

#Supply Side  
row.signs <- rep("<=",2)  
row.rhs<- c(100,120)  
  
#Demand Side  
col.signs <- rep(">=",4)  
col.rhs <- c(80,60,70,10)  
  
#running the lp.transport function   
lptrans <- lp.transport(costs, "min", row.signs, row.rhs, col.signs, col.rhs)  
  
  
#Getting the objective value  
lptrans$objval

## [1] 132790

#values of all the variables  
lptrans$solution

## [,1] [,2] [,3] [,4]  
## [1,] 0 60 40 0  
## [2,] 80 0 30 10

***80 AEDs*** *in Plant B - Warehouse1* ***60 AEDs*** *in Plant A - Warehouse2* ***40 AEDs*** *in Plant A - Warehouse3* ***30 AEDs*** *in Plant B - Warehouse3should be created in each facility, supplied to each of the three warehouses of the wholesalers, and then packaged to reduce the overall cost of manufacturing and shipment.*

***Formulating the dual of the above transportation problem***

*Since the primary goal was to reduce transportation costs, the secondary goal would be to increase value added (VA).*

$$ {\text Maximize \hspace{3mm} VA = } \hspace{3mm} 80W\_1 + 60W\_2 + 70W\_3 - 100P\_A - 120P\_B$$

***Subject to the following constraints***

$$ {\text Total \hspace{2mm} Payments \hspace{2mm} Constraints} $$

$${\text Where \hspace{2mm} W\_1 = Warehouse \hspace{2mm} 1}$$

$$\hspace{2mm} W\_2 = Warehouse \hspace{2mm} 2$$

$$\hspace{2mm} W\_3 = Warehouse \hspace{2mm} 3$$

$$\hspace{2mm} P\_1 = Plant \hspace{2mm} 1$$

$$\hspace{2mm} P\_2 = Plant \hspace{2mm} 2$$

***Economic Interpretation of the dual***

$$ \text From \hspace{3mm} the \hspace{3mm} above \hspace{3mm} we \hspace{3mm} can \hspace{3mm} see \hspace{3mm} that \hspace{3mm} W\_1 - P\_A >= 622$$

$$ which \hspace{3mm} can \hspace{3mm} be \hspace{3mm} exponented \hspace{3mm} as \hspace{3mm} W\_1 <= 622 + P\_A$$

$$ \text here \hspace{3mm} W\_1 \hspace{3mm} is \hspace{3mm} considered \hspace{3mm} as \hspace{3mm} the \hspace{3mm} price \hspace{3mm} payments \hspace{3mm} being \hspace{3mm} obtained \hspace{3mm} at \hspace{3mm} the \hspace{3mm} origin \hspace{3mm} which \hspace{3mm} is \hspace{3mm} nothing \hspace{3mm} else, \hspace{3mm}$$

$$\text but, \hspace{3mm} the \hspace{3mm} revenue,\hspace{3mm} meanwhile\hspace{3mm} P\_A + 622 \hspace{3mm} is \hspace{3mm} the \hspace{3mm} money \hspace{3mm} paid \hspace{3mm} at \hspace{3mm} the \hspace{3mm} origin \hspace{3mm} at \hspace{3mm} Plant\_A \hspace{3mm}$$

$$\text Therefore \hspace{3mm} the \hspace{3mm} equation \hspace{3mm} will \hspace{3mm} be\hspace{3mm} MR\_1 >= MC\_1.$$

$$\text To \hspace{3mm} maximize \hspace{3mm} profit \hspace{3mm} ,The \hspace{3mm} Marginal \hspace{3mm} Revenue (MR)\hspace{3mm} should \hspace{3mm}be \hspace{3mm}equal\hspace{3mm} to\hspace{3mm} Marginal\hspace{3mm} Costs(MC)$$

$$ \text That\hspace{3mm} is,\hspace{3mm}
MR\_1 = MC\_1$$

$$\text From \hspace{3mm} th\hspace{3mm} above\hspace{3mm} interpretation,\hspace{3mm} we\hspace{3mm} can\hspace{3mm} say\hspace{3mm} that,$$

$$\text Profit\hspace{3mm} maximization\hspace{3mm} takes\hspace{3mm} place \hspace{3mm} when\hspace{3mm} MC\hspace{3mm} is\hspace{3mm} equal\hspace{3mm} to\hspace{3mm} the\hspace{3mm}MR.$$

***If MR > MC, we must lower plant expenses in order to achieve the Marginal Revenue (MR).***

***If MR > MC, we must increase output supply in order to achieve Marginal Revenue (MR).***