Transportation Model

***Formulating Transportation Problem Using R***

*Activating all the required packages*

library("lpSolveAPI")  
library("lpSolve")  
library("tinytex")

*Creating a table for better understanding of the data*

cost <- matrix(c(22,14,30,600,100,  
 16,20,24,625,120,  
 80,60,70,"-","-"), ncol=5,byrow=T)  
  
colnames(cost) <- c("Warehouse1", "Warehouse2", "Warehouse3", "ProductionCost", "ProductionCapacity")  
  
rownames(cost) <- c("PlantA", "PlantB", "Demand")  
  
cost <- as.table(cost)  
cost

## Warehouse1 Warehouse2 Warehouse3 ProductionCost ProductionCapacity  
## PlantA 22 14 30 600 100   
## PlantB 16 20 24 625 120   
## Demand 80 60 70 - -

***The Objective Function is to Minimize the Transportation cost***

***Subject to the following constraints***

$${\text Supply \hspace{2mm} Constraints}$$

$${\text Demand \hspace{2mm} Constraints}$$

$${\text Non - Negativity \hspace{2mm} Constraints} $$

$$X\_{ij} >= 0 \hspace{4mm} \text {Where i = 1,2 and j = 1,2,3,4} $$

#Since demand is not equal to supply creating dummy variables   
  
#Creating a matrix for the given objective function  
trans.cost <- matrix(c(622,614,630,0,  
 641,645,649,0), ncol=4, byrow=T)  
trans.cost

## [,1] [,2] [,3] [,4]  
## [1,] 622 614 630 0  
## [2,] 641 645 649 0

#Defining the column names and row names  
colnames(trans.cost) <- c("Warehouse1", "Warehouse2", "Warehouse3", "Dummy")  
  
rownames(trans.cost) <- c("PlantA", "PlantB")  
  
trans.cost

## Warehouse1 Warehouse2 Warehouse3 Dummy  
## PlantA 622 614 630 0  
## PlantB 641 645 649 0

#Defining the row signs and row values   
row.signs <- rep("<=",2)  
row.rhs <- c(100,120)  
#Since it's supply function it cannot be greater than the specified units.  
  
#Defining the column signs and column values  
col.signs <- rep(">=",4)  
col.rhs <- c(80,60,70,10)  
#Since it's demand function it can be greater than the specified units.  
  
#Running the lp.transport function   
lptrans.cost <- lp.transport(trans.cost,"min", row.signs,row.rhs,col.signs,col.rhs)

#Getting the objective value  
lptrans.cost$objval

## [1] 132790

*The minimization value so obtained is* ***$132,790*** *which is the minimal combined cost thereby attained from the combined cost of production and shipping the defibrilators.*

#Getting the constraints value  
lptrans.cost$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 produced in each plant and then distributed to each of the three wholesaler warehouses in order to minimize the overall cost of production as well as shipping.*

***Formulate the dual of the above transportation problem***

*Since the primal was to minimize the transportation cost the dual of it would be to maximize the 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***

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

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

$$ \text Here \hspace{3mm} W\_1 \hspace{3mm} is \hspace{3mm} considered \hspace{3mm} as \hspace{3mm} the \hspace{3mm} price \hspace{3mm} payments \hspace{3mm} being \hspace{3mm} received \hspace{3mm} at \hspace{3mm} the \hspace{3mm} origin \hspace{3mm} which \hspace{3mm} is \hspace{3mm} nothing \hspace{3mm} else \hspace{3mm} but \hspace{3mm} the \hspace{3mm} revenue,\hspace{3mm} whereas\hspace{3mm} P\_A + 622 \hspace{3mm} is \hspace{3mm} the \hspace{3mm} money \hspace{3mm} paid \hspace{3mm} at \hspace{3mm} the \hspace{3mm} origin \hspace{3mm} at \hspace{3mm} Plant\_A \hspace{3mm}$$

***If MR < MC, in order to meet the Marginal Revenue (MR), we need to decrease the costs at the plants.***

***If MR > MC, in order to meet the Marginal Revenue (MR), we need to increase the production supply.***