Quantitative Management Modeling assignment module 6

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installing and Activating the required packages

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

Formulate and solve this transportation problem using R

Creating a table for better understanding of the data

```
tab <- matrix(c(22,14,30,600,100,
                16,20,24,625,120,
                80,60,70,"-","-"), ncol=5,byrow=T)
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         -              -
```

The Objective Function is to Minimize the Transportation cost

$$Z = 622X_{11} + 614X_{12} + 630X_{13} + 0X_{14} + 641X_{21} + 645X_{22} + 649X_{23} + 0X_{24}$$

Subject to the following constraints

$$Supply\ \ Constraints$$

$$X_{11} + X_{12} + X_{13} + X_{14} <= 100$$

$$X_{21} + X_{22} + X_{23} + X_{24} <= 120$$

$$Demand\ \ Constraints$$

$$X_{11} + X_{21} >= 80$$

$$X_{12} + X_{22} >= 60$$

$$X_{13} + X_{23} >= 70$$

$$X_{14} + X_{24} >= 10$$

$$\text{Non} - Negativity \;\; Constraints$$

$$X_{ij} >= 0 \quad \text{Where i = 1,2 and j = 1,2,3,4}$$

```r
#Since demand is not equal to supply creating dummy variables
#Creating a matrix for the given objective function
trans1 <- matrix(c(622,614,630,0,
                   641,645,649,0), ncol=4, byrow=T)
trans1
```

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

```r
#Defining the column names and row names
colnames(trans1) <- c("Warehouse1", "Warehouse2", "Warehouse3", "Dummy")
rownames(trans1) <- c("PlantA", "PlantB")
trans1
```

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

```r
#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
lptrans1 <- lp.transport(trans1,"min", row.signs,row.rhs,col.signs,col.rhs)
```

```r
#Getting the objective value
lptrans1$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.*

```r
#Getting the constraints value
lptrans1$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 - Warehouse3 should 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..*

2. Formulate the dual of this transportation problem

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

$$\text{M}axi mize\ \ VA =\ 80WH_1 + 60WH_2 + 70WH_3 - 100P_A - 120P_B$$

Subject to the following constraints

$$\text{T}otal\ \ Payments\ \ Constraints$$

$$WH_1 - P_A >= 622$$

$$WH_2 - P_A >= 614$$

$$WH_3 - P_A >= 630$$

$$WH_1 - P_B >= 641$$

$$WH_2 - P_B >= 645$$

$$WH_3 - P_B >= 649$$

$$\text{W}here\ \ WH_1 = Warehouse\ \ 1$$

$$WH_2 = Warehouse\ \ 2$$

$$WH_3 = Warehouse\ \ 3$$

$$P_A = Plant\ \ 1$$

$$P_B = Plant\ \ 2$$

3. Make an economic interpretation of the dual

$$WH_1 <= 622 + P_A$$

$$WH_2 <= 614 + P_A$$

$$WH_3 <= 630 + P_A$$

$$WH_1 <= 641 + P_B$$

$$WH_2 <= 645 + P_B$$

$$WH_3 <= 649 + P_B$$

$$\text{F}rom\ \ the\ \ above\ \ we\ \ get\ \ to\ \ see\ \ that\ \ WH_1 - P_A >= 622$$

$$that\ \ can\ \ be\ \ exponented\ \ as\ \ WH_1 <= 622 + P_A$$

Here W_1 *is considered as the price payments being received at the origin which is nothing else,*

$$\text{but the revenue, whereas } P_A + 622 \text{ is the money paid at the origin at } Plant_A$$

$$\text{Therefore the equation turns, out to be } MR_1 >= MC_1.$$

$$\text{For a profit maximization, The Marginal Revenue}(MR) \text{ should be equal to Marginal Costs}(MC)$$

$$\text{Therefore,} \quad MR_1 = MC_1$$

$$\text{Based on above interpretation, we can conclude that,}$$
$$\text{Profit maximization takes place if } MC \text{ is equal to } MR.$$

If MR < MC, We must lower plant costs in order to reach the Marginal Revenue (MR).

If MR > MC, We must boost manufacturing supply if we are to reach the Marginal Revenue (MR).