Quantitative Management Modeling assignment module 6

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installing and Activating the required packages

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

Formulate and solve this transportation problem using R

Creating a table for better understanding of the data

```r
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

$$X_{11} + X_{21} >= 80$$
$$X_{12} + X_{22} >= 60$$
$$X_{13} + X_{23} >= 70$$

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

$$Non-Negativity\ \ Constraints$$

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

```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).

$$Maximize \ VA = \ 80WH_1 + 60WH_2 + 70WH_3 - 100P_A - 120P_B$$

Subject to the following constraints

$$Total \ Payments \ Constraints$$
$$WH_1 - P_A >= 622$$
$$WH_2 - P_A >= 614$$
$$WH_3 - P_A >= 630$$
$$WH_1 - P_B >= 641$$
$$WH_2 - P_B >= 645$$
$$WH_3 - P_B >= 649$$

$$Where \ WH_1 = Warehouse \ 1$$
$$WH_2 = Warehouse \ 2$$
$$WH_3 = Warehouse \ 3$$
$$P_A = Plant \ 1$$
$$P_B = Plant \ 2$$

3. Make an economic interpretation of the dual

$$WH_1 <= 622 + P_A$$
$$WH_2 <= 614 + P_A$$
$$WH_3 <= 630 + P_A$$
$$WH_1 <= 641 + P_B$$
$$WH_2 <= 645 + P_B$$
$$WH_3 <= 649 + P_B$$

From the above we get to see that $WH_1 - P_A >= 622$

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

Here WH_1 *is considered as the price payments being received at the origin which is nothing else,*

but the revenue, whereas $P_A + 622$ is the money paid at the origin at $Plant_A$

Therefore the equation turns, out to be $MR_1 >= MC_1$.

For a profit maximization, The Marginal Revenue(MR) should be equal to Marginal Costs(MC)

Therefore, $MR_1 = MC_1$

Based on above interpretation, we can conclude that,
Profit maximization takes place if MC 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).