

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

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

Subject to the following constraints

Supply Constraints

$$X_{11} + X_{12} + X_{13} + X_{14} \leq 100$$

$$X_{21} + X_{22} + X_{23} + X_{24} \leq 120$$

Demand Constraints

$$X_{11} + X_{21} \geq 80$$

$$X_{12} + X_{22} \geq 60$$

$$X_{13} + X_{23} \geq 70$$

$$X_{14} + X_{24} \geq 10$$

Non – Negativity Constraints

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

#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 - Warehouse3 should 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).

$$\text{Maximize } VA = 80W_1 + 60W_2 + 70W_3 - 100P_A - 120P_B$$

Subject to the following constraints

Total Payments Constraints

$$W_1 - P_A \geq 622$$

$$W_2 - P_A \geq 614$$

$$W_3 - P_A \geq 630$$

$$W_1 - P_B \geq 641$$

$$W_2 - P_B \geq 645$$

$$W_3 - P_B \geq 649$$

Where $W_1 = \text{Warehouse 1}$

$W_2 = \text{Warehouse 2}$

$W_3 = \text{Warehouse 3}$

$P_1 = \text{Plant 1}$

$P_2 = \text{Plant 2}$

Economic Interpretation of the dual

$$W_1 \leq 622 + P_A$$

$$W_2 \leq 614 + P_A$$

$$W_3 \leq 630 + P_A$$

$$W_1 \leq 641 + P_B$$

$$W_2 \leq 645 + P_B$$

$$W_3 \leq 649 + P_B$$

From the above we get to see that $W_1 - P_A \geq 622$

that can be exponented as $W_1 \leq 622 + P_A$

Here W_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 $MR_1 \geq MC_1$.

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

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

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

If $MR < MC$, 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.