QMM Assignment

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R Markdown

```
tbl <- matrix(c(22,14,30,600,100 ,
16,20,24,625,120,
80,60,70,"-","-" ), ncol=5, byrow=TRUE)
colnames(tbl) <- c("Warehouse 1", "Warehouse 2", "Warehouse 3","Production cost","Production Capacity")
rownames(tbl) <- c("Plant A", "Plant B","Monthly Demand")
tbl <- as.table(tbl)
tbl
```

```
##                Warehouse 1 Warehouse 2 Warehouse 3 Production cost
## Plant A        22          14          30          600
## Plant B        16          20          24          625
## Monthly Demand 80          60          70          -
##                Production Capacity
## Plant A        100
## Plant B        120
## Monthly Demand -
```

The above transportation problem can be formulated in the LP format as below:

$$\begin{aligned} \text{Min} \;\; TC = 22x_{11} + 14x_{12} + 30x_{13} \\ +16x_{21} + 20x_{22} + 24x_{23} \\ +80x_{31} + 60x_{32} + 70x_{33} \end{aligned}$$

Subject to the following major constrains and variables

Supply constraints:

$$x_{11} + x_{12} + x_{13} \leq 100$$
$$x_{21} + x_{22} + x_{23} \leq 120$$

Demand Constraints:

$$x_{11} + x_{21} \geq 80$$
$$x_{12} + x_{22} \geq 60$$
$$x_{13} + x_{23} \geq 70$$

Non-Negativity of the variables:

$$x_{ij} \geq 0$$

where

$$i = 1, 2, 3$$

and

$$j = 1, 2, 3$$

```
library(lpSolve)
```

```
## Warning: package 'lpSolve' was built under R version 4.1.3
```

```
# Set up cost matrix

cost_tbl <- matrix(c(622,614,630,0,
641,645,649,0), ncol = 4,byrow = TRUE)

# Set Plant names

colnames(cost_tbl ) <- c("Warehouse 1", "Warehouse 2","Warehouse 3","Dummy")
rownames(cost_tbl ) <- c("Plant A", "Plant B")
cost_tbl
```

```
##         Warehouse 1 Warehouse 2 Warehouse 3 Dummy
## Plant A         622         614         630     0
## Plant B         641         645         649     0
```

#Set up constraint signs and right-hand sides (supply side)

```
row.signs <- rep("<=", 2)
row.rhs <- c(100,120)
```

#Demand (sinks) side constraints

```
col.signs <- rep(">=", 4)
col.rhs <- c(80,60,70,10)
```

#Run

```
lptrans_tbl <- lp.transport(cost_tbl, "min", row.signs, row.rhs, col.signs, col.rhs)
```

#Values of all 8 variables

```
lptrans_tbl$solution
```

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

#Value of the objective function

```
lptrans_tbl$objval
```

```
## [1] 132790
```

#Getting the constraints value

```
lptrans_tbl$solution
```

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

#In order to minimize the overall cost of production as well as shipping,the better approach is to produce 80 AEDs in Plant 2 - Warehouse1, 60 AEDs in Plant 1 - Warehouse2,40 AEDs in Plant 1 - Warehouse3, 30 AEDs in Plant 2 - Warehouse3 in each plant which are distributed to each of the three wholesaler warehouses .

#As a result,we formulate the dual of the above transportation problem

#Since the primal was to be minimized so that the transportation cost the dual of it would be to maximize the value added(VA).

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

Subject to the following constraints

$$Total\ \ Profit\ \ Constraints$$

$$MR_1 - MC_1 \geq= 622$$
$$MR_2 - MC_1 \geq= 614$$
$$MR_3 - MC_1 \geq= 630$$
$$MR_1 - MC_2 \geq= 641$$
$$MR_2 - MC_2 \geq= 645$$
$$MR_3 - MC2 \geq= 649$$
$$Where\ \ MR_1 = Marginal\ \ Revenue\ \ from\ \ Warehouse1$$
$$MR_2 = Marginal\ \ Revenue\ \ from\ \ Warehouse2$$
$$MR_3 = Marginal\ \ Revenue\ \ from\ \ Warehouse3$$
$$MC_1 = Marginal\ \ Cost\ \ from\ \ Plant1$$
$$MC_2 = Marginal\ \ Cost\ \ from\ \ Plant2$$

$$Economic\ \ Interpretation\ \ of\ \ the\ \ dual$$
$$MR_1 <= MC_1 + 622$$
$$MR_2 <= MC_1 + 614$$
$$MR_3 <= MC_1 + 630$$

$$MR_1 <= MC_2 + 641$$

$$MR_2 <= MC_2 + 645$$

$$MR_3 <= MC_2 + 649$$

#The above constraints are framed under the economic interpretation of the dual which technically follows the universal rule of profit maximization which are MR >= MC where "MR" is the Marginal Revenue and "MC" is the Marginal Cost.

$$MR_1 <= MC_1 + 621 \quad i.e. \quad MR_1 >= MC_1$$

#Marginal Revenue is mainly focused on the revenue generated for each additional unit sold relative to Marginal Cost (MC) i.e. The change in cost at Plant 1 along with an increase in the supply function should be greater than or equal to the revenue generated for each additional unit distributed to Warehouse 1.

#This approach is used in businesses to balance their production output with their costs to maximize profi by this process the businesses can avoid losses.