Assignment_3_QMM

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Loading Packages

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

Creating Table as per given data

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

colnames(cost) <- c("Warehouse 1", "Warehouse 2", "Warehouse 3", "Production Cost"
                    , "Production Capacity")

rownames(cost) <- c("Plant A", "Plant B", "Demand")

cost <- as.table(cost)
cost
```

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

Formulation of Primal

The Objective Function is to Minimize the Transportation cost

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

Subject to:

Supply Constraints:

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

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

Demand Constraints

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

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

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

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

$$X_{ij} >= 0 \quad \text{Where i = 1,2 for Plants A,B and j = 1,2,3 for Warehouses}$$

Since demand is not equal to supply we are adding dummy variable for solving the equation

Solving Primal using R

```
#Creating a matrix for the given objective function
costs <- matrix(c(622,614,630,0,
                 641,645,649,0), ncol=4, byrow=T)

#Defining the column names and row names
colnames(costs) <- c("Warehouse 1", "Warehouse 2", "Warehouse 3", "Dummy")

rownames(costs) <- c("Plant A", "Plant B")

costs
```

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

```
#Defining the row signs and row values based on above constraints
row.signs <- rep("<=",2)
row.rhs <- c(100,120)


#Defining the column signs and column values based on above constraints
col.signs <- rep(">=",4)
col.rhs <- c(80,60,70,10)
```

```
#Running the lp.transport function
trans.cost <- lp.transport(costs,"min", row.signs,row.rhs,col.signs,col.rhs)

#Getting the objective value
print(paste("The solution of primal is ",trans.cost$objval))
```

```
## [1] "The solution of primal is  132790"
```

```
trans.cost$solution
```

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

From the above results we can say that 132790 is the minimal cost obtained with

$$X_{12} = 60$$
$$X_{13} = 40$$
$$X_{21} = 80$$
$$X_{23} = 30$$

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:

$$W_1 - P_A \geq 622$$
$$W_2 - P_A \geq 614$$
$$W_3 - P_A \geq 630$$
$$W_1 - P_B \geq 641$$
$$W_2 - P_2 \geq 645$$
$$W_3 - P_B \geq 649$$
$$W_i > 0, \quad P_j > 0$$

Where i=1,2,3 are price payments recieved at destination Warehouses

j=A,B are Price payments paid at Origin plants

Economic Interpretation

From the above constraints we can see that$W_1 - P_A \geq 622$

which can be written as $W_1 \leq 622 + P_A$

Here W_1 is the price payments recieved at the destination warehouse 1. which is considered as revenue and the component $P_A + 622$ is the price payments paid at the origin plant A

Therefore the equation becomes, $MR_1 \geq MC_1$

For a profit maximization to happen, '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 happens if marginal cost is equal to marginal revenue.

If MR < MC, then we need to decrease the costs at the origin plants to meet with MR.

If MR > MC, then we need to increase the production supply to meet the demand with MR.