LOCATION OF WAREHOUSES

We have the problem of location of warehouses. The probable location depends upon

i. Demand of the nearby region
ii. Facilities for various transportation linkages i.e. by road, railways, availability of manpower etc.

By probable location we mean that here we can have the possibility of setting up a warehouse.

Out of the probable locations few will be picked up as the company wants to set up a fixed number of warehouses.

Now our aim is to choose a location of the warehouse with a view to minimize the total transportation from factory to warehouse and warehouse to wholesalers.

Suppose there are $'m'$ probable locations and out of these $'m'$ company wants to pick up only $'p'$ locations where they can have their warehouses.

Now x_{ijk}- number of units transported from the i^{th} factory to the k^{th} destination via the j^{th} warehouse, where

$i = 1,2, \dots, l \; factories$

$j = 1,2, \dots, m \; warehouses$

$k = 1,2, \dots, n \; destinations/wholesalers$

Since we are transporting finished units from the factory to the destination, we will have two types of transportation costs.

(1) From factory to warehouse.
(2) From warehouse to destination/wholesaler.

$C_{ij} - be\ the\ unit\ transportation\ cost\ from\ the\ i^{th}\ factory\ to\ j^{th}\ warehouse.$

$C_{j\,k} - be\ the\ unit\ transportation\ cost\ from\ the\ j^{th}\ warehouse\ to\ k^{th}\ destination.$

Therefore,

Total transportation cost will be

$\sum_{i=1}^{l} \sum_{j=1}^{m} \sum_{k=1}^{n} (C_{ij} + C_{jk}) x_{ijk}$

We want to minimize this total cost subject to some constraints.

Each factory has a limited capacity.

Therefore, the total number of units transported from each factory will be limited. This is one constraint.

Total shipment from i^{th} factory to all the destinations via all warehouses should be less than or equal to the availability (a_i) at the i^{th} factory.

i.e. $\sum_j \sum_k x_{ijk} \leq a_i$; $i = 1,2, \dots, l$.

Similarly, the total supply to the k^{th} destination via all the warehouses should be greater than equal to demand at the k^{th} destination.

i.e. $\sum_i \sum_j x_{ijk} \geq d_k$ $for\ all\ k = 1,2, \dots, n$.

By now we have also to take into consideration the capacity of the warehouses. Each warehouse has some upper and lower limit capacity

i.e. $L_j y_j \leq \sum_{i=1}^{l} \sum_{k=1}^{n} x_{ijk} \leq U_j y_j$

where U_j and L_j are upper and lower limits of the j^{th} warehouse. But out of $'m'$ only $'p'$ are selected

therefore, y_j can take only 2 values 0 to 1

$$y_j = \begin{cases} 1\ if\ the\ j^{th}\ possible\ location\ is\ selected\ for\ the\ warehouse \\ 0\ otherwise \end{cases}$$

If $y_j = 1$ we get

$L_j \leq \sum_{i=1}^{l} \sum_{k=1}^{n} x_{ijk} \leq U_j$, $j = 1,2, \dots m$

If $y_j = 0,$ we get

$0 \leq \sum_{i=1}^{l} \sum_{k=1}^{n} x_{ijk} \leq 0$

$\Rightarrow \sum_{i=1}^{l} \sum_{k=1}^{n} x_{ijk} = 0$

⇒ No shipment from the warehouse i.e. this warehouse is not operated.

Also, $\sum_j^m y_j = p$ since out of 'm' only p are to be selected.

Therefore, the complete problem is

$Max\ Z = \sum_{i=1}^{l} \sum_{j=1}^{m} \sum_{k=1}^{n} (C_{ij} + C_{jk}) x_{ijk}$

$s.t.$

$\sum_j \sum_k x_{ijk} \leq a_i$

$\sum_i \sum_j x_{ijk} \geq d_k$

$L_j y_j \leq \sum_{i=1}^{l} \sum_{k=1}^{n} x_{ijk} \leq U_j y_j$

$\sum_{j=1}^{m} y_j = p.$

Where y_j is an integer and x_{ijk} may or may not be integers.

If x_{ijk} are also integers then the above problem becomes an integer programming problem, otherwise it is a mixed integer programming problem and can be solved easily.