# A Geographical based Facility Location Approach to Ensure Efficient Supply Chain Management

**Ajith Kumar P J**
*PG Student*
*Department of Industrial Engineering & Management*
*Mangalam college of Engineering Ettumanoor*

**Shijo Thomas**
*Assistant Professor*
*Department of Mechanical Engineering*
*Mangalam college of Engineering Ettumanoor*

## Abstract

For almost every company, decisions about the distribution system are a strategic issue. The facilities we plan today help an organization achieve supply chain excellence. Supply chain management entails not only the movement of goods but also the decisions about, where to produce, what to produce and how much to produce at each site, where to locate plants and distribution centers. Facilities are critical components of multilevel networks necessary for supply chain management. The major objectives of facility planning are to, Improve customer satisfaction conforming to customer promises, increase return on assets; maximize speed for quick customer response, effective use of people, equipment, space and energy. The problem in this paper consists of a company whose five adequate facilities have to be located considering the variable constraints using the tools such as Genetic Algorithm and k- means clustering.
**Keywords: Supply Chain Management, Facility location, Genetic Algorithm, k- means clustering. Distance Formula**

---

## I. INTRODUCTION

For almost every company, decisions about the distribution system are a strategic issue. The facilities we plan today help an organization achieve supply chain excellence. Supply chain management entails not only the movement of goods but also the decisions about, (i) where to produce, what to produce and how much to produce at each site, (ii). What quantity of goods to be held in inventory at each stage of the process, (iii) how to share the information among the parties in the process and finally, (iv) Where to locate plants and distribution centers.

Milk distribution networks operated by large dairy processors demand milk distribution from there plant to a large number of demand locations spread over a wide geographical region. Here proposed an idea of facility allocation, which are used to store the milk for the distribution in MILMA, Thripunithura diary. Facilities are established in locations where several hundred liters of milk is available to justify the cost of building and operating these centers also these facility locations are centers for certain distribution locations. Since milk is a perishable product it must be handled with care. Milk collected at the facility is hence chilled. Except for some distribution areas close to the plant where directly distributed from the plant itself, so the plant itself is considered as one of the facility.The milk is transported to the dispatch center within a specified time frame owing to the perishable nature of the product.The milk is transferred to larger vehicles from the plant and then transported to the distribution centers. By the use of vehicles specific sizes, such as big tankers we can reduce the AM & PM trip into one trip. In future this facility can used for the milk collection also.

## II. PROBLEM DEFINITION AND MATHEMATICAL MODEL

### A. Problem Description

The project was held in the company called milma, one of the major milk distributors across Kerala. Milma mainly have milk and milk based products. The study was done at one among the milma plant which is situated at Tripunithura, Ernakulam diary. The Ernakulum diary has only one plant in its under. The plant is located at Tripunithura. After the production the firm, directly distribute the product from the plant to the various locations of its market to meet their customer demands. This paper aims to assign certain locations for the facilities so that reduces the cost for transporting goods from the plant to the customer.

### B. Assumptions and Modelling

1) Each location represents a possible place for a facility warehouse.
2) Only one facility may be located per location.
3) Transportation cost is directly proportional to the distance.

### C. Indices

I = set of demand locations, indexed as i.

 

J= set of (possible locations) facilities, indexed as j.
K= plant location, indexed as k

### *D. Model Parameters*

$d_{jk}$ = distance from plant location, k to facility location, j.
$d_{ij}$ = distance from facility location, j to demand location, i.
$c_{jk}$= unit transportation cost from plant location, k to facility location, j.
$c_{ij}$= unit transportation cost from facility, j to demand location, i.
$f_j$= fixed cost for allocating a facility at location, j.
Vi= customer demand.
Vij= despatch volume from facility to demand location.
Vjk= despatch volume from plant to facility.

### *E. Decision Variables*

$Y_j$= 1 if allocate facility at eligible location j.
0 if not.

### *F. Mathematical Model*

Total cost involving with new facility allocation and transportation is

$$= cjk*\sum_i\sum_j djkvjk + cij*\sum_i\sum_j dijvji + \sum_j fjYj$$

Subjected to,

$$\sum_i\sum_j vij = Vi$$

$$\sum_i\sum_j vij \leq \sum_j\sum_k vjk$$

$$Vi, Vij, Vjk \geq 0$$

but here we can found that unit transportation cost is $\alpha$ distance
$\alpha$ 1/(distance*volume)
and assuming that facility allocation cost is always an asset for the company so the paper have a concern about the minimization of distance. Here we get the objective function as

$$\text{Minimize } Z = \sum_j\sum_k djk+\sum_i\sum_j dij$$

## III. SOLUTION METHODOLOGIES

This network design problem is an extension to the traditional incapacitated facility location problem (UFLP).

### *A. Genetic Algorithm*

The proposed mathematical model is a NP hard problem. Thus genetic algorithm-based heuristic is used in order to obtain good solutions. Figure demonstrates the steps of this approach. The potential locations of plant, warehouse are summarized in table 3 and monthly demands of each distribution center locations are shown in table 4. For simplicity Euclidean distance is used in measuring travel distance.

### *B. k-Means Clustering Algorithm*

k-means is one of the simplest unsupervised learning algorithms that can solve the well-known clustering problem. The procedure follows a simple method which will group a given data set through a certain number of clusters (assume ‘k’ clusters) fixed a priori. The aim is to define ‘k’ centroids, one for each cluster. Then these centroids should be placed in a tactical way because different locations produce different results. So, a better choice is to place them as much as far away from one another. The next step is to take each point that belongs to a given data set and associate it to the nearest centroid. When there is no more data pending, the first iteration can be considered as complete and an early grouping is done. At this point, ‘k’ new centroids are recalculated by using the results of the previous step. After having these ‘k’ new centroids, a new grouping is done with the same data set points and the nearest new centroid. The same procedure is repeated a number of times. As a result of this repeated iterations, it may be noticed that the ‘k’ centroids change their location step by step until there is no more changes to be done.

### C. Distance Formula

This uses the 'haversine' formula to calculate the great-circle distance between two points – that is, the shortest distance over the earth's surface – giving an 'as-the-crow-flies' distance between the points (ignoring any hills they fly over, of course!).
Formula: $a = \sin^2(\Delta\varphi/2) + \cos\varphi_1 \cdot \cos\varphi_2 \cdot \sin^2(\Delta\lambda/2)$
$c = 2 \cdot a(\tan2(\sqrt{a}, \sqrt{(1-a)}))$
$d = R \cdot c$
Where, φ is latitude, λ is longitude, R is earth's radius (mean radius = 6,371km);

*Table- 1*
*Details about locations*

| Sl. No. | Locations | Latitude | Longitude |
|---|---|---|---|
| 1 | EDAPPALLY | 10.0236 | 76.3116 |
| 2 | VARAPUZHA | 10.0743 | 76.2713 |
| 3 | VAZHAKALA | 10.0177 | 76.3333 |
| 4 | ALUVA | 10.1075 | 76.3456 |
| 5 | EDATHALA | 10.0822 | 76.3828 |
| 6 | ANGAMALY | 10.1849 | 76.3753 |
| 7 | KOTTUVALLY | 10.1110 | 76.2450 |
| 8 | NORTH PARAVUR | 10.1404 | 76.2305 |
| 9 | FORT COCHI | 9.9657 | 76.2421 |
| 10 | MATTANCHERRY | 9.9586 | 76.2565 |
| 11 | PALLURUTHY | 9.9087 | 76.2730 |
| 12 | VAIKOM | 9.7216 | 76.3926 |
| 13 | PERUVA | 9.8281 | 76.5011 |
| 14 | TRIPUNITHURA | 9.9486 | 76.3463 |
| 15 | MULAMTHURUTHY | 9.8983 | 76.3839 |
| 16 | THALAYOLAPARAMBU | 9.7784 | 76.4505 |
| 17 | PIRAVOM | 9.8730 | 76.4919 |
| 18 | MUVATTUPUZHA | 9.9804 | 765892 |
| 19 | KOLENCHERRY | 9.9782 | 76.4739 |
| 20 | KOTHAMANGALAM | 10.0601 | 76.6350 |

### D. Step-by-Step Procedure of New Coded Program

1) Step 1: Input the locations and there corresponding latitude and longitude values.
2) Step 2: Input the number of facilities required, n.
3) Step 3: Set the plant location.
4) Step 4: Randomly select 6 set of n+1 locations as facilities.
5) Step 5: Group the entire market into n+1 clusters by assigning nearby locations into each facilities
6) Step 6: Find the distance covered from plant location to each facility and from facility to all locations under each clusters

$$\text{Minimize } Z = \sum_{j}\sum_{k} d_{jk} + \sum_{i}\sum_{j} d_{ij}$$

7) Step 7: Repeat steps 4, 5 and 6 until the required number of generations

## IV. NUMERICAL ANALYSIS

For illustrative purpose, the problem described in section 3 was solved by using the coded software using the k-means clustering Algorithm and GA. For that, the code for the proposed GA was created in a programming language known as Java and run with certain parameters. These parameters are; population size =59, maximum number of generations =100; the table below shows the best fitness values of each generation as a function of the number of generations. The GA solution procedure was executed on a computer equipped with a Windows7 i3 processor with a speed of 2.40GHz, and 2.00 GB of memory.

*Table - 2*
*The best solution for the selection of facilities*

| ALLOCATED FACILITIES | COORDINATES OF FACILITY LOCATIONS | |
|---|---|---|
| | LATITUDE | LONGITUDE |
| MUVATTUPUZHA | 9.9804 | 76.5892 |
| VARAPUZHA | 10.0743 | 76.2713 |
| PERUVA | 9.8281 | 76.5011 |
| EDATHALA | 10.0822 | 76.3828 |
| TRIPUNITHURA | 9.9486 | 76.3463 |
| PALLURUTHY | 9.9087 | 76.2730 |

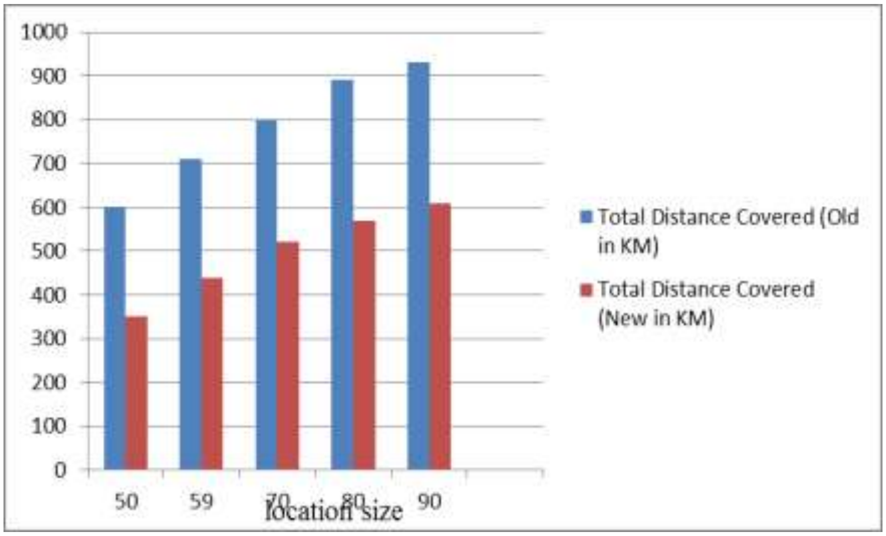


Fig. 1: performance with different location sizes

## V. RESULTS AND DISCUSSIONS

The existing transportation distance from the plant to the demand locations are found to be 719 KM. From GA the new transportation distance from the plant to the allocated 6 facilities and from the 6 facilities to the demand locations is obtained as 521 KM. Hence there is a saving off of 198 KM per day.

## VI. CONCLUSION

Detailed evaluation of the existing distribution system made it clear that it has some drawbacks and that affecting the profit. The possibility of modification of the system lies in the management decision. The management have to take decision regarding whether they are going to reschedule the whole routes or rearrange the system.

## REFERENCES

[1] Bing Wang, Xiaokang Fu, Tinggui Chen, Guanglan Zhou "Modeling Supply Chain Facility Location Problem and Its Solution Using a Genetic Algorithm " Journal of Software
[2] Rajesh Kumar S "Genetic Algorithm for solving the uncapacitated facility location problem "IJERT.
[3] T.G. Pradeepmon, Dr.Brijesh Paul "A Hybrid Algorithm for Uncapacitated Facility Location Problem" Int. J. Services. Economic and Management.
[4] Injazz J Chen, Antony Poulraj "Towards a Theory of Supply Chain Management: The Construct and Measurements" Journal of Operation Management.
[5] Govardhan Meruva, Amit.B.Mankar, T Radha Ramanan"Development of an Integrated Production and Distribution Planning Model with Multiple Transportation Modes –A Case Study " Proceeding for the National Conference on Emerging Trends in IEM
[6] A Anand Jayakumar, Dr. C Krishnaraj "Solving Supply Chain Network Gravity Location Model Using LINGO" IJISET.
[7] Beasley J.E., "Obtaining Test Problems via Internet," Journal of Global Optimization,
[8] Beasley J.E., and Chu P.C., "A Genetic Algorithm For the Set Covering Problem," European Journal of Operational research
[9] Benati S., and Laporte G, "Tabu search algorithms for the medianoid and centroid problems," Location Science.