Supply Chain Network Design for Plant Location and Selection of Capacity for Pump Manufacturing Companies

Rashwan[1], Saravanan .T[2], Rasu .K[3], Rajasimeswaran .D[4], Anand Jayakumar .A[5]

[1,2,3,4] *Final Year Students, Mechanical Engg Dept, SVS College of Engineering, Tamil Nadu, India*
[5] *Asst Professor, Mechanical Engg Dept, SVS College of Engineering, Tamil Nadu, India*

Abstract - *The primary objective of SCM is to fulfill customer demands through the most efficient use of resources, including distribution capacity, inventory, and labor. In theory, a supply chain seeks to match demand with supply and do so with the minimal inventory. Various aspects of optimizing the supply chain include liaising with suppliers to eliminate bottlenecks; sourcing strategically to strike a balance between lowest material cost and transportation, implementing just-in-time techniques to optimize manufacturing flow; maintaining the right mix and location of factories and warehouses to serve customer markets; and using location allocation, vehicle routing analysis, dynamic programming, and traditional logistics optimization to maximize the efficiency of distribution. Physical locations included in a supply chain network can be manufacturing plants, storage warehouses, major distribution centres, ports, intermodal terminals whether owned by a company, suppliers, a transport carrier, a third-party logistics provider, a retail store or an end customer. Transportation modes that operate within a supply chain network can include the many different types of trucks, trains for boxcar or intermodal unit movement, container ships or cargo planes. Site selection indicates the practice of new facility location, both for business and government. Site selection involves measuring the needs of a new project against the merits of potential locations. The practice came of age during the 20th century, as governments and corporate operations expanded to new geographies on a national and international scale. In this paper we are going to decide in which sites to start the factory and of what capacity.*

Key Words: **Supply chain, Network, Location, Transportation, Site.**

1. INTRODUCTION

Successful supply chain management requires many decisions relating to the flow of information, product, and funds. These decisions fall into three phases, depending on the frequency of each decision and the period over which a decision phase has an impact. The design, planning, and operation of a supply chain have a strong impact on overall profitability and success. A typical SCN design problem sets the configuration of the network and the missions of its locations. Some facilities may be opened, others closed, while others can be transformed using different capacity options. Each selected facility is assigned one or several production, assembly and/or distribution activities depending on the capacity options available at each location. The mission of each facility must also be specified in terms of product mix and facilities/customers to supply. Key raw-material suppliers must be selected. For each product-market, a marketing policy setting service and inventory levels, as well as maximum and minimum sales levels, must also be selected. The objective is typically to maximize net profits over a given planning horizon. Typical costs include fixed location/configuration costs, fixed vendor and market policy selection costs, as well as some variable production, handling, storage, inventory and transportation costs.

2. LITERATURE REVIEW

Anand Jayakumar A and Krishnaraj C [1] have created a mathematical revenue model for multiple customer segments. Anand Jayakumar A et al [2] have optimized a p median problem using python. Anand Jayakumar A et al [3] have optimized a fixed charge problem using python. Anand Jayakumar A and Krishnaraj C [4] have created a mathematical model for pricing and revenue management of perishable assets. Anand Jayakumar A and Krishnaraj C [5] have suggested on implementation of quality circle. Anand Jayakumar A et al [6] have suggested a mixed strategy for aggreage planning. Anand Jayakumar A et al [7] have created a mathematical model for aggregate planning. Anand Jayakumar A et al [8] have created a mathematical model for supply chain network design. Anand Jayakumar A et al [9] have created a mathematical model for aggregate planning for a pump manufacturing company. Anand Jayakumar A et al [10] have improved productivity in a stitching section. Anand Jayakumar A et al [11] have created another model for aggregate planning. Anand Jayakumar A et al [12] have reviewed on the mathematical models for supply chain network design. Anand Jayakumar A et al [13] have created a chase strategy for aggregate production planning. Anand Jayakumar A and Krishnaraj C [14] have created a mathematical model for supply chain network optimization using gravity location method. Krishnaraj C et al [15] have solved a supply chain network optimization model. Anand Jayakumar A et al [16] have presented a supply chain location allocation problem in multiple stages and dedicated supply. Anand Jayakumar A et al [17] have presented a facility layout problem.

3. WHAT IS LINGO?

LINGO is a simple tool for utilizing the power of linear and nonlinear optimization to formulate large problems concisely, solve them, and analyze the solution. Optimization helps you find the answer that yields the best result; attains the highest profit, output, or happiness; or achieves the lowest cost, waste, or discomfort. Often these problems involve making the most efficient use of your resources—including money, time, machinery, staff, inventory, and more. Optimization problems are often classified as linear or nonlinear, depending on whether the relationships in the problem are linear with respect to the variables. LINGO includes a set of built-in solvers to tackle a wide variety of problems. Unlike many modeling packages, all of the LINGO solvers are directly linked to the modeling environment. This seamless integration allows LINGO to pass the problem to the appropriate solver directly in memory rather than through more sluggish intermediate files. This direct link also minimizes compatibility problems between the modeling language component and the solver components. Local search solvers are generally designed to search only until they have identified a local optimum. If the model is non-convex, other local optima may exist that yield significantly better solutions. Rather than stopping after the first local optimum is found, the Global solver will search until the global optimum is confirmed. The Global solver converts the original non-convex, nonlinear problem into several convex, linear subproblems. Then, it uses the branch-and-bound technique to exhaustively search over these subproblems for the global solution. The Nonlinear and Global license options are required to utilize the global optimization capabilities.

4. THE MODELING FRAMEWORK

$$Min \quad \sum_{i=1}^{n} f_i y_i + \sum_{i=1}^{n} \sum_{j=1}^{m} c_{ij} x_{ij} \qquad (1)$$

Subject to

$$\sum_{i=1}^{n} x_{ij} = D_j \;\; for \;\; j = 1, \ldots, m \qquad (2)$$

$$\sum_{j=1}^{m} x_{ij} \leq K_i y_i \;\; for \;\; i = 1, \ldots, n \qquad (3)$$

$$y_i \in [0,1] \;\; for \;\; i = 1, \ldots, n, x_{ij} \geq 0 \qquad (4)$$

Where:
n = number of potential plant locations/capacity (each level of capacity will count as a separate location)
m = number of markets or demand points
Dj = annual demand from market j
Ki = potential capacity of plant i
fi = annualized fixed cost of keeping factory i open
cij = cost of producing and shipping one unit from factory i to market j (cost includes production, inventory, transportation and tariffs)
yi = 1 if plant i is open, 0 otherwise
xij = quantity shipped from plant i to market j
Equation (1) is the objective function and it minimizes the total cost (fixed + variable) of setting up and operating the network.

The constraint in
Equation (2) requires that the demand at each regional market be satisfied.

The constraint in
Equation (3) states that no plant can supply more than its capacity. (Clearly the capacity is 0 if the plant is closed and Ki if it is open. The product of the terms Kiyi captures this effect.

The constraint in
Equation (4) enforces that each plant is either open (yi = 1) or closed (yi = 0). The solution identifies the plants that are to be kept open, their capacity, and the allocation of regional demand to these plants.

The model is solved using LINGO.

5. DATA COLLECTION

The data was collected from four different companies in Coimbatore district of Tamil Nadu, India.

- Best Engineers Pumps (India) Pvt Ltd
- Alpha Pump Industry (India) Pvt Ltd
- Asthra Pumps (India) Pvt Ltd
- Sigma Pump Industry (India) Pvt Ltd

6. RESULT AND DISCUSSION

For Best Engineers pumps company we found that company need to open low capacity new manufacturing plant at Telangana state

For Alpha pump company we found that company need to open low capacity new manufacturing plant at Tamilnadu

For Asthra pump company we found that company need to open low capacity new manufacturing plant at Karnataka

For Sigma pump company we found that company need to open low capacity new manufacturing plant at Kerala and Gujarat.

3. CONCLUSION

We analyzed and found implementation of low capacity new manufacturing plants for four companies based on supply chain network design for plant location and selection of capacity for that companies in Lingo12.0 software.

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