



Supply Chain Freight Cost Optimization Algorithms and Swarm Intelligence Techniques: A Perspective

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Abstract- Optimal distribution of Finish Goods (FG) is key aspect in Supply Chain Management (SCM) for maximizing gross profit and dispatch adherence. Overall Freight Cost optimization performs major role in logistic and factory allocation planning. Vogel Approximation Method (VAM) is unit cost penalty method used to allocate supply to demand and to map factories with depots using Linear Programming (LP). Swarm Intelligence Technique derived from behavior of social insect's colony is in current research to use with Supply Chain Management (SCM) cost optimization using Artificial Intelligence.

Keywords- Vogel's Approximation Method (VAM), Ant colony optimization (ACO), artificial bee colony algorithm (ABC), Freight Cost (FC), Supply Chain Management (SCM)

I. INTRODUCTION

Optimal distribution of Finish Goods (FG) is key aspect in Supply Chain Management (SCM) for maximizing gross profit and dispatch adherence. Overall Freight Cost optimization performs major role in logistic and factory allocation planning. The objective is to determine the number of units to be shipped from the source to the destination, so that the total demand at the destinations is completely satisfied and the cost of transportation is minimal [1].

Artificial Intelligence (AI) is the concept and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making and translation between languages. Use of Artificial Intelligence (AI) in supply chains will ultimately result in enabling seamless flow of products and information from one end to the other.

Swarm intelligence (SI) is the communal behaviour of decentralized, self-organized systems, natural or artificial. Swarm Intelligence Technique derived from behavior of social insect's colony is in current research to use with Supply Chain Management (SCM) cost optimization using Artificial Intelligence.

Vogel Approximation Method (VAM) is unit cost penalty method used to allocate supply to demand and to map factories with depots using Linear Programming (LP). VAM was developed in 1958. VAM have been used to find initial basic feasible solution for the transportation model.

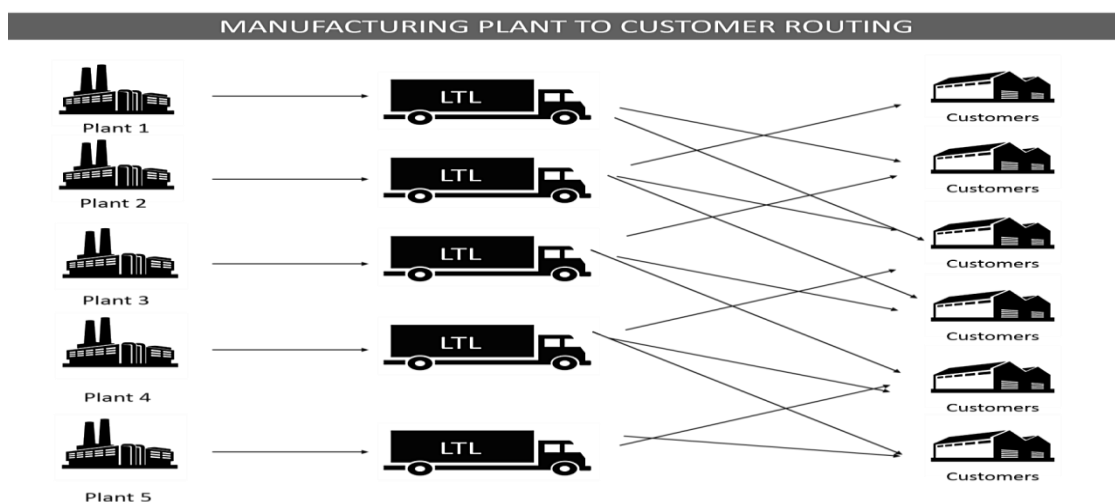


Figure 1. Problem Scenario

II. METHODOLOGIES

Survey of different methodologies shows it's feasibility to solve the factory allocation problem which can optimize the overall freight cost.

2.1 Algorithms

Many algorithms are available to find the initial basic feasible solutions to get the optimized value of total freight cost. Algorithms like Column Minimum Method (CMM), Row Minimum Method (RMM), North West-Corner Method (NWCN), Least Cost Method (LCM) and Vogel's Approximation Method (VAM) [1] are extensively used by Supply Chain Optimization solution providers. Vogel's Approximation Method (VAM) is one of the best algorithms with its available variant to be used.

2.1.1 Vogel's Approximation Method (VAM)

Calculate the penalty of each row and a column of source and destination matrix which has been used as an input data set. The penalty will be the difference between the two smallest freight costs in the row or column. Recognize the row or column with the largest penalty and assign highest possible stock to the destination having smallest shipping cost in that row or column. Mark the served row or column. Calculate new penalties with the same procedure till one row or column is left [1].

2.2 Swarm Intelligence Techniques

Some of the swarm intelligence techniques are proposed over the time to serve the dynamic routing and path finding problems. Techniques like exact methods [6], heuristics [7] and metaheuristics [8] have been proposed. Ant Colony Optimization (ACO) is one of the metaheuristic technique used to address this type of problems due to their dynamic adaption capabilities.

2.2.1 Ant Colony Optimization

The ant colony optimization is a technique for finding optimal paths which is based on the behavior of ants; searching for food. Initially ant roams randomly. It comes back to the colony and by dropping pheromones once it finds the source of food. Other ants follow the marked path initially and populate the path by dropping their own pheromones. Path gets optimized once couple of ants travels from food source to their colony. The similar method can be used to solve the logistic route finding and optimizing problem. MAX-MIN Ant System (AS) (MMAS) is currently one of the best variant of Ant Colony Optimization (ACO) technique [2].

Static methods may not be completely feasible for dynamic route finding problems because of the computational time required and dynamic change adherence capabilities [2].

An Ant System called Rank-based Ant System (ASRB) is applicable to solve the problem of forming the Supply Chain (SC), when the parameters like Production Cost (PC) and the Lead Time (LT) needs to be minimised together [3]. Ant Colony Optimisation (ACO) to be an excellent option to solve this kind of optimisation problems. Some technique like considering the ants which generates the best path is allowed to modify pheromones in the optimization process [3].

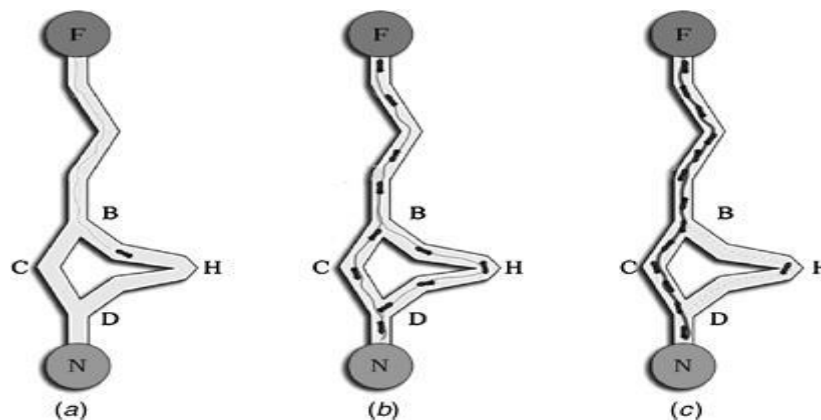


Figure 2. Ant Colony Optimization

2.2.2 Bee Colony Algorithm

New swarm intelligence technique, Artificial Bee Colony (ABC) is based on collective intelligence of behavior of honey bees, which is applicable for dynamic route optimizations. Employed bees, Onlooker bees and Scout bees are groups of different types based on their roles [4]. Initially food sources are produced for all employed bees. Each employed bee goes to a food source and defines a neighbour source, then estimates its nectar amount and taps in the hive. Each onlooker watches the taps of employed bees and chooses one of their sources depending on the taps and then goes to that source. After selecting a neighbour around that, it evaluates its nectar amount. Food sources which are excluded are determined and are replaced with the new food sources exposed by scouts. The best source of food would be marked. Repeat the same process until requirements are met [9].

Resolving the conflict in production planning as well as allocating the resources in a group manufacturing is a difficult problem that can take a large amount of time to solve it optimally and reasonably. Bi-objective variant of Bee Colony Optimization can be used enhance the performance and efficiency of conflict resolution by considering the resource allocation among group manufacturing members [5].

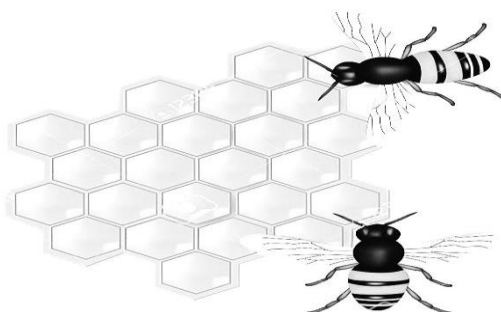


Figure 3. Bee Colony Optimization

III. LITERATURE REVIEW

Static route finding problem is always a fundamental issue in supply chain management and it is extended to dynamic route finding problem day by day as business scenario is expanded. Studied literature shows the availability and use of static as well as dynamic methodologies along with their applicable areas. From static computer algorithm to artificial intelligence techniques has been derived with the improvement of business strategies and computation machine capabilities.

Methodology	Technique	Feasibility	Usability	Dynamic Change Adaptability
Algorithm	Column Minimum Method (CMM)	Feasible	Used	No
	Row Minimum Method (RMM)	Feasible	Used	No
	North West-Corner Method (NWCN)	Feasible	Used	No
	Least Cost Method (LCM)	Feasible	Used	No
	Vogel's Approximation Method (VAM)	Feasible	Used	Partially
Artificial Intelligence (Swarm Intelligence)	Ant Colony Optimization	Feasibility needs to be tested	Not Proved	Yes
	Bee Colony Optimization	Feasibility needs to be tested	Not Proved	Yes

Table 1. Comparision of Applicable Techniques

IV. CONCLUSIONS

A variant of Vogel Approximation Method (VAM) and Swarm Intelligence Technique can be used to provide optimal distribution by reducing Total Freight Cost. Our further research will show the performance comparison of these techniques and will conclude the best feasible approach among all.

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