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Inventory Analysis Using Genetic Algorithm In Supply Chain Management

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ABSTRACT

With the dramatic increase in the use of the Internet for supply chain-related activities, there is a growing need for services that can analyze current and future purchases possibilities as well as current and future demand levels and determine efficient and economical strategies for the procurement of direct goods. Such solutions must take into account the current quotes offered by suppliers, likely future prices, projected demand, and storage costs in order to make effective decisions on when and from whom to make purchases. Based on demand trends and projections, there is typically a target inventory level that a business hopes to maintain. This level is high enough to be able to meet fluctuations in demand, yet low enough that unnecessary storage costs are minimized. Hence there is a necessity of determining the inventory to be held at different stages in a supply chain so that the total supply chain cost is minimized. Minimizing the total supply chain cost is meant for minimizing holding and shortage cost in the entire supply chain. This inspiration of minimizing Total Supply Chain Cost could be done only by optimizing the base stock level at each member of the supply chain which is very dynamic. A novel and efficient approach using Genetic Algorithm has been developed which clearly determines the most possible excess stock level and shortage level that is needed for inventory optimization in the supply chain so as to minimize the total supply chain cost.

1. INTRODUCTION

Supply chain can be described as an integral process wherein numerous entities of diverse nature (i.e., suppliers, manufacturers, distributors, and retailers) work in coalition so as to (1) obtain raw materials, (2) convert these raw materials into precise end products, and (3) deliver the end products to retailers .[1] A traditional supply chain consists of the acquirement of raw materials and production of items at one or more factories, shipping the items to various warehouses for storage and in turn shipping them to the respective retailers or customers

Supply chain management can be regarded as a set of procedures used to proficiently combine suppliers, manufacturers, warehouses and stores to ensure proper production and distribution of right quantities to the right location in right time and thereby reducing the total supply chain cost besides satisfying service level requirements.

Inventory management is one of the significant fields in supply chain management. Efficient and effective management of inventory throughout the supply chain significantly improves the ultimate service provided to the customer. Hence there is a necessity of determining the inventory to be held at different stages in a supply chain so that the total supply chain cost is minimized. Minimizing the total supply chain cost is meant for minimizing holding and shortage cost in the entire supply chain. This inspiration of minimizing Total Supply Chain Cost could be done only by optimizing the base stock level at each member of the supply chain. The dilemma occurring here is that the excess stock level and shortage level is very dynamic for every period. In this paper, we have developed a novel and efficient approach using Genetic Algorithm which clearly determines the most possible excess stock level and shortage level that is needed for inventory optimization in the supply chain so as to minimize the total supply chain cost. [2]

- The issues in supply chain management are the shorter product lifecycles which cultivate higher demand uncertainty and the action on global markets in turn increasing the supply chain complexity [3,5].
- Supply chain can be effectively managed to reduce costs and lead times and improve responsiveness to changing customer demands and consequently optimizing inventory [4]
- Inventory management and control, production, planning and scheduling; information sharing, coordination, monitoring; and operation tools are the four problems areas the research addresses from an operational perspective. [5]
- The total supply chain cost may be affected by having excess inventories and shortage of inventories. Consequently, inventory optimization is one of the hottest topics when the supply chain management is considered [6], [7], [8].

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- Inventory Optimization is designed to optimize inventory strategies to improve customer service, reduce lead times and costs and meet market demand.
- A central concern for inventory and supply chain manager is to find out the right amount of inventory at each location of the supply chain, without excesses or shortages while minimizing the total supply chain cost It is critical to accurately estimate the optimal inventory yield lost sales while excess of inventory may result in unnecessary storage cost.

2. LITERATURE REVIEW

Beamon presents a study and evaluations of the performance measures employed in supply chain models and have also displayed a framework for the beneficial selection of performance measurement systems for manufacturing supply chains. Three kinds of performance measures have been recognized as mandatory constituents in any supply chain performance measurement system. New flexibility measures have been also created for the supply chains [1]

In [4] Pongcharoen et al., proposes a multi-matrix real-coded Generic Algorithm (MRGA) based optimization tool that minimizes total costs associated with in supply chain logistics The objectives of this paper were to i)present the mathematical model for minimizing total costs raised from raw material ,manufacturing, holding inventory, transportations between parties and fixed operation costs; ii)describe a multi-matrix real-coded Genetic Algorithm that always guarantee feasible solutions obtained from both initialization and evolution processes and iii)present the computational experiments for investigating genetic parameters and operators using three sizes of dataset.

Scott et al.,[9] proposed a technique for use in supply-chain management that assists the decision-making process for purchases of direct goods. Based on projections for future prices and demand, Request-for – quote (RFQ) are constructed and quotes are accepted that optimize the level of inventory each day, while minimizing total cost. The problem is modeled as a Markov decision process, which allows for the computation of the utility of actions to be based on the utilities of consequential future states. Dynamic programming is then used to determine the optimal quote requests and accepts at each state .In this paper; we propose a decision-theoretic algorithm that advises the buyer when and from whom to buy by looking at possible future decisions. The buyer is advised to take an action if and only if there is no present or future alternative that would yield greater overall expected utility.

Abdel et al.,[10] described a fresh genetic algorithm (GA) approach for the integrated inventory distribution problem has been projected by Abdel et al. They have developed a genetic representation and have utilized a randomized version of a formerly developed construction heuristic in order to produce the initial random population. In this paper, the integrated inventory distribution problem, which is classified as a time domain problem, considers multiple planning periods, both inventory and transportation costs, and a situation in which backorders are permitted.

3. INVENTORY ANALYSIS USING GENETIC ALGORITHM

In practice, the supply chain is of length n, means having n number of members in supply chain such as factory, distribution centers, suppliers, retailers and so on. Here, for instance we are going to use a three stage supply chain that is illustrated in the figure 1. Our exemplary supply chain consists of a factory, distribution center 1 and distribution center 2

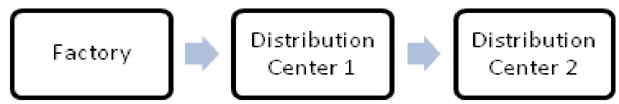

Figure 1. Three members in Supply Chain[2]

In the supply chain we are illustrated, the factory is the massive stock holding area where the stocks are manufactured as per the requirement of the distribution center 1. Then the distribution center 1 will take care of the stock to be supplied for the distribution center 2. As earlier discussed, the responsibility of our approach is to predict an optimum stock level by using the past records and so that by using the predicted stock level there will be no excess amount of stocks and also there is less means for any shortage. Hence it can be asserted that our approach eventually gives the amount of stock levels that needs to be held in the three members of the supply chain, factory, distribution center l and distribution center 2.

In our proposed methodology, we are using genetic algorithm for finding the optimal value. The flow of operation of our methodology is clearly illustrated in figure 2

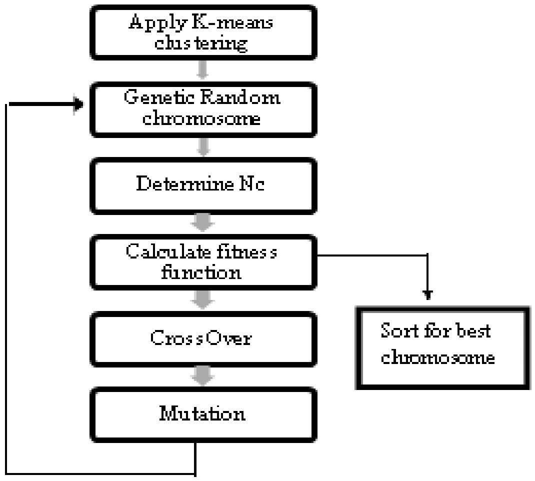

Figure 2 . Operational flow of methodology[2]

Initially, the amount of stock levels that are in excess and the amount of stocks in shortage in the different supply chain contributors are represented by zero or non-zero values. Zero refers that the contributor needs no inventory control while the non-zero data requires the inventory control. The non-zero data states both the excess amount of stocks as well as shortage amount. The excess amount is given as positive value and the shortage amount is mentioned as negative value. The first process needs to do is the clustering that clusters the stock levels that are either in excess or in shortage and the stock levels that are neither in excess nor in shortage separately. This is done simply by clustering the zero and non- zero values. For this purpose we are using, the efficient K means clustering algorithm.

After the process of K- means clustering is performed, the work starts its proceedings on Genetic algorithm, the heart of our work.

3.1 Chromosome Representation

The randomly generated initial chromosome is created by having the stock levels within the lower limit and the upper limit for all the contributors of the supply chain, factory and the distribution centers. The stock level of each member of the chromosome is referred as gene of the chromosome. Hence for n length supply chain, the chromosome length is also n. As we are using only three members of the chain, the length of the chromosome n is 3.

Initially, only two chromosomes will be generated and from the next generation a single random chromosome value will be generated

3.2 Fitness Function

Fitness functions ensure that the evolution is toward optimization by calculating the fitness value for each individual in the population. The fitness value evaluates the performance of each individual in the population.

3.3 Crossover

A single crossover function is used. The genes that are right of the cross over point in the two chromosomes are swapped and hence the cross over operation is done. After the crossover operation two new chromosomes are obtained.

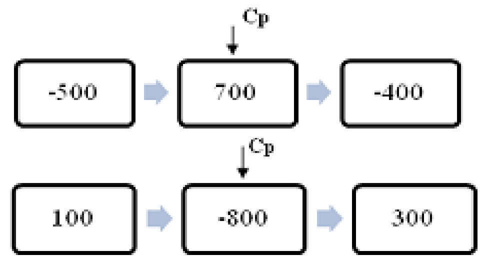

Figure 3. Before Crossover

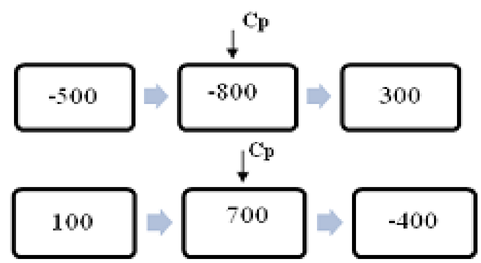

Figure 4. After Crossover

3.4 Mutation

The newly obtained chromosomes from the crossover operation are then pushed for mutation. By performing the mutation, a new chromosome will be generated. This is done by a random generation of two points and then performing swaps between both the genes.

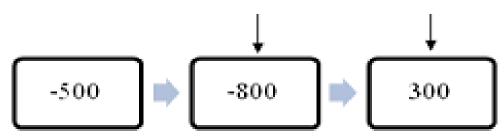

Figure 5. Before Mutation

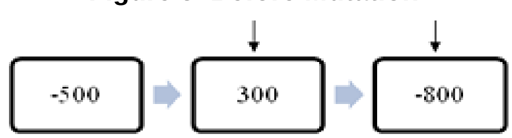

Figure 6. After Mutation

The mutation operation provides new chromosomes that do not resemble the initially generated chromosomes. After obtaining the new chromosome, another random chromosome will be generated. Then again the process repeats for a particular number of iterations while the two chromosomes that are going to be subjected for the process is decided by the result of the fitness function. Each number of iteration will give a best chromosome and this is will be considered to find an optimal solution for the inventory control. When the number of iterations are increased then the obtained solution moves very closer to the accurate solution have to improvise.

4. Result

The stock levels for the three different members of the supply chain, factory 1,distribution center 1 and distribution center 2 are generated using the MySQL and this generated data set used in each member of supply chain is used for evaluating the performance of the genetic algorithm.Sample data set is given in table 1.

Table 1 .Sample data set

Factory	Distribution centre 1	Distribution centre 1
792	-456	837
-591	-329	269
-746	721	-677
-550	-634	158
611	-295	-443
497	-170	847
-992	268	-270
792	-456	269
162	969	-507
591	-329	837
-329	-591	837
792	269	-456
-479	-796	-548
792	-456	837
611	-443	-295

The two initial chromosomes are generated at the beginning of the genetic algorithm are ‘1229 269 -456’ and ‘792 171 44’. These initial chromosomes are subjected for the genetic operators, Crossover and Mutation.As for our iteration value of ‘100’, the resultant chromosome moved towards the best chromosome after the each iterative execution. Hence at the end of the execution of 100th iteration, best chromosome ‘1229 44 171’ is obtained.

Simulation result showing the fitness function improvement-

For 10th Iteration- fitness= -0.00137

For 20th Iteration- fitness= -0.00413

For 50th Iteration- fitness= -0.0096

For 100th Iteration – fitness= -0.011

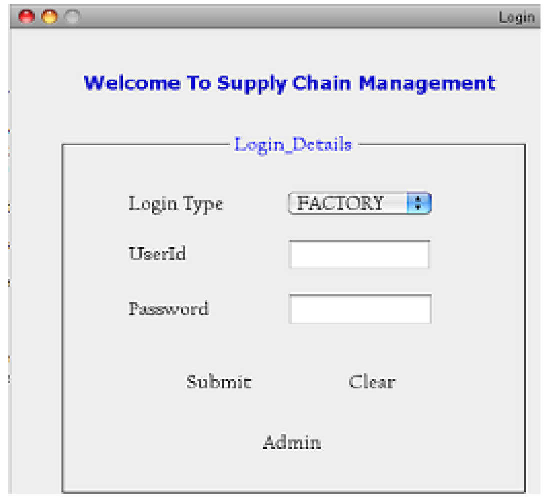

Figure 7. Admin Login Screen

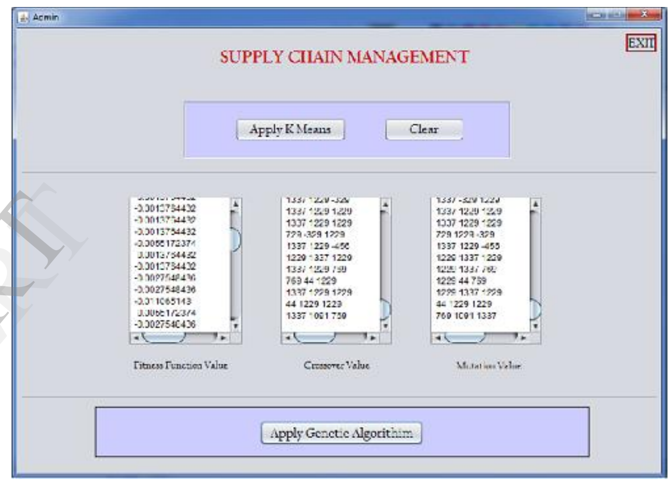

Figure 8. Main Genetic Algorithm Screen

5. CONCLUSION

Inventory management is one of the important fields in Supply chain management. I have presented a novel efficient approach using Genetic Algorithm which clearly determined the most possible excess stock level and shortage level that is needed for inventory optimization so as to minimize the total supply chain cost. The approach had been implemented in the JAVA ,NetBeans and MySQL database to visualize its performance. The stock level thus obtained is the optimal value which is sufficient and essential so that supply chain cost will be minimized

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