A Supply Chain Management Of Pharmaceutical For Deteriorating Items Using Genetic Algorithm

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Abstract- *supply chain inventory optimization of pharmaceutical and Genetic algorithm for deteriorating items in a manufacture of pharmaceutical, warehouse of pharmaceutical, three distribution centers of pharmaceutical, and three Retailer's of pharmaceutical environment using genetic algorithm. Demand is assumed to be known and constant. Shortages of pharmaceutical are not allowed and apply inflation of pharmaceutical. A warehouse of pharmaceutical is used to store the excess units over the fixed capacity of the two distribution centers of pharmaceutical. Further supply chain inventory optimization of pharmaceutical and Genetic algorithm optimization dispatching policies has been investigated in different scenarios in the model*

Keywords- supply chain of pharmaceutical, inventory optimization of pharmaceutical, warehouse of pharmaceutical, three Retailer's of pharmaceutical, three distribution centers of pharmaceutical, and Genetic algorithm

I. INTRODUCTION

Inventory control, otherwise known as stock control, is used to show how much stock have to maid available at any time, and how tracks are kept for it. It applies to every item that uses to produce a product or service, from raw materials to finished goods. It covers stock at every stage of the production process, from purchase and delivery to using and re-ordering the stock. Efficient stock control allows an organization/industry/company to have the right amount of stock in the right place at the right time. It ensures that capital is not tied up unnecessarily, and protects production if problems arise with the supply chain. Inventory control is the techniques of maintaining stock-items at desired levels. The purpose of all inventory models is to minimize inventory costs. As a result of the inventory model, a designer of air-condition machine decided to redesign its old model machine to enhance its working efficiency and reduce inventory costs in meeting a global market for its air-condition machines.

Inventory is held throughout the supply chain in the form of raw materials, work in process and finished goods. Inventory exists in the supply chain because of a mismatch between supply and demand. This mismatch is intentional at a manufacturer, where it is economical to manufacture in large lots that are then stored for future sales. The mismatch is also intentional at a retail store where inventory is held in anticipation of future demand. Inventory is a major source of cost in a supply chain and has a huge impact on responsiveness. An important role that inventory plays in the supply chain is (1) to increase the amount of demand that can be satisfied by having the product ready and available when the customer wants it. (2) To reduce cost by exploiting economics of scale that may exist during production and distribution. (3) To support a firm's competitive strategy. If a firm's competitive strategy requires very high level of responsiveness, a company can achieve this responsiveness by locating large amounts of inventory close to a customer. Conversely, a company can also use inventory to become more efficient by reducing inventory through centralized stocking.

Discussions so far were limited to GA that handled the optimization of a single parameter. The optimization criteria are represented by fitness functions and are used to lead towards an acceptable solution. A typical single objective optimization problem is the TSP. There the sole optimization criterion is the cost of the tour undertaken by the salesperson and this cost is to be minimized. However, In real life we often face problem which require simultaneous optimization of several criteria. For example, in VLSI circuit design the critical parameters are chip area power consumption delay fault tolerance etc. While designing a VLSI circuit the designer may like to minimize area power consumption and delay while at the same time would like to maximize fault tolerance. The problem gets more complicated when the optimizing criteria are conflicting. For instance an attempt to design low-power VLSI circuit may affect its fault tolerance capacity adversely. Such problems are known as multi-objective optimization (MOO). Multi-objective optimization is the process of systematically and simultaneously optimizing a number of objective functions. Multiple objective problems usually have conflicting objectives which prevents

simultaneous optimization of each objective. As GAs are population based optimization processes they are inherently suited to solve MOO problem. However traditional GAs are to be customized to accommodate such problem. This is achieved by using specialized fitness functions as well as incorporating methods promoting solution diversity. Rest of this section presents the features of multi-objective GAs.

II. RELATED WORKS

Narmadha at. al. (2010) proposed Multi-Product Inventory Optimization using Uniform Crossover Genetic Algorithm. Radhakrishnan et. al. (2009) gives a inventory optimization in Supply Chain Management using Genetic Algorithm. Singh and Kumar (2011) gives a inventory optimization in Efficient Supply Chain Management. Priya and Iyakutti (2011) proposed Web based Multi Product Inventory Optimization using Genetic Algorithm. Thakur and Desai (2013) a study inventory Analysis Using Genetic Algorithm In Supply Chain Management. Khalifehzadeh et. al. (2015) presented a four-echelon supply chain network design with shortage: Mathematical modelling and solution methods. Kannan et. al. (2010) Discuss a genetic algorithm approach for solving a closed loop supply chain model: A case of battery recycling. Jawahar and Balaji (2009) Proposed A genetic algorithm for the two-stage supply chain distribution problem associated with a fixed charge. Zhang et. al. (2013) presented A modified multi-criterion optimization genetic algorithm for order distribution in collaborative supply chain. Che and Chiang (2010) proposed A modified Pareto genetic algorithm for multi-objective build-to-order supply chain planning with product assembly. Yimer and Demirli (2010) Presented A genetic approach to two-phase optimization of dynamic supply chain scheduling. Wang, et. al. (2011) Proposed Location and allocation decisions in a two-echelon supply chain with stochastic demand – A genetic-algorithm based solution. Humphreys, et. al. (2009) presented Reducing the negative effects of sales promotions in supply chains using genetic algorithms. Sherman et. al. (2010) gives a production modelling with genetic algorithms for a stationary pre-cast supply chain. Ramkumar, et. al. (2011) proposed Erratum to "A genetic algorithm approach for solving a closed loop supply chain model: A case of battery recycling". Ye et. al. (2010) Proposed Some improvements on adaptive genetic algorithms for reliability-related applications. Guchhait et. al. (2010) presented Multi-item inventory model of breakable items with stock-dependent demand under stock and time dependent breakability rate. Changdar et. al. (2015) gives an improved genetic algorithm based approach to solve constrained knapsack problem in fuzzy environment. Sourirajan et. al. (2009) presented A genetic algorithm for a single product network design model with lead time and safety stock considerations. Jiang et. al. (2015) gives Joint optimization of preventive maintenance and inventory policies for multi-unit systems subject to deteriorating spare part inventory. Dey et. al. (2008) proposed Two storage inventory problem with dynamic demand and interval valued lead-time over finite time horizon under inflation and time-value of money. Jawahar and Balaji (2012) proposed A genetic algorithm based heuristic to the multi-period fixed charge distribution problem. Pasandideh et. al. (2010) gives a parameter-tuned genetic algorithm for multi-product economic production quantity model with space constraint, discrete delivery orders and shortages. Yadav et. al. (2016) proposed a cooperative Two-Warehouse Inventory Model for Deteriorating Items with Variable Holding Cost, Time-Dependent Demand and Shortages. Consider a similar model, Two Warehouse Inventory Model with Ramp Type Demand and Partial Backordering for Weibull Distribution Deterioration. put forward a model, A two-storage model for deteriorating items with holding cost under inflation and Genetic Algorithms. Singh et. al. (2016) proposed a Two-Warehouse Model for Deteriorating Items with Holding Cost under Particle Swarm Optimization. Consider a similar model, A Two-Warehouse Model for Deteriorating Items with Holding Cost under Inflation and Soft Computing Techniques. Yadav et. al. (2016) analyzed a Multi Objective Optimization for Electronic Component Inventory Model & Deteriorating Items with Two-warehouse using Genetic Algorithm. Sharma et. al. (2016) focused an Optimal Ordering Policy for Non-Instantaneous Deteriorating Items with Conditionally Permissible Delay in Payment under Two Storage Management. Yadav et. al. (2016) analyzed a Analysis of Genetic Algorithm and Particle Swarm Optimization for warehouse with Supply Chain management in Inventory control.

III. ASSUMPTIONS AND NOTATIONS

Assumptions

1. The production rate is $(\omega_0 - \omega_1 t_i)$ are linear function of time.
2. The demand rate is $(D_0 + D_1 t_i)$ are linear function of time.
3. The holding cost is $(H_1 t_i)$ are linear function of time.

Notations

θ_1 = Scale parameter of amelioration rate.

θ_2 = Shape parameter of amelioration rate.

$\alpha_1 + 1$ = Raw material's of pharmaceutical Scale parameter for the deterioration rate.

β_1 = Raw material's of pharmaceutical Shape parameter for the deterioration rate.

$\alpha_2 + 1$ = Storage Scale of pharmaceuticalparameter for the deterioration rate.

β_2 = Storage Shape of pharmaceuticalparameter for the deterioration rate.

$\alpha_3 + 1$ = Manufacturing of pharmaceutical Scale parameter for the deterioration rate.

β_3 = Manufacturing of pharmaceutical Shape parameter for the deterioration rate.

$\alpha_4 + 1$ = Warehouse of pharmaceutical cale parameter for the deterioration rate.

β_4 = Warehouse of pharmaceutical Shape parameter for the deterioration rate.

$\alpha_5 + 1$ = D.C − 1 of pharmaceuticalScale parameter for the deterioration rate.

β_5 = D.C − 1 of pharmaceuticalShape parameter for the deterioration rate.

$\alpha_6 + 1$ = D.C − 2 of pharmaceuticalScale parameter for the deterioration rate.

β_6 = D.C − 2 of pharmaceuticalShape parameter for the deterioration rate.

$\alpha_7 + 1$ = D.C − 3 of pharmaceuticalScale parameter for the deterioration rate.

β_7 = D.C − 3 of pharmaceuticalShape parameter for the deterioration rate.

$\alpha_8 + 1$ = Retailer's − 1 of pharmaceuticalScale parameter for the deterioration rate.

β_8 = Retailer's − 1 of pharmaceuticalShape parameter for the deterioration rate.

$\alpha_9 + 1$ = Retailer's − 2 of pharmaceuticalScale parameter for the deterioration rate.

β_9 = Retailer's − 2 of pharmaceuticalShape parameter for the deterioration rate.

$\alpha_{10} + 1$ = Retailer's − 3 of pharmaceuticalScale parameter for the deterioration rate.

β_{10} = Retailer's − 3 of pharmaceuticalShape parameter for the deterioration rate.

$I_{Ri}(t_i)$ = Raw material'sof pharmaceutical inventory level

$I_{Si}(t_i)$ = Storageof pharmaceutical inventory level .

$I_{Mi}(t_i)$ = Manufacturingof pharmaceutical finished goods inventory level .

$I_{Wi}(t_i)$ = Warehouse of pharmaceuticalfinished goods inventory level .

$I_{DCi}(t_i)$ = Distributor center of pharmaceuticalfinished goods inventory level .

$I_{Ri}(t_i)$ = Retailer's of pharmaceuticalfinished goods inventory level .

TC_{RM} = Raw material's of pharmaceuticalnet present total cost per unit time.

TC_S = Storage of pharmaceuticalnet present total cost per unit time.

TC_M = Manufacturing of pharmaceuticalnet present total cost per unit time.

TC_W = Warehouse of pharmaceuticalnet present total cost per unit time.

TC_{DC_i} = Distributor center of pharmaceuticalnet present total cost per unit time.

TC_{R_i} = Retailer's of pharmaceuticalnet present total cost per unit time.

IV. MATHEMATICS MODEL IN SUPPLY CHAIN INVENTORY CONTROL

The proposed method uses the Genetic Algorithm to study the stock level that needs essential inventory control. This is the pre-requisite idea that will make any kind of inventory control of pharmaceutical effective. For this purpose, we are using Economic Load Dispatch algorithm method as assistance. In practice, the supply chain is of length m, means having m number of members in supply chain of pharmaceutical such as Raw material of pharmaceutical, Storage of pharmaceutical, Manufacture of pharmaceutical, warehouse of pharmaceutical, Distribution centers of pharmaceutical, Distribution Center-1 of pharmaceutical, Distribution Center-2 of pharmaceutical and Distribution Center-3 of pharmaceutical. Each distribution center of pharmaceutical further comprises of several Retailer's but as stated in the example case, each Distribution center of pharmaceutical is having one agent. So, in aggregate there are three Retailers' of pharmaceutical, Retailer's-1 of pharmaceutical for Distribution Center-1 of pharmaceutical, Retailer's-2 of pharmaceutical for Distribution Center-2 of pharmaceutical and Retailer's-3 of pharmaceutical for Distribution Center-3 of pharmaceutical so on. Here, for instance we are going to use a Supply Chain of pharmaceutical that is illustrated in the figure 1.

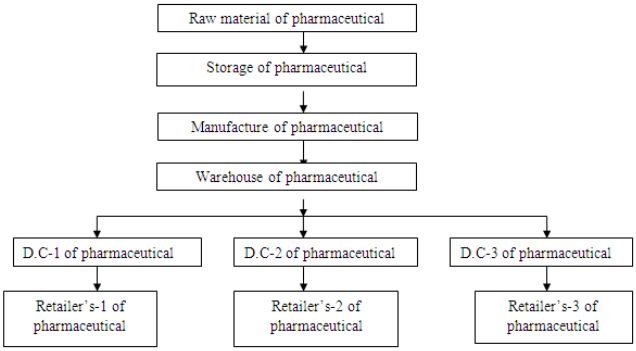

Fig.1

- **Raw material's of pharmaceutical:**

$$TC_{RM}=\left[\frac{1}{T}\left[\sum_{t_1=0}^{T_1}\left\{\begin{matrix}\left[\theta_1\theta_2 t_1^{\theta_2-1}I_{RM}(t_1)-(\alpha_1+1)\beta_1 t_1^{\beta_1-1}I_{RM}(t_1)\right]+(R_0t_1)\\ +\left[(H_1t_1)\{\theta_1\theta_2 t_1^{\theta_2-1}I_{RM}(t_1)-(\alpha_1+1)\beta_1 t_1^{\beta_1-1}I_R(t_1)\}\right]\end{matrix}\right\}\right]\right] \quad (1)$$

- **Storage of pharmaceutical:**

$$TC_S=\left[\frac{1}{T}\left[\sum_{t_2=0}^{T_2}\left\{\begin{matrix}\left[(D_0+D_1t_2)-(\alpha_2+1)\beta_2 t_2^{\beta_2-1}I_S(t_2)\right]+(S_0t_2)\\ +\left[(H_1t_2)\left\{(D_0+D_1t_2)-(\alpha_2+1)\beta_2 t_2^{\beta_2-1}I_S(t_2)\right\}\right]\end{matrix}\right\}\right]\right] \quad (2)$$

- **Manufacturing of pharmaceutical:**

$$TC_M=\left[\frac{1}{T}\left[\sum_{t_3=0}^{T_3}\left\{\begin{matrix}\left[(\omega_0-\omega_1t_3)-(D_0+D_1t_3)-(\alpha_3+1)\beta_3 t_3^{\beta_3-1}I_M(t_3)\right]+(M_0t_3)\\ +\left[(H_1t_3)\left\{(\omega_0-\omega_1t_3)-(D_0+D_1t_3)-(\alpha_3+1)\beta_3 t_3^{\beta_3-1}I_M(t_3)\right\}\right]\end{matrix}\right\}\right]\right] \quad (3)$$

- **Warehouse of pharmaceutical:**

$$TC_W=\left[\frac{1}{T}\left[\sum_{t_4=0}^{T_4}\left\{\begin{matrix}\left[(\omega_0-\omega_1t_4)-(D_0+D_1t_4)-(\alpha_4+1)\beta_4 t_4^{\beta_4-1}I_M(t_4)\right]+(W_0t_4)\\ +\left[(H_1t_4)\left\{(\omega_0-\omega_1t_4)-(D_0+D_1t_4)-(\alpha_4+1)\beta_4 t_4^{\beta_4-1}I_M(t_4)\right\}\right]\end{matrix}\right\}\right]\right] \quad (4)$$

- **Distributor center-1 of pharmaceutical:**

$$TC_{DC_1}=\left[\frac{1}{T}\left[\sum_{t_5=0}^{T_5}\left\{\left[(\omega_0-\omega_1t_5)-(D_0+D_1t_5)-(\alpha_5+1)\beta_5t_5^{\beta_5-1}I_{DC_1}(t_5)\right]+(C_0t_5)\right\}+\left[(H_1t_5)\left\{(\omega_0-\omega_1t_5)-(D_0+D_1t_5)-(\alpha_5+1)\beta_5t_5^{\beta_5-1}I_{DC_1}(t_5)\right\}\right]\right]\right]$$

(5)

- **Distributor center-2 of pharmaceutical:**

$$TC_{DC_2}=\left[\frac{1}{T}\left[\sum_{t_6=0}^{T_6}\left\{\left[(\omega_0-\omega_1t_6)-(D_0+D_1t_6)-(\alpha_6+1)\beta_6t_6^{\beta_6-1}I_{DC_2}(t_6)\right]+(C_0t_6)\right\}+\left[(H_1t_6)\left\{(\omega_0-\omega_1t_6)-(D_0+D_1t_6)-(\alpha_6+1)\beta_6t_6^{\beta_6-1}I_{DC_2}(t_6)\right\}\right]\right]\right]$$

(6)

- **Distributor center-3 of pharmaceutical:**

$$TC_{DC_3}=\left[\frac{1}{T}\left[\sum_{t_7=0}^{T_7}\left\{\left[(\omega_0-\omega_1t_7)-(D_0+D_1t_7)-(\alpha_7+1)\beta_7t_7^{\beta_7-1}I_{DC}(t_7)\right]+(C_0t_7)\right\}+\left[(H_1t_7)\left\{(\omega_0-\omega_1t_7)-(D_0+D_1t_7)-(\alpha_7+1)\beta_7t_7^{\beta_7-1}I_{DC_3}(t_7)\right\}\right]\right]\right]$$

(7)

- **Retailer's -1 of pharmaceutical:**

$$TC_{R_1}=\left[\frac{1}{T}\left[\sum_{t_8=0}^{T_8}\left\{\left[-(D_0+D_1t_8)-(\alpha_8+1)\beta_8t_8^{\beta_8-1}I_R(t_8)\right]+(R_2t_8)\right\}+\left[(H_1t_8)\left\{-(D_0+D_1t_8)-(\alpha_8+1)\beta_8t_8^{\beta_8-1}I_R(t_8)\right\}\right]\right]\right]$$

(8)

- **Retailer's-2 of pharmaceutical:**

$$TC_{R_2}=\left[\frac{1}{T}\left[\sum_{t_9=0}^{T_9}\left\{\left[\left[-(D_0+D_1t_9)-(\alpha_9+1)\beta_9t_9^{\beta_9-1}I_{R_2}(t_9)\right]+(R_4t_9)\right]+(H_1t_9)\left\{-(D_0+D_1t_9)-(\alpha_9+1)\beta_9t_9^{\beta_9-1}I_{R_2}(t_9)\right\}\right\}\right]\right]$$

(9)

- **Retailer's-3 of pharmaceutical:**

$$TC_{R_3}=\left[\frac{1}{T}\left[\sum_{t_{10}=0}^{T_{10}}\left\{\left[-(D_0+D_1t_{10})-(\alpha_{10}+1)\beta_{10}t_{10}^{\beta_{10}-1}I_R(t_{10})\right]+(R_4t_{10})\right\}+\left[(H_1t_{10})\left\{-(D_0+D_1t_{10})-(\alpha_{10}+1)\beta_{10}t_{10}^{\beta_{10}-1}I_R(t_{10})\right\}\right]\right]\right]$$

(10)

$$TC=\left[\frac{TC_{RM}+TC_S+TC_M+TC_W+TC_{DC_1}+TC_{DC_2}+TC_{DC_3}+TC_{R_1}+TC_{R_2}+TC_{R_3}}{T}\right]$$

(11)

$$TC=\left[\frac{1}{T}\left\{\begin{array}{l}\left[\sum_{t_1=0}^{T_1}\left\{\left[\theta_1\theta_2t_1^{\theta_2-1}I_{RM}(t_1)-(\alpha_1+1)\beta_1t_1^{\beta_1-1}I_{RM}(t_1)\right]+(R_0t_1)\right\}+\left\{+\left[(H_1t_1)\{\theta_1\theta_2t_1^{\theta_2-1}I_{RM}(t_1)-(\alpha_1+1)\beta_1t_1^{\beta_1-1}I_R(t_1)\}\right]\right\}\right]+\\ \left[\sum_{t_2=0}^{T_2}\left\{\left[(D_0+D_1t_2)-(\alpha_2+1)\beta_2t_2^{\beta_2-1}I_S(t_2)\right]+(S_0t_2)\right\}+\left\{+\left[(H_1t_2)\left\{(D_0+D_1t_2)-(\alpha_2+1)\beta_2t_2^{\beta_2-1}I_S(t_2)\right\}\right]\right\}\right]+\\ \left[\sum_{t_3=0}^{T_3}\left\{\left[(\omega_0-\omega_1t_3)-(D_0+D_1t_3)-(\alpha_3+1)\beta_3t_3^{\beta_3-1}I_M(t_3)\right]+(M_0t_3)\right\}+\left\{+\left[(H_1t_3)\left\{(\omega_0-\omega_1t_3)-(D_0+D_1t_3)-(\alpha_3+1)\beta_3t_3^{\beta_3-1}I_M(t_3)\right\}\right]\right\}\right]+\\ \left[\sum_{t_4=0}^{T_4}\left\{\left[(\omega_0-\omega_1t_4)-(D_0+D_1t_4)-(\alpha_4+1)\beta_4t_4^{\beta_4-1}I_M(t_4)\right]+(W_0t_4)\right\}+\left\{+\left[(H_1t_4)\left\{(\omega_0-\omega_1t_4)-(D_0+D_1t_4)-(\alpha_4+1)\beta_4t_4^{\beta_4-1}I_M(t_4)\right\}\right]\right\}\right]+\\ \left[\sum_{t_5=0}^{T_5}\left\{\left[(\omega_0-\omega_1t_5)-(D_0+D_1t_5)-(\alpha_5+1)\beta_5t_5^{\beta_5-1}I_{DC_1}(t_5)\right]+(C_0t_5)\right\}+\left\{+\left[(H_1t_5)\left\{(\omega_0-\omega_1t_5)-(D_0+D_1t_5)-(\alpha_5+1)\beta_5t_5^{\beta_5-1}I_{DC_1}(t_5)\right\}\right]\right\}\right]+\\ \left[\sum_{t_6=0}^{T_6}\left\{\left[(\omega_0-\omega_1t_6)-(D_0+D_1t_6)-(\alpha_6+1)\beta_6t_6^{\beta_6-1}I_{DC_2}(t_6)\right]+(C_0t_6)\right\}+\left\{+\left[(H_1t_6)\left\{(\omega_0-\omega_1t_6)-(D_0+D_1t_6)-(\alpha_6+1)\beta_6t_6^{\beta_6-1}I_{DC_2}(t_6)\right\}\right]\right\}\right]+\\ \left[\sum_{t_7=0}^{T_7}\left\{\left[(\omega_0-\omega_1t_7)-(D_0+D_1t_7)-(\alpha_7+1)\beta_7t_7^{\beta_7-1}I_{DC}(t_7)\right]+(C_0t_7)\right\}+\left\{+\left[(H_1t_7)\left\{(\omega_0-\omega_1t_7)-(D_0+D_1t_7)-(\alpha_7+1)\beta_7t_7^{\beta_7-1}I_{DC_3}(t_7)\right\}\right]\right\}\right]+\\ \left[\sum_{t_8=0}^{T_8}\left\{\left[-(D_0+D_1t_8)-(\alpha_8+1)\beta_8t_8^{\beta_8-1}I_R(t_8)\right]+(R_2t_8)\right\}+\left\{+\left[(H_1t_8)\left\{-(D_0+D_1t_8)-(\alpha_8+1)\beta_8t_8^{\beta_8-1}I_R(t_8)\right\}\right]\right\}\right]+\\ \left[\sum_{t_9=0}^{T_9}\left\{\left[\left[-(D_0+D_1t_9)-(\alpha_9+1)\beta_9t_9^{\beta_9-1}I_{R_2}(t_9)\right]+(R_4t_9)\right]+(H_1t_9)\left\{-(D_0+D_1t_9)-(\alpha_9+1)\beta_9t_9^{\beta_9-1}I_{R_2}(t_9)\right\}\right\}\right]+\\ \left[\sum_{t_{10}=0}^{T_{10}}\left\{\left[-(D_0+D_1t_{10})-(\alpha_{10}+1)\beta_{10}t_{10}^{\beta_{10}-1}I_R(t_{10})\right]+(R_4t_{10})\right\}+\left\{+\left[(H_1t_{10})\left\{-(D_0+D_1t_{10})-(\alpha_{10}+1)\beta_{10}t_{10}^{\beta_{10}-1}I_R(t_{10})\right\}\right]\right\}\right]\end{array}\right\}\right]$$

(12)

1. Genetic Algorithm Model in Supply Chain Inventory control

Which depicts the steps applied for the optimization analysis. 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.

A. Chromosome

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. As known, chromosome is constituted by genes which defines the length of the chromosomes. 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. Since a 10 member supply chain is used for illustration, the length of the chromosome n is 10, i.e. 10 genes. And the chromosome representation is pictured in Fig. 2. Each gene of the chromosome is representing the amount of stock that is in excess or in shortage at the respective members of the supply chain.

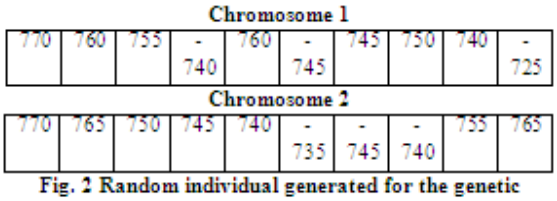

Fig. 2 Random individual generated for the genetic operation

These kinds of chromosomes are generated for the genetic operation. Initially, only two chromosomes will be generated and from the next generation a single random chromosome value will be generated. The chromosomes thus generated is then applied to find its number of occurrences in the database content by using a Select count ( ) function.

The function will give the number of occurrences/ repetitions of the particular amount of stock level for the ten members M_P that are going to be used further in the fitness function.

B. Selection:

The selection operation is the initial genetic operation which is responsible for the selection of the fittest chromosome for further genetic operations. This is done by offering ranks based on the calculated fitness to each of the prevailing chromosome. On the basis of this ranking, best chromosomes are selected for further proceedings.

C. Fitness

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.

$$U(i) = \log\left(1 - \frac{M_P}{M_q}\right) \quad i= 1,2,3,4,5,6,7LL, n$$

Where, M_P is the number of counts that occurs throughout the period.

M_q is the total number of inventory values obtained after clustering.

n is the total number of chromosomes for which the fitness function is calculated.

The fitness function is carried out for each chromosome and the chromosomes are sorted on the basis of the result of the fitness function. Then the chromosomes are subjected for the genetic operation crossover and mutation.

D. Crossover

As far as the crossover operation is concerned, a single point crossover operator is used in this study. The first two chromosomes in the mating pool are selected for crossover operation. The crossover operation that is performed for an exemplary case is shown in the following figure 3.

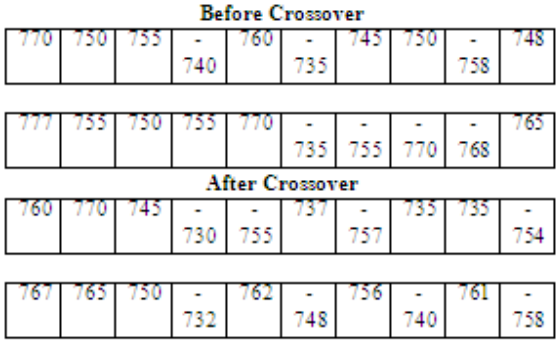

Fig.3. Chromosome representation

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.

E. Mutation

The newly obtained chromosomes from crossover operation are then pushed for mutation. By performing mutation, a new chromosome will be generated as illustrated below.

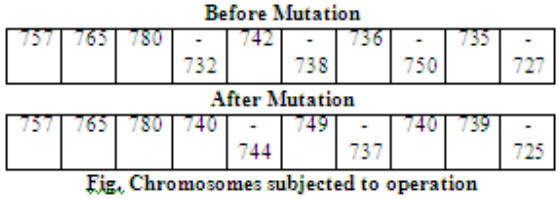

Fig. Chromosomes subjected to operation

This is done by random generation of two points and then performing swaps between both the genes.

VI. CONCLUSION

In this paper an integrated production of pharmaceutical supply chain inventory model of pharmaceutical with linear production of pharmaceutical and demand rate of pharmaceutical has been developed for deteriorating item and economic load dispatch using genetic algorithm is a significant component of supply chain management of pharmaceutical. In this model the deterioration, the multiple deliveries and the time discounting are considered from the perspective of Supply Chain supply chain of pharmaceutical, Raw material of pharmaceutical, Storage of pharmaceutical, Manufacture of pharmaceutical, warehouse of pharmaceutical, three distribution centers of pharmaceutical as well as three Retailer's of pharmaceutical using genetic algorithm and MATLAB.

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