

# MACHINE LEARNING AND DEEP LEARNING BASED OPTIMIZATION ALGORITHMS FOR COVID-19 PHARMACEUTICAL INDUSTRY SUPPLY CHAIN MANAGEMENT

PAVAN KUMAR CHAUBEY<sup>1</sup>, AJAY SINGH YADAV<sup>2</sup>, TARUN KUMAR ARORA<sup>3</sup>, NAVIN AHLAWAT<sup>4</sup>, PRIYAMBADA PUROHIT<sup>5</sup>, ANUPAM SWAMI<sup>6</sup>, and PRIYANKA AGARWAL<sup>7</sup>

<sup>1</sup>Department of Applied Science & Humanities, Tula's Institute Dehradun, Uttarakhand.

<sup>2</sup>Department of Mathematics, SRM Institute of Science and Technology, Delhi-NCR Campus, Ghaziabad.

<sup>3</sup>Department of Applied Science & Humanities, ABES Engineering College, Ghaziabad.

<sup>4</sup>Department of Computer Science, SRM Institute of Science and Technology, Delhi-NCR Campus, Ghaziabad.

<sup>5</sup>Department of Management, SRM Institute of Science and Technology, Delhi-NCR Campus, Ghaziabad.

<sup>6</sup>Department of Mathematics, Government Women Post Graduate College, Kandhla, Shamli.

<sup>7</sup>Department of Mathematics, SRM Institute of Science and Technology, Delhi-NCR Campus, Ghaziabad.

## Abstract

In this study, the concept of machine learning and Deep learning is explained, and algorithms for optimizing bacterial foraging are optimized under Covid-19 Pharmaceutical industry Supply chain management. By defining the basic phases and content of machine learning and Deep learning, the relationship between AI and optimization is examined. Based on this study, a bacterial feed optimization algorithm was considered under Covid-19 Pharmaceutical industry Supply chain management. Steps and operations of these artificial intelligence-based optimization algorithms, which were widely used in the literature, have been examined in detail. All algorithms discussed in this study are related to nature. Covid-19 Pharmaceutical industry Supply chain management of Pharmaceutical industry is one of medical issues that need special attention. One of the general problems in the production of Pharmaceutical industry is the total number of requirements that do not correspond to the production volumes available in the Pharmaceutical industry system. One of the limitations of the Covid-19 Pharmaceutical industry supply chain problems is the Covid-19 Pharmaceutical industry supply, where Pharmaceutical industry is a perishable product using Bacterial Foraging Optimization and the Singular Value Decomposition method. This research models the distribution of the Covid-19 Pharmaceutical industry supply chain so that the model can be used to minimize the operating costs of hospital vaccination availability due to the level of demand and type of Pharmaceutical industry using Bacterial Foraging Optimization and Singular Value Decomposition Method.

Keywords:-Supply chain,warehouse, distribution center, machine learning, Deep learning, Bacterial Foraging Optimization and Singular Value Decomposition Method

## 1. Introduction

The Covid-19 pandemic also stressed that although the virus or quarantine measures have not directly affected the factories in a particular area, it may still happen that the areas from which the raw material was found capture the area in Corona's grip. The crisis, which has taken over half of the world with its own power, is likely to affect the rest of the region due to the complex supply chain that exists in the world. This type of barrier is no

longer an uncommon thing. A study by the McKinsey Global Institute has shown that companies now expect disruptions in their supply chains that last a month or more after every 3.7 years. The reasons behind this can be the growing natural disaster, pandemic, terrorism, cyber attacks or insecurity related to trade policies - whatever. Due to the increasing risks in international trade, many decision makers place their emphasis on self-confidence in times of crisis. However, self-confidence is not in itself a guarantee of better security. Studies show that ending dependence on foreign products and raw materials directly means increased dependence on original products. But the risk of early crises on native products also remains. The fact is that international trade can act as a shield in the event of unforeseen events, because thereby the diversity of supply can be ensured. For example, if a factory stands still somewhere, companies can easily secure their supply from the factories elsewhere. With the help of international trade, the countries of the world can create many sources of demand and supply. International trade is also needed to promote new discoveries in the long run. The latest edition of the World Trade Report also says that open trade provides access to large markets, which motivates companies to take risks for new discoveries. Imports of capital and intermediate goods through international trade provide access to the latest technologies in developing countries. This gives them a chance to participate in the global value chain. Competition is also encouraged through trade. As a result, companies are always alert and encouraged to continue experimenting. Given the increasing risks in the company, it is imperative to develop the ability to do new experiments. In modern times, many people were given the opportunity to work from home due to digital measures to wind up work. 3D printing technology helped them find immediate solutions to a wide range of problems related to personal protective equipment, medical equipment and isolation wards. The Covid-19 epidemic has made it clear that the outbreak spread over an area of this interconnected world could reach other countries in a matter of days. No one is safe until everything is safe. At a time when all the countries of the world are starting to use life-saving Pharmaceutical industries, the need to promote international trade and cooperation is the highest today. Some member countries of the World Trade Organization have proposed an agreement under which the import duty on medical goods will be completely abolished. Along with this, proposals have also been made to implement the necessary reforms of international rules and systems during the crisis in trade in key commodities. The experience of Covid-19 has been the same throughout humanity. This can be a reason to start a continuous effort with each other, taking into account the future preparations for the countries of the world. The series of companies that ultimately make products and services available to consumers, including all the features that enable the production, delivery and recycling of materials, components, end products and services, is a Covid-19 Pharmaceutical industry supply chain. The term Covid-19 Pharmaceutical industry supply chain refers to the complex sequence of activities, information, and material flow involved in the production and distribution of a company's output. It consumes huge amounts of capital in the form of plant, equipment and inventories and is responsible for

most of the company's costs for goods and operating expenses. It creates significant value and ultimately determines the company's ability to satisfy customer requirements. As a result, effective Covid-19 Pharmaceutical industry supply chain management is an important strategic challenge for most companies. But formulating effective strategy requires a good understanding of what drives costs and service in a Covid-19 Pharmaceutical industry supply chain. Covid-19 Pharmaceutical industry supply chain management is the systematic, strategic coordination of the traditional business functions and tactics across these functions within a particular company and across companies within the Covid-19 Pharmaceutical industry supply chain with the aim of improving the long-term results of individual companies and the Covid-19 Pharmaceutical industry supply chain as a whole. Today, companies can no longer compete solely as individual entities in the ever-changing business world. Market globalization and increased competition are forcing organizations to rely on efficient Covid-19 Pharmaceutical industry supply chains to improve their overall performance. The Covid-19 Pharmaceutical industry supply chain has become an important topic in management science and industry. When individual companies in the Covid-19 Pharmaceutical industry supply chain make business decisions that ignore the interests of other chain members, this sub-optimization only transfers costs and additional latency along the Covid-19 Pharmaceutical industry supply chain. Ultimately, this is primarily higher prices for end products, lower Covid-19 service levels in the supply chain Pharmaceutical industry and thus lower demand for end customers. For this reason, the management of the Covid-19 Pharmaceutical industry supply chain certainly needs extra attention from the managers. If Covid-19 Pharmaceutical industry Supply Chain Pharmaceutical industry inventory information is not shared or exchanged between different parties in the Covid-19 Pharmaceutical industry supply chain, it may be in principle for the principles of weakly linked activities and decisions across the Covid-19 Pharmaceutical industry supply chain. Today, timely sharing and coordination of information across Covid-19 Pharmaceutical industry supply chains in addition to the new capabilities has changed the way Covid-19 Pharmaceutical industry supply chains operate. The global visibility of Pharmaceutical industry inventory profiles across the Covid-19 Pharmaceutical industry supply chain principles for reduced costs and improved customer service. In the Covid-19 Pharmaceutical industry supply chain, many problems still need careful consideration in terms of solution procedure to support the respective systems. In addition, collaborative relationships that focus on reducing uncertainty in operating environments by using improved information systems and business processes will result in more efficient allocation of key resources, faster market response times and more reliable Covid-19 Pharmaceutical industry supply chain performance. However, these co-operation schemes alone cannot compensate for fundamentally deficient and operationally inefficient production and distribution environments. Covid-19 Pharmaceutical industry supply chain management deals with total process quality and represents a new way of managing the business and the relationship with other members of Covid-19

Pharmaceutical industry supply chain. Supply chain management can be defined as: "Supply chain management is the coordination of production, storage, location and transport between players in the supply chain to achieve the best combination of responsiveness and efficiency for a given market. Many researchers in the inventory system have focused on a product that does not exceed deterioration. However, there are a number of things whose significance does not remain the same over time. The deterioration of these substances plays an important role and cannot be stored for long {Yadav et al. (1-10)} Deterioration of an object can be described as deterioration, evaporation, obsolescence and loss of use or restriction of an object, resulting in a lower stock consumption compared to natural conditions. When raw materials are placed in stock as a stock to meet future needs, there may be deterioration of objects in the arithmetic system that may occur for one or more reasons, etc. Storage conditions, weather or humidity. {Yadav, et al. (11-20)}. Inach generally claims that management owns a warehouse for storing purchased warehouse. However, for various reasons, management can buy or give more than it can store in the warehouse and name it OW, with an extra number in a rented warehouse called RW near OW or a little away from it {Yadav, a. al. (21-53)}. Inventory costs (including holding costs and depreciation costs) in RW are usually higher than OW costs due to additional costs of handling, equipment maintenance, etc. Reducing inventory costs will economically use RW products as quickly as possible. Actual customer service is provided only by OW, and to reduce costs, RW stocks are cleaned first. Such arithmetic examples are called two arithmetic examples in the store {Yadav and swami. (54-61)}. Managing the supply of electronic storage devices and integrating environmental and nervous networks {Yadav and Kumar (62)}. Analysis of seven supply chain management measures to improve inventory of electronic devices for storage by sending a financial burden using GA and PSO and analysis of supply chain management to improve inventory and equipment inventory using genetic calculation and model design and analysis of chain inventory from bi inventory and economic difficulty in the transport of goods by genetic calculation {Yadav, AS (63, 64, 65)}. Inventory policies for inventory and inventory needs and miscellaneous inventory costs under allowable payments and inventory delays An example of amortization of goods and services of various types and costs by keeping a business loan down and an inventory model with sensitive price needs, inventory costs as opposed to loans for business expenses under inflation { Swami, et. al. (66, 67, 68)}. The objectives of Multiple Objective Genetic Algorithm and PSO, which include supply and deficit improvement, inflation and a calculation model based on a genetic calculation of scarcity and low inflation of PSO {Gupta, et. al. (69, 70,)} An example with two stocks of depreciation on goods and inventory costs during particle upgrade and an example with two inventories of property damage and inventory costs in inflation and soft computer techniques {Singh, et. al. (71, 72)}. Delayed control of alcohol supply and refinement of particles and supply system for green cement and inflation by means of particle improvement and electronic inventory system and distribution center by means of genetic calculations {Kumar, et. al. (73,

74.75)}. Example of two-store depreciation and stock-based warehouses using a genetic stock and vehicle stock for demand and inflation stocks with two distribution centers using genetic stock {Chauhan and Yadav (76, 77)}. Marble Analysis Improving Industrial Reserves Based on Gene Technology and Improving Multiple Particles {Pandey, et. al. (78)}.White wine industry in supply chain management through nervous networks {Ahlawat, et. al. (79)}. Best policy to immediately import damaged goods and pay for conditional delays under the supervision of two warehouses {Singh, et. al. (80)}.

## 2. Process of Covid-19 Pharmaceutical industry supply chain Management

Covid-19 Pharmaceutical industry supply chain management is a process used by companies to ensure that their Covid-19 Pharmaceutical industry supply chain is efficient and cost effective. A Covid-19 Pharmaceutical industry supply chain is the collection of steps a company takes to turn raw materials into an end product. The five basic components of Covid-19 Pharmaceutical industry supply chain management are discussed below: -

1. Plan: The initial phase of the Covid-19 Pharmaceutical industry supply chain process is the planning phase. We need to develop a plan or strategy to address how the products and services will meet customer requirements and needs. In this step, the planning should primarily focus on designing a strategy that provides maximum profit. To manage all the resources required to design products and provide services, a strategy must be designed by the companies. Covid-19 Pharmaceutical industry supply chain management focuses primarily on planning and developing a set of measurements.

2. Develop (source): After planning, the next step involves development or sourcing. In this phase, we concentrate primarily on building a strong relationship with suppliers of the raw materials required for production. This involves not only identifying reliable suppliers, but also determining various planning methods for shipping, delivery and payment of the product. Companies need to choose suppliers to provide the goods and services they need to develop their product. So in this step, the Covid-19 Pharmaceutical industry supplier chain managers need to construct a set of pricing, delivery and payment processes with suppliers and also create measurements to control and improve the relationship. Finally, Covid-19 Pharmaceutical industry supply chain managers can combine all of these processes to manage their Pharmaceutical industry Inventory goods and services. This handling includes receipt and examination of shipments, transfer to production facilities and approval of supplier payments.

Make: The third step in the Covid-19 process for managing the Pharmaceutical industry supply chain is the manufacture or manufacture of products as required by the customer. In this step, the products are designed, produced, tested, packaged and synchronized for delivery. Here, the task of the Covid-19 Pharmaceutical industry supply chain manager is to plan all the activities required for manufacturing, testing, packaging and preparation for delivery. This phase is considered the most metrically intensive unit in the Covid-19

Pharmaceutical industry supply chain, where companies can measure quality levels, production output and worker productivity.

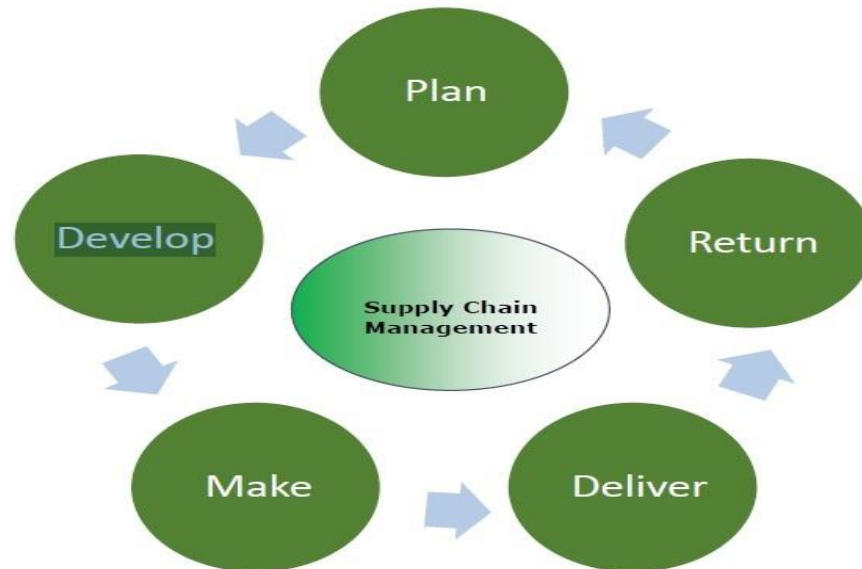


Fig. 1.- Process of Covid-19 Pharmaceutical industry supply chain Management

**4. Deliver:** The fourth phase is the delivery phase. Here, the products are delivered to the customer at the destination by the supplier. This phase is basically the logistics phase where customer orders are accepted and delivery of the goods is planned. The delivery phase is often referred to as logistics, where companies collaborate on receiving orders from customers, establish a network of warehouses, pick carriers to deliver products to customers and set up an invoicing system to receive payments.

**5. Return:** The last and final phase of Covid-19 Pharmaceutical industry supply chain management is called the return. In the phase, defective or damaged goods are returned to the supplier by the customer. Here, companies need to process customer inquiries and respond to their complaints, etc. This phase is often a problematic part of the Covid-19 Pharmaceutical industry supply chain for many companies. The planners of the Covid-19 Pharmaceutical industry supply chain need to find a responsive and flexible network to accept damaged, defective and extra products back from their customers and facilitate the return process for customers who have problems with delivered products.

### 3. Machine learning and Deep learning

Machine learning "combines algorithms learned from examples and data". This makes it possible to "estimate the values in the datasets presented as examples". Conclusion: The quality of the results depends on the quality of the data provided to the learning system (81): Controlled learning provides examples of how to learn the system and provides the correct answer. This type of AI is used to define video content, to estimate the price of a

house based on the past, or to predict medical risks. Unsupervised learning is to give the system many examples, but this time without giving good answers. Separate customer groups by similarities, detect irregularities (bank fraud) or identify connections (for example, placing two products side by side on a store shelf) and what the machine is learning. Semi-revised learning is to give the system many examples and give the right answer for some. Google or Facebook's services are enough to "recognize" the people in the pictures. Gain learning allows a system to evolve in a physical (i.e., a robot) or virtual environment. The system develops with sanctions and premiums. This is when a robot learns to walk alone, or a bot evolves into a video game.

#### **4. Deep Learning**

Deep learning is based on the ability of a technology to learn from raw data. Word processing, voice or face recognition; There are a large number of applications. YannLeCun and Geoffrey Hinton are the two leading experts who use neural networks inspired by biological neurons in this area. If these neuronal neurons can be connected in various ways, the neural networks consist of overlapping layers in most cases. The neural network is trained to recognize the contents of an image. Depending on the results, the "link force" between each neuron is corrected. Thus, the neural network was perfected until further recognition error disappeared. Cigref's guide says "Deep Learning is very powerful but also very expensive". Olik It should be kept for the most important classes, and other Deep learning algorithms should be used at a lower cost, which can result in sufficient results. OlivThe AI machine is learning to learn and deep learning warns Olivier Ezratty in a new blog post. "There are a number of limitations: best AI solutions often combine together various techniques," he said, including other techniques including programming and rule engines and silenced them due to resonance in deep learning(Buchanan, 2005).

## 5. Step by Step Flow process of Covid-19 Pharmaceutical industry supply chain Management:

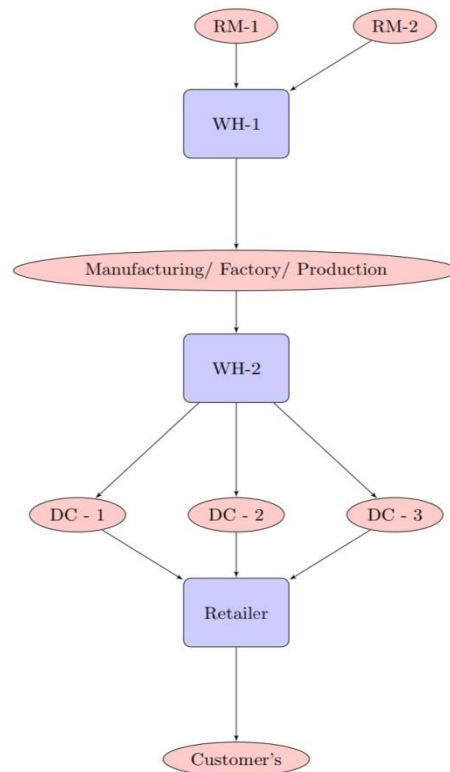


Figure : Flow Chart Of Supply-Chain Model

## Fig.2: Six-Step Flow process of Covid-19 Pharmaceutical industry supply chain Management:

### 6. Step by Step Explanation of the flow process:

#### 6.1. Notations

R1 : Raw-material first.

R2 : Raw-material second.

M1 : Medicine first.

M2 : Medicine Second.

W1 : Inbound Ware-house which is stored raw-materials before manufacturing.



W2 : Ware-house which is stored finished goods.

D1 : Distribution center first.

D2 : Distribution center second.

D3 : Distribution center third.

## 6.2. Explanation of Model

First of all, let R1 be the raw-material for medicine M1 and R2 be the raw-material for medicine M2. We take both the raw-materials from different places and then with the help of transportation we bring it from origin places to ware-house W1. Both the raw-materials are stored in W1, until the rawmaterials are not required for manufacturing. Manufacturer takes the raw-materials from W1 according to their requirements with the help of transportation. After that manufacturer make the medicines M1 and M2 by the related raw-materials. After that both the medicines M1 and M2 stored in warehouse W2 with the help of transportation, and then distributes both the medicines M1 and M2 to distribution centers from W2, with the help of transportation. We distribute the medicine M1 in D1, medicine M2 in D2 and medicine M2 in D3 from ware-house W2 according to their requirements. Locations of all these distribution centers are different. Now, all the distribution centers are distributes their products (medicines) to the same retailer. First, D1 and D2 distribute their product to retailer and then D1 and D3 distributes their product to retailer, with the help of transportation.

## 7. Machine learning and Deep learningand Optimization

### Machine learning and Deep learning on singular value decomposition

These methods are used in Machine learning and Deep learning on singular value decomposition In Machine learning and Deep learning, statistical and mathematical methods are used to learn from data sets. Dozens of different methods exist for this, whereby a general distinction can be made between two systems, namely symbolic approaches on the one hand and sub-symbolic approaches on the other. While symbolic systems are, for example, propositional systems in which the knowledge content, i.e. the induced rules and the examples are explicitly represented, sub-symbolic systems are artificial neuronal networks. These work on the principle of the human brain, whereby the knowledge contents are implicitly represented.

The singular value decomposition of a matrix A is the factorization of A in to the product of three matrices  $A = UDV^T$  where the columns of U and V are orthonormal and the matrix D is diagonal with positive entries.

Where U and V are orthogonal matrices with orthonormal Eigen vectors chosen from  $AA^T$  and  $A^T A$  respectively D is a diagonal matrix with r elements equal to the root of positive Eigen Values of  $AA^T$  or  $A^T A$  (both matrices have the same positive Eigen values). The diagonal elements are composed of singular values

$$D = \begin{bmatrix} \sqrt{\lambda_1} & & & \\ & \sqrt{\lambda_1} & & \\ & & \ddots & \\ & & & \sqrt{\lambda_r} \end{bmatrix} \quad D = \begin{bmatrix} \sigma_1 & & & \\ & \sigma_2 & & \\ & & \ddots & \\ & & & \sigma_r \end{bmatrix}$$

is if A is an m x n Matrix can be factorized as

$$[A]_{m \times n} = [U]_{m \times m} [D]_{m \times n} [V^T]_{n \times n}$$

$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} = \begin{bmatrix} u_{11} & \dots & u_{m1} \\ \dots & \dots & \dots \\ u_{1m} & \dots & u_{mm} \end{bmatrix} \begin{bmatrix} \sigma_1 & 0 & 0 & \dots & 0 \\ 0 & \sigma_1 & \dots & \dots & 0 \\ 0 & 0 & \sigma_1 & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & \dots & a_{mn} \end{bmatrix} \begin{bmatrix} v_{11} & \dots & v_{1n} \\ \dots & \dots & \dots \\ v_{n1} & \dots & v_{nn} \end{bmatrix}$$

We can arrange Eigen vector in different orders to produce U and V to standardize the solution we order the Eigen vectors such come before these with smaller values  $\sigma_1 \geq \sigma_2 \geq \dots \geq \sigma_m$

## 8. Bacterial Foraging Optimization

To better understand the basics of BFO, it is worth mentioning briefly about the movements and life processes of the KoliBasili bacteria. Consequently, a coli bacterium may be present in different chemotaxis depending on the density of the medium (the substance) and its living conditions. KoliBasili bacteria carrying whips on them rotate their whips counter clockwise in environments suitable for food sources, movements based on swimming, tumbling and vice versa. By rotating these movements to include more rolling {Passino (82), Yang (83)}. During these processes, KoliBasili bacteria can be split in two or reproduced, or the presence of harmful sources in the environment or in accordance with the average life processes of these bacteria can end their lives. In addition, KoliBasili bacteria secrete a substance to attract the other coli bacteria in the appropriate environment, and the bacterial density of the environment is increased with this method

of spread {Passino (82), Yang (83)}. BFOs also use a variety of solution processes, inspired by all of these processes and using the particles they accept as bacteria, in a flock-oriented manner in the solution space. In this context, chemo taxis includes a mixture of different phases such as rolling, swimming, reproduction and elimination - distribution. We can describe the algorithmic solution steps in BFO, which are designed in the context of the described functions and functions {Yang(83)}. Investigation of Artificial Intelligence Based Optimization Algorithms {Okula, et.al. (84)}

1-Step (installation phase): Randomly disposes of N pieces of bacterial particles (potential solution variables) in the solution space. Algorithm parameters (egNk: maximum number of chemotaxis, Nyus: number of swimming movements, Nude images: number of replicates, Ne: maximum elimination number, tensile and repulsive coefficients, oed: probability of elimination). Perform the necessary arrangements to resolve the issue.
2-Step: Calculate the objective function value (fitness) according to the location of the bacteria (potential solution variables).
3-Step: Perform the following steps, repeat until: (in conjunction with each objective function size)
3-a-Step (chemotaxis phase): Perform the following steps for each bacterium up to the Nk value:
3-a-1-Step: Calculate the objective function value (suitability) according to the location of the next bacteria (potential solution variable).
3-a-2-Step: The objective function of the bacterium related to (fitness) cell to cell attractive effect of the update. Keep this value until the swimming phase.
3-a-13-Step: (Rolling phase): Generate random numbers up to the purpose function size in the range [-1, 1]. Run the scrolling process for the respective bacteria.
3-a-4-Step: Calculate the objective function value (suitability) according to the location of the bacteria (potential solution variable). The purpose of the relevant bacterium is to update the value of the functional function (fitness) from cell to cell with attractive effect.
3-a-4-Step (Swimming Phase): Perform the following steps for the related bacteria, up to the Nyush value.
3-a-5-1-Step: If the final objective function value (suitability) of the bacterium is better than stored before the swimming phase, keep this new value.
3-a-5-2-Step: Update the maintained objective function value (suitability) of the relevant bacteria according to the displacement value to be calculated.

3-a-6-Step : If not all bacteria have been treated yet, switch to the next bacterium and return to 3-a-1-step.
3-b-Step (Reproduction phase): Calculate the health status of each bacterium and sort them all from small to small according to these values.
3-c-Step: Remove the worst bacteria according to the set criteria. Let the bacteria grow in the best condition. New bacteria are in place of their parents.
3-d-Step: If the now value has not yet been reached, increase the counter for that value and go back to 3-a-step and continue with the next generation.
3-5-Step (Elimination - Distribution Phase): Transfer each bacterium to a new location according to the oed value.
4-Step: At the end of the processes, the value (s) obtained at the best global position are considered as the optimal value (s).

## 9. Implementation Results

We have implemented the analysis based on Bacterial Foraging Optimization and Singular Value Decomposition for optimal inventory management on the platform of MATLAB. As mentioned, we have the detailed information on excess and missing stock levels in each supply chain member, the most important times of product inventory levels to replenish each supply chain member as well as the main time of the commodity. The sample data with this information are given in Table 1.

Table 1: A sample data set along with its stock levels in each member of the supply chain

Bacterial Foraging Optimization									
T-I	RM-1	RM-2	WH-1	M	WH-2	DC-1	DC-2	DC-3	R
T-1	1225	1472	1485	1350	1267	1225	1472	1485	1350
T-2	1265	1442	1475	1321	1269	1265	1442	1475	1321
T-3	1222	1462	1465	1331	1262	1222	1462	1465	1331
T-4	1233	1443	1455	1341	1265	1233	1443	1455	1341
Singular Value Decomposition									
T-I	RM-1	RM-2	WH-1	M	WH-2	DC-1	DC-2	DC-3	R
T-1	1325	1272	1385	1250	1467	1225	1472	1485	1350
T-2	1365	1242	1375	1221	1469	1265	1442	1475	1321
T-3	1322	1262	1365	1231	1462	1222	1462	1465	1331
T-4	1333	1243	1355	1241	1465	1233	1443	1455	1341

Table 1 has the product ID, shipping ID, inventory levels that are in excess or missing at each supply chain member. Negative values represent lack of inventory levels, and positive values represent excess inventory levels. The transport ID mentioned in the form

acts as an index for unpacking the main times for stocks and raw material chair. Table 2 shows the sample data, which has transport ID and the most important times for stocks. For the five-member supply chain, four main times can be achieved.

Table 2: Sample data from Database which is having principal times for stocks

Bacterial Foraging Optimization									
T-I	RM-1	RM-2	WH-1	M	WH-2	DC-1	DC-2	DC-3	R
T-1	1125	1172	1185	1150	1167	1225	1472	1485	1350
T-2	1165	1142	1175	1121	1169	1265	1442	1475	1321
T-3	1122	1162	1165	1131	1162	1222	1462	1465	1331
T-4	1133	1143	1155	1141	1165	1233	1443	1455	1341
Singular Value Decomposition									
T-I	RM-1	RM-2	WH-1	M	WH-2	DC-1	DC-2	DC-3	R
T-1	1625	1672	1685	1650	1667	1225	1472	1485	1350
T-2	1665	1642	1675	1621	1669	1265	1442	1475	1321
T-3	1622	1662	1665	1631	1662	1222	1462	1465	1331
T-4	1633	1643	1655	1641	1665	1233	1443	1455	1341

Table 3: Initial random individuals

Bacterial Foraging Optimization									
T-I	RM-1	RM-2	WH-1	M	WH-2	DC-1	DC-2	DC-3	R
T-1	1154	1142	1234	1431	1354	1154	1142	1234	1431
T-2	1654	1653	1612	1617	1541	1654	1653	1612	1617
Singular Value Decomposition									
T-I	RM-1	RM-2	WH-1	M	WH-2	DC-1	DC-2	DC-3	R
T-1	1754	1742	1734	1731	1754	1154	1142	1234	1431
T-2	1554	1553	1512	1517	1540	1654	1653	1612	1617

To optimize bacterial foraging and analysis of singular value degradation, we need to generate random individuals with eight number of particles representing product ID and seven supply chain members. Table 3 describes two random individuals. Similarly, Table 4 represents random velocities corresponding to each particle of the individual.

Table 4: Initial Random velocities corresponding to each particle of the individual

Bacterial Foraging Optimization									
T-I	RM-1	RM-2	WH-1	M	WH-2	DC-1	DC-2	DC-3	R
T-1	1354	1342	1334	1331	1354	1154	1142	1234	1431
T-2	1154	1153	1112	1117	1141	1654	1653	1612	1617
Singular Value Decomposition									
T-I	RM-1	RM-2	WH-1	M	WH-2	DC-1	DC-2	DC-3	R
T-1	1154	1142	1134	1131	1154	1154	1142	1234	1431
T-2	1254	1253	1212	1217	1241	1654	1653	1612	1617

## 10. Conclusions

Pharmaceutical industry inventory is an important component of Covid-19 Pharmaceutical industry supply chain management. The members of the Covid-19 Pharmaceutical industry supply chain are responsible for minimizing the cost of a Covid-19 Pharmaceutical industry supply chain by managing the level of Pharmaceutical industry inventory in a series of production and distribution operations associated with different chain steps. As lead time plays a crucial role in the increase in the cost of the Covid-19 Pharmaceutical industry supply chain, the complexity of predicting optimal stock levels increases. We have proposed an innovative and efficient method using presented genetic algorithm aimed at reducing the overall Covid-19 Pharmaceutical industry supply chain cost, as it undoubtedly established the most likely excess inventory level and shortage level along with the primary time involved in supply the multi-product stockpiles required for the optimization of Pharmaceutical industry stocks in the Covid-19 Pharmaceutical industry supply chain so that the total cost of the Covid-19 Pharmaceutical industry supply chain is minimal. The proposed approach was implemented and its performance was evaluated using MATLAB 7.4. The performance of genetic algorithm was good as predicted. Following the proposed genetic algorithm-based approach to Pharmaceutical industry stock management, we determined the products that the members of the Covid-19 Pharmaceutical industry supply chain had

additional cost of possession or lack of throughout the Covid-19 Pharmaceutical industry supply chain. The proposed approach to Pharmaceutical industry inventory management has achieved the objectives of minimizing overall Covid-19 Pharmaceutical industry supply chain prices as well as lead time and determining the products that the respective Covid-19 Pharmaceutical industry supply chain members endured either further cost or lack of cost of main time consideration, which is an important information for Covid-19 Pharmaceutical industry supply chain Pharmaceutical industry Inventory optimization.

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