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Modeling and Solving an effect of Covid-19 pandemic on blood Supply Chain inventory management using Ant Colony Optimization

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Abstract- The impact of the Covid-19 pandemic on the inventory management of the blood supply chain is an essential part of inventory management in the area and has become an important concept for the overall profitability of the industrial scenario. It consists of several levels in which the material goes through different phases in order to reach the end customer. The impact of the Covid-19 pandemic on the inventory management of the three-tiered blood supply chain includes a blood collection point, blood distribution centers and surgical medical centers that bear the costs. A coordinated approach between levels is necessary so that the chain is precisely tuned for the lowest inventory and minimum cost, and therefore, maximum profit. In this article, we consider a three-level coordinated impact of the Covid-19 pandemic on inventory management of the blood supply chain with a single blood collection point providing a single type of product to distribution centers individual blood, then to individual surgical medical centers. A mathematical model is being developed for the coordinated effects of the Covid-19 pandemic on inventory management of the blood supply chain, which is solved by using the travelling salesman problem to optimize the ant colony for optimal values of decision variables and target functions. A numerical example is provided and the results obtained here are compared for these techniques.

Keywords:- Inventory, Supply Chain, Blood Collection Sites, Blood Distribution Centres, surgical medical centers and travelling salesman problem for Ant Colony Optimization

I. THE EFFECTS OF COVID-19 PANDEMIC ON BLOOD SUPPLY CHAIN INVENTORY MANAGEMENT NETWORK MODEL OF A REGIONALIZED BLOOD BANKING SYSTEM

Since the start of the Industrial Revolution, various industries have established business relationships with each other to deal with the challenges of marketing or sales channels. A sales channel that did not contain information about customer demand and requirements resulted in conflicting goals in that channel. Due to a lack of information, there remains a long and unpredictable time to deliver products to customers. Due to disorganization such as fluctuations in the delivery time, quality or quantity of a shipment, it is common for channels to overfill inventory, increasing the cost of channels to meet demand. client. Impact of the Covid-19 pandemic on the blood supply chain Inventory management consists of a number of companies that provide items or services to the customer or end user. In other words, the impact of the Covid-19 pandemic on the inventory management of the blood supply chain is a network (made up of suppliers, intermediaries, transport and logistics service providers) which represents the flow of raw, semi-finished and finished materials. products in the direction ahead of the customer while the information and cash flow back. An impact of the Covid-19 pandemic on inventory management in the blood supply chain Inventory management (SCM) integrates business processes to provide value-added goods, services and information for customers and others stakeholders. Impact of the Covid-19 pandemic on blood supply chain inventory management Inventory management ensures that customer needs are met by integrating the distribution channels and stages of the impact of the Covid-19 pandemic. 19 on inventory management in the blood supply chain. Designing and successfully executing the effects of the Covid-19 pandemic on inventory management of the blood supply chain clearly involves effective inventory management of the interactions between channels. In addition, the tendency associated with lean inventory management to reduce inventory levels is leading to an increased reliance between the effects of the Covid-19 pandemic on inventory management partners in the blood supply chain. This will increase the risk that the Covid-19 pandemic will impact the inventory management tools in the blood supply chain (i.e. suppliers, blood draws, customers, etc.). Yadav and Swami (1,3,8) "A model with a partial backlog in production inventory and lot size with time-varying operating costs and female decline". "Integrated supply chain model for material spoilage with linear demand based on inventory in an inaccurate and inflationary environment". "A flexible volume two-stage model with fluctuating demand and inflationary holding costs". Yadav et al. (2,4,5, 9,10,11) "Supply chain inventory model for two warehouses with soft IT optimization". "Multi-objective optimization for the stock model of electronic components and the degradation of double-bearing elements using a genetic algorithm". "An inflation inventory model for spoilage under two storage systems". "Chemical industry supply chain for warehouses with distribution centers using the Artificial Bee Colony algorithm". Management of the supply chain for electronic components of industrial electronics development for warehouses and their environmental impact using the particle swarm optimization algorithm". "Cost method for reliability considerations for the LOFO inventory model with warehouse for chemical industry". Pandey et al. (6) "An analysis of the inventory optimization of the marble industry based on genetic algorithms and particle swarm optimization". Malik et al. (7) "Security mechanism implemented in gateway service providers". Yadav et al. (12,13,14,15,16) "proposed the supply chain management of the National Blood Bank Center for the application of blockchain using a genetic algorithm". "provided drug industry supply chain management for blockchain applications using artificial nRsal networks". "suggested the red wine industry to manage the supply chain of distribution centers using nRsal networks". "A supply chain management for the rosé wine industry for storage using a genetic algorithm. "Providing supply chain management for the white wine industry for warehouses using nRsal networks". Chauhan and Yadav (17,18) "proposed a stock model for commodity spoilage where demand depends on two stocks and stocks using a genetic algorithm". "provide a car inventory system for inflation based on demand and inventory with a two-way distribution center using a genetic algorithm". Yadav et al. (19,20,21,22,23,24) "A method for calculating the reliability of the LIFO stock model with bearings in the chemical industry". "a Ensuring the management of the supply chain of electronic components for the development of the electronics industry in warehouses and the impact on the environment using the particle swarm optimization algorithm". "FIFO in Electrical Component Industry Green Supply Chain Inventory Model with Distribution Centers Using Particle Swarm Optimization". "LIFO in Automotive Components Industry Green Supply Chain Inventory Model with Bearings using Differential Evolution". "FIFO & LIFO in the Industry Green Supply Chain Inventory Model for Hazardous Substance Components with Storage using Simulated Annealing". "Health inventory control systems for blood bank storage with reliability applications using a genetic algorithm". Sana, (25,26) "Price competition between green and non-green products in the context of a socially responsible retail and consumer services business magazine". "An EOQ model for stochastic demand for limited storage capacity". Moghdani et al. (27) "Fuzzy model for economic production quantity with multiple items and multiple deliveries". Haseli et al. (28) "Basic criterion for the multi-criteria decision-making method and its applications". Ameri et al. (29) "Self-assessment of parallel network systems with intuitionistic fuzzy data: a case study". Birjandi et al. (30) "Assessment and selection of the contractor when submitting a tender with incomplete information according to the MCGDM method". Gholami et al. (31) "ABC analysis of clients using axiomatic design and incomplete estimated meaning". Jamali et al. (32) "Hybrid Improved Cuckoo Search Algorithm and Genetic Algorithm to Solve Marko Modulated Demand".

II. MODELLING BLOOD SUPPLY CHAIN INVENTORY MANAGEMENT

In accordance with the fundamental assumptions, we constrain and define the mathematical model. This mathematical model makes it possible to define the natural world of the cash flow problem linked to the impact of the Covid-19 pandemic on the inventory management of the blood supply chain at different levels. These amounts are presented in the form of mathematical concepts and formulated in the model proposed below. A digital representation solves the model using both the travelling salesman problem and the ant colony optimization and compares the results obtained.

The subsequent kind and assumptions are measured for the model.

1. Deterministic demand.
2. Instantaneous replenishment rate. Unit for each
3. Blood Distribution Centres inventory is an integer multiple of surgical medical canters's inventory.
4. Blood Collection Sites inventory is an integer multiple of Blood Distribution Centres inventory.
5. No shortages are allowed.

D=Demand rate in units for each unit time where $D=\left(e^{a+bT}\right)$

$\|BCS\|_{oc}$ =Blood Collection Sites ordering cost (Rs/order) where $\|BCS\|_{oc}=(\gamma_0+1)$

$\|BCS\|_{uc}$ =Blood Collection Sites unit cost (Rs/unit) where $\|BCS\|_{uc}=(\gamma_1+1)$

$\|BCS\|_{oq}$ =Replenishment quantity at the Blood Collection Sites in units where $\|BCS\|_{oq}=\lambda\left[\|BDC\|_{oq}\right]$

$\|BDC\|_{oc}$ =Blood Distribution Centres ordering cost (Rs/order) where $\|BDC\|_{oc}=(\beta_0+1)$

$\|BDC\|_{uc}$ =Blood Distribution Centres unit cost (Rs/unit) where $\|BDC\|_{uc}=(\beta_1+1)$

$\|BDC\|_{oq}$ =Blood Distribution Centres ordering quantity in units where $\|BDC\|_{oq}=\phi\left(\|SMC\|_{oq}\right)$

$\|SMC\|_{oc}$ =Surgical medical centers ordering cost (Rs/order) where $\|SMC\|_{oc}=(\alpha_0+1)$

$\|SMC\|_{uc}$ =Surgical medical centers unit cost (Rs/unit) where $\|SMC\|_{uc}=(\alpha_1+1)$

$\|SMC\|_{oq}$ =Surgical medical centers ordering quantity in units where $\|SMC\|_{oq}=(\alpha_2+1)$

ϕ=Distributor's replenishment quantity to surgical medical centers replenishment quantity.

λ=Blood Collection Sites replenishmentquantity to Blood Distribution Centres ordering quantity.

ζ=Carrying charge

θ=Surgical medical centers selling price

TC_{BCS} =The yearly total applicable cost of the Blood Distribution Centres

TC_{BDC} = The yearly total applicable cost of the Blood Distribution Centres

TC_{SMC} = The yearly total applicable cost of the surgical medical centers

TC_{BS} = The yearly total applicable cost of the Blood supply chain

III. MODEL FORMULATION

3.1 Surgical Medical Canters

The applicable total yearly costs of surgical medical centers result from the sum of the yearly ordering and transportation costs of surgical medical centers and can be expressed as: $\|SMC\|_{\mathrm{oc}} = \sum_{0}^{T_n} (\alpha_0 + 1)$

$$\|SMC\|_{\mathrm{uc}} = \sum_{0}^{T_n} (\alpha_1 + 1)$$

$$\|SMC\|_{oq} = \sum_{0}^{T_n} (\alpha_2 + 1)$$

$$TC_{SMC} = \frac{\|SMC\|_{\mathrm{oc}} \left(e^{a+bt}\right)}{\|SMC\|_{\mathrm{oq}}} + \frac{\|SMC\|_{\mathrm{oq}} \|SMC\|_{uc} \zeta}{2}$$

$$TC_{SMC} = \left\{ \frac{\left[\left\{\sum_{0}^{T_n} (\alpha_0 + 1)\right\}\left(e^{a+bT}\right)\right]}{\left[\sum_{0}^{T_n} (\alpha_2 + 1)\right]} + \frac{\left[\left\{\sum_{0}^{T_n} (\alpha_2 + 1)\right\}\left\{\sum_{0}^{T_n} (\alpha_1 + 1)\right\}\zeta\right]}{2} \right\} \quad (1)$$

3.2 Blood Distribution Centres

The applicable yearly total blood distribution center costs result from the sum of the yearly ordering and transport costs in blood distribution centers and can be expressed as follows: $\|BDC\|_{\mathrm{oc}} = \sum_{0}^{T_n} (\beta_0 + 1)$

$$\|BDC\|_{\mathrm{uc}} = \sum_{0}^{T_n} (\beta_1 + 1)$$

$$\|BDC\|_{oq} = \sum_{0}^{T_n} (\alpha_2 + 1)$$

$$TC_{BDC} = \frac{\left(\|BDC\|_{\mathrm{oc}}\right)\left(e^{a+bT}\right)}{\phi \|SMC\|_{\mathrm{oq}}} + \frac{(\phi - 1)\|SMC\|_{\mathrm{oq}} \left(\|BDC\|_{\mathrm{uc}}\right)\zeta}{2}$$

$$TC_{BDC} = \left\{ \frac{\left[\left\{\sum_{0}^{T_n} (\beta_0 + 1)\right\}\left(e^{a+bT}\right)\right]}{\left[\phi\left\{\sum_{0}^{T_n} (\alpha_2 + 1)\right\}\right]} + \frac{\left[(\phi - 1)\left\{\sum_{0}^{T_n} (\alpha_2 + 1)\right\}\left\{\sum_{0}^{T_n} (\beta_1 + 1)\right\}\zeta\right]}{2} \right\} \quad (2)$$

3.3 Blood Collection Sites

The applicable yearly total costs of the blood collection points result from the sum of the yearly order and the transport costs to the blood collection points and can be expressed as follows:

$$\|BCS\|_{oc} = \sum_{0}^{T_n} (\gamma_0 + 1)$$

$$\|BCS\|_{uc} = \sum_{0}^{T_n} (\gamma_1 + 1)$$

$$\|SMC\|_{oq} = \sum_{0}^{T_n} (\alpha_2 + 1)$$

$$TC_{BCS} = \frac{\left(\|BCS\|_{oc}\right)\left(e^{a+bT}\right)}{\lambda\left(\|BDC\|_{oq}\right)} + \frac{(\lambda - 1)\left(\|BDC\|_{oq}\right)\left\{\left[\|BCS\|_{uc}\right]\zeta\right\}}{2}$$

$$TC_{BCS} = \frac{\left(\|BCS\|_{oc}\right)\left(e^{a+bT}\right)}{\lambda\phi\|SMC\|_{oq}} + \frac{\phi(\lambda - 1)\|SMC\|_{oq}\left\{\left[\|BCS\|_{uc}\right]\zeta\right\}}{2}$$

$$TC_{BCS} = \left\{ \frac{\left[\left[\left\{\sum_{0}^{T_n}(\gamma_0 + 1)\right\}\left(e^{a+bT}\right)\right]\right]}{\left[\lambda\phi\left\{\sum_{0}^{T_n}(\alpha_2 + 1)\right\}\right]} + \frac{\left[\phi(\lambda - 1)\left\{\sum_{0}^{T_n}(\alpha_2 + 1)\right\}\left\{\sum_{0}^{T_n}(\gamma_1 + 1)\right\}\zeta\right]}{2} \right\} \quad (3)$$

3.4 Yearly total applicable cost of the Blood supply chain

The applicable yearly blood supply chain total costs result from the sum of the individual applicable yearly total costs at blood collection points, blood distribution centers and surgical medical centers and can be expressed as:

$$TC_{BS} = TC_{SMC} + TC_{BDC} + TC_{BCS}$$

$$TC_{BS}=\left[\begin{array}{l}\left\{\dfrac{\left[\left\{\sum_{0}^{T_n}(\alpha_0+1)\right\}\left(e^{a+bT}\right)\right]}{\left[\sum_{0}^{T_n}(\alpha_2+1)\right]}+\dfrac{\left[\left\{\sum_{0}^{T_n}(\alpha_2+1)\right\}\left\{\sum_{0}^{T_n}(\alpha_1+1)\right\}\zeta\right]}{2}\right\}\\ +\left\{\dfrac{\left[\left\{\sum_{0}^{T_n}(\beta_0+1)\right\}\left(e^{a+bT}\right)\right]}{\left[\phi\left\{\sum_{0}^{T_n}(\alpha_2+1)\right\}\right]}+\dfrac{\left[(\phi-1)\left\{\sum_{0}^{T_n}(\alpha_2+1)\right\}\left\{\sum_{0}^{T_n}(\beta_1+1)\right\}\zeta\right]}{2}\right\}\\ +\left\{\dfrac{\left[\left\{\sum_{0}^{T_n}(\gamma_{0+1})\right\}\left(e^{a+bT}\right)\right]}{\left[\lambda\phi\left\{\sum_{0}^{T_n}(\alpha_{2+1})\right\}\right]}+\dfrac{\left[\phi(\lambda-1)\left\{\sum_{0}^{T_n}(\alpha_{2+1})\right\}\left\{\sum_{0}^{T_n}(\gamma_{1+1})\right\}\zeta\right]}{2}\right\}\end{array}\right] \quad (4)$$

IV. TRAVELLING SALESMAN PROBLEM

The Traveling Salesman Problem (TSP) is a widespread computer problem that involves finding a way to Hamilton at minimal cost. The TSP has represented the interests of computer scientists and mathematicians, as the problem is not yet fully resolved, even after about half a decade of research. TSP can be applied to solve many practical problems such as logistics, transportation, semiconductor industry, etc. An effective TSP solution would thus ensure efficient execution of tasks and thus increase productivity. Due to its importance in many industries, TSP is still studied by researchers from various disciplines. TSP is known to be hard NP. This means that no known algorithm is guaranteed to resolve the optimality of all TSP instances within a reasonable execution time. In order to find exact solutions, various ant colony optimization hRsistics and algorithms have been developed to approximate the problems. They allow high quality solutions to be found with reasonable turnaround times. Optimization of ant colonies is generally improvement algorithms; H. You start with one or more possible solutions to the problem in question and suggest ways to improve those solutions. To solve the problem of TSP, researchers have proposed various meta-hRsistic approaches such as the optimization of ant colonies to solve TSP.

$$A_{ij}=\begin{cases}1 & \text{the path goes form city i to city j}\\ 0 & \text{otherwise}\end{cases} \quad (5)$$

$$\min\sum_{i=1}^{N}\sum_{j\neq i,\,j=1}^{N}D_{ij}A_{ij} \quad (6)$$

$$A_{ij}\in\{0,1\} \qquad \text{i, j-1,..........,N;} \quad (7)$$

$$B_i\in Z \qquad \text{i, =2,..........,n;} \quad (8)$$

$$\sum_{j \neq i, i=1}^{n} A_{ij} \in \{0,1\} \qquad j=1,..........,N; \qquad (9)$$

$$\sum_{j \neq i, j=1}^{n} x_{ij} \in \{0,1\} \qquad i=1,..........,N; \qquad (10)$$

$$B_i - B_j + NA_{ij} \leq N-1 \qquad 2 \leq i \neq j \leq N \qquad (11)$$

$$1 \leq B_i \leq N-1 \qquad 2 \leq i \leq N \qquad (12)$$

V. Ant Colony Optimization

Ant Colony Optimization (ACO) was introduced by Marco Dorigo in 1991 and applied to TSP. The ACO algorithm models the behavior of real ant colonies when determining the shortest path from food sources to nests. Ants can communicate with each other in their immediate environment using chemicals called pheromones. Ants release pheromones to the ground when they leave their nest to feed, then return to the nest. Ants move according to the amount of pheromones. The richer the pheromone trail on a path, the more likely it is that other ants will follow it. So a shorter route has a greater amount of pheromones, ants tend to choose a shorter route. It is thanks to this mechanism that the ants find the shortest way.

5.1 Working of ACO for TSP

Initially, each ant is placed at random on a city. When developing a viable solution, the ants select the next city to visit using a probabilistic decision rule. When an ant k declares in city i and constructs the partial solution, the probability of moving to the next neighbouring city j i is given by

$$[p_0]_{ij}^{k}(k) = \begin{bmatrix} \dfrac{\left\{[B_0]_{ij}(t_0)\right\}^{\alpha_3}\left\{[C_0]_{ij}\right\}^{\beta_3}}{\sum\limits_{[u_0] \in J_k(t_0)} \left\{[B_0]_{ij}(t_0)\right\}^{\alpha_3}\left\{[C_0]_{ij}\right\}^{\beta_3}} & \text{if } \; j \in J_k(i) \\ 0 & \text{otherwise} \end{bmatrix} \quad (12)$$

Where $[B_0]_{ij}$ is the intensity of trails between edge (i,j) and $[C_0]_{ij}$ is the hRsistic visibility of the edge (i, j), and $[C_0]_{ij} = \frac{1}{d_{ij}}$ α_3 Is the influencing factor of pheromones, β_3 is the influence of the local node, and $J_k(i)$ is a set of cities that remain to be visited when the ant is in city i. Once each ant has completed their turn, the amount of pheromones on each path will be adjusted with the following equation.

$$[B_0]_{ij}(t_0+1) = (1-\rho_0)[B_0]_{ij}(t_0) + \Delta[B_0]_{ij}(t_0) \quad (13)$$

is pheromone evaporation coefficient andρwhere

$$\Delta[B_0]_{ij}(t_0) = \sum_{k=1}^{m} \Delta[B_0]_{ij}^{k}(t_0) \quad (14)$$

$$\Delta[B_0]_{ij}^{k}(t_0)=\begin{bmatrix} \frac{Q_0}{[L_0]_k} & \text{if} \quad (i,j)\in \text{tour done by ant k} \\ 0 & \text{otherwise} \end{bmatrix} \quad (15)$$

(1-ρ) is the decay parameter of pheromones (0<ρ<1) where it represents the evaporation of the track when the ant chooses a city and decides to move. Lk is the length of the turn for each formed per ant k and m is the number of ants. Q is the pheromone deposition factor.

VI. NUMERICAL ILLUSTRATION

To understand the quantified effects of the proposed model, let us take a numerical representation. This gives us a clear idea of how ant colony optimization relates to the traveling salesman problem with the help of practical examples. The following numerical data is taken into account for the co-ordinated supply chain problem considered to illustrate the model presented. $\left(\|SMC\|_{\text{oq}}\right)=$ Rs 950/order $\|SMC\|_{\text{uc}}=$ Rs 640/unit $\left(\|BDC\|_{\text{oq}}\right)=$ Rs 525/order $\|BDC\|_{\text{uc}}=$ Rs 390/unit $\left(\|BCS\|_{\text{oq}}\right)=$ Rs 150/setup $\|BCS\|_{\text{uc}}=$ Rs 250/unit $\zeta=$ Rs 0.2/Re/Months $D=$ 15,000 units D= 15,000 units By applying the ant colony optimization and the travelling salesman problem to the data given above, equation (4) is solved to obtain the optimal values of the decision variable and the objective function and the results are presented in Table I.

Table I: Best Values of result Variables and purpose Function With and without management

Item Description	Travelling salesman problem	Ant Colony Optimization
$\left(\|SMC\|_{\text{oq}}\right)$	387 units	369 units
$\left(\|BDC\|_{\text{oq}}\right)$	1161 units	738 units
$\left(\|BCS\|_{\text{oq}}\right)$	1161 units	738 units
Positive integer (Inventory ratio ϕ)	15	12
Positive integer (Inventory ratio λ)	10	10
TC_{BCS}	RS 7356/-	RS 7,198.5/-
TC_{BDC}	RS 9872.9/-	RS 8,614.1/-
TC_{SMC}	RS 5813.9/-	RS 7,032.3/-
TC_{BS}	RS 23,042.9/-	RS 22,840.6/-
	RS 23,042.9/-	RS 22,840.6/-

From the table above, we show the comparison of the applicable total costs obtained from the two algorithms considered. Here, the resulting inventory ratio is assigned to a positive integer value shown in the table. The values of the decision variables and the objective function are optimized with both methods and then mapped side by side. We see that the total supply chain cost resulting from the street vendor problem is lower than that obtained by the ant colony optimization algorithm. 1 shows the continuous decrease of the applicable total costs up to a certain value of generations and shows a saturated behavior with an increasing number of generations.

VII. CONCLUSIONS

This article provides a comparative study as part of a line of research examining optimal inventory decisions regarding the impact of the Covid-19 pandemic on the inventory management of the blood supply chain at three levels in surgical medical centers. The comparison is based on the algorithm used to solve the three-level problem illustrated by a numerical example. The model compares the applicable optimized total costs at blood collection sites, blood distribution centers and surgical medical centers. It is observed that the replenishment of the surgical medical center is higher in the ant colony optimization method, with a similar number of shipments, as shown by positive integer values. In addition, it is worth noting that the traveling salesman problem, compared to the optimization of the ant colony, provides inferior for each formance for the applicable total cost of the whole chain. Therefore, it can be concluded from the comparative study that the traveling salesman problem produces better optimal values for decision variables and objective functions. The scope of the project is cited in industrial applications such as storage optimization in industry.

REFERENCES:

1. Yadav, A.S. and Swami, A. (2018) A partial backlogging production-inventory lot-size model with time-varying holding cost and weibull deterioration International Journal Procurement Management, Volume 11, No. 5.
2. Yadav, A.S. and Swami, A. (2018) Integrated Supply Chain Model For Deteriorating Items With Linear Stock Dependent Demand Under Imprecise And Inflationary Environment. International Journal Procurement Management, Volume 11 No 6.
3. Yadav, A.S. and Swami, A. (2019) A Volume Flexible Two-Warehouse Model with Fluctuating Demand and Holding Cost under Inflation. International Journal Procurement Management Volume 12 No 4, 441-456
4. Yadav, A.S., Kumar, J., Malik M., and Pandey, T.(2019) Supply Chain of Chemical Industry For Warehouse With Distribution Centres Using Artificial Bee Colony Algorithm. International Journal of Engineering and Advanced Technology.Volume-8, Issue-2S2, 14-19.
5. Yadav, A.S., Pandey, T., Ahlawat, N., Agarwal, S. and Swami, A. (2020) Rose Wine industry of Supply Chain Management for Storage using Genetic Algorithm. Test Engraining & Management, 83, 11223 - 11230
6. Yadav, A.S., Ahlawat, N., Agarwal, S., Pandey, T. and Anupam Swami, A. (2020) Red Wine Industry of Supply Chain Management for Distribution Center Using NRsal Networks. Test Engraining & Management, 83, 11215 – 11222
7. Yadav, A.S., Ahlawat, N., Dubey, R., Pandey, G. and Swami, A. (2020) Pulp and paper industry inventory control for Storage with wastewater treatment and Inorganic composition using genetic algorithm (ELD Problem). Test Engraining & Management, 83, 15508-15517
8. Yadav, A.S., Dubey, R., Pandey, G., Ahlawat, N. and Swami, A. (2020) Distillery Industry Inventory Control for Storage with Wastewater Treatment & Logistics Using Particle Swarm Optimization. Test Engraining & Management, 83, 15362-15370
9. Yadav, A.S., Mahapatra, R.P., Sharma, S. and Swami, A. (2017) An Inflationary Inventory Model for Deteriorating items under Two Storage Systems International Journal of Economic Research, Volume 14 No.9.
10. Yadav, A.S., Mishra, R., Kumar, S. and Yadav, S. (2016) Multi Objective Optimization for Electronic Component Inventory Model & Deteriorating Items with Two-warehouse using Genetic Algorithm International Journal of Control Theory and applications, Volume 9 No.2.
11. Yadav, A.S., Navyata, Sharma, N., Ahlawat, N. and Swami, A. (2020) Reliability Consideration costing method for LOFO Inventory model with chemical industry warehouse. International Journal of Advanced Trends in Computer Science and Engineering, 9, 1, 403-408.
12. Yadav, A.S., Navyata, Sharma, N., Ahlawat, N. and Swami, A. (2020)Reliability Consideration costing method for LOFO Inventory model with chemical industry warehouse. International Journal of Advanced Trends in Computer Science and Engineering. Volume 9 No 1, 403-408
13. Yadav, A.S., Pandey, P., Ahlawat, N., Dubey, R. and Swami, A. (2020) Wine Industry Inventory Control for Storage with Wastewater Treatment and Pollution Load Using Ant Colony Optimization Algorithm. Test Engraining & Management, 83, 15528-15535
14. Yadav, A.S., Selva., N.S. and Tandon, A. (2020) Medicine Manufacturing Industries supply chain management for Block chain application using artificial nRsal networks. International Journal of Advanced Science and Technology, 29, 8s, 1294-1301
15. Yadav, A.S., Swami, A., Ahlawat, N., Bhatt, D. and Kher, G. (2020) Electronic components supply chain management of Electronic Industrial development for warehouse and its impact on the

environment using Particle Swarm Optimization Algorithm International Journal Procurement Management. Optimization and Inventory Management (Book Chapter), 427-445

16. Yadav, A.S., Swami, A., Ahlawat, N., Bhatt, D. and Kher, G. (2020)Electronic components supply chain management of Electronic Industrial development for warehouse and its impact on the environment using Particle Swarm Optimization Algorithm International Journal Procurement Management. Optimization and Inventory Management (Book Chapter)427-445
17. Yadav, A.S., Swami, A., Kher, G. and Sachin Kumar (2017) Supply Chain Inventory Model for Two Warehouses with Soft Computing Optimization International Journal of Applied Business and Economic Research Volume 15 No 4.
18. Yadav, A.S., Tandon, A. and Selva., N.S. (2020) National Blood Bank Centre Supply Chain Management for Blockchain Application Using Genetic Algorithm. International Journal of Advanced Science and Technology, 29, 8s, 1318-1324
19. Yadav, A.S., Taygi, B., Sharma, S. and Swami, A. (2017) Effect of inflation on a two-warehouse inventory model for deteriorating items with time varying demand and shortages International Journal Procurement Management, Volume 10, No. 6.
20. Yadav, A.S. and Swami, A. (2019)An inventory model for non-instantaneous deteriorating items with variable holding cost under two-storage. International Journal Procurement Management Volume 12 No 6, 690-710.
21. Yadav, A.S., Bansal, K.K., Shivani, Agarwal, S. And Vanaja, R. (2020) FIFO in Green Supply Chain Inventory Model of Electrical Components Industry With Distribution Centres Using Particle Swarm Optimization. Advances in Mathematics: Scientific Journal. 9, No.7, 5115–5120.
22. Yadav, A.S., Kumar, A., Agarwal, P., Kumar, T. And Vanaja, R. (2020) LOFO in Green Supply Chain Inventory Model Of Auto-Components Industry With Warehouses Using Differential Evolution. Advances in Mathematics: Scientific Journal. 9 , No.7, 5121–5126.
23. Yadav, A.S., Abid, M., Bansal, S., Tyagi, S.L. And Kumar, T. (2020) FIFO &LOFO in Green Supply Chain Inventory Model Of Hazardous Substance Components Industry With Storage Using Simulated Annealing. Advances in Mathematics: Scientific Journal. 9 , No.7, 5127–5132.
24. Yadav, A.S., Ahlawat, N., Sharma, N., Swami, A. And Navyata (2020) Healthcare Systems Of Inventory Control For Blood Bank Storage With Reliability Applications Using Genetic Algorithm. Advances in Mathematics: Scientific Journal. 9 , No.7, 5133–5142.
25. Sana, S.S. (2020) Price competition between green and non-green products under corporate social responsible firm Journal of Retailing and Consumer Services 55, 102118.
26. Sana, S.S. (2015) An EOQ model for stochastic demand for limited capacity of own warehouse, Annals of Operations Research 233 (1), 383-399, 2015.
27. Moghdani, R., Sana, S.S. And Shahbandarzadeh, H. (2020) Multi-item fuzzy economic production quantity model with multiple deliveries, Soft Computing 24 (14), 10363-10387.
28. Haseli, G., Sheikh, R. And Sana, S.S (2020) Base-criterion on multi-criteria decision-making method and its applications International Journal of Management Science and Engineering Management 15,2, 79-88.
29. Ameri, Z., Sana, S.S. AndSheikh, R. (2019) Self-assessment of parallel network systems with intuitionist fuzzy data: a case study Soft Computing 23 (23), 12821-12832.
30. Birjandi, A.K., Akhyani, F., Sheikh, R. And Sana, S.S. (2019) Evaluation and selecting the contractor in bidding with incomplete information using MCGDM methodSoft Computing 23 (20), 10569-10585.
31. Gholami, A., Sheikh, R., Mizani, N. And Sana, S.S. (2018)ABC analysis of the customers using axiomatic design and incomplete rough set, RAIRO-Operations Research 52 (4-5), 1219-1232.
32. Jamali, G, Sana, S.S, Moghdani, R. (2018) Hybrid improved cuckoo search algorithm and genetic algorithm for solving Markov modulated demand, RAIRO-Operations Research 52 (2), 473-497.