Article

A study of Covid-19 pandemic on fertilizer supply chain inventory management using travelling salesman problem for Cuckoo Search Algorithms

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Abstract

The impact of the Covid-19 epidemic on inventory management in the fertilizer supply chain is an important part of inventory management in the region and has been an important idea for the overall benefit of the industrial situation. It consists of several steps through which the material goes through different stages to reach the end customer. The effects of the Covid-19 epidemic on the management of the three-fertilizer supply chain inventory include fertilizer production sites, fertilizer distribution center, and costly fertilizer representative. A coordinated approach between rates is needed to adjust the chain for lower stocks and lower costs, and thus higher profits. This paper discusses the effect of coordinating the three-step Covid-19 epidemic on inventory management in a single fertilizer distribution chain that provides one type of product to distribution centers for individual fertilizers and then for each fertilizer representative the Covid-19 on the inventory management in the fertilizer distribution chain is solved by using the problem of a traveling salesman to add an ant colony to better values of decision-making variables and targeting functions. A numerical model is provided and the results obtained here are compared with these methods.

Keywords inventory; supply chain; fertilizer manufacturing sites; fertilizer distribution center; fertilizer representative and travelling salesman problem; Cuckoo Search Algorithms.

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1 Effects of Covid-19 Pandemic on Fertilizer Supply Chain Inventory Management Network Model of A Regionalized Fertilizer Banking System

Various industries have established commercial relationships between them to meet marketing challenges or marketing channels. The sales center which have no information on the needs and requirements of the customer, have conflicting objectives in the facility. Because of the lack of information, the time to deliver goods to customers remains long and unpredictable. Because of the arrangement, such as depreciation of delivery time, quality, or bulk shipping, it is common for the stock to exceed the stock, which increases the cost of facilities to meet demand. The impact of the Covid-19 epidemic on fertilizer supply chain management includes several companies that provide products or services to the customer or end user. That is, the impact of the Covid-19 epidemic on fertilizer chain supply chain management is a network (including retailers, intermediaries, shipping and logistics suppliers) that represents the flow of raw materials, semi-finished and finished equipment. Goods are in the direction in front of the customer, when the information and cash flow are returned. The impact of the Covid-19 catastrophe on accounting management in fertilizer Supply Chain Management (SCM) involves business processes providing value-added products, services, and information to customers and other stakeholders. Impact of the Covid-19 epidemic on compost management chain supply chain inventory management ensures that customer needs are met as well as distribution channels and impact phases of the Covid-19 epidemic. The effect of Covid-19 catastrophe on inventory management in the fertilizer supply chain undoubtedly involves good management of facility interaction inventory. In addition, behaviors associated with poor inventory management inventory lead to a significant correlation between the effects of the Covid-19 epidemic on accounting management partners in the fertilizer distribution chain. This will increase the risk that the Covid-19 epidemic will affect inventory management tools in the fertilizer distribution chain (i.e., distributors, fertilizer pumps, customers, etc). Researchers believed that demand was a flexible work of time and that unacceptable demand was a diminished work of waiting time. Supply chain management can be defined as: "Supply chain management is the coordination of production, stock, location and transportation between actors in supply chain to achieve the best combination of responsiveness and efficiency to a given market". Many researchers in the inventory system have focused on products that do 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., 2014-2020). Deterioration of an object can be described as deterioration, evaporation, obsolescence and loss of use or limit of an object, resulting in lower stock consumption compared to natural conditions. When commodities are placed in stock as inventory to meet future needs, there may be deterioration of items in the system of arithmetic that may occur for one or more reasons, etc (Yadav et al., 2014-2020). It is generally claimed that management owns a warehouse to store purchased inventory. However, management can, for a variety of reasons, buy or give more than it can store in its warehouse and name it OW, with an additional number in a rented warehouse called RW located near OW or slightly away from it (Yadav et al., 2014-2020). 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. To reduce the cost of inventory it will economically use RW products as soon as possible. Actual customer service is provided only by OW, and in order to reduce costs, RW stocks are first cleaned. Such arithmetic examples are called two arithmetic examples in the warehouse (Yadav and Swami, 2013-2019). Many other studies included an example of depreciation of goods and services of various types and costs of holding down a Business-Loan and an inventory model with sensitive needs of prices, holding costs in contrast to loans of business expenses under inflation (Swami et al., 2015); the improvement of supply and deficit inventory, inflation, and a calculation model based on a genetic calculation of scarcity and low inflation by PSO (Gupta et al., 2015); an example with two warehouses depreciation of items and storage costs under particle upgrade and an example with two warehouses of material damage and storage costs in inflation and soft computer techniques (Singh et al., 2016); Delayed alcohol supply management and refinement of particles and green cement supply system and inflation using particle enhancement and electronic inventory calculation system and distribution center using genetic calculations (Kumar et al., 2019); an example of depreciation inventory with two warehouses and stock-based stocks using a genetic inventory and vehicle inventory system for demand and inflation of stocks with two distribution centers using genetic inventory (Chauhan and Yadav, 2020); Marble Analysis Improvement of industrial reserves based on genetic engineering and multi-particle improvement (Pandey et al., 2019); white wine industry in supply chain management using nervous networks (Ahlawat et al., 2020); best policy for importing damaged items immediately and payment of conditional delays under the supervision of two warehouses (Singh et al., 2016); Cuckoo Search problems (Yang and Deb, 2009, 2010), and other studies in the present references (Kirkpatrick et al., 1983; Wang et al., 2003; Tiwari et al., 2014).

2 Modelling Fertilizer Supply Chain Inventory Management

According to the basic assumptions, we reduce and define a mathematical model. This calculation model makes it possible to define the natural world of cash flow problems associated with the effects of the Covid-19 epidemic on the management of the fertilizer supply chain inventory at various levels. This amount is presented in the form of mathematical concepts and designed for the model below. Digital presentation solves the model by using the traveler's problem with cuckoo search algorithms and the results are obtained.

The subsequent kind and assumptions are measured for the model.

1. Deterministic demand.
2. Instantaneous replenishment rate. Fertilizer distribution center inventory is an integer multiple of medical canters' inventory.
3. Fertilizer manufacturing sites inventory is an integer multiple of fertilizer distribution center inventory.
4. No shortages are allowed.

D=Demand rate in units for each unit time where $D = \left(e^{bT} + C^{19}\right)$

γ_0=Fertilizer Manufacturing sites ordering cost.

γ_1=Fertilizer Manufacturing sites unit cost.

λ_0=Replenishment quantity at the Fertilizer Manufacturing sites in units.

β_0=Fertilizer distribution Center ordering cost.

β_1=Fertilizer distribution Center unit cost.

ϕ_0=Fertilizer distribution Center ordering quantity in units.

α_0=Fertilizer Representative ordering cost.

α_1=Fertilizer Representative unit cost.

α_2=Fertilizer Representative ordering quantity in units.

ϕ=Fertilizer distribution Center replenishment quantity to Medical centers replenishment quantity.

λ=Fertilizer Manufacturing Sites replenishmentquantity to Fertilizer distribution Center ordering quantity.

ζ=Carrying charge

θ=Fertilizer Representative selling price

TC_{FMS} =The yearly total applicable cost of the Fertilizer Manufacturing sites
TC_{FDC} = The yearly total applicable cost of the Fertilizer distribution Center
TC_{FR} = The yearly total applicable cost of the Fertilizer Representative
TC_{FSC} = The yearly total applicable cost of the Fertilizer supply chain

3 Model Formulation

3.1 Fertilizer representative

The applicable total yearly costs of fertilizer representative result from the sum of the yearly ordering and transportation costs of fertilizer representative and can be expressed as:

$$\alpha_0 = \sum_0^{T_n} \left(\alpha_0 + C^{19} \right)$$

$$\alpha_1 = \sum_0^{T_n} \left(\alpha_1 + C^{19} \right)$$

$$\alpha_2 = \sum_0^{T_n} \left(\alpha_2 + C^{19} \right)$$

$$TC_{FR} = \sum_0^{T_n} \left\{ \frac{\alpha_0 D}{\alpha_2} + \frac{\alpha_1 \alpha_2 \zeta}{2} \right\}$$

$$TC_{FR} = \sum_0^{T_n} \left\{ \frac{\left[\left(\alpha_0 + C^{19} \right) \left(e^{bt} + C^{19} \right) \right]}{\left(\alpha_2 + C^{19} \right)} + \frac{\left[\left(\alpha_2 + C^{19} \right) \left(\alpha_1 + C^{19} \right) \left(\zeta + C^{19} \right) \right]}{2} \right\} \quad (1)$$

3.2 Fertilizer distribution center

The applicable yearly total fertilizer distribution center costs result from the sum of the yearly ordering and transport costs in fertilizer distribution center and can be expressed as follows:

$$\beta_0 = \sum_0^{T_n} \left(\beta_0 + C^{19} \right)$$

$$\beta_1 = \sum_0^{T_n} \left(\beta_1 + C^{19} \right)$$

$$\phi_0=\sum_0^{T_n}\left(\alpha_2+C^{19}\right)$$

$$TC_{FDC}=\sum_0^{T_n}\left\{\frac{\beta_0 D}{\phi\alpha_2}+\frac{(\phi)\alpha_2\beta_1(\zeta)}{2}\right\}$$

$$TC_{FDC}=\sum_0^{T_n}\left\{\begin{array}{l}\frac{\left[\left(\beta_0+C^{19}\right)\left(e^{bt}+C^{19}\right)\right]}{\left[\left(\phi+C^{19}\right)\left(\alpha_2+C^{19}\right)\right]}+\\ \frac{\left[\left(\phi+C^{19}\right)\left(\alpha_2+C^{19}\right)\left(\beta_0+C^{19}\right)\left(\zeta+C^{19}\right)\right]}{2}\end{array}\right\} \quad (2)$$

3.3 Fertilizer manufacturing sites

The applicable yearly total costs of the fertilizer manufacturing sites result from the sum of the yearly order and the transport costs to the fertilizer manufacturing sites and can be expressed as follows:

$$\gamma_0=\sum_0^{T_n}\left(\gamma_0+C^{19}\right)$$

$$\gamma_1=\sum_0^{T_n}\left(\gamma_1+C^{19}\right)$$

$$\lambda_0=\sum_0^{T_n}\left(\alpha_2+C^{19}\right)$$

$$TC_{FMS}=\sum_0^{T_n}\left\{\frac{\gamma_0 D}{\lambda\lambda_0}+\frac{\left(\lambda+C^{19}\right)\lambda_0\left\{\gamma_0\zeta\right\}}{2}\right\}$$

$$TC_{FMS}=\sum_0^{T_n}\left\{\frac{\gamma_0 D}{\lambda\lambda_0\phi}+\frac{\left(\lambda+C^{19}\right)\phi\lambda_0\left\{\gamma_0\zeta\right\}}{2}\right\}$$

$$TC_{FMS} = \sum_{0}^{T_n} \left\{ \frac{\left[\left(\gamma_0 + C^{19}\right)\left(e^{bt} + C^{19}\right)\right]}{\left[\left(\lambda + C^{19}\right)\left(\alpha_2 + C^{19}\right)\left(\phi + C^{19}\right)\right]} + \frac{\left[\left(\phi + C^{19}\right)\left(\lambda + C^{19}\right)\left(\alpha_2 + C^{19}\right)\left(\gamma_1 + C^{19}\right)\left(\zeta + C^{19}\right)\right]}{2} \right\} \quad (3)$$

3.4 Yearly total applicable cost of the fertilizer supply chain

The applicable yearly fertilizer supply chain total costs result from the sum of the individual applicable yearly total costs at fertilizer manufacturing sites, Fertilizer distribution center and fertilizer representative and can be expressed as:

$$TC_{FSC} = TC_{FR} + TC_{FDC} + TC_{FMS}$$

$$TC_{MS} = \sum_{0}^{T_n} \left[\begin{array}{l} \left\{ \frac{\left[\left(\alpha_0 + C^{19}\right)\left(e^{bt} + C^{19}\right)\right]}{\left(\alpha_2 + C^{19}\right)} + \frac{\left[\left(\alpha_2 + C^{19}\right)\left(\alpha_1 + C^{19}\right)\left(\zeta + C^{19}\right)\right]}{2} \right\} + \\ \left\{ \frac{\left[\left(\beta_0 + C^{19}\right)\left(e^{bt} + C^{19}\right)\right]}{\left[\left(\phi + C^{19}\right)\left(\alpha_2 + C^{19}\right)\right]} + \frac{\left[\left(\phi + C^{19}\right)\left(\alpha_2 + C^{19}\right)\left(\beta_0 + C^{19}\right)\left(\zeta + C^{19}\right)\right]}{2} \right\} + \\ \left\{ \frac{\left[\left(\gamma_0 + C^{19}\right)\left(e^{bt} + C^{19}\right)\right]}{\left[\left(\lambda + C^{19}\right)\left(\alpha_2 + C^{19}\right)\left(\phi + C^{19}\right)\right]} + \frac{\left[\left(\phi + C^{19}\right)\left(\lambda + C^{19}\right)\left(\alpha_2 + C^{19}\right)\left(\gamma_1 + C^{19}\right)\left(\zeta + C^{19}\right)\right]}{2} \right\} \end{array} \right] \quad (4)$$

4 Travelling Salesman Problem

The Travelling Salesman Problem (TSP) is a widespread computer problem that involves finding a way to get to Hamilton at minimal cost. The TSP represented the interests of computer scientists and mathematicians, as the problem has not yet been completely resolved after half a decade of research. TSP can be used to solve many problems such as logistics, transportation, semiconductor industry, etc. A better TSP solution would ensure better performance of responsibilities and thus increase productivity. Because of its importance in many industries, TSP is still being studied by researchers from a variety of disciplines. TSP is known to be a complex NP. This means that no known algorithm will resolve the validity of all TSP conditions within a reasonable time of implementation. To find the right solution, researchers developed several heuristics and simulation algorithms for approximate problems. They facilitate the search for high-quality solutions and deadlines for change. Adding ant colonies is usually an improvement algorithm; Researchers start with one or more solutions to the problem involved and suggest ways to improve them. To solve the TSP problem, the researchers proposed a variety of technical methods, such as improving ant colonies to solve TSP.

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

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

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

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

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

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

$$B_i - B_j + NA_{ij} \le N - 1 \qquad 2 \le i \ne j \le N \quad (11)$$

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

5 Cuckoo Search Algorithms

Cuckoo Search (CS) is an improvement algorithm developed in 2009 by Yang and Deb (2009, 2010). They were inspired by the cuckoo's egg-laying behavior, which lays eggs in the nests of other native birds (other species). Some native birds can deal directly with intrusive chicks. If a host bird finds out that the eggs are not theirs, these alien eggs will be discarded or simply leave its nest and build a new nest elsewhere. The search for cuckoo has created a similar breeding habit and can therefore be used for a variety of research problems. It seems to be able to overcome other metaheuristic algorithms in the software. Each egg in the nest represents a solution, and a cuckoo egg a new solution. The goal is to use new and highly viable solutions (cuckoos) that will replace the solution is not very good on nest sites. CS is based on three relevant rules: 1. Each cuckoo lays one egg and lays its egg in a randomly selected nest; 2. The best nests and high quality eggs will be passed on to the next generation; 3. The number of host nests found is determined by the egg laid by the cuckoo is detected by the host bird with a possible *p* (0,1). Detection works on the worst nests and detected solutions are thrown from further calculations.

In the case of a traveling salesman, an additional imitation begins with a common initial comment. Objective work, viz. The total length of the visit) is equal to the current energy status of the system. It changes from one state to another, resulting in shorter visits. This is equivalent to slowing down. Changes that increase the length of the visit are only accepted by the possibility $p(d, T) = \exp(-d / T)$, where *d* is the change in the length of the visit and *T* is the system temperature. Temperature criterion controls the marking process. The

TSP algorithm using SA has two parts. The first section deals with distribution between processors and interactions between cities and each processor. The second section uses a type of connection program to transfer or relocate visit sites between processors. The whole SA process for resolving TSP is given as follows:

$\Rightarrow$ *Begin* $\Leftarrow$
$\Rightarrow$ *Objective function f* (p), *city distances array*; $\Leftarrow$
$\Rightarrow$ *Initial a population of n host nests* $(cities)$) *xi*, $\Leftarrow$
$\Rightarrow i = 1;2;\ ???;n;\Leftarrow$
$\Rightarrow$ *Cuckoos fly via Levy flight to find an initial route* $(solution)$. $\Leftarrow$
$\Rightarrow$ *Mend initial solutions and saved in the bulletin board*. $\Leftarrow$
$\Rightarrow$ *Evaluate the route length* $(fitness)$ *of solutions Fi*; $\Leftarrow$
$\Rightarrow$ (HTML translation failed) $\Leftarrow$
$\Rightarrow$ *Cuckoos start from their nest to search new nests*; $\Leftarrow$
$\Rightarrow$ (HTML translation failed) $\Leftarrow$
$\Rightarrow$ *Replace old nest by new one*, $\Leftarrow$
$\Rightarrow$ *Reverse the segment between old nest and new one*, $\Leftarrow$
$\Rightarrow$ *Refresh bulletin board*. $\Leftarrow$
$\Rightarrow$ *end if* $\Leftarrow$
$\Rightarrow$ *Host birds abandon pa* $\in (0;1)$ *nests, and search pa* $\Leftarrow$
$\Rightarrow$ *new nests*; $\Leftarrow$
$\Rightarrow$ *Refresh the bulletin board and keeping the best solutions* $\Leftarrow$
$\Rightarrow$ $(and\ nests)$. $\Leftarrow$
$\Rightarrow$ *Rank the solutions, and find the current best route* $(solution)$. $\Leftarrow$
$\Rightarrow t = t + 1; \Leftarrow$
$\Rightarrow$ *end while* $\Leftarrow$
$\Rightarrow$ *Post process results and visualization.* $\Leftarrow$
$\Rightarrow$ *end* $\Leftarrow$

6 Numerical Illustration

To understand the calculated effects of the proposed model, let us take a numerical presentation. It gives us a clear idea of how cuckoo search algorithms relate to the problem of a traveling salesman with the help of practical examples. The following numerical figures are considered in the corresponding supply problem shown to illustrate the model presented.

$\alpha_2 = \$350$/order $\alpha_1 =$ EUR340/unit $\phi_0 = \$325$/order $\beta_1 = \$390$/unit $\lambda_0 = \$350$/setup $\gamma_1 = \$350$/unit $\zeta = \$0.4$/Re/Months $D = 9{,}000$ units

Using Cuckoo Search Algorithms and the traveling data vendor problem, we solve equation (4) on the data given above to obtain the optimal values of the decision variable and the target function, and the results are presented in Table 1.

Table 1 Best values of result variables and purpose function with and without management.

Item Description	Travelling salesman problem	Cuckoo Search Algorithms
α_2	587 units	569 units
ϕ_0	3161 units	938 units
λ_0	3161 units	938 units
ϕ	35	32
λ	30	30
TC_{FMS}	$ 9356/-	$ 9,198.5/-
TC_{FDC}	$ 11872.9/-	$ 10,614.1/-
TC_{FR}	$ 7813.9/-	$ 9,032.3/-
TC_{FSC}	$ 43,042.9/-	$ 42,840.6/-

Table 1 shows a total comparison of the valid costs obtained from the two algorithms under consideration. The resulting stock ratio is given the full numerical guarantee of the number shown in the table. The values of the decision transformers and the targeted function are improved by both methods and then arranged separately. We find that the total cost of supply caused by the problem with street vendors is lower than that we get with the coward search algorithm. Table 1 shows a sharp decrease in the total current cost in the value of a particular generation and shows a behavior characterized by an increasing number of generations.

7 Conclusions

This paper presents comparative research as part of a series of studies examining best accounting decisions about the impact of the Covid-19 epidemic on inventory management in a three-component supply chain in a fertilizer representative. The analogy is based on the calculation used to solve the three-step problem shown by the numerical model. The model compares the corresponding total cost in the fertilizer production areas, the fertilizer distribution center, and the fertilizer representative. It is considered that the health center is the highest in the cuckoo search method, with the same number of shipments, as indicated by the positive numerical values. In addition, it should be noted that the difficulty of the traveling merchant compared to the improvement of the ant colony gives poor results for each performance at the corresponding cost of the whole chain. From comparative research, it can therefore be concluded that passenger distress sells better values for decision-making variables and targeting functions.

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