Article

Effect of Covid-19 pandemic on semiconductor industry supply chain inventory management: travelling salesman problem for simulated annealing and Cuckoo Search Algorithms

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Abstract

The impact of the Covid-19 epidemic on inventory management in the semiconductor industry supply is an important part of inventory management 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 impact of the Covid-19 pandemic on the inventory management of the three-tier semiconductor industry includes the locations of the semiconductor trading unit, the semiconductor industry warehouse, and the cost-effective agent of the semiconductor industry. A coordinated approach between rates is needed to adjust the chain for lower stocks and lower costs, and thus higher profits. In this paper, we discuss the effect of coordinating the three-step Covid-19 epidemic on the supply chain management of the semiconductor industry and one part of the semiconductor industry conference that provides one type of product for distribution centers for each industry of semiconductor and then semiconductor agent sector. The mathematical model is developed for the coordinated effects of the Covid-19 epidemic on inventory management in the supply of the semiconductor industry, solved by the problem of a traveling salesman adding an ant colony to better values for decision-making and targeting functions. A numerical model is provided and the results obtained here are compared with these methods.

Keywords inventory; supply chain; semiconductor industry business unit sites; semiconductor industry warehouse; semiconductor industry agent; travelling salesman problem; simulated annealing; Cuckoo Search Algorithms.

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

Various industries have established commercial relationships between them to meet marketing challenges or marketing channels since the beginning of the industrial revolution. Because of the lack of information, the time to deliver goods to customers remains long and unpredictable. And 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 semiconductor supply chain management includes several companies that provide products or services to the customer or end user. In other words, the impact of the Covid-19 epidemic on semiconductor chain supply chain management is a network (including retailers, intermediaries, shipping and logistics suppliers, etc.) 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 epidemics on accounting management in semiconductor Supply Chain Management (SCM) involves business processes providing value-added products, services, and information to customers and other stakeholders. The effect of Covid-19 catastrophe on inventory management in the semiconductor 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 semiconductor distribution chain. This will increase the risk that the Covid-19 epidemic will affect inventory management tools in the semiconductor distribution chain (i.e., distributors, semiconductor pumps, customers, etc). Researchers believed that demand was a flexible work of time and that unacceptable demand was a diminished work of waiting time. 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. 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). The deterioration of these substances plays an important role and cannot be stored for long (Yadav et al., 2014-2020). Management owns a warehouse to store purchased inventory. However, management can 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. These arithmetic examples are called two arithmetic examples in the warehouse (Yadav and Swami, 2013-2019). Many other studies included Cuckoo Search problems (Yang and Deb, 2009, 2010); 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 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); 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); 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); best policy for importing damaged items immediately and payment of conditional delays under the supervision of two warehouses (Singh et al., 2016), 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); 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), and other studies in the present references (Kirkpatrick et al., 1983; Wang et al., 2003; Tiwari et al., 2014).

2 Modelling Semiconductor Industry Supply Chain Inventory Management

In accordance with the basic assumptions, we limit and define the mathematical model. This mathematical model makes it possible to define the natural world of the cash flow problem associated with the impact of the Covid-19 pandemic on inventory management of the semiconductor industry supply chain at various levels. These amounts are presented in the form of mathematical concepts and formulated in the model below. The digital presentation solves the model by using the traveling vendor problem and simulated annealing and Cuckoo Search Algorithms.

The subsequent kind and assumptions are measured for the model.

1. Deterministic demand.
2. Instantaneous replenishment rate. Semiconductor industry warehouse inventory is an integer multiple of Semiconductor industry canters' inventory.
3. Semiconductor industry business unit sites inventory is an integer multiple of semiconductor industry warehouse inventory.
4. No shortages are allowed.

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

α_5=Semiconductor industry Business unit sites ordering cost.

α_6=Semiconductor industry Business unit sites unit cost.

λ_0=Replenishment quantity at the Semiconductor industry Business unit sites in units.

α_3=Semiconductor industry warehouse ordering cost.

α_4=Semiconductor industry warehouse unit cost.

ϕ_0=Semiconductor industry warehouse ordering quantity in units.

α_0=Semiconductor industry Agent ordering cost.

α_1=Semiconductor industry Agent unit cost.

α_2=Semiconductor industry Agent ordering quantity in units.

ϕ=Semiconductor industry warehouse replenishment quantity to Medical centers replenishment quantity.

λ=Semiconductor industry Business unit Sites replenishmentquantity to Semiconductor industry warehouse ordering quantity.

ζ=Carrying charge

θ=Semiconductor industry Agent selling price

TC_{SIB}=The yearly total applicable cost of the Semiconductor industry Business unit sites

TC_{SIW} = The yearly total applicable cost of the Semiconductor industry warehouse

TC_{SIA} = The yearly total applicable cost of the Semiconductor industry Agent

TC_{SISC} = The yearly total applicable cost of the Semiconductor industry supply chain

3 Model Formulation

3.1 Semiconductor industry agent

The applicable total yearly costs of semiconductor industry agent result from the sum of the yearly ordering and transportation costs of semiconductor industry agent and can be expressed as:

$$TC_{SIA} = \sum_{0}^{T_n} \left\{ \frac{\alpha_0 D}{\alpha_2} + \frac{\alpha_1 \alpha_2 \zeta}{2} \right\}$$

$$TC_{SIA} = \sum_{0}^{T_n} \left\{ \frac{\left[\left(\frac{\alpha_0}{C_{19}} \right) \left(\frac{e^{bt}}{C_{19}} \right) \right]}{\left(\frac{\alpha_2}{C_{19}} \right)} + \frac{\left[\left(\frac{\alpha_2}{C_{19}} \right) \left(\frac{\alpha_1}{C_{19}} \right) \left(\frac{\zeta}{C_{19}} \right) \right]}{2} \right\} \quad (1)$$

3.2 Semiconductor industry warehouse

The applicable yearly total Semiconductor industry warehouse costs result from the sum of the yearly ordering and transport costs in Semiconductor industry warehouse and can be expressed as follows:

$$TC_{SIW} = \sum_{0}^{T_n} \left\{ \frac{\alpha_3 D}{\phi \alpha_2} + \frac{(\phi) \alpha_2 \alpha_4 (\zeta)}{2} \right\}$$

$$TC_{SIW} = \sum_{0}^{T_n} \left\{ \frac{\left[\left(\frac{\alpha_3}{C_{19}}\right)\left(\frac{e^{bt}}{C_{19}}\right)\right]}{\left[\left(\frac{\phi}{C_{19}}\right)\left(\frac{\alpha_2}{C_{19}}\right)\right]} + \frac{\left[\left(\frac{\phi}{C_{19}}\right)\left(\frac{\alpha_2}{C_{19}}\right)\left(\frac{\alpha_3}{C_{19}}\right)\left(\frac{\zeta}{C_{19}}\right)\right]}{2} \right\} \quad (2)$$

3.3 Semiconductor industry business unit sites

The applicable yearly total costs of the Semiconductor industry Business unit sites result from the sum of the yearly order and the transport costs to the Semiconductor industry Business unit sites and can be expressed as follows:

$$TC_{SIB} = \sum_{0}^{T_n} \left\{ \frac{\alpha_5 D}{\lambda \lambda_0} + \frac{(\lambda)\lambda_0 \{\alpha_5 \zeta\}}{2} \right\}$$

$$TC_{SIB} = \sum_{0}^{T_n} \left\{ \frac{\alpha_5 D}{\lambda \lambda_0 \phi} + \frac{(\lambda)\phi\lambda_0 \{\alpha_5 \zeta\}}{2} \right\}$$

$$TC_{SIB} = \sum_{0}^{T_n} \left\{ \frac{\left[\left(\frac{\alpha_5}{C_{19}}\right)\left(\frac{e^{bt}}{C_{19}}\right)\right]}{\left[\left(\frac{\lambda}{C_{19}}\right)\left(\frac{\alpha_2}{C_{19}}\right)\left(\frac{\phi}{C_{19}}\right)\right]} + \frac{\left[\left(\frac{\phi}{C_{19}}\right)\left(\frac{\lambda}{C_{19}}\right)\left(\frac{\alpha_2}{C_{19}}\right)\left(\frac{\alpha_6}{C_{19}}\right)\left(\frac{\zeta}{C_{19}}\right)\right]}{2} \right\} \quad (3)$$

3.4 Yearly total applicable cost of the semiconductor industry supply chain

The applicable yearly semiconductor industry supply chain total costs result from the sum of the individual applicable yearly total costs at semiconductor industry business unit sites, semiconductor industry warehouse and semiconductor industry agent and can be expressed as:

$$TC_{SISC} = TC_{SIA} + TC_{SIW} + TC_{SIB}$$

$$TC_{SISC} = \sum_{0}^{T_n} \left[\left\{ \frac{\left[\left(\frac{\alpha_0}{C_{19}}\right)\left(\frac{e^{bt}}{C_{19}}\right)\right]}{\left(\frac{\alpha_2}{C_{19}}\right)} + \frac{\left[\left(\frac{\alpha_2}{C_{19}}\right)\left(\frac{\alpha_1}{C_{19}}\right)\left(\frac{\zeta}{C_{19}}\right)\right]}{2} \right\} + \left\{ \frac{\left[\left(\frac{\alpha_3}{C_{19}}\right)\left(\frac{e^{bt}}{C_{19}}\right)\right]}{\left[\left(\frac{\phi}{C_{19}}\right)\left(\frac{\alpha_2}{C_{19}}\right)\right]} + \frac{\left[\left(\frac{\phi}{C_{19}}\right)\left(\frac{\alpha_2}{C_{19}}\right)\left(\frac{\alpha_3}{C_{19}}\right)\left(\frac{\zeta}{C_{19}}\right)\right]}{2} \right\} + \left\{ \frac{\left[\left(\frac{\alpha_5}{C_{19}}\right)\left(\frac{e^{bt}}{C_{19}}\right)\right]}{\left[\left(\frac{\lambda}{C_{19}}\right)\left(\frac{\alpha_2}{C_{19}}\right)\left(\frac{\phi}{C_{19}}\right)\right]} + \frac{\left[\left(\frac{\phi}{C_{19}}\right)\left(\frac{\lambda}{C_{19}}\right)\left(\frac{\alpha_2}{C_{19}}\right)\left(\frac{\alpha_6}{C_{19}}\right)\left(\frac{\zeta}{C_{19}}\right)\right]}{2} \right\} \right] \quad (4)$$

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. It 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. It 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, 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 Simulated Annealing and Cuckoo Search Algorithms

Cuckoo Search (CS) is an improvement algorithm developed in 2009 by Yang and Deb (2009, 2010). He was 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.

The additional simulation technique (SA) was described in 1983 by Kirkpatrick et al. Imitated packaging is the oldest algorithm of high-level possibilities used to find the approximate solution to the search for a global problem. It is guided by the incorporation of minerals, which is a method of controlling the cooling of the material to reduce defects. A similar simulation algorithm starts with a random solution. Each iteration creates a solution almost randomly. If this solution is the best solution, it will replace the current solution. If this is a poor solution, you can choose to change the current solution and the probability that depends on the temperature parameter. When the algorithm is active, the temperature parameter decreases, which gives the inferior solution a less chance of changing the current solution. Allowing a poor solution at the beginning helps prevent the approach of the natives rather than the lower level of the world. The output of the algorithm is influenced by two parameters: initial temperature, temperature drop rate, and algorithm suspension parameters.

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:

$$\left|\begin{array}{l}
\Rightarrow \text{begin procedure SA} \Leftarrow \\
\Rightarrow \text{generate initial solutions} \Leftarrow \\
\Rightarrow \text{set temperature, and cooling rate} \Leftarrow \\
\Rightarrow \text{while}\left(\text{termination criteria not meet}\right) \Leftarrow \\
\Rightarrow \text{generate new solutions} \Leftarrow \\
\Rightarrow \text{access new solutions} \Leftarrow \\
\Rightarrow \text{if } \left(\text{accept new solution}\right) \Leftarrow \\
\Rightarrow \text{update storage} \Leftarrow \\
\Rightarrow \text{adjust temperature} \Leftarrow \\
\Rightarrow \text{end if} \Leftarrow \\
\Rightarrow \text{end while} \Leftarrow \\
\Rightarrow \text{post-process results and output} \Leftarrow \\
\Rightarrow end \Leftarrow
\end{array}\right\rangle$$

A cuckoo flies between cities obeying Levy distribution. At the beginning, a cuckoo visited n cities once and saved its traveled order in the bulletin. Individual is a nest which represents the first city (the end city) of a route (solution). Population is all n nests which represent n cities. A solution represents an available route. Bulletin board save all n solutions and refresh by offspring's generation by generation. In every generation, n cuckoos start from their nests flying around to get new nests replacing of the olds. By partially reversing of segment of route (start from old nest to the new nest) the algorithm eliminates crossover edges to find shorter route (better solution). Fitness defined as its route length: the smaller, the better. The general procedure of Cuckoo Search Algorithm to solve Travelling Salesman Problem is shown below:

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

6 Numberical Illustration

To understand the calculated effects of the proposed model, let us take a numerical presentation. This gives us a clear idea of how enhanced search and cuckoo search connects with the problem of a traveling merchant using practical examples. The following numerical figures are considered in the corresponding supply problem shown to illustrate the model presented.

$\alpha_2 = Rs.1150/\text{order}$ $\alpha_1 = \text{Rs.}1140/\text{unit}$ $\phi_0 = \text{Rs. } 1125/\text{order}$ $\alpha_3 = \text{Rs. } 1190/\text{unit}$ $\lambda_0 = \text{Rs. } 1150/\text{setup}$

$\alpha_5 = \text{Rs. } 1150/\text{unit}$ $\zeta = Rs.1.2/\text{Re/Months}$ $D = 17{,}000$ units

By applying the simulated annealing and Cuckoo Search methods and traveler vendor problem in the data above, equation (4) is solved to obtain the best values of decision divergence and objective role, and the results are presented in Table 1.

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 obtained by the Simulated Annealing Algorithm and Cuckoo Search Algorithms. 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.

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

Item Description	Travelling Salesman Problem	Simulated Annealing and Cuckoo Search Algorithms
α_2	12387 units	1369 units
ϕ_0	11161 units	1738 units
λ_0	11161 units	1738 units
ϕ	115	112
λ	110	110
TC_{SIB}	Rs.17356/-	Rs.17,198.5/-
TC_{SIW}	Rs.19872.9/-	Rs. 18,614.1/-
TC_{SIA}	Rs.15813.9/-	Rs. 17,032.3/-
TC_{SISC}	Rs.123,042.9/-	Rs.122,840.6/-

7 Conclusions

This paper presents comparative research as part of a series of studies examining the best mathematical decisions about the impact of the Covid-19 epidemic on inventory management in the supply of the third-tier semiconductor industry. The analogy is based on the calculation used to solve the three-step problem shown by the numerical model. The model compares the corresponding cost in the areas of the semiconductor industry unit, the semiconductor industry warehouse, and the semiconductor industry agent. It is considered that the recovery of the semiconductor industrial center is greater with the Imitation method and the cuckoo search methods with the same number of shipments, as shown by the positive positive 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 implementation at the total 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. The scope of the project has been described in industrial use as a conservation improvement in the industry.

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