Inventory model for decay items with safe chemical storage and inflation using artificial bee colony algorithm

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Abstract: A deterministic Safe Chemical Storage inventory model has been developed for the deterioration of items with increasing demand, with inflation effects on stocks using artificial bee colony algorithm. The Safe Chemical Storage has a fixed capacity of *C* units using artificial bee colony algorithm. Stock outs are allowed and partially deferred, and inventories are expected to deteriorate in excess of time with a changeable rate of deterioration using artificial bee colony algorithm. The inflation consequence has also been taken into account for the different costs of the Safe Chemical Storage inventory organisation. The numerical example is also used to examine the behaviour of the model using artificial bee colony algorithm. The cost minimisation technique is second-hand to get hold of the terms of total cost and other parameters using artificial bee colony algorithm.

Keywords: safe chemical storage; inflation; shortages; ramp time demand; deterioration items; ABCG; artificial bee colony algorithm.

Reference to this paper should be made as follows: Yadav, A.S., Swami, A., Ahlawat, N., Kher, G. and Kumar, S. (2022) 'Inventory model for decay items with safe chemical storage and inflation using artificial bee colony algorithm', *Int. J. Applied Management Science*, Vol. 14, No. 1, pp.57–70.

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1 Introduction

A lot of researchers have comprehensive the EOQ model to require models that vary over time. Some researchers have discussed storage models with a linear demand trend. The main limitations of the time-varying demand flow are that they imply a standardised change in the demand flow per unit of time. This is hardly ever the case for raw materials on the market. In topical years, several models have been developed whose demand rate changes exponentially over time. For recurring products such as clothing, weather, etc., at the end of the season, the demand for these items decreases exponentially during an near the beginning period. Subsequently, the demand for products will become stable rather than decrease exponentially. It is assumed that such a request is fairly sensible. Such a state of affairs can be represented by the ramp-type demand rate. An important subject of stock theory is the unsatisfied demands that occur in the event of bottlenecks or inventory levels. In the majority of the models developed, the researchers felt that the bottlenecks were either totally delayed or completely lost.

The previous case, called the previous case or the previous case, represents a situation in which the request is returned completely without a request. In the case of sale also called loss, we believe that the unsatisfied demand has been completely lost. When hitch occurs, some customers are also eager to wait for the backlog, while others choose to buy from other suppliers. In many cases, customers are obliged for late delivery and may be willing to wait a bit before receiving their first choice. For example, for fashionable raw materials and high-tech products with shorter life cycles, the customer's willingness to wait for residuals decreases with the length of the waiting time. Thus, the period of waiting for the next fill will determine whether the backlog is accepted or not. In many real-life situations, the longer the wait, the less time it takes. For realistic business conditions, the backlog must be variable and dependent on the waiting time for the next replenishment. Many researchers have changed their inventory policies for safe storage of chemicals, taking into account "proportional residues over time". Safe handling of chemicals requires regular inspection of storage areas and strict inventory control. The intrinsic hazard of chemicals can be reduced by reducing the amount of chemicals. On the other hand, if chemicals are to be used, appropriate storage and handling can trim down or do away with the risks involved. All chemical storage areas and cabinets should be inspected at least once a year and all unwanted or expired chemicals must be removed. Typical storage considerations may include heat, explosion control, aeration, separation, and detection. Proper separation is necessary to prevent incompatible materials from coming into contact with each other. Physical barrier and / or shrinkage are effective for proper isolation. Proper storage information is typically found in safety data sheets, labels, or other chemical reference materials. According to the requirements of 29 CFR 1910.1200, a safety data sheet for each hazardous substance must be available at your workplace. Safety data sheets must be provided by the manufacturer or distributor of purchased chemicals. Safety data sheets are also available through the LINDEN system, DCC's chemical monitoring system. The system records the CDC's chemical inventory and contains a safety data sheet for most chemicals on the list. The Internet can also be used to search security data sheets. To quickly search for a security data sheet on the Internet, go to the CDC intranet, select Database, then Scientific Information and then Security Data Sheet. This site contains manufacturer-specific information and general information.

After reviewing the literature, we see that there were some defects in previous research. In the field of integrated inventory models, the above conditions are rarely combined with secure chemical storage using artificial bee colony algorithms. The artificial bee colony algorithm is a search algorithm that relies on natural selection and inference of genetics. The general procedure of the artificial bee colony algorithm is to evaluate the fitness (or value of the objective function) for a randomly generated source population. On the basis of merit, then selection is made for breeding. In some individuals, hybridisation and mutation are performed to produce the next generation of offspring. This process is repeated until the maximum number of generations or convergence is reached.

2 Literature review

Agarwal et al. (2016) analysed an estimate of the loss result using time association rule extraction. Agarwal et al. (2015) presented an EOQ estimate for imperfect quality elements using clustering association rule mining. Agarwal et al. (2018) analysed an optimal control policy with inventory classification using data mining techniques. Agarwal and Mittal (2019) discussed an inventory classification using multi-level association rule mining. Yadav and Swami (2018a) analysed an integrated supply chain model for deteriorating commodities whose demand is dependent on linear stock in an inaccurate and inflationary environment. Yadav and Swami (2018b) discussed a model of the size of a production lot in stock with partial backlog with a variable cost of ownership and Weibull deterioration. Yadav et al. (2018a) presented a supply chain inventory model for decaying items with two warehouses and partial orders under inflation. Yadav et al. (2018b) proposed an inventory model for deteriorating items with two warehouses and a variable cost of ownership. Yadav et al. (2018c) analysed an electronic component inventory model for deteriorated warehousing items using a genetic algorithm. Yadav et al. (2018d) discussed an analysis of the management of ecological supply chain stocks for warehouses with environmental collaboration and sustainability performance using a genetic algorithm. Yadav and Kumar (2017) presented an electronic component supply chain management for a warehouse with environmental collaboration and neural networks. Yadav et al. (2017a) analysed the effect of inflation on a two-warehouse stock model for items in decline with demand and shortages over time. Yadav et al. (2017b) discussed an inflationary inventory model for deteriorating items under two storage systems. Yadav et al. (2017c) proposed a two store inventory model based on fuzzy bases for non-instant deteriorating items with conditionally permissible late payment. Yadav (2017) analysed an analysis of supply chain management in inventory optimisation for a warehouse with logistics using a genetic algorithm. Yadav et al. (2017d) discussed a supply chain inventory model for two warehouses with soft IT optimisation. Yadav et al. (2016) presented a multi-objective optimisation for the electronic component inventory model and deteriorating items with two warehouses using a genetic algorithm.

3 Assumptions and notations

The development of the mathematical model of the inventory system is based on the following assumptions:

1 "A single item is considered over a prescribed period *T* units of time".

2 The demand charge $D(t)$ at time t is deterministic and in use as a ramp type function of time i.e. $D(t) = \left(A_0 + 1\right)e^{-(\eta_0+1)\{t-(t-t_1)H(t-t_1)\}}, \left(A_0 + 1\right) > 0, \left(\eta_0 + 1\right) > 0$

3 The replenishment rate is infinite and lead-time is zero.

4 The backlogging rate is $\exp(-(B_0+1)\,t)$, when inventory is in shortage. The backlogging parameter (B_0+1) is a positive constant.

5 The variable rate of deterioration in Safe Chemical Storage is taken as $(\eta+1)(t)$ = $(\eta+1)\,t$. Where 0< $(\eta+1)$ << 1 and only applied to on hand inventory.

6 The Safe Chemical Storage (SCS) has a fixed capacity of C units;

7 The goods of Safe Chemical Storage are consumed only.

In addition, the following notations are used throughout this paper:

$I_{SCS}(t)$	inventory level in Safe Chemical Storage at any time *t*.
C	Capacity of the Safe Chemical Storage.
Q	Ordering quantity per cycle.
T	Planning horizon.
(R_0+1)	Inflation rate.
C_{HC}	Holding cost in Safe Chemical Storage.
C_{DC}	Deterioration cost per unit.
C_{SC}	Shortage cost in Safe Chemical Storage.
C_{LSC}	Opportunity cost due to lost sales.
$(\pi+1)$	Replenishment cost per order.
TCSCS	Total cost Safe Chemical Storage.

4 Formulation and solution of the model

4.1 The inventory levels at safe chemical storage are governed by the following differential equations

$$\frac{dI_{SCS}(t)}{dt} = -(\eta+1)(t)I_{SCS}(t) \qquad 0 \le t < t_1 \tag{1}$$

$$\frac{dI_{SCS}(t)}{dt} + (\eta+1)(t)I_{SCS}(t) = -(A_0+1)e^{-(\eta_0+1)t_1} \qquad t_1 \le t \le t_2 \tag{2}$$

and

$$\frac{dI_{SCS}(t)}{dt} = -(A_0+1)e^{-(\eta_0+1)t_1}e^{-(B_0+1)t} \qquad t_2 \le t \le T \tag{3}$$

with the boundary conditions,

$$I_{SCS}(0) = C \;\; \& \;\; I_{SCS}(t_2) = 0 \tag{4}$$

the solutions of equations (1), (2) and (3) are given by

$$I_{SCS}(t) = Ce^{-(\eta+1)t^2/2} \qquad 0 \le t < t_1 \tag{5}$$

$$I_{SCS}(t) = (A_0+1)e^{-(\eta_0+1)t_1}\left\{(t_2-t)+(\eta+1)\frac{(t_2^3-t^3)}{6}\right\}e^{-(\eta+1)t^2/2} \qquad t_1 \le t \le t_2 \tag{6}$$

and

$$I_{SCS}(t) = \frac{(A_0+1)}{(B_0+1)}e^{-(\eta_0+1)t_1}\left\{e^{-(B_0+1)t}-e^{-(B_0+1)t_2}\right\} \qquad t_2 \le t \le T \tag{7}$$

respectively.

Owing the continuity of $I_{SCS}(t)$ at point $t = t_1$, it follows from equations (5) and (6), one has

$$\begin{aligned} Ce^{-(\eta+1)t_1^2/2} &= (A_0+1)e^{-(\eta_0+1)t_1}\left\{(t_2-t_1)+(\eta+1)\frac{(t_2^3-t_1^3)}{6}\right\}e^{-(\eta+1)t_1^2/2} \\ C &= (A_0+1)e^{-(\eta_0+1)t_1}\left\{(t_2-t_1)+(\eta+1)\frac{(t_2^3-t_1^3)}{6}\right\} \end{aligned} \tag{8}$$

The total average cost consists of following elements:

(i) Ordering cost in Safe Chemical Storage

$$OC = (\pi+1) \tag{9}$$

(ii) Holding cost in Safe Chemical Storage

$$\begin{aligned} HC &= C_{HC}\left[\int_0^{t_1} I_{SCS}(t)e^{-(R_0+1)t}dt + \int_{t_1}^{t_2} I_{SCS}(t)e^{-(R_0+1)(t_1+t)}dt\right] \\ HC &= C_{HC}\left[\begin{array}{l} C\left(t_1-\frac{(R_0+1)t_1^2}{2}-\frac{(\eta+1)t_1^3}{6}\right)+ \\ (A_0+1)e^{-(\eta_0+1)(t_1+(R_0+1))}\left[\frac{t_2^2}{2}-\frac{rt_2^3}{6}+\frac{(\eta+1)t_2^4}{12}\right. \\ -\frac{(R_0+1)(\eta+1)}{20}t_2^5-\frac{t_1}{2}(2t_2-t_1)-\frac{(\eta+1)t_1}{24}(4t_2^3-t_1^3) \\ +\frac{(R_0+1)t_1^2}{6}(3t_2-2t_1) \\ \left.+\frac{(R_0+1)(\eta+1)t_1^2}{30}(5t_2^3-3t_1^3)+\frac{(\eta+1)t_1^3}{24}(4t_2-3t_1)\right] \end{array}\right] \end{aligned} \tag{10}$$

(iii) Cost of deteriorated units in Safe Chemical Storage

$$DC = C_{DC}\left[\int_0^{t_1}(\eta+1)\,tI_{SCS}(t)e^{-(R_0+1)t}dt + \int_{t_1}^{t_2}(\eta+1)\,tI_{SCS}(t)e^{-(R_0+1)(t+t_1)}dt\right]$$

$$DC = C_{DC}(\eta+1)\begin{bmatrix} C\left(\frac{t_1^2}{2}-\frac{(R_0+1)t_1^3}{3}\frac{(\eta+1)t_1^4}{8}\right)+(A_0+1)e^{-t_1((\eta_0+1)+(R_0+1))} \\ \left(\frac{t_2^3}{6}-\frac{rt_2^4}{12}+\frac{(\eta+1)t_2^5}{40}-\frac{(R_0+1)(\eta+1)t_2^6}{36}-\frac{t_1^2}{6}(3t_2-2t_1)\right. \\ -\frac{(\eta+1)t_1^2}{60}(5t_2^3-2t_1^3)-\frac{(R_0+1)t_1^3}{12}(4t_2-3t_1)- \\ \left.\frac{(R_0+1)(\eta+1)t_1^3}{36}(2t_2^3-t_1^3)-\frac{(\eta+1)t_1^4}{40}(5t_2-4t_1)\right) \end{bmatrix} \tag{11}$$

(iv) Shortage cost in Safe Chemical Storage

$$SC = C_{SC}\left[\int_{t_2}^{T}-I_{SCS}(t)e^{-r(t_2+t)}dt\right]$$

$$SC = \frac{-(A_0+1)C_{SC}e^{-((R_0+1)t_2+(\eta_0+1)t_1)}}{(B_0+1)}\left[\int_{t_2}^{T}e^{-((R_0+1)+(B_0+1))t}dt - e^{-(B_0+1)t_2}\int_{t_2}^{T}e^{-(R_0+1)t}dt\right]$$

$$SC = \frac{(A_0+1)C_{SC}e^{-((R_0+1)t_2+(\eta_0+1)t_1)}}{(B_0+1)(R_0+1)((B_0+1)+(R_0+1))}\begin{bmatrix}(B_0+1)e^{-((B_0+1)+(R_0+1))t_2} \\ +e^{-(R_0+1)T}\left\{(R_0+1)e^{-(B_0+1)T}-((B_0+1)+(R_0+1))e^{-(B_0+1)t_2}\right\}\end{bmatrix} \tag{12}$$

(v) Opportunity cost due to lost sales

$$OPC = C_{LSC}\int_{t_2}^{T}(A_0+1)\left(1-e^{-(B_0+1)t}\right)e^{-(\eta_0+1)t_1}e^{-(R_0+1)(t_2+t)}dt$$

$$= \frac{C_{LSC}(A_0+1)e^{-((\eta_0+1)t_1+(R_0+1)t_2)}}{(R_0+1)((B_0+1)+(R_0+1))}\begin{bmatrix}e^{-(R_0+1)t_2}\left\{((B_0+1)+(R_0+1))-(R_0+1)e^{-(B_0+1)t_2}\right\} \\ -e^{-(R_0+1)T}\left\{((B_0+1)+(R_0+1))-(R_0+1)e^{-(B_0+1)T}\right\}\end{bmatrix} \tag{13}$$

Therefore, the total average cost per unit time of our model is obtained as follows

$$TCSCS(t_2,T)=\frac{1}{T}[\,\mathit{Ordering}\ \text{Cost in Safe Chemical Storage} + \text{Holding cost in Safe Chemical Storage} + \text{Deterioration cost} + \text{Shortage cost} + \text{Opportunity cost}] \tag{14}$$

$$TCSCS(t_2,T)=\frac{1}{T}\left[\begin{array}{l}\{(\pi+1)\}+\left\{C_{HC}\left[\begin{array}{l}C\left(t_1-\frac{(R_0+1)t_1^2}{2}-\frac{(\eta+1)t_1^3}{6}\right)+\\(A_0+1)e^{-(\eta_0+1)(t_1+(R_0+1))}\left[\frac{t_2^2}{2}-\frac{rt_2^3}{6}+\frac{(\eta+1)t_2^4}{12}\right.\\-\frac{(R_0+1)(\eta+1)}{20}t_2^5-\frac{t_1}{2}(2t_2-t_1)-\frac{(\eta+1)t_1}{24}(4t_2^3-t_1^3)\\+\frac{(R_0+1)t_1^2}{6}(3t_2-2t_1)\\\left.+\frac{(R_0+1)(\eta+1)t_1^2}{30}(5t_2^3-3t_1^3)+\frac{(\eta+1)t_1^3}{24}(4t_2-3t_1)\right]\end{array}\right]\right\}\\+\left\{C_{DC}(\eta+1)\left[\begin{array}{l}C\left(\frac{t_1^2}{2}-\frac{(R_0+1)t_1^3}{3}\frac{(\eta+1)t_1^4}{8}\right)+(A_0+1)e^{-t_1((\eta_0+1)+(R_0+1))}\\\left(\frac{t_2^3}{6}-\frac{rt_2^4}{12}+\frac{(\eta+1)t_2^5}{40}-\frac{(R_0+1)(\eta+1)t_2^6}{36}-\frac{t_1^2}{6}(3t_2-2t_1)\right.\\-\frac{(\eta+1)t_1^2}{60}(5t_2^3-2t_1^3)-\frac{(R_0+1)t_1^3}{12}(4t_2-3t_1)-\\\left.\frac{(R_0+1)(\eta+1)t_1^3}{36}(2t_2^3-t_1^3)-\frac{(\eta+1)t_1^4}{40}(5t_2-4t_1)\right)\end{array}\right]\right\}\\+\left\{\frac{(A_0+1)C_{SC}e^{-((R_0+1)t_2+(\eta_0+1)t_1)}}{(B_0+1)(R_0+1)((B_0+1)+(R_0+1))}\right.\\\left.\left[\begin{array}{l}(B_0+1)e^{-((B_0+1)+(R_0+1))t_2}\\+e^{-(R_0+1)T}\left\{(R_0+1)e^{-(B_0+1)T}-((B_0+1)+(R_0+1))e^{-(B_0+1)t_2}\right\}\end{array}\right]\right\}\\+\left\{\frac{C_{LSC}(A_0+1)e^{-((\eta_0+1)t_1+(R_0+1)t_2)}}{(R_0+1)((B_0+1)+(R_0+1))}\right.\\\left.\left[\begin{array}{l}e^{-(R_0+1)t_2}\left\{((B_0+1)+(R_0+1))-(R_0+1)e^{-(B_0+1)t_2}\right\}\\-e^{-(R_0+1)T}\left\{((B_0+1)+(R_0+1))-(R_0+1)e^{-(B_0+1)T}\right\}\end{array}\right]\right\}\end{array}\right] \tag{15}$$

the total cost per unit time, the optimal values of t_1 and T can be obtained by solving the following equations simultaneously

$$\frac{\partial TCSCS}{\partial t_1} = 0 \tag{16}$$

and $$\frac{\partial TCSCS}{\partial T} = 0 \tag{17}$$

provided, they satisfy the following conditions

$$\left.\begin{array}{l} \dfrac{\partial^2 TCSCS}{\partial t_2^2} > 0, \dfrac{\partial^2 TCSCS}{\partial T^2} > 0 \\ \text{and} \\ \left(\dfrac{\partial^2 TCSCS}{\partial t_2^2}\right)\left(\dfrac{\partial^2 TCSCS}{\partial T^2}\right) - \left(\dfrac{\partial^2 TCSCS}{\partial t_2 \partial T}\right)^2 > 0 \end{array}\right\} \tag{18}$$

Therefore, numerical solution of these equations is obtained by using the software MATLAB 7.0.1.

4.2 Artificial bee colony algorithm

This segment provides the planned pseudo-code of the hybrid algorithm with the inventory model settings.

S-1: "Define the parameters of the artificial bee colony algorithm".

S-2: "Initialise the bee population is the state for the cost of ownership which is the case 1 for the acceleration coefficient 1".

S-3: "Initialise the bee population is the state for the cost of ownership which is the case 2 for the acceleration coefficient 2".

S-4: "Find the quit counter for bee spectators".

S-5: "For case 1, check the recruited bees from the acceleration coefficient 1".

S-6: "For Case 2, check the recruited bees using the Acceleration Coefficient 2".

S-7: "Produce the new solution for bees employed with two cases".

S-8: "If k ≠ i, the best solution is equal to".

S-9: "If the cost of new bees is less than or equal to that of the total population, cycle = cycle + 1".

S-10: "Now find the fitness value of all probabilities".

S-11: "Find the best cost solutions so far".

The total cost of production and the error must be minimised, which leads to maximizing the fitness function

5 Numerical

To illustrate the model numerically the following parameter values are considered.

(A_0+1) = 75 units, $(\pi+1)$= Rs. 150 per order, (R_0+1) = 0.10 unit, C_{HC} = Rs. 30.0 per unit per year, (η_0+1) = 1.2 unit, $(\eta+1)$ =1.002 unit, C_{SC} = Rs. 24.0 per unit per year, t_1 = 1.2 year, C_{LSC} = Rs. 8.0 per unit, (B_0+1) = 1.1 unit, T = 2 year, Then for the minimisation of total average cost and with help of software. The optimal policy can be obtained such as:

t_2 = 0.922103 year, S = 42.186012 units and $TCSCS$ = Rs.792.22115 per year.

GA: real coded

Population = 40

Generations = 222

Crossover probability = 3.0

Mutation probability = 0.5

6 Sensitivity analysis

For various associated parameters, a sensitivity analysis is presented below in numerical and graphical form.

7 Observations

1 Table 1 shows the outcome of demand parameter (A_0+1) on T and on $TCSCS$ from this, we have noticed that an increase in demand parameter (A_0+1) shows a reverse effect of decrement in T and the same outcome of increment in $TCSCS$.

2 Table 2 presents the outcome of demand parameter (η_0+1) on T and on $TCSCS$ It is noticed that with an increment in demand parameter (η_0+1), values of 'T' increase while value of $TCSCS$ decreases.

3 Table 3 the variation in stock capacity (C) of Safe Chemical Storage is discussed. Here it is shown that with an increase in capacity of the owned warehouse the $TCSCS$ of the system gradually decreases.

4 Table 4 presents the deviation of backlogging parameter (B_0+1) at distinct points and it is noticed that as backlogging parameter (B_0+1) increases, the values of T and $TCSCS$ decrease.

5 Table 5 list the variation in "selling price" C_{LSC} and from this; we have noticed that an increment in selling price shows maintains a reverse effect of decrement in $TCSCS$.

6 Table 6 shows the deviation of deterioration parameter $(\eta + 1)$ at distinct points and it is noticed that as deterioration parameter $(\eta + 1)$ increases, the values of and 'T' decrease while $TCSCS$ increases.

Table 1 Optimal solution for distinct values of demand parameter $(A_0 + 1)$

% change in $(A_0 + 1)$	$(A_0 + 1)$	T	$TCSCS$
–15	30	72.7548	621.452
–10	32.5	72.6578	650.534
–5	34	72.5783	649.354
0	36.7	72.5555	648.236
5	38	71.8594	648.001
10	40.2	71.7589	647.987
15	42	71.4598	647.982

Table 2 Optimal solution for distinct values of demand parameter $(\eta_0 + 1)$

% change in $(\eta_0 + 1)$	$(\eta_0 + 1)$	T	$TCSCS$
–15	0.42	92.7548	691.452
–10	0.425	92.6578	680.534
–5	0.4256	92.5783	679.354
0	0.5	92.5555	668.236
5	0.52	91.8594	658.001
10	0.524	91.7589	647.987
15	0.5264	91.4598	637.982

Table 3 Optimal solution for distinct values of safe chemical storage capacity (C)

% change in (C)	*(C)*	T	$TCSCS$
–15	60	75.7548	699.452
–10	65	75.6578	698.534
–5	70	75.5783	697.354
0	75	74.5555	696.236
5	80	73.8594	696.001
10	90	71.7589	695.987
15	100	70.4598	695.982

Table 4 Optimal solution for distinct values of backlogging parameter (B_0+1)

% change in (B_0+1)	*(C)*	*T*	*TCSCS*
–15	0.52	72.754	699.452
–10	0.53	72.657	598.534
–5	0.59	72.578	597.354
0	0.63	72.555	496.236
5	0.65	70.859	496.001
10	0.64	70.758	495.987
15	0.62	70.459	495.982

Table 5 Optimal solution for distinct values of selling price (C_{LSC})

% change in C_{LSC}	C_{LSC}	*T*	*TCSCS*
–15	14.0	32.7548	679.452
–10	14.5	32.6578	678.534
–5	14.9	32.5783	677.354
0	15.0	32.5555	676.236
5	15.2	31.8594	676.001
10	15.9	31.7589	675.987
15	16.0	31.4598	675.982

Table 6 Optimal solution for distinct values of deterioration parameter $(\eta+1)$

% change in $(\eta+1)$	$(\eta+1)$	*T*	*TCSCS*
–15	0.004	22.7548	609.452
–10	0.0041	22.6578	608.534
–5	0.00421	22.5783	607.354
0	0.5	22.5555	606.236
5	0.52	20.8594	606.001
10	0.524	20.7589	605.987
15	0.5341	20.4598	605.982

Table 7 Artificial bee colony algorithm (ABCA) model optimal solution

% change in P	*WW*	*% change in ABCA*			
	OPT	*BEST*	*MAX*	*AVG*	*STD*
–15	151.10	210.10	210.10	302.10	302.10
–10	151.11	210.11	210.11	308.11	308.11
–5	151.21	211.21	211.21	310.21	310.21
0	151.23	211.23	211.23	311.23	311.23
5	151.24	212.24	212.24	315.24	315.24
10	151.54	212.54	212.54	316.54	316.54
15	151.58	213.58	213.58	318.58	318.58

8 Conclusion

This study contains some realistic features that are probably related to the Safe Chemical Storage inventory of equipment using artificial bee colony algorithm. The deterioration (deterioration) of overtime for physical products and stock outs is a natural phenomenon in real life situations using artificial bee colony algorithm. Safe Chemical Storage Inventory bottlenecks are allowed in the template. In a lot of cases, customers are linked to a late delivery and may be enthusiastic to wait a short while before getting their first choice using ABCA. In general, the length of the next fill wait is the most important factor in decide whether the backlog is accepted or not. The willingness of a client to wait for arrears during a bottleneck period decreases with the length of the wait using artificial bee colony algorithm. As a result, stock outs are allowed and partially reorganised in this chapter, and the recovery rate is measured a decreasing function of the next fill timeout using artificial bee colony algorithm. The request rate is considered as an exponential ramp time function, in which the demand decreases exponentially during certain initial periods and becomes constant thereafter using artificial bee colony algorithm. Since most policymakers believe that inflation does not have a significant impact on inventory policy for safe chemical stocks, the effects of inflation are not taken into account in some stocktaking inventories. Stocks of safe chemicals; However, from a financial point of view, stocks are a capital investment and must be supplemented by other assets for the limited capital of an enterprise, using AABC. Therefore, the impact of inflation on the storage system must be taken into account. Therefore, this concept is also adopted in this model using artificial bee colony algorithm. The numerical representation of the model shows that the Safe Chemical Storage inventory conservation period increases as the return and ramp parameters increase, while the storage period decreases as the deterioration and inflation parameters increase using artificial bee colony algorithm. The initial Safe Chemical Storage inventory decreases with increasing deterioration, inflation, and ramp parameters as Safe Chemical Storage inventory increases with increasing residue parameters using artificial bee colony algorithm. The overall average cost of the system continues to increase along with residue and deterioration parameters, while decreasing with inflation and upward parameters. The future model can be expanded in different ways. For example, we could extend this deterministic model to a stochastic model using artificial bee colony algorithm. We could also extend the model with more realistic features, such as: Quantity discount or unit cost, inventory cost and others that may vary over time using artificial bee colony algorithm.

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