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OPTIMIZATION OF TOTAL AVERAGE INVENTORY PRICE USING FUZZY COMPUTATIONSDEPENDS UPON RESTRAINT ON INVENTORY IN STOCK

M.ANEES FATHIMA[1],C D NANDAKUMAR[2], S SRINIVASAN[3]
[123]Department of Mathematics & Actuarial Sciences,
B.S. Abdur Rahman Crescent Institute of Science and Technology.
Chennai,600048, Tamil Nadu, India.
maneesfathima2012@gmail.com[1]prof.cdnandakumar@gmail.com[2]srinivasan@crescent.education[3]

ABSTRACT
This paper focuses on the amount of limitation on inventory products of all types kept in stock according to storage space. Following to the inventory management, average total ordered quantities and average total cost is estimated using demand price, cost per unit, ordering price, holding price. The main aim is to show the estimated average total ordered quantities should not exceed the amount of limitation on inventory products kept in stock. Incase if it exceeds, inventory can be controlled by the Lagrange's Multiplier Technique. Holding price, ordering price, cost per unit is assumed in form of crisp value and parabolic fuzzy numbers for each item. Analytical computations are carried out to compute the average ordered quantities and minimum average total cost.

1. Introduction

There are numerous causes of developing inventories. Actual inventory control broadening the production of the companies. Inventory control stands up in two questions that when and how muchamount of products to be ordered. There are various form of ambiguities deterioration, misappropriation, shortages, storing price, set up price, etc. in inventory arrangements. Inventory is a reckoning operation or scheme assumed to improve the management or persuade the accomplishment of an administration to secure the products or avert extortion and failures etc. Connected to financial range, Inventory management intends to curtain the maximal price and to hike the profit. Inventory management perceives the demand to evolve the designs inorder to contribute the various assistance to fulfil the needs of all customers. Inventory scheduling and management is related with procurement and stockpile of products needed for running business and factories. Fuzzy concept is initiated to solve inventory problems and to produce the accurate outcome. Total cost can be minimized using fuzzy inventory models for the beneficial of the customers. There have been frequent trials to put fuzzy concept in inventory administration inorder to choose the alternative solution for smooth and efficiency running of business.

2. Literature Analysis on Fuzzy Inventory Models

Chung et.al designed an inventory models for defecting products under extension and admissible detention in reimbursements [1]. In recent inquiries, models connected to various deterioration elaborated [2]. De elongated the triangular dense fuzzy set and initiated triangular dense fuzzy lock set to manage the situation during the decisions taken in inventory [3].
De originated the intensity of fuzziness using polygonal fuzzy set [4]. Goswami et.al [5] practiced the triangular dense fuzzy set in a pollution perceptive back ordered economic productive model.Three coat stock string network model including limited reservoir and arbitrary separation in triangular dense fuzzy lock set surroundings described [6]. An inventory model with re-order concealed by antagonistic dense fuzzy sense [7]. Sana et.al. enlarged the economic productivity model with numerous consignment for the area constraints by assuming demand price as triangular fuzzy numbers [8]. In [9], assumed pay-off suspension strategy in multi-items unique machine economic productive model including replacement, breakdown and shortages.In [10], fuzzy set theory advanced to hook the ambiguous actual universe complications.

STATEMENT OF THE PROBLEM

In the present paper, an inventory model with unallowable shortage is considered in both crisp and fuzzy sense. The central aim of this research is to measure the optimal set-up products and average total price. The measured ordered products isto be within the given range of inventory products. If average ordered quantity exceeds the average total number of units then it is considered as inventory level is not within the anticipated range.

RESEARCH METHODOLOGY

The stated problem is worked out byapplyingGraded mean Integration and Lagrange's Multiplier techniques in this research.The ordered quantities and minimum total cost is evaluated using ordering cost, carrying cost, cost per unit of each type of item in both crisp and fuzzy sense. Graded Mean Integration method is applied for the estimations. Lagrange's multiplier technique is applied to bring out the average ordered quantity within range of inventory level. Average Total cost is obtained depends upon the optimal average ordered quantities. All the measures assessed and estimated through the Analytical Study and Numerical illustrations applying both crisp and fuzzy values.

3. Definitions

3.1Fuzzy Number

Considering $\tilde{A}$ as fuzzy number, convex formalized fuzzy set of the real number R then

(i) It exists absolutely at specific$x_0 \in$ R comprises$\mu_{\tilde{A}}(x_0) = 1$, where x_0 is named to nearest value of $\tilde{A}$.

(ii) It consists of membership function $\mu_{\tilde{A}}(x)$ is piecewise continuous.

(iii) Fuzzy numbers stated in R. It exhibits with numerous perception includes limited membership. The degree of membership can be confiscated through membership functions. There are distinct models of membership function constructed using various fuzzy numbers such as triangular, parabolic, trapezoidal, triangular, Gaussian fuzzy numbers. In general, membership functions will not be a symmetric.

3.2Parabolic Fuzzy Number

This fuzzy number constitutes of two parabolic sections. The Parabolic Fuzzy Number is composed of two parabolic sections of the associateship degree enclosed by Modal and ambit values. It is characterized by a ternary Parabolic Fuzzy Numbers $\{l,\ m,\ n\}$ with Modal value m and parameters of the left and right ambits l and n. The associateship function of the parabolic fuzzy number P is stated in form

$$P_{\tilde{A}}(x) = \begin{cases} L(x) = 1 - \left(\frac{x-l}{m-l}\right)^2 & , \ when\ l \le x \le m; \\ R(x) = 1 - \left(\frac{n-x}{n-m}\right)^2 & , \ whenm \le x \le n; \\ 0 & , \quad otherwise \end{cases} \quad (1)$$

3.3DefuzzificationofParabolic Fuzzy Number Using Graded Mean Integration Method

Considering $\tilde{A} = (l,\ m,\ n)$ as a Parabolic fuzzy number and graded mean integration for $\tilde{A}$defined from$O$ stated by

$$d(\tilde{A},\ 0) = \frac{1}{6}(l + m + n) \quad (2)$$

4. FUZZY INVENTORY MODEL

The suggested inventory model in fuzzy surrounding depends upon the limitation on inventory level preserved in stock has obtained the ordered quantity and total cost using ordering price, demand price, holding price and price per product.

4.1 NOTATIONS

In this paper, the following notations connected to the parameters,

TABLE I

h	-	Storage cost for single unit
v	-	Ordering charge for single unit
D	-	Demand Rate for per unit
TC	-	Total cost for average inventory level
$\widetilde{TC}$	-	Fuzzy total cost
$\tilde{h}$	-	holding price in fuzzy sense
γ	-	Price per unit
$\tilde{v}$	-	Fuzzy ordering cost
$\widetilde{TC}$	-	Fuzzy Total inventory cost.
t	-	Ordered quantity
$\tilde{t}$	-	Fuzzy ordered quantity
T	-	Total number of units preserved in stock
μ	-	Lagrangian Multiplier is greater than zero

4.2 ASSUMPTIONS

The few presumptions are assumed in this paper. Unallowable shortage is permitted. Whole demand rate is consistent for each component. Storage price, setup price,cost per unit of each typeis fuzzified.

4.3 INVENTORY MODEL IN CRISP SENSE

The average count of all units preserved in stock not expected to exceed total number of units.

Average count of all units $=\frac{1}{2}\sum_{i=1}^{n} t_i \leq T$ (3)

Optimum Ordered quantity $t_i^* = \sum\sqrt{\frac{2\, v_i\, D}{h_i\gamma_i}}$ (4)

Cost of Average Inventory $TC = \sum_{i=1}^{n} \gamma_i \frac{1}{2} t_i$ (5)

If the average count of all units exceeds average of total numbers of units, then Lagrange's Multiplier Technique applied. This technique implies μ is assumed value to bring out the average count of all units in inventory is less than average of total number of units.

Optimum Ordered quantity $t_i^* = \sqrt{\frac{2\, v_i\, D}{h_i\gamma_i + \mu}}$ (6)

4.4 INVENTORY MODEL IN FUZZY SENSE

Here the OrderedPrice, HoldingPrice and price per unit is expressed in form of Parabolic Fuzzy numbers and indicated using Graded Mean IntegrationMethod.

Average count of all units = $\frac{1}{2}\sum_{i=1}^{n} \tilde{t}_i \leq T$(7)

Fuzzy Optimum Ordered quantity $\tilde{t}_i^* = \sum\sqrt{\frac{2\, \tilde{v}_i\, D}{\tilde{h}_i\tilde{\gamma}_i}}$(8)

Fuzzy Cost of Average Inventory $\widetilde{TC}= \sum_{i=1}^{n} \tilde{\gamma}_i \frac{1}{2} t_i$(9)

Lagrange's Multiplier Technique

Optimum Ordered quantity $t_i^* = \sqrt{\frac{2\, \tilde{v}_i\, D}{\tilde{h}_i\tilde{\gamma}_i + \mu}}$(10)

4.5 ANALYTICAL ILLUSTRATIONS

A company produces three engine components 1, 2, 3 in bunch. The company consists store room with sparse warehouse capacity to have 400 units of all type of components. The Demand rate per unit of each component is allotted as 500 and 400 units. The details of each engine component per month given in table.

Crisp Data

Engine Components	Component 1	Component 2	Component 3
Cost per Unit	5	10	15
Ordering Charge	50	75	100
Holding Charge	10%	20%	30%

Solution:

Let $v_1 = Rs.\ 50,\ v_2 = Rs.\ 75,\ v_3 = Rs.\ 100, h_1 = 10\%\ ,\ h_2 = 20\%,\ h_3 = 30\%,$ $D = 500\ units\ per\ month,\ \gamma_1 = Rs.\ 5,\ \gamma_2 = Rs\ .10,\ \ \gamma_3 = Rs.15,\ T = 400\ units.$ Applying the costs in (3), (4), (5)& (6), we obtain $\boldsymbol{t_i^* = 329.48},\ \boldsymbol{TC = Rs.2877}$.Since the average ordered quantity t_i^*exceeds the average of total number of units T, here we apply Lagrange's Multiplier Technique by assuming $\mu = 2.1$ in (6), we get $\boldsymbol{t_i^* = 198.51}$, Minimum average total cost $\boldsymbol{TC} = \boldsymbol{Rs.1946.11}$. Now we obtain the average ordered quantity is within the range of inventory.

Similarly if $D = 400\ units\ per\ month$, we obtain $\boldsymbol{t_i^* = 294.7},\ \boldsymbol{TC = Rs.2573.3}$. Since the average ordered quantity t_i^*exceeds the average of total number of units T, here we apply Lagrange's Multiplier Technique by assuming $\mu = 2.1$ in (6), we get $\boldsymbol{t_i^* = 177.56}$, minimum average total cost $T\boldsymbol{C = Rs.1740.75}$.

Fuzzy Data 1:

Engine Components	Component 1	Component 2	Component 3
Cost per Unit	(4, 5, 6)	(9, 10, 11)	(14, 15, 16)
Ordering Charge	(48, 50, 52)	(73, 75, 77)	(98, 100, 102)
Holding Charge	(10% , 11%, 12%)	(19%, 20%, 21%)	(29%, 30%, 31%)

Solution:

Let $\tilde{v}_1 = (48, 50, 52), \tilde{v}_2 = (73, 75, 77),\ \tilde{v}_3 = (98, 100, 102), \tilde{h}_1 = (10\%, 11\%, 12\%),\ \tilde{h}_2 = (19\%, 20\%, 30\%), \tilde{h}_3 = (29\%, 30\%, 31\%)\ , D = 500\ units\ per\ month,\ \ \widetilde{\gamma_1} = (4, 5, 6),\ \widetilde{\gamma_2} = (9, 10, 11), \widetilde{\gamma_3} = (14, 15, 16),\ \ T = 400\ units$ Applying the costs in (7), (8), (9)& (10), we obtain $\boldsymbol{t_i^* = 185.98},\ \boldsymbol{TC = Rs.4919.7}$. Since the average ordered quantity t_i^*does not exceed the average of total number of units T, we obtain the anticipated average inventory level within the range and we get minimum average total cost.

Similarly if $D = 400\ units\ per\ month$, we obtain $\boldsymbol{t_i^* = 166.34},\ \boldsymbol{TC = Rs.4399.8}$ Since the average ordered quantity t_i^*does not exceed the average of total number of units T, we obtain the anticipated average inventory level within the range and we get minimum average total cost.

Fuzzy Data 2:

Engine Components	Component 1	Component 2	Component 3
Cost per Unit	(2, 5, 7)	(8, 10, 12)	(13, 15, 17)
Ordering Charge	(43, 50, 56)	(68, 75, 81)	(93, 100, 106)
Holding Charge	(10% , 13%, 15%)	(18%, 20%, 22%)	(28%, 30%, 32%)

Solution:
Let $\tilde{v}_1 = (43, 50, 56)$, $\tilde{v}_2 = (68, 75, 81)$, $\tilde{v}_3 = (93, 100, 106)$, $\tilde{h}_1 = (10\%, 13\%, 15\%)$, $\tilde{h}_2 = (18\%, 20\%, 22\%)$, $\tilde{h}_3 = (28\%, 30\%, 32\%)$, $D = 500\, units\ per\ month$, $\widetilde{\gamma_1} = (2, 5, 7)$, $\widetilde{\gamma_2} = (8, 10, 12)$, $\widetilde{\gamma_3} = (13, 15, 17)$, $T = 400\, units$ Applying the costs in (7), (8), (9) & (10), we obtain $\boldsymbol{t_i^* = 182.42}$, $\boldsymbol{TC = Rs.4778.28}$. Since the average ordered quantity t_i^* does not exceed the average of total number of units T, we obtain the anticipated average inventory level within the range and we get minimum average total cost.
Similarly if $D = 400\, units\ per\ month$, we obtain $\boldsymbol{t_i^* = 163.17}$, $\boldsymbol{TC = Rs.4273.95}$ Since the average ordered quantity t_i^* does not exceed the average of total number of units T, we obtain the anticipated average inventory level within the range and we get minimum average total cost.

Observation
It is observed that
1. Using Crisp data, obtained average ordered quantity exceeds the total number of units. So average ordered quantity is not within range of inventory and lagrange's Multiplier technique is applied to bring the anticipated average ordered quantity within the range of inventory. As we reduce the average ordered quantity, minimum average total cost is obtained for various demands.
2. Using Fuzzy data such as parabolic fuzzy numbers and graded mean integration method, obtained average ordered quantity does not exceed the total number of units. So ordered quantity is within the anticipated range of inventory and minimum average total cost is obtained.
3. Using Fuzzy data, We obtain the average ordered quantities does not exceed the total number of units for various demands comparing with the crisp data. Incase if the stock are in lots depends upon the store house, We apply the various fuzzy numbers and graded mean integration method to get the average ordered quantities less than the average total number of units. As average ordered quantities gets reduce, Average total cost is minimized.

5. CONCLUSION
In this paper, fuzzy inventory model is advanced with unallowable shortage includingstock based items in both crisp and fuzzy surroundings. This modelengrosses on estimating average ordered quantities and average total cost based on the raw materials kept in stock in allotted sufficient storage space. Average ordered quantities and average total cost is estimated using crisp data and fuzzy datas. Parabolic fuzzy numbers, Graded Mean Integration Method and Lagrange's Multiplier technique is applied for the estimations. From the analytical illustrations, it is concluded that using crisp data and fuzzy datas, average ordered quantities obtained should not exceed the average total number of units kept in stock in allotted storage space. This controls the range of inventory and minimum average total cost is obtained. Incase average ordered quantities exceeds the average total number of units, can be controlled applying Lagrange's Multiplier technique. It is essential that total number of units, ordering price, holding price, cost per unit and demand is given to find the range of inventory with in the allotted storage space. The other vital part is comparing with crisp data, fuzzy data brings the minimum average ordered quantities within the range of inventory and minimum average total cost is computed for various demands. When the stock are in lots as per the storage space, fuzzy model is convenient to estimate the average ordered quantity and minimum average total cost using various fuzzy numbers and defuzzification through different methods such as graded mean integration method and signed distance method.

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