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An Inventory Model with no Shortage in Fuzzy Environment

V. Seerengasamy[1], P. Vijayalakshmi[2], S. Vimala[3], S. Krishna Prabha[4]

Professor and Head[1], Assistant Professor [2,4]

Department of Mathematics, PSNA College of Engineering and Technology, Dindigul, Tamil Nadu, India

[3]Assistant Professor, Department of Mathematics, Mother Teresa Women's University, Kodaikannal, Tamil Nadu, India

ABSTRACT

In this paper we consider an inventory model with no shortage in fuzzy environment.Tne run size is assumed to be constant and a new run will be started whenever inventory is zero. The demand rate is assumed to be uniform and production rate is finite. Here we consider the different costs under fuzzy environment and they are defuzzified using two different methods .The analytical development is provided with an example and the results are compared.

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I. INTRODUCTION

Inventory provides service to the customers at short notice. Inventory is one of the most expensive and important assets of companies. Managers have long recognized that good inventory control is crucial. On the other hand, customers become dissatisfied when frequent inventory outages. Therefore, the proper inventory control help in growth of an organization. When to order and how much to order are the two questions associated with Inventory control.

Finding an optimal solution that helps in making decision for minimizing the total cost or maximizing the profit gain with reference to the above two questions is called inventory problem. A set of specific values of variables under discussion that minimizes the total cost of the system or maximizes the total profit of the system will be considered as the solution of inventory problem. Haris (1915) [10] derived the basic well known square root formula for EOQ model for constant demand Donalson, W.A. (1977)[5] have found an analytical solution for Inventory Replenishment policy for linear trending demand. Ranking fuzzy subsets over the unit interval was explained by Yager (1978) [15]. Buchanan (1980)[1]. Found alternative solution methods for inventory replenishment problem under increasing demand. Kacpryzk and P Staniewski (1982) [11] have discussed the various issues of Long-term inventory policy-making through fuzzy decision making models. Replenishment policies for linear trend demand have been improved by Goyal (1985)[7]. The concept of Economic order interval for an item with linear trend demand was described by Goyal et al (1986)[8].Fuzzy production inventory for fuzzy product quantity with triangular fuzzy number was explained in detail by S. C. Chang (1999)[3].Optimal EOQ models for deteriorating items with time-varying demand was described by Hariga (1996)[9].The inventory model with increasing demand under inflation was proposed by Sarkar and Sana (2010)[14]. Dey and Rawat (2011)[4] developed an EOQ model without shortage cost by using Triangular fuzzy number. Fuzzy inventory model without shortages using fuzzy trapezoidal number was presented by Dutta and Kumar (2012)[6]. Ranganathan and Thirunavukarasu(2014)[13] have developed and described with an example about an Inventory control model for constant deterioration in Fuzzy environment. Fuzzy Inventory Model with Shortages Using Different Fuzzy Numbers was discussed by Nabendu Sen, Sanjukta Malakar (2015)[12]. Fuzzy Inventory Model without Shortages Using Signed Distance Method was explained by Chandrasiri(2016)[2] .

The paper is designed as follows. In section 2 the basic concepts are explained.Matematical model for Inventory is derived in section3.A numerical example is solved in section 4.The paper is concluded in section5.

II. METHODS AND MATERIAL

2. Preliminaries

2.1 Fuzzy Set : The characteristic function μ_A of a crisp set $A \subseteq X$ assigns a value either 0 or 1 to each member in X .A function $\mu_{\breve{a}}$ such that the value assigned to the element of the universal set X fall within a specified range i.e. $\mu_{\breve{a}}$: X → [0,1] .The assigned value indicates the membership grade of the element in the set A .The function $\mu_{\breve{a}(x)}$ is called the membership function and the set $\hat{A} = \{(x, \mu_{\breve{a}(x)}; x \in X)\}$defined by $\mu_{\breve{a}(x)}$ for each $x \in X$ is called a fuzzy set.

2.2. Triangular fuzzy number (TFNs): A fuzzy number ậ on R is said to be a triangular fuzzy number (TFN) or linear fuzzy number if its membership function ậ : R →[0,1] has the following characteristics

$$\mu_{ậ(x)} = \begin{cases} (x - a_1) / (a_2 - a_1) \text{ if } a_1 \le x \le a_2 \\ (a_3 - x) / (a_3 - a_2) \text{ if } a_2 \le x \le a_3 \\ 0 \quad \text{otherwise} \end{cases}$$

We denote this triangular fuzzy number by ậ = (a_1, a_2, a_3) .We use F(R) to denote the set of all triangular fuzzy numbers.

Also if m = a_2 represents the modal value or midpoint, α = $(a_2 - a_1)$ represents the left spread and β = $(a_3 - a_2)$ represents the right spread of the triangular fuzzy number ậ = (a_1, a_2, a_3), then the triangular fuzzy number ậ can be represented by the triplet ậ = (α, m, β) i.e. ậ = $(a_1, a_2, a_3) = (\alpha, m, \beta)$

2.3. Operations of TFNs: Let $a = [a_1, a_2, a_3]$ and $b = [b_1, _2, b_3]$ be two triangular fuzzy numbers then the arithmetic operations on a and b as follows.

Addition: $a + b = (a_1+b_1, a_2+b_2, a_3+b_3)$

Subtraction: $a - b = (a_1-b_1, a_2-b_2, a_3-b_3)$

Multiplication:

a. $b = \frac{a_1}{3}(b_1+b_2+b_3), \frac{a_2}{3}(b_1+b_2+b_3), \frac{a_3}{3}(b_1+b_2+b_3)$ $if\ R(a) > 0$

$a\ .\ b = \frac{a_3}{3}(b_1+b_2+b_3), \frac{a_2}{3}(b_1+b_2+b_3), \frac{a_1}{3}(b_1+b_2+b_3)$ if $R(a) < 0$

2.4. Defuzzification : Defuzzification is the process of finding singleton value (crisp value) which represents the average value of the TFNs. Here use Yager's ranking and Method of magnitude to defuzzify the TFNs because of its simplicity and accuracy.

2.4.1. Yager's Ranking Technique [10, 12]: Yager's ranking technique which satisfies compensation, linearity, additivity properties and provides results which consists of human intuition. For a convex fuzzy number ã, the Robust's Ranking Index is defined by,

R (ã) $= \int_0^1 (0.5)(a^L{}_\propto, a^U{}_\propto d \propto$ ------------------------ (1)

Where $(a^L{}_\propto, a^U{}_\propto) = \{(b-a) \propto + a, c - (c-b) \propto\}$ which is the α – level cut of the fuzzy number ã

2.4.2 Use of Graded Mean Integration Method for Defuzzification of Different Associated Costs which are Considered Different Fuzzy Numbers

By applying another important method of defuzzification, graded mean integration value of fuzzy numbers we can make study on the same inventory purchasing model whose costs are different fuzzy numbers.

By this method of defuzzification: For triangular fuzzy numbers (TFN),

$\tilde{A} = (a_1, a_2, a_3)$

$P(\tilde{A}) = \frac{1}{6}(a_1 + 4a_2 + a_3)$--------------------------------(2)

3. Mathematical Model:

Manufacturing model with no shortages (Demand Rate uniform, production finite)

It is assumed that run sizes are constant and that a new run will be started whenever Inventory is zero. Let

R = number of items required per unit time
K = number of items produced per unit time
C_1 = cost of holding per item per unit time
C_3= cost of setting up a production run
q= number of items produced per run, q = Rt
t = time interval between runs

Here each production run of length t consists of two parts t_1 and t_2, where (i) t_1 is the time during which the stock is building up at constant rate K- R units per unit time. (ii) t_2 is the time during which there is no production(or supply) and inventory is decreasing at a constant rate R per unit time.

Let I_m be the maximum Inventory available at the end of time t_1 which expected to be consumed during the remaining period t_2 at the demand rate R.

Then $I_m = (K-R)\, t_1$(or)

$$t_1 = \frac{Im}{K-R} \qquad \ldots\ldots\ldots\ldots\ldots(3)$$

Now the total quantity produced during time t_1 is q and quantity consumed during the same period is Rt_1, therefore the remaining quantity available at the end of time t_1 is

$$I_m = q - Rt_1$$

$$= q - \frac{R.Im}{K-R}$$

from (3)

$$\therefore I_m \left(1 + \frac{R}{K-R}\right) = q \text{ (or) } I_m = \frac{K-R}{K} q \qquad \ldots\ldots(4)$$

Now holding cost per production run for time period t $\} = \frac{1}{2} I_m t\, C_1$

And set up cost per production run $= C_3$

$\therefore$ Total average cost per unit time $C(I_m, t) = \frac{1}{2} I_m C_1 + \frac{C3}{t}$

$C(q, t) = \frac{1}{2}\left(\frac{K-R}{K} q\right) C_1 + \frac{C3}{t}$ from (4)

$$C(q) = \frac{1}{2}\left(\frac{K-R}{K} q\right) C_1 + \frac{C3}{\frac{q}{R}}$$

$$= \frac{1}{2}\frac{K-R}{K} C_1 q + \frac{C3R}{q}$$

For minimum value of C(q)

$$\frac{d}{dq}[C(q)] = \frac{1}{2}\frac{K-R}{K} C_1 - \frac{C3R}{q2} = 0$$

Which gives $q = \sqrt{\frac{2C3}{C1}\frac{RK}{K-R}}$

$\therefore$Optimum lot size $q_0 = \sqrt{\frac{K}{K-R}}\sqrt{\frac{2C3R}{C1}}$

$\therefore$Optimum time Interval $t_0 = \frac{q0}{R}$

$$= \sqrt{\frac{K}{K-R}}\sqrt{\frac{2C3R}{C1}}$$

Optimum average cost/unit time

$$C_0 = \frac{1}{2}\frac{K-R}{K} C_1\sqrt{\frac{2C3}{C1}\frac{RK}{K-R}} + C_3\, R\sqrt{\frac{C1(K-R)}{2C3RK}}$$

$$= \sqrt{2C1C3R\frac{K-R}{K}}$$

$$= \sqrt{\frac{K-R}{K}}\sqrt{2C1C3R}$$

Note: (i) If K = R then $C_0 = 0$, (i.e.,) there will be no holding cost and set up cost (ii) if $K = \infty$, (i.e.,) production rate is Infinite, this model reduces to model I.

III. RESULTS AND DISCUSSION

Numerical Example:

An item produced at a rate of (25, 50, 75) items per day. The demand occurs at a rate of (15, 25, 35) items per day. If the setup cost is Rs.(50,100 ,150) per set up cost and holding cost is Rs (0.075,0.01,0.0125) per unit of item per day find the economic lot size for one run, assuming that the shortages are not permitted. Also find the time of cycle and minimum total cost for one run. Deffuzzfying the triangular fuzzy number by using the above two methods by using **Yager's Ranking Technique** (1) and **Graded Mean Integration** (2)

$$R(\tilde{a}) = \int_0^1 (0.5)(a^L{}_\propto, a^U{}_\propto d \propto$$

$$P(\tilde{A}) = \frac{1}{6}(a_1 + 4a_2 + a_3)$$

The above triangular fuzzy numbers are converted into crisp fuzzy numbers. By both the methods of deffuzzification we get the same crisp value Given R=25 items per day

C_1=Rs 0.01 per unit day, C_3 = rs.100 per set up
K=50 items per day.

$$q_0 = \sqrt{\frac{K}{K-R}}\sqrt{\frac{2C_3R}{C_1}} = \sqrt{\frac{2X100X25}{0.01}}\sqrt{\frac{50}{25}} = 1000 \text{ items}$$

$$t_0 = \frac{q_0}{R} = \frac{1000}{25} = 40 \text{ days}$$

Minimum Daily cost $= \sqrt{2C_1C_2R}\sqrt{\frac{K-R}{K}} =$

$\sqrt{2x0.01x100x25x\frac{25}{50}}$ = Rs.5

Minimum total cost = 5x40 =Rs. 200

IV. CONCLUSION

An inventory model with no shortages under fuzzy environment is considered and two different methods of deffuziffication are applied for triangular fuzzy numbers. By comparing with the numerical example, we can conclude that by both the methods we obtain only the same crisp values. We derive at the economic lot size, time of cycle and the optimum cost. We can apply this method with various types of fuzzy numbers and different cases of inventory.

V. REFERENCES

[1] Buchanan, J. T "Alternative solution methods for inventory replenishment problem under increasing demand," Journal of Operational Research Society. 31: 615-620. (1980),

[2] Chandrasiri A. M. P.",Fuzzy Inventory Model without Shortages Using Signed Distance Method", International Journal of Science and Research (IJSR),Volume 5 Issue 7, July (2016)

[3] Chang. S. C., "Fuzzy production inventory for fuzzy product quantity with triangular fuzzy number", Fuzzy Sets and Systems, 107,37–57. (1999).

[4] Dey, P.K., Rawat A," A fuzzy inventory model without shortages using triangular fuzzy number".Fuzzy Information and Engineering 1:59-68. (2011).

[5] Donalson, W.A. "Inventory Replenishment policy for linear trending demand, an analytical solution". Operation research quarterly 28:663-670(1977).

[6] Dutta, D. and Kumar, P. "Fuzzy inventory model without shortage using Trapezoidal Fuzzy number with sensitivity Analysis ".IOSR Journal of Mathematics 4:32-37,(2012).

[7] Goyal S. K ,"On improving replenishment policies for linear trend demand,". Engineering costs and production Economics 10:73-76. (1985).

[8] Goyal, S. K., Kusy, M. and Soni, R. ,"A note on economic order interval for an item with linear trend demand". Engineering costs & Production economics 10: 253-255. (1986).

[9] Hariga, M.." Optimal EOQ models for deteriorating items with time-varying demand". Journal of the operational Research Society 47:1228-1246. (1996)

[10] Harris, F.W. "Operations and Cost Factory Fuzzy Numbers," Management Series. USA: A.W. Shaw Co(1915)..

[11] Kacpryzk. J and Staniewski.P, "Long-term inventory policy-making through fuzzydecision making models", Fuzzy Sets and Systems, vol. 8, (1982), pp. 117–132

[12] Nabendu Sen, Sanjukta Malakar ,"A Fuzzy Inventory Model with Shortages Using Different Fuzzy Numbers", American Journal of Mathematics and Statistics, 5(5): 238-248, 2015

[13] Ranganathan. V, Thirunavukarasu.P, "An Inventory control model for constant deterioration in Fuzzy environment", International Journal of Fuzzy Mathematics and Systems.,ISSN 2248-9940 Volume 4, Number 1 (2014), pp. 17–26

[14] Sarkar, B., and Sana, S."A finite replenishment model with increase in demand under inflation",. Int, J. Mathematics in Operation research 2(3): 347-385. . (2010).

[15] Yager. R. R, "Ranking fuzzy subsets over the unit interval," in Proceedings of the IEEE Conference on Decision and Control (CDC ’78), pp. 1435–1437, Albuquerque, NM, USA, August (1978).