A finite planning horizon fuzzy inventory modelusing hexagonal fuzzy number

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Abstract

An inventory model allowing deterioration, shortages and backlogging as fuzzy parameters is discussed. It is a finite planning horizon model where the cycle lengths are not fixed. All the parameters except time are considered to be Hexagonal fuzzy number. The model is defuzzyfied using signed distance method.

Keywords: *Finite planning horizon, Hexagonal fuzzy number, Credit period rate*

1. Introduction

[12] has introduced about fuzzy sets and their operations in the year 1965. [3] wrote a book on fuzzy arithmetic in their book in 1991. Initially [5] along with triangular, trapezoidal discussed pentagonal fuzzy number for their fuzzy operations and fuzzy Matrix properties.

Considering hexagonal fuzzy number for cost parameters minimum total cost was derived by [1]. [1] defuzzyfied the model using Mean Deviation method. [2] also discussed an inventory model along with shortages and fully backlogging items taking parameters as hexagonal fuzzy number.

[2, 14] defuzzyfied the model with signed distance method. [6] with fixed cycle length discussed an inventory model taking parameters as pentagonal and hexagonal fuzzy number and defuzzyfied using method as signed distance method and graded mean integration representation.

Here we are discussing a fuzzy inventory model with deterioration, time quadratic demand including shortage, lost sales in a finite planning horizon with different cycle length, with credit period rate considering hexagonal fuzzy number as parameters, defuzzyfied with signed distance method.

In this paper section 2 contains assumptions and notations. In section 3 we have discussed model formulation and findings. In section number 4 a formulated example is studied and discussed. And the proposed model is concluded in the last section 5.

2. Assumptions and notations

Here the extension of model given by [7] is discussed. The model given by [7] is considered to be fuzzy. All the variables for retailer such as holding cost hr, a, b, c for time dependent quadratic demand $f(t) = a + bt + ct^2$, shortage cost S, cost of lost sale l, deterioration constant, are considered to be hexagonal fuzzy number.

Also, for supplier purchase cost W is considered to be hexagonal fuzzy number. Except time variable, the total cost is fuzzified. All the variables are considered to be hexagonal fuzzy number.

The total cost is then defuzzyfiedusing signed distance method as given by [4].

3. Proposed model

The model is same as [7] except that all the parameters are considered to be hexagonal fuzzy number.

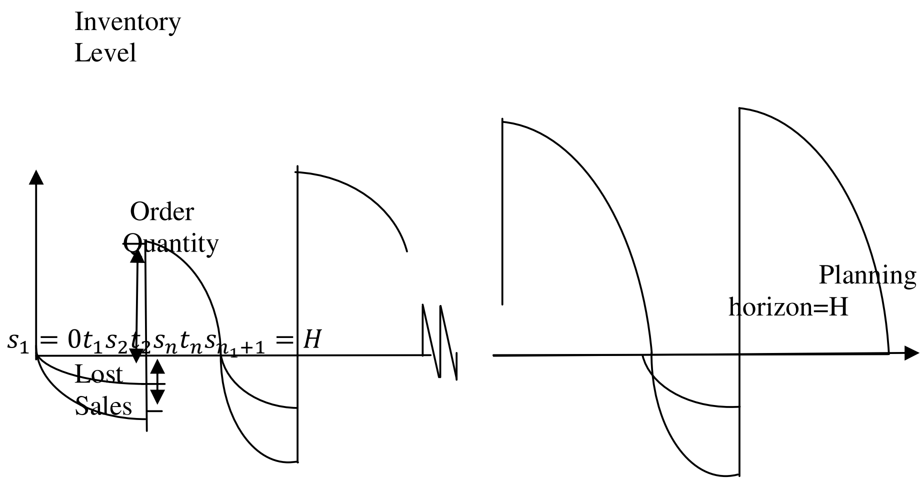

Figure 1. Display of proposed model

4. Discussion on some parameter values

Here we have discussed about hexagonal tuples for each cost related variable. The problem is solved by taking the following hexagonal tuple values.

h_{r1}=2.8, h_{r2}=2.9, h_{r3}=3., h_{r4}=3., h_{r5}=3.1, h_{r6}=3.2, b_1=4.8, b_2=4.9, b_3=5, b_4=5, b_5=5.1, b_6=5.2, W_1=0.28, W_2=0.29, W_3=0.3, W_4=0.3, W_5=0.31, W_6=0.32, a_1=6.8, a_2=6.9, a_3=7, a_4=7, a_5=7.1, a_6=7.2, l_1=11.5, l_2=11.75, l_3=12, l_4=12, l_5=12.25, l_6=12.5, α_1=0.001, α_2=0.0015, α_3=0.002, α_4=0.002, α_5=0.0025, α_6=0.003, δ_1=5.8, δ_2=5.9, δ_3=6, δ_4=6, δ_5=6.1, δ_6=6.2,S_1=1.8, S_2=1.9, S_3=2, S_4=2, S_5=2.1, S_6=2.2,θ_1=0.18, θ_2=0.19, θ_3=0.2, θ_4=0.2, θ_5=0.21, θ_6=0.22,c_1=0.98, c_2=0.99, c_3=1, c_4=1, c_5=1.01, c_6=1.02, $\mathrm{Cs}_1 = 0.28$, $\mathrm{Cs}_2 = 0.29, \mathrm{Cs}_3 = 0.3, \mathrm{Cs}_4 = 0.3, \mathrm{Cs}_5 = 0.31, \mathrm{Cs}_6 = 0.32, \mathrm{Ss}_1 = 116, \mathrm{Ss}_2 = 118, \mathrm{Ss}_3 = 120, \mathrm{Ss}_4 = 120, \mathrm{Ss}_5 = 122, \mathrm{Ss}_6 = 124, \mathrm{hc}_1 = 0.94, \mathrm{hc}_2 = 0.95$, $\mathrm{hc}_3 = 0.96, \mathrm{hc}_4 = 0.96, \mathrm{hc}_5 = 0.97, \mathrm{hc}_6 = 0.98, \mathrm{Sr}_1 = 36, \mathrm{Sr}_2 = 48, \mathrm{Sr}_3 = 40, \mathrm{Sr}_4 = 40, \mathrm{Sr}_5 = 42, \mathrm{Sr}_6 = 44, H = 4$.

Table 1 displays the total cost of retailer for the different number of cycles starting from 1 to 7. The most economic or optimal cost of retailer is shown by keeping the value bold at four number of cycles. For a finite planning horizon model, the optimal replenishment time for a retailer corresponding to 4 cycles is shown in 2. Beginning of shortage in each such cycle is given in table 3. For supplier the defuzzyfied total cost using signed distance method for different number of cycles in a planning horizon is given in table 4. The optimal cost as shown in table 4 is for a planning horizon with 2 cycles. Figure 2 shows the convex graph for retailer's cost.

Figure 3 shows the convex graph of supplier corresponding to number of cycles. The optimal replenishment time for a centralized case corresponding to table 4 is shown in table 5 and table 6. In table 7 for five different values of calculated credit period rate and corresponding profit percentage of retailer and supplier are displayed.

Table 1. Retailers total cost

				$\widetilde{TC}_r^d$			
↓ $\rightarrow n_1$ $\widetilde{hc}$	1	2	3	4	5	6	7
0. 96	54 8.05	38 6.98	32 9.60	**31 8.51**	32 9.24	35 1.02	37 9.00

Table 2. t_i^s

$\boldsymbol{t_1}$	$\boldsymbol{t_2}$	$\boldsymbol{t_3}$	$\boldsymbol{t_4}$
0.1 84	1.4 2	2.4 2	3.2 8

Table 3. s_i^s

$\boldsymbol{s_1}$	$\boldsymbol{s_2}$	$\boldsymbol{s_3}$	$\boldsymbol{s_4}$	$\boldsymbol{s_5}$
	.34	.36	.23	.0

Table 4. Suppliers total cost

				$\widetilde{TC}_s^d$			
↓ $\rightarrow n_2$ $\widetilde{hc}$	1	2	3	4	5	6	7
0. 96	370.43	**32 8.14**	38 6.83	49 2.24	62 0.55	76 0.66	90 7.45

Table 5. t_i^s

$\boldsymbol{t_1}$	$\boldsymbol{t_2}$	$\boldsymbol{t_3}$	$\boldsymbol{t_4}$
.18	.42	.42	.28

Table 6. s_i^s

s_1	s_2	s_3	s_4	s_5
	.34	.36	.23	.0

Table 7a. Table for five different values of $\tilde{h}_c$

$\tilde{h}_c$	$\widetilde{TC}_r^{do}$	$\widetilde{TC}_s^{do}$	$\tilde{n}_2^{do}$	$\widetilde{Q^{do}}$	$\tilde{\lambda}_{min.}$	$\tilde{\lambda}_{max.}$	$\tilde{\lambda}_{avg.}$
.96	3 18.51	4 92.23	4	4 0.73	0.5 62198	1. 91659	1.2 394
.08	3 18.51	4 92.23	4	4 0.73	0.4 97762	1. 69631	1.0 9704
.32	3 18.51	4 92.23	4	4 0.73	0.4 05254	1. 38034	0.8 92796
.44	3 18.51	4 92.23	4	4 0.73	0.3 70886	1. 26303	0.8 16958
.2	3 18.51	4 92.23	4	4 0.73	0.4 46719	1. 52193	0.9 84322

Table 7b. Table for five different values of $\tilde{h}_c$

$\tilde{h}_c$	$\widetilde{TC}_r^{co}$	$\widetilde{TC}_s^{co}$	$\tilde{n}_2^{do}$	$\widetilde{Q^{do}}$	% change of ret. total cost	% change of sup. total cost
.96	2 32.369	4 14.264	2	6 5.45	27. 0456	15. 8391
.08	2 33.077	4 13.556	2	6 5.45	26. 8233	15. 9829
.32	2 33.976	4 12.657	2	6 5.45	26. 541	16. 1657
.44	2 34.275	4 12.358	2	6 5.45	26. 4471	16. 2264
.2	2 33.59	4 13.043	2	6 5.45	26. 6622	16. 0872

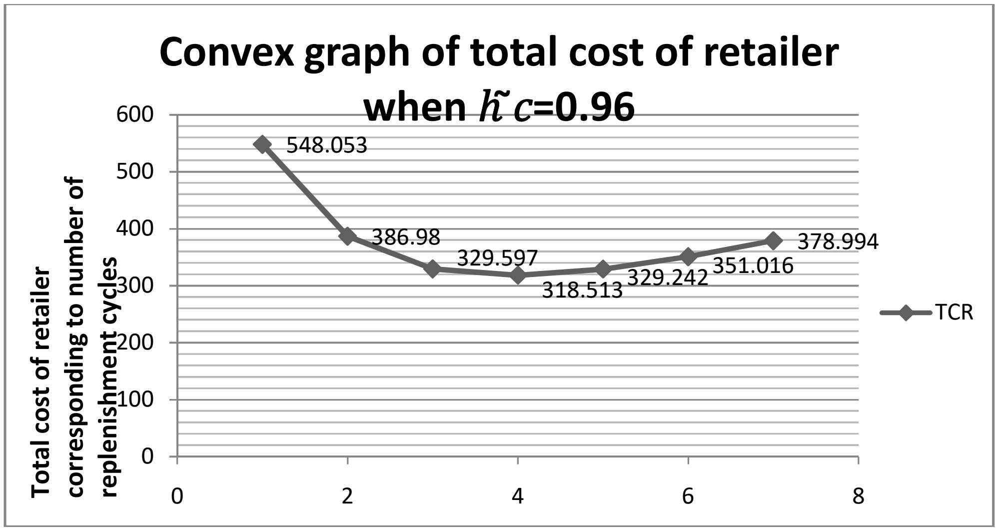

Figure 2. Graphical representation for total cost of retailer when $\tilde{h}_c = 0.96$

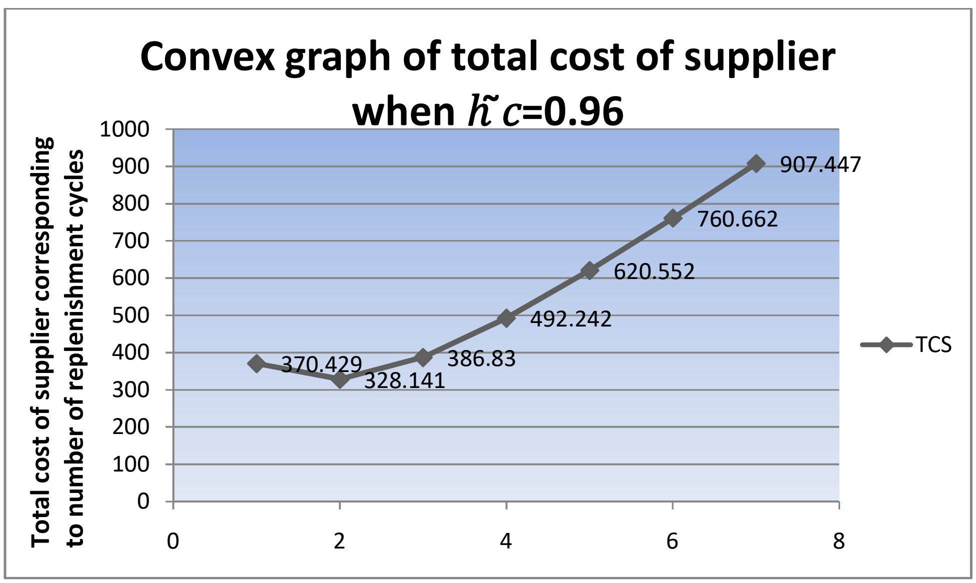

Figure 3. Graphical representationfor total cost of supplier when $\tilde{h}_c$

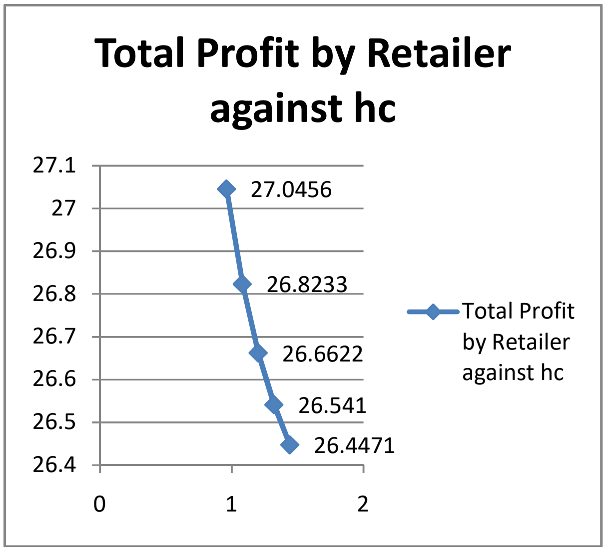

Figure 4. Final retailer's exact profit.

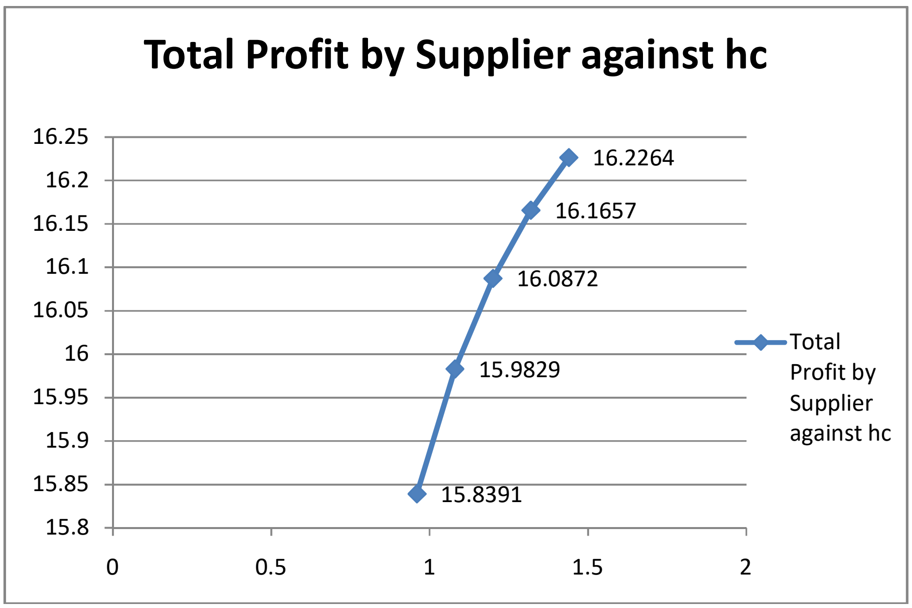

Figure 5. Final supplier's exact profit.

5. Conclusion

Profit percent after profit sharing amongst the key players that is retailer and supplier is obtained

when the model is centralized and is shown in table 7. On comparing the result with [7] it has been observed that there is a change in profit percentage gained by both the players. This clearly indicates that without considering fuzziness the result thus obtained for the model is incomplete. There are two graphs shown in figure 4 and 5 which represents that there is a rise in profit percentage for supplier if the value of hc increases, but is opposite in the case of retailer.

That is profit percentage decreases if the value of hc increases. Extension of the proposed model in the direction or introducinginflationwhich was dealt by [8, 9, 10, 13, 16]. Also,authors can discuss and extend the proposed model by introducing remanufacturing as discussed by [11,15].

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