An inventory model using trapezoidal fuzzy number

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Abstract

An inventory model is fuzzyfied by assuming trapezoidal fuzzy number. The present model is having quadratic demand in a planning horizon which is finite. The model is returned to crisp model using signed distance method. One example is solved to identify the conclusion.
Keywords: Inventory, trapezoidal fuzzy number, Finite Planning Horizon.**.**

1. Introduction

For some conditions which abrupt the certainty of an inventory model cannot be neglected, rather giving due weightage by taking the parameters as trapezoidal fuzzy numbers can suffice the requirement. Fuzzy set was introduced in 1965 by [13]. [3] can be referred for the concept of fuzzy arithmetic. Presented a paper with inventory model without shortages using trapezoidal fuzzy number by [2]. [2] used signed distance method as well as Graded mean integration method for defuzziffication. [1] formulated the infinite production fuzzy inventory model for time-deteriorating products. [1] studied their model taking setup cost, holding cost and demand as fuzzy numbers.

We have discussed an inventory model considering lost sale due to shortage with all parameters as trapezoidal fuzzy number.
Segment 2 is for presumptions. Segment 3 is for formulation and solution of model. In segment 4 a numerical example with its solution is given. Conclusion of the present model has been discussed in the segment 5.

2. Presumptions

This is a further study on model given [8]. Here all the variables are taken as trapezoidal fuzzy number and the defuzzified using signed distance method. Parameter related to supplier are also taken as trapezoidal fuzzy number. Thus we can say that total cost is now fuzzy in which parameters are trapezoidal fuzzy number.

3. Proposed model

As already mentioned we have proposed trapezoidal fuzzy number for the existing [8] model. As given in [1] the defuzzyfication can be done both by signed distance method and Graded mean integration method we have opted for signed distance method.

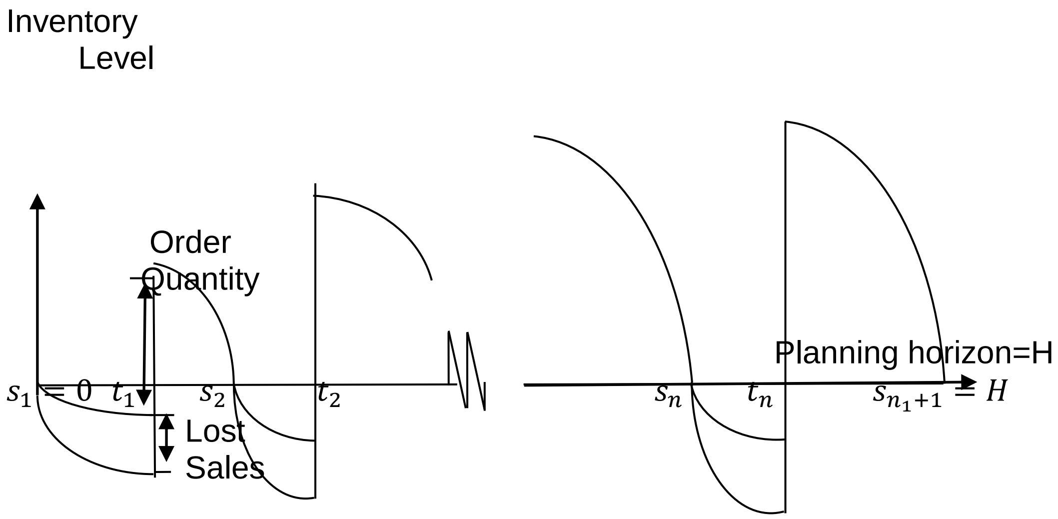

Figure 1. Graphical representation of Inventory Model

4. Numerical Example

For each parameter the value for trapezoidal tuplets are as follows:- $\mathrm{hr}_1 = 2.8, \mathrm{hr}_2 = 2.9, \mathrm{hr}_3 = 3.1, \mathrm{hr}_4 = 3.2, a_1 = 7 - 0.2, a_2 = 7 - 0.1, a_3 = 7 + 0.1, a_4 = 7 + 0.2, b_1 = 4.8, b_2 = 4.9, b_3 = 5.1, b_4 = 5.2, c_1 = 0.98, c_2 = 0.99, c_3 = 1.01, c_4 = 1.02, W_1 = 0.28, W_2 = 0.29, W_3 = 0.31, W_4 = 0.32, S_1 = 2 - 0.2, S_2 = 2 - 0.1, S_3 = 2 + 0.1, S_4 = 2 + 0.2, l_1 = 11.5, l_2 = 11.75, l_3 = 12.25, l_4 = 12.5, \alpha_1 = 0.001, \alpha_2 = 0.0015, \alpha_3 = 0.0025, \alpha_4 = 0.003, \delta_1 = 5.8, \delta_2 = 5.9, \delta_3 = 6.1, \delta_4 = 6.2, \theta_1 = 0.18, \theta_2 = 0.19, \theta_3 = 0.21, \theta_4 = 0.22.$

Table 1 displays optimal total cost of retailer when every variable is trapezoidal fuzzy number and the model is solved using method. The optimal cost is obtained when the retailer will opt for 4 cycles. In Table 2 and 3 it is shown in bold font the time period of replenishment and shortage start time in a cycle.

Table 1. Retailers total cost

	TC_r^{ind}				
$\downarrow$ $\rightarrow$ n_1 $\tilde{\alpha}$	1	2	3	4	5
0.002	546.015	382.334	322.328	**308.653**	316.82

Table 2. Time period of replenishment

No. of cycles	t_1	t_2	t_3	t_4	t_5	t_6	t_7

1	2.1982						
2	0.957162	2.72741					
3	0.384274	1.89177	3.06769				
4	**0.191333**	**1.44562**	**2.44179**	**3.2909**			
5	0.120794	1.18088	2.03918	2.77749	3.43442		
6	0.0871077	1.00307	1.75736	2.41183	2.99718	3.53118	
7	0.067804	0.874062	1.54772	2.13682	2.66627	3.15085	3.60016

Table 3. Commencement of shortage

No. of cycles	s_1	s_2	s_3	s_4	s_5	s_6	s_7	s_8
1	0	4.						
2	0	2.56186	4.					
3	0	1.77028	2.98741	4.				
4	**0**	**1.35691**	**2.3793**	**3.24094**	**4.**			
5	0	1.11254	1.98855	2.73607	3.39876	4.		
6	0	0.947738	1.71481	2.37637	2.96632	3.50358	4.	
7	0	0.82761	1.51097	2.10574	2.63898	3.1263	3.57769	4.

Suppliers total optimal cost is obtained for 2 number of cycles as shown in Table 4. In Table 5 and 6 it is shown in bold font the time period of replenishment and shortage start time in a cycle when supplier takes over. Table 7a, 7b, 7c and 7c is same as table in [8].

Table 4. Suppliers total cost

	$\widetilde{TC}_s^d$			
$\downarrow$ $\rightarrow$ n_1 $\tilde{a}$	1	2	3	4
0.96	378.268	**333.32**	389.386	492.222

Table 5. Time period of replenishment

No. of cycles	t_1	t_2	t_3	t_4	t_5	t_6	t_7
1	2.1982						
2	0.957162	2.72741					
3	0.384274	1.89177	3.06769				
4	0.191333	1.44562	2.44179	3.2909			
5	0.120794	1.18088	2.03918	2.77749	3.43442		
6	0.0871077	1.00307	1.75736	2.41183	2.99718	3.53118	
7	0.067804	0.874062	1.54772	2.13682	2.66627	3.15085	3.60016

Table 6. Commencement of shortage

No. of cycles	t_1	t_2	t_3	t_4	t_5	t_6	t_7
1	2.1982						
2	0.957162	2.72741					

3	0.384274	1.89177	3.06769				
4	0.191333	1.44562	2.44179	3.2909			
5	0.120794	1.18088	2.03918	2.77749	3.43442		
6	0.0871077	1.00307	1.75736	2.41183	2.99718	3.53118	
7	0.067804	0.874062	1.54772	2.13682	2.66627	3.15085	3.60016

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

$\tilde{\alpha}$	$\widetilde{TC}_r^{do}$	$\widetilde{TC}_s^{do}$	$\tilde{n}_2^{do}$	$\widetilde{Q}^{do}$
0.0016	308.653	492.222	4	40.6747
0.0018	308.676	492.223	4	40.6776
0.0022	308.721	492.225	4	40.6836
0.0024	308.744	492.226	4	40.6866
0.002	308.698	492.224	4	40.6806

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

$\tilde{\alpha}$	Min Credit period rate	Max Credit period rate	Average Credit period rate
0.0016	0.4833	1.53321	1.00825
0.0018	0.483542	1.53322	1.00838
0.0022	0.484026	1.53325	1.00864
0.0024	0.484268	1.53327	1.00877
0.002	0.483784	1.53324	1.00851

Table 7c. Table for five different values of $\tilde{\alpha}$

$\tilde{\alpha}$	$\widetilde{TC}_r^{co}$	$\widetilde{TC}_s^{co}$	$\tilde{n}_2^{do}$	$\widetilde{Q}^{do}$	% change of ret. total cost	% change of sup. total cost
0.0016	224.873	417.065	2	65.3463	27.1436	15.269
0.0018	224.913	417.084	2	65.345	27.136	15.2653
0.0022	224.994	417.121	2	65.3424	27.1208	15.2579
0.0024	225.034	417.14	2	65.3411	27.1131	15.2543
0.002	224.954	417.103	2	65.3437	27.1284	15.2616

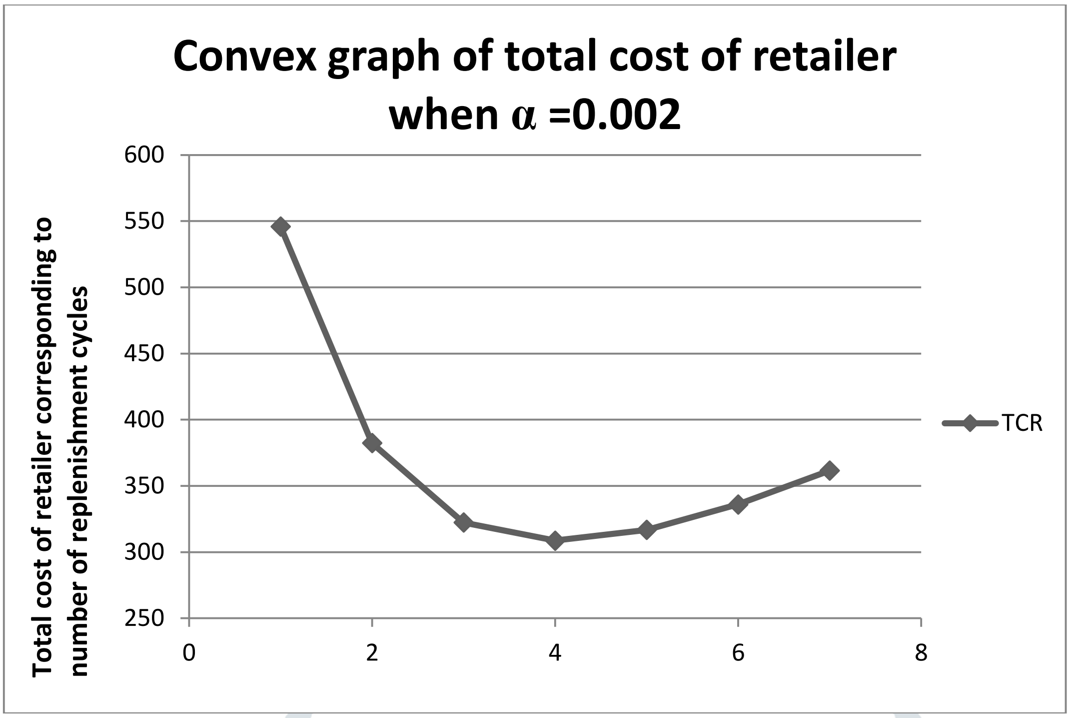

Figure 2. Convex graph for total cost of retailer when $\tilde{\alpha} = 1510$

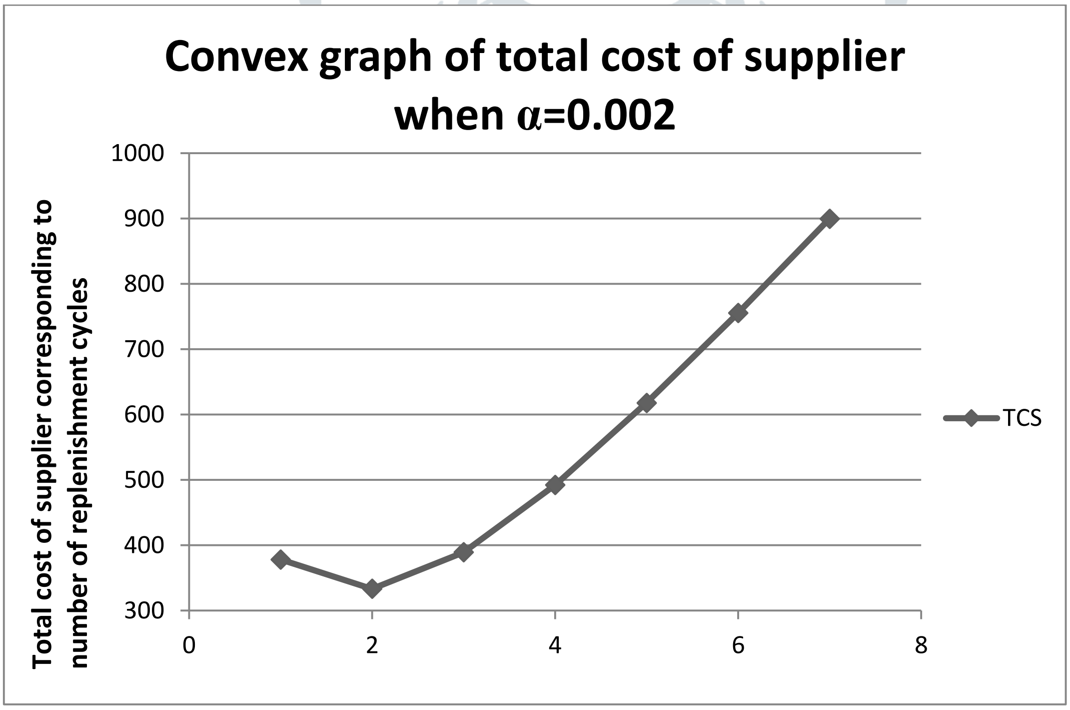

Figure 3. Convex graph for total cost of supplier when $\tilde{\alpha} = 1510$

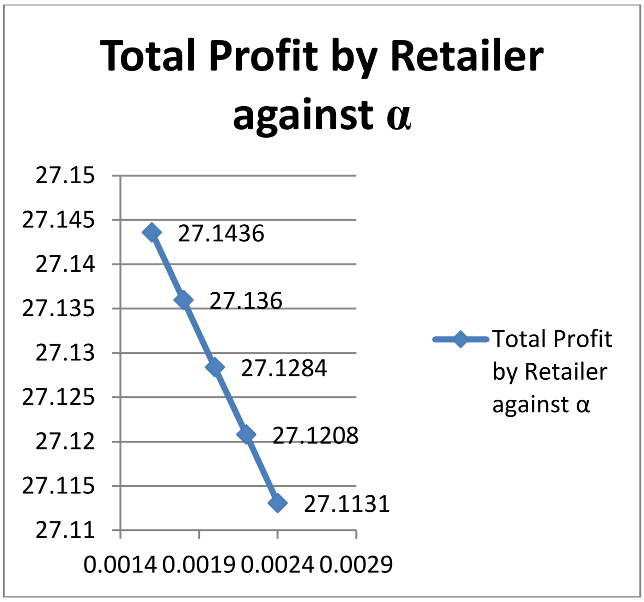

Figure 4. Total profit by retailer

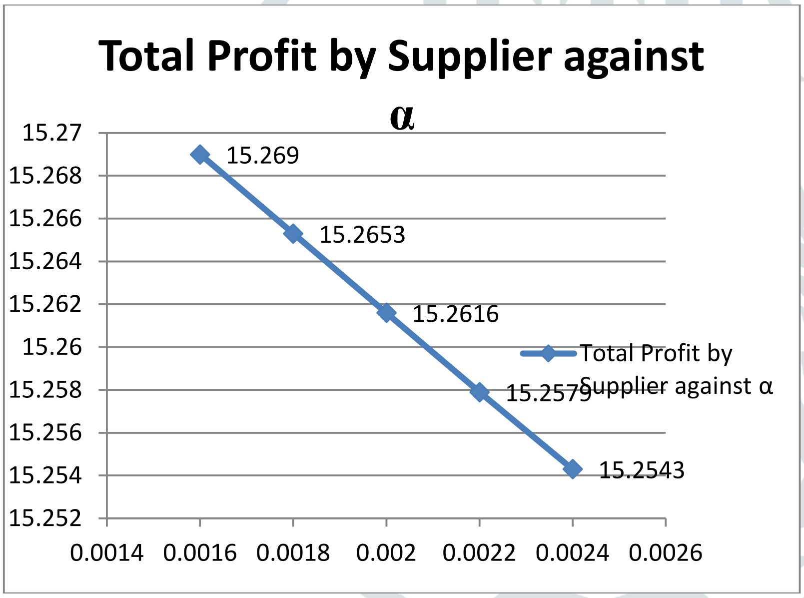

Figure 5. Total profit by retailer

5. Conclusion

The convexity graph of retailer and supplier is shown in Figure 2 and 3. Also it is concluded from figure 4 and 5 that total profit percent decreases with increase in $\tilde{\alpha}$. The model discretely puts stress on the importance of considering fuzzyness in the inventory theory. The numerical example is illustrated for the validation of this fuzzy model. The present model can be extended considering ination such as in [12, 11, 7, 6, 11] or by greening of the model as in [9, 5, 10] or further fuzzyfication by [4].

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