An inventory model using trapezoidal fuzzy number defuzzyfied with graded mean integration method

Sanjay Mishra (1), Nitin Kumar Mishra*(2), Vikramjeet Singh(3), Pushpinder Singh(4), Seema Saxena(5)

1,2,5Department of Mathematics, Lovely Professional University, Phagwara , Punjab(India) 144411.
3Department of Mathematics, IKGPTU Campus, Batala, Punjab(India) 143506.

4Department of civil engineering University of windsor, Windsor, Canada.

Abstract

The inventory model with trapezoidal fuzzy number has been studied. The model is an extended model. Shortage and backlog is taken into account. This model is defuzzyfied with graded mean integration method.

Keywords: Fuzzy, Trapezoidal fuzzy number, Graded mean integration method.

1. Introduction

The 1965 paper suggested fuzzy set which was authored by [16] and for fuzzy arithmetic concept [4] has presented a paper. Optimal policy for deteriorating items with trapezoidal fuzzy demand and partial backlogging was given by [2]. Also, trapezoidal demand rate was considered by [6]. An inventory model with trapezoidal demand was discussed by [15]. [3] established an inventory model using trapezoidal fuzzy number. [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.

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

Here in this paper we have discussed the extension of [10]. Solution to [10] is established considering each parameter as trapezoidal fuzzy number and have used Graded mean integration method for defuzzification.

3. Proposed model

As mentioned in 2 we propose trapezoidal fuzzy number for the existing [10] model. Following [1] the defuzzyfication is done by Graded mean integration method.

Inventory

Level

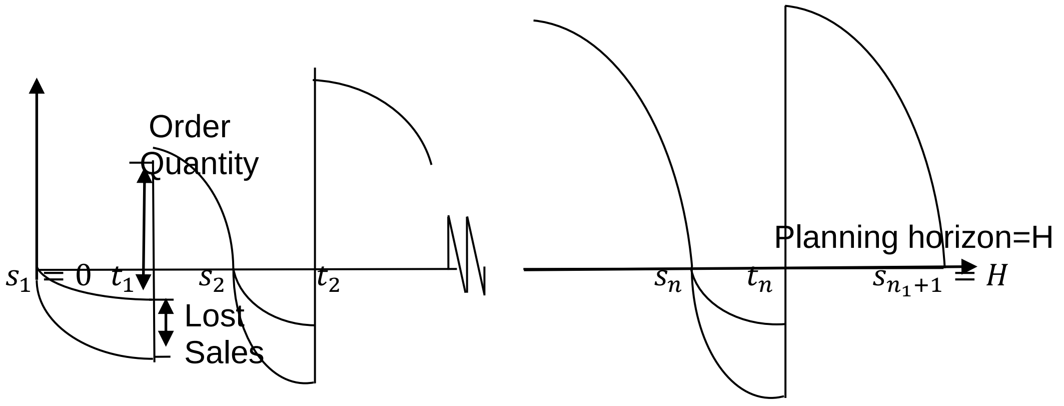

Figure 1. Graphical representation of Inventory Model

4. Numerical Example

For each parameter the value for trapezoidal tuplets are as follows:- $\mathrm{Sr}_1 = 36, \mathrm{Sr}_2 = 38, \mathrm{Sr}_3 = 42, \mathrm{Sr}_4 = 44, \mathrm{Ss}_1 = 116, \mathrm{Ss}_2 = 118, \mathrm{Ss}_3 = 122, \mathrm{Ss}_4 = 124, H = 4, \mathrm{Cs}_1 = 0.28, \mathrm{Cs}_2 = 0.29, \mathrm{Cs}_3 = 0.31, \mathrm{Cs}_4 = 0.32, \mathrm{hc}_1 = 1, \mathrm{hc}_2 = 1.15, \mathrm{hc}_3 = 1.25, \mathrm{hc}_4 = 1.4, \mathrm{hr}_1 = 2.8, \mathrm{hr}_2 = 2.9, \mathrm{hr}_3 = 3.1, \mathrm{hr}_4 = 3.2, a_1 = 7 - 0.2, a_2 = 7 - 0.1, a_3 = 7 + 0.1, a_4 = 7 + 0.2, b_1 = 4.8, b_2 = 4.9, b_3 = 5.1, b_4 = 5.2, c_1 = 0.98, c_2 = 0.99, c_3 = 1.01, c_4 = 1.02, W_1 = 0.28, W_2 = 0.29, W_3 = 0.31, W_4 = 0.32, S_1 = 2 - 0.2, S_2 = 2 - 0.1, S_3 = 2 + 0.1, S_4 = 2 + 0.2, l_1 = 11.5, l_2 = 11.75, l_3 = 12.25, l_4 = 12.5, \alpha_1 = 0.001, \alpha_2 = 0.0015, \alpha_3 = 0.0025, \alpha_4 = 0.003, \delta_1 = 5.8, \delta_2 = 5.9, \delta_3 = 6.1, \delta_4 = 6.2, \theta_1 = 0.18, \theta_2 = 0.19, \theta_3 = 0.21, \theta_4 = 0.22$

Table 1 confirms optimal total cost of retailer when all the parameters are trapezoidal fuzzy number. The present model is solved using Graded mean integration method. The optimal cost is reached for 4 cycles by the retailer. In Table 2 and 3 this is shown in bold font the time of replenishment and shortage commencment in each cycle.

Table 1. Retailers total cost

	TC_r^{ind}				
$\downarrow$ $\rightarrow$ n_1 $\tilde{\alpha}$	1	2	3	4	5
0.002	545.971	382.313	322.31	**308.635**	316.803

Table 2. Time period of replenishment

No. of cycles	t_1	t_2	t_3	t_4	t_5	t_6	t_7
1	2.19788						

2	0.956851	2.7273					
3	0.384126	1.8917	3.06766				
4	**0.191287**	**1.44561**	**2.44179**	**3.2909**			
5	0.120778	1.18088	2.03919	2.7775	3.43443		
6	0.0871021	1.00308	1.75737	2.41184	2.99719	3.53119	
7	0.0678026	0.874069	1.54773	2.13683	2.66628	3.15086	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	2.56176	3.99999					
3	0	1.77022	2.98739	4.				
4	**0**	**1.3569**	**2.3793**	**3.24094**	**4.**			
5	0	1.11254	1.98856	2.73608	3.39877	4.		
6	0	0.947743	1.71482	2.37638	2.96633	3.50359	4.	
7	0	0.827616	1.51098	2.10575	2.63899	3.1263	3.57769	4.

Suppliers total optimal cost is for two 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 it is a centralized case. Table 7a, 7b, 7c and 7c are constructed on the same lines as done in [10].

Table 4. Suppliers total cost

	$\widetilde{TC}_s^d$			
$\downarrow$ $\rightarrow$ n_1 $\tilde{\alpha}$	1	2	3	4
0.002	378.249	**333.32**	389.386	492.221

Table 5. Time period of replenishment

No. of cycles	t_1	t_2	t_3	t_4	t_5	t_6	t_7
1	2.19788						
2	**0.956851**	**2.7273**					
3	0.384126	1.8917	3.06766				
4	0.191287	1.44561	2.44179	3.2909			
5	0.120778	1.18088	2.03919	2.7775	3.43443		
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Table 6. 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**	**2.56176**	**3.99999**					
3	0	1.77022	2.98739	4.				
4	0	1.3569	2.3793	3.24094	4.			
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6	0	0.947743	1.71482	2.37638	2.96633	3.50359	4.	
7	0	0.827616	1.51098	2.10575	2.63899	3.1263	3.57769	4.

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	308.635	492.221	4	40.6843
0.0018	308.658	492.222	4	40.6873
0.0022	308.703	492.224	4	40.6933
0.0024	308.726	492.225	4	40.6963
0.002	308.681	492.223	4	40.6903

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	0.480323	1.52199	1.00116
0.0018	0.480564	1.522	1.00128
0.0022	0.481045	1.52203	1.00154
0.0024	0.481286	1.52205	1.00167
0.002	0.480805	1.52202	1.00141

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	226.034	415.894	2	65.3798	26.7635	15.5067
0.0018	226.074	415.912	2	65.3784	26.7559	15.5031
0.0022	226.154	415.95	2	65.3758	26.7407	15.4958
0.0024	226.194	415.969	2	65.3745	26.733	15.4921
0.002	226.114	415.931	2	65.3771	26.7483	15.4994

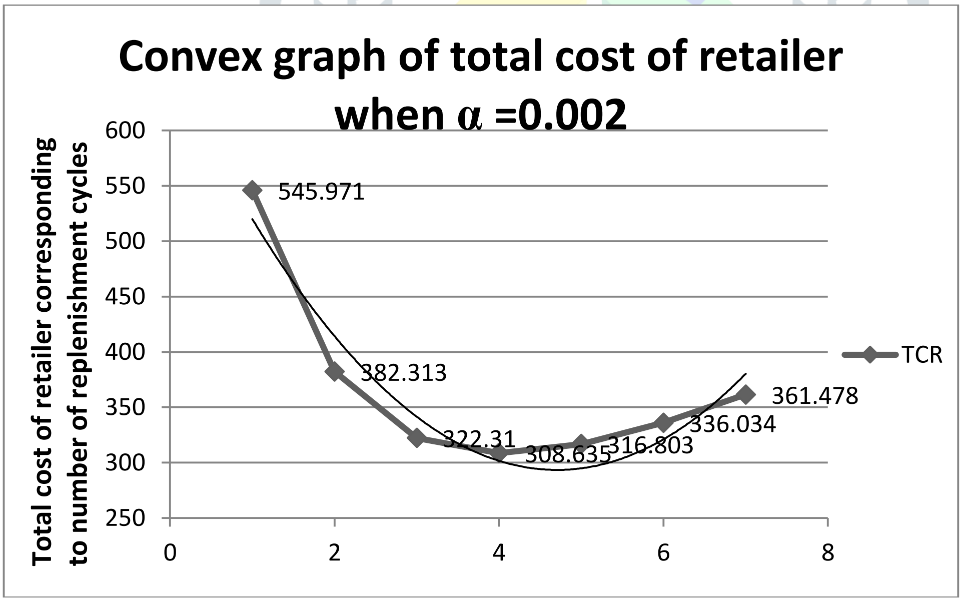

Figure 2. Convex graph for total cost of retailer when $\tilde{\alpha} = 1510$

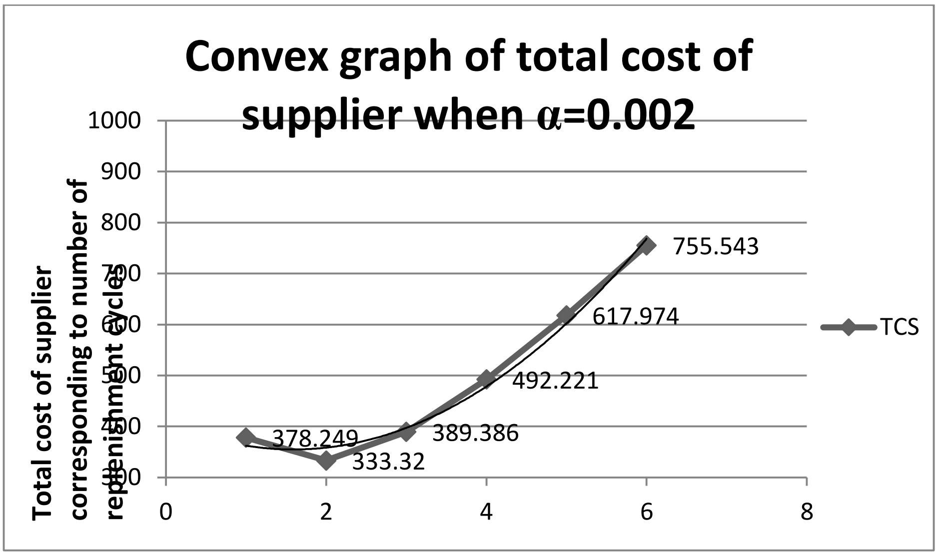

Figure 3. Convex graph for total cost of supplier when $\tilde{\alpha} = 0.002$

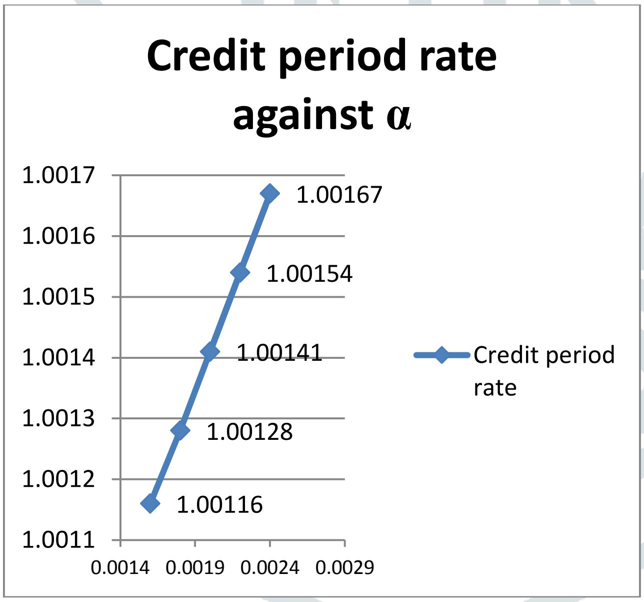

Figure 4. Credit period rate against $\tilde{\alpha}$

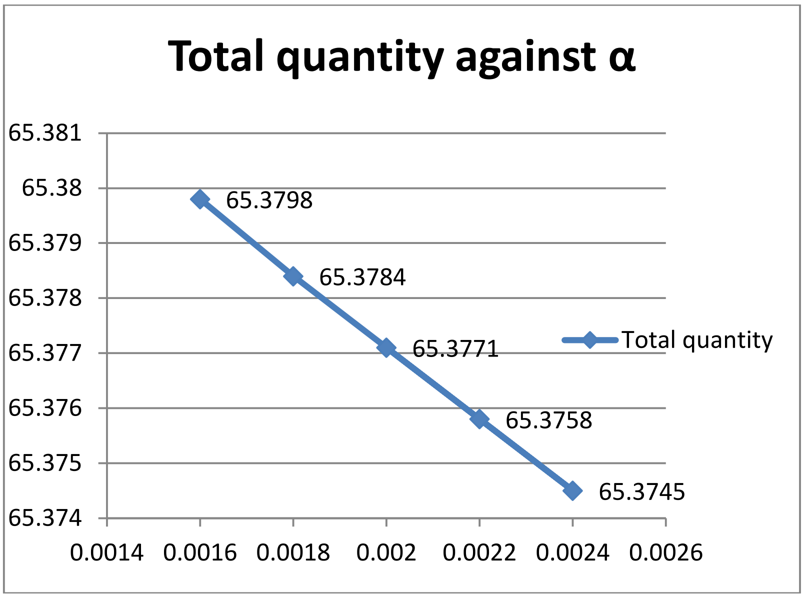

Figure 5. Total quantity against $\tilde{\alpha}$

5. Conclusion

The total cost is a convex graph as shown in Figure 2 and 3. From figure 4 we see that credit period rate increases with $\tilde{\alpha}$. From figure 5 we see that the total quantity to be ordered decreases with $\tilde{\alpha}$. Same numerical example as in [10] but with fuzzy values is solved here. The present model can be further studied for ination such as in [14, 13, 9, 8, 13] or greening can be introduced as in [11, 7, 12] or further analysis with fuzzyfication can be done as in [5].

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