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A fuzzy inventory model with adequate shortage using graded mean integral value method

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ABSTRACT

Uncertainty is prompted by fuzziness in many inventory models, and fuzziness is the closest potential strategy to reality. We suggested a hazy inventory system with an adequate shortage that is a complete backlog in this paper. To calculate the fuzzy total cost, we have a hazy understanding of carrying costs, backorder costs and inventory costs using Fuzzy triangular numbers. The goal of this research is to use the Graded Maximum Integration Value Method to defuzzify the actual profit function. A mathematical formulation is also provided to show the difference between crisp and fuzzy modeling that have been built.

Keywords: Shortages, Inventory model, Triangular fuzzy number, EOQ.

1. Introduction

Inventory management system describes the amount of any material or item used in a business. An inventory control system is a systematic methodology that monitor inventory levels and determines what levels should be sustained, when they should be replaced, and how large orders should be. The most basic categories of manufacturing inventory are materials, finished inventory, components items, supplies, and work-in-progress. There are numerous other reasons for inventories. Answering two questions is extensively related with the topic of inventory control. When should you place your order? How much should you order? Stock control is the act of finding the best quantity and quality of items availability when and where they're needed while maintaining storage and ordering expenses to a minimum. The level of inventory that a business can carry is either high or low, depending on the costs associated with having too much or too little inventory.

The fuzzy theory of inventory modeling is actually the closest approach because reality is not accurate and can only be expressed to some extent. Similarly, fuzzy logic enhances modeling by incorporating unpredictability and bringing it closer to the truth.

Kamezi (2010) [1] created an inventory with parameters that are fuzzy and that may have unpredictable results. Syed and Aziz [2] (2007) used the signed distance approach to investigate the fuzzy inventory model without shortage. Applied Trapezoidal fuzzy range with desirable scarcity with an stock version via way of means of Parvathi and Gajalakshmi [3]. Rajalakshmi and Michael Rosario (2017) [4] Use the signed distance technique to analyze a fuzzy stock version with authorized shortfall. In a fuzzy context, Nabendu and Sanjukta (2015) [14] taken into consideration inventories issues without shortages, in addition to exceptional charges as fuzzy integers that had been defuzzified the use of the signed distance method. Harris (1915) [9] set up

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a fee and operations model. For fuzzy variety of orders and fuzzy predicted sales quantity, Yao et al. (2000) [10] offered a Fuzzy stock without backorder. A Fuzzy set became set up via way of means of Zadeh (1965) [7].

2. Definition and Preliminaries

2.1. Fuzzy set [7]

A fuzzy set is one in which members can have a degree of membership and therefore membership values can range from 0 to 1.

2.2. Fuzzy number [7]

A fuzzy number is defined as a fuzzy numbers in the positive integer R that defines a fuzzy interval. Normalize and convexity a fuzzy number.

2.3. Graded Mean Integration Method (GMIM):

Assuming the fuzzy set $\tilde{A}$ is stated on R. Then the grade mean integration method of $\tilde{A}$ is represented as

$$d(\tilde{A},\ 0)=\frac{1}{2}\frac{\int_0^1 \alpha[A_L(\alpha)+A_R(\alpha)]d\alpha}{\int_0^1 \alpha d\alpha} \quad (2)$$

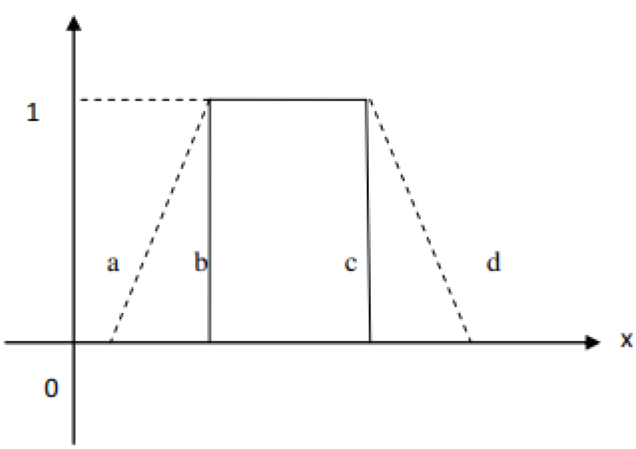
2.4. Triangular Fuzzy Number [7]:

A Triangular fuzzy number $\tilde{A} = (l,\ m,\ n)$ is expressed with its associates' function $\mu_{\tilde{A}}$ is stated as

$$\mu_{\tilde{A}} = \begin{cases} L(x) = \frac{x-l}{m-l} &, when l \le x \le m \\ R(x) = \frac{n-x}{n-m} &, when m \le x \le n \\ 0 &, \quad otherwise \end{cases} \quad (3)$$

The α – cut of $\tilde{A} = (l,m,n)$, $0 \le \alpha \le 1$ is $A(\alpha) = [A_L(\alpha), A_R(\alpha)]$ where

$A_L(\alpha) = l + (m-l)\alpha$ and $A_R(\alpha) = -(n-m)\alpha$.



2.5 Graded Mean Integration [7]:

JOURNAL OF ALGEBRAIC STATISTICS
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Considering $\tilde{A} = (l,\ m,\ n)$ as a grade mean integral and a triangular fuzzy value for $\tilde{A}$defined from O stated by
$d(\tilde{A}, 0)= \frac{1}{6}[l + 4m + n]$

3.1. Notations

To develop a clean and concise inventory system with backorders, use the notation and parameters listed below.

P	-	Length of days
h	-	Storing Cost
k	-	The cost to place an order for one day
v	-	ordering cost
D	-	total demand during the course of the scheduling period[0,P]
v_t	-	length of a rotation
t	-	Ordered quantity per rotation
u	-	shortage quantity per rotation
TC	-	Total cost for the planning duration $[0,\ P]$
$\tilde{h}$	-	Fuzzy storing price
$\tilde{k}$	-	Fuzzy backorder price
$\tilde{v}$	-	Fuzzy ordering cost

3.2. Assumptions

The following assumptions are taken into account in my project.

1. The demand for the good is assumed to be unchanged.

2. The timetable is consistent.

3. Cost-cutting is permitted.

4. To merely fuzzily hold the cost of holding, ordering, and shortfall costs.

4. INVENTORY MODEL

4.1. CRISP CASE

The whole cost in crisp sense over the scheduling duration$[0,\ \ P]$is given by

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$F(v,\ t) = \left[\mathrm{h} t_1 \frac{v-u}{2} + \mathrm{k}\ t_2 \frac{u}{2} + t\right] \frac{D}{v}$

$$= \frac{h\,(v-u)^2\,P}{2v} + \frac{ku^2\,P}{2v} + \frac{tD}{v},\ (0 < u < v)$$

Here t_1 represents duration period of dimension and t_2 represents shortage duration of dimension, so that

$$\frac{v-u}{t_1} = \frac{v}{t_v} = \frac{u}{t_2} = \frac{D}{P}$$

The crisp optimal solutions are

Optimal order quantity $t^* = \sqrt{\frac{2\,(h+k)\ tD}{hkP}}$

Optimal shortage quantity $u^* = \sqrt{\frac{2\,htD}{k\,(h+k)\,P}}$

Minimal total cost $\mathrm{F}(t^*,\ u^*) = \sqrt{\frac{2\,hkvDP}{h+k}}$(14)

4.2. FUZZY CASE

$\tilde{h} = (h_1, h_2, h_3)$, $\tilde{k} = (k_1, k_2, k_3)$, $\tilde{t} = (t_1, t_2, t_3)$

$FTC = \frac{\tilde{h}(t-u)^2\,P}{2v} + \frac{\tilde{k}u^2\,P}{2v} + \frac{\tilde{t}\,D}{v}$

$FTC = \left[\frac{(h_1,h_2,h_3)\otimes(v-u)^2\otimes P}{2\otimes v},\ \frac{(k_1,\ k_2,\ k_3)\otimes u^2\otimes P}{2\otimes v},\ \frac{(t_1,t_2,t_3)\otimes D}{t}\right]$

$= \left[\frac{h_1(v-u)^2\ P}{2\,v} + \frac{k_1 u^2\,P}{2\,v} + \frac{t_1 D}{v},\ \frac{h_2(v-u)^2\,P}{2\,v} + \frac{k_2 u^2\,P}{2\,v} + \frac{t_2 D}{v},\ \frac{h_3(v-u)^2 P}{2\,v} + \frac{k_3 u^2\,P}{2\,v} + \frac{t_3\,D}{v}\right]$

Triangular fuzzy numbers is defuzzified applying Graded Mean Integration method (4), then we acquire

$d\left(F_{(v,\ u)}(\alpha)\right) = \frac{1}{6}[l + 4m + n]$

Applying defuzzification

$d(F_{(v,\ u)}(h,\ k,\ t,\ 0)) = \frac{1}{6}\left[\frac{(h_1 + 4\,h_2 + h_3)(v-u)^2\ P}{2v} + \frac{(k_1 + 4\,k_2 + k_3)\,u^2\ P}{2v} + \frac{(t_1 + 4\,t_2 + t_3)\ D}{v}\right]$

$F_{(v,\ u)}{}'d = 0$

$$\frac{1}{6}\left[\frac{P}{2}(h_1 + 4\,h_2 + h_3)\left(1 - \frac{u^2}{v^2}\right) - \frac{u^2\,P}{2\,v^2}(k_1 + 4\,k_2 + k_3) - \frac{D}{v^2}(t_1 + 4\,t_2 + t_3)\right] = 0$$

$$\frac{P}{2}(h_1 + 4\,h_2 + h_3)\left(1 - \frac{u^2}{v^2}\right) - \frac{u^2\,P}{2\,v^2}(k_1 + 4\,k_2 + k_3) - \frac{D}{v^2}(t_1 + 4\,t_2 + t_3) = 0$$

After solving we get

$$v^* = \sqrt{\frac{2\,D\ (t_1 + 4\,t_2 + t_3)(h_1 + 4\,h_2 + h_3 + k_1 + 4\,k_2 + k_3)}{P\,(h_1 + 4\,h_2 + h_3)(k_1 + 4\,k_2 + k_3)}}$$

and $u^* = \sqrt{\frac{2\,D\ (t_1 + 4\,t_2 + t_3)(h_1 + 4\,h_2 + h_3)}{P\ (h_1 + 4\,h_2 + h_3 + k_1 + 4\,k_2 + k_3)(k_1 + 4\,k_2 + k_3)}}$

This exhibit that $F_d(v,\ u)$ is minimum at $t_d^*\ and\ u_d^*$.

JOURNAL OF ALGEBRAIC STATISTICS
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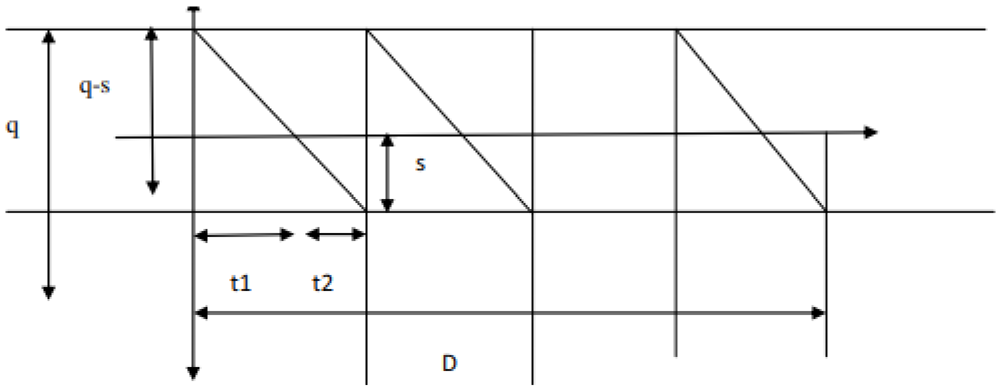
5. Diagrammatic Representation:



6. Numerical analysis

Let $P = 5, \tilde{h} = (1,\ 4,\ 8), \tilde{k} = (9,\ 12,\ 16), \tilde{v} = (17,\ 20,\ 24)$.

Demand (D)	v^*	u^*	FTC
100	5.98	13.07	710.39
110	5.46	13.64	829.77
120	**5.85**	**14.25**	**866.66**
130	5.13	14.83	902.05
140	6.32	15.39	936.11

Table 6.1: Estimation of total cost using triangular fuzzy datas though arithmetic inquiry.

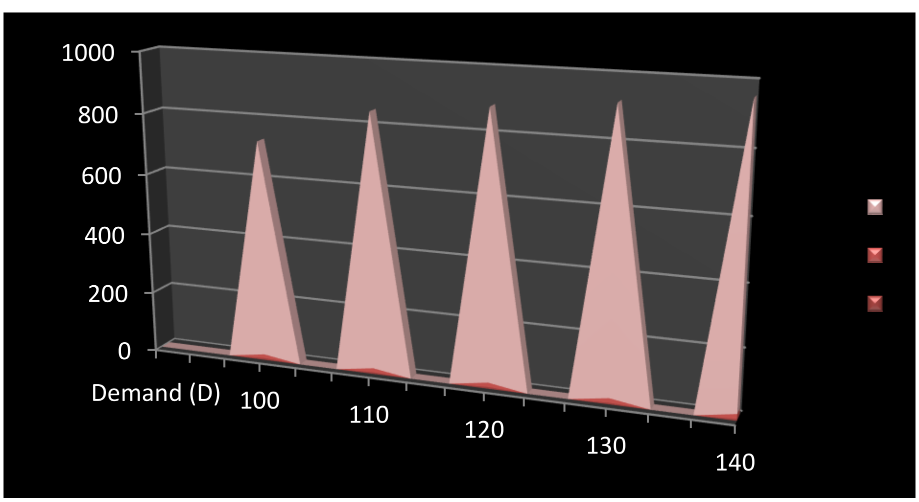


Figure 6.1: Estimation of total cost using triangular fuzzy datas though arithmetic inquiry.

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7.**Conclusion**

In this paper, we investigated the fuzzy inventory model with an acceptable shortage and a constant demand assumption. We fuzzified the ordering and carrying costs using triangular fuzzy numbers. The fuzzy model yielded a lower total cost than the crisp model, and the triangular number provided the lowest total cost of all the numbers tested. Numerical examples help illustrate the analysis.

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