Retraction

Retraction: Optimization of Fuzzy Model for Signed Distance Method (J. Phys.: Conf. Ser. 1916 012123)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Optimization of Fuzzy Model for Signed Distance Method

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Abstract. The research involves the estimation of minimum total cost of an inventory under both stable and imprecise environment. Demand related to unit cost is assumed here. Cost parameters and decision variables are uncertain in nature that are defuzzified by signed distance method. The KKT conditions are applied to optimize the objective function. Numerical example is contributed to describe the comparison between crisp and fuzzy solutions.

Key words: Triangular fuzzy numbers-KKT conditions-signed distance method.

1. Introduction

Decision making is one of the well known process of attaining an optimum solution in an environment with different criterions. Decision making problems are common in real life and most of the real life problems involves several objects which are considered into account. An inventory problem is a decision making problem which optimizes the objective function under various constraints [1]. Inventory control is one among the most important problems both from theoretical and practical approach. An abundant number of papers has been devoted to this area of research. The basic idea is to meet sufficient demand with stock as minimum as possible [2].

Though the literature involves many inventory control systems, a demand varying over unit price is assumed with different costs in uncertain conditions.

An EOQ based inventory problem in crisp circumstances is promoted with minimum total cost without any ambiguity. Though these models are capable of providing an optimum solution under various situations, they are unfit to represent the real life scenario. This results in errors in decision making. Thus the concept of fuzzy approach is introduced instead of using usual probability theory which gives an accurate result [3].

Initially, the concept of fuzziness was first defined by [4] which receives a considerable attention from researchers of all fields like production, inventory management etc. [5] the objective function by converting a purchasing problem to an NLPP. [6] developed a non-linear fuzzy model where some of the input parameters are fuzzified with imprecise storage space.

[7] attempted to approach operational research in an imprecise environment. [8] proposed an imprecise purchasing model by using trapezoidal fuzzy numbers for back orders. [9] obtained a
membership function for the fuzzy cost in an inventory model with backorders whereas [10] considered fuzzy numbers to calculate the total price without backorders.

In this work, a fuzzy EOQ model with shortages and a varying demand is optimized. Numerical examples are illustrated to calculate both crisp and fuzzy annual total cost which leads to choose which model gives a better optimal solution.

2. Mathematical formulation

A model with shortages and demand dependent on unit price is assumed whose objective function is given by Equations (1) and (2)

\[ TC = pr + \frac{Sr}{L} + \frac{I^2 h}{2L} + \frac{(L-I)^2 M}{2L} \]  

Let \( r = Ap^{-\beta} \), \( A>0 \) and \( 0<\beta<1 \) are constants.

\[ TC = Ap^{1-\beta} + \frac{SAp^{-\beta}}{L} + \frac{I^2 h}{2L} + \frac{(L-I)^2 M}{2L} \]  

3. Assumptions and Notations

3.1 Assumptions
* The need determines
* Deficit allowed and fully backed up

3.2 Notations
TC - Cost of goods
L - Lot size
I - Maximum amount
S - Order costs
r - Demand rate
p - price value
h - The cost of holding a unit cost of M-Shortage

Here S, r, h & M are input parameters and p, L, are variable variables.

4. Crisp Mathematical Model

The suggested crisp economic order quantity (EOQ) model is illustrated by Equations (3) , (4) and (5)

\[ TC = Ap^{1-\beta} + \frac{SAp^{-\beta}}{L} + \frac{I^2 h}{2L} + \frac{(L-I)^2 M}{2L} \]  

According to inventory management, the analytic solution of the proposed model is given by
\[ p = \left[ \frac{MhS\beta^2}{2A(h + M)(1 - \beta)^2} \right]^{\frac{1}{2-\beta}} \]  

(4)

\[ L = \frac{S\beta}{p(1 - \beta)} \]  

(5)

5. Fuzzified Mathematical Model

In general, holding and ordering cost are often imprecise and hence expressed in linguistic terms. With this fact, the shortage cost, batch size, unit cost and inventory level are also considered as uncertain parameters.

Equation (1) can be fuzzified as follows by Equations (6-12):

\[ \tilde{TC} = \tilde{A}p^{1-\beta} + \frac{\tilde{sA}_{\beta}}{\tilde{L}} + \frac{\tilde{hI}^2}{\tilde{2L}} + \frac{\tilde{M}(\tilde{L} - \tilde{I})^2}{\tilde{2L}} \]  

(6)

where \( \sim \) indicates the fuzzification of parameters. SDM is used to calculate the optimum solution of (2).

The above mentioned fuzzy parameters are defined as follows.

\[ S = (S - \theta_1, S, S + \theta_2), S > \theta_1 \]  

\[ h = (h - \theta_3, h, h + \theta_4), h > \theta_3 \]  

\[ M = (M - \theta_5, M, M + \theta_6), M > \theta_5 \]  

\[ \tilde{I} = (I - \theta_7, I, I + \theta_8), I > \theta_7 \]  

\[ L = (L - \theta_9, L, L + \theta_{10}), L > \theta_9 \]  

\[ \tilde{p} = (p - \theta_{11}, p, p + \theta_{12}), p > \theta_{11} \]  

(7)

Let \( \tilde{TC} = (C_1, C_2, C_3) \). Then by Signed distance method

\[ d(\tilde{TC}) = \frac{1}{4} \left[ C_1 + 2C_2 + C_3 \right] \]  

(8)
By using Karush-Kuhn Tucker conditions approach, formula for decision variables are derived as follows:

\[
\begin{align*}
 p &= \left[ \frac{\beta^2 (h - \theta_4 + 2h + h + \theta_4)(S + \theta_2 + 2S + S - \theta_1)}{(h - \theta_3 + M - \theta_3 + 2(h + M) + h + \theta_4 + M + \theta_6)} \right]^{\frac{1}{(1 - \beta)}} \\
 L &= \frac{\beta (S + \theta_2 + 2S + S - \theta_1)}{4p(1 - \beta)} \\
 I &= \left[ \frac{\beta (S + \theta_2 + 2S + S - \theta_1)}{(M - \theta_3 + 2M + M + \theta_6)} \right] \\
 d(TC) &= \frac{1}{4} \left[ \frac{A(p - \theta_{11})(p - \theta_{12})^{-\beta}}{L - \theta_9} + \frac{A(S - \theta_3)(p - \theta_{12})^{-\beta}}{L - \theta_9} + \frac{(h - \theta_3 + M - \theta_3)(I - \theta_7)^2}{2(L + \theta_10)} + \frac{(L - \theta_5)(M - \theta_3)}{2} - (I + \theta_8)(M + \theta_6) \right]
\end{align*}
\]
6. Numerical example and Sensitivity Analysis

6.1 Crisp Model

Order Cost \( S = 150 \), Holding Cost \( h = 0.25 \), Penalty cost \( M = 5 \), \( A = 100 \)

| \( \beta \) | \( p \) | \( r = Ap^\beta \) | \( I \) | \( L \) | \( TC \) |
|---|---|---|---|---|---|
| 0.86 | 5.33 | 23.71 | 164.65 | 172.88 | 167.52 |
| 0.87 | 6.30 | 20.16 | 151.75 | 159.34 | 164.96 |
| 0.88 | 7.54 | 16.90 | 138.94 | 145.89 | 162.18 |
| 0.89 | 9.16 | 13.93 | 126.18 | 132.49 | 159.14 |
| 0.90 | 11.35 | 11.23 | 113.28 | 118.94 | 155.78 |

6.2 Fuzzy model

Signed distance method:

Input values:
\( S = (30, 150, 195) \); \( h = (0.06, 0.25, 0.36) \); \( M = (1, 5, 7.6) \) and \( A = 100 \)

| \( \beta \) | \( \tilde{p} \) | \( \tilde{r} \) | \( \tilde{I} \) | \( \tilde{L} \) | \( \tilde{TC} \) |
|---|---|---|---|---|---|
| 0.86 | 4.41 | 27.91 | 174.20 | 182.82 | 163.15 |
| 0.87 | 5.20 | 23.83 | 160.96 | 168.92 | 160.92 |
| 0.88 | 6.21 | 20.05 | 147.69 | 154.99 | 158.47 |
| 0.89 | 7.54 | 16.56 | 134.20 | 140.84 | 155.76 |
| 0.90 | 9.32 | 13.41 | 120.77 | 126.74 | 152.79 |

6.3 Observations

Table 1 shows the calculations of Total cost for a crisp EOQ model by varying the values of \( \beta \).
- As the \( \beta \) value increases, the unit cost also increases.
- As the \( \beta \) value increases, the inventory level, lot-size and also the total cost value decreases.

From Table 2, it is clear that:
- The increment in \( \beta \) value rises the unit price value, whereas the inventory level, ordering quantity and inventory cost value depreciates.

7. Conclusion and Future Scope

It is observed from the numerical example that the total cost value obtained using signed distance method is though nearer to the crisp values, it is more accurate than that of crisp values. Hence it can be concluded that the SD method optimizes the objective function. The results indicates that the increase in the parameter value \( \beta \) depreciates the annual inventory in different proposed models.

The model can be improved by comparing the calculated values of total cost by SD and GMI methods. The total cost can also be determined by assuming various costs as trapezoidal and pentagon fuzzy numbers.
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