Our Responses to the Editor and Reviewers' comments

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Title: An integrated vendor-buyer replenishment policy for deteriorating items with fuzzy environment and resource constraint

Dear Editor:

We would like to express our sincere thanks to you and the anonymous Reviewers for their constructive comments and suggestions to improve the manuscript. In the following are the honorable Reviewers' comments (given in italic font) and our responses (given in blue prints general font). Changes have been made with blue print for reviewer 1 and green print for reviewer 2 and red print in the text for reviewer 3.

Attached please find our revisions and our point by point responses to the reviewers' comments. Thank again for your valuable suggestions and comments.

Yours sincerely,

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Responses to Reviewer #1's Comments:

Reviewer #1's comments: The authors develop an integrated deteriorating item inventory replenishment model with fuzzy environment and resource constraint. My concern regarding this article is subject to the following minor revision:

1. The review of literature is inadequate. The authors are advised to upgrade the literature including recent related published work.
2. Scope of managerial implication should be strengthened in revised version.
3. Novelty compared to the existing literature should be mentioned in conclusion section.
4. Correct the grammatical bugs and typos.

Responses to Reviewer # 2's Comments:

Reviewer #2's comments: The paper is well written and organized and is worth of publication. My recommendation is revision because of the following comments.

1. The abstract should be enhanced significantly by findings.
2. The literature review section is poor and should be improved by some related and recent works.
3. The main contribution of the work should be clarified.
4. I suggest preparing a table for literature review (enhance existing one) section in which all works are compared.
5. Please prepare a section entitled "problem description".

Responses to Reviewer # 3's Comments:

Reviewer # 3's Comments:

Dear Author(s), your article entitled "An integrated vendor- buyer …….resource constraints" is an interesting article. However it requires major modifications before its final production. The observations cum suggestions are as follows:

1. *In page 10, Eq (30), you wrote: "where wavy bar '~' denotes the fuzziness of the total cost and two constraint". I think it is wrong statement. It should be: "where wavy bar '~' stands for fuzzification". However, it is better to look "$\lesssim$" instead of "$\leq$" or*

"$\tilde{=}$" instead of "$=$" in both the constraints and the objective function of Eq (30) respectively.

Our responses:

Thank you for the valuable suggestions. In the revised manuscript, we have revised the erroneous symbol, description. The revision is shown below with yellow mark.

$$\begin{aligned} \tilde{\text{Minimize}} \quad & TC(n, T_2) \tilde{=} TC_b(n, T_2) + TC_p(n, T_2) \\ \text{subject to} \quad & AI_p(n, T_2) \tilde{\leq} \tilde{MAI}_p, \\ & AI_b(n, T_2) \tilde{\leq} \tilde{MAI}_b, \\ & T_2 \geq 0, \\ & n \geq 1, \text{ where } n \text{ is an integer.} \end{aligned}$$

where the wavy bar '~' stands for fuzzification of the total cost and two constraints.

2. *In page no. 12, Eq (34), I think all "$=$" should be replaced by "$\geq$" isn't it ?*

Our responses:

Thank you for the valuable suggestions. In the revised manuscript, we have rewritten the description and explained the meaning. The revision is shown below with yellow mark.

$$
\begin{aligned}
\text{Maximize} \quad & W_1\mu_{\tilde{TC}} + W_2\mu_{\tilde{MAI}_p} + W_3\mu_{\tilde{MAI}_b} \\
\text{subject to} \quad & 1 - \frac{TC(n,\, T_2) - TC^1}{TC^0 - TC^1} = \mu_{\tilde{TC}}, \\
& 1 - \frac{AI_p(n,\, T_2) - MAI_p^1}{MAI_p^0 - MAI_p^1} = \mu_{\tilde{MAI}_p}, \\
& 1 - \frac{AI_b(n,\, T_2) - MAI_b^1}{MAI_b^0 - MAI_b^1} = \mu_{\tilde{MAI}_b}, \\
& T_2 \geq 0, \;\; n \geq 1, \;\; \text{where } n \text{ is an integer}, \\
& \mu_{\tilde{TC}};\; \mu_{\tilde{MAI}_p};\; \mu_{\tilde{MAI}_b} \in [0, 1].
\end{aligned}
\tag{34}
$$

where W_1, W_2 and W_3 are positive weights provided by a decision-maker of an enterprise for the fuzzy joint cost and the fuzzy inventory investment constraints. The three transformed investment constraints including the total cost and vendor-buyer inventory cost are derived from their corresponding membership functions in (31)-(33) respectively.

3. *What is the justification to consider all the fuzzy membership functions are of same type?*

Our responses:

Thank you for the positive comments and insightful suggestions. In the revised manuscript, we have rewritten the description and explained the meaning. The revision is shown below.

Considering the cost model with the three constraints, the smaller relevant cost or inventory investment is preferred by the enterprise. For the acceptable intervals of the three constraints, our model uses linear decreasing numbers instead of the triangular fuzzy numbers. Hence, a simple fuzzy linear decreasing membership function representation is adopted and the pictorial representations of these functions are illustrated in Figure 2.

4. *Your work is much closure to cite this article " Sujit Kumar De, P.K. Kundu and Adrijit Goswami, Economic Ordering policy of deteriorated items with shortages and fuzzy cost-coefficient for vendor and buyer, Int. J. of Fuzzy Systems and Rough Systems, 2008, 1(2), 69-76.*

Our responses:

In the revised manuscript, we have included the suggested paper in the References, and discussed their contribution in the Literature Review. Another relevant literature is also listed in the reference as follows:

1. De, S. K., Kundu, P.K., & Goswami, A. (2008). Economic Ordering policy of deteriorated items with shortages and fuzzy cost coefficient for vendor and buyer, *International Journal of Fuzzy Systems and Rough Systems*, 1(2), 69-76.
2. Chitra, D., & Parvathi, P. (2014). Decision making under fuzzy environment for deteriorating items with stock dependent demand under inflation effect, *International Journal of Mathematics and Computer Applications Research*, 4(2), 1–10.

Literature Review:

1. De et al. (2008) studied an EOQ model for deteriorating seasonal commodity where shortages are allowed and fuzzy cost parameters are considered in the integrated supply chain. Our study enhanced their model by considering the vendor-buyer inventory investment separately and discussed a cost sharing mechanism to improve the cooperative relationship in the integrated supply chain.
2. Chitra and Parvathi (2014) discussed a fuzzy EOQ model for deteriorating items with stock dependent demand under permissible delay in payments and inflation. They did not allow for shortages. The objective is to minimize the retailers' total inventory cost assuming triangular fuzzy numbers.

5. *You have used Genetic Algorithm approach for linear parameters. How can it be justified?*

Our responses:

Thank you for the valuable suggestions. In the revised manuscript, we have added the relevant references and explained our model using MIHDE method as shown below.

MIHDE method is an improved hybrid differential evolution (HDE) method which is a simple population based stochastic function optimization method proposed by Chiou and Wang (1999). Its main structure is to adopt the three different mechanisms in the multi-point linear search (i.e., mutation operation in HDE/DE method), reorganization (i.e., crossover operation in HDE/DE method), and selection to generate the next generation. Ten different linear mutation strategies in the parent individual and difference linear vector selection are suggested by Price et al. (2005) and Storn and Price (1996). Since the above models cannot be handled by HDE method because it uses a real coding to represent each decision variable (i.e., gene in HDE represents decision variable in the real-world problem), MIHDE method is used to derive the optimal solution.

Price et al. (2005) and Storn and Price (1996) introduced the interval (0, 1.2] for F to ensure the quickest possible convergence. As shown in Equation (40), the temporary mutant individual, $(\hat{\mathbf{x}}^G, \hat{\mathbf{y}}^G)_i$, $i = 1, \ldots, Np$, is basically a perturbed duplicate of the parent individual $(\mathbf{x}^G, \mathbf{y}^G)_p$ at G^{th} iteration. Therefore, the parent individual $(\mathbf{x}^G, \mathbf{y}^G)_p$ selection is based on the type of mutation operations. Different from GA, the mutation operation with the parent individual and linear vector selection (MIHDE method) implemented in each iteration/generation is to enhance the diversified search in the process of evolution.

Reference:

1. Price, K., Storn R., & Lampinen, J. (2005). *Differential Evolution: A Practical Approach to Global Optimization*, Springer, Berlin.

6. What are the graphical trends and novelty of the article?

Our responses:

In the revised manuscript, we have included the trends in the numerical example section. The revision is shown below

From Table 4, the CFP method with fuzzy joint cost and constraints maximizes the weighted sum of each achievement level shown in the last column. As shown in Type B, the achievement levels of both the fuzzy joint cost and vendor's constraint are lower than that of the fuzzy buyer's constraint. The fuzzy buyer's constraint has the lowest weight among the three fuzzy components. Similarly, in Type C, the achievement level of the fuzzy joint cost is only 0.010; this is far less than its weight, $W_1 = 0.2$. It seems that this method cannot fully reflect the expectation of the decision-maker. This is because the decision-maker wants to achieve a higher benefit than other intuitions by designing a higher weight fuzzy joint cost. Therefore, our study applies the IWFNLP method to overcome the drawbacks of the CFP method. On the other hand, when the IWFNLP method is used, the ratios of the achievement levels to the weights for the fuzzy joint cost, fuzzy vendor's and buyer's inventory investment constraints are nearly identical. The results are significant. For example, in Type B, the fuzzy joint cost, fuzzy vendor's and buyer's inventory investment constraints are 0.756/0.48 = 1.575, 0.537/0.32 = 1.678 and 0.315/0.2 = 1.575, respectively. When the difference between the ratios of the three components is small, the IWFNLP method can obtain a minimal total cost using the MIHDE method.

7. *Rewrite the conclusion section according to your research findings and novelty of the methodology.*

Our responses:

We have rewritten the conclusion section in the revised manuscript. The revision is shown below.

Different from previous researches, our study considers a perishable item with collaborative vendor-buyer ordering policy and finite replenishment rate. Furthermore, due to the importance of inventory and capital investment in today's fuzzy marketing environments, researches in fuzzy collaborative inventory models have become very popular research in recent decades. Therefore, in our integrated model with deteriorating inventory replenishment policy, we construct the crisp/fuzzy models with inventory investment constraints with fuzzy environments. The fuzzy model has been formulated using the convex fuzzy programming (CFP) and inverse weighted fuzzy non-linear programming (IWFNLP) methods. These models are classified as MINLP problems. To solve the NP-hard problem within a reasonable computational time, mixed

integer hybrid differential evolution (MIHDE) technique was used in our study. The MIHDE method has proved to be effective computational tool in searching for good solutions, and is popular among managers in making decisions under real-life marketing environments. In this study, we have demonstrated that the CFP method has maximized the weighted sum of each achievement level. Moreover, our results have shown that the IWFNLP method is a more efficient decision tool; the result of our study conforms to the expectation of the system operators and management. For future research, permissible backlogging, delay in payments and for multiple vendors and buyers supply chain can be considered.