Response to Reviewer 3 Comments

First of all, we thank all the reviewers for their valuable time and constructive comments. We have thoroughly checked the English grammar and spelling in the manuscript. In the following, we would like to respond to each reviewer separately.

Reviewer #3

Point 1: Line 153: Expand R&D as Research & Development, the first time that acronym appears in the paper.

Response 1: Thank you for your insightful comments and suggestions. We corrected the expression as you suggested and went through the whole manuscript carefully to correct similar issues.

Point 2: Figure 1: In that Figure, correct the typo as "Serviceable".

Response 2: We appreciate your feedback. Following your suggestions, we have rectified the typo and meticulously reviewed the entire manuscript for similar issues.

Point 3: The symbol phi in the equation on line 191 and the one on line 193 are different. Please correct.

Response 3: Thank you for your suggestion, we have made modifications to the symbol and reviewed the other sections accordingly.

Point 4: To eliminate confusion, can the authors use the superscript, say, "E" for exponential and, say, "N" for normal distribution for equations 1 through 4? For example, VE1 for Eqn (1), VN2 for Eqn (4) etc.

Response 4: I apologize for the oversight in providing the distinctions in the formula under different quality distributions. They have been corrected as follows: " V_1^E represents the average recovery cost when q follows an exponential distribution; V_2^E represents the average remanufacturing cost when q follows an exponential distribution; V_1^N represents the average recovery cost when q follows a normal distribution; V_2^N represents the average remanufacturing cost when q follows a normal distribution."

Point 5: Add a justification, just before Section 3.2., for why only Exponential and Normal distributions are used and how do these fare with reality.

Response 5: In response to your suggestion, we have incorporated a discussion prior to Section 3.2.1, elucidating the rationale for employing exponential and normal distributions so as to better simulate realistic scenarios. This explanation is detailed as follows.

When addressing the uncertainty associated with the quality of recycled products, several scenarios are considered. Some of these scenarios posit that the quality of the recycled products follows an

exponential distribution [12, 30], while others presume a normal distribution [31]. To assess the robustness of varying quality distributions, we independently model different quality distributions for the purpose of comparison and validation.

Point 6: In Table 1, the number of remanufacturing periods and the number of manufacturing periods are demoted by r and m, respectively. But in lines 254 & 255 (and in the remainder of the manuscript), those variables are denoted as m and n, respectively. Please fix these notational typos, throughout the whole manuscript and maintain consistency. E.g., on line 281, should it be (q, T, m, n) or (q, T, r, m)? Perhaps it's best to revisit Table 1.

Response 6: We appreciate your meticulous attention to the detail of the symbols. In response, we have amended Table 1 to maintain consistency in the notation used throughout the manuscript.

Point 7: Similar to item 4 above, you could have it as ATCE for Eqn (13) and ATCN for Eqn (14).

Response 7: Thank you for your suggestion, we have made modifications and meticulously reviewed the entire manuscript for similar issues.

Point 8: In essence, the problem is to minimize the total cost function ATC over four decision variables: q, T, r, and m. What are the accompanying constraints? Allude to them in a paragraph.

Response 8: Responding to your suggestion, we have incorporated relevant constraints into Table 1, such as specifying the range of 'q' as [0,1].

Point 9: Justify, why the solution method is reduced to using genetic algorithm and particle swarm optimization. Moreover, at the start of Section 5, convince the reader why an analytical solution (using calculus, second-order conditions etc.) was not utilized in this paper. If so, why closed-form solutions do not exist?

Response 9: Thank you for your insightful comments and suggestions. Given the nonlinear and nonconvex nature of the present problem, closed-form solutions are typically unattainable. In dealing with such complex issues, traditional analytical methods may not always deliver satisfactory outcomes. This is especially applicable when dealing with non-convex and non-differentiable functions where second-order conditions do not apply, rendering calculus-based solutions impractical.

Genetic Algorithm and Particle Swarm Optimization are examples of heuristic optimization techniques, which are particularly suitable for problems characterized by high nonlinearity and non-convexity. These methods execute a global search within the solution space, possessing the capability to avoid local optima, a limitation of many traditional methods that solely perform local searches. Furthermore, these techniques demonstrate considerable versatility, adaptability, and robustness in managing a diverse array of problems.

Therefore, we have added an explanation about using the heuristic algorithm in Section 5. In our endeavor to minimize the system's average total cost, we optimize the following decision variables

in this study: the cycle length (T), the number of manufacturing periods (n), the number of remanufacturing periods (m), and the optimal quality level of recycled products (q). Due to the nonlinear and nonconvex nature of this problem, it is typically challenging to find closed-form solutions. The Genetic Algorithm (GA), a classical heuristic algorithm for function optimization, is often used as a performance evaluation benchmark [33], thus making it an apt choice for searching for the optimal solution in this study. However, considering its limitations, such as premature convergence and weak local search ability [34], we also employ the Particle Swarm Optimization (PSO) to simultaneously solve the model. This dual-method approach allows us to circumvent the constraints of a single algorithm and provides a more comprehensive analysis. Such an approach not only validates the reliability of the model but also offers reliable evidence through specific examples.

Point 10: Line 637: The expression "more optimal" is awkward; please revise.

Response 10: Thank you for your suggestion, we have made modifications.

Point 11: Because the authors employed algorithms that do not necessarily guarantee optimality, there should be some discussion on the "quality of solutions" in terms of the optimality gap. Please include a paragraph on this in Section 7.

Response 11: We appreciate your insightful reminder. In response, we have incorporated a discussion in Section 5 to articulate the rationale behind our selection of the two heuristic algorithms and our strategy to guarantee their efficacy. In essence, the validity and robustness of our model are confirmed by contrasting the outcomes of these two algorithms. Moreover, as illustrated in the example presented in Section 6 (Table 4), the maximum discrepancy - the GAP - between the two algorithms is 0.005%. This slender margin further underscores the robustness of our model and the reliability of the deployed algorithms."

Point 12: Line 191 and the rest of the manuscript: I find the decision variable q termed as "optimal" quality level problematic because it is not. Therefore, please remove the word "optimal" from that definition wherever it is mentioned in the paper. However, if the study had had found a closed-form solution for the optimal quality level, that could be denoted by q* .

Response 12: Thank you very much for your suggestion. We have changed the original 'optimal quality level' to 'approximate optimal quality level'.