

Answer for review report 2 (round 1).

Thank you for reading this paper.

The MDPI has revised the English of the manuscript. The file number is English-edited-81340.

1. "This study focuses on linear programming that solved a non-dominated trade-off of the multi-period multi-product CLSCND problem to determine the optimal solution for total cost, carbon dioxide emissions, and employment opportunities."

Answer: Thanks to the reviewer for your guidance.

The description of the Kim et al. reference needs clarification. The following is the corrected version.

Line 96-101:

Kim et al. [**Error! Reference source not found.**], aiming at the problem of closed-loop supply chain network design (CLSCND), proposed a multi-objective mixed-integer linear programming (MMILP) model. Its objectives include minimizing total costs, minimizing carbon dioxide emissions, and maximizing employment opportunities. The results showed that using the MMILP model can provide meaningful parameters for strategic decisions of business companies and managers.

I have revised the description of this study's purpose to explain all the content more straightforwardly and clearly. Here is the revised version:

Line 122-131:

Driven by the challenge of complex environmental situations, this study proposes a fuzzy, nonlinear, multi-objective programming model to tackle the trade-off between logistics TCQCE and carbon emission mitigation of ESG principles in e-commerce operations. This fuzzy nonlinear multi-objective programming offers practical solutions for e-commerce companies. The trade-off issue between sustainability and efficiency was also evaluated by Parilina, Yao, and Zaccour [17]. This approach bridges existing research gaps by incorporating fuzzy theory to account for ecological uncertainty and utilizing nonlinear models for more comprehensive representation. Furthermore, this model provides valuable delivery guidance for policy-makers, regulators, and stakeholders, ultimately promoting sustainable development within the e-commerce industry.

There is important to ensure consistency in the objective declaration.

Answer: I am sorry that it is not clearly described in the content description. The former content refers to the research purpose and results of Kim et al., while the latter content is the purpose of this study. The two paragraphs revised above have been corrected.

2.

### **3. Methodology 275**

#### *3.1. Research structure 276*

“This research aims to achieve sustainable development in ESG and addresses the trade-off issues related to TCQCE in logistics and transportation.” [other objective declar.]

Answer: Thanks to the reviewers for your guidance. The original unclear target semantics have been modified to the following sentences better to fit the core of this paper's research.

Line 291-293:

This research aims to propose a FNMOPM that incorporates time management to address the trade-offs between TCQCE and delivery time in sustainable e-commerce logistics.

### **Section 4**

Lines 363-364: “The approach employs fuzzy set theory,  $\alpha$ -cut defuzzification, nonlinearity, mathematical programming, and multi-objective to address the correlations between TCQCE and ESG”

ESG is much more than Carbon Emission. The paper does not address the Social or Governance aspects of ESG. Same way, Carbon Emission is relevant to Sustainability, but Sustainability is much more than it.

Answer: Thanks to the reviewer for the reminder. The scope of ESG in this study has been revised to limit the ESG in the full text to the scope of carbon emissions mitigation, which does not cover social and governance aspects of ESG. This refinement allows for a more in-depth analysis of carbon emissions mitigation within the context of ESG.

### **Section 5**

The Discussion section, from line 518 to 533 should discussed the results of the projects and the revised literature in Introduction and/or section 2, but new literature is added and it relation with the results is not clear. Only project G appears in the discussion.

Answer: Following your instructions, I incorporated the original content into the introduction or section 2 while rewriting the discussion section, enhancing its meaningfulness.

### **Conclusion**

“This study centered around the case study of Project G by SASSWOOD corporation 536 in Taiwan...”. However, the Fig.2 (CPM) suggests that this is one project, with several sub-projects... Furthermore, lines 541-542 suggest projects I, D, and E as alternatives to project G, but I is dependent of G. It is very difficult to

understand. Considering the phrase (line 538) “The analysis of this real-world scenario provided valuable insights and solutions...” but none real-world description was presented, only abstract “projects” and respective data. I do not understand how it can be useful for practical decision-making, despite the value of the calculations.

Answer: Thank you to the reviewer for the reminder. This study reproduces Figure 2 more visually. Furthermore, the description is rewritten on line 538. The content is as follows:

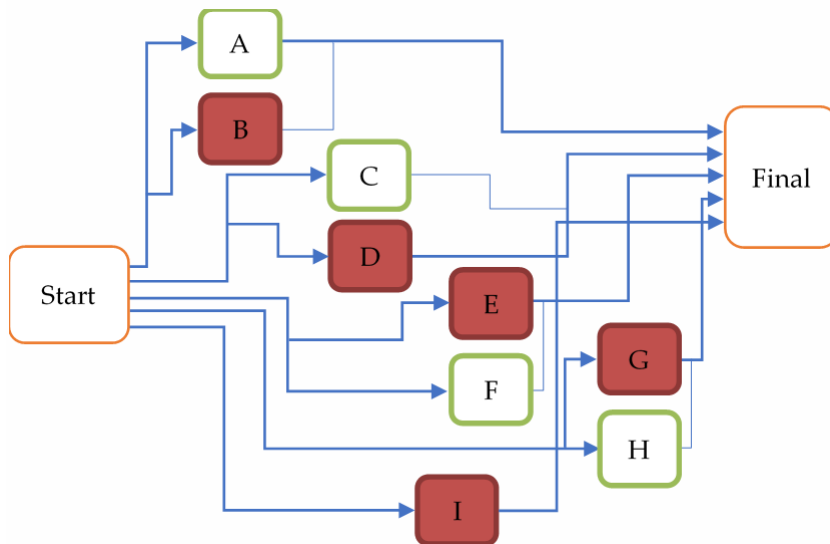


Figure 2. The project's critical path.

Line 570-572 (538):

This study focused on Project G, conducted by SASSWOOD Corporation in Taiwan. The project aimed to mitigate carbon emissions in the logistics industry by extending delivery times and utilizing FNMOPM to address TCQCE trade-offs in e-commerce logistics.

The order of magnitude of the changes is very large: approx. 1900% in costs, 7800% in carbon emissions (“...between 5259.31 and 419199.60 tons ... cost between 79586.17 and 1591901.68”)... Furthermore, the absence of significant digits difficult the interpretation and raises doubts and the question: Are the numbers correct?

Considering the magnitude of the changes, for practical management decisions, more details of the dependence between variables and the sensitivity between them could be discussed and presented in a way that facilitates application by managers.

Answer : I appreciate the reviewer’s guidance. I have rewritten the content and variable relationships mentioned earlier to enhance transparency. Additionally, I am grateful to the reviewer for identifying areas

where the paper can be expressed more clearly. Moreover, the instructions for lines 576-589 are rewritten. The content is as follows:

This study used the quality Project G as an example to calculate its cost and carbon emissions. Project G's delivery time was adjusted, mitigating carbon emissions between 5259.31 and 419,199.60 tons. This is consistent with Hypothesis 2, which states that extended delivery times lead to lower carbon emissions.

The quality in Project G dropped from 85.00% to 75.25%. If the company wanted to improve its quality, the cost would increase between 79,586.17 and 1,591,901.68. This meets Hypothesis 3, stating that quality requirements will affect cost increases.

According to the results mentioned above, costs were 19 times higher and carbon emissions were 78 times higher. The primary variable relationship was that this study used a nonlinear model as the algorithm, and it is not a linear relationship. Therefore, nonlinearity is better for handling the variables of fluctuating situations. Thus, this study has successfully implemented an effective solution to reduce carbon emissions in the e-commerce logistics industry. Adopting a fuzzy nonlinear multi-objective programming model addresses gaps in the previous research on extended delivery times.

Regarding the objective fulfillment: There are different, with some inconsistency, declarations of objectives along the text: line 87, 96, 114, 277. Considering that some of them include social responsibility and governance, as part of ESG, you have a problem: this points is not supported by the results; your results involves only the interdependence and the fuzzy relation in TCQCE.

Answer: I am grateful to the reviewers for their guidance. I rewrote the content to make it consistent.

Line 87:

This study commenced with time management using nonlinear multi-objective programming to address the waiting days of shipping times to reduce carbon emissions, thereby maintaining the convenience of e-commerce and accomplishing the carbon emission mitigation goal of ESG principles.

Rewrote (line 91-94):

This study commenced with time management using nonlinear multi-objective programming to address the waiting days of shipping times to reduce carbon emissions, thereby maintaining the convenience of e-commerce and accomplishing the carbon emission mitigation goal of ESG principles.

Line 96: I am grateful to the reviewers for their guidance. My expression here needs to be more explicit, and the content has been corrected. The words "this study" refer to Kim's research.

This study focuses on linear programming that solved a non-dominated trade-off of the multi-period multi-product CLSCND problem to determine the optimal solution for total cost, carbon dioxide emissions, and employment opportunities.

Rewrote (line 95-101):

What is the optimization methodology regarding TCQCE in e-commerce? In 2024, Kim et al. [**Error! Reference source not found.**], aiming at the problem of closed-loop supply chain network design (CLSCND), proposed a multi-objective mixed-integer linear programming (MMILP) model. Its objectives include minimizing total costs, minimizing carbon dioxide emissions, and maximizing employment opportunities. The results showed that using the MMILP model can provide meaningful parameters for strategic decisions of business companies and managers.

Line 114:

Although fuzzy factors are used to solve the problem of environmental uncertainty, this study not only uses fuzzy theory to deal with ecological uncertainty but also produces nonlinear models to solve environmentally complex situations to fill the gaps in the research.

Rewrote (line 114-121) :

Kim et al. [15] and Rezakhanlou et al. [16] focused on a linear model. There is still a gap between linear models and the actual environment. Nonlinear programming offers a more robust approach by representing the nonlinear interactions among variables. Furthermore, real-world uncertainty factors and environmental dynamics can be imprecise. The fuzzy theory addresses these uncertainty factors by incorporating degrees of membership instead of relying solely on strict binary values. Therefore, integrating fuzzy theory and nonlinear multi-objective programming offers a robust framework for addressing trade-offs in decision-making.

Line 277:

This research aims to achieve sustainable development in ESG and addresses the trade-off issues related to TCQCE in logistics and transportation. From a consumer's perspective, the generally acceptable delivery time ranges from 1 to 3 days. To reduce costs and carbon emissions, e-commerce companies incorporate a flexible two-day delivery window into their logistics arrangements, treating each delivery task as a project.

Rewrote (line 291-297):

This research aims to propose a FNMOPM that incorporates time management to address the trade-offs between TCQCE and delivery time in sustainable e-commerce logistics. From a consumer's perspective, the generally acceptable delivery time ranges from 1 to 3 days. To reduce costs and carbon emissions, e-commerce companies can incorporate a flexible two-day delivery window into their logistics arrangements,

treating each delivery task as a project. Therefore, proactive planning and evaluation are essential in complex environments within the research framework.

### Formal details

Error line 516.

Answer: Report to the reviewer. Line 516 needs to be corrected. I have corrected the miscalculation.

Lines 549-550: "Project G explained that quality has dropped from 85% to 75.25%. If the company wants to improve quality, that will increase the cost between 79586.17 and 1591901.68." – Problems with the significant digits. What the data accuracy? 85.00% to 75.25% OR 85% to 75%. Can costs increase 1900%? It is very important and more explanation about this possible cost increase is desirable, as well the unit (TWD, for example, not only numbers) and its significant digits (cents make sense?).

Answer: I appreciate the reviewers' guidance. As per your previous guidance, I have carefully reviewed the accuracy of the figures and improved the clarity of their descriptions in the discussion and conclusion sections. Thank you to the reviewers for identifying the areas that required correction in the paper. Rewritten as follows:

Line 541-550:

## 5. Discussion

**Balancing Efficiency and Sustainability:** This article explores the trade-off between efficiency (time and cost) and sustainability (reduced carbon emissions) in e-commerce logistics. This research showed that quality dropped from 85.00% to 75.25%. To enhance the quality to 90.00%, companies must pay up to 1900% of the original price, 19 times the cost. Conversely, staying at 75.25% quality reduces payouts by 19 times. This is a payout ratio of 19:1. To remain at 75.25%, it only costs TWD 1, but to reach 90.00%, companies have to spend TWD 19 more. Consumers who reduce carbon emissions are willing to accept slower delivery speeds. At this time, e-commerce companies could not only reduce carbon emissions but also reduce costs and expenses and relatively increase their revenue. Therefore, this brings optimistic prospects for the growth of the business.

Line 583-589:

## 6. Conclusions:

According to the results mentioned above, costs were 19 times higher and carbon emissions were 78 times higher. The primary variable relationship was that this study used a nonlinear model as the algorithm, and it is not a linear relationship. Therefore, nonlinearity is better for handling the variables of fluctuating situations. Thus, this study has successfully implemented an effective

solution to reduce carbon emissions in the e-commerce logistics industry. Adopting a fuzzy nonlinear multi-objective programming model addresses gaps in the previous research on extended delivery times.

Many problems of units and significant digits in tables.

Answer: I have rechecked the numbers. Thank you to the reviewer.