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RESEARCH PAPER

An Integrated Perishable Inventory Routing Problem with Consistent Driver Services and Fresh Product Delivery using Possibility and Necessity Measures

Mohammad Hasan Esmaili[1] & Seyed Meysam Mousavi[*2]

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ABSTRACT
To demonstrate the importance of customer satisfaction, one can mention a number of service providers that attempt to differentiate themselves in terms of their satisfied customers, witnessing high growth. In this paper, some factors such as driver consistent services and delivering fresh products that increase retailers' and customers' satisfaction were considered in a Perishable Inventory Routing Problem (PIRP) under possibility and necessity classes of fuzzy uncertainty measures. In a typical Inventory Routing Problem (IRP), a distribution center delivers products to a set of customers through a limited time horizon and, simultaneously, makes a decision about inventory and routing to minimize the total cost. The proposed model was formulated as mixed-integer programming. Two types of consistent driver services were regarded for different kinds of customers including particular and typical customers. To investigate the validity of the model, the problem was solved at two values of possibility and necessity measures.

KEYWORDS: *Perishable products; Driver consistent; Freshness; Inventory routing problem; Possibility and necessity measures.*

1. Introduction

The continuity of a business life depends on many reasons including investigating business performance, updating strategies according to the new situation, and customer satisfaction. The significance of customer satisfaction as one of the above main reasons can be business incentives to grow and become well known in the competitive market. A series of essential activities must be implemented to achieve these goals since these efforts can be better aligned with new ideas and creativity. In recent decades, the number of related activities to promote customer satisfaction has surged, which is the reason why the role of customer satisfaction enjoys such significance in today's business world. Ensuring and providing consistent services is a practical plan that may impact customer satisfaction.

The issue of providing consistent services for the vehicle routing problem was introduced by Groër et al. [1] for the first time, in which the principal objective was to minimize the difference in the initialization times of services in different periods. Although some applications of consistent services are home meal delivery, homecare, and post-delivery services [2], the potentiality of this idea is enough to generalize it to further domains. Furthermore, businesses that ensure consistent services and are aware of their short-term costs will reap more benefits in a longer term and different dimensions.
There are different types of consistent services including drivers' consistency, time consistency, and quantity consistency that have been studied so far with respect to the Vehicle Routing Problem (VRP). Driver consistency is defined as assigning one (consistent) or a limited number of drivers (generalized consistent) to each customer during the planning horizon [1-3]. By satisfying customers' demand in this way, a better relationship between the service provider and customers can be formed.
Fig. 1. shows the difference between visiting customers with driver consistency (hard) and

* Corresponding author: *Seyed Meysam Mousavi*
sm.mousavi@shahed.ac.ir

1. *MSc Student, Department of Industrial Engineering, Faculty of Engineering, Shahed University, Tehran, Iran.*
2. *Associate Professor, Department of Industrial Engineering, Faculty of Engineering, Shahed University, Tehran, Iran.*

driver generalized consistency (soft) illustrated in a spectrum defined at an interval.

Another type of consistency called 'arrival time consistency' guarantees that the starting times of services in different periods are almost the same. This type of consistency was studied by Campelo et al. [4], Spliet and Gabor [5], Spliet and Desaulniers [6], and Kovacs et al. [3]. Third one, quantity consistency, was studied by Coelho et al. [7] who found that the number of delivered products to retailers in different periods was consistent.

Usually, the larger portion of a family's income is devoted to food; thus, wasted food is wasted money. Fruits, vegetables, dairy products, meat, and seafood are perishable foods that they consume fresh or store to eat at another time. There is some limitation to storing these types of products; for example, (a) physical restrictions are stored out in the sun and heat under controlled moisture and temperature zone and (b) time restriction, perhaps the main restriction, is the finite consumption time. Neglecting these factories generally causes a decrease in their quality, freshness, and occasion, which leads to the depreciation of their ultimate values.

The above-mentioned remarks alongside (a) the high financial turnover of food industries, (b) the potential of maintaining consistent services to improve more by applying optimization activities during their operation process from product or packing to delivering them to final customers, and (c) the small number of spoilage products are enough reasons to pay more attention in more detail.

This paper demonstrates the distribution network of perishable products in a Perishable Inventory Routing Problem (PIRP), which is classified into NP-hard problem. In the PIRP context, integrating operational decisions such as replenishment scheduling, inventory control, and vehicle routing is defined as the main characteristic. In this problem, Distribution Center (DC) regulates the number of products based on a trade-off between the pros and cons of how many should receive and how many should be stored to fulfill demand in other different periods and ensure lower costs. According to this context, DC responds to retailers that run the risk of facing shortage and satisfy their demands in each period. The overall reduction of costs incurred by the decisions made [8] can be considered a win-win situation.

This paper is organized as follows. Section 3 first introduces the problem and, then, represents the perishable inventory routing model with driver consistency constraints and the applied fuzzy approach demonstrated. Computational experiments and numerical results are summarized in Section 4, which concludes the analysis of the trade-off between vehicle's capacity, possibility and necessity values and system costs. Finally, Section 5 concludes the paper with the outcome.

2. Literature Review

The researches related to the PIRP have investigated different facets of the problem. Many pieces of research work on environmental activities. For example, Soysal et al. [9] studied horizontal collaboration on managing perishable products and greenhouse gas emission in the inventory routing problem with a case study and multiple products under uncertain demands. In this research, various essential performance indicators such as emissions cost as fuel and spoilage, and driving time were investigated. Biuki et al. [10] represented a location-routing-inventory model that demonstrated a two-phase method for the problem of Supply Chain Network Design (SCND). The environmental impacts of Greenhouse Gas (GHG) emissions and the social implications of job creation were mentioned in this research. Although most of the related published papers have considered one or two aspects of sustainability, this paper covers all the related aspects. Dai et al. [11] studied the Location Inventory Routing Problem (LIRP) for perishable products and considered the parameters of greenhouse gas emission and capacitated vehicle problem in the fuzzy method. To minimize the total costs, they nominated two metaheuristic algorithms: Hybrid Genetic (HGA) and Hybrid Harmony Search (HHS).

Some researchers have investigated a different approach to product delivery (e.g., [12]) and assumed last-mile delivery with patterns in a two-echelon inventory-routing problem for perishable products. Since this distributing technique is selected, customers are not subject to holding costs and only depots are in charge.

Furthermore, a number of studies have investigated different approaches to reduce the deterioration rate of perishable products and deliver them at a high level of quality and with freshness. For example, Coelho and Laporte [13] envisaged three different selling policies, namely Fresh First (FF), Old First (OF), and Optimized Priority (OP), and there are differences between them FIFO and LIFO politics with respect to inventory management. Amorim et al. [14] applied a make-to-order strategy to reduce the number of spoiled products in a Perishable Production and Routing Problem (PPRP).

Driver consistence (hard) Driver generalized consistence (soft)

Fig. 1. The difference between visiting customers with driver consistence and driver generalized consistence

Their model includes two types of perishable products: the first one with fixed shelf life and the second one with loose shelf life. In [15], a three-echelon fuzzy green vehicle routing problem was represented. In this paper, uncertainty in demands was assumed to be triangular fuzzy numbers as input data. To cope with the chance-constrained programming model, the credibility theory was applied. A summary of the related articles regarding the PIRP is addressed in Table 1.

Despite the advantages of driver consistency that promote the retailer and customer satisfaction, it was left unaddressed in studies relating to PIRP.

The main objective of this paper is to elevate retailer and customer satisfaction concerning a Perishable Inventory Routing Problem (PIRP). For this reason, driver consistency is considered and retailers are categorized into two groups: particular and typical ones. Particular retailers must be visited with a driver in the planning period (consistent driver services) and typical ones with a limited number of drivers (generalized consistent services). Some retailers may find themselves in a particular condition that may justify their separation from the driver(s) in this way. This is the first step to achieving the professed objective of this study.

The other innovation of this paper is formed based on a critical issue about perishable products that should be delivered with a high level of quality and freshness to achieve significant satisfaction. This idea is applied with a given percentage of fresh products delivered to retailers, ensuring that the specific percentage of retailers selling fresh products. It is not possible to determine the exact value of retailer satisfaction because the value varies due to different factors and ideas; therefore, this part of the problem is susceptible to uncertain parameters. Fuzzy possibility and necessity approaches are used to cope with uncertainty. As a result, implementing the above methods ensures lower costs which can satisfy both retailers and customers, as depicted in Fig. 2.

Tab. 1. A summary of recent PIRP studies

Authors	Routing			Inventory		Perishability		Uncertainty		
	Consistent services									
	Driver	Time	Quantity	Depot	Retailer	Shelf life	Freshness	Fuzzy	Stochastic	Robust
Dai et al. [11]				✓	✓	✓		✓		
Hiassat et al. [16]					✓	✓				
Soysal et al. [17]						✓			✓	
Coelho et al. [18]				✓	✓					
Rohmer et al. [12]				✓		✓				
Crama et al. [19]					✓	✓	✓		✓	
Coelho and Laporte [13]				✓	✓	✓				
Alkaabneh et al. [8]				✓	✓	✓				
This study	✓				✓	✓	✓	✓		

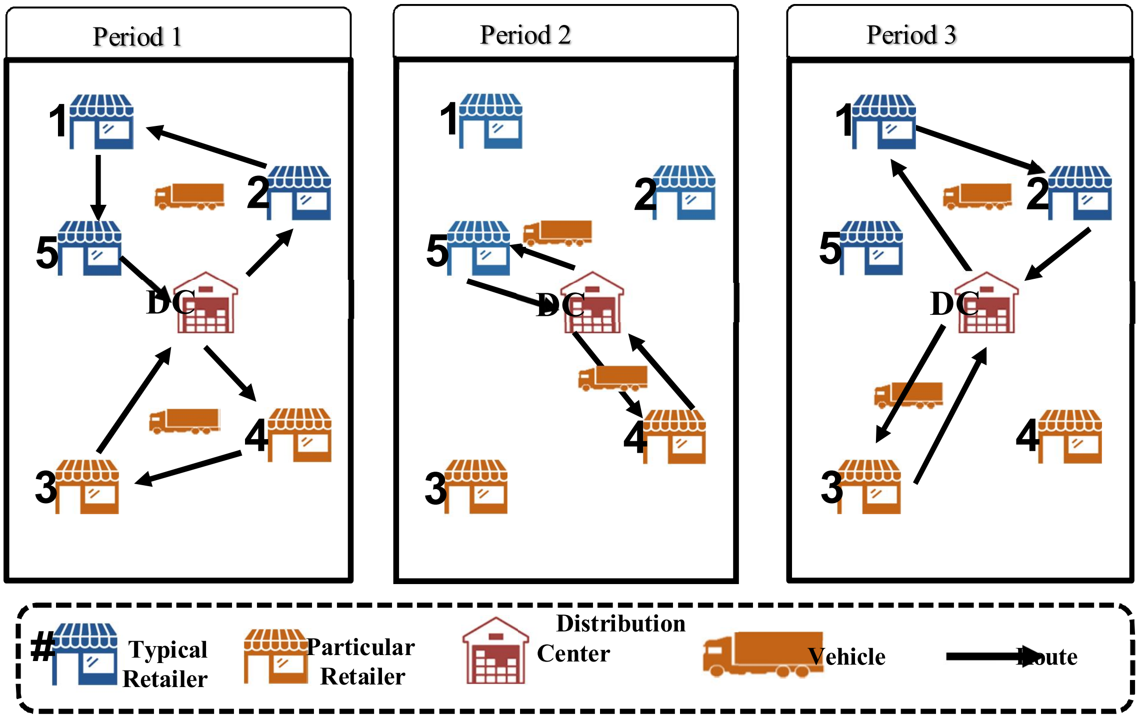

Fig. 2. An illustrative example of the proposed Model

3. Mathematical Model

In this section, a mathematical model is proposed for the PIRP by considering driver consistency. Two different types of consistency are considered for different types of retailers: typical and particular ones. Particular retailers must be visited by only one driver on the planning horizon. However, generalized driver consistency is applied to typical retailers. Therefore, the objective function contains routing, holding inventory, and consistency costs. In this paper, customer satisfaction is addressed by meeting customer demands with fresh products. The predefined amount of customer demands at each retailer must be met with fresh products to achieve a particular level of customer satisfaction. However, the exact amount of demands that must be met by fresh products to achieve a high level of satisfaction cannot be determined. Therefore, the proportion of demand in each retailer $(\tilde{L}_i)$ is defined as fuzzy parameter. The percentage of fresh products delivered to the i^{th} customer $\tilde{L}_i$ modeled with triangular fuzzy numbers $\tilde{L}_i = (\underline{L}_i, \hat{L}_i, \overline{L}_i)$, where $\underline{L}_i \le \hat{L}_i \le \overline{L}_i$ for each customer *i*, as shown in Fig. 3.

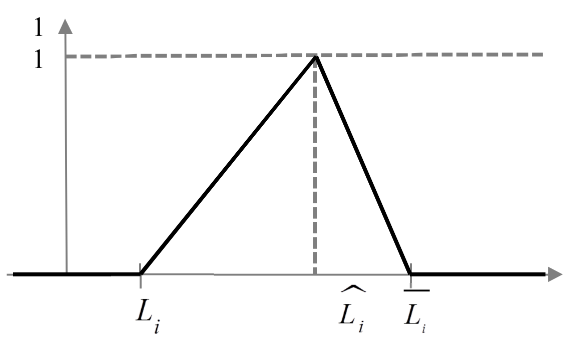

Fig. 3. Triangular fuzzy number $\tilde{L}_i = (\underline{L}_i, \hat{L}_i, \overline{L}_i)$

The applied method promoted retailer satisfaction. The results of implementing this method affected retailers whose customers were beneficiary by receiving top fresh products from their retailers. Driver consistent services as another way to increase retailer satisfaction has been mentioned in this model. Because of the different characteristics of retailers, they are divided into two groups: particular and typical groups. The primary assumptions of the proposed model are given as follows:

- All kinds of customers should be served by at most one vehicle in each period.
- All demands must be fulfilled.
- There is a limited inventory level at the distribution center to satisfy customer demands
- Products from the distribution center delivered to customers are fresh.
- Products are delivered to customers before the spoilage.

Tab. 2. Summary of notations

Sets	
N	Set of nodes including depot and customers
A	Set of arcs
R	Set of customers
$R^{particular}$	Set of customers with hard driver consistency
$R^{typical}$	Set of customers with soft consistency (generalized)
S	Set of aged products
F	Set of fresh age
K	Set of vehicles
T	Set of time periods
Parameters	
c_{ij}	Routing cost on arc $(i,j) \in A$
h_i	Holding cost per unit of product for each customer $i \in R$
δ	Consistency cost
r_t	Number of products available at the distribution center in time period $t \in T$
d_{it}	The demand for customer $i \in R$ in period $t \in T$
C_i	Inventory capacity for customer $i \in R$
$\tilde{L}_i$	Triangular fuzzy percentage of delivering fresh product per each customer $i \in R$, $\tilde{L}_i \sim (\overline{L}_i, \hat{L}_i, \underline{L}_i)$
α	Amount of service possibility
β	Amount of service necessity
Q	The capacity of a vehicle
Decision variables	

I_i^{gt}	Amount of inventory with age g at customer $i\epsilon R$ in period $t\epsilon T$
D_i^{gt}	The amount of the i^{th} customer demand met by-products with age g in period t
q_i^{kt}	The amount of fresh product which transports from DC to yjr i^{th} customer by vehicle k in period t
y_i^{kt}	1, if customer $i\epsilon N$ served by vehicle $k\epsilon K$ in period $t\epsilon T$, otherwise 0
x_{ijkt}	1, if vehicle $k\epsilon K$ drives on the route between customers i, $j\epsilon N$ in period $t\epsilon T$, otherwise 0
Z_i^k	1, if customer $i\epsilon R^{typical}$ is assigned to vehicle k, otherwise 0
$Z_{\max}$	The maximum number of different drivers assigned to a particular customer
G_{ikt}	The sequence number of customers $i\epsilon N$ in the route corresponding to vehicle k in period $t\epsilon T$

The proposed mathematical model is formulated as follows:

$$Min \sum_{i\in N}\sum_{g\in S}\sum_{t\in T} h_i I_i^{gt} + \sum_{(i,j)\in A}\sum_{k\in K}\sum_{t\in T} c_{ij} x_{ijkt} + \delta Z_{\max} \tag{1}$$

Subject to:

$$I_i^{gt} = I_i^{g-1,t-1} - D_i^{gt} \qquad g \in S \setminus \{0\},\ i \in R,\ t \in T \tag{2}$$

$$I_i^{0t} = \sum_{k\in K} q_i^{kt} - D_i^{0t} \qquad i \in R, t \in T \tag{3}$$

$$\sum_{i\in R}\sum_{k\in K} q_i^{kt} \le r_t \qquad t \in T \tag{4}$$

$$d_{it} = \sum_{g\in S} D_i^{gt} \qquad i \in R, t \in T \tag{5}$$

$$\sum_{g\in S} I_i^{gt} \le C_i \qquad i \in R, t \in T \tag{6}$$

$$\sum_{k\in K} q_i^{kt} \le C_i - \sum_{g\in S} I_i^{g,t-1} \qquad i \in R, t \in T \tag{7}$$

$$q_i^{kt} \le C_i y_i^{kt} \qquad i \in R, k \in K, t \in T \tag{8}$$

$$\sum_{t\in T} d_{it} \widetilde{L_i} \le \sum_{g\in F}\sum_{t\in T} D_i^{gt} \qquad i \in R \tag{9}$$

$$\sum_{i\in R} q_i^{kt} \le Q\, y_0^{kt} \qquad k \in K, t \in T \tag{10}$$

$$\sum_{k\in K} y_i^{kt} \le 1 \qquad i \in R, t \in T \qquad (11)$$

$$Z_i^k \ge y_i^{kt} \qquad i \in R, k \in K, t \in T \qquad (12)$$

$$\sum_{k\in K} Z_i^k = 1 \qquad i \in R^{particular} \qquad (13)$$

$$\sum_{k\in K} Z_i^k \le Z_{\max} \qquad i \in R^{typical} \qquad (14)$$

$$\sum_{j\in N\setminus\{i\}} x_{ijkt} = \sum_{j\in N\setminus\{i\}} x_{jikt} \qquad i \in N, k \in K, t \in T \qquad (15)$$

$$\sum_{j\in N\setminus\{i\}} x_{ijkt} = v_{ikt} \qquad i \in R, k \in K, t \in T \qquad (16)$$

$$G_{jkt} \ge G_{ikt} + Nx_{ijkt} - R \qquad i \in R, j \in N, k \in K, t \in T \qquad (17)$$

$$\sum_{i\in R} x_{0ikt} \le 1 \qquad k \in K, t \in T \qquad (18)$$

$$I_i^{gt}, D_i^{gt}, q_i^{kt} \ge 0 \qquad i \in R, g \in S, k \in K, t \in T \qquad (19)$$

$$y_i^{kt} \in \{0,1\} \qquad i \in N, k \in K, t \in T \qquad (20)$$

$$Z_i^k \in \{0,1\} \qquad i \in R, k \in K, t \in T \qquad (21)$$

$$x_{ijkt} \in \{0,1\} \qquad (i,j) \in A, k \in K, t \in T \qquad (22)$$

$$Z_{\max} \ge 0 \qquad (23)$$

The objective function (1) consists of three terms: inventory, routing, and consistency costs, respectively. Constraints (2) and (3) guarantee the inventory flow balance between customers for products of different ages. Constraint (4) ensures that each customer receives fresh products from DC. Constraint (5) states that the demand of each customer is met with products of different ages in each period. Constraint (6) guarantees the inventory capacity of each customer in each period. Constraint (7) ensures that the number of delivered products to the i^{th} customer is at most equal to empty space. Constraint (8) assumes the relationship between the decision variables q and y. Constraint (9) guarantees that the special amount of each customer's demand should be met with fresh products. Constraint (10) ensures that vehicle capacity should be respected. Constraint (11) guarantees that each customer should be visited by at most one vehicle in each period. Vehicle assignment to a customer in each period is regulated by Constraint (13). Constraints (14) and (15) correspond to the consistent and generalized types of driver consistency for their specific customers, respectively. Flow control constraints are represented by (16) and (17).

Constraint (18) is related to sub-tour elimination. Constraint (19) demonstrates that, at most, one visit in each period can be performed by a vehicle. Finally, domain decision variables are detected by Constraints (20)-(23).

To deal with uncertainty, the possibility theory is applied, which is a mathematical theory for certain forms. Two concepts utilized by possibility theory are possibility and necessity. The amount of possibility α and necessity β is defined with a fuzzy triangular function membership. Jamison and Lodwick [20], Werners [21], and Werners and Kondratenko [22] investigated the fuzzy number as a method of illustrating the uncertainty of a given value (quantity) by defining a possibility for the quantity.

To model fresh product delivery and based on requests/demand of each customer, two fuzzy approaches are applied. The decision-maker sets a certain degree $\alpha \in [0,1]$ in advance and defines it as follows:

$$Pos\left(\sum_{t\in T} d_{it}\tilde{L}_i \le \sum_{g\in F}\sum_{t\in T} d_i^{gt}\right) \ge \alpha \qquad i \in R; \qquad \alpha \in [0,1] \tag{24}$$

The other approach is to consider the firm's condition, which is a specific degree of necessity β defined below:

$$Nec\left(\sum_{t\in T} d_{it}\tilde{L}_i \le \sum_{g\in F}\sum_{t\in T} d_i^{gt}\right) \ge \beta \qquad i \in R; \qquad \beta \in [0,1] \tag{25}$$

Preconditions (24) and (25) for the mentioned constraint can be changed as follows:

$$Pos\left(\sum_{g\in F}\sum_{t\in T} d_i^{gt} - \sum_{t\in T} d_{it}\tilde{L}_i \ge 0\right) \ge \alpha \qquad i \in R; \qquad \alpha \in [0,1] \tag{26}$$

$$Nec\left(\sum_{g\in F}\sum_{t\in T} d_i^{gt} - \sum_{t\in T} d_{it}\tilde{L}_i \ge 0\right) \ge \beta \qquad i \in R; \qquad \beta \in [0,1] \tag{27}$$

The possibility Pos (serve $\tilde{L}_i$) and necessity Nec (serve $\tilde{L}_i$) ensure that each retailer receives a percentage of the fresh products during their demands period, as represented by a mathematical model below:

$$Pos(Serve\,\tilde{L}_i) = \begin{cases} 1, & \sum_{f\in F}\sum_{t\in T} d_i^{gt} \ge \sum_{t\in T} d_{it}\hat{L}_i \\ \dfrac{\sum_{f\in F}\sum_{t\in T} d_i^{gt} - \sum_{t\in T} d_{it}\underline{L}_i}{\sum_{t\in T} d_{it}(\hat{L}_i - \underline{L}_i)} & \sum_{t\in T} d_{it}\underline{L}_i \le \sum_{f\in F}\sum_{t\in T} d_i^{gt} \le \sum_{t\in T} d_{it}\hat{L}_i \\ 0, & \sum_{f\in F}\sum_{t\in T} d_i^{gt} \le \sum_{t\in T} d_{it}\underline{L}_i \end{cases} \tag{28}$$

$$Nec(Serve\,\tilde{L}_i) = \begin{cases} 1, & \sum_{f\in F}\sum_{t\in T} d_i^{gt} \ge \sum_{t\in T} d_{it}\bar{L}_i \\ \dfrac{\sum_{f\in F}\sum_{t\in T} d_i^{gt} - \sum_{t\in T} d_{it}\hat{L}_i}{\sum_{t\in T} d_{it}(\bar{L}_i - \hat{L}_i)} & {}_i \le \sum_{f\in F}\sum_{t\in T} d_i^{gt} \le \sum_{t\in T} d_{it}\bar{L}_i \\ 0, & \sum_{f\in F}\sum_{t\in T} d_i^{gt} \le \sum_{t\in T} d_{it}\hat{L}_i \end{cases} \tag{29}$$

Werners and Drawe [23] found the following relationship between possibility and necessity:

$$Pos(serve\,\tilde{L}_i) < 1 \Rightarrow Nes(serve\,\tilde{L}_i) = 0 \tag{30}$$

For *α, β >0* mentioned constraints are modeled by as crisp equivalents for Fuzzy Constraint (9), respectively:

$$Pos(serve\,\tilde{L}_i) \geq \alpha \Leftrightarrow \sum_{t\in T}(\alpha \hat{L}_i + (1-\alpha)\underline{L}_i)\,d_{it} \leq \sum_{g\in F}\sum_{t\in T} d_i^{gt} \qquad i \in R \qquad \alpha\in[0,1] \tag{31}$$

$$Nec(serve\,\tilde{L}_i) \geq \beta \Leftrightarrow \sum_{t\in T}(\beta \overline{L}_i + (1-\beta)\hat{L}_i)\,d_{it} \leq \sum_{g\in F}\sum_{t\in T} d_i^{gt} \qquad i \in R \qquad \beta\in[0,1] \tag{32}$$

Now, the problem is solved using the mentioned objective function and Constraints (2-8), (10-23), (31), and (32).

4. Computations and Results

The represented mathematical model is solved by Julia Software on an Intel Core i7 with 1.8 GHz CPU and 8 GB of RAM. To evaluate the proposed model, ten customers have been considered, six of which are particular, and the others are typical. Four vehicles with the same capacity and three-time periods are considered. The values of the parameters were calculated by Coelho and Laporte [13].

The obtained routes in different periods under different values of possibility and necessity are illustrated in Figs. 4 and 5. Fig. 4 illustrates the problem with *α*=1, *β*=1 in three periods. It is clear that, based on the problem assumptions in the first period, all of the retailers received fresh products and satisfied their demands. In the second period, the difference between the two given values of possibility and necessity is shown. The results reported 11867 units for routing costs and 105.25 units for inventory costs. Results shown in Fig. 5 are obtained for *α*=0.7, *β*=0, reporting 9514 units for routing and 704.2 units for inventory costs.

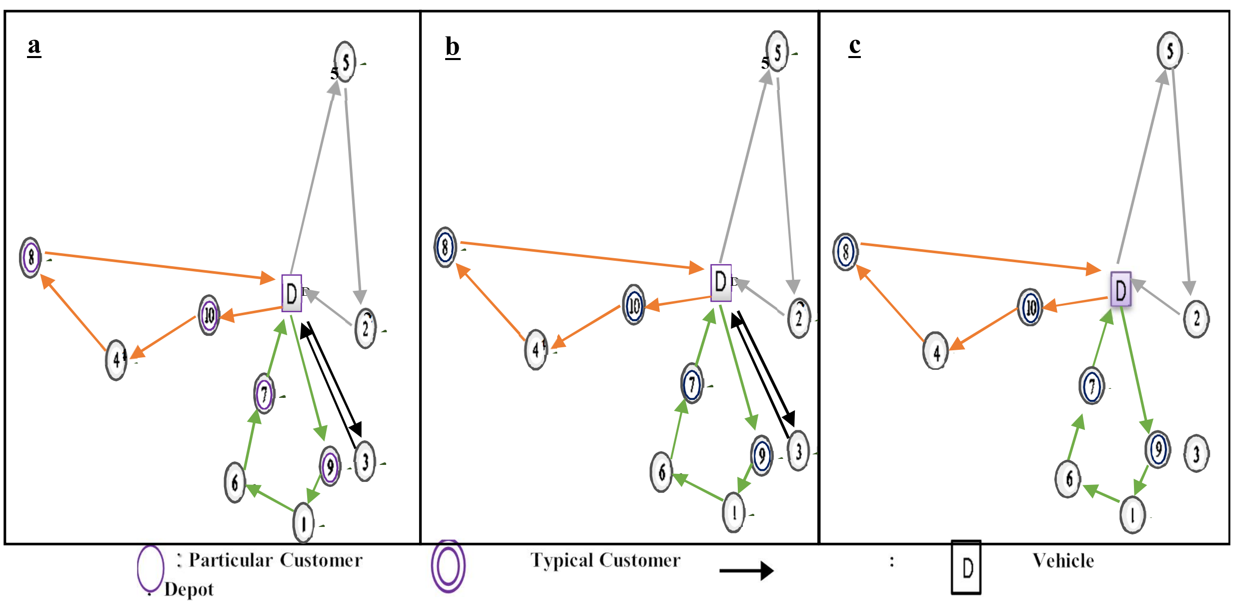

Fig. 4. Product delivery with *α*=1, *β*=1 in a) the first period, b) second period, and c) third period

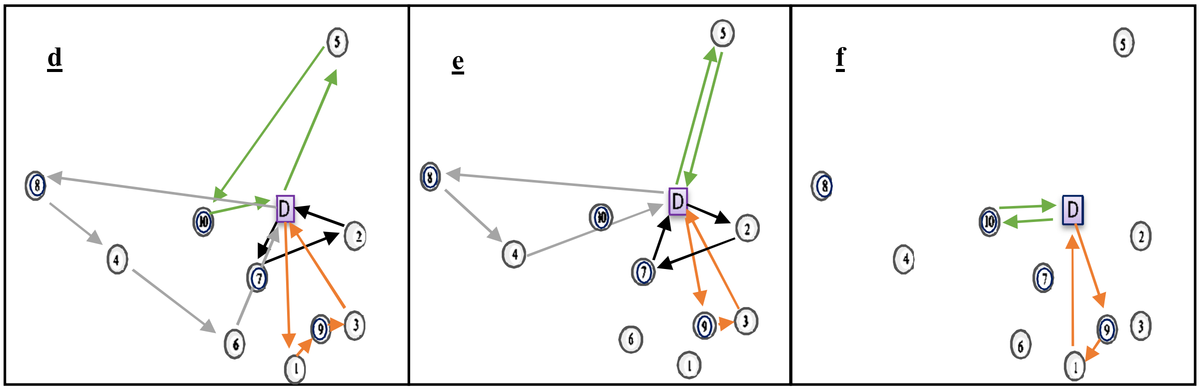

Fig. 5. Product delivery with *α*=0.7, *β*=0 in a) the first period, b) second period, and c) third period

Accordingly, the existing 598.95-unit difference in inventory costs showed the efficiency of the proposed model, which is proved according to the different dedicated degrees of *α, β*.

The results of routing and inventory costs for different vehicle capacities and different values of possibility and necessity are reported in Table 3. Accordingly, increasing *α, β* values causes an increase in routing costs because of the insurance to delivering fresh products and the models avoiding storing more products. By increasing vehicle capacities, the growing (ascending) trend of costs slows down, or residual capacity may also play a role here.

Fig. 6 represents the comparison among Consistent Inventory Routing Problem (CIRP), Generalized Consistent Inventory Routing Problem (GCIRP), and proposed model costs at the same vehicle capacity (Q=400). In the CIRP model in which all of the customers are visited by the same driver during the planning horizon, high costs are incurred, as compared to GCIRP and proposed models. The results of increasing alpha and beta amounts, which influenced routing costs, are consistent with the previous results.

Tab. 3. Comparison between routing and inventory costs on different vehicle capacity for possibility and necessity values

Vehicle Capacity	α=0.1, β= 0		α =0.4, β= 0		α = 0.7, β= 0		α = 1, β= 0		α =1, β= 0.4		α =1, β=0.7		α =1, β= 1	
	Inventory Cost	Routing Cost	Inventory Cost	Routing Cost	Inventory Cost	Routing Cost	Inventory Cost	Routing Cost	Inventory Cost	Routing Cost	Inventory Cost	Routing Cost	Inventory Cost	Routing Cost
350	704.2	9514	704.2	9514	704.2	9514	444.7	10239	142.6	11079	147.3	11792	105.2	11867
450	416.2	8637	416.2	8637	416.2	8637	367.8	9022	234.6	9388	79.2	10461	79.2	10461
550	864.7	759	864.7	7595	864.7	7595	539.8	8422	258.4	9388	93.1	9951	93.1	9951
650	814.5	7125	829.2	7117	829.2	7117	323.5	8212	227.9	8420	0	9585	0	9585
750	886.85	6820	886.9	6820	886.9	6820	489.3	7849	304.5	8164	30.4	9510	0	9585

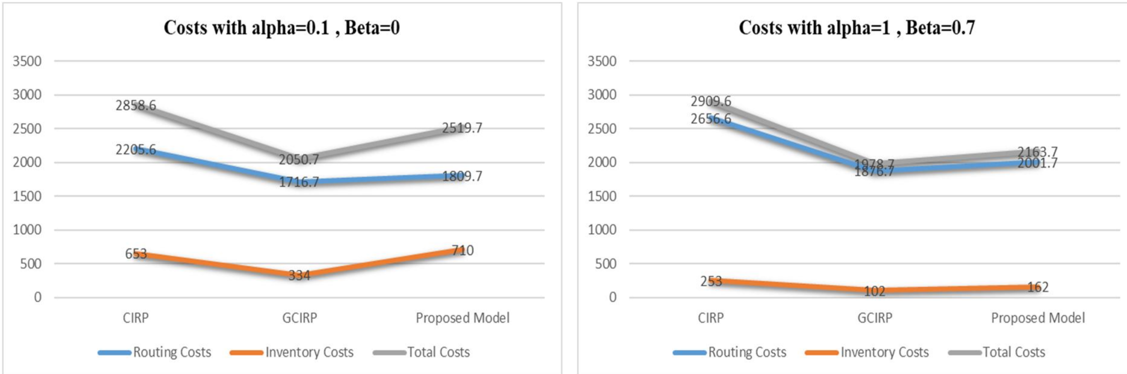

Fig. 6. Comparison between CIRP, GCIRP, and proposed model costs

5. Conclusion

In recent decades, the number of applications related to customer satisfaction has experienced a steady, high growth. Branding increases the number of customers to gain more stock market which can be the reason for this trend. Along these lines, a mathematical model was represented involving a series of activities related to retailer and customer satisfaction simultaneously. Driver consistent services consider retailers' satisfaction and customer satisfaction by receiving fresh products. To cope with the lack of information, a fuzzy approach was applied. The possibility and necessity as classes of fuzzy uncertainty measures were used to deal with the condition. The results such as routing and inventory costs for different vehicle capacities and different values of possibility and necessity were reported. Accordingly, increasing α, β values causes increase in routing costs because the insurance to delivering fresh products and model avoiding the storing of more products. By increasing vehicle capacity, this growing trend slowed down, or perhaps residual capacity played a role.

Since the results confirmed the efficiency of the proposed model, this study suggested a research perspective to apply heuristics or metaheuristic algorithms to solve the large-sized problem. Considering other kinds of uncertainties, e.g., stochastic programming and robust optimization, can be other pieces of advice to close the article closer to the real world.

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