An Upgraded Approach to Solve Fuzzy Transportation Problems

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Abstract

TP has many applications and applications and applications to reduce costs. A good algorithm has been developed to adjust the TP in the context of all given parameters, namely the supply, demand and TC team one, well. However, in real applications, there are many different situations due to uncertainty. It is therefore important to study PT in an uncertain environment. In this paper, an updated procedure is proposed to fix FTP where all parameters represents the non-triangular FN. The first is to use a non-trivial assembly to convert FTP to an LP with FC and net resistance. The second is to use a new vending system to turn the problem-solving lab into a three-wire lab. The value of a well-updated system is assessed compared to existing systems from an application model. The results obtained show that the updated method proposed in this study is simpler and more efficient than some existing methods commonly used in literature.

Keywords: Fuzzy Transportation Problem, Fuzzy Numbers, Solid Transportation Problems, Linear Programming Problem.

Abbreviations

Transportation Problem	:	TP
Transportation Cost	:	TC
Fuzzy Transportation Problem	:	FTP
Fuzzy Number	:	FN
Linear Programming	:	LP
Fuzzy Cost	:	FC
Linear Programming Problem	:	LPP
Fuzzy Linear Programming	:	FLP

Membership Function	:	MF
Objective Function	:	OF
Solid Transportation Problem	:	STP
Fuzzy Variables	:	FV
Goal Programming	:	GP
Optimal Solution	:	OS
Initial Basic Feasible Solution	:	IBFS
Fuzzy Supply	:	FS
Fuzzy Demand	:	FD
Fuzzy Quantity	:	FQ
Objective Value	:	OV

1. Introduction

TP is an important LPP installed network that appears in many situations and should receive a lot of attention in documentation. The main idea of this problem is to find the minimum TC of the product to meet the requirements in the destination by using the resources at the beginning. TP can be used for a variety of situations such as planning, production, investment, plant location, product management, project management and many more [26]. In general, TP is handled assuming TC and the price and rejection values are directly related, i.e. around the network. However, in most cases, the decision maker has no information about the TP rate. As [35] explained, the following factors may affect the state of fuzziness in TPs: (a) the decision-maker lacks sufficient information about the TC unit of the transport function and therefore the TC does not n ', (b) there may be some kind of misconception about the demand for a new product on the market, (c) there may be uncertainty about the availability of the product from the source or importer due to time constraints. Also, in the fast, there are many different conditions due to uncertainty, such as changing weather conditions, oil prices, and traffic conditions. It is therefore important to study TP in an uncertain environment. Since TP is actually LPP, the easiest way is to add the current FLP format to FTP [4, 19, 22, 25, 33, 39, 44, 49]. However, some of the existing systems provide only a clever solution that represents agreement in the case of nonlinear data [3, 28-29, 32, 36].
FTP studies are also available, [27] demonstrated that the solution obtained by FLP always worked and developed in the previous studies, FLP in several of the best ways to fix TP. [13] developed an algorithm to adjust TPs where supply and demand are solid foundations with linear or triangular MF. [46] used FSs to fix the TP and the required by the parametric program. Their approach provides a solution that meets the highest objectives and objectives at the same time. [34] discussed the TP type and FC rate and turned the problem into a TP bicriterion on OF net. Their system provides only a good solution based on a good solution of the changed problems. [5] proposed a free STP of trapezoidal FN representing transportation cost, requirement and authority. They put together a parametric system to find a non-trivial solution. [21] devised a method based on the extension principle to obtain unnecessary OV via FTP as well as FC and FS rates as well as the required number. The LP system requires several objectives to solve the FTP problem. Liu incorporated a similar mechanism to regulate nonlinear STP [12]. [42] showed two ways to reduce the FTP cost of supply chain and the required are trapezoidal FNs. They used a parametric method to find a non-invasive solution with the aim of reducing the TC concentration in both systems. [50] studied STP bicriterion in the stochastic parameter and built three mathematical models for the problem, including the expected GP value, the unpredictable GP block, and the GP-based space. [37] proposed a STP of a specific load in an unfamiliar environment, where immediate and unpaid prices, supply standards and requirements, as well as transportation capacity were FV. [18] demonstrated a non-

invasive GP approach to solving the generation / transfer configuration problem embedded in a number of unimportant objectives in an uncertain environment. [14] devised a new GP-based system to streamline FTP and FC. [23] proposed several ways to fix TP in a non-invasive network. [17] used algorithm cells to solve TPs in random numbers. [43] produced FTP, using trapezoidal FNs and developed a modified fuzzy distribution system to achieve the OS in FN format. [24] introduced a new algorithm, a zero-sum algorithm for finding seamless FTP operating systems with critical parameters. [30] devised a strategy for reducing TC as well as travel time when demand, supply and TC per minute are available in FN. [40] developed a new FLPP-based system to find the FTP OS. They developed a new system based on the quality function to fix FTP on the TC, product supply and demand are fully represented by trapezoidal [38]. After that, [11] introduced a similar algorithm to fix the same type of FTP assuming that the decision maker was unsure of the correct TC values but there was nothing wrong with that involved in products and demand. [20] introduced a simpler algorithm to solve an FTP problem that was simpler and easier to understand than the method suggested in [45]. In addition, a new mechanism was developed to locate a non-invasive OS that had no transport problems on the new trapezoidal FN representation of [48]. [1] devised a systematic approach to fix all types of FTP, both increasing or decreasing OF. [15] proposed a new complex strategy for the consideration and choice of investing in intelligent travel systems. A unique set of many STPs with nonsense penalties, sources, requirements and liability was developed and implemented by [31]. FLP-based messaging systems for FS, request, and travel capabilities have been included in this report. [6] developed a fuzzy version of the Vogel method and MODI to achieve a non-invasive IBFS and a viable solution that could be done, one by one, without translating them into classic TP. Furthermore, [52] developed algorithms to find the OS of FTP, where supply, demand and price are all FN. Their algorithm provides the decision maker a better solution compared to current systems. [16] used examples to show that their system will not always lead to a useless OS. [41] discussed the psychological analysis of FTP. [7] demonstrated an ingenious GP approach to resolving TP with multiple objectives and intermediate costs. Furthermore, [10] compared two working TPs with 2 fuzzy parameters where unit TCs, the specific charge and the first problem in TC units, charge , supply and demand and the second problem are type FV 2. [9] focused on the generation of PTS OS in a nonlinear environment, which assumes that all parameters are type 2 FV due to lack of transparency.

In this study, the following contributions were made by developing a new destruction method to mimic and modify FTPs: (a) Unlike some current methods, it is assumed that the arrival, desire and group TC values are negative triangular FNs. (b) The shortcomings of the existing FTP method are briefly discussed. (c) How to manage FTP is divided into two main parts. The first is to convert FTP to LPP with FC blocking on the net. The second is to develop a new sales strategy to convert the resulting LPP into three TP net. (d) The computational compression of the required method is greatly reduced compared to some conventional methods commonly used in literature.

2. Preliminaries

In this section, we examine some important concepts related to the fuzzy set concept, which will be used in other scripts [2].

First Definition: A FN is a convex normalized fuzzy set v * of real row R; the MF who goes on and on.

Second Definition: FN $v^* = (v_1, v_2, v_3)$ is said to be FN triangular if its MF is given as follows:

$$\theta_{v^*}(y) = \frac{y - v_1}{v_2 - v_1}, v_1 \le y \le v_2$$

$$\theta_{v^*}(y) = \frac{v_3 - y}{v_3 - v_2}, v_2 \le y \le v_3 \quad \text{(A1)}$$
$$\theta_{v^*}(y) = 0, \textit{ elsewhere}$$

FN $v^* = (v_1, v_2, v_3)$ can also mean $v^* = [v(m), v(d), v(v)]$. In this case, the point *(v) d* of the triangle FN v * gives the highest point $\boldsymbol{\theta_{v^*}(y)}$, i.e., $\boldsymbol{\theta_{v^*}(v^d)} = 1$, this is also called v * triangular FN core. Furthermore, *(v)l* and *(v)v* are individually spaced supporting the bottom and top of the triangular FN v *. All FN settings are defined as triangular TF (R).

Third Definition: It is said that FN triangular $v^* = (v_1, v_2, v_3)$ is the positive FN triangular if $v_1 \ge 0$. All these FN triangular curves are defined as all TF (R) *.

Forth Definition: It is said that the two triangular FNs $v^* = (v_1, v_2, v_3)$ and $u^* = (u_1, u_2, u_3)$ are equal, $v^* = u^*$, $v_1 = u_1$, $v_2 = u_2$ if only and $v_3 = u_3$.

Fifth Definition: Let $v^* = (v_1, v_2, v_3)$ and $u^* = (u_1, u_2, u_3)$ be two negative triangular FNs in $l \in R$. Then the mathematical function is given in v * and u * by:

i) $l \ge 0,\ lv^* = (lv_1, lv_2, lv_3)$

ii) $l < 0,\ lv^* = (lv_3, lv_2, lv_1)$

iii) $v^* \times u^* = (v_1 + u_1, v_2 + u_2, v_3 + u_3)$

iv) $v^* \times u^* = (v_1 u_1, v_2 u_2, v_3 u_3)$

3. FTP

In a typical TP, the decision maker is thought to have accurate information about the magnitude of the problem. In real-world applications, TC standards, product supply and demand may not be fully understood due to uncontrolled events. To deal with such situations, a fuzzy program is put on paper to fix TP. FTP, by a decision maker who is unsure of the exact principles of TC, supply and demand, can be developed [51] as follows:

$$min \sum_{j=1}^{n} \sum_{k=1}^{o} d_{jk}^* \times y_{jk}^*$$

Subject to:

$$\sum_{k=1}^{o} y_{jk}^* = t_j \qquad j = 1,2,3,...,n$$

$$\sum_{k=1}^{o} y_{jk}^* = e_k \qquad k = 1,2,3,...,o$$

$$y_{jk}^* \in TF(R), \quad j = 1,2,...,n, \quad k = 1,2,...,o. \quad \text{(A2)}$$

where, n = total number of points, o = total number of places, t_j = FS of product and j^{th} origin, e_k = FD of product and place kth where, d_{jk} = fuzzy TC per minute product from j^{th} from k^{th} point and y_{jk}^* = FQ of the product to be transferred from j^{th} point from k^{th} to reduce the total TC concentration.

Sixth Definition: Eq.A2 is considered a balanced FTP, if:

$$\sum_{j=1}^{n} t_j = \sum_{k=1}^{o} e_k$$

Elsewhere, it is known as unbalanced FTP.

First Remark: Without a general hiccup, we think the Eq.A2 is balanced one.

Second Remark: Since the negative number of products in the negative TC is insignificant, it is assumed that all parts of the FTP are not negative triangular FNs. About 2 words, take it as d_{jk}, t_j, e_k and y_{jk} and all represent it $d_{jk} = (d_{jk})\, m, (d_{jk})\, d, (d_{jk})\, v,\ t_j = (t_j)\, m, (t_j)\, d, (t_j)\, v.$, $e_k = (e_k)\, m, (e_k)\, d, (e_k)\, v$ and $y^*_{jk} = (y^*_{jk})\, m, (y^*_{jk})\, d, (y^*_{jk})\, v$, one. So from description 5, Eq.A2 can be interpreted as follows:

$$\sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{m}\left(y_{jk}\right)^{m},\left(d_{jk}\right)^{d}\left(y_{jk}\right)^{d},\left(d_{jk}\right)^{v}\left(y_{jk}\right)^{v}\right)$$

Subject to Constraints:

$$\begin{gathered}
\sum_{k=1}^{o}\left(\left(y_{jk}\right)^{m},\left(y_{jk}\right)^{d},\left(y_{jk}\right)^{v}\right)=\left(\left(e_{k}\right)^{m},\left(e_{k}\right)^{d},\left(e_{k}\right)^{v}\right),\ k=1,2,3,\ldots,o \\
\sum_{j=1}^{n}\left(\left(y_{jk}\right)^{m},\left(y_{jk}\right)^{d},\left(y_{jk}\right)^{v}\right)=\left(\left(t_{j}\right)^{m},\left(t_{j}\right)^{d},\left(t_{j}\right)^{v}\right),\ j=1,2,3,\ldots,n \\
\left(y_{jk}\right)^{v}-\left(y_{jk}\right)^{d}\geq o,\ j=1,2,3,\ldots,n;\ k=1,2,3,\ldots,o \\
\left(y_{jk}\right)^{d}-\left(y_{jk}\right)^{m}\geq o,\ j=1,2,3,\ldots,n;\ k=1,2,3,\ldots,o \\
\left(y_{jk}\right)^{m}\geq 0, j=1,2,3,\ldots,n; k=1,2,3,\ldots,o
\end{gathered} \tag{A3}$$

Similarly, with respect to definition 4, Eq.A3 can be rewritten as follows:

$$\sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{m}\left(y_{jk}\right)^{m}\right),\sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{d}\left(y_{jk}\right)^{d}\right),\sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{v}\left(y_{jk}\right)^{v}\right) \tag{A3.0}$$

Subject to Constraints:

$$\sum_{j=1}^{n}\left(\left(y_{jk}\right)^{m}\right)=\left(t_{j}\right)^{m},\ j=1,2,3,\ldots,n \tag{A3.1}$$

$$\sum_{j=1}^{n}\left(\left(y_{jk}\right)^{d}\right)=\left(t_{j}\right)^{d},\ j=1,2,3,\ldots,n \tag{A3.2}$$

$$\sum_{j=1}^{n}\left(\left(y_{jk}\right)^{v}\right)=\left(t_{j}\right)^{v},\ j=1,2,3,\ldots,n \tag{A3.3}$$

$$\sum_{k=1}^{o}\left(\left(y_{jk}\right)^{m}\right)=\left(t_{j}\right)^{m},\ k=1,2,3,\ldots,o \tag{A3.4}$$

$$\sum_{k=1}^{o}\left(\left(y_{jk}\right)^{d}\right)=\left(t_{j}\right)^{d},\ k=1,2,3,\ldots,o \tag{A3.5}$$

$$\sum_{k=1}^{o}\left(\left(y_{jk}\right)^{v}\right)=\left(t_{j}\right)^{v},\ k=1,2,3,\ldots,o \tag{A3.6}$$

$$\left(y_{jk}\right)^{v}-\left(y_{jk}\right)^{d}\geq o,\ j=1,2,3,\ldots,n;\ k=1,2,3,\ldots,o \tag{A3.7}$$

$$\left(y_{jk}\right)^{d}-\left(y_{jk}\right)^{m}\geq o,\ j=1,2,3,...,n;\ k=1,2,3,...,o \tag{A3.8}$$

$$\left(y_{jk}\right)^{m}\geq 0, j=1,2,3,...,n; k=1,2,3,...,o \tag{A3.9}$$

Also, for the Eq.A2 equilibrium inhibitors, they use Forth Definition. In the next section, new ways to overcome these weaknesses are suggested.

4. Newly Developed Approach

It is useful to point out that we can think of Eq.A3.0 as LPP has several objectives having OF:

$$\sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{m}\left(y_{jk}\right)^{m}\right),\sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{d}\left(y_{jk}\right)^{d}\right),\sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{v}\left(y_{jk}\right)^{v}\right)$$

based on the operating space of Eq.A.3.0. Also, blockchain (Eq.A3.7), (Eq.A3.8) and (Eq.A3.9) in Eq.A3.0 (and Eq.A2 and Eq.A3) are guaranteed only in the system d exploitation must have been a negative triangular FN. This means that without these constraints, the potential gap of Eq.A3.0 is separated by a series of changes (y_k) *m*, (y_k) *d* and (y_k) *v*. Therefore, we remove these barriers from the scope of the A3.0 scale and solve the underlying problem that makes these barriers satisfactory. This confirms that the OS was obtained as a negative FN triangular. Regarding the above discussion, we first find out the operating system of this net problem:

$$min\sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{m}\left(y_{jk}\right)^{m}\right) \tag{A4}$$

Subject to Constraints:

$$\sum_{j=1}^{n}\left(\left(y_{jk}\right)^{m}\right)=\left(t_{j}\right)^{m},\ j=1,2,3,...,n \tag{A4.1}$$

$$\sum_{k=1}^{o}\left(\left(y_{jk}\right)^{m}\right)=\left(t_{j}\right)^{m},\ k=1,2,3,...,o \tag{A4.2}$$

$$\left(y_{jk}\right)^{m}\geq 0, j=1,2,3,...,n; k=1,2,3,...,o \tag{A4.3}$$

As we have seen, the problem (Eq.A4) is pure TP that can be solved using standard travel simplex algorithm. The OS of this issue is a left-hander of the non-essential OS of Eq.A4.2. Note that the Eq.A4.3 bandwidth guarantees an unobtrusive OS of the Eq.A2 as a negative FN. Now assuming that (*y*) *m* = (y_{jk}) on × 1 is the OS of the problem (Eq.A4), we solve the following problem to enter the OS of Eq. A2:

$$min\sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{d}\left(y_{jk}\right)^{d}\right) \tag{A5}$$

Subject to Constraints:

$$\sum_{j=1}^{n}\left(y_{jk}\right)^{d}=\left(t_{j}\right)^{d},\ j=1,2,3,...,n \tag{A5.1}$$

$$\sum_{k=1}^{o}\left(y_{jk}\right)^{d}=\left(t_{k}\right)^{d},\ k=1,2,3,...,o \tag{A5.2}$$

$$\left(y_{jk}\right)^{d}\geq\left(y_{jk}\right)^{m},\ j=1,2,3,...,n;\ k=1,2,3,...,o \tag{A5.3}$$

Note that the barrier (Eq.A5.3) ensures that the fuzzy OS of the Eq.A2 is not lower than its left. Furthermore, it is clear that Eq.A5 is a limited TP that can be corrected using the method provided by [24]. Finally, assuming that $(y)d = \left(y_{jk}\right)d$ on × 1 are the OS of the problem (Eq.A5), we solve the following problem to get the exact point of the fuzzy OS of the Eq .A2:

$$min\sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{v}\left(y_{jk}\right)^{v}\right) \tag{A6}$$

Subject to Constraints:

$$\sum_{j=1}^{n}\left(y_{jk}\right)^{v} = \left(t_{j}\right)^{v},\ j = 1,2,3,\ldots,n \tag{A6.1}$$

$$\sum_{k=1}^{o}\left(y_{jk}\right)^{v} = \left(t_{k}\right)^{v},\ k = 1,2,3,\ldots,o \tag{A6.2}$$

$$\left(y_{jk}\right)^{v} \geq \left(y_{jk}\right)^{d},\ j = 1,2,3,\ldots,n;\ k = 1,2,3,\ldots,o \tag{A6.3}$$

As we have seen, this problem is also limited TP can be solved by using the method given in [8]. Moreover, the barrier (Eq.A6.3) supports that the correct position of the fuzzy OS of Eq.A2 is greater than or equal to its center. Therefore, the OS of the problem of Eq.A4, Eq.A5 and Eq.A6 ensure that the base OS of Eq.A2 is a triangular FN that is not negative. In summary, if *(y) m*, *(y) d* and *(y) v* are SO of network problems Eq.A4, Eq.A5 and Eq.A6, respectively, then *y = (y) m*, *(y) d*, *(y) v* would be the base OS of Eq.A2. Finally, the optimal value of the Eq.A2 problem is obtained by adding y and $d \times y$ as follows:

$$\begin{aligned} d \times y &= \sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{m},\left(d_{jk}\right)^{d},\left(d_{jk}\right)^{v}\right)\times\left(\left(y_{jk}\right)^{m},\left(y_{jk}\right)^{d},\left(y_{jk}\right)^{v}\right) \\ &= \sum_{j=1}^{n}\sum_{k=1}^{o}\left(\left(d_{jk}\right)^{m}\left(y_{jk}\right)^{m},\left(d_{jk}\right)^{d}\left(y_{jk}\right)^{d},\left(d_{jk}\right)^{v}\left(y_{jk}\right)^{v}\right) \end{aligned}$$

5. Merits of Newly Proposed Method

In this section, the benefits of an expected FTP processing method are defined.

- Not only will the required system to implement FTP and TC representing FN be implemented in the principle of donations and requests as existing numbers, but it can also be used to configure FTP on all FN-enabled devices.
- The OS looks like a negative FN, that is, there are no negative components either in the FQ product or in the non-core TC.
- Using different methods such as northwest corner system, minimum price system and Vogel fuzzy approximation system to find the IBFS of the problem (Eq.A4), (Eq.A5) and (Eq.A6) lead to the same total CT.
- The main advantage of the proposed method is that solving the Eq.A2 problem (Eq.A4), (Eq.A5) and (Eq.A6) is relatively large compared to the problem (Eq.A3. 0) by a. mathematical considerations, regarding the number of barriers to change. There is a direct relationship between the conventional complexity of LPP and the number of barriers to change. In particular, since the memory size required to place the backup in the simplex algorithm is square of the number of constraints, reducing the number of constraints of the LP type is very important from a mathematical point of view. Thus, the reduction in the number of inhibitions and the variability of the LP type leads to a reduction in the complexity of the LP type modified by

simplex algorithms and key methods such as Khachian's ellipsoid algorithm and projective algorithms.

Compare the resistance and variability of the problem (Eq.A4), (Eq.A5) and (Eq.A6) the problem (Eq.A3.0). Problem (Eq.A4) has no barrier *(n + o)* and no change, while problem (Eq.A3.0) has *3 (n + o) +2* no barrier and 3 no change. This indicates that the problem (Eq.A4) has *2 (n + o + no)* barriers and 2 less change than the problem (Eq.A3.0), so the use of the problem (Eq.A4) is strong the economy in terms of the problem (Eq. .A3.0) is based on mathematical concepts. There is a similar comparison between the resistance and exchange rate (Eq.A5) and (Eq.A6) and (Eq.A3.0). It is noteworthy that the constraints (Eq.A5.3) and (Eq.A6.3) agree that the variance $(y_k)d$ and $(y_k)v$ are limited. The simplex bounded system also uses these blockchains in the same way as the simplex bounded block $(y_k)m\geq 0$. This means that these barriers do not increase the number of barriers immediately. Therefore, regarding the above discussion, we recommend using problem (Eq.A4), (Eq.A5), and (Eq.A6) instead of problem (Eq.A3.0) to solve Eq.A2 from a mathematical point of view.

6. Applications of Newly Proposed Method

In this section, the model application is analyzed using the recommended method and evaluating the obtained results.

First Example: One company has two sources P1 and P2, as well as three E1, E2 and E3 sources; TC fuzzy for quantity of products from j^{th} source to where k^{th} is d_{jk} where,

$$d_{jk} = \left[(20,30,40)(60,70,90)(90,100,110)(70,80,90)(85,95,115)(35,45,55)\right]$$

The FS of the product in the first and second stages are (80, 100, 130) and (50, 70, 100), respectively. FD of the product in the first place, second and third are (40, 50, 60), (30, 40, 50) and (70, 90, 120), respectively. The company wants to determine the FQ of the product that needs to be shipped from any start to anywhere so that the total TC value is minimal. This problem can be solved with the following FTP:

$$min\ (20,30,40)y_{11}\times(60,70,90)y_{12}\times(90,100,110)y_{13}\times(70,80,90)y_{21}\times(90,100,120)y_{22}\times(40,50,60)y_{23}$$

Subject to Constraints:

$$\begin{aligned}&y_{11}\times y_{12}\times y_{13} = (80,100,130), y_{21}\times y_{22}\times y_{23} = (50,70,100), y_{11}\times y_{21} = (40,50,70),\\ &y_{12}\times y_{22} = (30,40,50), y_{13}\times y_{23} = (65,85,115), y_{11}, y_{12}, y_{13}, y_{21}, y_{22}, y_{23}\in TF(R).\end{aligned} \quad \text{(A7)}$$

Total FS = (125, 165, 225) = total FD so FTP is appropriate. Regarding the problem (Eq.A6), this problem can be translated into the following FTP:

$$\begin{aligned}&Min\ 20(y_{11})m+60(y_{12})m+90(y_{13})m+70(y_{21})m+85(y_{22})m+35(y_{23})m,\\ &30(y_{11})d+70(y_{12})d+100(y_{13})d+80(y_{21})d+95(y_{22})d+45(y_{23})d,\\ &40(y_{11})v+90(y_{12})v+110(y_{13})v+90(y_{21})v\ +115(y_{22})v+55(y_{23})v\end{aligned}$$

Subject to Constraints:

$$(y_{11})m+(y_{12})m+(y_{13})m=80, (y_{11})d+(y_{12})d+(y_{13})d=100, (y_{11})v+(y_{12})v+(y_{13})v = 130,$$

$$\begin{aligned}&(y_{21})m+(y_{22})m+(y_{23})m=50,(y_{21})d+(y_{22})d+(y_{23})d=70,(y_{21})v+(y_{22})v+(y_{23})v=100,\\&(y_{11})m+(y_{21})m=40,(y_{11})d+(y_{21})d=50,(y_{11})v+(y_{21})v=70,(y_{12})m+(y_{22})m=30,\\&(y_{12})d+(y_{22})d=40,(y_{12})v+(y_{22})v=50,(y_{13})m+(y_{23})m=65,(y_{13})d+(y_{23})d=85,\\&(y_{13})v+(y_{23})v=115,\\&(y_{jk})d-(y_{jk})m\geq 0,(y_{jk})v-(y_{jk})d\geq 0,(y_{jk})m\geq 0,\ j=1,\ 2;k=1,\ 2,\ 3\end{aligned} \tag{A8}$$

In this case, regarding the problem (Eq.A4), we will first fix the following TP net to get the left side of Eq.A7:

$$Min\ 20(y_{11})m+60(y_{12})m+90(y_{13})m+70(y_{21})m+85(y_{22})m+35(y_{23})m,$$

Subject to Constraints:

$$\begin{aligned}&(y_{11})m+(y_{12})m+(y_{13})m=80,(y_{21})m+(y_{22})m+(y_{23})m=50,(y_{11})m+(y_{21})m=40,\\&(y_{12})m+(y_{22})m=30,(y_{13})m+(y_{23})m=65,(y_{11})m,(y_{12})m,(y_{13})m,(y_{21})m,(y_{22})m,(y_{23})m\geq 0\end{aligned} \tag{A9}$$

Fix TP (Eq.A9) using the standard transportation simplex algorithm that delivers the best OS and OV:

$$(y_{11})m=40,(y_{12})m=30,(y_{13})m=20,(y_{21})m=5,(y_{22})m=5,(y_{23})m=50,(d\times y)m=5030. \tag{A10}$$

Now based on the OS (Eq.A10) and related to the problem (Eq.A5), we are setting up a limited LPP to access the free OS space of FTP (Eq.A7):

$$Min\ 30(y_{11})d+70(y_{12})d+100(y_{13})d+80(y_{21})d+95(y_{22})d+45(y_{23})d$$

Subject to Constraints:

$$\begin{aligned}&(y_{11})d+(y_{12})d+(y_{13})d=100,(y_{21})d+(y_{22})d+(y_{23})d=70,(y_{11})d+(y_{21})d=50,\\&(y_{12})d+(y_{22})d=40,(y_{13})d+(y_{23})d=85,\\&(y_{11})d\geq 40,(y_{12})d\geq 30,(y_{13})d\geq 20,(y_{21})d\geq 0,(y_{22})d\geq 0,(y_{23})d\geq 50.\end{aligned} \tag{A11}$$

Classical TP can be corrected using the method provided above. OS and OV (Eq.A11) problems are found as follows:

$$(y_{11})d=50,(y_{12})d=40,(y_{13})d=20,(y_{21})d=5,(y_{22})d=5,(y_{23})d=70,(d\times y)d=7930. \tag{A12}$$

Also, regarding OS (Eq.A12) and Troubleshooting (Eq.A6), we solve the following bounded LPP to find the true fuzzy OS core of Eq.A7:

$$Min\ 40(y_{11})v+90(y_{12})v+130(y_{13})v+90(y_{21})v+115(y_{22})v+55(y_{23})v$$

Subject to Constraints:

$$(y_{11})v+(y_{12})v+(y_{13})v=130,(y_{21})v+(y_{22})v+(y_{23})v=100,$$

$$\left(y_{11}\right)v+\left(y_{21}\right)v=70,\left(y_{12}\right)v+\left(y_{22}\right)v=50,\left(y_{13}\right)v+\left(y_{23}\right)v=115, \quad \text{(A13)}$$
$$\left(y_{11}\right)v\geq 50,\left(y_{12}\right)v\geq 40,\left(y_{13}\right)v\geq 20,\left(y_{21}\right)v\geq 5,\left(y_{22}\right)v\geq 5,\left(y_{23}\right)v\geq 70.$$

OS and OV (Eq.A11) problems are found as follows:

$$\left(y_{11}\right)v=70,\left(y_{12}\right)v=50,\left(y_{13}\right)v=20,\left(y_{21}\right)v=5,\left(y_{22}\right)v=5,\left(y_{23}\right)v=100,(d\times y)v=12930. \quad \text{(A14)}$$

Finally, based on OS (Eq.A10), (Eq.A12) and (Eq.A14), the OS and OV of Eq.A7 are offered as follows:

$$y=y_{11}=\left(y_{11}\right)m,\left(y_{11}\right)d,\left(y_{11}\right)v=\left(40,\ 50,\ 70\right);y=y_{12}=\left(y_{12}\right)m,\left(y_{12}\right)d,\left(y_{12}\right)v=\left(30,\ 40,\ 50\right)$$
$$y=y_{13}=\left(y_{13}\right)m,\left(y_{13}\right)d,\left(y_{13}\right)v=\left(20,\ 20,\ 20\right);y=y_{21}=\left(y_{21}\right)m,\left(y_{21}\right)d,\left(y_{21}\right)v=\left(5,\ 5,\ 5\right)$$
$$y=y_{22}=\left(y_{22}\right)m,\left(y_{22}\right)d,\left(y_{22}\right)v=\left(5,\ 5,\ 5\right);y=y_{23}=\left(y_{23}\right)m,\left(y_{23}\right)d,\left(y_{23}\right)v=\left(50,\ 70,\ 100\right)$$

$$d\times y=\sum_{j=1}^{n}\sum_{k=1}^{o}d_{jk}\times y_{jk}=\left(5030,7930,12930\right) \quad \text{(A15)}$$

The minimum TC minimum can be converted to the default OS. Using the required method, the minimum nonlinear TC is w = (5030,7930,12930) which can be translated as follows:
- The minimum TC total is 5030 minutes.
- The maximum possible TC is 7930 minutes.
- The minimum travel time is 12930 minutes.

This result indicates that the minimum TC minimum will be more than 5030 minutes and less than 12930 minutes and the maximum chance is that the minimum TC total is 7930 minutes. It can be seen that there is no negative aspect of the OS that fuzzy got in the fuzzy TC collection, as you consider the existing system, if we apply the general distribution system fuzzy switch to find the OS without issue. An Eq.A6 with the help of IFBFS, obtained based on generalized fuzzy northwest corner system, then we get the following fuzzy OS and there is a negative part in the FQ of the product y_{13} which should be changed by originally from third place and therefore no physical meaning.

$$y=y_{11}=\left(y_{11}\right)m,\left(y_{11}\right)d,\left(y_{11}\right)v=\left(40,\ 50,\ 70\right);y=y_{12}=\left(y_{12}\right)m,\left(y_{12}\right)d,\left(y_{12}\right)v=\left(30,\ 40,\ 50\right)$$
$$y=y_{13}=\left(y_{13}\right)m,\left(y_{13}\right)d,\left(y_{13}\right)v=\left(20,\ 20,\ 20\right);y=y_{21}=\left(y_{21}\right)m,\left(y_{21}\right)d,\left(y_{21}\right)v=\left(5,\ 5,\ 5\right) \quad \text{(A16)}$$
$$y=y_{22}=\left(y_{22}\right)m,\left(y_{22}\right)d,\left(y_{22}\right)v=\left(5,\ 5,\ 5\right)$$

Also, the levels y_{13} and fuzzy OS (Eq.A15) and (Eq.A16) are equal, i.e. R (-40, 20, 70) = R (20, 20, 20) = 20, where obviously. (-40, 20, 70) ≠ (20, 20, 20) and this indicates another setback of the method, which used the degree function to adjust the FTP. Finally, to get the base OS of Eq.A7 based on the problem (Eq.A3.0), we will fix the following LPPs as follows:

$$Min\ \left(20\left(y_{11}\right)m+55\left(y_{11}\right)d+40\left(y_{11}\right)v\right)/4+\left(60\left(y_{12}\right)m+135\left(y_{12}\right)d+90\left(y_{12}\right)v\right)/4$$
$$+\left(90\left(y_{13}\right)m+195\left(y_{13}\right)d+110\left(y_{13}\right)v\right)/4+\left(70\left(y_{21}\right)m+155\left(y_{21}\right)d+90\left(y_{21}\right)v\right)/4 \quad \text{(A17)}$$
$$+\left(85\left(y_{22}\right)m+185\left(y_{22}\right)d+115\left(y_{22}\right)v\right)/4+\left(35\left(y_{23}\right)m+85\left(y_{23}\right)d+55\left(y_{23}\right)v\right)/4$$

Subject to Constraints of Problem (Eq.A8).
The classic LPP provides an unparalleled OS of Eq.A7 that is compatible with the rare OS (Eq.A15) obtained on the basis of the system we recommended. However, there are two main reasons why

we consider the proposed method as follows:

- The classical LPP (Eq.A17) applied to fix FTP (Eq.A7) is not a modified LPP, while the problem (Eq.A9), (Eq.A11) and (Eq.A13) fix FTP (Eq. .A7) as classic TPs. To fix TPs, a tabular method is preferred over the LP method [11] so it may be recommended to use the expected method instead of the current method to fix FTPs.
- The primitive LPP (Eq.A17) applied to fix FTP (Eq.A7) has 27 obstacles and 18 variables, while the problem (Eq.A9) has 5 obstacles and 6 variables. There is a similar comparison between rates of prevention and change problems (Eq.A11) and (Eq.A13) and (Eq.A17). Therefore, using the problem (Eq.A9), (Eq.A11) and (Eq.A13) to fix FTP (Eq.A7) is a big deal compared to the problem (Eq.A17) based on the assumption of math. , about the number of restrictions and changes. In summary, it is better to use the methods we have recommended than the existing methods to resolve FTP from a conventional view.

7. Conclusion

A large number of TPs at different levels of sophistication have been documented in the paper. However, some of these models have a small global application because common TPs take net data for TC, requesting and query values. Unlike conventional TPs, we analyzed inaccurate data on real TP and developed a simpler method and corrected these weaknesses in the form described. In the FTP discussed in this study, non-negative triangular FNs represent all aspects of the problem. In this article, we are trying to create some important LPPs to fix FTP, which have fewer restrictions and changes compared to other existing LPPs. In particular, the proposed method can be useful in large-scale applications. Since the proposed system is based on the ancient travel simplex algorithm, it is easy to learn and apply the required system to get a real-time FTP operating system in the application world. One of the advantages of the recommended methods is that the fuzzy OS acquired and the best advantage are the negative triangular FNs. Finally, we believe that there are many more studies that need to be further explored. Some of these points are discussed below:

- The recommended method works well in fixing FTP because all invalid parameters are represented as triangular FNs. The consolidation of this system to find the free OS of TP and trapezoidal FN will be an interesting research project in the future.
- STP assesses supply, demand and transportation to meet transportation needs effectively. Therefore, research on the topic to create the process required to obtain non-trivial OV from nonlinear STP when price, supply and required quantities in non-triangular FNs travel capacity are negative, as leave it at another checkpoint.

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