ISSN: 0974-5823 Vol. 7 No. 5 May, 2022

International Journal of Mechanical Engineering

Experimental Development of Triangular Fuzzy Arithmetic and an Effective Approach to Real-World Fuzzy Transportation Problems

[1]G.Veeramalai **[2]M.Angayarkanni** **[3]P.Ramesh**, **[4]M.Prabakaran**

[1]Department of Mathematics, M.Kumarasamy College of Engineering (Autonomous), Karur,

[2]Department of Mathematics, Kandaswami Kandar's College, P. Velur, Namakkal.

[3]Department of Mathematics, SVST Kongunad Arts and Science College, Namakkal.

[4]Department of Mathematics, Vivekanandha college of Education for women, Tiruchengode, Namakkal

Abstract

The fuzzy optimum solution to the fuzzy vehicle routing problem (FTP) with all parameters being fuzzy integers is presented using a novel approach. The proposed technique is based on the crisp mobility methodology and the zero point method, and it ensures that the optimum fuzzy solution as well as the optimal fuzzy best position of the FTP has no negative components. A FTP is answered using the provided approach as an example. The suggested technique is suitable for determining the fuzzy optimum solution of FTPs that arise in real-life circumstances.

Keywords: Fuzzy transit problems; zero point technique; positively fuzzy optimum solution; optimistic fuzzy integer

1. Introduction

Many firms are seeking to develop new methods to generate and deliver benefits for consumers in history's highly competitive environment. It's becoming increasingly difficult to figure out just how when to properly deliver items to clients in sufficient quantities at a low cost. Transportation models give a powerful foundation for meeting this challenge. For lowering transportation costs, transportation models have a wide range of applications in logistic and supply chains. With the premise of a specific sources, destination parameter, and penalty factors, a number of effective approaches for addressing transportation issues have been devised. Due to unpredictable circumstances, all of the characteristics of transportation issues may not be understood accurately in real-world applications. Zadeh [11] proposed fuzzy numbers that might represent astonishing facts. Zimmermann [12] found the best solution to a problem.

We present a new approach for obtaining a fuzzy optimum solution to an FTP with all parameters being fuzzy integers in this study. The suggested technique gives a non-negative fuzzy optimum solution and a non-negative optimal fuzzy value is taken of FTPs, which addresses the drawbacks of previous methods [7,1,6, 3, 8]. The suggested solution is based just on zero point method, which is a transportation problem-solving algorithm. As a result, the novel technique can also alleviate the problem of uneven transportation. The proposed strategy for addressing a fuzzy problem of traffic congestion is demonstrated using a numerical example. The proposed technique is an acceptable way for tackling a real-world difficulty of determining the fuzzy optimum solutions to fuzzy transportation difficulties.

2. Preliminaries

2.1. Fuzzy number and Fuzzy transportation problem

Zadeh [12] provides the following mathematically oriented definitions of fuzzy set and membership function.

2.2 Transportation Problems

F. L. Hitchcock initially devised and suggested the Transportation Problems (TP) in 1941[1], [2]. Its goal is generally to reduce total transportation costs [3]-[7]. Other targets that might be defined include reducing overall delivery time, increasing profit, and so on. The Hitchcock-Koopman transportation problem is represented by the following linear transportation model: Minimize $z = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij} x_{ij}$

Subject to $\sum_{j=1}^{n} x_{ij} = a_{i,} i = 1,2,.....,m \quad (Supply)$

$$\sum_{i=1}^{m} x_{ij} = b_{j,} j = 1,2,.....,n \quad (Demand)$$

$$x_{ij} \geq 0 \quad for\, all\, i\, and\, j$$

Here,

x_{ij} = The quantity of commodities transported from point i to point j

c_{ij} = The cost of transporting a unit of commodities from point i to point j

a_i = The amount of supply accessible at each point of origin i

b_j = The supply of demand at every location j

m = Amount of beginnings in aggregate (Sources)

n = The overall amount of locations (Sinks)

Traditional transportation techniques [17] can be used to tackle this challenge.

3. Methodological Approaches

Reverse Dynamical Algorithm

We now provide a novel technique for addressing fuzzy transport problems that is founded just on crisp transport systems algorithm, namely Pandian & Natarajan's zero point method [9].

The following is the current approach:

Algorithm

Step 1: Represent the issue (P3) using the FTP as a starting point and solve it using the zero point approach. Let be an optimum solution of (P3) with x_{ij}^3, i=1,2,...,m and j=1,2,...,n.

Step 2: Create a problem (P2) using the supplied FTP then solve it using the zero point approach. Let { x_{ij}^2 , i=1,2,...,m and j =1,2,...,n} be the best option for (P2).

Step 3: Create a problem (P1) using the supplied FTP and solve it using the zero point approach. Let { x_{ij}^1 ,i =1,2,...,m and j =12,..,n} be an optimal solution of (P1)

Step 4: { x_{ij}^1 , x_{ij}^2 , x_{ij}^3 , x_{ij}^4 , i=1,2,...,m and j =1,2,...,n} is the best option for the given FTP (P)

Remark 3.2: Because it will be based just on zero point approach, the crisp transportation algorithm, the suggested method may also solve an imbalanced fuzzy transportation issue.

4. Mathematical Exemplification

The following example shows how the proposed technique works.

Example 4.1: Consider the following transportation situation, which is completely ambiguous.

Supply

	(2,3,4)	(3,4,6)	(11,12,14)	(7,8,11)	**(6,7,12)**
	(1,2,4)	(0,1,1)	(6,7,8)	(1,2,3)	**(1,2,3)**
	(5,6,8)	(8,9,12)	(15,16,19)	(9,10,12)	**(10,12,17)**
Demand	**(7,8,11)**	**(5,6,11)**	**(3,4,6)**	**(2,3,4)**	**(17,21,32)**

The given FTP is a balanced one since total fuzzy demand = total fuzzy supply = (17, 21, 32).

Now, using the supplied FTP, solve the following issue (P3):

Supply

	4	6	14	11	**12**
	4	1	8	3	**3**
	8	12	19	12	**17**
Demand	**11**	**11**	**6**	**4**	**32**

Now, by the zero point method, the optimal solution of ($P4$) is $x_{12}^{3}=11$, $x_{13}^{3}=1, x_{23}^{3}=3, x_{31}^{3}=11,$ $x_{33}^{3}=2,$ $x_{34}^{3}=4$ and the cheapest mode of transportation is 278.

Now, using the supplied FTP, solve the following issue (P2):

Supply

	3	4	12	8	**7**
	2	1	7	2	**2**
	6	9	16	10	**12**
Demand	**8**	**6**	**4**	**3**	**21**

With $x_{ij}^{2} \le x_{ij}^{3}$

Now, by the zero point method, the optimal solution of ($P2$) is $x_{12}^{2}=6$, $x_{13}^{2}=1, x_{23}^{2}=2, x_{31}^{2}=8,$ $x_{33}^{2}=1,$ $x_{34}^{2}=3$ and the minimum transportation cost is 144.

Now, using the supplied FTP, solve the following issue (P1):

Supply

	2	3	11	7	**6**
	1	0	6	1	**1**
	5	8	15	9	**17**
Demand	**7**	**5**	**3**	**2**	**17**

With $x_{ij}^{1} \le x_{ij}^{2}$

Now, by the zero point method, the optimal solution of ($P1$) is $x_{12}^1 = 5$, $x_{13}^1 = 1, x_{23}^1 = 1, x_{31}^1 = 7$, $x_{33}^1 = 1$, $x_{34}^1 = 3$ and the minimum transportation cost is 100.

As a result, the best FTP option is $x_{12} = (5,6,11)$; $x_{13} = (1,1,1)$; $x_{23} = (1,2,3)$; $x_{31} = (7,8,11)$; $x_{33} = (1,1,2)$; $x_{34} = (2,3,4)$ and the entire minimum fuzzily calculated transit price is (100,144, 278).

5. Conclusion

The produced fuzzy ideal solution and fuzzy relative efficiency are both non-negative fuzzy numbers, which is the main advantage of a proposed technique. Because the suggested technique is based just on classical transportation method, it is simple to learn and implement to identify the fuzzy optimal solution to fuzzy transportation issues that arise in real-world scenarios. The suggested technique generates an optimum solution that may be used by decision makers when dealing with real-world transportation problems with fuzzy parameters.

References:

1. Zadeh, L.A., The concept of a Linguistic variable and its applications to approximate reasoning – parts I, II and III", Inform. Sci. 8(1975) 199-249; 8 1975 301-357; 9(1976) 43-80.
2. R.L. Burden, J.D. Faires (2005). *Numerical Analysis*, eight editions. Thomson, USA.
3. George J. Klir, Ute St. Clair, Bo Yuan (1997). *Fuzzy Set Theory: Foundations and Applications.* Prentice Hall PTR.
4. J.J. Buckley, Y. Qu (1991). Solving fuzzy equations: a new solution concept. *Fuzzy Sets and System*. 39: 291-301.
5. S. Abbasbandy, B. Asady (2004). Newton's method for solving fuzzy nonlinear equations. *Appl Math Comput* 159: 349-356
6. S. Abbasbandy S, R. Ezzati (2006). Newton's method for solving a system of fuzzy nonlinear equations. *Appl Math Comput* 175: 1189-1199
7. S. Abbasbandy , A. Jafarian (2006). Steepest descent method for solving fuzzy nonlinear Equations. *Appl Math Comput* 175: 581-589
8. J.J. Buckley, E. Eslami and T. Feuring (2002). *Fuzzy Mathematics in Economics and Engineering*. Physica-Verlag.
9. D. Dubois, H. Prade (1980). *Fuzzy sets and systems*. Theory and application. Academic, New York.
10. R. Goetschel, W. Voxman (1986). *Elementary Calculus*, Fuzzy Sets and Systems 18:31-43
11. J.E. Dennis, R.B Schnabel (1983). *Numerical Methods for Unconstrained Optimization and Nonlinear Equations*, Prentice-Hall Jersey.
12. J. Wright, Stephen, Nocedal, Jorge (2006). *Numerical Optimization*, 2e.pp (614)
13. H.J. Zimmermann (1991). *Fuzzy set theory and its application*. Kluwer, Dordrecht.
14. Kaufmann, A., Introduction to theory of Fuzzy Subsets, Vol. I (Academic Press, New York, 1975).
15. R. Goetschel, W. Voxman (1986). *Elementary Calculus*, Fuzzy Sets and Systems 18:31-43
16. Abbasbandy S., Ezzati R., Jafarian A.: LU decomposition method for solving fuzzy system of linear equations. Applied Mathematics and Computation **172**, 633–643 (2006)
17. Abbasbandy S., Jafarian A.: Steepest descent method for system of fuzzy linear equations ,Applied Mathematics and Computation **175**, 823–833 (2006).

18. Abbasbandy S., Jafarian A., Ezzati R.: Conjugate gradient method for fuzzy symmetric positive-definite system of linear equations. Applied Mathematics and Computation **171**, 1184–1191 (2005)
19. Allahviranloo T.: Numerical methods for fuzzy system of linear equations. Applied Mathematics and Computation **155**, 493–502 (2004)
20. Nasseri S.H., Sohrabi M., Ardil E.: Solving fully fuzzy linear systems by use of a certain decomposition of the coefficient matrix. International Journal of Computational and Mathematical Sciences, **2**, 140−142 (2008)
21. Nasseri S.H., Zahmatkesh F.: Huang method for solving fully fuzzy linear system of equations. The Journal of Mathematics and Computer Science, **1**, 1-5 (2010).
22. Lipschutz S.: Shaum's Outline of Theory and Problems of Linear Algebra, 3rd edition, McGraw Hill Book Company, New York, (2005).
23. Sun X., Guo S.: Solution to general fuzzy linear system and its necessary and sufficient condition. Fuzzy Information and Engineering **3**, 317-327 (2009)
24. G.Veeramalai **,** M.Angayarkanni, Connectedness in Triangular Fuzzy Topology, International Journal of All Research Education and Scientific Method, Volume 8, Issue 12, December-2020, P:381-386
25. G.Veeramalai,"Unconstrained Optimization Techniques Using Fuzzy Non Linear Equations" Asian Academic Research Journal of Multi-Disciplinary, Volume 1, Issue 9, (May2013), 58-67.
26. G.Veeramalai, P.Ramesh, "Haar's measure using triangular fuzzy finite topological group", International journal of innovative technology and Exploring Engineering", Vol.8, Issue-11, 2019, 1581-1583.