Neutrosophic Sets and Systems

Volume 29 Article 13

10-15-2019

Unraveling Neutrosophic Transportation Problem Using Costs Mean and Complete Contingency Cost Table

Krishna Prabha Sikkannan

Vimala Shanmugavel

Follow this and additional works at: https://digitalrepository.unm.edu/nss_journal

Recommended Citation

Sikkannan, Krishna Prabha and Vimala Shanmugavel. "Unraveling Neutrosophic Transportation Problem Using Costs Mean and Complete Contingency Cost Table." *Neutrosophic Sets and Systems* 29, 1 (2020). https://digitalrepository.unm.edu/nss_journal/vol29/iss1/13

This Article is brought to you for free and open access by UNM Digital Repository. It has been accepted for inclusion in Neutrosophic Sets and Systems by an authorized editor of UNM Digital Repository. For more information, please contact amywinter@unm.edu, lsloane@salud.unm.edu, sarahrk@unm.edu.

Neutrosophic Sets and Systems, Vol. 29, 2019
University of New Mexico

Unraveling Neutrosophic Transportation Problem Using Costs Mean and Complete Contingency Cost Table

Krishna Prabha Sikkannan[1] and Vimala Shanmugavel[2]

[1] PSNA College of Engineering and Technology, Dindigul, India.
E-mail: jvprbh1@gmail.com
[2] Mother Teresa Women's University, Kodaikannal, 624102, India. E-mail: tvimss@gmail.com

Abstract: As neutrosophic deal with uncertain, inconsistent and also indeterminate information, the model of NS is a significant technique to covenant with real methodical and engineering. Neutrosophic fuzzy is more generalized than intuitionistic fuzzy .The common process for unraveling the neutrosophic transportation problems involves procedures like, north-west corner method, matrix minima method and Vogel's approximation method. By determining the mean of the specified costs the optimal elucidation of the neutrosophic fuzzy transportation problem is initiated in this paper. This technique has been implemented into two phases. In first methodology, the complete contingency cost table is constructed and in the second phase and the optimum allocation is made. The significance of this technique confers a better optimal solution compared to other methods. A numerical example for the projected technique is explicated and compared along with existing techniques.

Keywords: Neutrosophic Fuzzy Transportation Problem, Complete Contingency Cost Table (CCCT), Costs Mean.

1. Introduction

The prominent fail on the charge and the pricing of raw materials and commodities is evidently owing to transportation cost. The outlay of transportation is elicited by dealer and manufacturer. Exclusive of the conservative methods like North West corner method, row minima method, least cost method, column minima method ,Vogel's approximation method and modified distribution method many researchers have endowed with new techniques to find a better initial basic feasible solution for the transportation problem.

To handle imprecise, uncertain and indeterminate problems that cannot be dealt by fuzzy and its various types, the neutrosophic set theory (NS) theory was illustrated by samarandache in 1995.NS is acquired by three autonomous mapping such as truth (T), indeterminacy (I) and falsity (F) and takes values from $]0^{-}, 1^{+}[$. The scope of neutrality is explained with the aid of NS theory. NSs can be accomplished to handle uncertainty in an enhanced way. Single valued neutrosophic acquires extra consideration and get optimized solution than other types of fuzzy sets because of accurateness, adoptability and link to a system. Vogel's approximation technique for solving the Transportation Problem was premeditated by Harvey and Shore (1970) [32].

Application of heuristics for solving Transportation Problem was proposed by Shimshak, Kaslik and Barelay (1981) [31]. Deshumukh (2012) [17] offered a pioneering technique for unraveling Transportation Problem. Sudhakar, Arunnsankar, and Karpagam (2012) [34] have given a modified approach for solving transportation problem. Transportation Problems with mixed restrictions have been resolved by Pandian and Natarajan (2010) [25]. Abdel-Basset, M., Manogaran, G., Gamal, A., & Chang, V. (2019) [2] presented an intelligent medical decision support model based on soft computing and IOT to detect and observe type-2 diabetes patients. Abdel-Basset, M., Mohamed, R., Zaied, A. E. N. H., & Smarandache, F. (2019) [3] discovered a hybrid plithogenic decision-making approach with quality function deployment for selecting supply chain sustainability metrics. The proposed method is a combination of quality function deployment (QFD) with plithogenic aggregation operations.

Researchers like Md. Amirul Islam(2013)[22], Quddos et al and Sudhakar et al (2012)[26], Serder Korukoglu and Serkan Balli(2011) [30], Balakrishnan (1990)[11],Reena et al (2014,2016)[27,28], Urashikumari et al(2017) [35], Biswas.P(2016) [12] Krishna Prabha and Vimala (2016)[21,36], Palanivel and Suganya(2018) [24], Abul et al (2017) [9], Hajjari(2011)[18], Hitchcock .F.L(1947)[19], Joshua(2017)[20], Mohanaselvi et al (2012)[23], Said Broumi(2019)[15,29],Chang (1981)[16], Smarandache (2005)[33] and Wang(2010)[37] have predicted a variety of techniques for solving transportation and NS transportation problems. Real life transportation problem in neutroshopic environment is deliberated by Akansha singhet al(2017) [10]. The same numerical problem is considered. Abdel-Basset, M., Atef, A., & Smarandache, F. (2019) [6] invented a hybrid Neutrosophic multiple criteria cluster decision making approach for project selection. A novel group decision making replica based on neutrosophic sets for heart disease diagnosis was recommended by Abdel-Basset, M., Gamal, A., Manogaran, G., & Long, H. V. (2019)[7].The idea of first-and high-order NTS was suggested by Abdel-Basset, M., Chang, V., Mohamed, M., & Smarandache, F. (2019)[8].

Broumi et al. (2018)[14] proposed an innovative system and technique for the planning of telephone network using NG. Broumi et al (2019) [13] proposed SPP under interval valued neu trosophic setting. Score function is utilized in machine erudition. Abdel-Basset et al (2019) [1] have proposed a novel model for evaluation hospital medical care systems with plithogenic sets and this research stratifies the plithogenic multi criteria decision making (MCDM) technique for defining the considerable weights of assessing standards, and the VIKOR technique is applied for enhancing the serving efficiency classifications of the possible substitutes. Abdel-Basset, M., & Mohamed, M. (2019)[4] proposed a powerful framework based on neutrosophic sets to aid patients with cancer. Abdel-Basset, M., Mohamed, M., & Smarandache, F. (2019) [5] determined a Linear fractional programming based on triangular neutrosophic numbers. By means of the recommend approach, the transformed MOLFP problem is condensed to a single objective linear programming (LP) problem which can be deciphered simply, by proper linear programming method. In this paper, new unconventional technique to unravel neutrosophic Fuzzy transportation problem using Mean and CCCT is proposed and presented with numerical example. The paper is organized as follows. Section 1 confers the introduction part and section 2 deals with the preliminary. In section 3 the algorithm for unraveling is presented .A numerical example is illustrated in section 4 and the result is compared with existing methods. Finally the paper is concluded in section 5.

2. Preliminaries

Definition 2.1: Let X be a space of points with generic elements in X denoted by x .The neutrosophic set A is an object having the form, $A=\{\langle x : T_A(X), I_A(X), F_A(X)\rangle , x \in X\}$,where the functions T,I,F : X→]$^-$0,1$^+$[define respectively the truth-membership function, indeterminacy-membership function and falsity- membership function of the element $x \in X$ to the set A with the condition $^-0 \leq T_A(X) + I_A(X) + F_A(X) \leq 3^+$ .The functions are real standard or nonstandard subsets of]$^-$0,1$^+$[.

Definition 2.2 [13] Let $R_N = \langle [R_T , R_I, R_M, R_E,](T_R, I_R, F_R)\rangle$ and $S_N = \langle [S_T , S_I, S_M, S_E,](T_S, I_S, F_S)\rangle$ be two trapezoidal neutrosophic numbers (TpNNs) and $\theta \geq 0$,then

$R_N \oplus S_N = \langle [R_T + S_T , R_I + S_I, R_M + S_M, R_E + S_E](T_R + T_s - T_R T_s, I_R I_s, F_R F_S)\rangle$

$R_N \otimes S_N = \langle [R_T . S_T , R_I . S_I, R_M . S_M, R_E . S_E](T_R . T_s , I_R + I_s - I_R . I_s, F_R + F_S - F_R . F_S)\rangle$

$\theta R_N = \langle [\boldsymbol{\theta} R_T , \boldsymbol{\theta} R_I, \boldsymbol{\theta} R_M, \boldsymbol{\theta} R_E,](1-(1-T_R))^\theta, (I_R)^\theta, (F_R)^\theta)\rangle$

Definition2.3 [13]: Let R= [R_T, R_I, R_M, R_E] and $R_T \leq R_I \leq R_M \leq R_E$ then the centre of gravity (COG) in R is

$$\text{COG(R)} = \begin{cases} R \ if \ R_T = R_I = R_M = R_E \\ \frac{1}{3}\left[R_T + R_I + R_M + R_E - \frac{R_T R_I - R_M R_E}{R_E + R_M - R_I - R_T}\right] \\ otherwise \end{cases} \text{-------------- (1)}$$

Definition2.4 [13]: Let $S_N = \langle [S_T , S_I, S_M, S_E,](T_S, I_S, F_S)\rangle$ be a TpNN then the score, accuracy and certainty functions are as follows

$S(S_N) = COG(R) \times \frac{(2+T_S-I_S-F_S)}{3}$ -------------- (2)

$a(S_N) = COG(R) \times (T_S - I_S)$

$C(S_N) = COG(R) \times (T_S)$

Definition2.5 [12]: Let N be a trapezoidal neutrosophic number in the set of real numbers with the truth, indeterminacy and falsity membership functions are defined by

$$T_N(x) = \begin{cases} \frac{(x-a)t_N}{b-a} , & a \leq x \leq b \\ t_N , & b \leq x \leq c \\ \frac{(d-x)t_N}{d-c} , & c \leq x \leq d \\ 0 , & otherwise \end{cases}$$

$$I_N(x) = \begin{cases} \frac{b-x+(x-a)t_N}{b-a} , & a \leq x \leq b \\ i_N , & b \leq x \leq c \\ \frac{x-c+(d-x)i_N}{d-c} , & c \leq x \leq d \\ 0 , & otherwise \end{cases}$$

$$T_N(x) = \begin{cases} \frac{b-x+(x-a)f_N}{b-a} , & a \leq x \leq b \\ f_N , & b \leq x \leq c \\ \frac{x-c+(d-x)f_N}{d-c} , & c \leq x \leq d \\ 0 , & otherwise \end{cases}$$

Where t_N = [t^L, t^U] ⊂ [0,1], i_N = [i^L, i^U] ⊂ [0,1], and f_N = [f^L, f^U] ⊂ [0,1] are interval numbers.Then the number N can be denoted by ([a,b,c,d]: [t^L, t^U], [i^L, i^U] ,[f^L, f^U]) called interval valued trapezoidal neutrosophic number.

3. Customized Algorithm

The algorithm is accomplished into two phases:

1. Complete Contingency Cost Table (CCCT)
2. Optimum Allocation of Transportation Problem

3.1 Complete Contingency Cost Table – CCCT

Step 1 The slightest cost of each element in every row should be deducted and relegate it to the right-top of subsequent elements from the given Transportation Table (TT).

Step 2 The slightest cost of each element in every row should be deducted and consign them on the right-foot of the corresponding elements.

Step 3 Frame the CCCT by accumulating the right-top and right-foot elements.

3.2 Optimum Allocation of Transportation Problem

Step 1 The Row Mean Total Opportunity Cost (RMTOC) is found by calculating the row mean along every row. Column Mean Total Opportunity Cost (CMTOC) is found by calculating the column mean along every column.

Step 2 Spot the prevalent element among the RMTOCs and CMTOCs, if there is more than one prevalent element then select the prevalent element along which the least cost element is present. If there is more than one smallest element, select any one of them arbitrarily.

Step 3 Allocate x_{ij}= min (a_i, b_j) on the left top of the least entry in the (i ,j)th of the TT

Step 4

If $a_i < b_j$, leave the ith row and obtain $b_j^! = b_j - a_i$.

If $a_i > b_j$, leave the jth column and obtain $b_j^! = a_i - b_j$.

If $a_i = b_j$, leave either ith row or jth column but not both.

Step 5 Repeat the Steps 1 to 4 until all allocations are made.

Step 6 Estimate, Z = $\sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij}X_{ij}$, where Z is the minimum transportation cost,C_{ij} is the cost element of the TT.

4. Numerical Example

Consider the following Neutrosophic Transportation Problem,

Table 1: Neutrosophic Transportation Table

	D1	D2	D3	D4	SUPPLY
O1	(3, 5, 6,8); 0.6, 0.5, 0.4	(5, 8, 10, 14); 0.3, 0.6, 0.6	(12, 15, 19, 22); 0.6, 0.4, 0.5	(14, 17, 21, 28); 0.8, 0.2, 0.6	(22,26,28,32); 0.7, 0.3, 0.4
O2	(0, 1, 3,6); 0.7, 0.5, 0.3	(5, 7,9, 11); 0.9, 0.7, 0.5	(15, 17, 19, 22); 0.4, 0.8, 0.4	(9, 11, 14, 16); 0.5, 0.4, 0.7	(17, 22, 27,31); 0.6, 0.4, 0.5
	(4, 8, 11, 15); 0.6, 0.3, 0.2	(1, 3, 4, 6); 0.6, 0.3, 0.5	(5, 7, 8, 10); 0.5, 0.4, 0.7	(5, 9, 14, 19); 0.3, 0.7, 0.6	(21,28,32,37);

O3					0.8, 0.2, 0.4
DEMAND	(13, 16, 18, 21); 0.5, 0.5, 0.6	(17, 21, 24, 28); 0.8, 0.2, 0.4	(24, 29, 32, 35); 0.9, 0.5, 0.3	(6, 10, 13, 15); 0.7, 0.3, 0.4	

Converting the trapezoidal neutrosophic numbers into crisp numbers by using (1) and (2), By

$\mathbf{s}(S_N)$ = COG $(R) \times \frac{(2+T_S - I_S - F_S)}{3}$, COG $(R) = \frac{1}{3}\left[R_T + R_I + R_M + R_E - \frac{R_E R_M - R_I R_T}{R_E + R_M - R_I - R_T}\right]$

(3, 5, 6, 8); 0.6, 0.5, 0.4

COG $(R) = \frac{1}{3}\left[3+5+6+8-\frac{8*6-5*3}{8+6-5-3}\right] = \frac{1}{3}\left[22-\frac{48-15}{6}\right] = \frac{1}{3}\left[22-\frac{33}{6}\right] = \frac{1}{3}[22-5.5] = \frac{16.5}{3} = 5.5$

$\mathbf{s}(S_N) = 5.5 \times \frac{(2+0.6-0.5-0.4)}{3} = 5.5 \times 0.56 = 3.116 = 3$

Similarly proceeding for all numbers we get the resulting crisp TT.

Table 2: Crisp Transportation Table

	D1	D2	D3	D4	SUPPLY
O1	3	4	8	9	26
O2	1	4	8	6	24
O3	4	2	3	5	30
	17	23	28	12	

4.1 Formation of the Complete Contingency Cost Table (CCCT)

From the given crisp transportation table, remove the least value from each of the elements of every row and consign them on the right-top of subsequent elements. In each column deduct the least value from each element and place them on the right-foot of the corresponding elements. Add the right-top and right-foot elements of Steps 1 and 2 and frame the **C**CCT.

Table 3: Complete Contingency Cost Table

	D1	D2	D3	D4	SUPPLY
O1	2	3	10	10	26
O2	0	5	12	6	24
O3	5	0	1	3	30
	17	23	28	12	

4.2 Allocation of the cost with supply and demand:

Calculate the mean of complete contingency costs of cells along each row and each column just subsequent to and beneath the supply and demand amount correspondingly inside the first brackets. By solving the given problem using the above steps, we get the following final allocation. The ( ) represents the allocations and [ ] represents the mean along each row/column.

Table 4: R /C SD Total Opportunity Cost

	D1	D2	D3	D4	SUPPLY	MEAN			
O1	2(3)	3(23)	10	10	26	[6.25]	[5]	[5]	[2.5]
O2	0(14)	5	12	6(10)	24	[5.75]	[3.7]	[3.7]	[2.5]
O3	5	0	1(28)	3(2)	30	[2.25]	[2.7]		
DEMAND	17	23	28	12					
MEAN	[2.3]	[2.6]	[7.7] MAX	[6.3]					
	[2.3]	[2.6]		[6.3] MAX					
	[1]	[4]		[8] MAX					
	[1]	[4] MAX							

The total opportunity cost is given bellow,

Table 5: CCCT Total Opportunity Cost

	D1	D2	D3	D4
O1	3(3)	4(23)	8	9
O2	1(14)	4	8	6(10)
O3	4	2	3(28)	5(2)

The optimum cost is given by (3x3)+(4x23)+(1x14)+(6x10)+(3x28)+(5x2) = 9+92+14+60+84+10 =269

Advantages and limitations of the proposed algorithm Advantages

By correlating the systematic algorithm with existing methods like North West corner, least cost and Vogel's approximation method we get the following results. This approach can be easily extended and applied to other neutrosophic networks such as Single-value, cubic, Bipolar, Interval bipolar neutrosophic numbers and so on.

Table 6: Comparison Table

NWC	MMM	VAM	PROPOSED METHOD
349	339	272	269

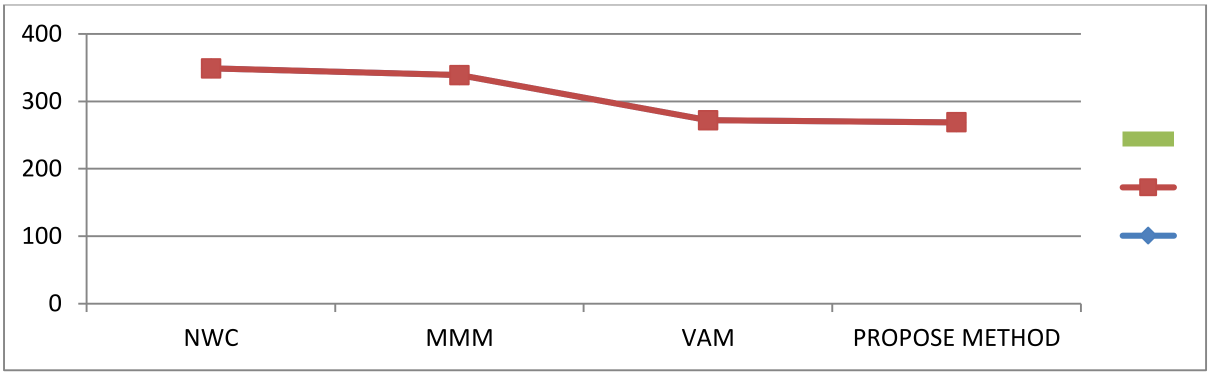

Figure 1: Comparison Chart

5. Conclusion

The advantage of using the new algorithm with CCCT is discussed in this paper. We use a numerical example to illustrate the efficiency of our proposed algorithm. The main goal of this work is to portray an algorithm for solving transportation problem, in the neutrosophic environment using CCCT. The proposed algorithm will be very effective for real-life problem. The algorithm can be extended for all kinds of neutrosophic fuzzy numbers. The new method of manipulating mean is easier and saves time. This method gives a better optimum solution when compared with other methods.

Reference

1. Abdel-Basset, M., & Mohamed, M. A novel and powerful framework based on neutrosophic sets to aid patients with cancer. *Future Generation Computer Systems*. 2019.98, 144-153.
2. Abdel-Basset, M., Atef, A., & Smarandache, F. A hybrid Neutrosophic multiple criteria group decision making approach for project selection. *Cognitive Systems Research*.2019. 57, 216-227.
3. Abdel-Basset, M., Chang, V., Mohamed, M., & Smarandche, F. A Refined Approach for Forecasting Based on Neutrosophic Time Series. *Symmetry*.2019. 11(4), 457.
4. Abdel-Basset, M., El-hoseny, M., Gamal, A., & Smarandache, F. A Novel Model for Evaluation Hospital Medical Care Systems Based on Plithogenic Sets. *Artificial Intelligence in Medicine*.2019, 101710.
5. Abdel-Basset, M., Gamal, A., Manogaran, G., & Long, H. V. A novel group decision making model based on neutrosophic sets for heart disease diagnosis. *Multimedia Tools and Applications*.2019. 1-26.
6. Abdel-Basset, M., Manogaran, G., Gamal, A., & Chang, V. A Novel Intelligent Medical Decision Support Model Based on Soft Computing and IoT. *IEEE Internet of Things Journal*. 2019.
7. Abdel-Basset, M., Mohamed, M., & Smarandache, F.Linear fractional programming based on triangular neutrosophic numbers. *International Journal of Applied Management Science*.2019. 11(1), 1-20.
8. Abdel-Basset, M., Mohamed, R., Zaied, A. E. N. H., & Smarandache, F. A hybrid plithogenic decision-making approach with quality function deployment for selecting supply chain sustainability metrics. *Symmetry*.2019. 11(7), 903.

9. Abul Kalam Azad .S.M., Bellel Hossain. Md., Mizanur Rahman. Md. An algorithmic approach to solve transportation problems with the average total opportunity cost method. *International Journal of Scientific and Research Publications*.2017.Volume 7, Issue 2,
10. Akanksha Singh,Amit Kumar ,S.S.Appadoo .Modified Approach for optimization of real life transportation problem in neutroshopic environment. *Mathematical Problems in Engineering*, 2017,Article id : 2139791.
11. Balakrishnan. N.Modified Vogel's Approximation Method for Unbalance Transportation Problem. *Applied Mathematics Letters* 1990.3(2), 9,11.
12. Biswas.P, Pramanik.S, & Giri.B.C.(2018). Distance measurebased MADM strategy with interval trapezoidal neutroshopic numbers, *Neutrosophic sets and systems*, 19, 40-46.
13. Broumi , Bakali. A., Talea ,.M.,Nagarajan, Smarandache ,F.(2019). The Shortest path problem in interval valued trapezoidal and triangular neutroshopic environment., *Complex & Intelligent Systems*.https://doiorg/10.1007/
14. Broumi S, Mohamed T, Bakali A, Smarandache F .Single valued neutrosophic graphs',*J New Theory* .2016.10:86–101.
15. Broumi S, Ullah K, Bakali A, Talea M, Singh PK, Mahmood T, Samarandache F, Bahnasse A, Patro SK, Oliveira AD .Novel system and method for telephone network planing based on neutrosophic graph.*Glob J Comput Sci Technol E Netw Web Secur* 2018.18(2):1–11.
16. Chang.W.Ranking of fuzzy utilities with triangular membership functions. *Proceedings of International Conference on Policy Analysis and Systems*. 1981., 263–272.
17. Deshmukh. N. M.An Innovative Method for Solving Transportation Problem.*International Journal of Physics and Mathematical Science*.2012. ISSN: 2277-2111.
18. Hajjari. T., Abbasbandy. S.A Promoter Operator for Defuzzification Methods.2011 *Australian Journal of Basic and Applied Sciences* .2011. 5(10): 1096-1105.
19. Hitchcock .F.L., The distribution of a product from several sources to numerous localities. *Journal of Mathematical Physics*.1941.20(1-4): 224- 230.
20. Joshua .R.R, Akilandeswari .V.S, Lakshmi Devi .P.K and Subashini .N . Norh- East Corner Method- An Initial Basic Feasible Solution for Transportation Problem. *International Journal for Applied Science and Engineering technology* ,2017,.5(5): 123-131.
21. Krishna Prabha.S.,Vimala.S.Implementation of BCM for Solving the Fuzzy Assignment Problem with Various Ranking Techniques. *Asian Research Journal of Mathematics* 1(2): 1-11, 2016, Article no.ARJOM.27952
22. Md. Amirul Islam *et al.*Profit Maximization of a Manufacturing Company: An Algorithmic Approach. *J. J. Math. and Math. Sci*., , 2013,Vol. 28, 29-37.
23. Mohanaselvi .S, Ganesan. K.Fuzzy optimal solution to fuzzy transportation problem: A new approach.*International Journal on Computer Science and Engineering*. 2012; 4(3).
24. Palanivel.M., and Suganya.M. A New Method to Solve Transportation Problem - Harmonic Mean Approach. *Eng Technol Open Acc 2(3):* 2018.*ETOAJ*.MS.ID.555586 .
25. Pandian .P., and Natarajan .G.A New Approach for Solving Transportation Problems with Mixed Constraints. *Journal of Physical Sciences*, Vol. 14, 2010, 53-61.
26. Quddos .A., Javaid .S., Khalid .M.M.A New Method for finding an Optimal Solution for Transportation Problems. *International Journal on Computer Science and Engineering*.2012. 4(7): 1271-1274.
27. Reena, Patel .G., Bhathawla .P..H .An Innovative Approach to Optimum Solution of Transportation Problem. *International Journal of Innovative Research in Science, Engineering Technology*.2016. 5(4): 5695-5700.
28. Reena, Patel G, Bhathawla PH .The New Global Approach to Transportation Problem. International Journal of Engineering Technology. *Management and Applied Science*, 2014, 2(3): 109-113.
29. Said Broumi ,Deivanayagampillai Nagarajan' Assia Bakali' Mohamed Talea, Florentin Smarandache' Malayalan Lathamaheswari, The shortest path problem in interval valued trapezoidal and triangular neutrosophicenvironment.*Complex and Intelligent Systems*, Feb 2019, 26 .

30. Serdar Korukoglu and Serkan Balli.An Improved Vogel's Approximation Method for the Transportation Problem. Association for Scientific Research', *Mathematical and Computational Application*, , 2001,.Vol.16 No.2, 370-381.
31. Shimshak D.G., Kaslik J.A. and Barelay T.D.A modification of Vogel's Approximation Method through the use of Heuristics. *Infor,*1981, 19,259-263.
32. Shore H.H.The Transportation Problem and the Vogel's Approximation Method. *Decision Science* ,1970,1(3-4), 441-457.
33. Smarandache F .A unifying field in logic. Neutrosophy: neutrosophic probability, set, logic.*4th edn. American Research Press, Rehoboth*,2005.
34. Sudhakar .V.J, Arunsankar .N., Karpagam .T. A New Approach to find an Optimum Solution of Transportation Problems. *European Journal of Scientific Research* 2012,68(2): 254-257,
35. Urashikumari, Patel .D, Dhavakumar, Ravi, Bhasvar. C.Transportation Problem Using Stepping Stone Method and its Application. *International Journal of Advanced Research in Electrical, electronics and Instrumentation Engineering*, 2017,6(1): 46-50.
36. Vimala.S., and Krishna Prabha.S.Fuzzy Transportation Problem through Monalisha's Approximation Method. *British Journal of Mathematics & Computer Science,* 2016, *17*(2): 1-11, Article no.BJMCS.26097
37. Wang H, Smarandache F, Zhang Y, Sunderraman R .Single valued neutrosophic sets. *MultispMultistruct* 2010,4:410–413.

Received: June 23, 2019. Accepted: October 15, 2019