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Solving Transportation Problem with k-Decagonal Neutrosophic Number Using Monalisha's Approximation Method

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Abstract

This paper presents a new approach for solving transportation problems using Decagonal Neutrosophic Numbers. In this work, a new approximation method called Monalisha's Approximation Method (MAM) is proposed to obtain a feasible transportation cost. The proposed method considers the uncertain and indeterminate nature of transportation costs. A numerical example is given to illustrate the procedure of the proposed method. The obtained result is compared with existing transportation methods, and the optimality of the solution is verified using the MODI method. The results show that proposed Monalisha's Approximation Method is simple and effective for solving transportation problems under Neutrosophic uncertainty.

Keywords: *Transportation Problem, Decagonal Numbers, Neutrosophic Numbers, Monalisha's Approximation Method for Optimal Solution (MAMOS).*

Mathematics Subject Classification (MSC) 2020*: 90C08, 90C70, 03B52.*

1. Introduction

[4] Due to mass population, there is a huge challenging to company, how to deliver the commodity to numbers of consumer or sources to a number of destinations in a minimizing cost value. This kind of thought is called Transportation Problem (TP) and it is a special case to of Linear Programming Problem (LPP) where the company's objective is decrease the expenses. Basic transportation problem was introduced by Hitchcock. This kind of knowledge can be direct programming technique and then tackled easiest strategy. Dantzig developed a primal simplex technique to transportation problem. Transportation Problem is a different type of content therefore simplex method is not capable for deriving the objectives. [7] Due to some lackness in simplex method for solving TP, a new Initial Basic Feasible Solution (IBFS) method was developed like North-west corner, Least-cost method, and Vogel's approximation method. In classical TP the decision makers gets the values of capacity, requirement and transportation cost value i.e. the decision makers possess the defuzzified numbers. Even though, in our day to day life implementations, the decision makers may not be gotclearly to all the parameters of transportation problem due to some uncontrolled factors. To overcome these uncontrolled factors, fuzzy decision-making method has introduced by Prof. Zadeh in 1965. Since, many of the researchers have put investigation on Fuzzy Transportation Problem.All the parameters are trapezoidal fuzzy numbers and that method extent to solve Fully Fuzzy TP has created by Das.G Charles Rabinson and Chandrasekarn have givenPentagonal fuzzy numbers inFuzzy transportation problem.We experienced with inefficient and uncertain data where it isn't valuablethought to the data just by the methodsfor membership function and nonmembership function. In 1988, Smarandache has introduced the structure of Neutrosophic Set (NS) which is the most efficient tool of both fuzzy and intuitionistic fuzzy. Neutrosophic Set be considered by three degrees, i.e. (i) Truth-MembershipDegree (TMD), (ii) Indeterminacy Membership Degree (IMD), and(iii) Falsity Membership Degree (FMD). Lately, Wang introduced a Single Value Neutrosophic Set (SVNS) problem for solving some problem. Ye created the

Trapezoidal Neutrosophic Set (TrNS) by collecting the thought of Trapezoidal Fuzzy Numbers (TrFN) and Single Value Neutrosophic Set. To take the benefit of NS, several researchers proposed different method for solving LP problem under Neutrosophic environment. Recently, Charles Rabinson G and Pachamuthu have given a Neutrosophic Fuzzy Transportation Problem for Finding Optimal Solution Using Nanogonal Number. Lai and Hwang [1992] considered the situations where all parameters are in fuzzy number. (Lai and Huang, 1992) assume that the parameters have a triangular possibility distribution. Bazaraa, Jarvis and Sherali [1990] define linear programming problems with fuzzy numbers and simplex method is used for finding the optimal solution of the fuzzy problem. Pattnaik [2012] presented several linear and nonlinear inventory models. Swarup, Gupta and Mohan [2006] explain the method to obtain sensitivity analysis or post optimality analysis of the different parameters in the linear programming problems.

Neutrosophic always provide sets anawesome role in unclear situation. Before going to discuss the development of our research paper, we highlighted the many of the author's research work towards the TP with mixed constraints. In this way, there is to setup another idea for Decagonal Neutrosophic transportation problem. This total situation has induced us to build up another strategy for involves TP with Decagonal Neutrosophic numbers. We characterize Neutrosophic Transportation Problem (NTP) issue in which the source, requirement and transportation cost is taken as Decagonal Neutrosophic numbers Using Monalisha's Approximation Method.

2. Preliminaries:

2.1 Neutrosophic Set:[2]

Let X be non-empty set with an element in x denoted by A^N. A non-empty Neutrosophic set A^N in X is formulated by a Truth membership function $\mu_A(x)$, an Indeterminacy membership function $\sigma_A(x)$, and a Falsity membership function $v_A(x)$ and is denoted by $A^N = \{[x, \mu_A(x), \sigma_A(x), v_A(x) | \, x \epsilon X]\}$. The three functions satisfy

$$0 \le \mu_A(x) + \sigma_A(x) + v_A(x) \le 3$$

2.2 Single valued Neutrosophic Set (SVNS):[2]

Let X be a non-empty elements with an element in x denoted by A^N. A Single valued Neutrosophic set (SVNS) in X is formulated by Truth-membership function $\mu_A(x)$, Indeterminacy membership function $\sigma_A(x)$, and a Falsity membership function $v_A(x)$. For each point x in X, $\mu_A(x), \sigma_A(x), v_A(x) \epsilon [0,1]$.

2.3 Single Valued Decagonal Neutrosophic Number (DeSVNN):[2]

A SDeNN($\grave{D}$) is defined as SDeNN=$\left\langle \begin{matrix} [(k_1, l_1, m_1, n_1, o_1, p_1, q_1, r_1, s_1, t_1); \mu][(k_2, l_2, m_2, n_2, o_2, p_2, q_2, r_2, s_2, t_2); \sigma] \\ [(k_3, l_3, m_3, n_3, o_3, p_3, q_3, r_3, s_3, t_3); v] \end{matrix} \right\rangle$

where $\mu, \sigma, v \epsilon [0,1]$. The truly membership function $(\mu_{SDeNN}): \bar{R} \to [0, \mu]$, the non- membership function $(\sigma_{SDeNN}): \bar{R} \to [0,1]$, and the falsity membership function $(v_{SDeNN}): \bar{R} \to [v, 1]$

$$(\mu_{SDeNN}) = \begin{cases} 0 & , x < k_1 \\ c\left(\frac{x-k_1}{l_1-k_1}\right) & , k_1 \le x \le l_1 \\ c\left(\frac{x-l_1}{m_1-l_1}\right) & , l_1 \le x \le m_1 \\ c & , m_1 \le x \le n_1 \\ c + (1-c)\left(\frac{x-n_1}{0_1-n_1}\right) & , n_1 \le x \le 0_1 \\ 1 & , 0_1 \le x \le p_1 \\ c + (1-c)\left(\frac{q_1-x}{q_1-p_1}\right) & , p_1 \le x \le q_1 \\ c & , q_1 \le x \le r_1 \\ c\left(\frac{S_1-x}{s_1-r_1}\right) & , r_1 \le x \le s_1 \\ c\left(\frac{t_1-x}{s_1-t_1}\right) & , s_1 \le x \le t_1 \\ 0 & , x > t_1 \end{cases}$$

$$(\sigma_{SDeNN}) = \begin{cases} 0 & ,x < k_2 \\ c\left(\dfrac{x-k_2}{l_2-k_2}\right) & ,k_2 \le x \le l_2 \\ c\left(\dfrac{x-l_2}{m_2-l_2}\right) & ,l_2 \le x \le m_2 \\ c & ,m_2 \le x \le n_2 \\ c+(1-c)\left(\dfrac{x-n_2}{0_2-n_2}\right) & ,n_2 \le x \le 0_2 \\ 1 & ,0_2 \le x \le p_2 \\ c+(1-c)\left(\dfrac{q_2-x}{q_2-p_2}\right) & ,p_2 \le x \le q_2 \\ c & ,q_2 \le x \le r_2 \\ c\left(\dfrac{S_2-x}{s_2-r_2}\right) & ,r_2 \le x \le s_2 \\ c\left(\dfrac{t_2-x}{s_2-t_2}\right) & ,s_2 \le x \le t_2 \\ 0 & ,x > t_2 \end{cases}$$

$$(v_{SDeNN}) = \begin{cases} 0 & ,x < k_3 \\ c\left(\dfrac{x-k_3}{l_3-k_3}\right) & ,k_3 \le x \le l_3 \\ c\left(\dfrac{x-l_3}{m_3-l_3}\right) & ,l_3 \le x \le m_3 \\ c & ,m_3 \le x \le n_3 \\ c+(1-c)\left(\dfrac{x-n}{0_3-n_3}\right) & ,n_3 \le x \le 0_3 \\ 1 & ,0_3 \le x \le p_3 \\ c+(1-c)\left(\dfrac{q_3-x}{q_3-p_3}\right) & ,p_3 \le x \le q_3 \\ c & ,q_3 \le x \le r_3 \\ c\left(\dfrac{S_3-x}{s_3-r_3}\right) & ,r_3 \le x \le s_3 \\ c\left(\dfrac{t_3-x}{s_3-t_3}\right) & ,s_3 \le x \le t_3 \\ 0 & ,x > t_3 \end{cases}$$

2.4 Ranking technique based on centroid of centroid method [2]:

$$\text{RCCDe}=\left[\frac{2(k+t)+6(l+m+n+q+r+s)+7(o+p)}{54} \times \frac{19}{18}\right]$$

2.5 Score and Accuracy Function [2]:

Let us consider a single valued Decagonal Neutrosophic Numbers (SDeNN) as SDeNN= $(S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}; \mu, \sigma, v)$. The initial application of score values to get the judgment of conversion of SDeNN to crisp Number. Also, the mesn of the SDeNN components is $\left(\frac{S_1+S_2+S_3+S_4+S_5+S_6+S_7+S_8+S_9+S_{10}}{10}\right)$ and score value of the membership parts is $\left\{\frac{2+\pi-\rho-\sigma}{3}\right\}$.

2.6 Transportation Model [10]:

Minimize $Z = \sum_{i=1}^{m}\sum_{j=1}^{n} X_{ij}C_{ij}$ subject to constraints:

$\sum_{j=i}^{n} X_{ij=a_i}, i = 1,2, \dots . m$(supply constraint)

$\sum_{i=1}^{m} X_{ij} = b_j, j = 1,2, \dots n$(demand constraint) and $\forall X_{ij} \ge 0$

2.7 Neutrosophic Transportation Model [2]:

Assume that there are m number of sources and n destinations.

Mathematically, the DeNTP may be stated as:

Minimize $Z = \sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij}^{DeN} X_{ij}$

subject to

$\sum_{j=i}^{n} X_{ij=a_j}, j = 1,2, \dots .m$

$\sum_{i=1}^{m} X_{ij} = b_i, i = 1,2, \dots n$

$\forall X_{ij} \geq 0$

3. Solving Transportation Problem with Decagonal Neutrosophic Number using Monalisha's Approximation method.

3.1 New Score and Accuracy Function:

Let $\widetilde{A_D}$=$(S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}; \mu, \sigma, v)$. Be a Single- Valued Decagonal Neutrosophic Number (SDec$\acute{N}$N), where $(S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10})$ represent the structural decagonal components. To transform the SDec$\acute{N}$N inti an equivalent crisp value while incorporating the accuracy index of truth over uncertainty, a novel Score function

S$(\widetilde{A_D})$ is formulated as = $\left(\frac{1+\mu-\sigma-v}{2}\right)$.

3.2 k-Decagonal Neutrosophic Number Algorithm:

Step 1:

Using Ranking technique based on Centroid of centroid Method for converting defuzzification.

Step 2:

Using Score Value for finding single value from each cell.

Step 3:

Find IBFS using Decagonal Neutrosophic Numbers

Step 4:

if $b_j > a_i$ then the cells values will be divided by 2. i.e it can be reduced half of the value

Step5:

- Step (a): Determine the cost table from the given problem.

(i) Examine whether total demand equals total demand. If yes, go to step (b).

(ii) If not, introduce a dummy row/column having all its cost elements as zero and supply/ demand as the (+ve) difference of supply and demand.

- Step (b): Locate the smallest element in each row of the given cost matrix and then subtract the same from each element of that row.
- Step (c): In the reduced matrix obtained in step (b), locate the smallest element of each column and then subtract the same from each element of that column.
- Step (d): For each row of the transportation table identify the smallest and the next - to - smallest costs. Determine the difference between them for each row. Display them alongside the transportation table by enclosing them in parenthesis against the respective rows. Similarly compute the differences for each column.
- Step (e): Identify the row or column with the largest difference among all the rows and columns. If a tie occurs, use any arbitrary tiebreaking choice. Let the greatest difference correspond to i^{th} row and let 0 be in the ith row. Allocate the maximum feasible amount$X_{ij} = \min(a_i, b_j)$ in the $(i, j)^{th}$ cell and cross off either the ith row or the j^{th} column in the usual manner.
- Step (f): Recompute the column and row differences for the reduced transportation table and go to step (e). Repeat the procedure until all the rim requirements (the various origin capacities and destination requirements are listed in the right most outer column and the bottom outer row respectively) are satisfied.

3.3 Numerical Example:

A Company named KSK Private Ltd., has three Medical Supply centres for delivering medicines. The medicines are to be transported to three hospitals under decagonal Neutrosophic numbers.

	M	N	O	
J	**T**(0.70,0.50,0.80,0.60,0.90, 0.30,0.32,0.40,0.58,0.62), **I** (0.55,0.65,0.75,0.85,0.95, 0.15,0.25,0.35,0.45,0.60), **F**(0.60,0.70,0.80,0.55,0.40, 0.32,0.34,0.36,0.38,0.50).	**T**(0.23,0.33,0.43,0.53,0.63, 0.73,0.83,0.93,0.86,0.76), **I** (0.42,0.32,0.22,0.62,0.52, 0.72,0.82,0.92,0.45,0.35), **F**(0.91,0.81,0.71,0.61,0.51, 0.41,0.31,0.21,0.11,0.19).	**T**(0.97,0.87,0.77,0.67, 0.57,0.47,0.37,0.27, 0.17,0.12), **I**(0.46,0.36,0.25,0.32, 0.76,0.18,0.39,0.20, 0.25,0.42), **F**(0.76,0.52,0.34,0.82 0.75,0.65,0.58,0.91, 0.49,0.80)	**40**
K	**T**(0.60,0.59,0.58,0.57,0.50, 0.56,0.55,0.54,0.53,0.52), **I**(0.35,0.40,0.45,0.50,0.55, 0.60,0.65,0.70,0.75,0.80), **F**(0.82,0.58,0.60,0.55,0.45, 0.53,0.48,0.82,0.70,0.68)	**T**(0.80,0.79,0.78,0.77,0.76, 0.75,0.74,0.73,0.72,0.71), **I**(0.75,0.72,0.68,0.58,0.48, 0.38,0.28,0.18,0.16,0.90), **F**(0.28,0.58,0.88,0.38,0.55, 0.31,0.48,0.67,0.45,0.31)	**T**(0.70,0.29,0.31,0.72, 0.84,0.61,0.72,0.33, 0,30,0.24), **I**(0.79,0.87,0.67,0.98, 0.78,0.58,0.48,0.69, 0.24,0.62), **F**(0.25,0.41,0.67,0.75, 0.85,0.47,0.67,0.41, 0.31,0.49)	**50**
L	**T**(0.14,0.13,0.17,0.27,0.34, 0.57,0.19,0.58,0.19,0.74), **I**(0.37,0.47,0.97,0.24,0.71, 0.87,0.82,0.92,0.67,0.58), **F**(0.90,0.96,0.11,0.24,0.34, .87,0.21,0.36,0.78,0.11)	**T**(0.27,0.58,0.34,0.13,0.23, 0.25,0.34,0.22,0.71,0.62), **I**(0.67,0.24,0.31,0.45,0.65, 0.74,0.39,0.52,0.41,0.31), **F**(0.57,0.67,0.37,0.47,0.57, 0.67,0.77,0.97,0.27,0.68)	**T**(0.31,0.27,0.47,0.59, 0.92,0.50,0.47,0.38, 0.14,0.27), **I**(0.17,0.28,0.78,0.71, 0.94,0.95,0.68,0.74, 0.71,0.92), **F**(0.21,0.94,0.92,0.97, 0.93,0.82,0.81,0.87, 0.24,0.93)	**30**
	70	**20**	**30**	

Solution:

Step 1: Ranking technique based on Centroid of Centroid Method for converting defuzzification

	M	N	O	
J	(0.57,0.55,0.49)	(0.62,0.53,0.47)	(0.52,0.35,0.66)	**40**
K	(0.55,0.57,0.62)	(0.75,0.51,0.48)	(0.50,0.67,0.52)	**50**
L	(0.33,0.66,0.48)	(0.36,0.46,0.60)	(0.43,0.68,0.76)	**30**
Requirement	**70**	**20**	**30**	

Step 2: The Score function is used to obtain a single crisp value from each cell.

	M	N	O	Capacity
J	0.27	0.31	0.26	**40**
K	0.18	0.38	0.16	**50**
L	0.10	0.15	0.01	**30**
Requirement	**70**	**20**	**30**	

Step 3: Determine the IBFS Using k-Decagonal method

	M	N	O	Capacity
J	0.27	0.31	0.26	**40**
K	0.18	0.38	0.16	**50**
L	0.10	0.15	0.01	**30**
Requirement	**70**	**20**	**30**	

Step 4: if $b_j > a_i$ then the cells values will be divided by 2. i.e it can be reduced half of the value.

	M	N	O	Capacity
J	0.13	0.31	0.26	40
K	0.09	0.38	0.16	50
L	0.05	0.15	0.01	30
Requirement	70	20	30	

Step 5: Apply Monalisha's Approximation Method

	M	N	O	Capacity
J	0	0	0	40
K	0.01	0.07	0	50
L	0.08	0.03	0	30
Requirement	70	20	30	

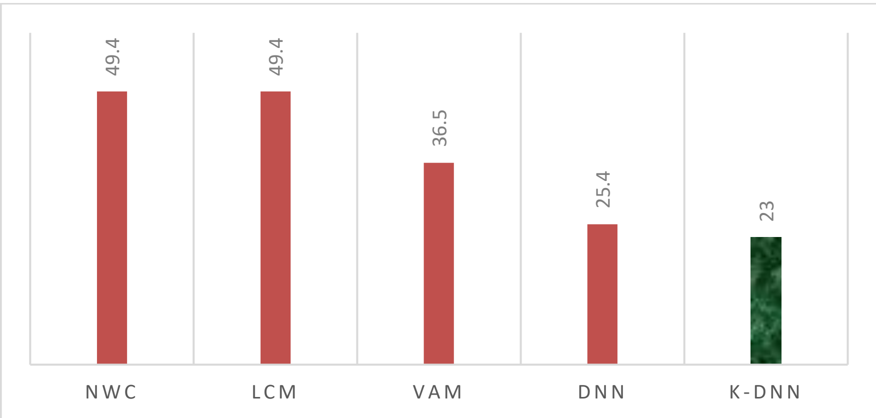
Total Cost = $(0.27 \times 20) + (0.31 \times 20) + (0.18 \times 20) + (0.16 \times 30) + (0.10 \times 30)$

=23.0

3.4 Comparison Table:

Example	NWCM	LCM	VAM	DNN	PROPOSED
1	49.4	49.4	36.5	25.4	23.0

3.5 Graphical Representation:



Conclusion:

In this paper, we have worked on k-Decagonal Neutrosophic Numbers using Monalisha's Approximation Method to find minimum value for the above problem. In future we can apply these techniques like assignment problem.

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