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Study on Public Health Transportation Using Triangular Neutrosophic Fuzzy Environment

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Abstract: *Transportation is a very essential tool to transport the particles/products from one place (origin) to another place (destination) with minimum cost or minimum time. Nowadays we come across so many problems (unexpected situations) like traffic, breakdown, etc. when we transport our particles/products from one place (origin) to another place (destination). Our wish to rectify this kind of unexpected situations with help of Neutrosophic Fuzzy Concept. We are going to justify this idea with some numerical examples.*

Keywords: Transportation Problem, Neutrosophic Fuzzy number, Neutrosophic Fuzzy Transportation problem.

Introduction

The Transportation Problem is a various type of the network problem in optimization Techniques. The transportation model plays a significant role in logistics and supply chain items. The motto is to schedule shipments from sources to destinations so that total transportation cost is minimized. The problem seeks a production and distribution plan that minimizes total transportation cost. The transportation problem itself was first developed by Hitchcock (1941), and was independently treated by Koopmans and Kantorovich however it could be solved for optimally as answers to complex business problem only in 1951, when George B. Dantizig delivered the new concept of Linear programming problem (LPP) in calculating the transportation technique. Dantzing (1951) insisted the standard LP-formulation for TP and applied the simplex method to determine it. Since then the transportation problem has become the classical common subject in almost every textbook on operation research and mathematical programming. [2] In current scenario, there is a necessity to transport the particles from different origin places to different places. In this paper, various methods have been proposed to find the optimal way of transporting the items i.e., to find the quantity of the items to be supplied from different places to different places so that the total transportation value is least. However, the general methods (Modified Distribution method or linear programming problems etc.) are proposed by assuming that the values of all the parameters (cost, capacity and requirement) are clearly and hence can be pointed as a real numbers. Transportation problems in which capacity and requirement are pointed as fuzzy numbers whereas money for transporting unit quantity of the product from a particular source to a particular destination is pointed by a real numbers, is named as fuzzy transportation problems of type – I. Transportation problems in which value for transporting unit quantity of the item from a particular place to a particular place is pointed by a fuzzy numbers whereas capacity and demand are pointed as real numbers, is named as fuzzy transportation problems of type – II. Transportation problems in which all the parameters i.e., cost for transporting unit quantity of the product from a particular origin to a particular destination, capacity and requirement, are pointed as fuzzy numbers, is called as fully fuzzy transportation problems. Transportation problems in which capacity and requirement are represented as Intuitionistic fuzzy numbers whereas cost for transporting unit quantity of the item from a particular source to a particular destination is pointed by real numbers, is named as Intuitionistic fuzzy transportation problems of type – I. Linear programming problem (LPP) is a opted planning source for various disciplines like business, finance, engineering, economics, etc. the decision making plays a important role in all business. The decision making is of different types based on the situation and data provided. In the past the decision making had criteria that the decision is fixed for the situations. Nowadays whenever we deals with day today decision making the uncertainty comes into existence. So the decision makers are complicated to take decision making. L.A. Zadeh has derived a set called Fuzzy sets to deal with the uncertainty or vagueness. The fuzzy sets have its own growth in the past decades and now the fuzzy concepts are making all decisions very easily. The fuzzy logic is applied almost in all fields of research and technology. In view of the distribution challenges (e.g. high distribution costs) encountered in the medical sector and its output on the economy in general," this study provides an optimize transportation modeling of medical goods to patients at lowest transportation cost.

Fuzzy Set: A Fuzzy set is characterized by a membership function mapping elements of a domain, space, or universe of discourse X to the unit interval [0,1].(i.e.)A^F = {(,x (μ_{A^F}(x)); x ∈ X }, hereμ_{A^F} : → [0,1]is a mapping called the degree of membership function of the fuzzy set and μ_{A^F}(x) called the membership function value of x ∈ X in the fuzzy set.

Fuzzy Number: A fuzzy set A^F defined on the universal set of real numbers R, is said to be a fuzzy number if its membership function has the following characteristics:

- $\mu_{A^F}(x) : R \to [0,1]$ is continuous.
- $\mu_{A^F}(x) = 0$ for all $x \in (-\infty, a] \cup [c, \infty)$
- $\mu_{A^F}(x)$ strictly increasing on (a,b) and strictly decreasing on (b,c)
- $\mu_{A^F}(x) = 1$ for all $x \in [a,c]$ where $a < b < c$.

Neutrosophic Set: Let X be a non-empty set. A Neutrosophic set is defined as AN = { x, ⟨ TAN(x), IAN(x),FAN (x)⟩ | x∈ X, TAN(x), IAN(x),FAN (x) /x∈X }, where TAN(x), IAN(x), and FAN (x) ∈ [0, 1] for each x∈X and 0 ≤ Sup TAN(x) + Sup IAN(x) +Sup FAN (x) ≤ 3.

Single Valued Neutrosophic Set: Let X be set of points (objects) with members in X denoted by x. A single valued neutrosophic set (SVNS) A in X is characterized by truth-membership function TA, indeterminacy-membership function IA and falsity-membership function FA. For each point x in X, TA(x), IA(x), FA(x) ∈ [0,1].

Single-Valued Refined Neutrosophic Set (RNS): Let U be a universe of discourse, and a set ARNS .Then ARNS = {<x, T1A(x), T2A(x), …, TpA(x); I1A(x), I2A(x), …, IrA(x); F1A(x), F2A(x), …, FsA(x)> | x ε

U}, where all TjA(x), $1 \leq j \leq m$, IkA(x), $1 \leq k \leq n$, FlA(x), $1 \leq l \leq o$, : U → [0, 1] and where TjA(x) indicates the j-th sub-membership degree, IkA(x) indicates the k-th sub-indeterminacy degree, FlA(x) indicates the l-th sub-non-membership degree, with m, n, o ≥ 1 integers, where m + n + o = $n \geq 4$. All neutrosophic sub-components TjA(x), IkA(x), FlA(x) are independent with respect to each other.

2. Preliminaries

In Classical Transportation Problems (CTP) is assumed that decision maker about the precise values of transportation cost, availability and demand of the items. In real world applications, all these vlaues of the transportation problems may not be known clearly due to uncertainty factors. For example, In real life problems the following situations may arise:

(i) Let a item is to be transported first time at a destination and no expert have knowledge about the transportation value then there exist uncertainty about the transportation value.
(ii) If a new item is entered in the market then there always exists vagueness about the demand of that particular item.
(iii) In daily life situation, it can be taken that whenever a demander enquiry to a supplier that the particular item is stock able or not, sometimes supplier answers yes it is stock able but after a few minutes supplier answers sorry at this moment this item is not stock able.

3. Mathematical Model for Fuzzy Transportation Problem

Now the Mathematical Model for the problem

Minimum Z =

Subject to

= , j = 1 to n

= , i = 1 to m

0, i= 1 to m and j= 1to n.

Neutrosophic Triangular Fuzzy Number: A Neutrosophic Triangular fuzzy number is defined by A^N = $\{x, (\alpha_{N1}(x), \alpha_{N2}(x), \alpha_{N3}(x)), (\beta_{N1}(x), \beta_{N2}(x), \beta_{N3}(x)), (\gamma_{N1}(x), \gamma_{N2}(x), \gamma_{N3}(x)) / x \epsilon X\}$ where $(\alpha_{N1}(x), \alpha_{N2}(x), \alpha_{N3}(x)) : X \to [0,1]$ is truth membership value, $((\beta_{N1}(x), \beta_{N2}(x), \beta_{N3}(x)) : X \to [0,1]$ is indeterminacy membership value and $((\gamma_{N1}(x), \gamma_{N2}(x), \gamma_{N3}(x) : X \to [0,1]$ is falsity membership value of x in A^N for every $x \in X$.

Membership Functions In Triangular Neutrosophic Fuzzy Number

A Triangular Neutrosophic Fuzzy Number is specified as A_N= (u_1, u_2, u_3; v_1, v_2, v_3; w_1, w_2, w_3) and whose True, Indeterminacy, and Falsity membership are specified as follows:

$$T_{AN}(x) = \begin{cases} \frac{(x-u_1)}{(u_2-u_1)}, & u_1 \le x \le u_2 \\ 1, & x = u_2 \\ \frac{(u_3-x)}{(u_3-u_2)}, & u_2 \le x \le u_3 \end{cases}$$

$$I_{AN}(x) = \begin{cases} \frac{(v_2-x)}{(v_2-v_1)}, & v_1 \le x \le v_2 \\ 1, & x = v_2 \\ \frac{(x-v_2)}{(v_3-v_2)}, & v_2 \le x \le v_3 \end{cases}$$

$$F_{AN}(x) = \begin{cases} \frac{(w_2-x)}{(w_2-w_1)}, & w_1 \le x \le w_2 \\ 1, & x = w_2 \\ \frac{(x-w_2)}{(w_3-w_2)}, & w_2 \le x \le w_3 \end{cases}$$

Ranking Of Triangular Fuzzy Number

$A_N = [\, u_1, v_1, w_1 \,]$the ranking function Ṝ: F(Ṝ) →Ṝ by graded mean is defined as

$$Ṝ\,(A_N) = \left(\frac{u_1+4v_1+w_1}{6}\right)$$

Tackling The Growing Problem Of Transporting Organs

The current organ transportation system relies on organ procurement organizations (OPOs), which broker organ acceptance as well as the movement of organs and transplant teams of surgeons, per fusionists, coordinators and trainees sometimes traveling under unsafe circumstances. Organtrans portation is significant for various reasons, one of which is that each additional hour of travel may shortest the life of the organs can provide to the transplanted patient. Unfortunately, this challenge is expected to expand as extreme weather events associated with climate change become more common. The logistical challenge of transporting organs can be looked at from three different perspectives: capacity, safety and cost.

Capacity

The capacity of the current system to transport more organs seems to be limited, for example, when organs are trans- ported via commercial aviation. Organ donation tends to occur in the evening or early morning, which potentially delays move- ment of the recovered organ until the airport opens and a flightis available.“Inmy mind this is crazy,”says Dr.Scalea.“

Safety

In June 2007, an organ procurement team died in an aircraft accident in Michigan.2 the tragic loss focused attention on the safety risks taken during travel for organ procurement. According to a survey of transplant surgeons, combined with data from the National Transportation Safety Board, the procurement air travel fatality rate is 1,000 times higher than that of scheduled commercial aircraft, giving surgeons who travel by air for procurement "the riskiest job in medicine."3,4 Moreover, Dr. Axelrod worries that the pressure to secure aircraft under the new allocation policies will lead to lower safety standards as organ procurement teams are forced to accept riskier transportation options. For example, procurement teams may no longer be able to limit their selection of planes and pilots to those with the highest safety ratings.

Cost

The highest the travel risk, then presumably the higher the cost of insurance will be. All told, Dr. Axelrod estimates that the cost of transplanting a liver when air travel is involved will increase considerably, and will be 20,000 more than for ground transport. That increase in cost poses a huge challenge for transplant programs, particularly those located further from primary sources of organs. As it stands, organ transportation cost is generally not paid for by private insurers and is only partially reimbursed by Medicare. Dr. Axelrod explains "As the transportation costs of these organs go up, the margins for liver transplant are further reduced".

The Truth About Organ Transport And Transplantation In India

At least 9 hearts and 2 livers could not reach needy patients in time in 2016 in India. India lacks a robust organ transport system. Cost of organ transplant is at least Rs 15-20 lakh in India. At least nine hearts and two livers could not reach needy patients in time last year in different parts of the country, even as lakhs of people wait at top hospitals for life-saving transplants amid acute shortage of donors. Experts point to the lack of a robust system to transport organs to super-specialty hospitals in quick time. The National Organ & Tissue Transplant Organization (NOTTO), the country's apex organ donation agency, is now framing a proposal to airlift cadaver organs and will send a report to the Union health ministry."Cadaver organs have a short life and so transplant should be done within a few golden hours,"Dr Vimal Bhandari, director of NOTTO, told Mail Today. "Therefore, we are preparing a proposal for airlifting organs at any given moment."

Uncertainty in Medical Diagnosis

Inconsistent is a source which makes the decision-making technique more difficult in medical diagnosis. Everyone is different person from the otherperson at physical level as well as mental level, symptoms of a disease expressed by patients are linguistic in nature and vary person to person. In real-life situations, the imprecise nature of medical documents and uncertain information gathered for decision-making requires the use of fuzzy. After the development of the fuzzy set, various extensions have been seen and successfully applied in medical diagnosis. Sanchez 1976, first formulated the diagnosis models involving fuzzy matrices representing the medical knowledge between symptoms and diseases. Fuzzy set theory has several properties that make it suitable for formalizing the uncertain information upon which medical diagnosis and treatment is usually based. Medical knowledge consists of medical descriptions and assertions that are incomplete and uncertain. It may be said to comprise knowledge about causal relationships based on theory, statistical information, pure definitions, and personal judgment.

4. Numerical Example

Consider a transportation problem with three organs like Heart, Liver, Eyes and five hospitals H_1, H_2, H_3, H_4whose costs are considered to be Triangular Neutrosophic Fuzzy numbers in lakhs. The problem is to find the optimal transportation in an efficient way. [Real time application in GJC Pharmaceuticals - Lalgudi, Trichy].

Hospitals / Organs	H_1	H_2	H_3	H_4	Availability ( )
Heart	(0.3,0.4,0.5)	(0.4,0.5,0.8)	(0.5,0.7,0.9)	(0.3,0.5,0.8)	(3,6,7)
Liver	(0.4,0.5,0.8)	(0.1,0.4,0.6)	(0.3,0.6,0.8)	(0.2,0.3,0.7)	(2,7,8)
Eyes	(0.1,0.7,0.9)	(0.2,0.3,0.6)	(0.3,0.4,0.5)	(0.4,0.6,0.9)	(4,6,9)
Requirement ( )	(1,3,6)	(3,6,9)	(2,5,7)	(1,4,6)	

Solution:

Step 1: Convert Triangular NTP into Crisp Number using ranking method

Hospitals / Organs	H_1	H_2	H_3	H_4	Availability ( )
Heart	0.40	0.53	0.70	0.52	6
Liver	0.53	0.38	0.58	0.35	6
Eyes	0.63	0.33	0.40	0.62	6
Requirement ( )	3	6	5	4	

It is balanced transportation problem since the total availability is equal to the total requirement.

i.e) $\sum a_i = \sum b_j = 18$.

Step 2: Find the initial basic feasible solution using existing methods and also find Optimality test

IBFS = (3 × 0.40) + (3 × 0.53) + (2 × 0.38) + (1 × 0.33) + (5 × 0.40) + (4 × 0.35)
= 7.28

After testing Optimality all $\Delta_{ij} \geq 0$ so we got optimal solution.

5. Proposed Method

Step 1: Check the total availability and the total requirement are equal or not If they are equal go to step 3 otherwise go to step 2.
Step 2: Make the unbalanced transportation problem in to balanced transportation problem.
Step 3: Select the maximum value from row wise and subtract with other element in the respective rows and columns.
Step 4: Apply VAM method to calculate IBFS.

6. Comparison Table

Sr. .No.	NWCM	LCM	VAM	Optimal Solution	Proposed Method	Optimal Solution
1	8.95	7.84	7.28	7.28	0.33	0.33

7. Conclusion

This research paper has proposed a new ranking for Triangular Neutrosophic fuzzy numbers. The proposed ranking is applied to expound Triangular Neutrosophic fuzzy transportation problem. Further, a numerical example has determined whose costs are taken as Triangular Neutrosophic fuzzy numbers .The proficiency of the proposed technique is shown in the comparison table. As a future extension, the proposed algorithm may be used to solve, Trapezoidal fuzzy Assignment problem (any number) and Pentagonal fuzzy interval valued fuzzy assignment and Pentagonal Neutrosophic fuzzy transportation problems with any number.

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