Tri Pythagorean Fuzzy Technique using in Transportation Problem for a felicitous solution

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Abstract:

The motto of this research to deliver the technique in a fine way to determine the optimal (felicitous) solution for the Tri Pythagorean Fuzzy Transportation Problem (TPFTP). Frequently, we are not focused on the mode of the transportation for the transportation problem. In TP our objective has to calculate the lowest cost or leastexpenseswhen the product to transport from one region to another region. In this research we have focused on three different types of Conveyance of Transport (COT) like by our own vehicle, aero plane and train. To formulate a new algorithm for this kind of TP to compute the felicitous solution. There will be two different case of solutions based on time and based on expenses according to any one of the mode of transportation. Someexamples are taken into put theexperiment the algorithm and importance of the new technique. In future, for furtherresearches definitely it will be utilized.

Keywords: Tri Pythagorean Fuzzy Numbers, Tri Pythagorean Fuzzy Transportation Problem, Score function.

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Introduction:

[11] Prof.Zadeh has told the vagueness concept which has very capable to solve the problems with untruth data in many real-livessituations. Some situations, we wish to find theOptimizevalue (felicitousvalues)for existing problems. Few situations, thedata hashandledin the form of uncertain, unreliableandunstable. Theinferences are not stableand clear therefore;the vaguenessconcepthas into existence.

Duringdecades,thefuzzyoptimizationhasconqueredpopularityamongresearcherssinceitswidespreadscopesinvariousbranchesofnetwork path problem, pickup delivery problem, travels alesmenproblem, traffic assignment problem and network flowproblem. Transportation problemcarries asuitablejob in many day to day lifeimplementations.It has been transported costs of capacity/requirementwhich pointedinthe wayofcrisp numbers. Tillthesevaluesarecommonlynotedasvague or unclear. Variousmethods have been developed by researchers to solve this kind of situation. Yager developed another fuzzy subset which is calledPythagorean Fuzzy Set (PFS), which the sum of the squares of membership &the non- membership valuesare equal to or less than 1. Many methods are available in the sector of Pythagorean Fuzzy Set to compute multi-criteria decision-making problems which are called the extension of TOPSIS,weightedgeometric operator alternative queuing method,etc. Pythagorean FuzzySet is to locate the respective crisp valued. This research paper is carried as follows: in the rest of the research, littleprimaryinformation, messages on Pythagorean Fuzzy Settheory and arithmetic rules on Pythagorean Fuzzy Numbers (PFNs) are available. The rest of the chaptershave the existing types under crisp and fuzzy transportation problems.

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Definition 2.1:[2] Let X be a non-empty Pythagorean Fuzzy Set (PFS) is having the form
P_y= $\{(x,(\vartheta^P(x),\delta^P(x)))\ |x\in X\}$ where the function$\vartheta^{Py}(x)$: X [0, 1] → and$\delta^{Py}(x)$: X[0,1] →arethedegreeofMembershipandnon-membershipof the element x∈Xto P_y, respectively for every x∈X, it holdsthat
$0 \leq [\theta^P(x)]^2+[\delta^P(x)]^2 \leq 1$.

Definition 2.2:[2] Let$a^p{}_1 = (\theta^p{}_u, \delta^p{}_r)$,$b^p{}_1 = (\theta^p{}_v, \delta^p{}_s)$ and $c^p{}_1 = (\theta^p{}_w, \delta^p{}_t)$ be three Pythagorean FuzzyNumbers(PFN).

(i)Additive Property:$a^p{}_1 \oplus b^p{}_1 \oplus c^p{}_1$= ($\sqrt{(\theta^p{}_u)^2+(\theta^p{}_v)^2+(\theta^p{}_w)^2-(\theta^p{}_u)^2.(\theta^p{}_v)^2(\theta^p{}_{w)}{}^2}$, $(\delta^p{}_r).(\delta^p{}_s)(\delta^p{}_t)$)

(ii)Multiplicative Property:$a^p{}_1 \otimes b^p{}_1 \otimes$= $c^p{}_1$ = ($(\theta^p{}_u).((\theta^p{}_v).(\theta^p{}_w)$, $\sqrt{(\delta^p{}_r)^2+(\delta^p{}_s)^2+(\delta^p{}_t)^2-(\delta^p{}_r)^2.(\delta^p{}_s)^2.(\delta^p{}_t)^2}$)

Definition 2.3: [3]Let$a^p{}_1 = (\theta^p{}_u, \delta^p{}_r)$, $b^p{}_1 = (\theta^p{}_v, \delta^p{}_s)$ be two Pythagorean Fuzzy Numbers(PFN).

(i) Score function: $S(a^p) = \frac{1}{2}(1+(\theta^p{}_u)^2-(\delta^p{}_r)^2)$

(ii) Accuracy function: $A(a^p)) = (\theta^p{}_u)^2+(\delta^p{}_r)^2$

There are various cases arise:

Case (i): ꞩ $(a^p{}_1)$ >ꞩ $(b^p{}_1)$,iff$(a^p{}_1) > b^p{}_1$

Case (ii): ꞩ $(a^p{}_1)$<ꞩ $(b^p{}_1)$,iff $(a^p{}_1) < b^p{}_1$

Case (iii): if ꞣ $(a^p{}_1)$<ꞣ $(b^p{}_1)$ and $a^p{}_1 < b^p{}_1$, then ꞩ $(a^p{}_1)$ = ꞩ ($b^p{}_1$)

Case (iv): if ꞣ $(a^p{}_1)$>ꞣ $(b^p{}_1)$ and$a^p{}_1 > b^p{}_1$, then ꞩ $(a^p{}_1)$ = ꞩ ($b^p{}_1$)

Case (v): if ꞣ $(a^p{}_1)$= ꞣ $(b^p{}_1)$ and$a^p{}_1 = b^p{}_1$,then ꞩ $(a^p{}_1)$ = ꞩ ($b^p{}_1$)

Pythagorean Fuzzy Transportation Problem (Type I):

[5] The product has transported from all origins toall destinations by TM_1. It has the objective function particularly only cost value in the form of Pythagorean Fuzzy number others will be the form of Crisp numbers:
The Mathematical Model for this type I will be

Min Z = $\sum_{i=0}^{u} \quad \sum_{j=0}^{v} \quad \sum_{k=0}^{w} x_{ijk}\, c^{p}{}_{ijk}$
Subject to

$\sum_{j=0}^{v} x_{ijk} = a_i$, i = 1 to u (Supply) and k = 1 to w

$\sum_{i=0}^{u} x_{ijk} = b_i$, j = 1 to v (Demand) and k = 1 to w

$\sum_{k=0}^{w} x_{ijk} = e_k$, j = 1 to v (Conveyance) and i = 1 to u

$x_{ijk} \geq 0$, ∀ i,j,k

Example:

Consider the following TPFTP table:

	D_1	D_2	D_3	D_4	a_i
O_1	(0.4,0.7) (0.6,0.3) (0.8,0.2)	(0.5,0.4) (0.7,0.4) (0.9,0.3)	(0.8,0.3) (0.6,0.5) (0.6,0.2)	(0.6,0.3) (0.5,0.2) (0.9,0.2)	26
O_2	(0.4,0.2) (0.7,0.5) (0.3,0.8)	(0.7,0.3) (0.4,0.7) (0.8,0.5)	(0.4,0.8) (0.7,0.2) (0.8,0.3)	(0.7,0.3) (0.4,0.5) (0.6,0.3)	24
O_3	(0.7,0.1) (0.8,0.4) (0.5,0.8)	(0.8,0.1) (0.7,0.2) (0.7,0.5)	(0.6,0.1) (0.8,0.3) (0.7,0.4)	(0.9,0.1) (0.6,0.4) (0.5,0.7)	30
b_j	17	23	28	12	

Solution:
step1: Total supply = Total demand = 80
∴The given TPFTP is balanced.

Step 2: If both the total for demand is equal to total for supply move to step3.

Table for Mode of Transportation 1(MOT$_1$):

	D_1	D_2	D_3	D_4	a_i
O_1	0.6,0.3	0.9,0.3	0.8,0.3	0.9,0.2	26
O_2	0.8,0.3	0.7,0.3	0.7,0.2	0.4,0.5	24
O_3	0.7,0.1	0.7,0.2	0.7,0.4	0.9,0.1	30
b_j	17	23	28	12	

Step3: Convert the PFN into Crisp value using Score function

	D_1	D_2	D_3	D_4	a_i
O_1	0.635	0.860	0.775	0.885	26
O_2	0.775	0.700	0.725	0.455	24
O_3	0.740	0.725	0.665	0.900	30
b_j	17	23	28	12	

Step 4: By VAM, find the IBFS for the TPFTP

	D_1	D_2	D_3	D_4	a_i
O_1	17 0.635	0.860	9 775	0.885	26
O_2	0.775	12 700	0.725	12 455	24
O_3	0.740	11 725	19 665	0.900	30
b_j	17	23	28	12	

Step5: To apply Optimality Test for the IBFS

Since all $\Delta_{ij} \geq 0$, the felicitous solution has reached.

Cost Z = (17×0.635) + (12 × 0.7) + (11× 0.725) + (9 × 0.775) + (19 × 0.665) + (12 × 0.455)

= Rs**. 52.24.**

Table for Mode of Transportation 2(MOT_2):

	D_1	D_2	D_3	D_4	a_i
O_1	0.4,0.7	0.5,0.4	0.6,0.2	0.5,0.2	26
O_2	0.7,0.5	0.8,0.5	0.4,0.8	0.6,0.3	24
O_3	0.5,0.8	0.7,0.5	0.8,0.3	0.5,0.7	30

b_j	17	23	28	12	

Convert the PFN into Crisp value using Score function

	D_1	D_2	D_3	D_4	a_i
O_1	0.335	0.545	0.660	0.605	26
O_2	0.620	0.695	0.260	0.635	24
O_3	0.305	0.620	0.775	0.380	30
b_j	17	23	28	12	

By VAM, find the IBFS for the TPFTP

	D_1	D_2	D_3	D_4	a_i
O_1	0.335	22 0.545	4 0.660	0.605	26
O_2	0.620	0.695	24 0.260	0.635	24
O_3	17 0.305	1 0.620	0.775	12 0.380	30
b_j	17	23	28	12	

To apply Optimality Test

Since all $\Delta_{ij} \geq 0$, the felicitous solution has reached.

Cost Z = (17×0.305) + (22 × 0.545) + (1× 0.620) + (4× 0.660) + (24× 0.260) + (12 × 0.380)

= Rs**. 31.235.**

Table for Mode of Transportation 1(MOT$_3$):

	D_1	D_2	D_3	D_4	a_i
O_1	08.,0.2	0.7,0.4	0.6,0.5	0.6,0.3	26
O_2	0.4,0.2	0.4,0.7	0.8,0.3	0.7,0.3	24
O_3	0.8,0.4	0.8,0.1	0.6,0.1	0.6,0.4	30

b_j	17	23	28	12	

Convert the PFN into Crisp value using Score function

	D_1	D_2	D_3	D_4	a_i
O_1	0.800	0.665	0.555	0.635	26
O_2	0.560	0.335	0.775	0.700	24
O_3	0.740	0.815	0.675	0.600	30
b_j	17	23	28	12	

By VAM, find the IBFS for the TPFTP

	D_1	D_2	D_3	D_4	a_i
O_1	0.800	50.665	26 50.555	0.635	26
O_2	1 50.560	23 30.335	20.775	0.700	24
O_3	16 30.740	50.815	2 50.675	12 30.600	30
b_j	17	23	28	12	

To apply Optimality Test

Since all $\Delta_{ij} \geq 0$, the felicitous solution has reached.

Cost Z = (1×0.560) + (16× 0.740) + (23× 0.335) + (26× 0.335) + (2× 0.675) + (12 × 0.600)

= Rs**. 43.085.**

Comparison Table:

Datas	Supply	Demand	Cost	IBFS	Optimality Test	Felicitous Solution

Mode Of Transport						
MOT 1	(26,24,30)	(17,23,28,12)	Given Costs	52.24	≥ 0	52.24
MOT 2	**(26,24,30)**	**(17,23,28,12)**	**Given Costs**	**31.24**	$\geq$ **0**	**31.24**
MOT 3	(26,24,30)	(17,23,28,12)	Given Costs	43.09	≥ 0	43.09

Conclusion:

In this TrPyFTP, We have used same values for all three types of transportation modes except the cost values.In TP cost plays an important role, score function and arithmetic operations very significant to find optimal solution for the TP. We have suggested here for TP mode of transportation is very essential. The Path or Route of the transportation is concentrated. In future our method can be applied for all real life problems and etc.

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