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EMERGING TRENDS IN SCIENCE AND TECHNOLOGY (ETIST-2021)

27th October 2021

Jointly Organized by

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A nations's growth is in proportion to education and intelligence spread among the masses. Having this idealistic vision, two great philanthropists late. S.P. Nallamuthu Gounder and Late. Arutchelver Padmabhushan Dr.N.Mahalingam formed an organization called Pollachi Kalvi Kazhagam, which started NGM College in 1957, to impart holistic education with an objective to cater to the higher educational needs of those who wish to aspire for excellence in knowledge and values. The College has achieved greater academic distinctions with the introduction of autonomous system from the academic year 1987-88. The college has been Re-Accredited by NAAC and it is ISO 9001 : 2015 Certified Institution. The total student strength is around 6000. Having celebrated its Diamond Jubilee in 2017, the college has blossomed into a premier Post-Graduate and Research Institution, offering 26 UG, 12 PG, 13 M.Phil and 10 Ph.D Programmes, apart from Diploma and Certificate Courses. The college has been ranked within Top 100 (72nd Rank) in India by NIRF 2021.

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Topologized Graphical Method for Pentagonal Fuzzy Transportation Problems

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ABSTRACT: In the present scenario, the researchers are seeking applications of topological spaces in many branches of mathematics. Topologized graph has been developed and applied in Colouring and Matching of Graph and Transportation Problems in recent days. First, we transform the fuzzy transportation problem into a crisp transportation problem using prescribed ranking technique then we have introduced a new method to find the optimal solution of the pentagonal fuzzy transportation problems using topologized graphical method. This method provides a novel approach to obtain the minimum cost of the Pentagonal Fuzzy Transportation problem.

KEYWORDS: Topologized Graph, Transportation Problem, Pentagonal Fuzzy Numbers

1. INTRODUCTION

In recent decades Topology and Graph theory are the two major application areas of Mathematics. Topological spaces and graphs plays a substantial part in optimizing techniques. Recently the fuzzy topological graph was introduced and studied by Jayalakshmi[2] et. al. in 2017.Amongst all the applications, the most eventful and wide ranging application of quantitative analysis in solving business problems is transportation problem. It is also the other unique application of linear programming problem. Originally, the intension is to minimize the cost of shipping goods from one locality to another so that the desires of each arrival area are encountered and every shipping locality functions within its capacity. In order to solve a transportation problem, the decision parameters such as availability, requirement and the unit transportation cost of the model must be fixed at crisp values. But in real life applications supply, demand and unit transportation cost may be ambiguous due to several factors. Pandian and Natarajan [5] proposed a fuzzy zero-point method to find the fuzzy optimal solution of fuzzy transportation problems. Quite a few researchers had developed so many methods to find optimal solution of a Transportation problem. But in the topological point of view a few of the researchers analyzed the solution of Fuzzy Transportation problem. Recently in 2019 Santhi and Kungumaraj [7] have introduced the topological solution of a transportation problem using topologized graph. By using Robust Ranking Technique to convert Fuzzy transportation problem into crisp

transportation problem [8]. Thus, here we have introduced a new type of topological approach to obtain the optimal solution

Definition 2.1. Fuzzy Set

Let X be a non-empty set. A fuzzy set A of X is defined as $\bar{A}$= (x,$\mu_{\bar{A}}$(x); x ∈ X)

where $\mu_{\bar{A}}$ (x) is called the membership function which maps each element of

X to a value between 0 and 1

Definition 2.2. Fuzzy Number

A fuzzy number $\bar{A}$ is a convex normalized fuzzy set on the real line R such that:

(i) There exists at least one x ∈ R with $\mu_{\bar{A}}$(x) = 1

(ii) $\mu_{\bar{A}}$(x) is piecewise continuous.

Definition 2.3. Pentagonal Fuzzy Number

A fuzzy number A on R is said to be a pentagonal fuzzy number (PFN) or linear fuzzy number which is named as (a_1, a_2, a_3, a_4, a_5) if its membership function $\mu A(x)$ has the following characteristic

$$\mu_{\bar{A}}(x) = \begin{cases} 0\,, if\ x < a_1 \\ u_1\left(\frac{x-a_2}{a_3-a_2}\right)\,, if\ a_1 \le x \le a_2 \\ 1\,, if\ x = a_3 \\ 1-(1-u_2)\left(\frac{a_4-x}{a_4-a_3}\right)\,, if\ a_3 \le x \le a_4 \\ (u_2)\left(\frac{a_5-x}{a_5-a_4}\right)\,, if\ a_4 \le x \le a_5 \\ 0\quad,\quad if\ x > a_5 \end{cases}$$

Definition 2.4. Topologized Graph

A topologized graph is a topological space X such that

(i) Every singleton is open or closed.

(ii) For every x ∈ X, $|\partial(x)| \le 2$, since ∂ (x) is denoted by the boundary of a point x.

Here the topology is defined on the graph, since the space X is the union of vertices and edges.

Definition 2.5. Robust Ranking Technique [10]

If ã is a Pentagonal fuzzy number, then the Robust Ranking is defined by

ã = { a_1, a_2, a_3, a_4, a_5}

$R(\tilde{a}) = \int_0^1 0.5\left(a_\alpha^L a_\alpha^U\right) d\alpha$ Where $a_\alpha^L a_\alpha^U$ is the α level cut of the fuzzy number ã and

$a_\alpha^L a_\alpha^U = \{(a_2 - a_1)\alpha + a_1, a_5 - (a_5 - a_4)\alpha\}$

$R(\tilde{a})$ gives the representative value of fuzzy number ã

3.PENTAGONAL FUZZY TRANSPORTATION PROBLEM USING TOPOLOGIZED GRAPH

PROPOSED ALGORITHM

The proposed algorithm consists of the following steps:

Step 1: Construct a balanced Fuzzy Transportation table ($\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$) for the given transportation problem

Step 2: Apply the Robust ranking technique to convert the Fuzzy Transportation Problem into a crisp transportation problem.

Step 3: Represent the Transportation Problem in a graph by taking supply and demand points as vertices a_i & b_j and edges are denoted for unit transportation cost c_{ij} from i^{th} supply point to j^{th} demand point. .

Step 4: In each row or column, choose the first two minimum unit transportation cost c_{ij} then modify the graphical representation.

Step 5: Generate a topological space whose elements are vertices $s_i(i = 1,2,3, \dots)$, $d_j(j = 1,2,3, \dots)$ and edges e_{ij} of the modified graph. Suppose the modified graph satisfies the two conditions of the topologized graph, go to the next step or else rearrange the graph and make it a topologized graph.

Step 6: Identify the vertex in Topologized graph which has the smallest transportation cost and allocate $x_{ij} = \min\{a_i, b_j\}$

- Case (i): If $\min\{a_i, b_j\} = a_i$ then allocate $x_{ij} = a_i$ and strike out the i^{th} supply vertex and decrease b_j at demand vertex d_j, then proceed to the next step.
- Case (ii): If $\min\{a_i, b_j\} = b_j$ then allocate $x_{ij} = b_j$ and strike out the j^{th} demand point and decrease a_i at supply point s_i, then proceed to the next step.
- Case (iii): If $\min\{a_i, b_j\} = a_i = b_j$ then allocate $x_{ij} = a_i = b_j$ and strike out both supply and demand points and proceed to the next step.

Step 7: Calculate new supply and demand for remaining vertices s_i & d_j after that repeat the same process as in step 6 until all demands and supplies are exhausted.

Step 8: Suppose any of the quantities a_i or b_j are not allocated in any one of the supply points or demand points then select that particular vertex and include one edge and allocate accordingly to satisfy the remaining supply and demand quantities.

		DESTINATION				
		s_1	s_2	s_3	s_4	**SUPPLY**
PRODUCTION	d_1	(2,4,6,8,9)	(3,5,7,8,9)	(2,4,5,6,7)	(3,4,6,7,12)	30
	d_2	(0,2,5,6,8)	(4,5,6,8,11)	(2,3,5,7,11)	(1,5,6,9,11)	27
	d_3	(1,2,3,4,5)	(2,3,4,6,8)	(4,5,6,8,9)	(6,7,8,9,13)	40
	d_4	(3,5,6,7,8)	(1,5,6,7,8)	(2,7,8,9,10)	(3,3,4,5,9)	50
DEMAND		20	40	34	53	

Step 9: If each vertex has two or three allocations not more than three, then it gives the optimal solution for the given transportation table. Otherwise change the topologized graph and repeat the steps from 5 to 9.

3.1 Numerical Example

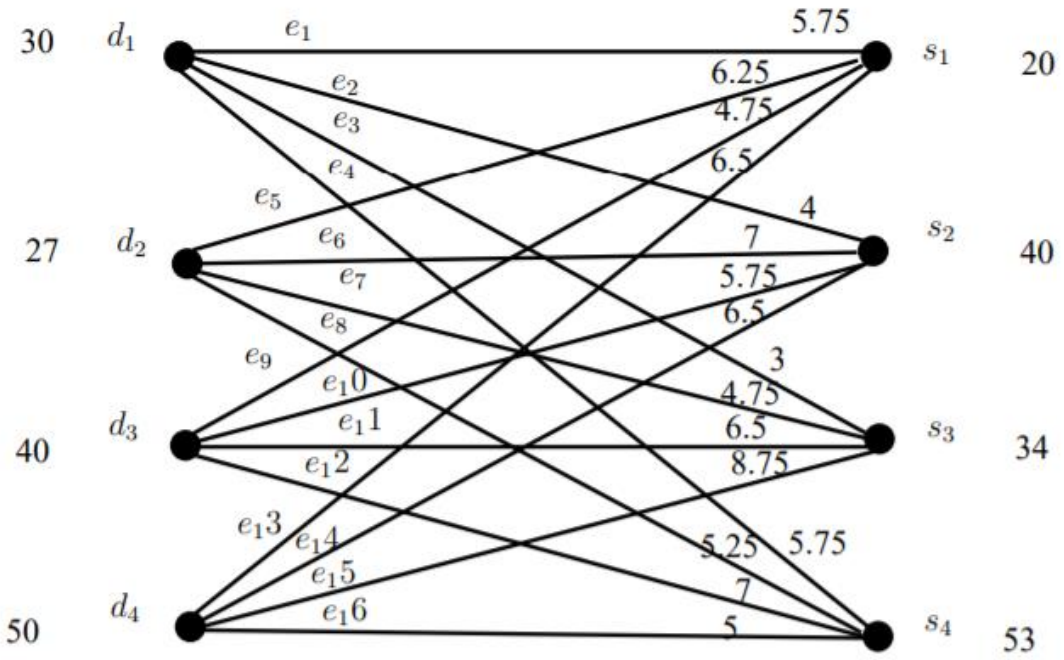
Consider a fully fuzzy Transportation problem in which supply at sources, demand at destinations and fuzzy unit transportation costs are assumed to be pentagon fuzzy numbers

By applying Robust Ranking technique to convert Pentagonal fuzzy transportation problem to Crisp Transportation problem

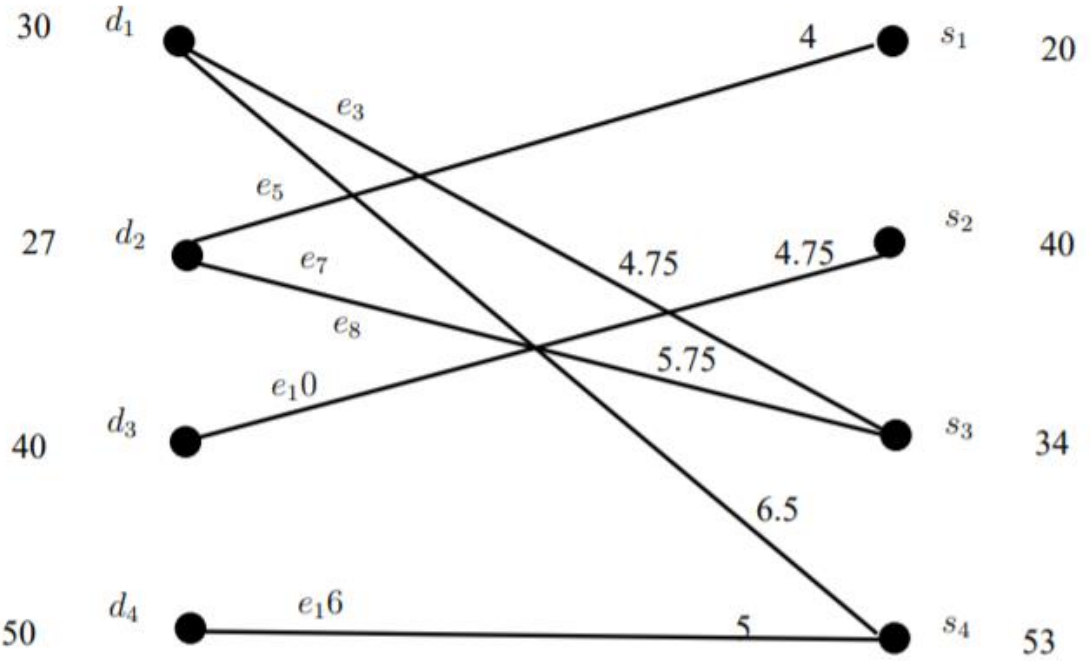
		DESTINATION				
		s_1	s_2	s_3	s_4	**SUPPLY**
SOURCE	d_1	5.75	6.25	4.75	6.5	30
	d_2	4	7	5.75	6.5	27
	d_3	3	4.75	6.5	8.75	40

	d_4	5.75	5.25	7	5	50
DEMAND		20	40	34	53	

The graphical representation of the above transportation problem is given below:



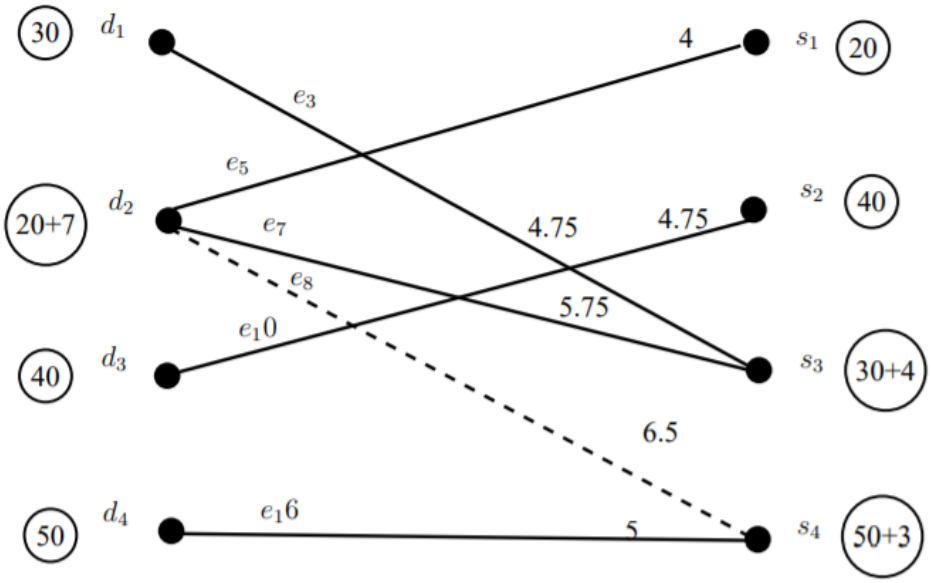
From the above graph and by the proposed algorithm, the following graphical representation obtained:
In this graph d_1, d_2, d_3, d_4 s, s_2, s_3, s_4 are denoted as vertices which are considered as the destination and origin of the transportation problem. And $e_1, e_2, e_3, e_4, e_5, e_6 e_7, e_8, e_9, e_{10}, e_{11}, e_{12}, e_{13}, e_{14}, e_{15}, e_{16}$ are denoted an Edges which are connect the origin and destination of the transportation problem.



Let $X = \{d_1, d_2, d_3, o_1, o_2, o_3, o_4, e_1, e_2, e_3, e_4, e_5, e_6 e_7, e_8, e_9, e_{10}, e_{11}, e_{12}, e_{13}, e_{14}, e_{15}, e_{16}\}$ Two conditions of the topologized graph has been satisfied in the above graph with the topology

$\tau = \{\phi, X, \{s_1\}, \{s_2\}, \{s_1, s_2\}, \{s_1, e_5, d_2, e_7, s_3, e_3, d_1, e_4, s_4, e_{16}, d_4\}, \{s_1, e_5, d_2, e_7, s_3, e_3, d_1, e_4, s_4, e_{16}, d_4, s_2\}, \{s_2, e_{10}, d_3\}, \{s_2, e_{10}, d_3, s_1\}\}$.

By the proposed algorithm , the allocations has been done and the quantity 3 is not allocated in s_4 and d_2. So, include one edge between these two vertices to complete the allocation process. The following graphical representation shows the final allocation for each and every vertex.



By the proposed algorithm, the optimal solution of the Pentagonal fuzzy transportation problem is given by

x_{13} = 30 , $x_{21} = 20$, $x_{24} = 3, x_{23} = 4, x_{32} = 40$, $x_{42} = 24.25$, x_{44}=50

The corresponding optimal cost Rs = (4.75*30) + (4*20) +(5.75*4) + (6.5*3) +(4.75*40) +(5*50) = Rs.705

2. CONCLUSION

The transportation problems reduce the time to deal with the minimum cost of fetching the things from one place to another. Many methods are there to fulfill this requirement to obtain the least cost and some of the methods may deal with the minimum delivering time. If the topograph of the origin and destination to transport things is known, then it is easy to transfer the things within a short period of time out of low cost. For this purpose, a new way to deal with Pentagonal Fuzzy Transportation Problem with the support of topologized graph is developed here. It has some significant part in connecting Topology, Graph Theory and Fuzzy Transportation Problem. Comparatively Topologized Graphical Method consumes less time, involves minimum number of steps and provides minimum transportation cost.

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BIOGRAPHY:

I have completed M.Sc., B.Ed., Ph.D. I have gained my doctoral degree in April 2021 in the field of Topology. I have published 15 papers both in National and International Reputed Journals. Among the fifteen, two are published in Scopus indexed journals. Currently I'm working as an Assistant Professor of Mathematics in Sri Krishna Arts and Science College, Coimbatore. In total I have ten years of teaching experience in Arts and Science Colleges.

Ms.V.Nandhini received Under graduate ,Post graduate and Master of Philosophy degree in Mathematics from Bharathiar University,Coimbatore,Tamil Nadu,India in the years 2016,2018 and 2019 respectively.Currently she is working as Assistant Professor in the Department of Mathematics in Sri Krishna Arts and Science College,Coimbatore – 641008.Her Research work includes Topology,Nano topology,Fuzzy topology and Topology optimization.She Published more than 10 journals and 2 conference proceedings.