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RTD & CETD Matrices in Spherical Fuzzy Environment

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ABSTRACT:

Matrix theory is an efficient tool in mathematics, due to its easily accessible nature. Being a higher extension of hard set, concept of fuzzy set is well used in fuzzy matrix theory in the up gradation process of matrix theory, and later to spherical fuzzy matrix theory, refined time dependent matrix, average time dependent matrix and combined effect time dependent matrix are very useful application tools in the scenario of matrix theory. In this paper these three tools are introduced in spherical fuzzy matrix environment and a real life application has also provided

Keywords: Spherical Fuzzy Set, Fuzzy Matrix, Spherical Fuzzy Matrix, RTD Matrix, ATD Matrix, CETD Matrix

2020 AMS Classification: 15B15

1. Introduction

In early nineteenth century mathematicians and statisticians used concept of set theory to solve uncertainties. Ancient days probability theory used widely, but later its draw backs reduced its relevance considerably. This opened a new path of utilizing different tools in mathematical world in divergent ways. Demand of real-life situations to include its membership values put a milestone for the introduction of fuzzy set theory in 1965 by L.A. Zadeh [30]. Approach of probability theory is by perception but that of fuzzy set theory is strictly from linguistic information. Kutlu Gündoğdu, Fatma and Cengiz Kahraman [11] introduced spherical fuzzy set theory in 2019 as a higher extension of fuzzy set as a three-dimensional approach. Basically, it could be thought of a mixed approach of fuzzy, pythagorean & picture fuzzy sets. In that way, it comprises positive, neutral and refusal memberships. Some similar perception as membership, non-membership and hesitancy can also be think of! Uses of fuzzy set theory spreads to various fields like mathematics, engineering, medicine etc. Spherical fuzzy set comprises a multidimensional space visible as a Sphere. Sphere's centre contains maximum membership value. Degree of uncertainty is indicated with the extent of the Sphere. This new concept is more efficient in decision making and pattern recognition problems.

Matrix theory is more useful in practical situations while comparing with any other existing tools of mathematics and it is developed in the year 1853, by Caley Hamilton [4]. For studying passenger transport problem, in 1998, W. B. Vasantha Kandasamy and V. Indira [23], developed Fuzzy matrix theory. They introduced four new types of matrices, initial raw data matrix, average time dependent matrix (ATD Matrix), refined time dependent data matrix (RTD Matrix), combined effect time dependent data matrix (CETD Matrix). This new way of thinking in matrix theory handled sophisticated situations in mathematics in an easier way than any of the existing. Later many mathematicians have contributed into fuzzy logic through various researches. By using, fuzzy relational maps, Victor Deva doss. A, Aseervatham. S [25] showed, classification of emotions through musical instruments. M. Suresh, and Greeda J [21] analysed situation of 'women harassment' in villages. Vivehananthan. V, Rajeswari. K, Anbalagan. S, discussed, effective completion of typewriting examination using fuzzy matrix theory [28]. Victor Devadoss. A, Felix. A, Immaculate Anbarasi [27] conducted a study in Chennai by using CETD matrix to study women school teacher's stress. Cengiz Kahraman, Fatma Kutlu Gündoğdu [5] studied on decision making with spherical fuzzy sets, Saraswati. A, Praveen Prakash. A, Vinoth Kumar. P [24] analysed fuzzy matrix using RTD and CETD matrix. Radhika. K, Anbalagan, Alexander and Suganthi Mariyappan [16] analysed risk factors of Breast cancer using CETD matrix. Clement Joe Anand. M, Felix Augustin [6] used CETD Matrix approach in analysing dimensions of personality of people. Kuppuswami. G, Sujatha. R and Vasantha kandasamy. W.B [10] studied traffic flow analysis CETD matrix. Lookman Sithic. H, Uma Rani. R [13] gave fuzzy matrix theory as a knowledge discovery in health care domain, Silambarasan in his paper [18] had studied about spherical fuzzy matrices, Priya. P, Ramya.R, Sangeetha.S, Saranya. A [15] analysed basic concepts of fuzzy matrices, Suvankar Biswas and Tapan Kumar Roy [20] shown fuzzy linear integral equation and its application in bio mathematical model, Vivehananthan. V, Rajeswari. K, Anbalagan. S, [28] analysed and shown the effective completion of type writing examination using Fuzzy Matrix, Thomson. G in his paper [22] studied about the convergence of powers of a fuzzy matrix. On 25th September 2007 Jean Charles Robinet and Frederick Delay took a research on the effects of rock matrix heterogeneities near fracture walls on the residence time distribution of solutes using RTD matrix [8]. The approach of CETD matrix for analysing the men affected by cardiovascular diseases in chennai is studied by Clement Joe Anand M and Lalithamaheswari M L on 2nd February 2015[7]. Albert William M, Janet Sheeba and Victor Devadoss analysed about breast cancer using RTD matrix and published it on June 1st 2013[3]. S Johnson Savarimuthu and S Gunalakshmi analysed about women harassment in villages using CETD matix models [9]. W B Vasantha Kandasamy in the year 2012 published a paper [29] based on innovative uses of matrices. The problems faced by rural tamil medium students in professional engineering college was studied using CETD matrix by A Kirupa and T Pathinathan on 1st June 2013[12]. Rahul Deshmukh found fuzzy matrix model for analysing the problems in the agricultural sector [17]. Fuzzy matrix is used to analyse dengue fever by R Sophia Porcheivi and M

Siochana in the year 2018[19]. Dimensions of personalities of women in Chennai is studied using CETD matrix by A Victor Devadoss and Clement Joe Anand [26]. V Madhun and Dr B Amudhambigai studied about the health hazard of the women scavengers using Fuzzy matrix [14]. Diabetes is a chronic health condition which affects a human body when it is incapable to produce enough insulin or incapable to use insulin effectively. People of every age group from new-born to old are affected with this condition. Type 1 diabetes, Type 2 diabetes, Gestational diabetes are the three types of diabetes usually seen among people. This paper, provides two different ways to find out age –group of people who are more affected by this disease using 'CETD matrix, in spherical fuzzy set' environment. Initial data collected by survey has undergone through some processes to convert it to RTD matrix and finally its combined effect has studied using CETD matrix. Graph has provided to highlight the age group in a more clear manner.

2. Preliminaries

This section discusses relevant definitions and properties used in this paper.

Definition 2.1 (Fuzzy Set) [30]: Let X be a space of points with generic element denoted by x such that $X = \{x\}$. A fuzzy *set* A in X is characterized by a membership value function $f_A(x)$ which associates with each point in X, a real number in the interval [0,1] with the value of f_A (x) represents the "grade of membership" of x in A.

Definition 2.2 (Spherical Fuzzy Set) [11]: Let U be a universe. Let A be a spherical fuzzy set. Then A is defined by, $A = \{\langle(x, (\mu_A, \vartheta_A, \pi_A))\rangle / x \in U\}$. The triplet $(\mu_A, \vartheta_A, \pi_A)$ such that $(\mu_A^2 + \vartheta_A^2 + \pi_A^2 \leq 1)$ is known as spherical fuzzy set, where μ, ϑ, π in A are membership, non-membership and hesitancy degrees of x. Values of all these three will be in [0, 1].

Definition 2.3 (Fuzzy Matrix) [1]: A fuzzy matrix may be a matrix with elements having values is a fuzzy interval. Unit interval in the fuzzy matrix is called fuzzy interval. A fuzzy matrix (FM) A of order m× n is defined as A= $[< a_{ij}, a_{ij} >]_{m\times n}$ where a_{ij} is the membership value of the element a_{ij} in A

Definition 2.4 (Spherical Fuzzy Matrix) [11] : A spherical fuzzy matrix (SFM) A = $\left(\langle\zeta_{a_{ij}}, \eta_{a_{ij}}, \delta_{a_{ij}}\rangle\right)$ of non-negative real numbers $\zeta_{a_{ij}}$, $\eta_{a_{ij}}$, $\delta_{a_{ij}} \in [0, 1]$ satisfying the condition $0 \leq \zeta^2{}_{a_{ij}} + \eta^2{}_{a_{ij}} + \delta^2{}_{a_{ij}} \leq 1$ for all i, j where $\zeta_{a_{ij}} \in [0, 1]$ is called the degree of membership, $\eta_{a_{ij}} \in [0, 1]$ is called the degree of neutral membership and $\delta_{a_{ij}} \in [0, 1]$ is called the degree of non-membership.

Definition 2. 5 (ATD Matrix) [23]: Average time dependent data (ATD) matrix (a_{ij}) is obtained by dividing each entry of the raw data matrix by the number of year or the time period that is the difference of the class interval of each row. This matrix represents a data, which is totally uniform.

Definition 2. 6 (RTD Matrix) [23] : Using the average μ_j of each jth column and σ_j the S.D of the each jth column, a parameter α is choosing from the interval [0, 1] and form the refined time dependent matrix (RTD matrix), using the formula given below : ATD matrix is redefining into refined time dependent fuzzy matrix. Entries of RTD matrix are =1, 0 or 1. Row sum of this matrix will give maximum age group.

$a_{ij} \leq (\mu_j - \alpha * \sigma_j)$ Then $e_{ij} = -1$ else; $a_{ij} \in (\mu_j - \alpha * \sigma_j, \mu_j + \alpha * \sigma_j)$ then $e_{ij} = 0$ else $a_{ij} \geq (\mu_j - \alpha * \sigma_j)$ then $e_{ij} = 1$.

Definition 2.7 (CETD Matrix) [23]: Using refined time data matrices obtained, a combined effective time dependent data matrix (CETD) is framed. It gives cumulative effect of all those entries. This is done by finding row sum matrix of the RTD matrix and also by combining these matrix by varying α ∈ [0, 1], so that a combined effective time dependent data (CETD) matrix is obtained.

Definition 2.8 (Spherical Fuzzy operations) [11]:

Union:

$$\bar{A}_s \cup \bar{B}_s = \left\{ \begin{array}{c} max\{\mu_{A_S,}\mu_{B_S}\}, min\{\vartheta_{A_S,}\vartheta_{B_S}\}, \\ min\left\{\left(1-\left(\left(max\{\vartheta_{\bar{A}_S}, \vartheta_{\bar{B}_S}\}\right)^2 + \left(min\{\vartheta_{\bar{A}_S}, \vartheta_{\bar{B}_S}\}\right)^2\right)\right)^{\frac{1}{2}}, max\{\pi_{\bar{A}_S}, \pi_{\bar{B}_S}\}\right\} \end{array} \right\}$$

Intersection:

$$\bar{A}_s \cap \bar{B}_s = \left\{ \begin{array}{c} min\{\mu_{\bar{A}_S}, \mu_{\bar{B}_S}\}, min\{\vartheta_{\bar{A}_S}, \vartheta_{\bar{B}_S}\}, \\ max\left\{\left(1-\left(\left(min\{\mu_{\bar{A}_S,}\mu_{\bar{B}_S}\}\right)^2 + \left(max\{\vartheta_{\bar{A}_S}, \vartheta_{\bar{B}_S}\}\right)^2\right)\right)^{\frac{1}{2}}, min\{\pi_{\bar{A}_S}, \pi_{\bar{B}_S}\}\right\} \end{array} \right\}$$

Addition:

$$\bar{A}_s \oplus \bar{B}_s = \left\{ \begin{array}{c} (\mu_{\bar{A}_S}^2 + \mu_{\bar{B}_S}^2 - \mu_{\bar{A}_S}^2\mu_{\bar{B}_S}^2)^{\frac{1}{2}}, \vartheta_{\bar{A}_S}\vartheta_{\bar{B}_S} \\ \left((1-\mu_{\bar{B}_S}^2)\pi_{\bar{A}_S} + (1-\mu_{\bar{A}_S}^2)\pi_{\bar{B}_S} - \mu_{\bar{A}_S,}\pi_{\bar{B}_S}\right)^{\frac{1}{2}} \end{array} \right\}$$

Multiplication:

$$\bar{A}_s \otimes \bar{B}_s = \left\{ \begin{array}{c} \mu_{\bar{A}_S}\, \mu_{\bar{B}_S}, \left(\vartheta_{\bar{A}_s}^2 + \vartheta_{\bar{B}_s}^2 - \vartheta_{\bar{A}_s}^2\vartheta_{\bar{B}_s}^2\right)^{1/2} \\ \left((1-{\vartheta_{\bar{B}_S}}^2)\pi_{\bar{A}_S} + (1-{\vartheta_{\bar{A}_S}}^2)\pi_{\bar{B}_S} - \pi_{\bar{A}_S}\pi_{\bar{B}_S}\right)^{1/2} \end{array} \right\}$$

Multiplication by a scalar: $\boldsymbol{\lambda > 0}$:

$$\lambda.\bar{A}_S = \left\{ \begin{array}{c} \left(1-(1-\mu_{\bar{A}_S}^2)^{\lambda}\right)^{1/2}, {\vartheta_{\bar{A}_S}}^{\lambda} \\ \left((1-\mu_{\bar{A}_S}^2)^{\lambda} - (1-\mu_{\bar{A}_S}^2 - \pi_{\bar{A}_s}^2)^{\lambda}\right)^{1/2} \end{array} \right\}$$

Power of $\boldsymbol{\bar{A}_S}$; $\boldsymbol{\lambda > 0}$:

$${\bar{A}_S}^{\lambda} = \left\{ \begin{array}{c} {\mu_{\bar{A}_S}}^{\lambda}, \left(1-(1-\vartheta_{\bar{A}_S}^2)^{\lambda}\right)^{1/2} \\ \left((1-{\vartheta_{\bar{A}_S}}^2)^{\lambda} - (1-\vartheta_{\bar{A}_s}^2 - \mu_{\bar{A}_S}^2)^{\lambda}\right)^{1/2} \end{array} \right\}$$

Definition 2.9 (Compliment of a SFS) [2]: For a spherical fuzzy set, $\bar{A}_S = (\mu_{\tilde{A}_S}, \vartheta_{\tilde{A}_S}, \pi_{\tilde{A}_S})$, its compliment is $\tilde{A}_S^c = (\vartheta_{\tilde{A}_S}, \mu_{\tilde{A}_S}, \pi_{\tilde{A}_S})$

3. Special matrices of Spherical Fuzzy Set and its Application

3.1 Special matrices in Spherical Fuzzy Set Environment

In this section RTD matrix and CETD matrix for spherical fuzzy sets are introduced

Definition 3.1.1(RTD Matrix for Spherical Fuzzy Matrix for Method I): Let μ_j and σ_j be the average spherical fuzzy mean (using definition 2.8) and spherical standard deviation (using definition 2.8) of each j^{th} column of the initial data matrix. After converting to ATD matrix, choose parameters $\alpha, \beta, \gamma \in [0,1]$ and frame the *refined time dependent matrix* (RTD Matrix) using the following formula:

$$(e_{ij,}e^{*}_{ij}, e^{**}_{ij}) = \begin{cases} -1, \ a_{ij} \le \mu_j - \alpha * \sigma_j \ , \quad b_{ij} \ge \mu_j - \beta * \sigma_j \ , \quad c_{ij} \ge \mu_j - \gamma * \sigma_j \\ 0, \ a_{ij} \in (\mu_j - \alpha * \sigma_j, \mu_j + \alpha * \sigma_j), \ b_{ij} \in (\mu_j - \beta * \sigma_j, \mu_j + \beta * \sigma_j), \ c_{ij} \in (\mu_j - \gamma * \sigma_j, \mu_j + \gamma * \sigma_j) \\ 1, \ a_{ij} \ge \mu_j - \alpha * \sigma_j \ , \quad b_{ij} \le \mu_j + \beta * \sigma_j \ , \ c_{ij} \le \mu_j + \gamma * \sigma_j \end{cases}$$

Definition 3.1.2 (RTD Matrix for Spherical Fuzzy Matrix for Method II) : Let μ_j and σ_j be the average mean and standard deviation of each j^{th} column of the initial data matrix. After converting to ATD matrix, choose parameters $\alpha, \beta, \gamma \in [0,1]$ and frame the *refined time dependent matrix* (RTD Matrix) using the following formula:

$$(e_{ij,}e^{*}_{ij}, e^{**}_{ij}) = \begin{cases} -1, \ a_{ij} \le \mu_j - \alpha * \sigma_j \ , \quad b_{ij} \ge \mu_j - \beta * \sigma_j \ , \quad c_{ij} \ge \mu_j - \gamma * \sigma_j \\ 0, \ a_{ij} \in (\mu_j - \alpha * \sigma_j, \mu_j + \alpha * \sigma_j), \ b_{ij} \in (\mu_j - \beta * \sigma_j, \mu_j + \beta * \sigma_j), \ c_{ij} \in (\mu_j - \gamma * \sigma_j, \mu_j + \gamma * \sigma_j) \\ 1, \ a_{ij} \ge \mu_j - \alpha * \sigma_j \ , \quad b_{ij} \le \mu_j + \beta * \sigma_j \ , \ c_{ij} \le \mu_j + \gamma * \sigma_j \end{cases}$$

3.2 Application

In this section one application for the newly introduced special matrices is discussed using graphs.

3.2.1Detection of maximum age group that is affected by Type II Diabetes by data collection and by using a CETD (8 × 6) Spherical fuzzy matrix

A survey has conducted among people of different areas of Thrissur District, Kerala state in the month of december 2023. Prime aim of this survey is to find out the age group in which type II diabetes is more affected, using the new tool developed in section 3.1. As a preliminary stage, depending upon the study of this disease from google search and with some experts, a questionnaire is framed. In next stage, initial raw data collected using the questionnaire is converted into ATD matrix and finally into RTD matrix, using spherical fuzzy tool. Finally, corresponding CETD matrix and graph has also provided. Two different methods opted.

Method 1:

A survey has conducted among 800 people in Kumaranellur, Engadiyur villages of Thrissur District, Kerala state by using a questionnaire framed, based upon 'expert's opinion' and from information's from google search. It is made use as below:

Step 1: Data converted to Spherical Fuzzy Matrix.

Age	S_1	S_2	S_3	S_4	S_5
4 - 9	(0.1,0.7,0.2)	(0.05,0.85,0.1)	(0.06,0.75,0.20)	(0.05,0.90,0.05)	(0.3,0.5,0.2)
10 - 24	(0.2,0.7,0.1)	(0.15,0.8,0.05)	(0.15,0.65,0.2)	(0.1,0.8,0.1)	(0.2,0.7,0.1)
25 - 34	(0.35,0.5,0.15)	(0.2,0.7,0.1)	(0.3,0.5,0.2)	(0.25,0.55,0.2)	(0.35,0.45,0.2)

35 - 44	(0.4,0.4,0.2)	(0.3,0.6,0.1)	(0.32,0.48,0.2)	(0.3,0.6,0.1)	(0.35,0.4,0.25)
45 - 54	(0.7,0.2,0.1)	(0.6,0.15,0.25)	(0.55,0.3,0.15)	(0.7,0.2,0.1)	(0.8,0.1,0.1)
55 - 64	(0.75,0.2,0.05)	(0.65,0.1,0.25)	(0.55,0.25,0.20)	(0.75,0.05,0.2)	(0.78,0.1,0.12)
65 – 74	(0.5,0.2,0.3)	(0.5,0.05,0.45)	(0.4,0.5,0.1)	(0.68,0.05,0.27)	(0.5,0.4,0.1)
75 - 85	(0.45,0.4,0.15)	(0.4,0.35,0.25)	(0.3,0.4,0.3)	(0.2,0.2,0.6)	(0.1,0.8,0.1)

Step 2: ATD Matrix for the Corresponding Initial Data

Age	S_1	S_2	S_3	S_4	S_5
4 - 9	(0.1,0.9,0.1)	(0.1,0.968,0)	(0.03,0.9,0)	(0.022,0.97,0.038)	(0.13,0.87,0.09)
10 - 24	(0.05,0.9,0.03)	(0.04,0.98,0.01)	(0.04,0.9,0.05)	(0.026,0.98,0.02)	(0.05,0.9,0.03)
25 - 34	(0.11,0.93,0.05)	(0.06,0.96,0.02)	(0.09,0.9,0.06)	(0.08,0.94,0.06)	(0.11,0.92,0.07)
35 - 44	(0.13,0.9,0.07)	(0.097,0.9,0.03)	(0.1,0.9,0.07)	(0.09,0.95,0.03)	(0.1,0.9,0.09)
45 - 54	(0.3,0.9,0.04)	(0.2,0.8,0.098)	(0.2,0.9,0.06)	(0.025,0.85,0.04)	(0.3,0,8,0.05)
55 - 64	(0.28,0.85,0.11)	(0.2,0.8,0.1)	(0.2,0.9,0.07)	(0.28,0.74,0.09)	(0.3,0.8,0.06)
65 – 74	(0.03,0.85,0.11)	(0.2,0.7,0.2)	(0.2,0.9,0.03)	(0.24,0.74,0.12)	(0.2,0.9,0.04)
75 – 85	(0.15,0.9,0.05)	(0.1,0.9,0.09)	(0.09,0.9,0.1)	(0.06,0.85,0.21)	(0.03,0.8,0.03)

Step 3: Average and Standard Deviation of the corresponding ATD Matrix

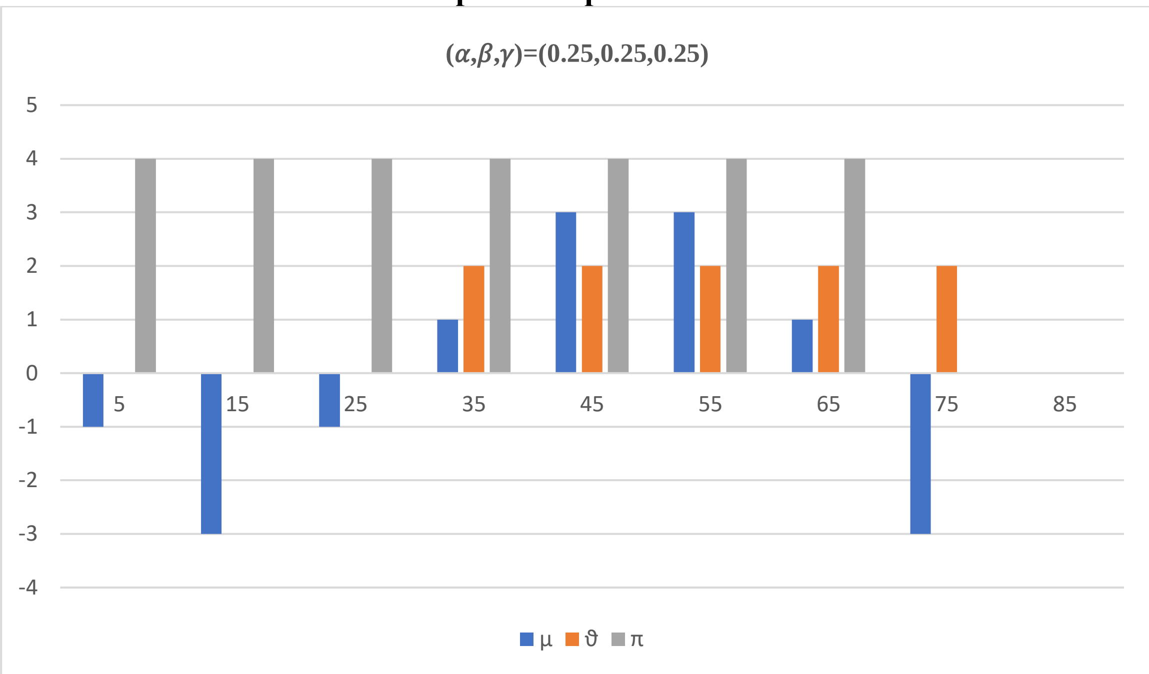
Average	**(0.2,0.9,0.08)**	**(0.097,0.9,0.4)**	**(0.1,0.9,0.5)**	**(0.4,0.4,0.7)**	**(0.1,0.9,0.5)**
SD	(0.2,0.9,0.6)	(0.4,0.07,0.3)	(0.004,0.14,0.41)	(0.3,0.07,0.5)	(0.2,0.07,0.4)

Step 4: RTD Matrix for the Corresponding ATD Matrix

Case 1 : $(\boldsymbol{\alpha},\boldsymbol{\beta},\boldsymbol{\gamma})=(\mathbf{0.25},\mathbf{0.25},\mathbf{0.25})$ **Row Sum**

$$\begin{bmatrix} (-1,0,0) & (1,-1,1) & (-1,1,1) & (-1,-1,1) & (1,1,1) \\ (-1,0,0) & (1,-1,1) & (-1,1,1) & (-1,-1,1) & (-1,1,1) \\ (-1,0,0) & (1,-1,1) & (-1,1,1) & (-1,-1,1) & (1,1,1) \\ (-1,0,0) & (1,1,1) & (1,1,1) & (-1,-1,1) & (1,1,1) \\ (1,0,0) & (1,1,1) & (1,1,1) & (-1,-1,1) & (1,1,1) \\ (1,0,0) & (1,1,1) & (1,1,1) & (-1,-1,1) & (1,1,1) \\ (-1,0,0) & (1,1,1) & (1,1,1) & (-1,-1,1) & (1,1,1) \\ (-1,0,0) & (1,1,1) & (-1,1,1) & (-1,-1,1) & (-1,1,1) \end{bmatrix} \qquad \begin{bmatrix} (-1,0,4 \\ (-3,0,4) \\ (-1,0,4) \\ (1,2,4) \\ (3,2,4) \\ (3,2,4) \\ (1,2,4) \\ (-3,2,4 \end{bmatrix}$$

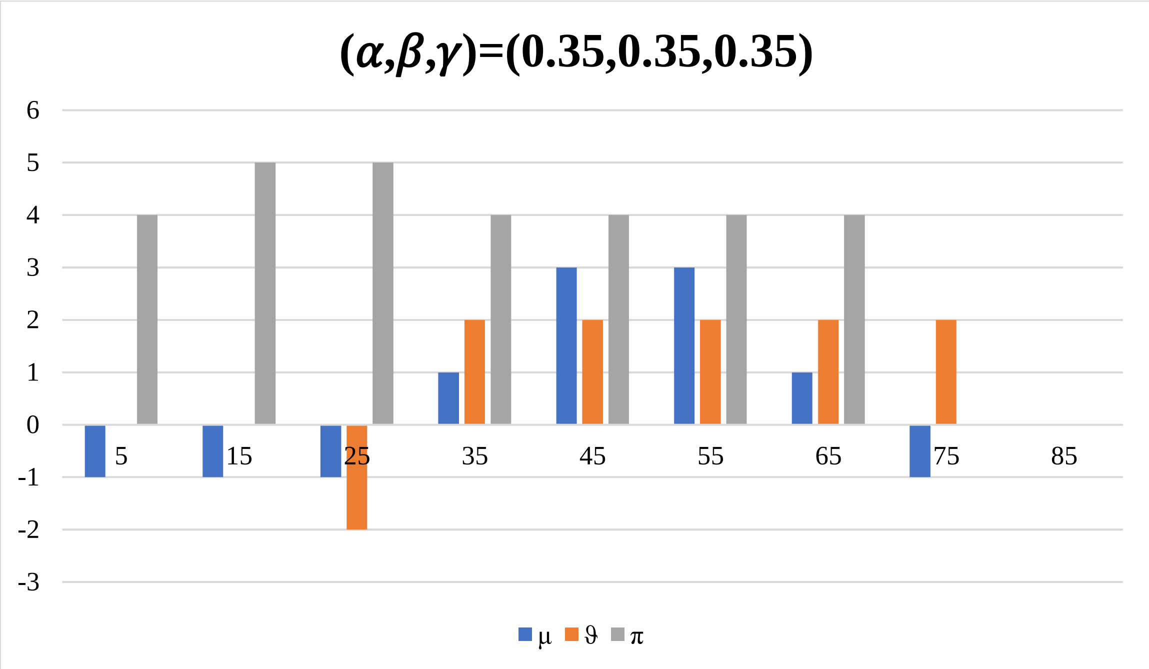
Graphical Representation



Case 2 : $(\boldsymbol{\alpha},\boldsymbol{\beta},\boldsymbol{\gamma}) = (\mathbf{0.35},\mathbf{0.35},\mathbf{0.35})$ **Row Sum**

$$\begin{bmatrix} (-1,0,0) & (1,-1,1) & (-1,-1,1) & (-1,1,1) & (1,1,1) \\ (-1,0,1) & (1,-1,1) & (-1,-1,1) & (-1,1,1) & (1,1,1) \\ (-1,0,1) & (1,-1,1) & (-1,-1,1) & (-1,1,1) & (1,-1,1) \\ (-1,0,0) & (1,1,1) & (1,-1,1) & (-1,1,1) & (1,1,1) \\ (1,0,0) & (1,1,1) & (1,-1,1) & (-1,1,1) & (1,1,1) \\ (1,0,0) & (1,1,1) & (1,-1,1) & (-1,1,1) & (1,1,1) \\ (-1,0,0) & (1,1,1) & (1,-1,1) & (-1,1,1) & (1,1,1) \\ (1,0,0) & (1,1,1) & (-1,-1,1) & (-1,1,1) & (-1,1,1) \end{bmatrix} \qquad \begin{bmatrix} (-1,0,4) \\ (-1,0,5) \\ (-1,-2,5) \\ (1,2,4) \\ (3,2,4) \\ (3,2,4) \\ (1,2,4) \\ (-1,2,4) \end{bmatrix}$$

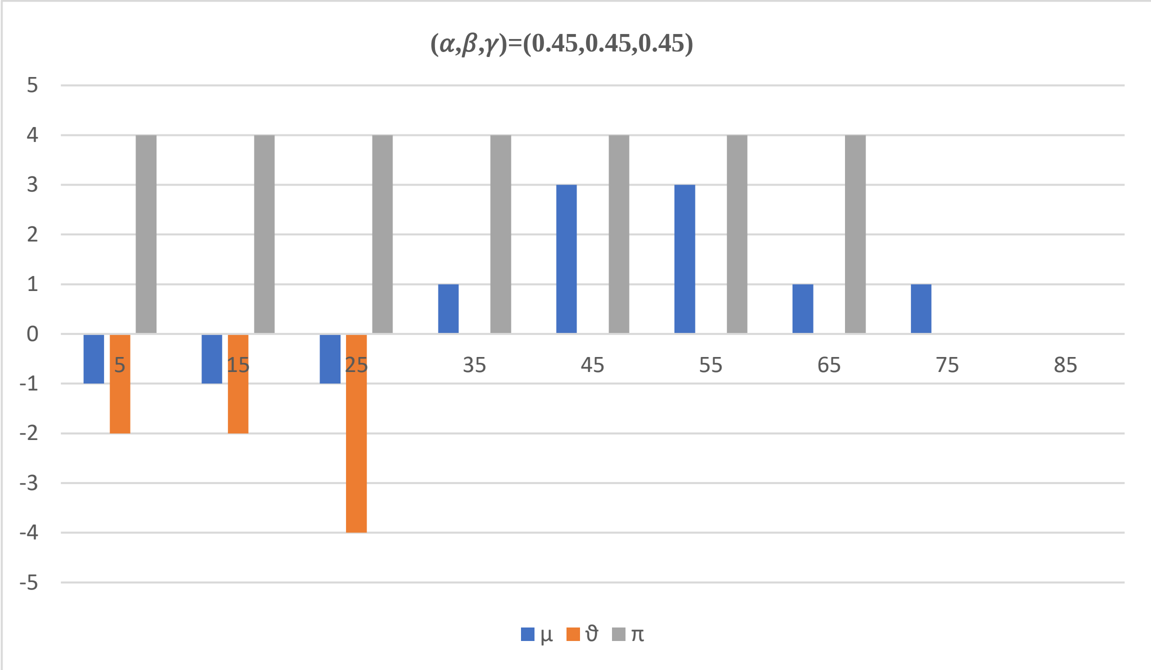
Graphical Representation



Case 3 : $(\alpha,\beta,\gamma)=(0.45,0.45,0.45)$ **Row Sum**

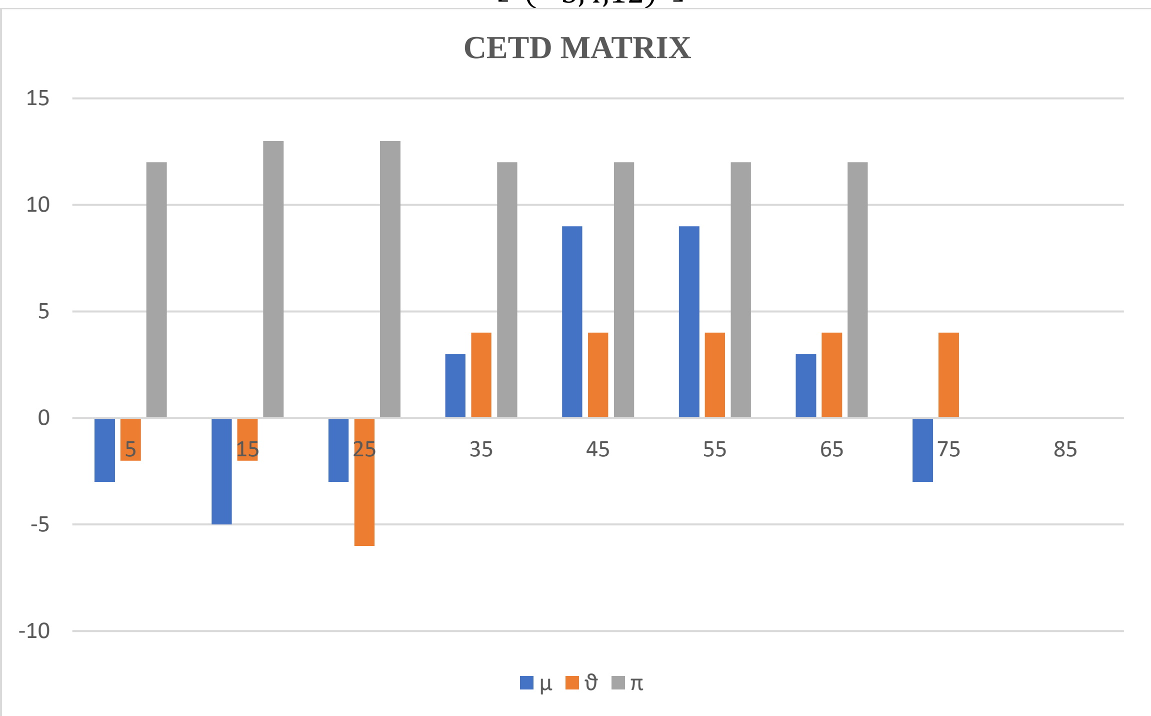
$$\begin{bmatrix} (-1,0,0) & (1,-1,1) & (-1,-1,1) & (-1,-1,1) & (1,1,1) \\ (-1,0,0) & (1,-1,1) & (-1,-1,1) & (-1,-1,1) & (1,1,1) \\ (-1,0,0) & (1,-1,1) & (-1,-1,1) & (-1,-1,1) & (1,-1,1) \\ (-1,0,0) & (1,1,1) & (1,-1,1) & (-1,-1,1) & (1,1,1) \\ (1,0,0) & (1,1,1) & (1,-1,1) & (-1,-1,1) & (1,1,1) \\ (1,0,0) & (1,1,1) & (1,-1,1) & (-1,-1,1) & (1,1,1) \\ (-1,0,0) & (1,1,1) & (1,-1,1) & (-1,-1,1) & (1,1,1) \\ (1,0,0) & (1,1,1) & (1,-1,1) & (-1,-1,1) & (1,1,1) \end{bmatrix} \quad \begin{bmatrix} (-1,-2,4) \\ (-1,-2,4) \\ (-1,-4,4) \\ (1,0,4) \\ (3,0,4) \\ (3,0,4) \\ (1,0,4) \\ (1,0,4) \end{bmatrix}$$

Graphical Representation



Step 5: CETD MATRIX AND IT'S CONSOLIDATED GRAPH

$$\begin{bmatrix} (-3,-2,12) \\ (-5,-2,13) \\ (-3,-6,13) \\ (3,4,12) \\ (9,4,12) \\ (9,4,12) \\ (3,4,12) \\ (-3,4,12) \end{bmatrix}$$



METHOD 2

Same as method 1, a survey has conducted in some other nearby village Akampadam, Kumblangad in Thrissur district, Kerala state, using a questionnaire differently designed which is capable to draw direct data instead of spherical fuzzy values. Data has undergone through usual existing procedures. But in RTD conversion stage, a newly framed formula is used to get spherical fuzzy matrix. Corresponding CETD matrix is also a spherical fuzzy matrix. Its graph also provided.

Step 1: Initial Data collection

Age	S_1	S_2	S_3	S_4	S_5
4 - 9	4	9	11	8	17
10 - 24	9	21	18	10	25
25 - 34	15	25	19	15	25
35 - 44	20	24	28	30	30
45 - 54	32	36	35	40	29
55 - 64	30	35	28	32	35
65 – 74	30	25	28	25	30
75 - 85	28	30	25	30	25

Step 2: ATD Matrix for the Corresponding Initial Data

Age	S_1	S_2	S_3	S_4	S_5
4 - 9	0.8	1.8	2.2	1.6	3.4
10 - 24	0.6	1.5	1.2	0.7	1.7
25 - 34	1.6	2.7	2.1	1.6	2.7
35 - 44	2.2	2.6	3.1	3.3	3.3
45 - 54	3.5	4	3.8	4.4	3.2
55 - 64	3.3	3.8	3.1	3.5	3.8
65 - 74	3.3	2.7	3.1	2.7	3.3
75 - 85	2.8	3	2.5	3	2.5

Step 3: Average and Standard Deviation of the corresponding ATD Matrix

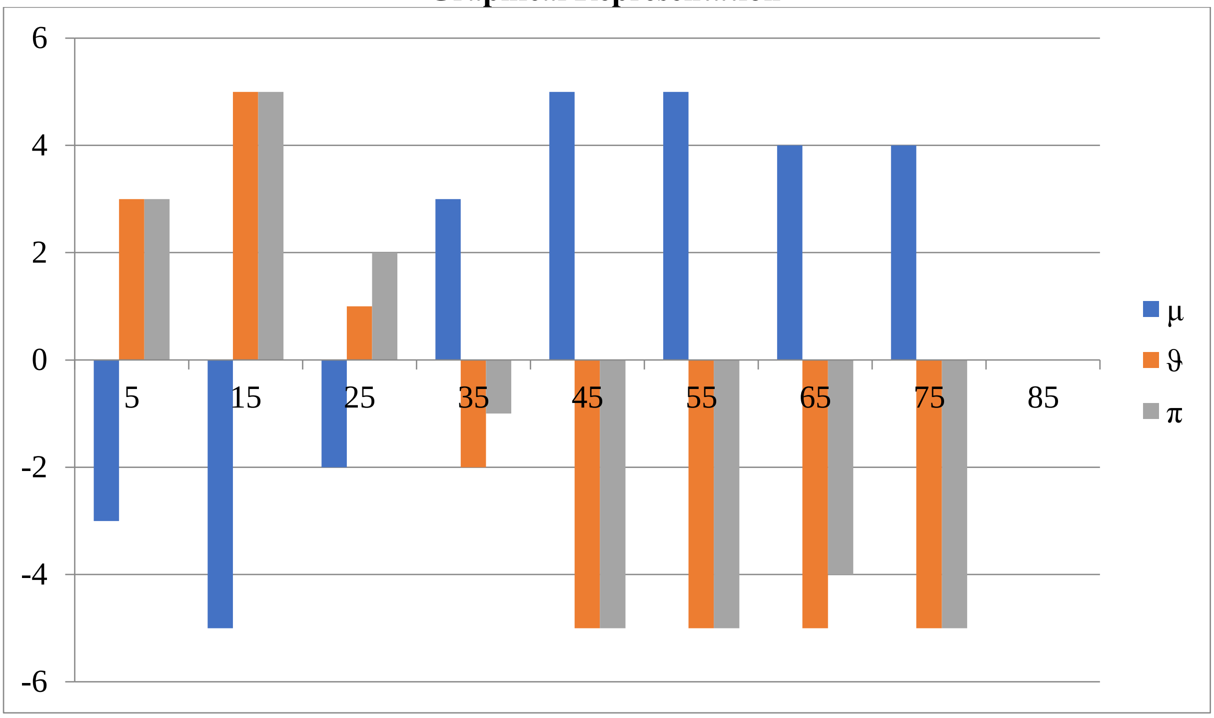
Average	**2.3**	**2.8**	**2.6**	**2.6**	**2**
SD	0.43	0.32	0.305	0.45	0.5

Step 4: RTD Matrix for the Corresponding ATD Matrix

Case 1: $(\alpha, \beta, \gamma)=(0.25, 0.30, 0.35)$ **Row Sum**

$$\begin{bmatrix} (-1,1,1) & (-1,1,1) & (-1,1,1) & (-1,1,1) & (1,-1,-1) \\ (-1,1,1) & (-1,1,1) & (-1,1,1) & (-1,1,1) & (-1,1,1) \\ (-1,1,1) & (0,-1,0) & (-1,1,1) & (-1,1,1) & (1,-1,-1) \\ (1,0,1) & (-1,1,1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (1,-1,-1) & (0,-1,0) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (1,-1,-1) & (1,-1,-1) & (-1,-1,-1) & (1,-1,-1) & (1,-1,-1) \end{bmatrix} \quad \begin{bmatrix} (-3,3,3) \\ (-5,5,5) \\ (-2,1,2) \\ (3,-2,-1) \\ (5,-5,-5) \\ (5,-5,-5) \\ (4,-5,-4) \\ (4,-5,-5) \end{bmatrix}$$

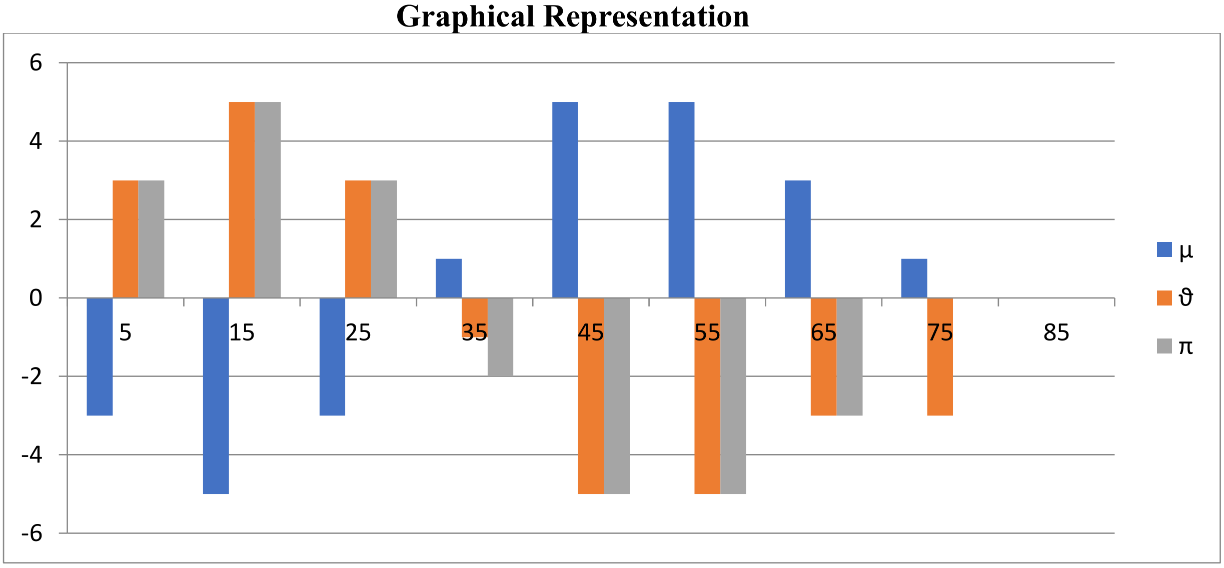
Graphical Representation



$$\textbf{Case 2: } (\boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}) = (\mathbf{0.30}, \mathbf{0.25}, \mathbf{0.35}) \qquad \textbf{Row Sum}$$

$$\begin{bmatrix} (-1,1,1) & (-1,1,1) & (-1,1,1) & (-1,1,1) & (1,-1,-1) \\ (-1,1,1) & (-1,1,1) & (-1,1,1) & (-1,1,1) & (-1,1,1) \\ (-1,1,1) & (-1,1,1) & (-1,1,1) & (-1,1,1) & (1,-1,-1) \\ (-1,1,0) & (-1,1,1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (1,-1,-1) & (-1,1,1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (-1,-1,-1) & (1,-1,-1) & (-1,1,1) & (1,-1,-1) & (1,-1,-1) \end{bmatrix} \quad \begin{bmatrix} (-3,3,3) \\ (-5,5,5) \\ (-3,3,3) \\ (1,-1,-2) \\ (5,-5,-5) \\ (5,-5,-5) \\ (3,-3,-3) \\ (1,-3,-3) \end{bmatrix}$$

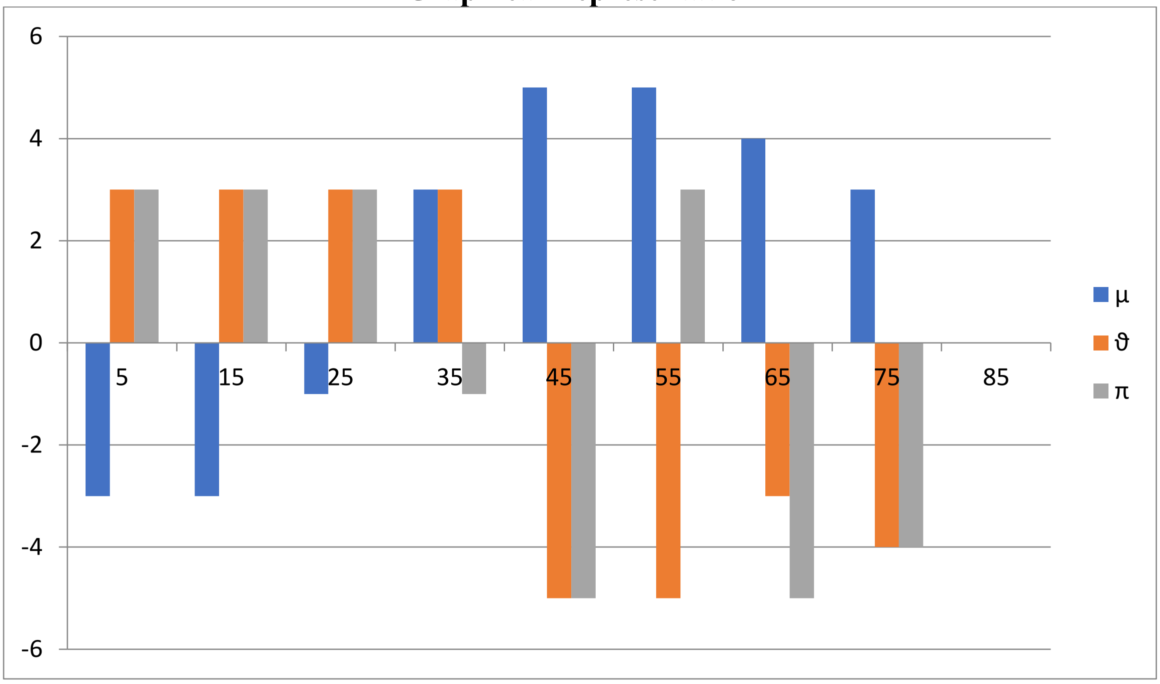
Graphical Representation



Case 3: $(\boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma})=(\mathbf{0.35}, \mathbf{0.30}, \mathbf{0.25})$ **Row Sum**

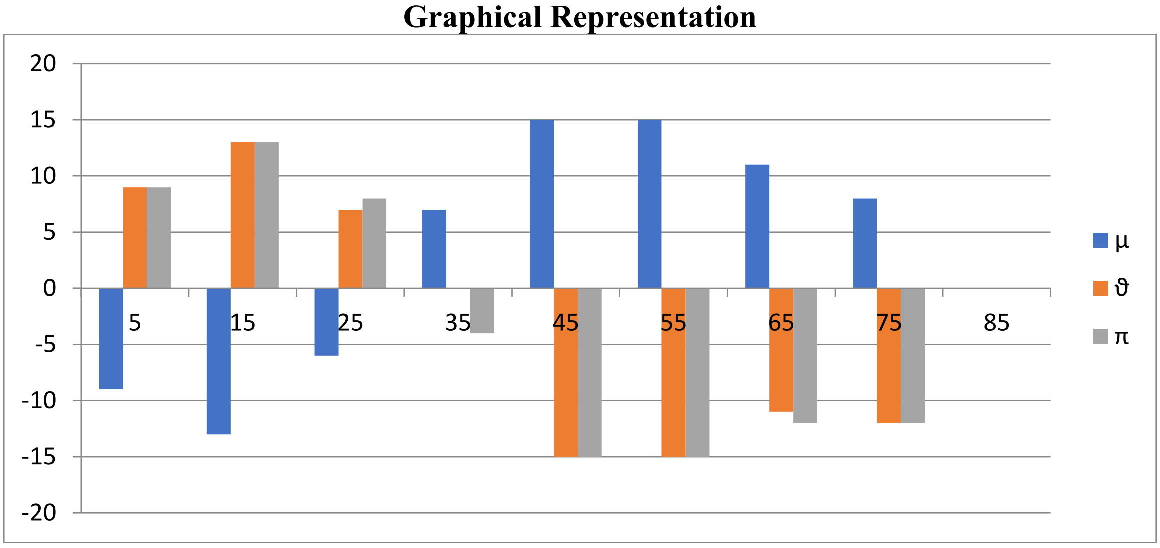
$$\begin{bmatrix} (-1,1,1) & (-1,1,1) & (1,1,1) & (-1,1,1) & (1,-1,-1) \\ (-1,1,1) & (-1,1,1) & (1,-1,-1) & (-1,1,1) & (-1,1,1) \\ (-1,1,1) & (1,1,1) & (-1,1,-1) & (-1,1,1) & (1,-1,-1) \\ (-1,-1,1) & (1,1,1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) & (1,-1,-1) \\ (1,-1,-1) & (1,1,-1) & (1,-1,-1) & (1,-1,-1) & (-1,-1,-1) \\ (1,-1,-1) & (1,-1,-1) & (-1,-1,-1) & (-1,0,0) & (1,-1,-1) \end{bmatrix} \quad \begin{bmatrix} (-3,3,3) \\ (-3,3,3) \\ (-1,3,3) \\ (3,3,-1) \\ (5,-5,-5) \\ (5,-5,3) \\ (4,-3,-5) \\ (3,-4,-4) \end{bmatrix}$$

Graphical Representation



Step 5: CETD Matrix

$$\begin{bmatrix} (-9,9,9) \\ (-13,13,13) \\ (-6,7,8) \\ (7,0,-4) \\ (15.-15,-15) \\ (15,-15,-7) \\ (11,-11,-12) \\ (8,-12,-12) \end{bmatrix}$$



In both methods, from CETD matrix, it is clear that, type II diabetes is more affected to the age group 45 to 55. This result, point out to the fact that the people in this age group must take precautionary measures and have to monitor their diabetes by some usual check-ups like HBA1c or some other proper medical tool to avoid future complications like kidney failure, vision complaints, stroke etc.

4. Conclusion

Real-life application of matrix theory is more recognized nowadays in mathematical research world, because of its utility to computers. RTD and CETD matrices are a different, special approach in matrix theory, which could be considered as a more useful tool to make comparison in time dependent problems. In this paper, RTD and CETD matrices are introduced in spherical fuzzy set environment, by using two different methods. This concept can be made use in different matrices like Toplitz, Centro symmetric, and Heisenberg etc. In decision making problems, this new tool can be used to solve problems in complicated situations.

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5. References

1. Anjan Mukherjee and Abhik Mukherjee,"Application of Fuzzy Matrix Theory In COVID-19 Pandemic",IOSR Journal of Mathematics
2. Ashraf.S, Abdullah.S, Mahmood.T, Ghani. F, Mahmood.T, Spherical Fuzzy Sets and their applications in multi-attribute decision making problems, Journal of Intelligent Fuzzy Systems, (2019), 36: ISSN :2829 – 2844
3. Albert William M, Victor Devadoss A, Janet Sheeba J, "An Analysis of Breast cancer using RTD Matrix", Volume: 02 Issue: 01 June 2013 Page No.20-23 ISSN: 2278-2419
4. Cayley, A. "A Memoir on the Theory of Matrices", (1858) . *Philos. Trans*. 148.
5. Cengiz Kahraman, Fatma Kutlu Gündoğdu, "Decision Making with Spherical Fuzzy Sets, Volume 392
6. Clement Joe Anand.M, Felix Augustin,"A CETD Matrix Approach to Analyze the Dimensions of Personality of Person" DOI:10.1109/CSCI.2014.92

7. Clement Joe Anand M and Lathamaheswari M L, "A combined effective time dependent matrix Approach to analyze the men affected by cardiovascular disease (CVD) in Chennai.", volume 4 issue 2 February 2015 ISSN 2319-7242
8. Jean Charles Robinet,Frederick Delay, "The Effect of Rock matrix Heterogeneities Near Fracture walls on the Residence Time Distribution (RTD) of solutes ", 25 Sept 2007.
9. Johnson savarimuthu S and Gunalakshmi S, "Analysis of women Harassment in villages using CETD matrix, model", volume: 04 Issue 02 December 2015, ISSN 2278-2397
10. Kuppuswami.G, Sujatha.R and Vasantha kandasamy W.B,"Study of Traffic flow using CETD Matrix Vol 8 (24), DOI:10.17485/ijst/2015/v8i24 /80191,September 2015
11. Kutlu Gündoğdu, Fatma, and Cengiz Kahraman, Spherical fuzzy sets and spherical fuzzy TOPSIS method,Journal of intelligent & fuzzy systems 36.1 (2019): 337-352.
12. Kirupa A,Pathinathan T, "A study on the problems faced by Rural Tamil medium students in professional engineering college using CETD matrix vol 02 Issue 01 June 2013, ISSN 2278-2397
13. Lookman Sithic. H, UmaRani. R, "Fuzzy Matrix Theory as a Knowledge Discovery in Health Care Domain" Procedia Computer science 47(2015)282-291
14. Madhun V and Dr Amudhambigai B," A Study on the health Hazards of the women Scavengers using Fuzzy matrix", ISSN 2321-8045, 2014
15. Priya. P, Ramya.R, Sangeetha.S, Saranya.A, Basic concepts of fuzzy matrices, (2019), 8 (12)
16. Radhika. K, Anbalagan, Alexander and Suganthi Mariyappan, "Risk Factor Of Breast Cancer Using Cetd Matrix-An Analysis", International Journal of Applied Engineering Research ISSN 0973—562 Volume 14, Number 4, 2019 (Special Issue)
17. Rahul Deshmukh, "Fuzzy matrix model for analyzing problems in Agriculture Sector", Volume 08, Issue 06 June 2021, ISSN 2395-0072
18. Silambarasan, Spherical Fuzzy Matrices, TWMS J. App. and Eng. Math. Vol.13 (1), (2023), pp.98-109
19. Sophia porcheivi R and Siochana M, "An analysis of Dengue fever using Fuzzy matrix ", Vol 15, No.2, 2018 ISSN 2320-3242
20. Suvankar Biswas and Tapan Kumar Roy, Fuzzy Linear Integral Equation and its Application in Bio Mathematical Model
21. Suresh.M, Greeda.J, "Analysis Of Women Harassment In Villages Using CETD Matrix Model", Vol.6(6), ISSN-2349-5162
22. Thomson.M. G, Convergence of Powers of a Fuzzy Matrix, Journal of Analytics and Applications, (1977),57, 476 - 480
23. Vasantha kandasamy W.B and Indira. V, "Maximizing the passengers comfort in the Madras transport corporation" using fuzzy programming progress of mat. Banaras Hindu, 2-91-134
24. Saraswati. A, Praveen Prakash. A, Vinoth Kumar. P, "A fuzzy matrix Analysis – Using an RTD and CETD Matrix", International Journal of Engineering Research, ISSN 0973-4562 Vol.10 No.80 (2015)
25. Victor Devadoss.A, Aseervatham. S," Emotion Classification Through Musical Features using Fuzzy Relational maps(FRMs)", Annals of Pure and Applied Mathematics 9(2), 167-175,2015
26. Victor Devadoss.A and Clement Joe Anand, "Dimensions of Personality of women in Chennai using CETD matrix", International Journal of Computer Applications, Volume 50, No.5 July 2012
27. Victor Devadoss. A, Felix. A, Immaculate Anbarasi, "Women Teachers Affected by Stress in Chennai Schools using CETD Matrix", International Journal of Business Intelligent, Volume: 02 Issue: 02 December 2013, Pages No.28-32 ISSN: 2278-2400

28. Vivehananthan. V, Rajeswari. K, Anbalagan. S, “EFFECTIVE COMPLETION OF TYPEWRITING EXAMINATION – USING FUZZY MATRIX”, Volume 14, Number 4, 2019 International Journal of Applied Engineering Research ISSN 0973-4562
29. W.B Vasantha Kandasamy -2012, Innovative uses of matrices
30. Zadeh, Lotfi A. "Fuzzy sets." Information and control 8.3 (1965): 338-353.