Analyze the Effect of Western Classical Music in Chennai using Categorized CETD Matrix

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Abstract— The objective of this paper is to find out the maximum age group of people who realize musical emotions for the western classical symphonies in Chennai. To analyze this, we have taken the emotion model with the nine factors according to Zentner et al., (2008). For the first time in the year 1998 matrix theory was developed by W. B. Vasantha and V. Indira to study the passenger transportation problem. To study this problem, they divided and defined four types of matrices are called Initial Raw Data Matrix, Average Time Dependent Data Matrix (ATD Matrix), Refined Time Dependent Data Matrix (RTD Matrix) and Combined Effect Time Dependent Data Matrix (CETD Matrix). In the year 2003 the same technique was used by W. B. Vasantha to study the migrant laborers who were affected by HIV/AIDS. In 2004, W. B. Vasantha and A. Victor Devadoss used to study the agriculture laborers. Now we use this new model to study the musical experience of the people in Chennai.

This research article is organized as follows: In the first section we give an introduction for previous works in musical emotions and recall the methods of applications of CETD matrix. In section two, we describe the elements of music and the chosen emotion model. The section three, we apply CETD model to the problem and derive our conclusions in the final section.

Key words— Music Elements, Emotion Model, ATD Matrix, RTD Matrix, CETD Matrix.

1 INTRODUCTION

MUSIC plays a major role in most people everyday lives (Menon & Levitin, 2005; Zentner, Grandjean & Scherer, 2008). Music has maintained its importance to humans is because of its emotional rewards (Zentner, Grandjean & Scherer, 2008). Research over the past decade has concluded that music listening is a pleasurable experience. It may seem ironic that music evokes pleasure within its listeners as it seems to have little in common with other reward stimuli. That is, a strong emotional response such as pleasure typically exists either with a clear biological purpose such as survival (eating) or species perpetuation (love, sex) (Kringelbach, 2005; Kringelbach & Berridge, 2010), in response to tangible items which have a secondary reward, such as money or other possessions, or as a result of direct stimulation of the dopaminergic pathways in the mesolimbic system of the brain, such as those stimuli with addictive qualities, for example synthetic or pharmacological chemicals and gambling (Salimpoor, Benovoy, Longo, Copperstock & Zatorre, 2009; Salimpoor, Benovey, Larcher, Dagher & Zatorre, 2011).

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1.1 THE METHOD OF APPLICATION OF CETD MATRIX

1.1.1 Categorized Average Time Dependent (CATD) Matrix

Raw data transform along the rows the age group and along the columns for different categories using the raw data matrices we make it into the Average Time Dependent (ATD) matrices ($a_{ij}{}^k$) [k=1, 2, 3 … for categories] by dividing each entry of the raw data matrices by the number of years i.e., the time period. This matrix represents a data, which is totally uniform. At the third stage we find the average and Standard Deviation (S.D) of every column in the ATD matrices.

1.1.2 Categorized Refined Time Dependent (CRTD) Matrix

Using the average $\mu_j{}^k$ of each j^{th} column and $\sigma_j{}^k$ the S.D of the each column we chose a parameter α from the interval [0, 1] and form the Refined Time Dependent Matrix (RTD matrix),

Using the formula

$$k = 1, 2, 3, \ldots \text{for categories}$$

$$\text{if } a_{ij}{}^k \le \left(\mu_j{}^k - \alpha * \sigma_j{}^k\right) \text{ then } e_{ij} = -1 \text{ else}$$

$$\text{if } a_{ij}{}^k \in \left(\mu_j{}^k - \alpha * \sigma_j{}^k, \mu_j{}^k + \alpha * \sigma_j{}^k\right) \text{ then } e_{ij} = 0 \text{ else}$$

$$\text{if } a_{ij}{}^k \ge \left(\mu_j{}^k + \alpha * \sigma_j{}^k\right) \text{then } e_{ij} = 1$$

We redefine the ATD matrix into the Redefined Time Dependent Fuzzy matrix for here the entries are -1, 0 or 1. Now the row sum of this matrix gives the maximum age group.

1.1.3 Combined Effective Time Dependent Data

(CETD) Matrix

We also combine the above RTD matrices by varying the $\alpha \in [0, 1]$, so that we get the combined Effective Time Dependent Data (CETD) matrix. The row sum is obtained for CETD matrix and conclusions are derived based on the row sums. All these are represented by graphs and graphs play a vital role in exhibiting the data by the simplest means, which can be even understood by a layman.

2 EMOTION MODEL

There are two models employed to measure emotion:
[1] The basic emotion theory (which employs the discrete or categorical emotion theory) and
[2] The dimensional model of emotion (also known as the affective circumflex model) (Zentner & Eerola, 2010).
Here we have used the GEMS-9 model (Zentner et al., 2008). Zentner, Grandjean and Scherer (2008) have suggested that musical emotions are not always similar to the emotions we encounter everyday life. This is because musical emotions are not associated with goal-oriented behavior as everyday emotions might be (Krumhansl, 1997). For this reason Zentner et al., (2008) constructed a model which is specific to music. The following table illustrated below is the nine factors and their sub-units.

Table 1. The GEMS nine factors emotion model

Wonder	**Transcendence**	**Tenderness**
W_1-Happy	Tr_1-Transcendence	T_1-Tenderness
W_2-Allured	Tr_2-Inspired	T_2-Love
W_3-Amazed	Tr_3-Spirituality	T_3-Affectionate
W_4-Moved	Tr_4-Thrills	T_4-Sensual
W_5-Dazzled		T_5-Softened-up
Nostalgia	**Peacefulness**	**Power**
N_1-Sentimental	P_1-Calm	Po_1-Energetic
N_2-Dreamy	P_2-Serene	Po_2-Triumphant
N_3-Nostalgic	P_3-Relaxed	Po_3-Fiery
N_4-Melancholic	P_4-Soothed	Po_4-Strong
	P_5-Meditative	Po_5-Heroic
Joyful Activation	**Tension**	**Sadness**
J1-Stimulated	Te_1-Agitated	
J_2-Joyful	Te_2-Nervous	S_1-Sorrowful
J_3-Animated	Te_3-Tense	
J_4-Dancing	Te_4-Impatient	S_2-Depressed
J_5-Amused	Te_5-Irritated	

2.1 MUSICAL ELEMENTS

The fundamental elements of music and their related terms are given as follows.

Table 2. Elements of Music

Elements	Basic Related Terms
Rhythm	beat, meter, tempo, syncopation
Dynamics	forte, piano,…etc, crescendo, decrescendo
Melody	pitch, theme, conjunct, disjunct
Harmony	chord, progression, consonance, dissonance, key, tonality, atonality
Tone color	register, range, instrumentation

3 DESCRIPTION OF THE PROBLEM

In this research we give an algebraic approach to the musical experience of people in Chennai for western symphonies. For that we have interviewed 150 both men and women with the age ranging from 14 to 75 in Chennai. First by the emotion factor model, each nine factors have different number of sub-units. We selected 12 music excerpts from L.V. Beethoven, Symphonie-6, Pastorale and George Friedrich Handel (tracks each one of maximum 2 or 1.50 minutes) having Major and Minor scales (modes) with different properties in the elements of music and played them to each individual through ear phones. Their opinions (felt emotions) are recorded in the data sheet which is given to them. In which they are highly (maximum) experiencing each nine emotion factor at what peak age group. We analyze these problems using fuzzy matrix, we call the RTD matrix as fuzzy matrix for that take their entries from the set {-1, 0, 1}. So the terms RTD matrix or fuzzy matrix mean one and the same matrix. In this research we will discuss different number of sub-units of each emotion factors of person which are taken as the columns of the initial raw data matrix and the age in years 14-20, 21-25, 26-30, 31-35, 36-40, 41-45, 46-57, and 58-75 as the rows. The 'estimation of the maximum age group is five-stage process. In the first stage we give the matrix representation of the raw data. Entries corresponding to the intersection of rows and columns are values corresponding to the live network. The 3×6 matrix is not uniform i.e. the number of individual years in each interval may not be the same. So in the second stage we in order to obtain an unbiased uniform effect on each and every data so collected, transform this initial matrix into an Average Time Dependent Data (ATD) matrix. To make the calculations easier and simpler we in the third stage using the simple average technique convert the above average time dependent data matrix in to a matrix with entries $e_{ij} \in \{-1, 0, 1\}$. We name this matrix as the Refined Time Dependent Data Matrix (RTD matrix) or as the fuzzy matrix. The value of e_{ij} corresponding to each entry is determined in a special way described in the first section of this research. At the fourth stage using the fuzzy matrices we obtain the Combined Effect Time Dependent Data matrix (CETD matrix), which gives the cumulative effect of all these entries. In the final stage we obtain the row sums of the CETD matrix. The tables given are self-explanatory at each stage. The graph of the RTD matrix and CETD matrix are given.

Here each sub-units have two categories (k=1,2) where first one represents symphonies having Major mode and second one for Minor mode as well as the matrices in the above for Major and below for Minor modes.

Estimation of maximum age group of people getting wonder by using 8×5 matrix.
In this section we apply 5 sub-units.

Table 3: Initial raw data matrix of Wonder of order 8×5

Wonder	W_1		W_2		W_3		W_4		W_5	
14-20	25	16	3	7	4	4	1	9	3	4
21-25	19	15	7	10	8	5	13	15	3	12

26-30	11	3	0	3	4	1	1	3	1	1
31-35	4	5	1	0	2	0	5	3	0	0
36-40	2	5	1	3	4	1	2	0	2	0
41-45	4	0	2	2	2	1	0	3	2	0
46-57	6	4	3	2	1	1	3	2	1	0
58-75	4	3	3	1	2	2	2	2	3	2

Table 4: The ATD matrix of Wonder of order 8×5

Wonder	W_1		W_2		W_3		W_4		W_5	
14-20	**3.6**	**2.3**	**0.4**	**1.0**	**0.6**	**0.6**	**0.1**	**1.3**	**0.4**	**0.6**
21-25	**3.8**	**3.0**	**1.4**	**2.0**	**1.6**	**1.0**	**2.6**	**3.0**	**0.6**	**2.4**
26-30	**2.2**	**0.6**	**0**	**0.6**	**0.8**	**0.2**	**0.2**	**0.6**	**0.2**	**0.2**
31-35	**0.8**	**1.0**	**0.2**	**0**	**0.4**	**0**	**1.0**	**0.6**	**0**	**0**
36-40	**0.4**	**1.0**	**0.2**	**0.6**	**0.8**	**0.2**	**0.4**	**0**	**0.4**	**0**
41-45	**0.8**	**0**	**0.4**	**0.4**	**0.4**	**0.2**	**0**	**0.6**	**0.4**	**0**
46-57	**0.5**	**0.3**	**0.3**	**0.2**	**0.1**	**0.1**	**0.3**	**0.2**	**0.1**	**0**
58-75	**0.2**	**0.2**	**0.2**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.2**	**0.1**

Table 5: The Average and Standard Deviation of given ATD matrix.

Avg	**1.54**	**1.05**	**0.38**	**0.60**	**0.60**	**0.30**	**0.59**	**0.80**	**0.28**	**0.41**
S.D	**1.46**	**1.06**	**0.43**	**0.66**	**0.49**	**0.33**	**0.87**	**0.98**	**0.20**	**0.83**

The RTD matrix for α = 0.1(Major) The row sum matrix

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

The RTD matrix for α = 0.1(Minor) The row sum matrix

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

The RTD matrix for α = 0.2 (Major) The row sum matrix

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

The RTD matrix for α = 0.2(Minor) The row sum matrix

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

The RTD matrix for α = 0.35 (Major) The row sum matrix

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

The RTD matrix for α = 0.35(Minor) The row sum matrix

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

The RTD matrix for α = 0.63 (Major) The row sum matrix

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

The RTD matrix for α = 0.63(Minor) The row sum matrix

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

Depicting maximum age group of people getting Wonder for Major (fig.1) and Minor (fig.2) mode with different α values

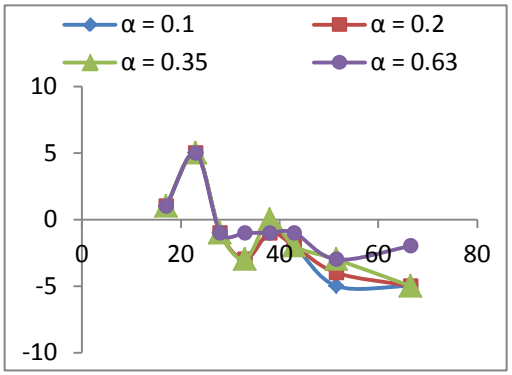

fig.1

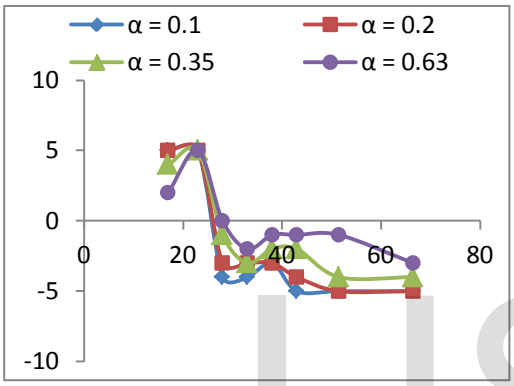

fig.2

The CETD Matrix (Major) The row sum matrix

$$\begin{bmatrix} 4 & 0 & 0 & -3 & 3 \\ 4 & 4 & 4 & 4 & 4 \\ 3 & -4 & 3 & -3 & -3 \\ -3 & -3 & -3 & 3 & -4 \\ -4 & -3 & 3 & -2 & 3 \\ -3 & 0 & -3 & -4 & 3 \\ -4 & -1 & -4 & -2 & -4 \\ -4 & -3 & -4 & -3 & -3 \end{bmatrix} \quad \begin{bmatrix} 4 \\ 20 \\ -4 \\ -10 \\ -3 \\ -7 \\ -15 \\ -17 \end{bmatrix}$$

The CETD Matrix (Minor) The row sum matrix

$$\begin{bmatrix} 4 & 3 & 4 & 3 & 2 \\ 4 & 4 & 4 & 4 & 4 \\ -3 & 0 & -2 & -1 & -2 \\ 0 & -4 & -4 & -1 & -3 \\ 0 & 0 & -2 & -4 & -3 \\ -4 & -2 & -2 & -1 & -3 \\ -4 & -3 & -3 & -2 & -3 \\ -4 & -4 & -3 & -4 & -3 \end{bmatrix} \quad \begin{bmatrix} 16 \\ 20 \\ -8 \\ -12 \\ -9 \\ -12 \\ -15 \\ -18 \end{bmatrix}$$

Depicting maximum age group of people getting Wonder for CETD matrix (fig.3).

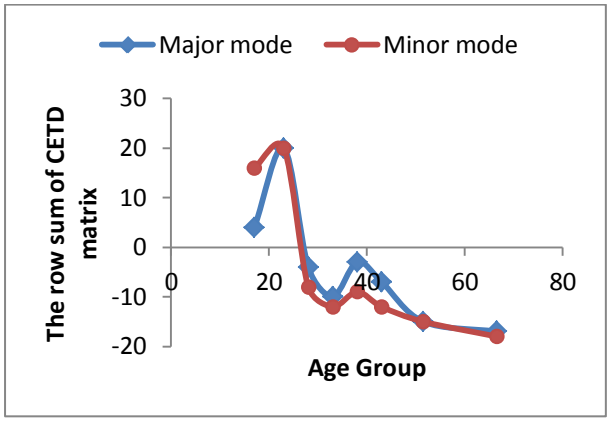

fig.3

Estimation of maximum age group of people getting Transcendence by using 8×4 matrix.

In this section we apply 4 sub-units.

Table 6: Initial raw data matrix of Transcendence of order 8×4

Transcendence	Tr_1		Tr_2		Tr_3		Tr_4	
14-20	1	5	11	8	7	16	2	7
21-25	3	3	13	15	10	11	8	4
26-30	4	3	5	7	1	6	1	3
31-35	1	1	4	5	2	3	2	3
36-40	0	0	2	5	3	2	3	3
41-45	1	0	3	0	2	4	0	0
46-57	2	2	3	4	3	4	2	5
58-75	1	2	0	2	6	3	3	3

Table 7: The ATD matrix of wonder of order 8×4

Transcendence	Tr_1		Tr_2		Tr_3		Tr_4	
14-20	**0.1**	**0.7**	**1.6**	**1.1**	**1.0**	**2.3**	**0.3**	**1.0**
21-25	**0.6**	**0.6**	**2.6**	**3.0**	**2.0**	**2.2**	**1.6**	**0.8**
26-30	**0.8**	**0.6**	**1.0**	**1.4**	**0.2**	**1.2**	**0.2**	**0.6**
31-35	**0.2**	**0.2**	**0.8**	**1.0**	**0.4**	**0.6**	**0.4**	**0.6**
36-40	**0.0**	**0.0**	**0.4**	**1.0**	**0.6**	**0.4**	**0.6**	**0.6**
41-45	**0.2**	**0.0**	**0.6**	**0.0**	**0.4**	**0.8**	**0.0**	**0.0**
46-57	**0.2**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.2**	**0.4**
58-75	**0.1**	**0.1**	**0.0**	**0.1**	**0.3**	**0.2**	**0.2**	**0.2**

Table 8: The Average and Standard Deviation of given ATD matrix.

Avg	**0.27**	**0.30**	**0.90**	**1.00**	**0.65**	**1.00**	**0.43**	**0.52**
S.D	**0.28**	**0.29**	**0.84**	**0.96**	**0.60**	**0.83**	**0.51**	**0.32**

We are taking α = 0.15, 0.24, 0.4, 0.71 to find the CETD matrix.

Depicting maximum age group of people getting for Transcendence for Major (fig.4) and Minor (fig.5) mode with different α values

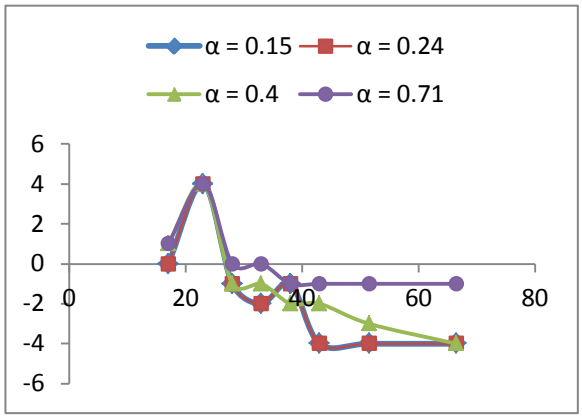

fig.4

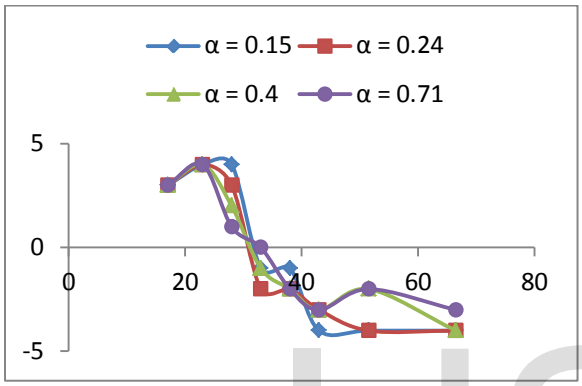

fig.5

The CETD Matrix (Major) The row sum matrix

$$\begin{bmatrix} -3 & 4 & 3 & -2 \\ 4 & 4 & 4 & 4 \\ 4 & 0 & -4 & -3 \\ -2 & 0 & -3 & 0 \\ -4 & -3 & 0 & 2 \\ -2 & -2 & -3 & -4 \\ -2 & -4 & -3 & -3 \\ -3 & -4 & -3 & -3 \end{bmatrix} \quad \begin{bmatrix} 2 \\ 16 \\ -3 \\ -5 \\ -5 \\ -11 \\ -12 \\ -13 \end{bmatrix}$$

The CETD Matrix (Minor) The row sum matrix

$$\begin{bmatrix} 4 & 0 & 4 & 4 \\ 4 & 4 & 4 & 4 \\ 4 & 3 & 2 & 1 \\ -2 & 0 & -3 & 1 \\ -4 & 0 & -4 & 1 \\ -4 & -4 & -1 & -4 \\ -2 & -4 & -4 & -2 \\ -3 & -4 & -4 & -4 \end{bmatrix} \quad \begin{bmatrix} 12 \\ 16 \\ 10 \\ -4 \\ -7 \\ -13 \\ -12 \\ -15 \end{bmatrix}$$

Depicting maximum age group of people getting Transcendence for CETD matrix (fig.6)

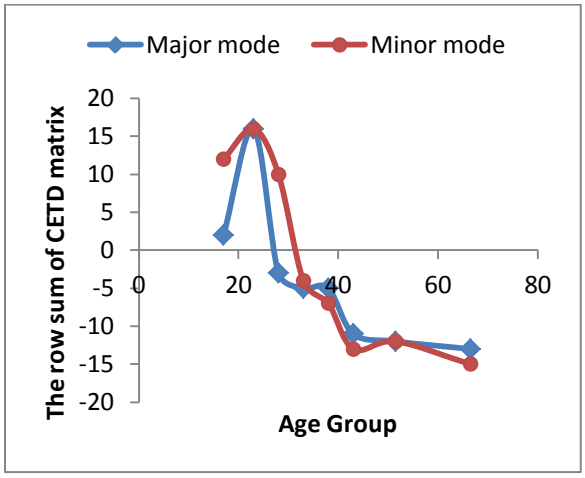

fig.6

Estimation of maximum age group of people getting Tenderness by using 8×5

In this section we apply 5 sub-units.

Table 9: Initial raw data matrix of Tenderness of order 8×5

Tenderness	T1		T2		T3		T4		T5	
14-20	6	4	9	12	9	16	7	9	8	8
21-25	13	8	13	17	14	22	6	11	14	16
26-30	0	5	8	5	6	6	2	0	2	7
31-35	6	7	3	5	3	6	0	0	4	7
36-40	2	1	3	4	3	3	1	2	1	0
41-45	0	1	0	8	2	3	1	0	3	2
46-57	3	2	1	4	5	4	0	3	3	4
58-75	2	3	0	2	4	3	2	1	2	1

Table 10: The ATD matrix of Tenderness of order 8×5

Tenderness	T1		T2		T3		T4		T5	
14-20	0.9	0.6	1.3	1.7	1.3	2.3	1.0	1.3	1.1	1.1
21-25	2.6	1.6	2.6	3.4	2.8	4.4	1.2	2.2	2.8	3.2
26-30	0.0	1.0	1.6	1.0	1.2	1.2	0.4	0.0	0.4	1.4
31-35	1.2	1.4	0.6	1.0	0.6	1.2	0.0	0.0	0.8	1.4
36-40	0.4	0.2	0.6	0.8	0.6	0.6	0.2	0.4	0.2	0.0
41-45	0.0	0.2	0.0	1.6	0.4	0.6	0.2	0.0	0.6	0.4
46-57	0.3	0.2	0.1	0.3	0.4	0.3	0.0	0.3	0.3	0.3
58-75	0.1	0.2	0.0	0.1	0.2	0.2	0.1	0.1	0.1	0.1

Table 11: The Average and Standard Deviation of given ATD matrix.

Avg	0.68	0.66	0.85	1.24	0.94	1.35	0.39	0.52	0.79	0.99
S.D	0.89	0.59	0.92	1.03	0.84	1.40	0.46	0.80	0.88	1.06

We are taking α = 0.18, 0.27, 0.45, 0.82 to find the CETD matrix.

Depicting maximum age group of people getting Tenderness for Major (fig.7) and Minor (fig.8) mode with different α values

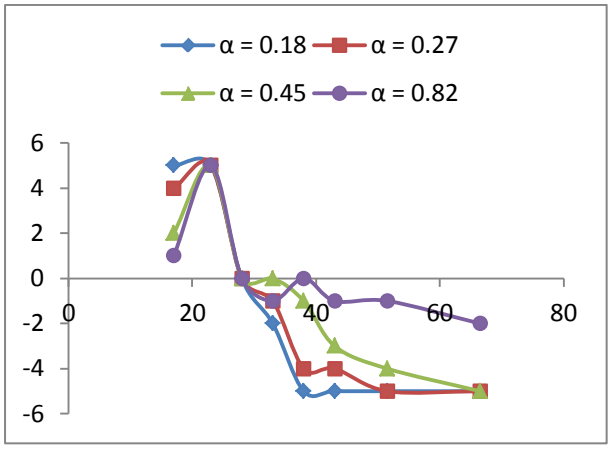

fig.7

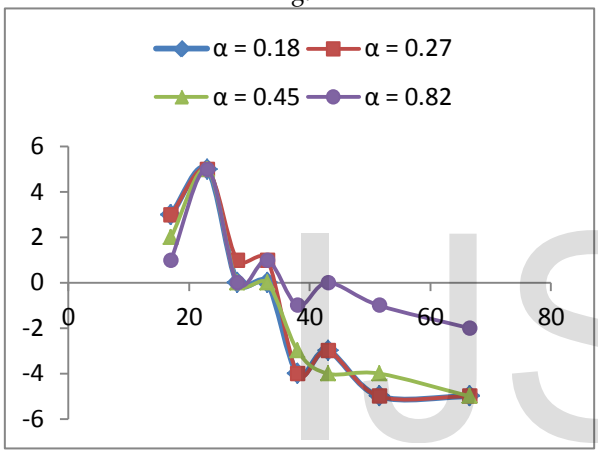

fig.8

The CETD Matrix (Major)

$$\begin{bmatrix} 1 & 3 & 2 & 4 & 2 \\ 4 & 4 & 4 & 4 & 4 \\ -3 & 3 & 2 & 0 & -2 \\ 3 & -1 & -2 & -4 & 0 \\ -2 & -1 & -2 & -2 & -3 \\ -3 & -4 & -3 & -2 & -1 \\ -2 & -3 & -3 & -4 & -3 \\ -3 & -4 & -4 & -3 & -3 \end{bmatrix}$$

The row sum matrix

$$\begin{bmatrix} 12 \\ 20 \\ 0 \\ -4 \\ -10 \\ -13 \\ -15 \\ -17 \end{bmatrix}$$

The CETD Matrix (Minor)

$$\begin{bmatrix} 0 & 2 & 3 & 4 & 0 \\ 4 & 4 & 4 & 4 & 4 \\ 3 & -1 & 0 & -3 & 2 \\ 4 & -1 & 0 & -3 & 2 \\ -3 & -2 & -3 & 0 & -4 \\ -3 & 2 & -3 & -3 & -3 \\ -3 & -4 & -3 & -2 & -3 \\ -3 & -4 & -3 & -3 & -4 \end{bmatrix}$$

The row sum matrix

$$\begin{bmatrix} 9 \\ 20 \\ 1 \\ 2 \\ -12 \\ -10 \\ -15 \\ -17 \end{bmatrix}$$

Depicting maximum age group of people getting Tenderness for CETD matrix (fig.9)

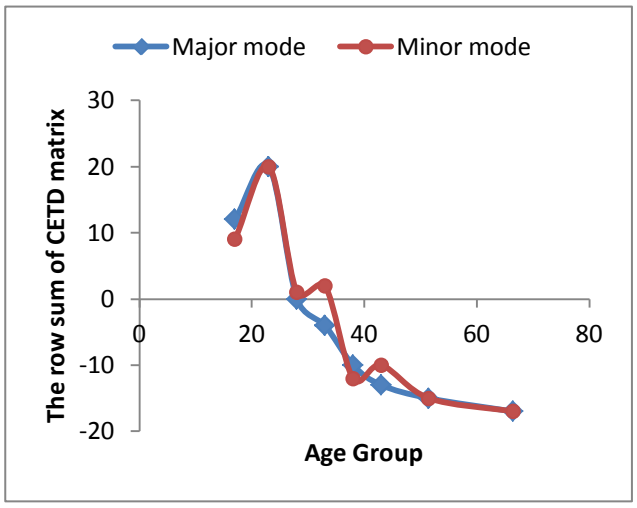

fig.9

Estimation of maximum age group of people getting Nostalgia by using 8×4 matrix.

In this section we apply 4 sub-units.

Table 12: Initial raw data matrix of Nostalgia of order 8×4

Nostalgia	N_1		N_2		N_3		N_4	
14-20	11	12	19	20	5	16	5	9
21-25	14	41	19	18	9	26	10	17
26-30	0	7	8	9	5	5	2	12
31-35	3	7	7	8	10	7	2	7
36-40	6	5	1	7	3	8	1	7
41-45	2	2	2	4	2	2	2	4
46-57	3	5	3	4	3	3	1	3
58-75	2	3	1	2	1	3	2	4

Table 13: The ATD matrix of Nostalgia of order 8×4

Nostalgia	N_1		N_2		N_3		N_4	
14-20	**1.6**	**1.7**	**2.7**	**2.9**	**0.7**	**2.3**	**0.7**	**1.3**
21-25	**2.8**	**8.2**	**3.8**	**3.6**	**1.8**	**5.2**	**2.0**	**3.4**
26-30	**0.0**	**1.4**	**1.6**	**1.8**	**1.0**	**1.0**	**0.4**	**2.4**
31-35	**0.6**	**1.4**	**1.4**	**1.6**	**2.0**	**1.4**	**0.4**	**1.4**
36-40	**1.2**	**1.0**	**0.2**	**1.4**	**0.6**	**1.6**	**0.2**	**1.4**
41-45	**0.4**	**0.4**	**0.4**	**0.8**	**0.4**	**0.4**	**0.4**	**0.8**
46-57	**0.3**	**0.4**	**0.3**	**0.3**	**0.3**	**0.3**	**0.1**	**0.3**
58-75	**0.1**	**0.2**	**0.1**	**0.1**	**0.1**	**0.2**	**0.1**	**0.2**

Table 14: The Average and Standard Deviation of given ATD matrix.

Avg	**0.87**	**1.84**	**1.30**	**1.56**	**0.85**	**1.54**	**0.54**	**1.39**
S.D	**0.95**	**2.63**	**1.36**	**1.20**	**0.71**	**1.65**	**0.62**	**1.07**

We are taking α = 0.16, 0.25, 0.53, 0.72 to find the CETD matrix.

Depicting maximum age group of people getting Nostalgia for Major (fig.10) and Minor (fig.11) mode with different α values

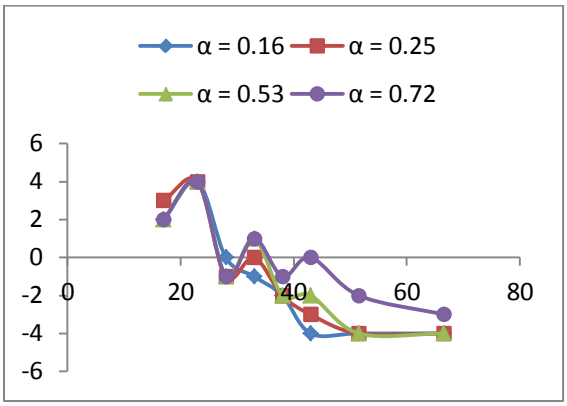

fig.10

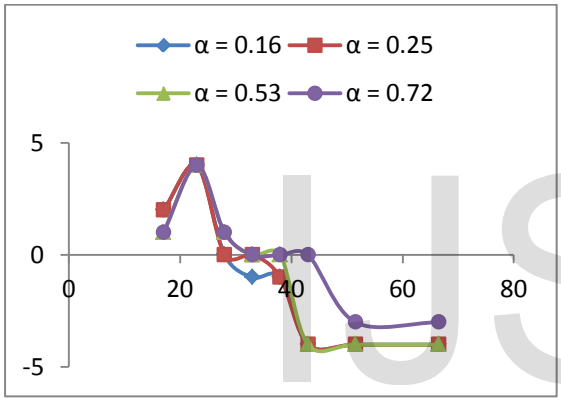

fig.11

The CETD Matrix (Major)

$$\begin{bmatrix} 4 & 4 & -1 & 2 \\ 4 & 4 & 4 & 4 \\ -4 & 1 & 1 & -1 \\ -2 & 0 & 4 & -1 \\ 2 & -4 & -2 & -3 \\ -2 & -3 & -3 & -1 \\ -3 & -4 & -4 & -3 \\ -4 & -4 & -4 & -3 \end{bmatrix}$$

The row sum matrix

$$\begin{bmatrix} 9 \\ 16 \\ -3 \\ 1 \\ -7 \\ -9 \\ -14 \\ -15 \end{bmatrix}$$

The CETD Matrix (Minor)

$$\begin{bmatrix} 0 & 4 & 2 & 0 \\ 4 & 4 & 4 & 4 \\ -1 & 1 & -2 & 4 \\ -1 & 0 & 0 & 0 \\ -2 & 0 & 0 & 0 \\ -3 & -3 & -3 & -3 \\ -3 & -4 & -4 & -4 \\ -3 & -4 & -4 & -4 \end{bmatrix}$$

The row sum matrix

$$\begin{bmatrix} 6 \\ 16 \\ 2 \\ -1 \\ -2 \\ -12 \\ -15 \\ -15 \end{bmatrix}$$

Depicting maximum age group of people getting Nostalgia for CETD matrix (fig.12)

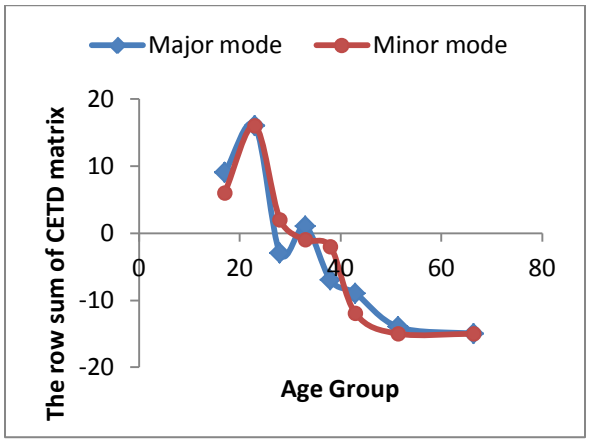

fig.12

Estimation of maximum age group of people getting Peacefulness by using 8×5 matrix.

In this section we apply 5 sub-units.

Table 15: Initial raw data matrix of Peacefulness of order 8×5

Peace	P_1		P_2		P_3		P_4		P_5	
14-20	21	29	10	16	15	22	2	11	4	9
21-25	19	27	13	7	23	24	13	16	6	9
26-30	7	8	1	4	3	8	5	6	1	4
31-35	14	17	4	7	9	8	4	7	0	3
36-40	7	7	0	3	4	3	1	2	0	2
41-45	5	7	0	1	5	5	0	2	1	2
46-57	4	5	3	2	4	4	3	2	2	0
58-75	2	3	1	0	3	2	1	2	1	3

Table 16: The ATD matrix of Peacefulness of order 8×5

Peace	P_1		P_2		P_3		P_4		P_5	
14-20	3.0	4.1	1.4	2.3	2.1	3.1	0.3	1.6	0.6	1.3
21-25	3.8	5.4	2.6	1.4	4.6	4.8	2.6	3.2	1.2	1.8
26-30	1.4	1.6	0.2	0.8	0.6	1.6	1.0	1.2	0.2	0.8
31-35	2.8	3.4	0.8	1.4	1.8	1.6	0.8	1.4	0.0	0.6
36-40	1.4	1.4	0.0	0.6	0.8	0.6	0.2	0.4	0.0	0.4
41-45	1.0	1.4	0.0	0.2	1.0	1.0	0.0	0.4	0.2	0.4
46-57	0.3	0.4	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.0
58-75	0.1	0.2	0.1	0.0	0.2	0.1	0.1	0.1	0.1	0.2

Table 17: The Average and Standard Deviation of given ATD matrix.

Avg	1.73	2.24	0.67	0.86	1.43	1.65	0.65	1.06	0.30	0.68
S.D	1.33	1.87	0.93	0.79	1.45	1.59	0.86	1.04	0.41	0.60

We are taking α = 0.15, 0.32, 0.48, 0.76 to find the CETD matrix.

Depicting maximum age group of people getting Peacefulness for Major (fig.13) and Minor (fig.14) mode with different α values

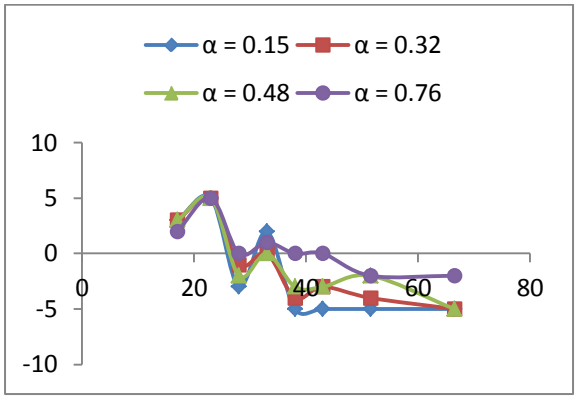

fig.13

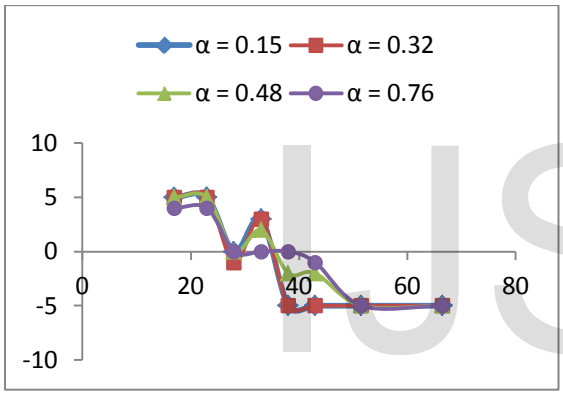

fig.14

The CETD Matrix (Major)

$$\begin{bmatrix} 4 & 4 & 2 & -2 & 3 \\ 4 & 4 & 4 & 4 & 4 \\ -1 & -3 & -3 & 2 & -1 \\ 4 & 0 & 1 & 1 & -3 \\ -1 & -3 & -2 & -3 & -3 \\ -3 & -3 & -1 & -3 & -1 \\ -4 & -2 & -4 & -2 & -1 \\ -4 & -3 & -4 & -3 & -3 \end{bmatrix}$$

The row sum matrix

$$\begin{bmatrix} 11 \\ 20 \\ -6 \\ 3 \\ -12 \\ -11 \\ -13 \\ -17 \end{bmatrix}$$

The CETD Matrix (Minor)

$$\begin{bmatrix} 4 & 4 & 4 & 3 & 4 \\ 4 & 3 & 4 & 4 & 4 \\ -2 & 0 & 0 & 0 & 1 \\ 3 & 3 & 0 & 2 & 0 \\ -2 & -2 & -3 & -3 & -2 \\ -2 & -4 & -2 & -3 & -2 \\ -4 & -4 & -4 & -4 & -4 \\ -4 & -4 & -4 & -4 & -4 \end{bmatrix}$$

The row sum matrix

$$\begin{bmatrix} 19 \\ 19 \\ -1 \\ 8 \\ -12 \\ -13 \\ -20 \\ -20 \end{bmatrix}$$

Depicting maximum age group of people getting Peacefulness for CETD matrix (fig.15).

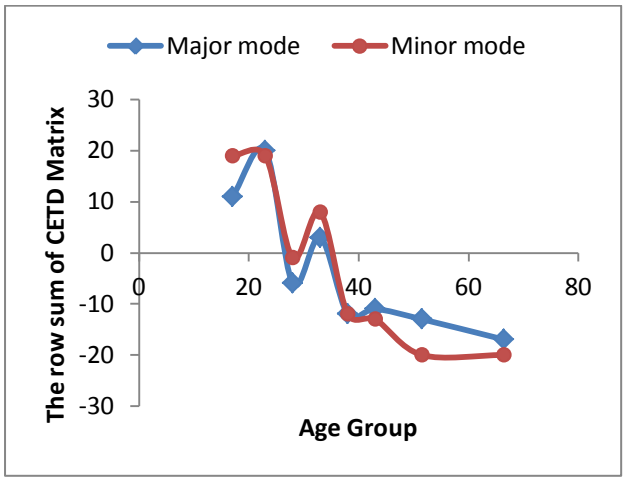

fig.15

Estimation of maximum age group of people getting Power by using 8×5 matrix.

In this section we apply 5 sub-units.

Table 18: Initial raw data matrix of Power of order 8×5

Power	Po_1		Po_2		Po_3		Po_4		Po_5	
14-20	12	13	8	6	2	3	7	10	5	4
21-25	18	16	13	13	7	4	9	8	6	15
26-30	9	4	5	6	0	3	2	6	2	3
31-35	6	6	5	3	2	2	2	2	4	2
36-40	6	3	5	2	1	0	2	1	1	3
41-45	3	1	0	0	0	3	1	0	2	2
46-57	3	4	1	0	2	2	2	2	2	1
58-75	1	3	1	0	0	1	0	2	1	0

Table 19: The ATD matrix of Power of order 8×5

Power	Po_1		Po_2		Po_3		Po_4		Po_5	
14-20	1.7	1.9	1.1	0.9	0.3	0.4	1.0	1.4	0.7	0.6
21-25	3.6	3.2	2.6	2.6	1.4	0.8	1.8	1.6	1.2	3.0
26-30	1.8	0.8	1.0	1.2	0.0	0.6	0.4	1.2	0.4	0.6
31-35	1.2	1.2	1.0	0.6	0.4	0.4	0.4	0.4	0.8	0.4
36-40	1.2	0.6	1.0	0.4	0.2	0.0	0.4	0.2	0.2	0.6
41-45	0.6	0.2	0.0	0.0	0.0	0.6	0.2	0.0	0.4	0.4
46-57	0.3	0.3	0.1	0.0	0.2	0.2	0.2	0.2	0.2	0.1
58-75	0.1	0.2	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.0

Table 20: The Average and Standard Deviation of given ATD matrix.

Avg	1.30	1.04	0.86	0.71	0.31	0.38	0.55	0.64	0.49	0.71
S.D	1.13	1.04	0.86	0.88	0.47	0.29	0.59	0.66	0.39	0.95

We are taking α = 0.13, 0.24, 0.5, 0.81 to find the CETD matrix.

Depicting maximum age group of people getting Power for Major (fig.16) and Minor (fig.17) mode with different α values

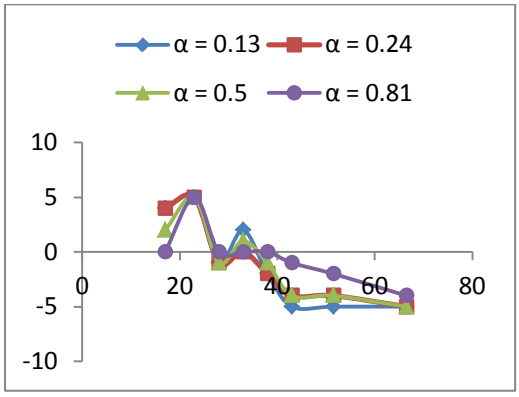

fig.16

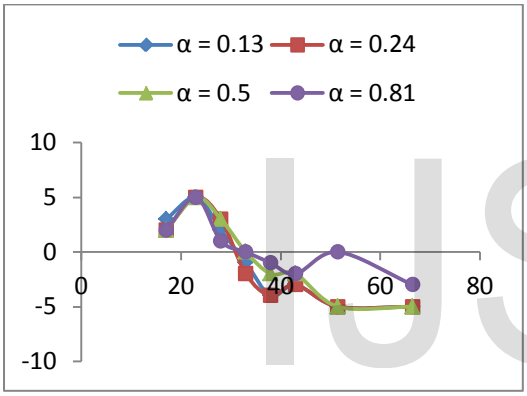

fig.17

The CETD Matrix (Major) The row sum matrix

$$\begin{bmatrix} 2 & 2 & 0 & 3 & 3 \\ 4 & 4 & 4 & 4 & 4 \\ 2 & 1 & -3 & -2 & -1 \\ 0 & 1 & 1 & -2 & 3 \\ 0 & 1 & -1 & -2 & -3 \\ -3 & -4 & -3 & -3 & -1 \\ -4 & -4 & -1 & -3 & -3 \\ -4 & -4 & -3 & -4 & -4 \end{bmatrix} \quad \begin{bmatrix} 10 \\ 20 \\ -3 \\ 3 \\ -5 \\ -14 \\ -15 \\ -19 \end{bmatrix}$$

The CETD Matrix (Minor) The row sum matrix

$$\begin{bmatrix} 4 & 1 & 0 & 4 & 0 \\ 4 & 4 & 4 & 4 & 4 \\ -1 & 3 & 3 & 4 & 0 \\ 1 & 0 & 0 & -2 & -2 \\ -2 & -2 & -4 & -3 & 0 \\ -4 & -3 & 3 & -4 & -2 \\ -3 & -3 & -3 & -3 & -3 \\ -4 & -3 & -4 & -4 & -3 \end{bmatrix} \quad \begin{bmatrix} 9 \\ 20 \\ 9 \\ -3 \\ -11 \\ -10 \\ -15 \\ -18 \end{bmatrix}$$

Depicting maximum age group of people getting Power for CETD matrix (fig.18).

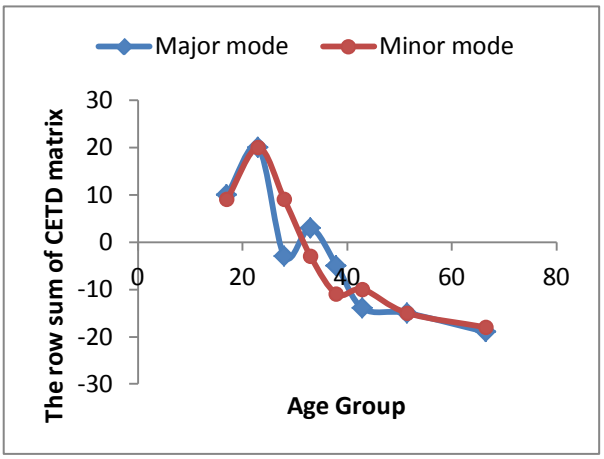

fig.18

Estimation of maximum age group of people getting Joyful Activation by using 8×5 matrix.

In this section we apply 5 sub-units.

Table 21: Initial raw data matrix of Power of order 8×5

Joyful Activation	J_1		J_2		J_3		J_4		J_5	
14-20	8	6	24	17	12	12	23	10	5	8
21-25	15	12	31	18	5	9	36	15	7	9
26-30	2	3	15	6	2	1	11	2	6	2
31-35	2	4	8	11	5	4	14	7	5	3
36-40	4	3	8	1	0	1	9	4	0	0
41-45	1	1	9	3	0	2	4	2	1	1
46-57	2	3	5	2	1	4	2	3	2	3
58-75	1	2	3	1	0	2	1	2	3	2

Table 22: The ATD matrix of Joyful Activation of order 8×5

Joyful Activation	J_1		J_2		J_3		J_4		J_5	
14-20	1.1	0.9	3.4	2.4	1.7	1.7	3.3	1.4	0.7	1.1
21-25	3.0	2.4	6.2	3.6	1.0	1.8	7.2	3.0	1.4	1.8
26-30	0.4	0.6	3.0	1.2	0.4	0.2	2.2	0.4	1.2	0.4
31-35	0.4	0.8	1.6	2.2	1.0	0.8	2.8	1.4	1.0	0.6
36-40	0.8	0.6	1.6	0.2	0.0	0.2	1.8	0.8	0.0	0.0
41-45	0.2	0.2	1.8	0.6	0.0	0.4	0.8	0.4	0.2	0.2
46-57	0.2	0.3	0.4	0.2	0.1	0.3	0.2	0.3	0.2	0.3
58-75	0.1	0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.2	0.1

Table 23: The Average and Standard Deviation of given ATD matrix.

Avg	0.77	0.73	2.28	1.31	0.52	0.69	2.29	0.97	0.61	0.56
S.D	0.97	0.73	1.94	1.30	0.64	0.69	2.31	0.96	0.54	0.61

We are taking α = 0.17, 0.23, 0.46, 0.75 to find the CETD matrix.

Depicting maximum age group of people getting Joyful Activation for Major (fig.19) and Minor (fig.20) mode with different α values

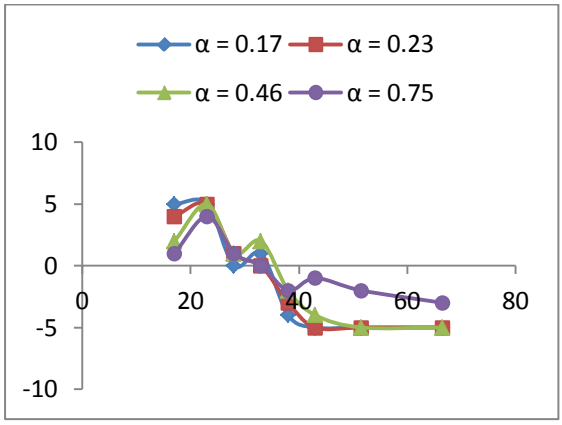

fig.19

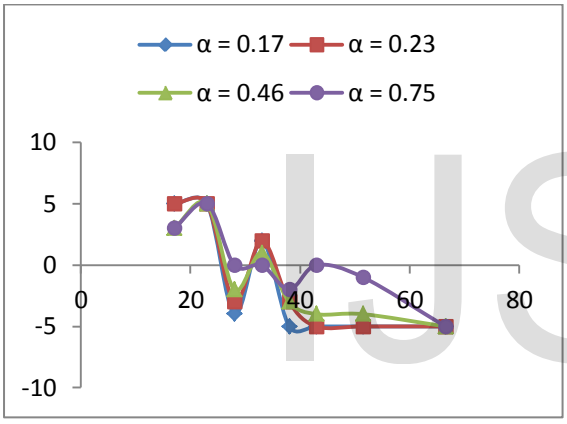

fig.20

The CETD Matrix (Major)

$$\begin{bmatrix} 2 & 3 & 4 & 2 & 1 \\ 4 & 4 & 3 & 4 & 4 \\ -2 & 2 & -1 & 0 & 4 \\ -2 & -2 & 3 & 1 & 3 \\ 0 & -2 & -4 & -1 & -4 \\ -3 & -2 & -4 & -3 & -3 \\ -3 & -4 & -3 & -4 & -3 \\ -3 & -4 & -4 & -4 & -3 \end{bmatrix}$$

The row sum matrix

$$\begin{bmatrix} 12 \\ 19 \\ 3 \\ 3 \\ -11 \\ -15 \\ -17 \\ -18 \end{bmatrix}$$

The CETD Matrix (Minor)

$$\begin{bmatrix} 2 & 4 & 4 & 2 & 4 \\ 4 & 4 & 4 & 4 & 4 \\ -1 & 0 & -3 & -3 & -2 \\ 0 & 3 & 0 & 2 & 0 \\ -1 & -4 & -3 & -1 & -4 \\ -3 & -3 & -2 & -3 & -3 \\ -3 & -4 & -3 & -3 & -2 \\ -4 & -4 & -4 & -4 & -4 \end{bmatrix}$$

The row sum matrix

$$\begin{bmatrix} 16 \\ 20 \\ -9 \\ 5 \\ -13 \\ -14 \\ -15 \\ -20 \end{bmatrix}$$

Depicting maximum age group of people getting Joyful Activation for CETD matrix (fig.21).

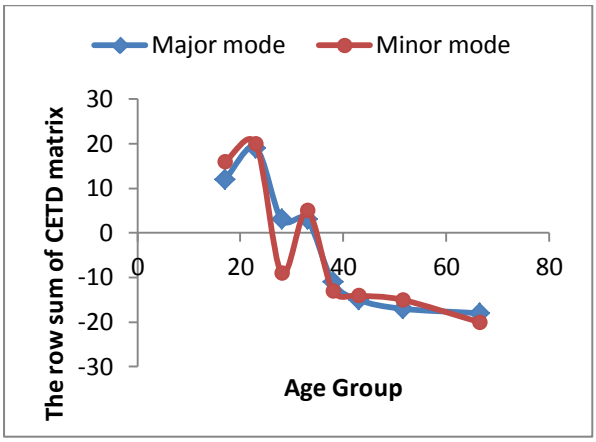

fig.21

Estimation of maximum age group of people getting Tension by using 8×5 matrix.

In this section we apply 5 sub-units.

Table 24: Initial raw data matrix of Tension of order 8×5

Tension	Te1		Te2		Te3		Te4		Te5	
14-20	0	5	3	10	4	9	2	2	2	0
21-25	3	3	8	6	6	11	4	15	1	6
26-30	1	4	4	2	3	4	3	1	3	0
31-35	2	2	0	3	2	4	2	3	1	3
36-40	2	0	0	1	1	2	1	3	0	3
41-45	1	1	0	1	0	1	1	1	0	1
46-57	1	2	3	2	0	3	1	2	0	1
58-75	0	1	1	2	1	2	0	1	2	0

Table 25: The ATD matrix of Tension of order 8×5

Tension	Te1		Te2		Te3		Te4		Te5	
14-20	0.0	0.7	0.4	1.4	0.6	1.3	0.3	0.3	0.3	0.0
21-25	0.6	0.6	1.6	1.2	1.2	2.2	0.8	3.0	0.2	1.2
26-30	0.2	0.8	0.8	0.4	0.6	0.8	0.6	0.2	0.6	0.0
31-35	0.4	0.4	0.0	0.6	0.4	0.8	0.4	0.6	0.2	0.6
36-40	0.4	0.0	0.0	0.2	0.2	0.4	0.2	0.6	0.0	0.6
41-45	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.2	0.0	0.2
46-57	0.1	0.2	0.3	0.2	0.0	0.3	0.1	0.2	0.0	0.1
58-75	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0

Table 26: The Average and Standard Deviation of given ATD matrix.

Avg	0.24	0.37	0.39	0.54	0.38	0.76	0.32	0.64	0.17	0.34
S.D	0.22	0.31	0.56	0.51	0.41	0.70	0.27	0.97	0.20	0.43

We are taking α = 0.13, 0.34, 0.62, 0.87 to find the CETD matrix.

Depicting maximum age group of people getting Tension for Major (fig.22) and Minor (fig.23) mode with different α values

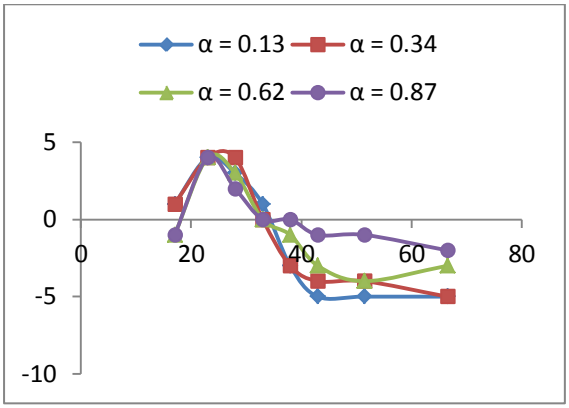

fig.22

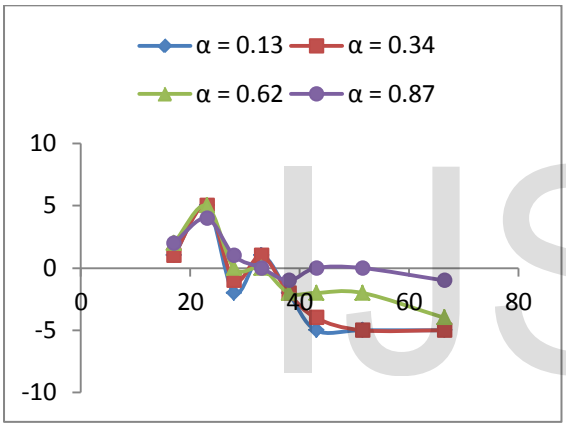

fig.23

The CETD Matrix (Major) The row sum matrix

$$\begin{bmatrix} -4 & 0 & 2 & 0 & 2 \\ 4 & 4 & 4 & 4 & 0 \\ -1 & 3 & 2 & 4 & 4 \\ 3 & -3 & 0 & 1 & 0 \\ 3 & -3 & -2 & -2 & -3 \\ -1 & -3 & -4 & -2 & -3 \\ -3 & -1 & -4 & -3 & -3 \\ -4 & -2 & -3 & -4 & -2 \end{bmatrix} \quad \begin{bmatrix} 0 \\ 16 \\ 12 \\ 1 \\ -7 \\ -13 \\ -14 \\ -15 \end{bmatrix}$$

The CETD Matrix (Minor) The row sum matrix

$$\begin{bmatrix} 4 & 4 & 3 & -2 & -3 \\ 3 & 4 & 4 & 4 & 4 \\ 4 & -1 & 0 & -2 & -3 \\ 0 & 0 & 0 & 0 & 2 \\ -4 & -3 & -2 & 0 & 2 \\ -2 & -3 & -3 & -2 & -1 \\ -2 & -3 & -3 & -2 & -2 \\ -3 & -3 & -4 & -2 & -3 \end{bmatrix} \quad \begin{bmatrix} 6 \\ 19 \\ -2 \\ 2 \\ -7 \\ -11 \\ -12 \\ -15 \end{bmatrix}$$

Depicting maximum age group of people getting Tension for CETD matrix (fig.24).

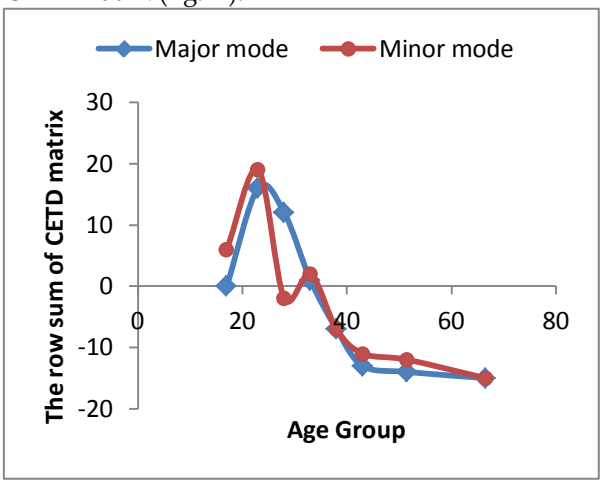

fig.24

Estimation of maximum age group of people getting Sadness by using 8×2 matrix.

In this section we apply 2 sub-units.

Table 27: Initial raw data matrix of Sadness of order 8×2

Sad	S_1		S_2	
14-20	13	26	7	9
21-25	20	65	6	23
26-30	4	17	4	7
31-35	5	8	2	3
36-40	3	5	4	2
41-45	1	2	0	2
46-57	2	4	2	9
58-75	1	4	3	6

Table 28: The ATD matrix of Sadness of order 8×2

Sad	S_1		S_2	
14-20	**1.9**	**3.7**	**1.0**	**1.3**
21-25	**4.0**	**13.0**	**1.2**	**4.6**
26-30	**0.8**	**3.4**	**0.8**	**1.4**
31-35	**1.0**	**1.6**	**0.4**	**0.6**
36-40	**0.6**	**1.0**	**0.8**	**0.4**
41-45	**0.2**	**0.4**	**0.0**	**0.4**
46-57	**0.2**	**0.3**	**0.2**	**0.8**
58-75	**0.1**	**0.2**	**0.2**	**0.3**

Table 29: The Average and Standard Deviation of given ATD matrix.

Avg	**1.08**	**2.96**	**0.57**	**1.22**
S.D	**1.31**	**4.28**	**0.44**	**1.42**

We are taking α = 0.12, 0.23, 0.45, 0.71 to find the CETD matrix.

Depicting maximum age group of people getting Sadness for Major (fig.25) and Minor (fig.26) mode with different α values

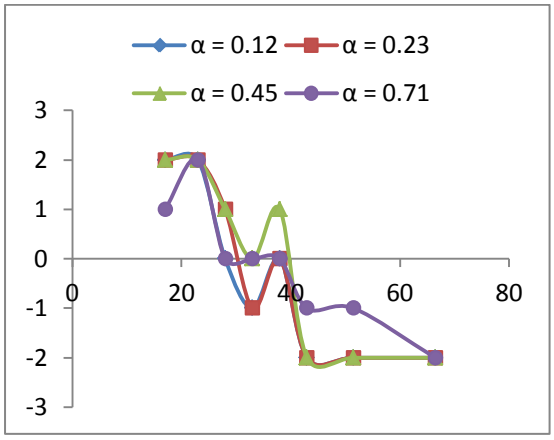

fig.25

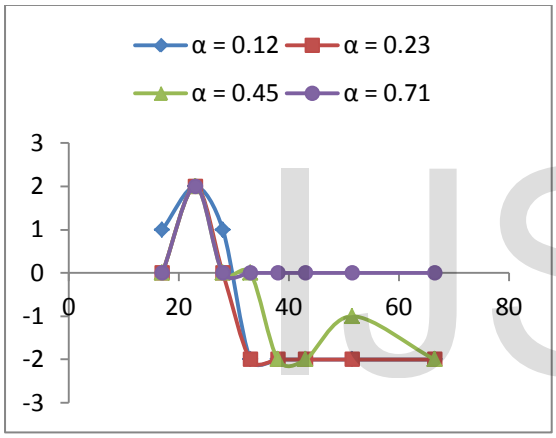

fig.26

The CETD Matrix (Major) The row sum matrix

$$\begin{bmatrix} 3 & 4 \\ 4 & 4 \\ -1 & 3 \\ 0 & -2 \\ -2 & 3 \\ -3 & -4 \\ -3 & -4 \\ -4 & -4 \end{bmatrix} \qquad \begin{bmatrix} 7 \\ 8 \\ 2 \\ -2 \\ 1 \\ -7 \\ -7 \\ -8 \end{bmatrix}$$

The CETD Matrix (Minor) The row sum matrix

$$\begin{bmatrix} 1 & 0 \\ 4 & 4 \\ 0 & 1 \\ -2 & -2 \\ -3 & -3 \\ -3 & -3 \\ -3 & -2 \\ -3 & -3 \end{bmatrix} \qquad \begin{bmatrix} 1 \\ 8 \\ 1 \\ -4 \\ -6 \\ -6 \\ -5 \\ -6 \end{bmatrix}$$

Depicting maximum age group of people getting Sadness for CETD matrix (fig.27).

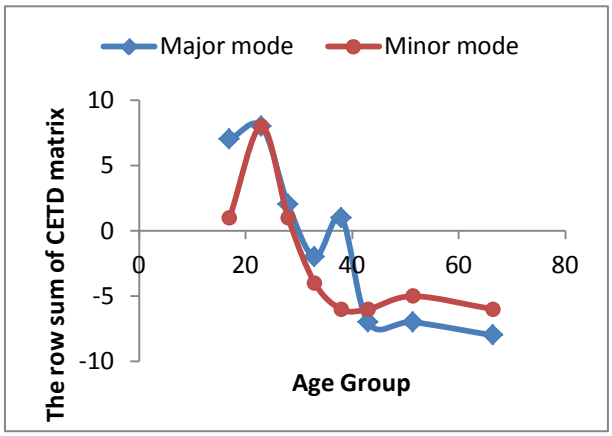

fig.27

4 Conclusions

We can see from the below table that the peak age of the people in Chennai who highly realize the emotions at the age between 21-24 for both Major and Minor mode categories in the western symphonies. And the experiencing capacity decreases from 28 and 38 because people do not have much interest to listen.

Table 30: Peak age for the corresponding Emotions

Emotion	Peak Age (Interval)	Decreasing from	
		Major	Minor
Wonder	23 (21-25)	38	28
Transcendence	23 (21-25)	28	28
Tenderness	23 (21-25)	28	33
Nostalgia	23 (21-25)	33	28
Peacefulness	23 (21-25)	33	33
Power	23 (21-25)	33	28
Joyful Activation	23 (21-25)	28	33
Tension	23 (21-25)	28	33
Sad	23 (21-25)	38	28

We can conclude that the proposed CETD is the best model to find the peak age for comparing any number of different categories.

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