

An analysis on Sustainability of Women in Entrepreneurship using Fuzzy Matrix

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Abstract

This paper gives a brief survey on the entrepreneurial mindset of women from distinct age groups. The method of application of Combined Effective Time Dependent Data Matrix, Average Time Dependent Data Matrix and Refined Time Dependent Data Matrix which are the fuzzy models are studied using fuzzy matrices. The notion of fuzzy models using the statistical concepts of the real data matrices is obtained. In order to make analysis, a sample study from northern to southern part of the city Chennai Located at Tamil Nadu, India has been taken. The graphical representation at different Parameters of α are drawn. Also, concept of correlation is applied to deduce which factors have the effects on other factors which affect entrepreneurship. Conclusion and some suggestions are provided.

Keywords

Entrepreneurship, Fuzzy matrix, RTD matrix, ATD matrix, CETD matrix, correlation.

Introduction

The concept of fuzzy set initially was introduced by Zadeh [18] in 1965. Fuzzy set theory is an extension of classical set theory. The concept of fuzzy relation on a set was defined by Zadeh [17][18]. In the last thirty years Bell [2], Dubois and Prade [4], Kerre [5], Lowen [7], Meenakshi et al. [8,9,10], Roesenfeld [11], Zimmermann [19] and others have extended the ideas of fuzzy set theory to topology, algebra, Hilbert spaces, graphs, games theory, logic and computing, etc. The basic concept of fuzzy matrices introduced by Vasantha Kandas, Florentin Smarandache and Ilanthenral [15,16] are studied. They gave the basic notions of matrices and the properties of fuzzy matrices. Using MATLAB for Fuzzy Logic was studied by Sivanandam et al. [12]. Risk analysis for a customer in a construction, Response Prediction of Wind Turbine Power Generation are models explaining application of fuzzy concepts [1,6]. Study of Demonetization, study on the health hazards of the women scavengers using fuzzy matrices are few which explain about the application of the fuzzy matrix concepts [3,14]. Karl Pearson derived the formula for correlation coefficient from a related idea introduced by Francis Galton [13].

Preliminaries

Entrepreneurship

Entrepreneurship is the process in which we design, launch and run a new business. Most often these are small business initially. People who create and own them are called entrepreneurs. In today's world of entrepreneurship, India is clearly seeing a revolution in women entrepreneurs. Also in India, women constitute around 14% of the total entrepreneurship in the nation. Today's women entrepreneurs come from all classes of life and from all parts of the country in all industries including the fields that have traditionally been bastions of male domination

Factors affecting women entrepreneurs in India

We can construct a model based on the factors affecting the sustainability of women entrepreneurs in India. Few of those factors are efficiency in mobilizing funds, criticism, self-valuation, communication skills, family support, inadequate knowledge and more.

Fuzzy sets and matrices

Definition: [15]

Let T_{mn} be the set of all $m \times n$ matrices over T . If $m = n$, we write T_n . Elements of T_{mn} are called as membership value matrices, binary fuzzy relation matrices (or) fuzzy matrices. Boolean matrices over the Boolean algebra $\{0,1\}$ are special types of fuzzy matrices.

Definition:[15]

Let $A = (a_{ij}) \in T_{mn}$. Then the element a_{ij} is called the (i, j) entry of A . Let A_{i*} (A_{*j}) denote the i^{th} row (j^{th} column) of A .

Definition:[15]

The $n \times m$ zero matrix, O is the matrix all of whose entries are zero. The $n \times n$ identity matrix, I is the matrix, (δ_{ij}) such that $\delta_{ij} = 1$ if $i = j$ and $\delta_{ij} = 0$ if $i \neq j$. The $n \times m$ universal matrix, J is the matrix all of whose entries are 1.

Definition:[15]

In certain fuzzy matrices we include $[1, -1]$ as the fuzzy interval. Hence, $[0, 1]$ or $[-1, 1]$ will be known as fuzzy interval. Thus if $a_{ij} \in [1, -1]$ we call (a_{ij}) to be fuzzy matrix.

Example:

$$\begin{bmatrix} .3 & .1 & .4 \\ 1 & .2 & .7 \\ 0 & .5 & .3 \end{bmatrix}$$
 This is a fuzzy matrix.

Correlation [13]

We can find out if there is any correlation between any 2 variables under study. If the change in one variable affects a change in the other variable, then the variables are said to be correlated. A formula called correlation coefficient is the measure of intensity or degree of a linear relationship between 2 variables. Also, its value ranges from -1 to 1.

Mathematical modelling on sustainability of women entrepreneurship

Factors affecting entrepreneurship

As we said earlier there are many factors that affect the sustainability of women in entrepreneurship. Here we consider these factors $X_1, X_2, X_3, X_4, X_5, X_6, X_7$ and X_8 as:

- X_1 - Efficiency in mobilising funds
- X_2 -Optimistic approach towards criticism
- X_3 -Self-efficiency and self confidence
- X_4 -Attraction towards the idea of networking
- X_5 -need for achievement
- X_6 -Family support
- X_7 -Adequate Knowledge of skills and guidance
- X_8 -Risk taking attitude

Extraction of data.

We have taken a survey from 200 women of different age groups to get the data for our model. From the survey, we deduce the data given here.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
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18-21	10	12	9	23	29	11	13	12
22-25	16	32	34	28	33	29	27	35
26-29	22	34	37	35	35	32	38	32
30-33	25	24	27	32	21	26	33	22
34-37	21	19	21	36	18	15	35	11

Table 1. Raw data from the survey

From this data we manipulate the different characteristics of different age groups.

Mathematical formulation

Formula for the problem[16]

In this section on the collected data a simple fuzzy matrix model with an effective technique is discussed. At first the raw data extracted from survey is converted into a time dependent matrix in table 1. Also, formula of correlation coefficient is discussed.

ATD matrix

After we obtain the time dependent matrix by using the techniques of average and standard deviation, the time dependent data matrix is converted into an Average Time Dependent Data Matrix (ATD Matrix) by taking age group along the rows and the factors along the columns. We divide each entry of the raw data matrix by the number of years to obtain ATD Matrix which represents a totally uniform data.

RTD matrix

From ATD using the average μ_j of each j^{th} column and σ_j the Standard Deviation of each j^{th} column, for any parameter α , the Refined Time Dependent Matrix (RTD Matrix) a_{ij} is formed using the formula:

If $a_{ij} \leq (\mu_j - \alpha * \sigma_j)$ then $e_{ij} = -1$ else

If $a_{ij} \in (\mu_j - \alpha * \sigma_j, \mu_j + \alpha * \sigma_j)$ then $e_{ij} = 0$ else

If $a_{ij} \geq (\mu_j + \alpha * \sigma_j)$ then $e_{ij} = 1$ else

where a_{ij} 's are the entries of the ATD Matrix and α is from the interval $[0, 1]$.

Thus, the ATD Matrix is converted into the Refined Time Dependent Data (RTD) Matrix. This fuzzy matrix has the entries -1 , 0 and 1 . Now, the row sum of this matrix gives the maximum age group whose sustainability in entrepreneurship is affected.

CETD matrix

Further, we can combine the matrices we get on varying $\alpha \in [0,1]$ to obtain the Combined Effective Time Dependent Data (CETD) Matrix. The row sum is found for the CETD matrix and we derive conclusions which depends on the row sums. Graphical representation of this data is provided as the graphs can exhibit the data in a way that anyone can understand

Correlation[13]

Correlation coefficient between 2 random variables X and Y is denoted by $r(X, Y)$.

$$r(X, Y) = \frac{\text{cov}(X, Y)}{\sigma_X \sigma_Y} \quad (4.4)$$

$$= \frac{\frac{1}{n} \sum XY - \bar{X} \bar{Y}}{\sigma_X \sigma_Y} \quad (4.5)$$

Where,

- n = quantity of information

- $\bar{X}$ = average of first variable values
- $\bar{Y}$ = average of second variable values
- $\sum XY$ = Sum of the Product of first & Second Value
- σ = standard deviation

If r is positive we say that the correlation is direct, if negative we say the correlation is diverse and if 0 we say that the variables are not correlated.

Application of the formula in our model

ATD matrix

From table 1, as we said in section 4.1.1 we obtain the ATD matrix

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
18-21	2.5	3	2.25	5.75	7.25	2.75	3.25	3
22-25	4	8	8.5	7	8.25	7.25	6.75	8.75
26-29	5.5	8.5	9.25	8.75	8.75	8	9.5	8
30-33	6.25	6	6.75	8	5.25	6.5	8.25	5.5
34-37	5.25	4.75	5.25	9	4.5	3.75	8.75	2.75

Table 2. ATD matrix

Average	4.7	6.05	6.4	7.7	6.8	5.65	7.3	5.6
Standard Deviation	1.32	2.03	2.49	1.19	1.66	2.04	2.22	2.47

Table 3. The average and standard deviation for each factor is deduced

RTD matrix

By using the formula from 4.1.2 and varying the value of α as 0.15, 0.35, 0.75 we get the following RTD matrices.

For $\alpha = 0.15$, e_{11} is calculated as follows:

$$\mu_1 - \alpha * \sigma_1 = 4.7 - (0.15)(1.32) = 4.502$$

$$a_{11} = 2.5$$

Here, we realize that $a_{11} < \mu_1 - \alpha * \sigma_1$

Therefore, $e_{11} = -1$

Similarly, by calculating all e_{ij} 's for the 4 values of α we get the following RTD matrices

For $\alpha = 0.15$,

ROW SUM

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

For $\alpha = 0.35$,

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

For $\alpha = 0.75$,

$$\begin{bmatrix} -1 & -1 & -1 & -1 & 0 & -1 & -1 & -1 \\ 1 & 1 & 1 & 0 & 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 & -1 & 0 & -1 \end{bmatrix} \begin{bmatrix} -7 \\ 6 \\ 7 \\ 0 \\ -2 \end{bmatrix}$$

CETD matrix

By adding the above four RTD matrices we get the following CETD matrix.

$$\begin{bmatrix} -3 & -3 & -3 & -3 & 1 & -3 & -3 & -3 \\ -1 & 3 & 3 & -2 & 3 & 3 & 0 & 3 \\ 2 & 3 & 3 & 3 & 3 & 3 & 3 & 3 \\ 3 & 0 & 0 & 1 & -3 & 2 & 2 & 0 \\ 2 & -2 & -2 & 3 & -3 & -3 & 2 & -3 \end{bmatrix} \begin{bmatrix} -20 \\ 12 \\ 23 \\ 5 \\ -6 \end{bmatrix}$$

Correlation coefficient

Applying the formula in section 4.1.4 by combining every 2 factors of the given 8 factors X_1 to X_8 we get

$$r(X_2, X_3) = 0.9897$$

$$r(X_2, X_6) = 0.9682$$

$$r(X_3, X_6) = 0.9641$$

$$r(X_4, X_7) = 0.9616$$

which are the values of r which are approximately 1.

$$r(X_4, X_8) = 0.0113 \text{ is the value of } r \text{ which is approximately } 0.$$

Regression Analysis

The relation between the significant parameters X_2, X_3, X_6 are obtained and their multiple regression coefficients are given in the following tables.

Regression Statistics	
Multiple R	0.9899884
R Square	0.9800769
Adjusted R Square	0.9601539
Standard Error	2.2299764
Observations	5

	Coefficients	Standard Error	t Stat	p value
Intercept	-3.6365154	3.148801902	-1.154888603	0.36748267
X_2	1.1004721	0.488368748	2.253363134	0.15299342
X_6	0.1152695	0.488075522	0.236171363	0.835282689

Table 4. Regression Analysis of X_3 on X_2 and X_6

Regression Statistics	
Multiple R	0.99110865
R Square	0.982296355
Adjusted R Square	0.964592711

Standard Error	1.716358496
Observations	5

	Coefficients	Standard Error	t Stat	p value
Intercept	3.029845146	2.280497376	1.328589622	0.315301002
X_6	0.198274098	0.354118101	0.559909525	0.631885243
X_3	0.651920322	0.289309926	2.253363134	0.15299342

Table 5. Regression Analysis of X_2 on X_6 and X_3

Regression Statistics	
Multiple R	0.96904579
R Square	0.939049748
Adjusted R Square	0.878099497
Standard Error	3.18658311
Observations	5

	Coefficients	Standard Error	t Stat	p value
Intercept	0.035094939	5.809236078	0.006041231	0.995728243
X_2	0.683440127	1.220626005	0.559909525	0.631885243
X_3	0.235377109	0.996636959	0.236171363	0.835282689

Table 6. Regression Analysis of X_6 on X_2 and X_3

Conclusion

A numerical study is developed to analyze the sustainability of women in entrepreneurship. It reveals that the women from age group 26-29 have healthy entrepreneurial mindset.

On the basis of our survey we suggest the following:

- (1) Most women less than 25 years should start to have their mindset to be independent with efficiency in mobilizing funds into consideration
- (2) Women should grow an optimistic mindset towards criticism there by, they don't hesitate to take risks with adequate knowledge
- (3) Family should support women even in their young age which makes them to be open to opportunities
- (4) Women should not loose self-confidence when they grow older.
- (5) Colleges, other educational institutions and work place should create awareness about entrepreneurship and give them opportunities to prove themselves with practical knowledge.

Further, on determining the correlation coefficient and multiple regression we can say that the factors self-confidence and family support are perfectly correlated positively with each other and also with optimistic approach. Also, attraction on the idea of networking and risk taking attitude are factors which are independent to each other.

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