Scrutinizing the Discrimination of African Senior Citizens through Linguistic Delphi Adapted Fuzzy Associative Memories

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Abstract

In Africa, the population of senior citizens (60 years and above) has increased rapidly from 12 million in 1950 to over 64.5 million in 2015. It is projected to reach 103 million by 2030 and 205 million by 2050. Majority of the African senior citizens are living in extreme poverty in rural areas. In the present African society, senior citizens are not given much importance in their families and expected to face sorrow till end of their last breathe. Senior citizens are treated as a burden in their families and given least care by the African society. Therefore, the objective of this paper is to demonstrate how discrimination affects senior citizens livelihoods in the society through Linguistic Delphi Adapted Fuzzy Associative Memories. Using Fuzzy Number and Fuzzy Associative memories, the relationship between causes and effects of the senior citizens discrimination is elucidated. Delphi Adapted Fuzzy Associative Memories (DAFAM) and algorithm was used to gather consensus of opinions, attitudes and choices of the society towards the senior citizens. DAFAM was used with expert's views to create one relational matrix. The expert's view deals statistically with several process of feedback from the group that gives the final prediction of consensus. The problem was further adapted to Linguistic Delphi Adapted Fuzzy Associative Memories model to analyse the impact of discrimination of senior citizens to their livelihoods. Finally, it was concluded that the attitude of the people should change towards senior citizens so that the problems faced by them in the society can be lessened.

Keywords — ***Fuzzy Associative Memories; Linguistic Variables; Delphi; Senior Citizens***

I. INTRODUCTION

A senior citizen is a person who gets old beyond the age of 60 years in Africa. The moment a person becomes a senior citizen he/she suffers many restrictions which reduces his/her importance or presence in the family and even in the society. A report by the United Nations Population Fund and Help Age Africa suggests that Africa had 64.5 million elderly persons in 2015, with the number predictable to grow to 103 million by 2030 [1]. According to the World Health Organization, nearly two billion people across the world are predicted to be over 60 years old by 2050, a figure that's more than triple what it was in 2000 [2]. As per the given census of World Health Organization, Japan is the most populous country with senior citizens (33%) in 2015 [3]. But the fact remains that the rate of ageing in the developing countries is by far fastest compared to the developed countries. Senior citizens in Africa are facing many challenges such as inadequate health services, income security and protection from poverty. The World Health Organization identified alcohol use, cardiovascular disease, hearing loss, nutrition, osteoporosis, physical activity, tobacco use and visual disability as some of the health challenges affecting the wellbeing of seniors [4]. In most African countries income security for senior citizens does not exit and in the small number of countries where such social grants exits they hardly provide enough income to sustain their livelihoods. Thus the priorities on ageing population that need urgent actions are food shortage, lack of drinking water, problems in obtaining adequate clothing, difficulty in obtaining firewood, lack of financial means to pay for health services, lack of government assistance when medical treatment is needed, lack of local government support towards older people in terms of food and housing and lack of personal security resulting from accusations of witchcraft [4].

In this paper, the inequalities of senior citizens in the society are analyzed using Delphi adapted Fuzzy Associative Memories with linguistic variables.

II. Methodology

A. Preliminaries

This section provides some basic definitions of fuzzy set theory, fuzzy numbers, and Fuzzy Associative Memories

Definition 2.1. A fuzzy set $\tilde{A}$ is a subset of a universe of discourse *X*, which is characterized by a membership function $\mu_{\tilde{A}}(x)$ representing a mapping $\mu_{\tilde{A}} : X \to [0,1]$. The function value of $\mu_{\tilde{A}}(x)$ is called the membership value, which represents the degree of truth that *x* is an element of fuzzy set $\tilde{A}$.

Definition 2.2. A fuzzy set $\tilde{A}$ defined on the set of real numbers R is said to be a fuzzy number and its membership function $\tilde{A} : R \to [0,1]$ has the following characteristics,

(i) $\tilde{A}$ is convex.

$$\mu_{\tilde{A}}(\lambda x_1 + (1-\lambda)x_2) \geq \min(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2)),$$
$$\forall x \in [x_1, x_2], \lambda \in [0,1].$$

(ii) $\tilde{A}$ is normal if $\max \mu_{\tilde{A}}(x) = 1$.

(iii) $\tilde{A}$ is piecewise continuous.

Definition 2.3. A triangular fuzzy number $\tilde{N}$ can be defined as a triplet (l, m, r) and the membership function $\mu_{\tilde{N}}(x)$ is defined as:

$$\mu_{\tilde{N}}(x) = \begin{cases} 0 & x < l \\ \left(\frac{x-l}{m-l}\right) & l \leq x \leq m \\ \left(\frac{r-x}{x-m}\right) & m \leq x \leq r \\ 0 & x > r \end{cases}$$

Where l, m, r are real numbers and $l \leq m \leq r$.

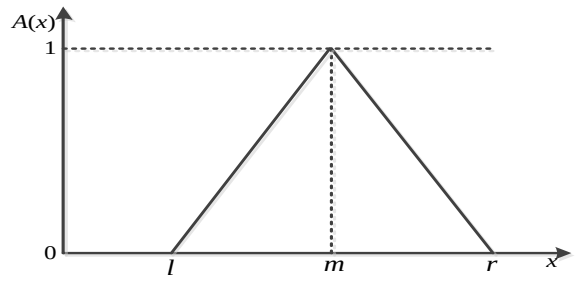

Fig. 1 Triangular Fuzzy Number

Definition 2.4. A linguistic variable is a variable whose values are linguistic terms [5; 6].

B. Fuzzy Associative Memories

Fuzzy Associative memories was introduced by Bart kosko [7]. It Gives relationship between causes and effects of the problem. The definitions and the basic notions of FAM are presented as follows [8]:

Definition 2.1.1: The n-dimensional unit hypercube is denoted as $I^n = [0, 1]^n = [0, 1] * \ldots * [0, 1]$. A fuzzy set defines a point in the cube I^n. Vertices of cube I^n are non- fuzzy sets. The n-dimensional unit hypercube I^n houses all the fuzzy subsets are of the form $X = x_1, \ldots\ldots, x_n$.

Definition 2.1.2: Fuzzy system defines mappings between cubes. Fuzzy system S plots fuzzy sets to fuzzy sets. That is, S: $I^n \rightarrow I^p$, where n and p are finite positive integers. The n-dimensional unit hypercube In consists of all the fuzzy subsets of the domain space $X = \{ (x_1, \ldots, x_n) \mid x_i \in R, \ i = 1,\ldots, n \}$. Similarly I^p consists of all the fuzzy subsets of the range space $Y = \{ (y_1, \ldots, y_p) \mid y_i \in R, \ i = 1,\ldots, p \}$. Hence X denotes a subset of R_n and Y denotes the subset of R_p. The system maps similar inputs to similar outputs. Thus the fuzzy system S maps balls of fuzzy sets in I^n to balls of fuzzy sets in I^p. These continuous fuzzy systems behave as an associative memory known as fuzzy associative memory. Thus fuzzy associative memories are transformations.

Definition 2.1.3: The fuzzy set association (A_i, B_i) is named as a "rule". The antecedent term Ai and the consequent term Bi in the fuzzy set association (Ai, Bi) are known as input associate and output associate respectively. The FAM system maps points A_j near A_i to points Bj near B_i. If Aj is closer to Ai, then the point (A_j, B_j) is closer to (Ai, Bi) in the product space $I^n \times I^p$. In this sense FAMs map balls in $I^n$to balls in I^p. Using the rule between the antecedent A_i and consequent Bi, we get the connection matrix M. FAM gives the gradation among the causes as per the attributes chosen by the expert.

Definition 2.1.4: If the symmetry state of a dynamical system is a unique state vector, then it is called a fixed point.

Definition 2.1.5: If the state vector duplication in the form of $A_1 \rightarrow A_2 \rightarrow \cdots \rightarrow A_i \rightarrow A_1$ then this equilibrium is called limit cycle.

C. Delphi Adapted Fuzzy Associative Memories

The Delphi method was advanced by Dalkey and Helmer [9] has been used to obtain reliable stream of answers through the result of surveys [10; 11]. Delphi is a group process relating a communication between the researcher and a group of recognized experts on specific topics through a series of surveys. Skutch and Hall [12] identified Delphi technique as a method for fast judgement on complex matters where the data is unavailable [13]. It is often professed to create a better interaction within a group [14; 15]. Delphi method is used in the area of Health Care [4], Distance Education [16], Journalism, [17], Visual Literacy [18], Electronic Commerce [19], Banking [20], Social Sciences [21], Education [13; 22]. The characteristics of Delphi include;

1. Anonymity: The experts who involved in the prediction process don't see each other which remain anonymous where it helps to prevent them from influencing and encourage the objective [23].
2. Feedback: The members give new idea and make a new judgment [23].
3. Statistical: The expert's view statistically deals with several process of feedback from the group that gives the final prediction of consensus [23].
4. Reduced Group Interactions: Overcomes some problems of group interaction [24].
5. Participants do not meet in one place [24].
6. Relatively inexpensive [24].
7. Encourages minority views to be aired [24].
8. Allows period of 'considered thought [24].
9. Does not allow individuals to dominate [24].

The concept of uniting fuzzy set theory and Delphi was proposed by Murray *et al.,* [25] and named the fuzzy Delphi method [26]. Linguistic variables are the variables whose values are not in numbers but it comprises linguistic terms. The linguistic values of the triangular Fuzzy numbers are chosen with five point scales [27].

Delphi Adapted Fuzzy Associative Memories was founded by Devadoss *et al.,* [28] to capture the most affected cause of the problem and it combines multiple experts' opinion into one relational matrix.

Table 1: Linguistic Variables of Triangular Fuzzy Number

Linguistic term	Fuzzy Value
Low	(0,0,0.25)
Below Average	(0,0.25,0.50)
Average	(0.25,0.50,0.75)
Above Average	(0.50,0.75,1)
High	(0.75,1,1)

D. Algorithm for Delphi Adapted Fuzzy Associative Memories

Step 1*:* Consider a system of *m* synaptic joining matrices $N_1=(b_{ij}^1)$, $N_2=(b_{ij}^2)$ …., $N_m=(b_{ij}^m)$ where i= 1, 2,3…n, j= 1,2… p which represents specialists opinion in terms of linguistic variables about the fundamental relationship between the neuron field F_x with n neurons and neuron field F_y with p neurons.

Step 2*:* Normalize each specialist's opinion by Linguistic Aggregated operators [12]

$$x_{ij}=\frac{ls_{ij}(1-ls_{ij})+rs_{ij}\times rs_{ij}}{1+rs_{ij}-ls_{ij}},\ where\ ls_{ij}=\frac{b}{1+b-a},\ rs_{ij}=\frac{c}{1+c-b}$$

Step 3: Then the matrices are joined as one synaptic connection matrix $M=(a_{ij})$ where $a_{ij}=\frac{P_{ij}+M_{ij}+O_{ij}}{6}$. Consider $P_{ij}=\min_{1\le n\le k}(a_{ij}^n), O_{ij}=\max_{1\le n\le k}(a_{ij}^n), M_{ij}=\frac{1}{k}\sum_{n=1}^{k}a_{ij}^n$

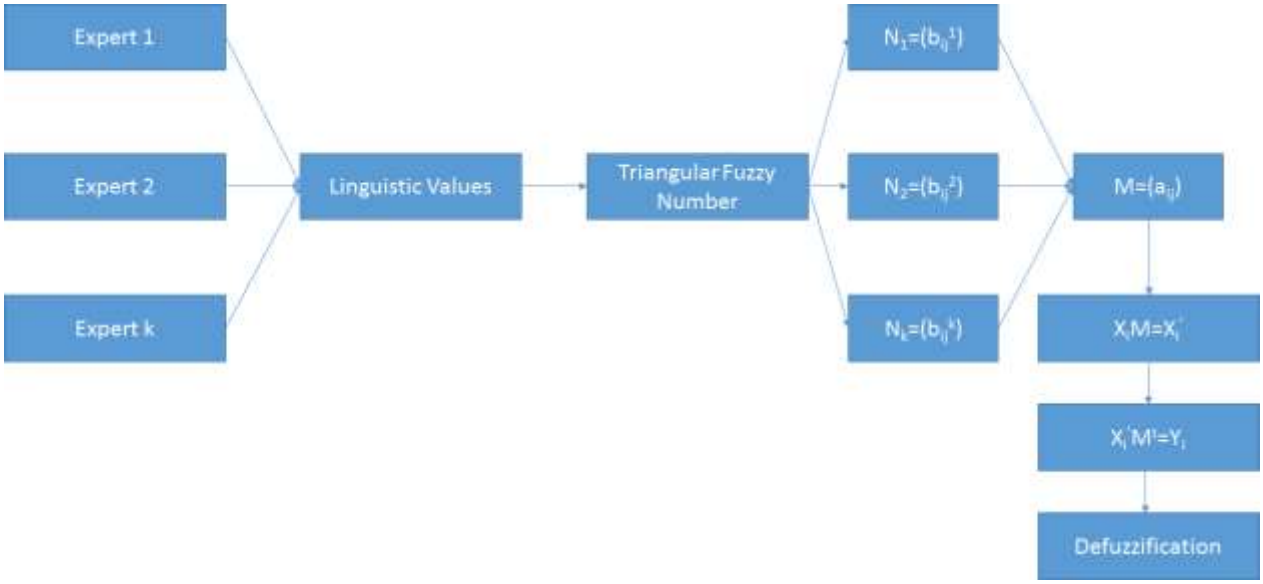

Fig. 2 Diagrammatic Representation of Delphi Process

E. Description of the Problem

A descriptive study by Chakwal [29] says that there are some factors by which senior citizens are more effected such as involvement in family discussions and the value given for their decisions, importance of their presence at social gathering etc. So, explaining some of these factors with some identified effects can help to understand their problems easier.

A. Factors Related to Discrimination of Senior Citizens (mainly in Africa):

F1-Participation in Household Activities:

As the persons grows older, he is going to be assigned with all the household works or activities and wanted everything to be done faster but doesn't get even respect for doing that work. They were kept aside from the family but used them for some activities.

F2-Involvement in Family Discussions:

Whenever there is a discussion among family members, the senior citizens are given the least priority to take part in the discussion and sometimes the rest of the family members are least bothered about the ideas given by the senior citizens of the family.

F3-Importance of Senior Citizens Decisions in Their Families:

There may be some situations where a senior citizen provides some solutions to the societal problems but their ideas are given least importance by the young generation. Even though the seniors give their ideas by experience, they are not considered and their point of view is mostly ignored.

F4-Attending Social Gatherings:

Even in the social gatherings, they won't give any importance to the presence of the senior citizens and least bothered about their involvement in the gathering.

F5-Assistance with health services:

There is a widespread lack of specialist services and personnel to serve the health needs of senior citizens. Most of senior citizens health needs are neglected.

B. Attributes Related to Effects of Discrimination to Senior citizens:

A1-Health:

Due to the discrimination of family members and the society at large, the health needs of senior citizen are never considered. This exacerbates their illnesses.

A2-Economic Security:

Some of the senior citizens are left by their families to live alone. With no proper social grants in most African countries, this has left them in extreme poverty with no enough food, no housing and clothes.

A3-Inclusion:

The senior citizens feel lonely as they are not interacted with anyone and don't have someone to share their experiences and pain, even the memories.

A4-Care:

The main effect of the discrimination is care because some senior citizens take care of their children till they become independent, the children do not have enough time to care for them. The society too tend to careless for them. This has made the likelihoods very difficult.

A5-Protection:

As no one cares, there is nothing like the person has someone in times of need. Even when some obstacle comes in their life no is there to protect them. The social protection systems in African are poorly designed to canter for senior citizens.

A6-Fear:

As no one cares, the feeling of fear will be started in the person as thinking of something is going to happen in future. So there won't be any belief of getting rid of the issues. Senior citizens too are sometimes accused of witchcraft. This makes them to live in fear.

A7-Lower Self Esteem:

Low self-esteem is characterized by a lack of confidence and feeling badly about oneself. People with low self-esteem often feel unlovable, awkward, or incompetent. This leads to most senior citizens losing hope and having no wish to continue living.

A8-Respect:

As the importance of the senior citizens decreases, the respect they get from the family and society also decreases. There is a need to teach the society to respect and value the senior citizens.

A9-Idleness:

The person will be habituated to idleness and even not able to talk with the people in their family. This leads to loneliness and helplessness. There is a need to create entertainments for senior citizens and allow them to exercises.

III. Results

We have collected the factors and effects described above from 4 Experts and their opinions are being converted into a dynamic system in the form of synaptic connection matrix with the linguistic variables. (Representing the persons as M1,M2,M3,M4)

M1=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	A	L	L	AA	A	H	AA	BA	H
F2	AA	A	BA	BA	L	H	A	L	AA
F3	A	L	BA	L	L	AA	H	BA	H
F4	H	H	L	H	H	A	AA	L	AA
F5	H	AA	BA	L	BA	H	AA	L	L

M2=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	H	BA	BA	AA	AA	A	A	L	AA
F2	A	AA	A	A	BA	AA	A	BA	H
F3	A	L	L	BA	BA	A	H	BA	H
F4	AA	AA	BA	H	H	A	AA	BA	A
F5	H	AA	BA	BA	A	A	A	BA	BA

M3=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	A	L	L	BA	BA	A	H	BA	H
F2	AA	A	BA	BA	L	H	A	L	AA
F3	H	BA	BA	AA	AA	A	A	L	AA
F4	H	H	L	H	H	A	AA	L	AA
F5	H	AA	BA	L	BA	H	AA	L	L

M4=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	AA	AA	BA	H	H	A	AA	BA	A
F2	A	AA	A	A	BA	AA	A	BA	H
F3	H	H	L	H	H	A	AA	L	AA
F4	A	L	L	BA	BA	A	H	BA	H
F5	H	AA	BA	L	BA	H	AA	L	L

Next, The Linguistic variables are now converted into Triangular Fuzzy number

M1=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	(0.25,0.50,0.75)	(0,0,0.25)	(0,0,0.25)	(0.50,0.75,1)	(0.25,0.50,0.75)	(0.75,1,1)	(0.50,0.75,1)	(0,0.25,0.50)	(0.75,1,1)
F2	(0.50,0.75,1)	(0.25,0.50,0.75)	(0,0.25,0.50)	(0,0.25,0.50)	(0,0,0.25)	(0.75,1,1)	(0.25,0.50,0.75)	(0,0,0.25)	(0.50,0.75,1)
F3	(0.25,0.50,0.75)	(0,0,0.25)	(0,0.25,0.50)	(0,0,0.25)	(0,0,0.25)	(0.50,0.75,1)	(0.75,1,1)	(0,0.25,0.50)	(0.75,1,1)
F4	(0.75,1,1)	(0.75,1,1)	(0,0,0.25)	(0.75,1,1)	(0.75,1,1)	(0.25,0.50,0.75)	(0.50,0.75,1)	(0,0,0.25)	(0.50,0.75,1)
F5	(0.75,1,1)	(0.50,0.75,1)	(0,0.25,0.50)	(0,0,0.25)	(0,0.25,0.50)	(0.75,1,1)	(0.50,0.75,1)	(0,0,0.25)	(0,0,0.25)

M2=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	(0.75,1,1)	(0,0.25,0.50)	(0,0.25,0.50)	(0.25,0.50,0.75)	(0.25,0.50,0.75)	(0.25,0.50,0.75)	(0.25,0.50,0.75)	(0,0,0.25)	(0.25,0.50,0.75)
F2	(0.25,0.50,0.75)	(0.50,0.75,1)	(0.25,0.50,0.75)	(0.25,0.50,0.75)	(0,0.25,0.50)	(0.50,0.75,1)	(0.25,0.50,0.75)	(0,0.25,0.50)	(0.75,1,1)
F3	(0.25,0.50,0.75)	(0,0,0.25)	(0,0,0.25)	(0,0.25,0.50)	(0,0.25,0.50)	(0.25,0.50,0.75)	(0.75,1,1)	(0,0.25,0.50)	(0.75,1,1)
F4	(0.50,0.75,1)	(0.50,0.75,1)	(0,0.25,0.50)	(0.75,1,1)	(0.75,1,1)	(0.25,0.50,0.75)	(0.50,0.75,1)	(0,0.25,0.50)	(0.25,0.50,0.75)
F5	(0.75,1,1)	(0.50,0.75,1)	(0,0.25,0.50)	(0,0.25,0.50)	(0.25,0.50,0.75)	(0.25,0.50,0.75)	(0.25,0.50,0.75)	(0,0.25,0.50)	(0,0.25,0.50)

M3=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	(0.25,0.50,0.75)	(0,0,0.25)	(0,0,0.25)	(0,0.25,0.50)	(0,0.25,0.50)	(0.25,0.50,0.75)	(0.75,1,1)	(0,0.25,0.50)	(0.75,1,1)
F2	(0.50,0.75,1)	(0.25,0.50,0.75)	(0,0.25,0.50)	(0,0.25,0.50)	(0,0,0.25)	(0.75,1,1)	(0.25,0.50,0.75)	(0,0,0.25)	(0.50,0.75,1)
F3	(0.75,1,1)	(0,0.25,0.50)	(0,0.25,0.50)	(0.25,0.50,0.75)	(0.25,0.50,0.75)	(0.25,0.50,0.75)	(0.25,0.50,0.75)	(0,0.25,0.50)	(0.25,0.50,0.75)
F4	(0.75,1,1)	(0.75,1,1)	(0,0,0.25)	(0.75,1,1)	(0.75,1,1)	(0.25,0.50,0.75)	(0.50,0.75,1)	(0,0,0.25)	(0.50,0.75,1)
F5	(0.75,1,1)	(0.50,0.75,1)	(0,0.25,0.50)	(0,0,0.25)	(0,0.25,0.50)	(0.75,1,1)	(0.50,0.75,1)	(0,0,0.25)	(0,0,0.25)

M4=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	(0.50,0.75,1)	(0.50,0.75,1)	(0,0.25,0.50)	(0.75,1,1)	(0.75,1,1)	(0.25,0.50,0.75)	(0.50,0.75,1)	(0,0.25,0.50)	(0.25,0.50,0.75)
F2	(0.25,0.50,0.75)	(0.50,0.75,1)	(0.25,0.50,0.75)	(0.25,0.50,0.75)	(0,0.25,0.50)	(0.50,0.75,1)	(0.25,0.50,0.75)	(0,0.25,0.50)	(0.75,1,1)
F3	(0.75,1,1)	(0.75,1,1)	(0,0,0.25)	(0.75,1,1)	(0.75,1,1)	(0.25,0.50,0.75)	(0.50,0.75,1)	(0,0,0.25)	(0.50,0.75,1)
F4	(0.25,0.50,0.75)	(0,0,0.25)	(0,0,0.25)	(0,0.25,0.50)	(0,0.25,0.50)	(0.25,0.50,0.75)	(0.75,1,1)	(0,0.25,0.50)	(0.75,1,1)
F5	(0.75,1,1)	(0.50,0.75,1)	(0,0.25,0.50)	(0,0,0.25)	(0,0.25,0.50)	(0.75,1,1)	(0.50,0.75,1)	(0,0,0.25)	(0,0,0.25)

Then, the linguistic variable are normalized by using Linguistic Aggregated operators,

Here, BA = (0, 0.25, 0.50) where a=0, b= 0.25, c= 0.50

$$ls_{ij} = \frac{b}{1+b-a} = \frac{0.25}{1+0.25-0} = 0.2 \quad , \quad rs_{ij} = \frac{c}{1+c-b} = \frac{0.50}{1+0.50-0.25} = 0.4$$

$$x_{ij}^{..} = \frac{ls_{ij}^{..}(1-ls_{ij}^{..}) + rs_{ij}^{..} \times rs_{ij}^{..}}{1+rs_{ij}^{..} - ls_{ij}^{..}} \quad , \quad x_{ij}^{..} = \frac{0.2(1-0.2)+0.4\times 0.4}{1+0.4-0.2} = 0.266$$

Similarly, we have normalized all the entries of all the four triangular fuzzy matrices.

M1=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	0.5000	0.0340	0.0340	0.7340	0.5000	0.9670	0.7340	0.2670	0.9670
F2	0.7340	0.5000	0.2670	0.2670	0.0340	0.9670	0.5000	0.0340	0.7340
F3	0.5000	0.0340	0.2670	0.0340	0.0340	0.7340	0.9670	0.2670	0.9670
F4	0.9670	0.9670	0.0340	0.9670	0.9670	0.5000	0.7340	0.0340	0.5000
F5	0.9670	0.7340	0.2670	0.0340	0.2670	0.9670	0.7340	0.0340	0.0340

M2=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	0.9670	0.2670	0.2670	0.7340	0.7340	0.5000	0.5000	0.0340	0.7340
F2	0.5000	0.7340	0.5000	0.5000	0.2670	0.7340	0.5000	0.2670	0.9670
F3	0.5000	0.0340	0.0340	0.2670	0.2670	0.5000	0.9670	0.2670	0.9670
F4	0.7340	0.7340	0.2670	0.9670	0.9670	0.5000	0.7340	0.2670	0.5000
F5	0.9670	0.7340	0.2670	0.2670	0.5000	0.5000	0.5000	0.2670	0.2670

M3=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	0.5000	0.0340	0.0340	0.2670	0.2670	0.5000	0.9670	0.2670	0.9670
F2	0.7340	0.5000	0.2670	0.2670	0.0340	0.9670	0.5000	0.0340	0.7340
F3	0.9670	0.2670	0.2670	0.7340	0.7340	0.5000	0.5000	0.0340	0.7340
F4	0.9670	0.9670	0.0340	0.9670	0.9670	0.5000	0.7340	0.0340	0.5000
F5	0.9670	0.7340	0.2670	0.0340	0.2670	0.9670	0.7340	0.0340	0.0340

M4=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	0.7340	0.7340	0.2670	0.9670	0.9670	0.5000	0.7340	0.2670	0.5000
F2	0.5000	0.7340	0.5000	0.5000	0.2670	0.7340	0.5000	0.2670	0.9670
F3	0.9670	0.9670	0.0340	0.9670	0.9670	0.5000	0.7340	0.0340	0.5000
F4	0.5000	0.0340	0.0340	0.2670	0.2670	0.5000	0.9670	0.2670	0.9670
F5	0.9670	0.7340	0.2670	0.0340	0.2670	0.9670	0.7340	0.0340	0.0340

Using step-3 of the algorithm, the matrices are joined as one synaptic connection matrix

	A1			A2			A3		
	P	O	M	P	O	M	P	O	M
F1	0.5000	0.9670	0.6753	0.0340	0.7340	0.2672	0.0340	0.2670	0.1505
F2	0.5000	0.7340	0.6170	0.5000	0.7340	0.6170	0.2670	0.5000	0.3835
F3	0.5000	0.9670	0.7335	0.0340	0.9670	0.3255	0.0340	0.2670	0.1505
F4	0.5000	0.9670	0.7920	0.0340	0.9670	0.6755	0.0340	0.2670	0.0923
F5	0.9670	0.9670	0.9670	0.7340	0.7340	0.7340	0.2670	0.2670	0.2670

	A4			A5			A6		
	P	O	M	P	O	M	P	O	M
F1	0.2670	0.9670	0.6755	0.2670	0.9670	0.6170	0.5000	0.9670	0.6168
F2	0.2670	0.5000	0.3835	0.0340	0.2670	0.1505	0.7340	0.9670	0.8505
F3	0.0340	0.9670	0.5005	0.0340	0.9670	0.5005	0.5000	0.7340	0.5585
F4	0.2670	0.9670	0.7920	0.2670	0.9670	0.7320	0.5000	0.5000	0.5000
F5	0.0340	0.2670	0.0923	0.2670	0.5000	0.3253	0.5000	0.9670	0.8503

	A7			A8			A9		
	P	O	M	P	O	M	P	O	M
F1	0.5000	0.9670	0.7338	0.0340	0.2670	0.2088	0.5000	0.9670	0.7920
F2	0.5000	0.5000	0.5000	0.0340	0.2670	0.1505	0.7340	0.9670	0.8505
F3	0.5000	0.9670	0.7920	0.0340	0.2670	0.1505	0.5000	0.9670	0.7920
F4	0.7340	0.9670	0.7923	0.0340	0.2670	0.1505	0.5000	0.9670	0.6168
F5	0.5000	0.7340	0.6755	0.0340	0.2670	0.0923	0.0340	0.2670	0.0923

The resultant matrix M is given by,

M=

	A1	A2	A3	A4	A5	A6	A7	A8	A9
F1	0.3570	0.1725	0.0753	0.3182	0.3085	0.3473	0.3668	0.0850	0.3765
F2	0.3085	0.3085	0.1918	0.1918	0.0753	0.4252	0.2500	0.0753	0.4252
F3	0.3667	0.2211	0.0753	0.2503	0.2503	0.2988	0.3765	0.0753	0.3765
F4	0.3765	0.2794	0.0655	0.3377	0.3377	0.2500	0.4155	0.0753	0.3473
F5	0.4835	0.3670	0.1335	0.0655	0.1820	0.3862	0.3182	0.0655	0.0655

When having the factor 1 (Participation in household activities) in ON state, which means

C1= (1 0 0 0 0)
C1.M= (0.3570 0.1725 0.0753 0.3182 0.3085 0.3473 0.3668 0.0850 0.3765)
↪ (0 0 0 0 0 0 1 0 1) = E1
E1 * M^T = (0.7635 0.6679 0.7216 0.7756 0.6041)
↪ (1 0 0 1 0) = B1

The above assumption is made by taking the maximum of two values as ON; the discrimination by participation in household activities and the factor of not attending social gatherings. As we can observe from the above binary pair, when these both factors (participation in household activities and attending social gathering), it results in (0 0 0 0 0 0 1 0 1), (1 0 0 1 0) as a binary pair of a fixed point. The above procedure is repeated by keeping each inequality in ON state condition and the results were obtained. The following table represents the triggering pattern.

Table 2: Triggering Patterns

Input Vector	Triggering Pattern	
(1 0 0 0 0)	(0 0 0 0 0 0 1 0 1)	(1 0 0 1 0)
(0 1 0 0 0)	(0 0 0 0 0 1 0 0 1)	(0 1 0 1 0)
(0 0 1 0 0)	(0 0 0 0 0 0 1 0 1)	(1 0 0 1 0)
(0 0 0 1 0)	(1 0 0 0 0 0 1 0 0)	(1 0 1 0 0)
(0 0 0 0 1)	(1 0 0 0 0 1 0 0 0)	(0 0 0 1 1)

From Table 2, it can be deduce that Delphi adapted FAM elucidates the factor which gets affected the most or affect others the most in various situation under analysis. These results were derived from different experts views. If F_1 and F_2 are both kept in an ON state, they will have a combined effect on A7 and A8. That is lack of participation in household activities and involvement in family discussions leads to low esteem in the senior citizens and lack of respect from society and family members. Other results can also be obtained in a similar way.

IV. Conclusion

Growing old is the natural phenomenon by every individual in the society. So, if the age is increasing that doesn't mean that they are becoming useless. While many Africa countries are implementing policies on ageing, translating those policies into action has been a major problem. The majority of African senior citizens are still facing many daily challenges. The attitude of the people should change towards senior citizens so that the problems faced by them in the society can be lessened. From DAFAM analysis, it shows that assistance with health services is the greatest challenge for most seniors citizens. Therefore, it is very important that senior citizens health needs are taken care of as a matter of priority in Africa. The other factor that needs to be looked at is economic security as this too has major impact to their likelihoods.

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Competing interests

All authors declare no conflict of interest.

References

[1] United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Ageing 2015 - Highlights (ST/ESA/SER.A/368).

[2] https://www.who.int/news-room/fact-sheets/detail/ageing-and-health Retrieved on 10th January, 2020.

[3] United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Ageing 2015 (ST/ESA/SER.A/390).

[4] Whitman, N. (1990). The committee meeting alternative: Using the Delphi technique. JONA, 20, 30–36. WHO. 1999. Ageing: Exploding the Myth. WHO, WHO/HSC/AHE/99.1. Geneva.

[5] Zadeh, L. A. (1975). The concept of a linguistic variable and its application to approximate reasoning (Part II). Information Science, 8: 301–357.

[6] Zadeh, L. A. (1965). Fuzzy sets. Information Control, 8(3), 338–353.

[7] Kosko, B. (1997). FUZZY ENGINEERING. Prentice Hall, Upper Sad- dle River, NJ, USA.

[8] Devadoss, A. V. and Christopher, S. (2013). The Effect of Globalisation on Education using Fuzzy Associative Memories. Indo-BhutanInternational Conference on Gross National Happiness, 2, 178-192.

[9] Dalkey, N. and Helmer, O. (1963). An Experimental Application of the Delphi Method to the use of the Experts. Management Science, 9 (3), 458-467.

[10] Hwang, C. L. and Lin, M. J. (1987).Group decision making under multiple criteria: Methods and applications. Springer-Verlag

[11] Khorramshahgol, R. and Moustakis, V. S. (1988). Delphi hierarchy process (DHP): A methodology for priority setting derived from the Delphi method and analytical hierarchy process. European Journal of Operational Research. 137, 347-354.

[12] Skutsch, M. and Hall, D. (1973). Delphi: Potential uses in education planning. In J. L. Barnes, (1987). An international study of curricular organizers for the study of technology. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

[13] Yousuf, M. I. (2007). Using experts opinion through Delphi Technique. Practical Assessment, Research & Evaluation, 12 (4), 1-7.

[14] Rowe, G., Wright, G. and Bolger, F. (1991). The Delphi technique: a re-evaluation of research and theory. Technological Forecasting and Social Change, 39 (3), 235–251.

[15] Prakash, A. P. and Vanathi, N. (2015). Delphi Triangular Fuzzy Cognitive Map (DTFCM). International journal of applied Engineering Research, 10 (80), 250-252.

[16] Thach, E. C. and Murphy, K. L. (1995). Competencies for distance education professionals. Educational Technology Research and Development, 43 (1), 57-79.

[17] Smith, M.A. (1997). Perceptions of Quality in Journalism and Communication Education: A Delphi Study. Journal of the Association for Communication Administration, 1, 32–50.

[18] Brill, J.M., Kim, D. and Branch, R.M. (2001). Visual literacy defined: the results of a Delphi study - can IVLA (operationally) define visual literacy? In R. E. Griffen, V. S. Williams & J. Lee (Eds.), Exploring the visual future: art design, science and technology. (pp. 9-15) Blacksburg, VA: The International Visual Literacy Association.

[19] Addison, T. (2003). E-commerce project development risks: evidence from a Delphi survey. International Journal of Information Management, 23, 25–40.

[20] Beales, R. (2005). Delphi creates fresh CDS challenge: a new cash-settlement method for simplifying credit derivatives faces a stern test with the latest bankruptcy, writes Richard Beales (capital markets & commodities). The Financial Times, p. 43

[21] Landeta, J. (2006). Current validity of the Delphi method in social sciences. Technological Forecasting and Social Change, 73 (5), 467-82.

[22] Grisham, T. (2009). The Delphi Techniques a method for testing complex and multifaceted topics. International Journal of Managing project in Business, 2 (1), 112-130.

[23] Samman, T. A. S. A. and Brahemi, R. M. R. A. (2014). Fuzzy Pert For Project Management. International Journal of Advances in Engineering and Technology, 7 (4), 1150-1160.

[24] Teijlingen, E., Pitchforth, E., Bishop, C. and Russell, E. (2006). Delphi method and nominal group technique in family planning and reproductive health research. J. Fam. Plann. Reprod. Health Care, 32 (4) 249–252.

[25] Murray, T. J., Pipino, L. L. and Gigch, J. P. Van. (1985). A Pilot Study of fuzzy set modification of Delphi. Human System Management, 5, 76–80

[26] Hsu, Y., Lee, C. H. and Kreng, V. E. (2010). The Application of Fuzzy Delphi Method and Fuzzy AHP in lubricant regenerative technology selection. Experts system with Applications, 37 (1), 419-405.

[27] Chen, T. Y. and Ku, T. C. (2008). Importance-Assessing Method with Fuzzy Number-Valued Fuzzy Measures and Discussions on TFNs And TrFNs. International Journal of Fuzzy systems, 10 (2), 92-103.

[28] Devadoss, A. V. and Ajay, D. and Sudha, K. (2014). Delphi Adapted Fuzzy Associative Memories as a multiple expert system and its application to study the impact of climate change on Environment. International Journal of communication and networking system, 3, 256-260.

[29] Yasir, S. and Muhammad, S. (2012). Factors explaining the discrimination and health status of senior citizen: A descriptive study of Chakwal, Pakistan. Journal of International Academic Research, 12, 1-9.