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Sieving Out the Poor Using Fuzzy Tools

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Abstract - This paper proposes a fuzzy complementary approach to the multi-dimensional measure of poverty. The paper uses the Capability approach initiated by Dr. Amartya Sen to examine the one-dimensional measures of poverty and its drawback. This paper adapts the method of 'counting and multidimensional poverty' as proposed by Sabina Alkire and James Foster [1] to the state of Bihar situation.

Keywords: BPL (Below Poverty Line), Totally Fuzzy and Relative (TFR)

I. INTRODUCTION

In India 'Poverty line' has become a 'Lakshman Rekha' while welfare measures are distributed. There is a poverty line in India and elsewhere, which tell us how we can measure poverty. The global line for extreme poverty is $ 1.25 per day (approximately Rs. 75.00: $ 1= Rs.60.00) and for moderate poverty is $ 2 per day (approximately Rs. 120.00). In India, until recently, we measured poverty in term of income – expenditure (consumption) and calorific values. These measures do not capture the full picture of the poor, as poverty has many dimensions and there is a need to recognize it as multi-dimensional.

1. One-dimensional approach

One-dimensional approach of poverty assessment is based on Income Poverty Line. Uni-dimensional model takes only absolute poverty into consideration. Absolute poverty line sets a poverty line as an income or consumption amount per year, based on the estimated value of goods necessary for proper living.

The government of India has set the poverty line BPL (Below Poverty Line) as anyone earning Rs. 27.20 per day or less in rural areas and up to Rs.33.33 a day in urban areas are poor [2]. This means that a person who consumes goods and services more than the set poverty line is not considered poor.Each state in India is not alike in terms of poverty estimation. It is due to a different geographical, social, political, and economical set up in each state. And each state has its own methods of alleviating poverty and reducing the number of the poor through various scheme programmes. For example, the figures of poverty ratio in the following states are reported (BPL-Below Poverty Level) in the national dailies [2] as it is given in the following table. In Bihar, BPL was estimated at 33.7% in 2011-12, compared to 54.4% in 2004-05, a reduction by 20.7 % percentage points. That means above 20% of the population has gone above BPL in Bihar.

From the above income based approach example it is clear that uni-dimensional approach is not able to capture the complexity of the multidimensional nature of the poverty in assessment. As Atkison, A. B. would put it "There is a widespread agreement that deprivation is multi-dimensional. It is not enough to look only at income poverty; we have also to look at other attributes." As Sen has put it, 'the role of income and wealth…. has to be integrated into a broader and fuller picture of success and deprivation." [3] Therefore, there is considerable and growing literature, both theoretical and empirical on the multi-dimensional measure of poverty.

Table -1: BPL status of some States in India

STATE	YEAR (2004-05)	YEAR (2011-12)	STATE	YEAR (2004-2005)	YEAR (2011-2012)
Worst - 5			Best - 5		
Bihar	54.4	33.74	Goa	24.9	5.09
Chhatitisgarh	49.4	39.93	Kerala	19.6	7.05
Jharkhand	45.3	36.96	Himachal Pradesh	22.9	8.06
Manipur	37.9	36.89	Punjab	20.9	8.26
Andhra Pradesh (A P)	31.4	34.67	Puducherry	14.2	9.69

II. MULTIDIMENSIONAL APPROACH

Across the country as well as all over the world, policymakers, government sectors and people in general have started to understand that poverty is multi- dimensional concept. It is a multi-dimensional in nature, as human deprivation has many factors such as basic needs (food, clothing and shelter), water, education, health, employment, social security and basic freedom and opportunities.

2.1 Sen's Capabilities approach

This approach defines poverty as the lack of key capabilities to ensure adequate functioning in a given society –"the capability to access food, health care, to obtain employment or other capabilities. Poverty, in other words, can be understood as "capability deprivation."[4]. People are poor because they lack the capabilities to create for themselves an acceptable standard of living. A person's capability to acquire the food necessary for survival, to achieve upward mobility, or to ensure education for one's children, determine whether or not he/she can be considered poor.

Therefore, poverty is nothing but the deprivation of capability. Hence, Poverty is a function of the deprivation of capability. The capabilities approach broadens the understanding of poverty. It is not a lack of money alone that constitutes poverty, but a person's capability to achieve an adequate standard of living. Thus through capabilities approach both extreme poverty and relative poverty can be understood. The authentic poor are those robbed by the ability to make choices for themselves the choice for safe and clean water, the choice for education, etc. The following table -2 gives a view of multi-dimensional approach of poverty in terms of capabilities.

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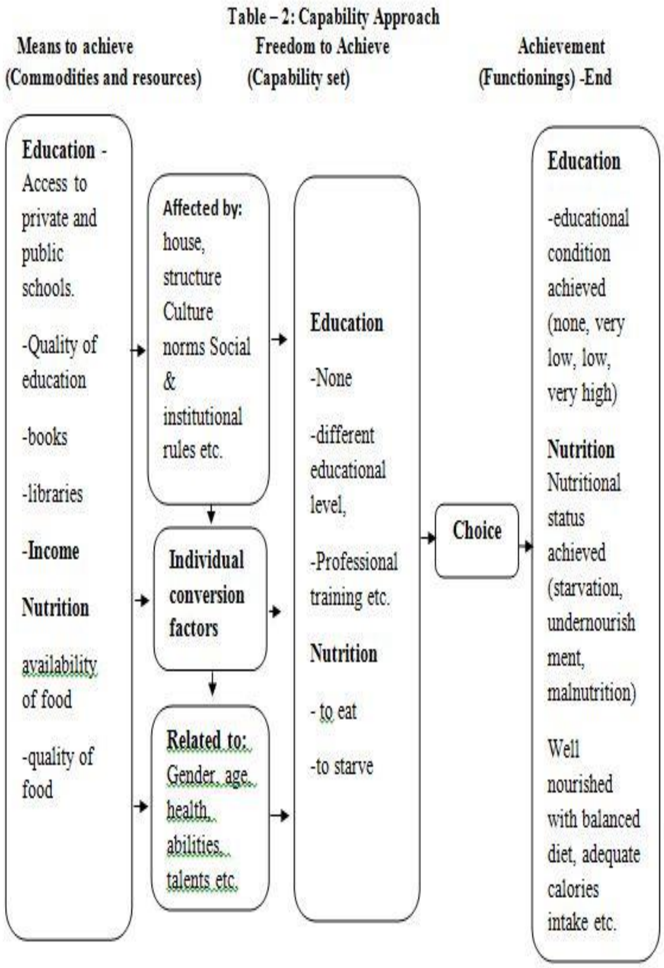
The Table – 2 illustrates that sieving out some as poor who are deprived in terms of consumption can alone result in omitting a significant proportion of poor people in some areas. Therefore, there is an urgent need to use multi-dimensional poverty measures to provide significant and accurate measures.



2.2 The Challenges of Multidimensional approach

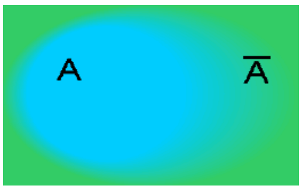
The challenges in using this method are that many capabilities or factors influencing a person are hard to measure. Where as monetary method provides a simple way to measure poverty. It is true that many dimensions and capabilities approach give a deeper understanding of the deprivation of a person, but it is hard to operationalize. Many of the dimensions capture complexity of deprivation in a technically solid way and enable a researcher to target the poor, but are difficult of measure on the individual level. However, it is accepted norm that measuring poverty must not look only at income but also look at other indicators.

III. CONCEPT OF FUZZY SUBSETS

Poverty is considered as a matter of degree or matter of grade rather than an attribute that is simply present or absent for individuals or household in the given population.
As a response to this complexity and to the lack of well-defined boundary, a new approach to the poverty measurement is being considered as an alternative approach called the Fuzzy Approach.

This new approach of measurement consists in a mathematical theory developed in the year 1965 by Lotfi Askar Zadeh, the father of fuzzy set theory and fuzzy logic.
According to him, "A fuzzy set is a class of objects with a continuum of grades of membership. Such a set is characterized by a membership (characteristic) function which assigns to each object a grade of membership ranging between zero and one. The notions of inclusion, union, intersection, complement, relation, convexity, etc. are extended to such sets, and various properties of these notions in the context of fuzzy sets are established." [5]. In a simple word, fuzzy set theory is a precise theory for dealing with imprecise and vague classes of set. In fuzzy subsets the boundary is blurred and an element x may gradually move from belongingness to non-belongingness.
Zadeh introduced membership of an element in the set or what is called a characteristic function of an element in a set, denoted by

$$\begin{aligned} \mu_{\underset{\sim}{A}}(x) &= 1 \quad if\ x \in A \\ &= 0 \quad if\ x \notin A \\ &= (0,1)\ along\ the\ boundary \end{aligned}$$



$\mu_{\underset{\sim}{A}}(x)$ indicates the degree of membership of x in $\underset{\sim}{A}$. And when $\mu_{\underset{\sim}{A}}(x) = 0$ means that x does not belong to $\underset{\sim}{A}$. Whereas when $\mu_{\underset{\sim}{A}}(x) = 1$ means that x belongs to $\underset{\sim}{A}$ completely. On the other hand when $0 < \mu_{\underset{\sim}{A}}(x) < 1$ means that x partially belongs to $\underset{\sim}{A}$. And further its ($\mu_{\underset{\sim}{A}}(x)$) degree or level or membership of $\underset{\sim}{A}$ increases in proportion to the proximity of $\mu_{\underset{\sim}{A}}(x)$ to 1. Projection of a Fuzzy relation
The first Projection:
The membership Function

Definition of Fuzzy Subsets
Let E be a set of denumerable or not and let x be an element of E . Then a fuzzy subset $\underset{\sim}{A}$ of E is a set of ordered pairs

$\mu_{\underset{\sim}{A}} = \{(x, \mu_{\underset{\sim}{A}}(x))\}, \forall\ x \in E\ and\ \mu : \underset{\sim}{A} \to [0,1].$ where $\mu_{\underset{\sim}{A}}(x)$ is membership characteristic function that takes its values in a totally ordered set $M = [0,1]$ and which indicates the degree or level or membership. $M = [0,1]$ is called membership set. Thus, in the fuzzy subset of $\underset{\sim}{A}$. , the value of

$$\mu^{(1)}_{\underset{\sim}{R}}(x) = \vee_{y} \mu_{\underset{\sim}{R}}(x, y)$$

Defines the first projection of $\underset{\sim}{R}$.

The Second Projection

In the similar fashion the membership function

$$\mu^{(2)}_{\underset{\sim}{R}}(y) = \vee_{x} \mu_{\underset{\sim}{R}}(x, y)$$ Defines the second projection of $\underset{\sim}{R}$

Global Projection

The second projection of the first projection or vice versa will be called Global projection of the fuzzy relation and will be denoted by $h(\underset{\sim}{R})$. Thus

$$h(\underset{\sim}{R}) = \vee_{x} \vee_{y} \mu_{\underset{\sim}{R}}(x, y)$$
$$= \vee_{y} \vee_{x} \mu_{\underset{\sim}{R}}(x, y)$$

Normal Relation

If $h(\underset{\sim}{R}) = 1$, the relation is said to be Normal.

Subnormal Relation

If $h(\underset{\sim}{R}) < 1$, the relation is called Subnormal.

IV. POVERTY AS MATTER OF DEGREE

The first attempt to apply the Fuzzy concepts to Multi-dimensional poverty measures were made by Andréa Cerioli and Sergio Zani in 1990. They criticized the traditional approach as well the multi-dimensional approach and proposed a new approach: a Fuzzy approach. The main criticisms are as follows:

1. The evaluation of individual income is often imprecise mostly because of respondents' unwillingness to provide exact information. A self – employed person like a tailor or a mason may not be able to indicate his/her income. It varies with a large difference from month to month. As a consequence, traditional income based indices may result in incorrect findings.
2. The abrupt distinction between poverty and non-poverty provided by Poverty Line (Rs. 5000.00) cut-off seems unrealistic. A gradual transition from extreme poverty to richness would be closer to reality.

In order to overcome the above drawbacks they suggested a different approach as to the measurement of poverty, following the theory of fuzzy sets [6].

Later it was developed into Totally Fuzzy and Relative (TFR) approach by Cheli and Lemmi in the year 1995. Again it was further developed by Betti et al. (2005) in the form of an Integrated Fuzzy and Relative (IFR) approach to analyse the poverty and social exclusion. [7]. The methodological implementation of this approach has been developed by a number of authors. Cheli and Betti (1999) and Betti et al (2005) focusing more on the " time dimension", in particular utilising the tool of transition matrices. Afterwards, Betti and Verma (1999, 2002,2004) and verma and Betti (2002) refined the approach giving focus on capturing the multi-dimensional aspects, developing the concepts of "manifest" and "latent" deprivation to reflect the intersection and union of different dimensions [8].

IV. THE NEED FOR FUZZY MULTIDIMENSIONAL POVERTY APPROACH

In sieving out the poor from the total population, income – based poverty does not capture the human poverty. Therefore, many economists, like Amartya Sen, policymakers and others experts adopted the Multi-dimensional as a complementary approach to the assessment of poverty.

The multi-dimensional poverty approach examines different features of deprivation present in the quality of human life and then arrives at an aggregate on the overall deprivation of the poor. Therefore, this multi-dimensional approach is important, instead of dealing with several dimensions or indicators at the same time. Taking a multidimensional approach must, ultimately be seen as an asset rather than a liability.

Multi-dimensional approach uses dual methods to identify who is multi-dimensionally poor. They are (i) dual cutoffs and (ii) A counting methodology.

(i) Dual cutoff method:

1. Identify all individuals deprived in any dimension within a dimension cutoff. This is the first cutoff which is nothing but the traditional dimension-specific poverty line or cutoff. This cutoff is set for each dimension and identifies whether a person is deprived with respect to that dimension.
2. Identify who is multi-dimensionally poor which expresses cross dimensional cutoff and gives deprivation in at least one third of the weighted indicators. This is the second cutoff which describes or explains deprivation in details and tells how widely deprived a person must be in order to be considered poor.

(ii) A counting methodology:

If the dimensions are equally weighted, the second cutoff gives the number of dimensions in which a person must be deprived to be considered multi-dimensionally poor. This equally weighted approach is known as the counting approach. And once the identification is done in terms of cutoff who is poor and who is not poor, the aggregation is carried out using natural extension of the Sabina Alkire and James Forster poverty measure in multidimensional space. It is constructed using the formula as mentioned below.

MPI = M_0 = H × A

where MPI refers to Multi-dimensional poverty indicators, M_0 refers to adjusted headcount, H is the percentage of people who are poor which spaces the incidence of multi-dimensional poverty that is given by the formula H= q/n (where q is the number of poor people and n is the total number people). A is the average proportion of weighted deprivations people suffer at the same time which shows the intensity of multi-dimensional poverty that is given by the formula A $=\left[\sum_{1}^{q} \frac{c_i}{N}\right] \div q$, where A is the average number of deprivation a poor person suffers. It is calculated by adding up the proportion of total deprivations each person suffers and dividing by the total number of poor persons.

Case study - 1

Consider the following case study from Nalanda District, Bihar. We take the following 3- Dimensions: Education, Health and Standard of Living with its subdivision as 10

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indicators. Each dimension and indicators are equally weighted as presented in the following table.

Table-3

Dimension (3)	Indicators (10)	Weights = Dimension wt. × indicator wt.
Education	Years of Schooling	1/3×1/2 = 1/6
	School Enrolment	1/3×1/2 = 1/6
Health	Nutrition	1/3×1/2 = 1/6
	Child Mortality	1/3×1/2 = 1/6
Standard of Living	Electricity	1/3×1/6 = 1/18
	Drinking water	1/3×1/6 = 1/18
	Sanitation	1/3×1/6 = 1/18
	Flooring	1/3×1/6 = 1/18
	Cooking Fuel	1/3×1/6 = 1/18
	Assets	1/3×1/6 = 1/18

Criteria to be Multi-dimensionally Poor

A person is identified as multi-dimensionally poor if he or she is deprived in at least on third of the dimension. In other words one third of the weighted indicators that is to say a person should be deprived at least two or more indicators. The following table gives the example of a Multi-dimensionally poor.

Table - 4

Indicators	Nutrition		Year of Schooling (child enrolment)		Deprivation status
1.Ramesh	No. Of indicators×wt.of indicators + No. of indicators×wt.of indicators = Result 10. (1/6) + 10. (1/6) = 3.34 ≥3 (Dimensions)				Yes (poor)
Indicators	Electricity,	water	Sanitation,	dirt house	Deprivation status
2.Meera	10·(1/18) +10·(1/18) + 10·(1/18) +10·(1/18) = 2.20 (<3)				Not poor
Indicators	Year of schooling	cooking fuel	sanitation	asset	Deprivation status
3.Ganesh	10·(1/6) + 10·(1/18) +10·(1/18) + 10·(1/18) = 3.33 (>3)				Yes(poor)

1. Ramesh is deprived in Nutrition and child enrolment. (if no household member has completed five years of schooling and if any child or adult is informed as malnourished)
2 .Meera is deprived in electricity, water, sanitation, and has a dirt floor.
3. Ganesh is deprived in years of schooling, has no proper sanitation (uses defecation) , less assets than expected in a society and uses fire wood for cooking food.

Observation

In Meera's case she is not considered multi-dimensionally poor, though she is deprived of electricity, water, sanitation, housing condition.

Although the poor or non-poor dichotomy has been commonly criticized, the capability approach fails to completely develop poverty indicators that are measurable. Therefore, the conclusion is made that still with one third cut-offs, a person who lives in poor condition, with no electricity, drinking water, cooking fuel and appropriate floor is not considered multi-dimensionally poor.

Therefore, it is observed that even in multi-dimensional approach method, there exists alarming misjudgement of poverty measurement. This leads to the new approach fuzzy approach for a better conclusion in measuring poverty.

V. FUZZY APPROACH

Let us consider a set E of n individuals or households and let $\underset{\sim}{A}$ be a subset of E consisting of the poor, such that a fuzzy membership is given by $\mu_{\underset{\sim}{A}}(x_i)$ where $(i = 1, 2, 3, \ldots, n)$ denote for each individual or household in $\underset{\sim}{A}$ and $\mu : \underset{\sim}{A} \to [0,1]$.

Then we have following critical limits in the given subset to identify the upper and lower bounds or grade or degree or membership or level of the poor.

1) $\mu_{\underset{\sim}{A}}(x_i) = 0$ if i^{th} individual is certainly not poor;
2) $\mu_{\underset{\sim}{A}}(x_i) = 1$ if i^{th} individual is poor;
3) $0 < \mu_{\underset{\sim}{A}}(x_i) < 1$ if i^{th} individual exhibits a partial membership in the subset of $\underset{\sim}{A}$.

Fuzzy Membership Function

Consider a set of the attributes j. Let x_{ij} denote the weights of the attributes. Let a_j denote the average of the weighted indictors. Then the membership function is defined by

$$\mu_{\underset{\sim}{A}}(x_i) = \frac{a_j \sim x_{ij}}{a_j} = W_j x_i \text{ -------} \quad (1)$$

where, symbol ~ refers to difference between a_j, and x_{ij} and $w_j x_i$ denotes the membership values.

6.1 Procedure

Step-1 Chose Indicators or variables for the selected dimensions
Step-2 Calculate weight
Step-3 Identification (who is poor) - Criteria
Step-4 Ranking
Step-5Aggregation

Step - 1 : Consider the following 5- Dimensions with its 15 subdivision as indicators.

Dimensions and Indicators are selected in the context of Bihar (India)

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Table-5

Dimensions (5)	Indicators (15)
Employment	Occupations
	Absence of Child Labour
Asset Ownership	Housing Type
	Household assets
	Livestock
	Land holding
	Electricity
	Access to drinking water
Health	Nutrition(dietary habits)
	child mortality
	Sanitation: toilets
Education	Level of Education
	Dropouts
	School enrolment
Social Relations	Connections at local level

Table-6

Persons	Income	Education	Child Labour	Housing condition	Land Holding	Livestock	Water	Nutrition	Sanitation	Social Relation
Person-1	816	16	0.8	0.9	0.1	0.1	0.2	0.7	0.8	0.5
Person-2	400	9	0.9	0.9	0.2	0.1	0.1	0.8	0.7	0.6
Person-3	316	8	0.9	0.9	0.1	0.2	0.1	0.8	0.8	0.8
Person-4	434	10	0.5	0.8	0.1	0.2	0.1	0.5	0.6	0.3
Person-5	580	12	0.5	0.4	0.2	0.1	0.3	0.6	0.5	0.4
Person-6	745	17	0.4	0.3	0.5	0.3	0.4	0.7	0.3	0.2
Person-7	890	16	0.2	0.1	0.6	0.5	0.5	0.8	0.2	0.1
Person-8	817	18	0.3	0.1	0.4	0.5	0.6	0.7	0.4	0.1
Person-9	748	15	0.4	0.3	0.6	0.5	0.5	0.6	0.3	0.2
Person-10	545	12	0.3	0.2	0.4	0.3	0.3	0.5	0.3	0.3
Grade Point average	629.1	13.3	0.52	0.49	0.32	0.32	0.31	0.67	0.49	0.35

Case Study – 2

Consider a case study of 10 individuals from Biyawani Village, Nalanda District, Bihar. They are represented by person- 1, person-2 … person -10 respectively. We take 10- indicators across the 10- individuals which will be further used for a validity of the fuzzy subset approach in measuring poverty. We have the following table as our case studies.

Details

Person- 1 earns Rs. 816. He has 16 years of schooling. His has a son who is 8- years old and he goes for work. He lives in a thatched house. He has a cattle and a goat. He has to walk more than 30 minutes to fetch water. His dietary habit is rice and dal or roti and dal and he occasionally eats meat. He uses goes to open field for toilet. He has some relation with ward member and sarpanch etc.

His income Rs.816.00 and years of schooling – 16 are kept as a raw data. All the values in other entries are marked according to the experts opinions. Some values are marked within the range of [0, 1] such as 0.8, 0.9, 0.1, 0.1, 0.2, 0.7, 0.8, 0.5 etc.

The same procedures are followed for all the ten persons to identify of the poor based on the following criteria given below. At end the grade point average is taken for the each indicator.

Criteria to each indicator

1. Income: A person is deprived if he /she lives in a household that falls under the standard income (poverty line) set by the Government India (Rs. 816.00 per Month-S.Tendullar Planning commission)

2. Years of Schooling: Deprived if no household member has completed high school degree or just she/he has 10 std. level of education.3. Child labour : 8 to 16 age group goes for work (even one child goes to work)

4. House Condition: Deprived if any household does not have concrete or brick house or just a house is built under Government Scheme (IAY- Indra Awas Yojana).

5. Land holding: Deprived if any household does not have even 10 katta piece of land or 1 –(one) acre of land.

6. Livestock: Deprived if any household does not have a cattle or goat.

7. Drinking Water: Deprived if availability of drinking water is not within 15 to 20 minutes of walking distance.

8. Nutrition (dietary Habits) : Deprived if a household has just two square of ordinary meals(rice + dal/vegetable or Roti+dal/vegetable/ chutney)

9. Sanitation (Toilet): Deprived if any household use common toilet or open defecation.

10. Social relation (connection): Deprived if any household member faces inability of take part in the life of community or has or have rare connection with Mukhiya, Sarpanch, or ward members etc.

6.2 Grade membership Values

A set of graded membership values are as calculated by the equation $\mu_{\underset{\sim}{A}}(x_i) = \frac{a_j \sim x_{ij}}{a_j} = w_j x_i$ where i individuals (i= $x_{1,}\, x_{2,}\, \ldots, x_i, \ldots, x_n$) over the j (j = $w_{1,} w_{2,} \ldots, w_{j,} \ldots, w_{m,}$) attributes (poverty indicators).

Step – 2

Using the above criteria, we fuzzify the raw data for the person-1. We do as below:

The grade membership values (weights) of the first person across the ten attributes are given below:

$\frac{629.1 \sim 816}{629.1} = \frac{186.9}{629.1} = 0.297$,

$\frac{16 \sim 13.3}{13.3} = \frac{2.7}{13.3} = 0.203$, $\frac{0.8 \sim 0.52}{0.52} = \frac{0.28}{0.52} = 0.538$,

$\frac{0.9 \sim 0.49}{0.49} = 0.836$

$\frac{0.32 \sim 0.1}{0.32} = 0.687$, $\frac{0.32 \sim 0.1}{0.32} = 0.687$,

$\frac{0.32 \sim 0.2}{0.32} = 0.375$, $\frac{0.7 \sim 0.67}{0.67} = 0.045$,

$\frac{0.8 \sim 0.49}{0.49} = 0.633$,

$\frac{0.5 \sim 0.35}{0.35} = 0.428$. Similarly, all the grade membership values are calculated which are given in the following table.

Table-7

Persons	w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	w_{10}
x_1	0.297	0.203	0.538	0.836	0.687	0.687	0.375	0.045	0.633	0.428
x_2	0.661	0.323	0.730	0.836	0.375	0.687	0.687	0.194	0.428	0.714
x_3	0.497	0.398	0.730	0.836	0.687	0.375	0.687	0.194	0.633	0.714
x_4	0.310	0.248	0.0003	0.310	0.687	0.375	0.687	0.254	0.224	0.142
x_5	0.078	0.097	0.0003	0.183	0.375	0.687	0.062	0.104	0.020	0.142
x_6	0.184	0.278	0.230	0.387	0.562	0.062	0.250	0.045	0.388	0.571
x_7	0.414	0.203	0.615	0.795	0.875	0.562	0.562	0.194	0.592	0.857
x_8	0.298	0.353	0.423	0.795	0.250	0.562	0.875	0.045	0.134	0.875
x_9	0.189	0.127	0.230	0.387	0.875	0.562	0.562	0.104	0.388	0.571
x_{10}	0.133	0.097	0.423	0.591	0.250	0.375	0.062	0.254	0.388	0.142

Step -3

Identification of the poor: Since we are interested in finding out who is poor, without loss of generality we impose some conditions on the experts while assigning the membership grade in accordance with section- 6 (Definition of fuzzy subset).

(i). Up to certain extent the membership values of the attributes x_{ij} across each x_i must be Zero who is not poor.

(ii) Up to certain extent the membership values of the attributes x_{ij} across each x_i must be One who is poor.

(iii) Up to certain extent the membership values of the attributes x_{ij} across each x_i must be either partially increasing or partially decreasing in order to grade a person Partially poor (degree of poverty) .

Satisfying these conditions, we group the membership values of indicators as clusters. The top most values are ranked as Rank I, the next clustered values are ranked II and so on as shown in the following table.

Table -8

w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	w_{10}
0.661 (x_2)	0.398 (x_3) 0.353 (x_8) 0.323 (x_2)	0.730 (x_2) 0.730 (x_3)	0.836 (x_1) 0.836 (x_2) 0.836 (x_3)	0.875 (x_7) 0.875 (x_9)	0.687 (x_1) 0.687 (x_2) 0.687 (x_5)	0.875 (x_8)	0.254 (x_4) 0.254 (x_{10})	0.633 (x_1) 0.633 (x_3)	0.875 (x_8) 0.857 (x_7)
0.497(x_3) 0.414(x_7)	0.278 (x_6) 0.248 (x_4)	0.615 (x_7)	0.795(x_7) 0.795 (x_8)	0.687 (x_1) 0.687 (x_3)	0.562 (x_7) 0.562 (x_8)	0.687 (x_2) 0.687 (x_3)	0.194 (x_2) 0.194 (x_3)	0.592 (x_7)	0.714 (x_2) 0.714 (x_3)

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	0.203 (x_1) 0.203 (x_7)			0.687 (x_4)	0.562 (x_9)	0.687 (x_4)	0.194 (x_7)		
0.310(x_4)	0.127(x_9)	0.538 (x_1)	0.591 (x_{10})	0.562 (x_6)	0.375 (x_3) 0.375 (x_4) 0.375 (x_5)	0.562 (x_7) 0.562 (x_9)	0.104(x_5) 0.104 (x_9)	0.428 (x_2)	0.571 (x_6) 0.571 (x_9)
0.298(x_8) 0.297(x_1)	0.097(x_5) 0.097 x_5	0.423 (x_8) 0.423 (x_{10})	0.387 (x_6) 0.387 (x_9) 0.310 (x_4)	0.375 (x_5) 0.375 (x_2)	0.062 (x_6)	0.375 (x_1)	0.045 (x_1) 0.045 (x_6) 0.045 (x_8)	0.388 (x_6) 0.388 (x_7) 0.388 (x_{10})	0.428 (x_1)
0.189(x_9) 0.184(x_6)	-	0.230 (x_6) 0.230 (x_9)	0.183 (x_5)	0.250 (x_8) 0.250 (x_{10})	-	0.250 (x_6)	-	0.224 (x_4)	0.142 (x_4)0.142 (x_5)0.142(x_{10})
0.133(x_{10})	-	0.0003 (x_4) 0.0003 (x_5)	-	-	-	0.062 (x_5) 0.062 (x_{10})	-	0.134 (x_8)	-
0.078 (x_5)	-	-	-	-	-	-	-	0.020 (x_5)	-

In the following table, we present the grouped clustered persons across the membership values. The top most values are ranked as Rank I, the next clustered values are ranked II and so on as shown in the following table.

Table-9

Ranks	w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	w_{10}
I	x_2	x_3, x_8, x_2	x_2, x_3	x_1, x_2, x_3	x_7, x_9	x_1, x_2, x_5	x_8	x_4, x_{10}	x_1, x_3	x_8, x_7
II	x_3, x_7	x_6, x_4, x_7, x_1	x_7	x_7, x_8	x_1, x_3 x_4	x_7, x_8 x_9	x_2, x_3 x_4	x_2, x_3 x_7	x_7	x_2, x_3
III	x_4	x_9	x_1	x_{10}	x_6	x_3, x_4, x_5	x_7, x_9	x_5, x_9	x_2	x_6, x_9
IV	x_1, x_8	x_5, x_{10}	x_8, x_{10}	x_4, x_6, x_9	x_2, x_5	x_6	x_1	x_1, x_6, x_8	x_6, x_7, x_{10}	x_1
V	x_6, x_9	-	x_6, x_9	x_5	x_8, x_{10}	-	x_6	-	x_4	x_4, x_5 x_{10}
VI	x_{10}	-	x_4, x_5	-		-	x_5, x_{10}	-	x_8	-
VII	x_5	-	-	-		-	-	-	x_5	-

Here, we observe that the fifth person – 5, that is (x_5) identified as least deprived person. Since, his values in the decreasing order come at the last rank.

The next stage of the step – 3 is to find out which person has the maximum frequency of occurrence in the list of ten indicators. The minimum occurrence in the list is identified as the next least deprived person as shown in the following table.

Stage- 1

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Table - 10

Maximum Number of Frequency of occurrence in each Rank										Maximum No. Of occurrence
x_1 3 times	x_2 5 times	x_3 4 times	x_4 1 time	x_5 1 time	x_6 0 times	x_7 2 times	x_8 3 times	x_9 1 time	x_{10} 1 time	x_2 5 times
x_1 2 times	x_2 3 times	x_3 5 times	x_4 2 times	x_5 0 time	x_6 1 time	x_7 7 times	x_8 2 times	x_9 1 times	x_{10} 0 times	x_7 7 times
x_1 1 time	x_2 1 time	x_3 1 time	x_4 2 times	x_5 2 times	x_6 2 times	x_7 1 times	x_8 0 times	x_9 4 times	x_{10} 1 time	x_9 4times
x_1 4 times	x_2 1 time	x_3 0 times	x_4 0 times	x_5 2 times	x_6 3 times	x_7 1time	x_8 3 times	x_9 1 time	x_{10} 3 times	x_1 4 times
x_1 0time	x_2 0 times	x_3 0 times	x_4 2 times	x_5 2 times	x_6 3times	x_7 0 times	x_8 1 time	x_9 2 times	x_{10} 2 times	x_6 3 times
x_1 0 times	x_2 0 times	x_3 0 time	x_4 1 time	x_5 0 times	x_6 0 times	x_7 0 times	x_8 1 time	x_9 2 times	x_{10} 2 times	x_9 , x_{10} 2times
x_1 0 times	x_2 0 times	x_3 0 times	x_4 0 times	x_5 2 times	x_6 0times	x_7 0 times	x_8 0 times	x_9 0 times	x_{10} 0 times	x_5 2times

Here, see that person – 3, person-4, person-8 and person-10 do not come in the list of maximum, so we go for another list of maximum occurrence as given below:

Stage- 2 Table - 11

	Maximum Number of Frequency of persons in each Rank			
				Maximum
x_3 6times	x_4 2times	x_8 3times	x_{10} 1time	x_3 6times
x_3 6times	x_4 3times	x_8 3times	x_{10} 3times	x_4 , x_8 , x_{10} 3 times
x_3 0times	x_4 0times	x_8 4times	x_{10} 2times	x_8 4times
x_3 0times	x_4 4times	x_8 0times	x_{10} 2times	x_4 4times
x_3 0times	x_4 1time	x_8 0times	x_{10} 2times	x_{10} 2times

Step – 4 Ranking

Finally, the ranking of the following the ten persons $x_1, x_2, \dots, x_{10}$ (where, $x_1, x_2, \dots, x_{10}$ refers to person-1 , person-2, … person-10 respectively) is done by using the fuzzy projection.

Stage – 1 Table-12

Rank	Maximum Number of Frequency of persons in each Rank										First Projection
I	x_1 3times	x_2 5times	x_3 4times	x_4 1time	x_5 1time	x_6 0time	x_7 2times	x_8 3times	x_9 1time	x_{10} 1time	x_2 5
II	x_1 2times	x_2 3times	x_3 5times	x_4 2times	x_5 0times	x_6 1time	x_7 7times	x_8 2times	x_9 1time	x_{10} 0time	x_7 7
III	x_1 1time	x_2 1time	x_3 1time	x_4 2times	x_5 2times	x_6 2times	x_7 1time	x_8 0time	x_9 4time	x_{10} 1time	x_9 4
IV	x_1 4times	x_2 1time	x_3 0time	x_4 0time	x_5 2times	x_6 3times	x_7 1time	x_8 3times	x_9 1time	3times	x_1 4
V	x_1 0time	x_2 0time	x_3 0time	x_4 2time	x_5 2time	x_6 3times	x_7 0time	x_8 1time	x_9 2time	x_{10} 2time	x_6 3
VI	x_1 0time	x_2 0time	x_3 0time	x_4 1time	x_5 2times	x_6 0time	x_7 0time	x_8 0time	x_9 2time	x_{10} 2times	x_5, x_9, x_{10} 2
VII	x_1 0time	x_2 0time	x_3 0time	x_4 0time	x_5 2times	x_6 0time	x_7 0time	x_8 0time	x_9 0time	x_{10} 0time	x_5 2
Second Projection	x_1 4	x_2 3	x_3 4	x_4 2	x_5 2	x_6 3	x_7 7	x_8 3	x_9 4	x_{10} 2	

Stage-2

Table-13

Rank		Maximum Number of Frequency of persons in each Rank			
					First Projection
I	x_3 6times	x_4 2times	x_8 3times	x_{10} 1time	x_3 6
II	x_3 4times	x_4 3times	x_8 3times	x_{10} 3times	x_3 4
III	x_3 0times	x_4 0times	x_8 4times	x_{10} 2times	x_8 4
IV	x_3 0times	x_4 4times	x_8 0times	x_{10} 2times	x_4 4
V	x_3 0times	x_4 1time	x_8 0times	x_{10} 2times	x_{10} 2
Second Projection	x_3 6	x_4 4	x_8 4	x_{10} 3	

VII. RESULT

Using fuzzy projection we get person- 7, person- 3 and person-2 (x_7 , x_3 , x_2) as the highest maximum projection or maximum occurrence. Similarly, we get person-1, person-4, person-8 and person-9 (x_1 x_4 , x_8 x_9 ,) are having the second highest projection or occurrence. And we get x_6 person – 6 as the third highest maximum occurrence in the list and as the next highest occurrence in the list are person-10 and person and person-6 (x_{10} , x_6), as the next maximum occurrence in the list. And finally, person-5 (x_5) occurs as the least deprived. Hence, we the following poverty status.

Table-14

Poverty Status				
Least Deprived	Less Deprived	Moderately Deprived	Deprived	Highly Deprived
x_5 ,	x_{10} ,	x_6	x_1 , x_4 , x_8 x_9	x_2 , x_3 , , x_7

7.1 Interpretation of the results

Thus from the above poverty status, we observe that person- 2, person-3 and person- 7 are highly deprived. Hence they deserve more attention. According to poverty degree status person- 1, person-4 , person-8 and person-9 are deprived. Therefore, they too are equally deprived. Hence they need welfare help. Further we observe that person- 6 is moderately deprived and person-10 is less deprived. Hence they also need an attention but compare to other six persons, they need only moderate welfare. And person- 5 is the least deprived. Hence, they do not come under the category of deprivation.

Hence, Poverty assessment basically tries to assess the level of poverty of an individual or a household to decide if it is the target group who need the government assistance.

VIII. CONCLUSION

The results depicting the levels of deprivation for the various categories are presented in the above fuzzy methodology. Therefore, the fuzzy approach is a better approach to link the crisp sets of poverty measure with fuzzy subset theory.

From the fuzzy subsets analysis poverty it clear that the problem of identifying the poor takes a combination of many capabilities factors to assess the poverty phenomenon.

Fuzzy approach is an inclusive approach rather than exclusive approach. It does not divide the whole population into two categories i.e. rich and poor rather it looks at the poverty problems in terms of inclusive approach aim at the maximum benefits for the maximum population. Hence, fuzzy approach is useful tool for both the short term goal as well as the long term goal. Therefore, the fuzzy approach has a greater effect in making of the policy.

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