Annals of
Pure and Applied
Mathematics

Assessment of Poverty with Reference to Education-Employment-Income-Status of Children, Using Fuzzy Membership Ranking Model (FmRM)

T. Pathinathan[1] and Raj Kumar[2]

[1]P.G and Research Department of Mathematics, Loyola College
Chennai-34, Tamil Nadu, India. E-mail: loyolapathi@gmail.com
[2]P.G and Research Department of Mathematics, Loyola College
Chennai-34, Tamil Nadu, India. E-mail: loyolarajsj@gmail.com

Abstract. Conventionally the population is divided into two groups: poor and non-poor or the haves and have-nots, demarked by poverty line. Recent studies regard poverty as a multi-dimensional phenomenon. Therefore, an analysis of poverty should be supplemented by the use of non-monetary indicators like deprivation and different types of hardship experienced by the several households.

This paper accommodates the measures based on education, employment, income and status of children in a household. It analyzes the inter-relationship between these components. These indicators capture the maximum facts of the degree of poverty. Using FmRM approach, we derive a conclusion to depict how poor the poor are.

Keywords: Poverty, Indicators, Fuzzy Membership and Fuzzy Ranking.

AMS Mathematics Subject Classification (2010): 03E72

1. Introduction
Poverty assessment uses indicators or certain parameters to help the policy programme to categorize one's level of poverty from another. The purpose of the measure of poverty is to support the policy makers to sharpen the focus on the poor. So that policymakers could decide to target the maximum numbers of beneficiaries. The four following dimensions are for the purpose: Education, employment, income and children's status in a household. They are considered for identifying maximum number of beneficiaries among the set of the poor people. Each dimension or parameter consists of several attributes to indicate the degree of poverty.

Most of the studies on poverty in India or across the world use income or expenditure as indicator. This uni-dimensional indicator based on poverty line is considered as the yardstick to identify individuals or household who should be considered poor. Recently (years 2012-13), the Indian government (Dr. Suresh Tendulkar) used this method to measure poverty in India. The Poverty Line method invited a big debate (controversy) across the country. It was controversial because this uni-dimensional model fails to capture the plight of poverty problem of the civilians.

With the 12th plan, the government of India has taken the first steps in acknowledging that poverty is multidimensional concept. Therefore, it cannot be reduced to income consumption expenditure alone. The writings of Amartya Sen on the Capability approach and the Millennium Development Goals draw attention to the multiple deprivations of poverty experienced by many of the poor. The works of Amartya Sen on Capabilities and Functionings played a significant role in promoting the use of multi-dimensional approach to poverty measurement. Therefore, this paper uses the multidimensional approach to identify the poor.

Based on the nature of fuzzy human thinking, Lotfi Askar Zadeh, a computer scientist at the University of California, Berkeley, originated the "fuzzy logic" or fuzzy set theory in 1965. Since then, this theory has been applied in various disciplines for a better conclusions or results. The application of Fuzzy membership ranking model to poverty measurement (a socio- economic problem) indicates the level or degree of poverty of a person. Data from Mahamadpur village, Nalanda District of the State of Bihar is collected to support the theoretical framework of the fuzzy measurement of poverty.

2. Review of literature: Approaches to poverty assessment
2.1. Traditional approach
The traditional approach defines the poor as all those individuals or households who fall below the poverty line. All those individuals or households are above the poverty line are classified as non-poor. The traditional approach of poverty measurement has two distinct features. (i) Uni-dimensional: considers only one indicator or one dimension of poverty that is money- metric dimension such as income and consumption/expenditure. (ii) Poverty line: classifies the population into two groups: poor and non-poor according to the poverty line. The researchers or policymakers choose this poverty line, depending on what the aim of the study or policy is. It could be absolute, relative or subjective or any combination of these. For example, Dr. Suresh Tendulkar, the former planning commission of India, chose the absolute poverty because the aim of the government policy was to provide the benefits of government programmes to the poor people of the country.

2.1.1. Shortcoming of the traditional approach
(i) It studies only one dimension of poverty at a time. (ii) It makes a clear cut distinction between the poor and non-poor. But in reality, there is no such clear cut distinction exists. (iii) It fails to capture the horizontal vagueness of poverty.

To overcome the shortcomings of traditional approach, the multi-dimensional approach was developed by Dr. Amartya Sen.

2.2. Multidimensional approach
The measurement of poverty depends on many factors rather than a single indicator or uni-dimension such as income or consumption expenditure. Poverty should be regarded as a multidimensional phenomenon of which income is only one aspect.

This approach has been significantly gaining its importance and wide acceptance due to multi-dimensional nature of poverty and also severity of poverty. The works of

Assessment of Poverty with Reference to Education-Employment-Income-Status of Children, Using Fuzzy Membership Ranking Model (FmRM)

Amarty Sen on Capabilities and Functionings played a significant role in promoting the use of multi-dimensional approach to poverty measurement.

Capability: A term used by Dr. Amartya Sen to refer to the freedom that a person has to be or to do, given his personal tastes and his command over the commodities. Therefore, for him poverty is capability failure.

Freedom: According to Dr. Amartya Sen it refers to a situation in which society has at its disposal various alternatives from which to satisfy its wants. According to him development is not meaningful without freedom to choose. Thus, we can say that if a person has no freedom of choice then he is doomed to be in poverty.

Functionings: what people do or can do with the commodities of given characteristics that may come to possess or control.

Later in the year 1997 UNDP (United Nation Development Programme) introduced the HPI (Human Poverty Index) as an example of a multidimensional index to poverty in terms of functionings failure. The HPI aggregates the country level deprivations into the living standard of a population for the basic dimensions of life, namely decent living standards, educational attainment rate and life expectancy at birth.

Therefore, the multidimensional approach addresses the notion of horizontal vagueness of poverty with multiple dimensions such as education, health, housing, nutrition, water, employment and safety as the dimension of core poverty.

2.2.1. Methods of multidimensional poverty measurement
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. Multi-dimensional approach uses dual methods namely (i) dual cutoffs and (ii) A counting methodology.

2.2.2. Shortcoming of the multidimensional approach
Despite its elegant contributions to poverty measures it has many problems associated with this approach namely, (i) there is no consensus on what dimensions of well-being should be included in poverty analysis. (ii) There is no set standard or method on how to measure multidimensional poverty. (iii) It has problem with regard to weights that the different dimensions contribute to overall poverty. (iv) It fails to capture the vertical vagueness of poverty.

2.3. The fuzzy approach
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 fuzzy multi-dimensional approach: Totally 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 poor and non-poor categorized by Poverty Line seems unrealistic. A gradual transition from extreme poverty to richness would be closer to reality.

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.

2.3.1. Totally fuzzy (TF) approach

The first measurement based on the fuzzy set theory was Totally Fuzzy (TF) method suggested by Andréa Cerioli and Sergio Zani in the year 1990. They said that fuzzy sets allow for more than one dimension of poverty to be used in measuring the status of a person, because the measurement yardstick is simply the "degree of membership" to the set of poor people in each dimension. The overall membership function acts as a deprivation indicator showing each household's overall deprivation relative to its surroundings. In determining membership function of individual or household i on indicator j. They suggested to define two thresholds values such as $j_{\min}$ and $j_{\max}$ such that if j for and individual is smaller than the $j_{\min}$ the person would be defined as definitely poor while if j is higher than $j_{\max}$ then the person is definitely not poor. If the individual's or household's deprivation were to fall between these two levels the membership function will be between x_{ij}, $j_{\min}$ and $j_{\max}$. Therefore, the definition for the membership function proposed by Andréa Cerioli and Sergio Zani is as follows:

$$\mu_j(i) = \begin{cases} 1 & if \quad x_{ij} \le j_{\min} \\ \dfrac{j_{\max} - x_{ij}}{j_{\max} - j_{\min}} & if \quad j_{\min} < x_{ij} < j_{\max} \\ 0 & if \quad x_{ij} \ge j_{\max} \end{cases}$$

2.3.2. Totally fuzzy and relative (TFR) approach

Chelli and Lemmi in the year 1995 argued that the Totally Fuzzy has two weaknesses. First, the choice of two threshold values is arbitrary. Second the choice of a linear function for the membership function lacks both a theoretical basis and empirical evidence. They argued to use a cumulative distribution function as the basis of membership function. They called this method "totally relative" because the membership function value is entirely determined by the relative position of individual in population distribution. They suggested the following membership formula:

$$\mu_j(i) = \mu_{j^{(k)}}(i) = \begin{cases} 0 & if\ k = 1 \\ \mu_{j^{(k-1)}}(i) + \dfrac{F(j_i^{(k)}) - F(j_i^{(k-1)})}{1 - F(j_i^{(1)})} & otherwise \end{cases}$$

where $\mu_j(i) = 1 - F(j_i)$ *or* $\mu_j(i) = F(j_i)$ and k categories in them (j^k indicators $k - th$ category of indicator j)

3. Theoretical considerations
3.1. Concept of fuzzy subsets
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

$$\mu_A(x) = 1 \quad if \ x \in A$$
$$= 0 \quad if \ x \notin A$$
$$= (0,1) \quad along \ the \ boundary$$

As a response to the lack of well-defined boundary, a new approach to the poverty measurement is being considered as an alternative approach called the fuzzy membership ranking method.

3.2. 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

$$\mu_{\underset{\sim}{A}} = \left\{(x, \mu_{\underset{\sim}{A}}(x))\right\}, \forall x \in E \ and \ \mu : \underset{\sim}{A} \to [0,1].$$

where $\mu_A(x)$ 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 $\mu_A(x)$ indicates the degree of membership of x in $\underset{\sim}{A}$. And when $\mu_A(x) = 0$ means that x does not belong to $\underset{\sim}{A}$. Whereas when $\mu_A(x) = 1$ means that x belongs to $\underset{\sim}{A}$ completely. On the other hand when $0 < \mu_A(x) < 1$ means that x partially belongs to $\underset{\sim}{A}$. And further its ($\mu_A(x)$) degree or level or membership of $\underset{\sim}{A}$ increases in proportion to the proximity of $\mu_A(x)$ to 1.

3.3. Fuzzy subset approach to poverty measurement
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,….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) $\mu_A(x_i) = 1$ if i^{th} individual is poor;

3) $0 < \mu_A(x_i) < 1$ if i^{th} individual exhibits a partial membership in the subset of $\underset{\sim}{A}$.

Fuzzy membership ranking method takes into account a new approach to the use of multidimensional analysis of poverty. This approach provides fuzzy subset formalism in the use of dimensions and its various indicators available from household surveys. The subset $\underset{\sim}{A}$ is fuzzy subset, because some of its members have partial membership in the set of the poor in a given population.

3.3.1. Notations
We define the following symbols, we will be using in the context of multi-dimensional poverty analysis.

E - the referential set or the set of individuals or households in the population of interest;

i - the ith element of set E ;

L - variables or indicators of the various dimensions (Education, Employment, Financial status, status of the children)

L_j - the jth variables of indicators in a set of k variables or indicators in each dimension;

l_{ij} - the values of the jth variables or indicators for i^{th} element of set E ;

$\underset{\sim}{A}$ - the subset of E consisting of the poor;

$\mu_A(i)$ - the membership function of the element i to the poor subset of $\underset{\sim}{A}$;

x_{ij} - the values of the membership function $\mu_A(i)$ in the closed interval between 0 and 1 for the jth variables or indicators and for the ith element of set E ;

3.3.2. Determination of critical limits
In the analysis of poverty, generally we need to have a cut-off or minimum or maximum level under which a person needs to be considered poor or non-poor. Therefore, without loss of generality, we choose lower bound (lower limit) and upper bound (upper limit) to identify the poor in given subset of the poor of the population. Thus, the critical limits are defined as follows:

l_1 - the subset of the population who are certainly poor according to the society's standard of living.

l_2 - the subset of the population who are certainly non-poor according to the society's standard of living.

l - the subset of the population who exhibit only partial membership to the poor set.

3.3.3. Expression of membership function
The design of the membership function $\mu_A(i)$ is a basic requirement in the application of the fuzzy subset approach. The membership function is used to capture each individual or household's degree of inclusion to the set of the poor. Membership function is used

because yardstick is the "degree of membership" to the set of the poor people in each dimension. Hence the membership functions of i over j^{th} indicators is defined as follows:

$$\mu_j(i) = \begin{cases} 1 & if \quad 0 \le l \le l_1 \\ \dfrac{l_2 - l}{l_2 - l_1} & if \quad l_1 \le l \le l_2 \\ 0 & if \quad l_2 \le l \end{cases} \tag{1}$$

In the equation above, $\mu_j(i)$ defines the degree of membership to the set of the poor according to the value of l over j^{th} indicators, l_1 and l_2 define the lower and upper bounds (limits) of l, separating the poor, through the gradual transition from the poor to the non-poor regions.

3.3.4. Membership function of a household's deprivation
A measurement of a household deprivation is the value of the membership function $\mu_A(i)$. The membership function of a household is derived by computing the weighted average across the jth indicators is given by the following formula:

$$\mu_A(i) = \frac{\sum_{j=1}^{k}(x_{ij} \times w_j)}{\sum_{j=1}^{k} w_j} \tag{2}$$

where x_{ij} is the value of the membership functions for   individual and   over the variable or indicators. And w_j are the weights of the indicators across the each dimension set according to the indicator categories.

And x_{ij} is the membership values that are derived by the following formula defined as:

$$\begin{aligned} x_{ij} &= \mu(l_{ij}), \quad \forall \quad l_1 < l_{ij} < l_2 \\ x_{ij} &= 1 \quad for \quad l_{ij} \le l_1 \\ x_{ij} &= 0 \quad for \quad l_{ij} \ge l_2 \end{aligned} \tag{3}$$

where l_{ij} is derived by the equation (1) and l_1, l_2 are the critical limits or lower and upper bound values chosen appropriately in the line of dimensions and their associated indicators.

Let there be $K = L_1, L_2, ..., L_k$ where $j = 1, 2, ... k$ indicators of the multi-dimensional variables that describe the set E of n households.

3.3.5. Calculations of poverty status
The poverty status of a several households is defined as follows:

$$\mu_{\underset{\sim}{A}}(i) = \frac{\sum_{j=1}^{k} (\mu_{\underset{\sim}{A}}(i) \times w_j)}{\sum_{j=1}^{k} w_j} \tag{4}$$

$$i.e \ Fuzzy\ Values\ Weightage = \frac{\sum (MFVs\ across\ the\ Dimensions \times lower\ bound\ Weight)}{\sum (lower\ bound\ Weights)}$$

where, *MFVs* refers to the membership function values across the each dimensions and multiplied by the corresponding lower limit bound weights in the set of the poor people.

3.3.6. Ranking: priority ranking method
Criteria for identifying and classifying a beneficiary among the poor is given by the following priority ranking method.

Table 1: Priority ranking method

Ranks	Priority Ranking	Fuzzy Values Range (Weights)	Deprivation Status	Fuzzy Poverty Status
(I)	First Highest Priority	0.8 – 1.0	Extremely Deprived	Very Very Poor
(II)	Second Highest Priority	0.6 – 0.8	Highly deprived	Very Poor
(III)	Third Highest Priority	0.4 – 0.6	Deprived	Poor
(IV)	Fourth Highest Priority	0.2 – 0.4	Moderately Deprived	Less Poor
(V)	Lowest Priority	0.0 – 0.2	Not-Deprived	Least poor

4. Case study
A survey has been conducted in Mahamadpur Village, Nalanda District, Bihar. A sample from the survey consisting the data from 10 households is taken for our calculations. They are represented by household-1, household-2… household -10 respectively. We have taken four dimensions such as Education, Employment, Financial status and status of children with their corresponding indicators across the 10- households which are further used for a validity of the fuzzy subset approach in measuring poverty. We also present briefly the reasons for choosing these four dimensions.

Education: The lack of education is one of the factors that capture the dynamics of poverty. It disproportionally affects children of the poor households and rural area and deprives them of the opportunity to break through poverty. There is saying- without a job; it is difficult to get out of poverty. And without education, it is difficult to find a job.

Table 2: Education level

0-Level	Very Low	Low	sufficient	Quite Good	Good	Very Good
Illiterate	Primary 5Th Class	Middle school 8th Class	Matric Pass 10th Class	Intermediate Pass 10+2 Class	Graduate	Post Graduate and Above

Assessment of Poverty with Reference to Education-Employment-Income-Status of Children, Using Fuzzy Membership Ranking Model (FmRM)

Employment: Another factor in understanding poverty is the employment. The relationship between education and employment has been impressive in explaining poverty phenomenon. Employment indicator assesses the formal and informal continuum occupational safety. It reflects income and human progress to reveal the well-being of the households.

Table 3: Types of employment

Very Low	Low	sufficient	Quite Good	Good	Very Good
-Manual Work -Agriculture -unskelled Labour -daily paid worker	-Skilled worker -Semi-skilled work **-** Mechanic -Electrian -Plumber -Carpenter -Craft work -Construction work -Maintenance etc.	- SelfEmployed - Smallbusiness - Streetvendors -Driver -Small farmer(1-acare cultivation) -Private teachers or - private works	**-**Own work place -own small business- hotel(street) - middle class farmer Own lands -Private high school teachers -Private work good paid	Organized private sector -Small company Shop Schools (privates) Fourth grade Governrnent workers Etc.	-All the well organized private or - Government Sectors -hospital -Hotel 1st,2nd and 3rd grade paid wok Etc.

Financial status: It is easily perceivable indicator and an important one. It captures the poverty in an explicitly manner. In general poverty measurement often uses income as scale or indicator reflecting the notion that conceptually economic deprivation is a main defining characteristic of being poor.

Table 4: Financial status (Income per Month)

Very Low	Low	sufficient	Quite Good	Good	Very Good
≤ Rs.5250.00	≤ Rs.7800.00	≤ Rs.10,300.00	Rs. 39,100.00	Rs.40,000.00	Above Rs. 40,000.00

Sources: C. Rangarajan Report on Poverty June 2014. And Report on payment scale Government of Bihar July, 2010 (in comparisons with daily wages and per month salary)

Status of the children: India's newest Nobel Laureate, Kailash Satyarthi believes child labour is not an outcome of poverty but a contributor. (Source: The Times of India, Thursday, October 30, 2014.) He says, "Child labour creates and perpetuates poverty. if you allow child labour , you allow poverty and illiteracy to continue." (Source: The Times of India, Monday, October 13, 2014.) Thus it captures and reflects the poverty of the household.

Table 5: Status of the children

Very Low	Low	Sufficient	Quite Good	Good	Very Good
Working not attending any school	Working as well as attending school (irregular)	Children attending school, but occasionally going for work	Children attending schools regularly, at times going for work	Attending schools with occasional absentees	Attending schools regularly without fail

Table 6 (a): Dimensions with weighted indicators and limits

Dimensions	Indicators	weight	Limits/ Bounds
Education (L_1)	Illiterate	0	$l_1 = 3$ $l_2 = 6$
	Primary	1	
	Middle School	2	
	Matric – 10th Class	3	
	Intermediate(10+2)	4	
	Graduate	5	
	Post Graduate/Above	6	

Table 6 (b):

Dimensions	Indicators	weight	Limits/ Bounds
Employment(L_2)	Unskilled/semi-skilled	1	$l_1 = 3$ $l_2 = 6$
	Agriculture	1	
	Daily paid worker	2	
	Skilled Labour	3	
	Self employed	4	
	Working in a private sectors	5	
	Organized social sector/ public sector with social security	6	

Table 6 (c):

Dimensions	Indicators	weight	Limits/ Bounds
Financial Status (L_3)	Rs.5250.00 Monthly	1	$l_1 = 1$ $l_2 = 4$
	Rs.7,035 Monthly	2	
	Rs.10,300.00 Monthly	3	
	Above 10,300.00 Monthly	4	

Table 6 (d):

Dimensions	Indicators	weight	Limits/ Bounds
Status of the children (L$_4$)	Working	1	
	Attending School but goes for work	2	$l_1 = 2$
	Attending school, at times goes for work	3	$l_2 = 4$
	Attending school regularly	4	

From equation (1), we get the values for $\mu(l_{ij})$ the variables i and j from the corresponding indicators and weights. The values for $\mu(l_{ij})$ are given in the following tables:

In the equation (1) above, $\mu_j(i)$ defines the degree of membership to the set of the poor according to the value of l over j^{th} indicators, l_1 and l_2 define the lower and upper bounds (limits) of l, separating the poor, through the gradual transition from the poor to the non-poor regions.

Table 7 (a): Value for $\mu(l_{ij})$ variable

Education	Fuzzy values corresponding to each indicator	Indicators
	1	Illiterate
	1	Primary
$\mu(l_{ij})$	1	Middle School
	0.6	Matric – 10th Class
	0.3	Intermediate(10+2)
	0	Graduate
	0	Post Graduate/Above

Table 7 (b): Value for $\mu(l_{ij})$ variable

Employment	Fuzzy values corresponding to each indicator	Indicators
	1	Unskilled/semi-skilled
	1	Agriculture
$\mu(l_{ij})$	1	Daily paid worker
	0.7	Skilled Labour
	0.5	Self employed
	0.2	Working in a private sectors Organized social sector/ public sector with social security

Table 7 (c): Value for $\mu(l_{ij})$ variable

	Fuzzy values corresponding to each indicator	Indicators
Financial status	1	Rs.5250.00 Monthly
	0.6	Rs.7,035 Monthly
$\mu(l_{ij})$	0.3	Rs.10,300.00 Monthly
	0.0	Above 10,300.00 Monthly
	0	Above

Table 7 (d): Value for $\mu(l_{ij})$ variable

	Fuzzy values corresponding to each indicator	Indicators
Status of the children	1	Working
	1	Attending School but goes for work
$\mu(l_{ij})$	1	Attending school, at times goes for work
	0.5	Attending school regularly but once in a while goes for work
	0	Regular schooling

Now, by using equation (3) we find the value for x_{ij} across each dimension and using equation (2) we find the membership values $\mu_A(i)$ for the households' deprivations corresponding to each dimension.

Table 8: Values for - x_{ij}

Dimensions	x_{ij}					
Education	1	1	1	1	1	0
Employment	1	1	1	1	1	0
Financial Status	1	1	1	0	0	0
Status of the Children	1	1	1	0	0	0

Now, we find the membership values $\mu_A(i)$ [Tables (9 and 10)] by using equations (2) and (4) respectively. The values are as follows:

Assessment of Poverty with Reference to Education-Employment-Income-Status of Children, Using Fuzzy Membership Ranking Model (FmRM)

Table 9: Household's Fuzzy Deprivation values corresponding to each dimension

$\mu_A(i)$	Education	Employment	Financial status	Status of the children
Household-1	0.7	0.7	0.6	0.7
Household-2	0.5	0.4	0.3	0.3
Household-3	0.7	0.5	0.4	0.4
Household-4	0.5	0.6	0.7	0.3
Household-5	0.1	0.2	0.3	0.2
Household-6	0.5	0.6	0.5	0.4
Household-7	0.2	0.4	0.2	0.4
Household-8	0.1	0.1	0.2	0.2
Household-9	0.3	0.3	0.2	0.3
Household-10	0.6	0.5	0.7	0.3

Table 10: Fuzzy Poverty Membership values

$\mu_A(i)$	Fuzzy Poverty Membership values
Household-1	0.70
Household-2	0.45
Household-3	0.55
Household-4	0.57
Household-5	0.20
Household-6	0.57
Household-7	0.22
Household-8	0.15
Household-9	0.32
Household-10	0.46

Ranking: Priority ranking method

Criteria for identifying and classifying for a beneficiary among the poor is given by the following priority category method.

Table 11: Priority category method

Ranks	Priority Categories	Fuzzy Values Range (Weights)	Deprivation Status	Fuzzy Poverty Status
(I)	First Highest Priority	0.8 – 1.0	Extremely Deprived	Very Very Poor
(II)	Second Highest Priority	0.6 - 0.8	Highly deprived	Very Poor
(III)	Third Highest Priority	0.4 - 0.6	Deprived	Poor
(IV)	Fourth Highest Priority	0.2 - 0.4	Moderately Deprived	Less Poor
(V)	Lowest Priority	0.0 - 0.2	Not-Deprived	Least poor

Table 12: Results: assessment of poverty using fuzzy membership ranking model

Fuzzy Values Range (Weights)	Fuzzy Poverty Values	Priority Categories	Deprivation Status	Fuzzy Poverty Status	Ranks
0.8 – 1.0	-	First Highest Priority	Extremely Deprived	Very Very Poor	(I)
0.6 - 0.8	H-1-0.70,	Second Highest Priority	Highly deprived	Very Poor	(II)
0.4 - 0.6	H-2-0.45, H-3-0.55, H-4-0.57, H-6-0.57, H-10-0.46,	Third Highest Priority	Deprived	Poor	(III)
0.2 - 0.4	H-5-0.20, H-7-0.22, H-9-0.32,	Fourth Highest Priority	Moderately Deprived	Less Poor	(IV)
0.0 - 0.2	H-8-0.15,	Lowest Priority	Not-Deprived	Least poor	(V)

5. Result and interpretations

Using fuzzy subset membership function we find that Household-1, is highly deprived and holds the second highest priority and hence Household-1 is very poor and it is ranked-II . Household -2, household-3, household-4, household -6 and household -10 have got third highest priority and they are really deprived and hence declared poor and they are ranked-III. The next category is househould-5, household- 7 and household-9. They hold fourth highest category and are moderately deprived and hence they are considered less poor and ranked-IV. The household-8 is having lowest priority and hence least poor. Thus, any policy of eradication of poverty could be made according to research findings. And household-5, household-7, household- 8 and household- 9 can be considered non-poor. On the other hand household-1, household -2, household-3, household-4, household -6 and household -10 could be considered poor.

6. Conclusions

Using Fuzzy Membership Ranking approach, we can justify that fuzziness or vagueness inherent in measuring poverty can be captured by the use of fuzzy subsets. Education, employment, financial status and status of children can be a better indicator to assess one's level of poverty. We conclude that Fuzzy membership ranking model is able to handle vagueness, impreciseness and complexity, strengthening the connection between fuzzy subset theory and empirical poverty data analysis.

Assessment of Poverty with Reference to Education-Employment-Income-Status of
Children, Using Fuzzy Membership Ranking Model (FmRM)

REFERENCES

1. R.R.Yager, *Fuzzy Sets and Applications: Selected Papers by L. A. Zadeh,* publisher, John Wiley and Sons Inc., Canada, (1987), p.29.
2. G.Betti, B.Cheli, A.Lemmi, V.Verma, University of Siena, Italy, Conference paper – The Fuzzy Approach to Multi-dimensional Poverty: the Case of Italy in the 90's, International Conference – The many dimensions of poverty, Brasilia, Brazil, 29-31 August 2005, Carlton Hotel.pp.1- 4.
3. Achille and G.Betti, *Fuzzy set approach to multidimensional poverty measurement*, Springer, printed, United State of America, 2006, pp.93-94.
4. A.Cerioli and S.Zani, A Fuzzy approach to The Measurement of Poverty, Studies in Contemporary Economics, C. Dagum, M. Zenga (Eds), Income and Wealth Distributions, Inequality and Poverty, Springer-Verlag Berlin Heidelberg, 1990, pp. 272-273.
5. A.Kaufmann, L.A.Zadeh and D.L.Swanson, Introduction to the Theory of Fuzzy Subsets, Vol. I, publisher, Academic Press, New York, San Francisco, London, 1975, pp. 5-6, 47-48.
6. D.Dubois and H.Prade, *Fuzzy Sets and Systems: Theory and Applications,* Publisher, Academic press, New York, London, Sydney San Francisco, 1980, pp.1-4.
7. M.Supratim, C.Amitava, B.Rupak, and K.Samarji, A fuzzy mathematics based approach for poor household identification, *International Journal of Mathematics and Scientific Computing*, 1(1) (2011),pp. 22-27.
8. Walt Sarel J Van Der, Journal, BER, A Multidimensional Analysis of Poverty in the Eastern Cape Province, South Africa, Bureau for Economic Research , Department of Economics, University of Stellenbosch, Africa, 2004, pp. 1-19.
9. M.C.S.Bantilan, F.T.Bantilan and M.M.de Castro, Fuzzy subset theory in measurement of poverty, *Journal of Philippine Development*, 34(XIX) (1992),pp. 97-127.
10. D.Miceli, measuring poverty using fuzzy sets, Discussion Paper no.38, *NATSEM*, University of Canberra, 1998.
11. S. Alkire and J. Foster, Counting and multidimensional poverty measure, OPHI Working Paper Series, 7 (2007) pp.78-89.
12. F.Raj, S.Mukherjee, M.Mukherjee, A.Ghose and R.N.Nag, Contemporary Development Economics, New Central Book Agency (P) Ltd, Kolkata (2007), pp. 624 – 656.
13. Michael Gr. Voskoglou, A triangular fuzzy model for assessing problem solving skills, *Annals of Pure and Applied Mathematics*, 7(1) (2014) 53-58.
14. M. Shahjalal, Abeda Sultana, Nirmal Kanti Mitra and A.F.M. Khodadad Khan, Compositional rule of inference and adaptive fuzzy rule based scheme with applications, *Annals of Pure and Applied Mathematics*, 3(2) (2013) 155-168.