Abstract

Background/Objectives: The study of poverty and analysis of the set of ’poor’ in terms of exact or classical (crisp set) is unrealistic because the concept of ’poor’ is non-exact. This paper uses multi-criteria fuzzy decision-making tools and fuzzy set theory to capture the extent of poverty of a household both in terms of quantitative and qualitative factors.

Methods/Statistical Analysis: This paper introduces pentagonal fuzzy numbers to analyze the level of poverty of a household. Stratified Fuzzy Analytical Hierarchy Process (SFAHP) has been utilized to compare the alternatives (different households) with respect to various criteria to estimate the fuzzy criteria weights based on the membership function. Findings: Impreciseness is accounted as measureable factor using Stratified Fuzzy AHP and Pentagonal Fuzzy Numbers approach. With help of this method a position of one's level of poverty has been captured. Thus it has logically been argued that one can overcome the dichotomy existing in the traditional method of analyzing poverty.

Applications/Improvements: This article represents the subjective arguments by establishing the qualitative multi-criteria fuzzy variables into membership grades like very poor, almost very poor, poor, rather poor and non-poor. Thus the whole data of the subset of the poor has been categorized by sieving out technique. This way the impreciseness is accounted as measureable factor using Stratified Fuzzy AHP and Pentagonal Fuzzy Numbers approach. Thus with help of this method the decision makers can identify a poor person in any existing socio-economical situations.

Keywords: Decision, Pentagonal Fuzzy Numbers, Poverty, SFAHP

1. Introduction

Poverty is conventionally analyzed by splitting the households in a population into two groups: ‘poor and non-poor’ defined in relation to the poverty line. This means that the set of poor is a crisp set. There is no partially poor person. The conventional method for poverty measurement depends too much on an arbitrary decision like setting a poverty line.

The ’poor and non-poor’ are not two mutually exclusive sets. Hence, the distinction between the poor and non-poor is fuzzy or vague. This paper argues that using a method based on ’fuzzy decision making’ can be a unique tool to deal with the vagueness that lies between the poor and non-poor. This paper asserts that poverty is a multi-dimensional concept and it integrates multiple dimensions in an intuitive way to arrive at a reliable conclusion.

The scope of this paper is to develop and refine fuzzy poverty measurement tools which commenced with the contribution of Andrea Cerioli and Sergio Zani in the year 1990. This method introduces pair-wise comparison judgment matrix using pentagonal fuzzy numbers based on the stratified fuzzy hierarchy process. We use scale 1 to 9 which was introduced in the year 1980 by Thomas L. Saaty in the context of decision making process. In this case two additional factors have been introduced:

- The choice of membership functions with fuzzy pentagonal numbers for the quantitative and qualitative specification of households' degree of poverty.
- The choice of rules for the fuzzification of the resulting fuzzy sets for normalizing the input and output data and aggregation of the fuzzy weights as defuzzification of the data for sieving the poor in a given population of subgroup of poor.
Further, poverty category is calculated using Sieving method. This way we make sure that the result is accurate and precise incorporating both qualitative and quantitative empirical data. Primary data is collected from various households of 20 blocks of Nalanda district, Bihar to substantiate the methodology. Thus we help the policy makers to sharpen the measure of poverty for their future planning.

In this paper we describe the nature of poverty can be constituted by a number of sets or attributes of non-monetary categories such as food (Roti), clothing (Kapda), housing (Makaan), employment (Kaam) and social status (Samman). These components are used as the part of multi-criteria fuzzy decision poverty analysis.

2. Stratified Fuzzy AHP Approach and its Development

Analytic Hierarchy Process (AHP) was introduced by Thomas L. Saaty in the year 1980. The major characteristic of the AHP method is the use of pair-wise comparisons, which are used to compare with respect to the various criteria, sub-criteria and alternatives to estimate criteria weights. Van Laarhoven and Pedryc introduced Fuzzy AHP in the year 1983. They proposed a method of fuzzy judgment by comparison of the triangular fuzzy numbers. They also used fuzzy numbers with triangular membership function with simple operation laws and the logarithmic least squares method to obtain element sequencing. Later in the year 1985, J.J. Buckley extended Saaty's method to incorporate fuzzy comparison ratio by using fuzzy trapezoidal fuzzy numbers. In 1995 Again Chang proposed the principle for comparison between the elements of the fuzzy numbers. In 2002, Cebeci and Cengiz Kahraman compared some catering firms using four attributes and fuzzy AHP.

The aim of the AHP is to capture the expert's knowledge and the conventional AHP still cannot reflect the human thinking style. Therefore, a fuzzy extension of AHP was developed to address and to solve imprecision inherent in the real world problem. We have evolved Stratified Fuzzy AHP method as one of the Multi-Criteria Decision Making tools.

2.1 Pentagonal Fuzzy Numbers and Stratified Fuzzy AHP Approach to Poverty Analysis

2.1.1 Poverty

A person who is poor implies poverty as lack of security, low wages, lack of employment opportunity, poor nutrition, poor access to safe drinking water, having too many children to feed, children being engaged in work to bring money to a family, poor educational opportunities and misuse of resources etc. whereas, for a non-poor person poverty is a lack of income. There is a general consensus that poverty is multi-dimensional. This view is clearly expressed by the following definition given by the World Bank in the year 2002.

Poverty is hunger. Poverty is lack of shelter. Poverty is being sick and not being able to see a doctor. Poverty is not being able to go to school and not knowing how to read. Poverty is not having a job, is fear for the future, living one day at time. Poverty is losing a child to illness brought by unclean water. Poverty is powerless, lack of representation and freedom.

It is in this context Mozaffar Qizilbash defines poverty as a vague concept. Thus we propose to measure the degree of poverty incorporating multi-dimensional aspects of deprivation into the definition.

2.2 Poverty Set: A Matter of Degree

Poverty Set can be defined as a matter of degree based on the fuzzy logic concept. The fuzzy decision making tool approach considers poverty as a matter of degree rather than an attribute that is simply present or absent for a household in a given population. In fuzzy logic a statement can be true to a certain degree. Therefore, the poor individual or a household are assigned a degree in relation to the membership functions. A poor person belonging to a given set in a varying degree is assigned with membership values 1 (the poorest person) and 0 (the non-poorest person). In mathematical terms it can be represented as follows: False: Truth value = 0, True: truth value = 1, Uncertain: 0 < Truth value < 1.

2.3 Fuzzy Subset Approach to Poverty Analysis

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

- \( \mu_\mathcal{A}(x_i) = 0 \), if \( i \)th individual is certainly not poor;
- \( \mu_\mathcal{A}(x_i) = 1 \), if \( i \)th individual is poor;
- \( 0 < \mu_\mathcal{A}(x_i) < 1 \), if \( i \)th individual exhibits a partial membership in the subset of \( \mathcal{A} \).

Fuzzy approach tries to answer: 1. How can we assign memberships to elements in a fuzzy set? 2. How can the notion of fuzzy sets be applied to practical problems? The first question concerns the construction of a numerical scale for membership values in such a way that the scale satisfies some conditions imposed on rational measurement system. It is done through assigning membership function to the criteria and alternatives.

3. Stratified Fuzzy AHP- Pentagonal Fuzzy Numbers: Methodology

3.1 Pentagonal Fuzzy Numbers

Pentagonal Fuzzy Number is defined as \( \mathcal{A}_\mathcal{P} = \{a_{-2}, a_{-1}, a_0, a_1, a_2\} \), where \( a_{-1} \) and \( a_{-2} \) denotes the smallest possible values (in decreasing order), \( a_0 \) the most promising value and \( a_1, a_2 \) the largest possible value (in increasing order) respectively.

Since each number in the pairwise comparison represents the subjective judgments opinion of the decision maker is a vague judgment. Therefore, the Fuzzy Numbers work the best to consolidate the fragmented judgments of the expert opinions.

Formula to Generate fuzzy pentagonal numbers defined as follows:

\[
\mathcal{A}_\mathcal{P} = (1, 1, 2, 3, 4), \quad \mathcal{A}_\mathcal{P} = (6, 7, 8, 9, 9), \quad \mathcal{A}_\mathcal{P} = (7, 8, 9, 9, 9).
\]

Figure 1. Pentagonal Fuzzy Number.

3.1.2 Construction of Pentagonal Fuzzy Numbers

The Pentagonal Fuzzy Number is represented by the five parameters such as \( a_{-2}, a_{-1}, a_0, a_1, a_2 \) where \( a_{-2} \) and \( a_{-1} \) denotes the smallest possible values (decreasing order), \( a_{0} \) the most promising value and \( a_1, a_2 \) the largest possible value (increasing order) respectively.

Since each number in the pairwise comparison represents the subjective judgment opinion of the decision maker is a vague judgment. Therefore, the Fuzzy Numbers work the best to consolidate the fragmented judgments of the expert opinions.

Formula to Generate fuzzy pentagonal numbers defined as follows:

\[
\mathcal{A}_\mathcal{P} = (a_{-2}, a_{-1}, a_0, a_1, a_2), \quad \forall a = 3, ..., 7.
\]

and defined by \( 1 = (1, 1, 1, 1, 1), \quad 2 = (1, 1, 2, 3, 4), \quad 8 = (6, 7, 8, 9, 9), \quad 9 = (7, 8, 9, 9, 9) \). Since fuzzy numbers scale is defined from 1 to 9.

3.2 Definition of Fuzzy Centre Value

Let \( \mathcal{C} \) be a Fuzzy Number and \( \mu_\mathcal{C} \) be its membership function for a given Fuzzy Number \( \mathcal{C} \), let \( a_0 \) be a core element of \( \mathcal{C} \) such that

\[
F_\mathcal{C} = a_0 - \frac{1}{2} \int_{-\infty}^{a_0} \mu_\mathcal{C}(x)dx + \frac{1}{2} \int_{a_0}^{\infty} \mu_\mathcal{C}(x)dx
\]
Therefore, for Pentagonal Fuzzy Numbers \( A_p = \{a_{-2}, a_{-1}, a_0, a_1, a_2\} \) and its fuzzy centre value is derived by the following expressions as defined:

\[
F_\xi = a_0 - \frac{1}{2} \int_{a_{-2}}^{a_2} \frac{(x-a_{-2})}{(a_{-1}-a_{-2})} dx - \frac{1}{2} \int_{a_{-1}}^{a_1} \frac{(x-a_{-1})}{(a_0-a_{-1})} dx - \frac{1}{2} \int_{a_1}^{a_2} \frac{(x-a_{-1})}{(a_0-a_{-1})} dx - \frac{1}{2} \int_{a_0}^{a_2} \frac{(x-a_{0})}{(a_2-a_0)} dx
\]

where, \( \mu_\xi(x) = \frac{(x-a_{-2})}{(a_{-1}-a_{-2})}, \mu_{\xi}(x) = \frac{(x-a_{-1})}{(a_0-a_{-1})}, \mu_{\xi}(x) = \frac{(x-a_{0})}{(a_2-a_0)} \) and then \( F_\xi \) is called a fuzzy centre value of \( \xi \). Where real-valued parameters \( A_p = \{a_{-2}, a_{-1}, a_0, a_1, a_2\} \) satisfy \( a_{-2} \leq a_{-1} \leq a_0 \leq a_1 \leq a_2 \), and its fuzzy centre value is defined by \( F_\xi = \frac{a_0}{2} + \frac{1}{4}(a_1 + a_2) \)

Where \( a_0 \) and \( a_1 \) are left arm minimum fuzzy weights and right arm maximum fuzzy weight and \( a_0 \) is the core value of the pentagonal numbers respectively.

### 3.3 Construction of Fuzzy Pair-Wise Comparison Matrix (Fuzzification)

\[
M = \begin{bmatrix} a_{ij} \end{bmatrix}_{n \times n} = \begin{cases} a_{ij} = \frac{E_i}{E_j}, & \text{How importance more (less) is } E_i \text{ w.r.t } E_j \\ a_{ij} = 1, & \text{Every element has the same importance} \\ a_{ij} = \frac{1}{a_{ij}}, & \text{if } E_i \text{ is } a_{ij} \text{ times more (less) importance than } E_j, \text{ otherwise vice versa} \end{cases}
\]

Where, \( E_i \) and \( E_j \) are the criteria compared one over the other and \( a_{ij} \) are the values assigned to the criteria.

#### 3.3.1 Establishment of Scale

- If a criterion on the Left is more important than the one matching on the Right, assign actual judgments value to the Left criterion.
- If a criterion on the Left is less important than the one matching on the Right, assign the reciprocal value to the right criterion.
- While comparing one household with the other, we relate one activity over another by favoring the highest possible affirmation.

### 3.3.2 Fuzzy Pentagon Scale Values

<table>
<thead>
<tr>
<th>Fuzzy Numbers</th>
<th>Relative Importance variables</th>
<th>Scale of a fuzzy pentagonal numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{1}{a} )</td>
<td>Reciprocal Values</td>
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</tr>
<tr>
<td>( \frac{1}{a} )</td>
<td>Reciprocal Values</td>
<td>( \left{ \frac{1}{a+1}, \frac{1}{a}, \frac{1}{a-1} \right} )</td>
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<tr>
<td>( \frac{1}{a} )</td>
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<td>( \left{ \frac{1}{a}, \frac{1}{a-1}, \frac{1}{a-2} \right} )</td>
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<tr>
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<td>( \left{ \frac{1}{a+1}, \frac{1}{a+2}, \frac{1}{a} \right} )</td>
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<td>Reciprocal Values</td>
<td>( \left{ \frac{1}{a+2}, \frac{1}{a+1}, \frac{1}{a} \right} )</td>
</tr>
</tbody>
</table>

### 3.4 Computational Procedures of Stratified Fuzzy AHP

To assign the weights of criteria, sub-criteria and alternatives, we proceed as given below:

**Step-1:** Construction of the hierarchical structure with decision elements: criteria and sub-criteria. Each decision maker is asked to express relative importance of the decision elements in the same level with help of a reference scale values: 1-9 scale.

**Step-2:** Collect the score of pair wise comparison and form pair wise comparison matrices for each of the \( n \) decision makers. It is done at each level using the scale response on the questionnaire. How important is one element when it is compared with the other element?

**Step-3:** Construction of a fuzzy judgment Matrix which are represented by the positive triangular numbers.

**Step-4:** Fuzzification is done by normalizing the fuzzy pentagonal Membership values.

**Step-5:** Calculation of the fuzzy Centre Membership values.

**Step-6:** Computation of the composite weight and finally obtaining the poverty status category of the households using fuzzy sieving technique.

### 3.4 Comparison Judgment Matrix is Defined as Follows

Consider the pentagonal fuzzy comparison matrix expressed by
3.5 Normalization of the Fuzzy Comparison Judgments to Obtain Fuzzy the Weights

\[ M = \{ g_{ij} \}_{n \times n} = \begin{bmatrix} (l, l, l, l) & (l, l, l, l) & \cdots & (l, l, l, l) \\
(l, l, l, l) & (l, l, l, l) & \cdots & (l, l, l, l) \\
\vdots & \vdots & \ddots & \vdots \\
(l, l, l, l) & (l, l, l, l) & \cdots & (l, l, l, l) 
\end{bmatrix} \]

(2)

where, \( w_i = \sum_{j=1}^{n} a_{ij} \) and \( d_{ij} \) is the fuzzy Pentagonal numbers.

This can also be expressed as \( w_i = w_1 \odot [w_1 \oplus w_2]^{-1} \)

Next step we sum up each row of the above normalized matrix of \( M \) by interval fuzzy arithmetic operations then row sums divided to \( n \).

3.6 Shifting Formula

Sieving formula gives the final fuzzy membership weights. In other words the defuzzification is done by using the sieving formula defined as:

\[ \mu(h_i) = \frac{h_i - \min(h_i)}{\text{Max}(h_i) - \min(h_i)} \]

(4)

Where, \( h_i \) is variable denoting normalized household weights,

\( i = 1, 2, 3 \ldots 100 \) (Total number of households),

\( \min(h_i) \) denotes minimum of all the \( h_i \) and \( \text{max}(h_i) \) denotes maximum of all the \( h_i \).

3.7 Fuzzy Sieve Grade Values for Poverty Evaluation

To categorize a set of population of poor, the following set of distinct fuzzy membership values is defined by

\( \varphi(h_i) = \{ \text{non poor (NP), rather poor (RP), poor (P), almost very poor (AVP), very poor (VP)} \} \)

3.8 Fuzzy Sieve Technique (FST)

Fuzzy sieving constraints category is defined by,

\[ \text{FST} = \{ T_1, T_2, T_3, T_4, T_5 \} \]

Where,

\[ T_1 = \{ h_i | 0.0 \leq h_i \leq 0.2 \}, \]

Seive Result: \( h_i = \text{non poor} \)

\[ T_2 = \{ h_i | 0.2 < h_i \leq 0.4 \}, \]

Seive Result: \( h_i = \text{rather poor} \)

\[ T_3 = \{ h_i | 0.4 < h_i \leq 0.6 \}, \]

Seive Result: \( h_i = \text{poor} \)

\[ T_4 = \{ h_i | 0.6 < h_i \leq 0.8 \} \]

Seive Result: \( h_i = \text{almost very poor} \)

\[ T_5 = \{ h_i | 0.8 < h_i \leq 1 \} \]

Seive Result: \( h_i = \text{very poor} \)

4. Case Study

We selected a random sample of 5 households from Ben Block, Nalanda District, Bihar, India from the available data by field work done by us. They are represented Figure 2. by Household-1, Household-2 … Household-5.
4.1 Pair-Wise Comparison of the Main Criteria using Fuzzy Pentagonal Numbers

Table 1. Fuzzy Decision Matrix: calculating the intensity of importance of main criteria

<table>
<thead>
<tr>
<th></th>
<th>Roti</th>
<th>Kapda</th>
<th>Makaan</th>
<th>Kaam</th>
<th>Samman</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roti</td>
<td>(1,1,1,1)</td>
<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
<td>(1/9,1/9,1/8,1/7)</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
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<tr>
<td>Kapda</td>
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<td>(1,1,1,1)</td>
<td>(5,6,7,8,9)</td>
<td>(1/9,1/9,1/8,1/7)</td>
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<tr>
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<td>(7,8,9,9,9)</td>
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<tr>
<td>Kaam</td>
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<td>(7,8,9,9,9)</td>
<td>(7,8,9,9,9)</td>
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<td>Samman</td>
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<td>(1/9,1/9,1/8,1/7)</td>
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</table>

4.1.1 Normalization of Main Criteria

Table 2. Aggregate sum of main criteria

<table>
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<tbody>
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<td>5.0000</td>
<td>6.0000</td>
<td>0.1111</td>
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<tr>
<td>Kapda</td>
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<td>6.0000</td>
<td>7.0000</td>
<td>0.1111</td>
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<tr>
<td>Makaan</td>
<td>(6,7,8,9,9)</td>
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<td>7.0000</td>
<td>8.0000</td>
<td>0.1111</td>
</tr>
<tr>
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<td>8.0000</td>
<td>9.0000</td>
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<td>9.0000</td>
<td>9.0000</td>
<td>0.1429</td>
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<td>Kapda</td>
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<td>9.0000</td>
<td>9.0000</td>
<td>9.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Makaan</td>
<td>(1,1,1,1)</td>
<td>9.0000</td>
<td>9.0000</td>
<td>9.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Kaam</td>
<td>(7,8,9,9,9)</td>
<td>9.0000</td>
<td>9.0000</td>
<td>9.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Samman</td>
<td>(2,3,4,5,6)</td>
<td>2.0000</td>
<td>0.1111</td>
<td>0.1111</td>
<td>0.1111</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Roti</th>
<th>Kapda</th>
<th>Makaan</th>
<th>Kaam</th>
<th>Samman</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roti</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>3.0000</td>
<td>0.1111</td>
<td>0.1111</td>
<td>0.1111</td>
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<tr>
<td>Kapda</td>
<td>(1/9,1/9,1/9,1/8,1/7)</td>
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<td>0.1250</td>
<td>0.1111</td>
<td>0.1111</td>
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<tr>
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<td>(1/9,1/9,1/9,1/8,1/7)</td>
<td>5.0000</td>
<td>0.1429</td>
<td>0.1250</td>
<td>0.1250</td>
</tr>
<tr>
<td>Kaam</td>
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<td>0.1667</td>
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</tr>
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</table>
### 4.1.1.1 Fuzzy Centre Normalized Weight with Pentagonal Fuzzy Number

**Table 3.** Normalized centre weight of main criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Normalized Fuzzy Weights</th>
<th>Average</th>
<th>Fuzzy Centre Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roti</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>31.6206 0.3883 22.7873 0.5388 49.2778 0.2492 19.7302 0.6223</td>
<td>0.4496</td>
<td>0.5452</td>
</tr>
<tr>
<td></td>
<td>32.6028 0.4390 24.7456 0.5783 51.3111 0.2789 20.7040 0.6912</td>
<td>0.4969</td>
<td></td>
</tr>
<tr>
<td></td>
<td>32.6151 0.5016 26.7401 0.6119 53.3611 0.3066 21.7083 0.7537</td>
<td>0.5434</td>
<td></td>
</tr>
<tr>
<td></td>
<td>32.6944 0.5646 27.8056 0.6638 51.4583 0.3587 22.7917 0.8099</td>
<td>0.5992</td>
<td></td>
</tr>
<tr>
<td></td>
<td>31.8651 0.6164 27.9762 0.7021 48.6429 0.4038 22.9762 0.8549</td>
<td>0.6443</td>
<td></td>
</tr>
<tr>
<td>Kapda</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22.7317 0.5377 49.2222 0.2483 19.6746 0.6212 31.8651 0.3836 0.4477</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24.6706 0.5770 51.2361 0.2779 20.6290 0.6901 32.6944 0.4354 0.4969</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>26.6329 0.6103 53.2540 0.3052 21.6012 0.7525 32.6151 0.4984 0.5429</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>27.6389 0.6618 51.2917 0.3566 22.6250 0.8085 32.6028 0.5610 0.5970</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>27.6762 0.6989 48.3429 0.4001 22.6762 0.8530 31.6260 0.6117 0.6409</td>
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<td></td>
</tr>
<tr>
<td>Makaan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>45.3333 0.1838 15.7857 0.5279 27.9762 0.2979 27.6762 0.3011 0.3277</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>46.3472 0.2017 15.7401 0.5938 27.8056 0.3362 27.6389 0.3382 0.3675</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>47.3790 0.2191 15.7262 0.6600 26.7401 0.3881 26.6329 0.3897 0.4142</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>43.4345 0.2402 14.7679 0.7066 24.7456 0.4217 24.6706 0.4230 0.4479</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39.5095 0.2660 13.8429 0.7592 22.7873 0.4612 22.7317 0.4623 0.4872</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kaam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>36.4524 0.7956 48.6429 0.5962 48.3429 0.5999 39.5095 0.7340 0.6814</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39.3929 0.8377 51.5483 0.6413 51.2917 0.6434 43.4345 0.7598 0.7205</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.3472 0.8737 53.3611 0.6934 53.2540 0.6948 47.3790 0.7809 0.7607</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>41.3333 0.8952 51.3111 0.7211 51.2361 0.7221 46.3472 0.7983 0.7842</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40.3333 0.9174 49.2778 0.7508 49.2222 0.7517 45.3333 0.8162 0.8090</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samman</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22.9762 0.1451 22.6762 0.1470 13.8429 0.2408 40.3333 0.0826 0.1539</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22.7917 0.1901 22.6250 0.1915 14.7679 0.2934 41.3333 0.1048 0.1950</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>21.7083 0.2463 21.6012 0.2475 15.7262 0.3400 42.3472 0.1263 0.2400</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>20.7040 0.3088 20.6290 0.3099 15.7401 0.4062 39.3929 0.1623 0.2968</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19.7302 0.3777 19.6746 0.3788 15.7857 0.4721 36.4524 0.2044 0.3583</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 4.1.2 Normalization of Sub-Criteria Food (ROTI)

**Table 4.** Relative weight importance of the food – sub-criteria

<table>
<thead>
<tr>
<th>Staple Food Intake</th>
<th>Adequate Food (Notorious) Intake</th>
<th>Health Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1,1,1,1,1)</td>
<td>(1/9, 1/8, 1/7, 1/6, 1/5)</td>
<td>(1/8, 1/7, 1/6, 1/5, 1/4)</td>
</tr>
<tr>
<td>(5,6,7,8,9)</td>
<td>(1,1,1,1,1)</td>
<td>(1,1,1,1,1)</td>
</tr>
<tr>
<td>(4,5,7,8)</td>
<td>(1,1,1,1,1)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

**Table 5.** Aggregated sum of the relative weight

<table>
<thead>
<tr>
<th>W1</th>
<th>W2</th>
<th>W3</th>
<th>RW1</th>
<th>RW2</th>
<th>RW3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.236111</td>
<td>7</td>
<td>6</td>
<td>1.45</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>1.267857</td>
<td>8</td>
<td>7</td>
<td>1.36667</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>1.309524</td>
<td>9</td>
<td>8</td>
<td>1.309524</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>1.366667</td>
<td>10</td>
<td>9</td>
<td>1.267857</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>1.45</td>
<td>11</td>
<td>10</td>
<td>1.236111</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>
4.1.2.1  **Fuzzy Centre Normalized Weight with Pentagonal Fuzzy Number for ROTI**

**Table 6.** Normalized Centre weight of sub-criteria ROTI

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>Average</th>
<th>Fuzzy Centre Weight</th>
<th>RW2</th>
<th>RW3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.101022</td>
<td>0.110012</td>
<td>0.105517</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>0.11252</td>
<td>0.123478</td>
<td>0.117999</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>0.127021</td>
<td>0.140665</td>
<td>0.133843</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>0.145907</td>
<td>0.163347</td>
<td>0.154627</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>0.171598</td>
<td>0.194631</td>
<td>0.183114</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>Average</th>
<th>Fuzzy Centre Weight</th>
<th>RW1</th>
<th>RW2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.828402</td>
<td>0.411765</td>
<td>0.620084</td>
<td>1.45</td>
<td>10</td>
</tr>
<tr>
<td>0.854093</td>
<td>0.470588</td>
<td>0.66234</td>
<td>1.36667</td>
<td>9</td>
</tr>
<tr>
<td>0.872979</td>
<td>0.529412</td>
<td>0.701195</td>
<td>1.309524</td>
<td>8</td>
</tr>
<tr>
<td>0.88748</td>
<td>0.588235</td>
<td>0.737858</td>
<td>1.267857</td>
<td>7</td>
</tr>
<tr>
<td>0.898978</td>
<td>0.647059</td>
<td>0.773019</td>
<td>1.236111</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>Average</th>
<th>Fuzzy Centre Weight</th>
<th>RW1</th>
<th>RW2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.805369</td>
<td>0.352941</td>
<td>0.579155</td>
<td>1.45</td>
<td>11</td>
</tr>
<tr>
<td>0.836653</td>
<td>0.411765</td>
<td>0.624209</td>
<td>1.36667</td>
<td>10</td>
</tr>
<tr>
<td>0.859335</td>
<td>0.470588</td>
<td>0.664962</td>
<td>1.309524</td>
<td>9</td>
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<tr>
<td>0.876522</td>
<td>0.529412</td>
<td>0.702967</td>
<td>1.267857</td>
<td>8</td>
</tr>
<tr>
<td>0.889988</td>
<td>0.588235</td>
<td>0.739111</td>
<td>1.236111</td>
<td>7</td>
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</tbody>
</table>

### 4.1.3 Normalization of Sub-Criteria Housing (MAKAAN)

#### 4.1.3.1 Pair-Wise Comparison Decision Matrix for Housing

<table>
<thead>
<tr>
<th>Types of Housing</th>
<th>Environment</th>
<th>Safe drinking water</th>
<th>Light sources</th>
<th>Sanitation</th>
<th>Consumer durables</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1,1,1,1,1)</td>
<td>(1/5, 1/4, 1/3, 1/2, 1)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1,2,3,4,5)</td>
</tr>
<tr>
<td>(1,2,3,4,5)</td>
<td>(1/5, 1/4, 1/3, 1/2, 1)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(2,3,4,5,6)</td>
</tr>
<tr>
<td>(1,1,1,1,1)</td>
<td>(1/5, 1/4, 1/3, 1/2, 1)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(2,3,4,5)</td>
</tr>
<tr>
<td>(3,4,5,6,7)</td>
<td>(1/5, 1/4, 1/3, 1/2, 1)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(2,3,4,5)</td>
</tr>
<tr>
<td>(3,4,5,6,7)</td>
<td>(1/5, 1/4, 1/3, 1/2, 1)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1,1,1,1)</td>
</tr>
<tr>
<td>(1/5, 1/4, 1/3, 1/2, 1)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(1/7, 1/6, 1/5, 1/4, 1/3)</td>
<td>(2,3,4,5)</td>
</tr>
</tbody>
</table>

**Table 7.** Aggregated sum of the relative weight

<table>
<thead>
<tr>
<th>W 1</th>
<th>W 2</th>
<th>W 3</th>
<th>W 4</th>
<th>W 5</th>
<th>W 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.628571</td>
<td>7</td>
<td>17</td>
<td>6.311111</td>
<td>4.742857</td>
<td>2.691667</td>
</tr>
<tr>
<td>3.75</td>
<td>11</td>
<td>21</td>
<td>9.375</td>
<td>5.916667</td>
<td>3.842857</td>
</tr>
<tr>
<td>4.933333</td>
<td>15</td>
<td>25</td>
<td>12.47619</td>
<td>7.2</td>
<td>5.083333</td>
</tr>
<tr>
<td>6.25</td>
<td>19</td>
<td>29</td>
<td>15.66667</td>
<td>8.75</td>
<td>6.533333</td>
</tr>
</tbody>
</table>

**Table 8.** Aggregated sum of the relative weight

<table>
<thead>
<tr>
<th>RW1</th>
<th>RW2</th>
<th>RW3</th>
<th>RW4</th>
<th>RW5</th>
<th>RW6</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>23</td>
<td>33</td>
<td>19.2</td>
<td>11.33333</td>
<td>8.75</td>
</tr>
<tr>
<td>6.25</td>
<td>19</td>
<td>29</td>
<td>15.66677</td>
<td>8.75</td>
<td>6.533333</td>
</tr>
<tr>
<td>4.933333</td>
<td>15</td>
<td>25</td>
<td>12.47619</td>
<td>7.2</td>
<td>5.083333</td>
</tr>
<tr>
<td>3.75</td>
<td>11</td>
<td>21</td>
<td>9.375</td>
<td>5.916667</td>
<td>3.842857</td>
</tr>
<tr>
<td>2.628571</td>
<td>7</td>
<td>17</td>
<td>6.311111</td>
<td>4.742857</td>
<td>2.691667</td>
</tr>
</tbody>
</table>
### Table 9. Normalized centre weight of sub-criteria MAKAAN

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>AVERAGE</th>
<th>FCW</th>
<th>RW1</th>
<th>RW2</th>
<th>RW3</th>
<th>RW4</th>
<th>RW5</th>
<th>RW6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1026</td>
<td>0.0738</td>
<td>0.1204</td>
<td>0.1883</td>
<td>0.2310</td>
<td>0.1432</td>
<td>23.0000</td>
<td>33.0000</td>
<td>19.2000</td>
</tr>
<tr>
<td>0.1648</td>
<td>0.1145</td>
<td>0.1931</td>
<td>0.3000</td>
<td>0.3647</td>
<td>0.2274</td>
<td>19.0000</td>
<td>29.0000</td>
<td>15.6667</td>
</tr>
<tr>
<td>0.2475</td>
<td>0.1648</td>
<td>0.2834</td>
<td>0.4066</td>
<td>0.4925</td>
<td>0.3190</td>
<td>15.0000</td>
<td>25.0000</td>
<td>12.4762</td>
</tr>
<tr>
<td>0.3623</td>
<td>0.2294</td>
<td>0.4000</td>
<td>0.5137</td>
<td>0.6192</td>
<td>0.4249</td>
<td>11.0000</td>
<td>21.0000</td>
<td>9.3750</td>
</tr>
<tr>
<td>0.5333</td>
<td>0.3200</td>
<td>0.5590</td>
<td>0.6278</td>
<td>0.7482</td>
<td>0.5577</td>
<td>7.0000</td>
<td>17.0000</td>
<td>6.3111</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>AVERAGE</th>
<th>FCW</th>
<th>RW1</th>
<th>RW2</th>
<th>RW3</th>
<th>RW4</th>
<th>RW5</th>
<th>RW6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4667</td>
<td>0.1750</td>
<td>0.2672</td>
<td>0.3818</td>
<td>0.4444</td>
<td>0.3470</td>
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<td>23.0000</td>
<td>19.2000</td>
</tr>
<tr>
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<td>0.4125</td>
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<td>0.5019</td>
<td>6.2500</td>
<td>29.0000</td>
<td>15.6667</td>
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<tr>
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<td>0.3750</td>
<td>0.5459</td>
<td>0.6757</td>
<td>0.7469</td>
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<td>4.9333</td>
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<td>12.4762</td>
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<tr>
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<td>0.4750</td>
<td>0.6696</td>
<td>0.7625</td>
<td>0.8318</td>
<td>0.7148</td>
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<td>21.0000</td>
<td>9.3750</td>
</tr>
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<td>0.7847</td>
<td>0.8290</td>
<td>0.8952</td>
<td>0.7963</td>
<td>2.6286</td>
<td>17.0000</td>
<td>6.3111</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Normalized Fuzzy Weights</th>
<th>AVERAGE</th>
<th>FCW</th>
<th>RW1</th>
<th>RW2</th>
<th>RW3</th>
<th>RW4</th>
<th>RW5</th>
<th>RW6</th>
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<tbody>
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<td>0.4250</td>
<td>0.4696</td>
<td>0.6000</td>
<td>0.6602</td>
<td>0.0957</td>
<td>8.0000</td>
<td>23.0000</td>
<td>19.2000</td>
</tr>
<tr>
<td>0.7706</td>
<td>0.5250</td>
<td>0.5727</td>
<td>0.7059</td>
<td>0.7627</td>
<td>0.0948</td>
<td>6.2500</td>
<td>29.0000</td>
<td>15.6667</td>
</tr>
<tr>
<td>0.8352</td>
<td>0.6250</td>
<td>0.6671</td>
<td>0.7764</td>
<td>0.8310</td>
<td>0.0807</td>
<td>4.9333</td>
<td>15.0000</td>
<td>12.4762</td>
</tr>
<tr>
<td>0.8855</td>
<td>0.7250</td>
<td>0.7557</td>
<td>0.8305</td>
<td>0.8830</td>
<td>0.0605</td>
<td>3.7500</td>
<td>11.0000</td>
<td>9.3750</td>
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<tr>
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<td>0.8250</td>
<td>0.8395</td>
<td>0.8743</td>
<td>0.9246</td>
<td>0.0380</td>
<td>2.6286</td>
<td>7.0000</td>
<td>6.3111</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>AVERAGE</th>
<th>FCW</th>
<th>RW1</th>
<th>RW2</th>
<th>RW3</th>
<th>RW4</th>
<th>RW5</th>
<th>RW6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4410</td>
<td>0.2153</td>
<td>0.1605</td>
<td>0.3577</td>
<td>0.4190</td>
<td>0.3187</td>
<td>8.0000</td>
<td>23.0000</td>
<td>33.0000</td>
</tr>
<tr>
<td>0.6000</td>
<td>0.3304</td>
<td>0.2443</td>
<td>0.5172</td>
<td>0.5893</td>
<td>0.4563</td>
<td>6.2500</td>
<td>19.0000</td>
<td>29.0000</td>
</tr>
<tr>
<td>0.7166</td>
<td>0.4541</td>
<td>0.3329</td>
<td>0.6341</td>
<td>0.7105</td>
<td>0.5696</td>
<td>4.9333</td>
<td>15.0000</td>
<td>25.0000</td>
</tr>
<tr>
<td>0.8069</td>
<td>0.5875</td>
<td>0.4273</td>
<td>0.7259</td>
<td>0.8030</td>
<td>0.6701</td>
<td>3.7500</td>
<td>11.0000</td>
<td>21.0000</td>
</tr>
<tr>
<td>0.8796</td>
<td>0.7328</td>
<td>0.5304</td>
<td>0.8019</td>
<td>0.8770</td>
<td>0.7643</td>
<td>2.6286</td>
<td>7.0000</td>
<td>17.0000</td>
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</table>

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>AVERAGE</th>
<th>FCW</th>
<th>RW1</th>
<th>RW2</th>
<th>RW3</th>
<th>RW4</th>
<th>RW5</th>
<th>RW6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3722</td>
<td>0.1710</td>
<td>0.1257</td>
<td>0.1981</td>
<td>0.3515</td>
<td>0.2437</td>
<td>8.0000</td>
<td>23.0000</td>
<td>33.0000</td>
</tr>
<tr>
<td>0.4863</td>
<td>0.2375</td>
<td>0.1695</td>
<td>0.2741</td>
<td>0.4752</td>
<td>0.3285</td>
<td>6.2500</td>
<td>19.0000</td>
<td>29.0000</td>
</tr>
<tr>
<td>0.5934</td>
<td>0.3243</td>
<td>0.2236</td>
<td>0.3659</td>
<td>0.5862</td>
<td>0.4187</td>
<td>4.9333</td>
<td>15.0000</td>
<td>25.0000</td>
</tr>
<tr>
<td>0.7000</td>
<td>0.4430</td>
<td>0.2941</td>
<td>0.4828</td>
<td>0.6948</td>
<td>0.5230</td>
<td>3.7500</td>
<td>11.0000</td>
<td>21.0000</td>
</tr>
<tr>
<td>0.8117</td>
<td>0.6182</td>
<td>0.4000</td>
<td>0.6423</td>
<td>0.8081</td>
<td>0.6561</td>
<td>2.6286</td>
<td>7.0000</td>
<td>17.0000</td>
</tr>
</tbody>
</table>

(Continued)
**Table 9. Continued**

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>AVERAGE</th>
<th>FCW</th>
<th>RW1</th>
<th>RW2</th>
<th>RW3</th>
<th>RW4</th>
<th>RW5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2518</td>
<td>0.1048</td>
<td>0.0754</td>
<td>0.1230</td>
<td>0.1919</td>
<td>0.1494</td>
<td>8.0000</td>
<td>23.0000</td>
</tr>
<tr>
<td>0.3808</td>
<td>0.1682</td>
<td>0.1170</td>
<td>0.1970</td>
<td>0.3052</td>
<td>0.2336</td>
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<td>19.0000</td>
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<td>0.2895</td>
<td>0.4138</td>
<td>0.3266</td>
<td>4.9333</td>
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<td>0.6353</td>
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<td>0.2373</td>
<td>0.4107</td>
<td>0.5248</td>
<td>0.4361</td>
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<td>11.0000</td>
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<tr>
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<td>0.5810</td>
<td>0.6485</td>
<td>0.5788</td>
<td>2.6286</td>
<td>7.0000</td>
</tr>
</tbody>
</table>

**4.1.4 Normalization of Sub-Criteria**

**Employment Status (KAAM)**

**4.1.4.1 Pairwise Comparison Decision Matrix for Employment Status**

<table>
<thead>
<tr>
<th>Formal Sector</th>
<th>Informal Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal Sector</td>
<td>(1,1,1,1,1)</td>
</tr>
<tr>
<td>Informal Sector</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
</tr>
</tbody>
</table>

**Table 10. Aggregated sum of the relative weight**

<table>
<thead>
<tr>
<th>W 1</th>
<th>W 2</th>
<th>RW1</th>
<th>RW2</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1.111111</td>
<td>10</td>
<td>1.2</td>
</tr>
<tr>
<td>7</td>
<td>1.125</td>
<td>9</td>
<td>1.16667</td>
</tr>
<tr>
<td>8</td>
<td>1.142857</td>
<td>8</td>
<td>1.142857</td>
</tr>
<tr>
<td>9</td>
<td>1.16667</td>
<td>7</td>
<td>1.125</td>
</tr>
<tr>
<td>10</td>
<td>1.2</td>
<td>6</td>
<td>1.111111</td>
</tr>
</tbody>
</table>

**4.1.4.2 Fuzzy Centre Normalized Weight with Pentagonal Fuzzy Number for KAAM**

**Table 11. Normalized centre weight of sub-criteria KAAM**

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>AVERAGE</th>
<th>FCW</th>
<th>RW1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.833333</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.833333</td>
</tr>
<tr>
<td>0.857143</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.857143</td>
</tr>
<tr>
<td>0.875</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.875</td>
</tr>
<tr>
<td>0.888889</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.888889</td>
</tr>
<tr>
<td>0.9000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.9000</td>
</tr>
</tbody>
</table>

**4.1.5 Normalization of Sub-Criteria (SAMMAN)**

**4.1.5.1 Pair Wise Comparison Decision Matrix for Social Status**

<table>
<thead>
<tr>
<th>Education</th>
<th>Caste Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1,1,1,1,1)</td>
<td>(7,8,9,9,9)</td>
</tr>
<tr>
<td>(1/9,1/9,1/9,1/8,1/7)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

**Table 12. Aggregated sum of the relative weight**

<table>
<thead>
<tr>
<th>W 1</th>
<th>W 2</th>
<th>RW1</th>
<th>RW2</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0000</td>
<td>1.1111</td>
<td>10.0000</td>
<td>1.1111</td>
</tr>
<tr>
<td>10.0000</td>
<td>1.1111</td>
<td>10.0000</td>
<td>1.1111</td>
</tr>
<tr>
<td>10.0000</td>
<td>1.1111</td>
<td>10.0000</td>
<td>1.1111</td>
</tr>
<tr>
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<td>1.1111</td>
<td>10.0000</td>
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</tr>
<tr>
<td>10.0000</td>
<td>1.1111</td>
<td>10.0000</td>
<td>1.1111</td>
</tr>
</tbody>
</table>

**4.1.5.2 Fuzzy Centre Normalized Weight with Pentagonal Fuzzy Number for SAMMAN**

**Table 13. Normalized centre weight of sub-criteria SAMMAN**

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>AVERAGE</th>
<th>FCW</th>
<th>RW2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.9000</td>
</tr>
<tr>
<td>0.9000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.9000</td>
</tr>
<tr>
<td>0.9000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.9000</td>
</tr>
<tr>
<td>0.9000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.9000</td>
</tr>
<tr>
<td>0.9000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.9000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normalized Fuzzy Weights</th>
<th>AVERAGE</th>
<th>FCW</th>
<th>RW1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.1000</td>
</tr>
<tr>
<td>0.1000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.1000</td>
</tr>
<tr>
<td>0.1000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.1000</td>
</tr>
<tr>
<td>0.1000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.1000</td>
</tr>
<tr>
<td>0.1000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.1000</td>
</tr>
</tbody>
</table>
### 4.2 Block BEN

#### Table 14. Pair wise comparison of five households for the staple food

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1)</td>
<td>(1,2,3,4,5)</td>
<td>(3,4,5,6,7)</td>
<td>(4,5,6,7,8)</td>
<td>(3,4,5,6,7)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/5,1/4,1/3,1/2,1)</td>
<td>(1,1,1,1)</td>
<td>(2,3,4,5,6)</td>
<td>(3,4,5,6,7)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/7,1/6,1/5,1/4,1/3,)</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1,1,1,1)</td>
<td>(1,2,3,4,5)</td>
<td>(2,3,4,5,6)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/7,1/6,1/5,1/4,1/3,)</td>
<td>(1/5,1/4,1/3,1/2)</td>
<td>(1,1,1,1)</td>
<td>(3,4,5,6,7)</td>
</tr>
<tr>
<td>$H_5$</td>
<td>(1/7,1/6,1/5,1/4,1/3,)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1/7,1/6,1/5,1/4,1/3,)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

**Normalized Fuzzy Centre Weight**

|     | 0.7176 | 0.6726 | 0.5006 | 0.4465 | 0.1627 |

#### Table 15. Pair wise comparison of five households for the adequate food

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1)</td>
<td>(3,4,5,6,7)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/7,1/6,1/5,1/4,1/3,)</td>
<td>(1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
<td>(3,4,5,6,7)</td>
<td>(3,4,5,6,7)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1)</td>
<td>(2,3,4,5,6)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/7,1/6,1/5,1/4,1/3,)</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1,1,1,1,1)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_5$</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/7,1/6,1/5,1/4,1/3,)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

**Normalized Fuzzy Centre Weight**

|     | 0.7406 | 0.6393 | 0.5339 | 0.4685 | 0.1176 |

#### Table 16. Pair wise comparison of five households for the health condition

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1)</td>
<td>(3,4,5,6,7)</td>
<td>(3,4,5,6,7)</td>
<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/7,1/6,1/5,1/4,1/3,)</td>
<td>(1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_5$</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

**Normalized Fuzzy Centre Weight**

|     | 0.7124 | 0.6659 | 0.5683 | 0.4578 | 0.1176 |

#### Table 17. Pair wise comparison of five households for the clothing

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1)</td>
<td>(2,3,4,5,6)</td>
<td>(2,3,4,5,6)</td>
<td>(4,5,6,7,8)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_5$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

**Normalized Fuzzy Centre Weight**

|     | 0.6659 | 0.6618 | 0.6081 | 0.4627 | 0.1015 |
### Table 18. Pair wise comparison of five households for the types of house

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1,1)</td>
<td>(1,2,3,4,5)</td>
<td>(4,5,6,7,8)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/5,1/4,1/3,1/2,1)</td>
<td>(1,1,1,1,1)</td>
<td>(3,4,5,6,7)</td>
<td>(3,4,5,6,7)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1,1,1,1,1)</td>
<td>(2,3,4,5,6)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_4$</td>
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<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1,1,1,1,1)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_5$</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Normalized Fuzzy Centre Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>0.7429</td>
</tr>
<tr>
<td>$H_2$</td>
<td>0.6782</td>
</tr>
<tr>
<td>$H_3$</td>
<td>0.4306</td>
</tr>
<tr>
<td>$H_4$</td>
<td>0.5096</td>
</tr>
<tr>
<td>$H_5$</td>
<td>0.1387</td>
</tr>
</tbody>
</table>

### Table 19. Pair wise comparison of five households for the environment

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1,1)</td>
<td>(2,3,4,5,6)</td>
<td>(3,4,5,6,7)</td>
<td>(5,6,7,8,9)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1,1,1,1,1)</td>
<td>(3,4,5,6,7)</td>
<td>(6,7,8,9,9)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1,1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_5$</td>
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<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>Normalized Fuzzy Centre Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>0.6960</td>
</tr>
<tr>
<td>$H_2$</td>
<td>0.6771</td>
</tr>
<tr>
<td>$H_3$</td>
<td>0.5714</td>
</tr>
<tr>
<td>$H_4$</td>
<td>0.4594</td>
</tr>
<tr>
<td>$H_5$</td>
<td>0.0961</td>
</tr>
</tbody>
</table>

### Table 20. Pair wise comparison of five households for the safe drinking water

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1,1)</td>
<td>(1,1,2,3,4)</td>
<td>(3,4,5,6,7)</td>
<td>(2,3,4,5,6)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/4,1/3,1/2,1,1)</td>
<td>(1,1,1,1,1)</td>
<td>(1,2,3,4,5)</td>
<td>(2,3,4,5,6)</td>
<td>(3,4,5,6,7)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1/5,1/4,1/3,2,1)</td>
<td>(1,1,1,1,1)</td>
<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1,1,1,1,1)</td>
<td>(3,4,5,6,7)</td>
</tr>
<tr>
<td>$H_5$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1,1,1,1,1)</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Normalized Fuzzy Centre Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>0.6765</td>
</tr>
<tr>
<td>$H_2$</td>
<td>0.5990</td>
</tr>
<tr>
<td>$H_3$</td>
<td>0.6605</td>
</tr>
<tr>
<td>$H_4$</td>
<td>0.4284</td>
</tr>
<tr>
<td>$H_5$</td>
<td>0.1356</td>
</tr>
</tbody>
</table>

### Table 21. Pair wise comparison of five households for the light source

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1,1)</td>
<td>(2,3,4,5,6)</td>
<td>(3,4,5,6,7)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1,1,1,1,1)</td>
<td>(1,2,3,4,5)</td>
<td>(3,4,5,6,7)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1/5,1/4,1/3,2,1)</td>
<td>(1,1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1,1,1,1,1)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_5$</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Normalized Fuzzy Centre Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>0.7082</td>
</tr>
<tr>
<td>$H_2$</td>
<td>0.6044</td>
</tr>
<tr>
<td>$H_3$</td>
<td>0.6141</td>
</tr>
<tr>
<td>$H_4$</td>
<td>0.4614</td>
</tr>
<tr>
<td>$H_5$</td>
<td>0.1119</td>
</tr>
</tbody>
</table>
Table 22. Pairwise comparison of five households for the sanitary facility

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1,1)</td>
<td>(3,4,5,6,7)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1,1,1,1,1)</td>
<td>(2,3,4,5,6)</td>
<td>(3,4,5,6,7)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/6,1/5,1/4,1/3,1/2)</td>
<td>(1,1,1,1,1)</td>
<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1,1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_5$</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

| Normalized Fuzzy Centre Weight | 0.7285 | 0.6009 | 0.6074 | 0.4649 | 0.0983 |

Table 23. Pairwise comparison of five households for the consumer durables

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1,1)</td>
<td>(3,4,5,6,7)</td>
<td>(3,4,5,6,7)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1,1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_5$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

| Normalized Fuzzy Centre Weight | 0.7383 | 0.6175 | 0.5753 | 0.4660 | 0.1030 |

Table 24. Pairwise comparison of five households for the employment – Formal Sector

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
<td>(1,1,1,1,1)</td>
<td>(3,4,5,6,7)</td>
<td>(4,5,6,7,8)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_2$</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1,1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
<td>(3,4,5,6,7)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1,1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_5$</td>
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<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

| Normalized Fuzzy Centre Weight | 0.7062 | 0.6681 | 0.5659 | 0.4584 | 0.1015 |

Table 25. Pairwise comparison of five households for the employment – Informal Sector

<table>
<thead>
<tr>
<th></th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
<th>$H_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1$</td>
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<td>(3,4,5,6,7)</td>
<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_2$</td>
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<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>$H_3$</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>$H_4$</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1,1)</td>
</tr>
<tr>
<td>$H_5$</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
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</tr>
</tbody>
</table>

| Normalized Fuzzy Centre Weight | 0.7389 | 0.6774 | 0.5708 | 0.4099 | 0.1030 |
Table 26. Pair wise comparison of five households for the education

<table>
<thead>
<tr>
<th></th>
<th>H₁</th>
<th>H₂</th>
<th>H₃</th>
<th>H₄</th>
<th>H₅</th>
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<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
<td>(7,8,9,9,9)</td>
</tr>
<tr>
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<td>(1/8,1/7,1/6,1/5,1/4)</td>
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<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>H₃</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1,1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>H₄</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1,1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
</tr>
<tr>
<td>H₅</td>
<td>(1/9,1/9,1/9,1/8,1/7)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1,1)</td>
</tr>
</tbody>
</table>

Normalized Fuzzy Centre Weight

0.7465  0.6576  0.5946  0.4018  0.0995

Table 27. Pair wise comparison of five households for the caste status

<table>
<thead>
<tr>
<th></th>
<th>H₁</th>
<th>H₂</th>
<th>H₃</th>
<th>H₄</th>
<th>H₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁</td>
<td>(1,1,1,1)</td>
<td>(1/8,1/7,1/6,1/5,1/4)</td>
<td>(1,1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
<td>(3,4,5,6,7)</td>
</tr>
<tr>
<td>H₂</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1/7,1/6,1/5,1/4,1/3)</td>
<td>(1,1,1,1,1)</td>
<td>(5,6,7,8,9)</td>
<td>(6,7,8,9,9)</td>
</tr>
<tr>
<td>H₃</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/9,1/8,1/7,1/6,1/5)</td>
<td>(1,1,1,1,1)</td>
<td>(6,7,8,9,9)</td>
<td>(5,6,7,8,9)</td>
</tr>
<tr>
<td>H₄</td>
<td>(1/9,1/9,1/9,1/8,1/7)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1/9,1/9,1/8,1/7,1/6)</td>
<td>(1,1,1,1,1)</td>
<td>(4,5,6,7,8)</td>
</tr>
</tbody>
</table>

Normalized Fuzzy Centre Weight

0.6570  0.6905  0.5801  0.4689  0.1036

Table 28. Confuzzy composite weight for BEN block

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weights of main criteria(Wₘ)</th>
<th>Pairwise compared weights (W_c)</th>
<th>Fuzzy Composite Weights (Wₘ × W_c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staple Food</td>
<td>0.0758</td>
<td>0.7176</td>
<td>0.6726 0.5006 0.4465 0.1627 0.0544</td>
</tr>
<tr>
<td>Adequate Food</td>
<td>0.3810</td>
<td>0.7406</td>
<td>0.6393 0.5339 0.4685 0.1176 0.2822</td>
</tr>
<tr>
<td>Health Condition</td>
<td>0.3609</td>
<td>0.7124</td>
<td>0.6659 0.5683 0.4578 0.0956 0.2571</td>
</tr>
<tr>
<td>Kapda</td>
<td>0.2948</td>
<td>0.6659</td>
<td>0.6618 0.6081 0.4627 0.1015 0.1963</td>
</tr>
<tr>
<td>Types of House</td>
<td>0.1375</td>
<td>0.7429</td>
<td>0.6782 0.4306 0.5096 0.1387 0.1021</td>
</tr>
<tr>
<td>Environment</td>
<td>0.2446</td>
<td>0.6905</td>
<td>0.6771 0.5714 0.4594 0.0961 0.1702</td>
</tr>
<tr>
<td>Safe drinking water facility</td>
<td>0.2620</td>
<td>0.6765</td>
<td>0.5990 0.6605 0.4284 0.1356 0.1773</td>
</tr>
<tr>
<td>Light sources</td>
<td>0.2283</td>
<td>0.7082</td>
<td>0.6044 0.6141 0.4614 0.1119 0.1617</td>
</tr>
<tr>
<td>Sanitation facility</td>
<td>0.1784</td>
<td>0.7285</td>
<td>0.6009 0.6074 0.4649 0.0983 0.1299</td>
</tr>
<tr>
<td>Consumer durables</td>
<td>0.1419</td>
<td>0.7383</td>
<td>0.6175 0.5753 0.4660 0.1030 0.1047</td>
</tr>
<tr>
<td>Formal sector</td>
<td>0.6557</td>
<td>0.7062</td>
<td>0.6681 0.5659 0.4584 0.1015 0.4630</td>
</tr>
<tr>
<td>Informal sector</td>
<td>0.0972</td>
<td>0.7389</td>
<td>0.6774 0.5708 0.4099 0.1030 0.0718</td>
</tr>
<tr>
<td>Education</td>
<td>0.2232</td>
<td>0.7465</td>
<td>0.6576 0.5946 0.4018 0.0995 0.1667</td>
</tr>
<tr>
<td>Caste status</td>
<td>0.0248</td>
<td>0.6570</td>
<td>0.6905 0.5801 0.4689 0.1036 0.0163</td>
</tr>
</tbody>
</table>

Aggregate Weight

2.3538  2.1463  1.9016  1.5047  0.3587
Using the sieve formula we get the Membership values of five households from Ben blocks.

\[
\mu_{\Delta_p}(h_i) = \frac{h_i - \min(h_i)}{\text{Max}(h_i) - \min(h_i)}
\]

| \(H_1\) | \(\frac{2.3538 - 0.3587}{1.9951} = \frac{1.9951}{1.9951} = 1\) |
| \(H_2\) | \(\frac{2.1463 - 0.3587}{1.9951} = \frac{1.7876}{1.9951} = 0.8959\) |
| \(H_3\) | \(\frac{1.9016 - 0.3587}{1.9951} = \frac{1.5429}{1.9951} = 0.7733\) |
| \(H_4\) | \(\frac{1.5047 - 0.3587}{1.9951} = \frac{1.1460}{1.9951} = 0.5744\) |
| \(H_5\) | \(\frac{0.3587 - 0.3587}{1.9951} = \frac{0}{1.9951} = 0\) |

where Minimum Sieve value (\(\min(h_i)\)) is 0.3587 and Maximum Sieve value (\(\text{Max}(h_i)\)) is 2.3538. These data is obtained from the overall aggregate fuzzy weights across the BEN block of Nalanda district, Bihar.

4.3 Poverty Status Category

Table 29. Poverty Status of BEN block

<table>
<thead>
<tr>
<th>Households</th>
<th>Membership values</th>
<th>Poverty Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-1</td>
<td>1</td>
<td>Very Poor</td>
</tr>
<tr>
<td>H-2</td>
<td>0.8957</td>
<td>Almost Very Poor</td>
</tr>
<tr>
<td>H-3</td>
<td>0.7733</td>
<td>Poor</td>
</tr>
<tr>
<td>H-4</td>
<td>0.5744</td>
<td>Rather poor</td>
</tr>
<tr>
<td>H-5</td>
<td>0</td>
<td>Non-poor</td>
</tr>
</tbody>
</table>

5. Result and Interpretation: Poverty Categories

From the Stratified Fuzzy AHP, it is clear that the problem of identifying the poor takes a combination of many process factors. Household-1 with membership value (1.0) is stated very poor, household-2 with membership weight (0.8957) is stated almost very poor, household-3 with membership weight (0.7733) is stated poor, household-4 with membership weight (0.5744) is stated rather poor and household-5 with membership weight (0.0) is stated non-poor.

6. Conclusion

An analysis of poverty is an apt example for working in a fuzzy environment. Impreciseness existing in the crisp decision methodology of estimating poverty had been captured through this paper. It used intrinsic fuzzy decision making technique to capture the level of poverty of the five households. This article represents the subjective arguments by establishing the qualitative multi-criteria fuzzy variables into membership grades like very poor, almost very poor, poor, rather poor and non-poor. Thus the whole data of the subset of the poor has been categorized by sieving out technique. This way the impreciseness or vagueness or uncertainty is accounted as measureable factor using Stratified Fuzzy AHP and Pentagonal Fuzzy Numbers approach. With help of this method the position of one’s level of poverty has been identified. Thus it has been claimed that, with this method one can overcome the dichotomy existing in the traditional (crisp) method of analyzing poverty. Fuzzy set theory can be propagated as further scope to address the real world problem.

7. Acknowledgements

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8. References