Title : Application of the AHP method for the Multi-Criterion choice of women's groups in Burkina Faso

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Summary

Strengthening the role of women in the development process is based on several principles. The principle, the specific actions undertaken for women is of paramount importance for each country.

Some development officials as well as some NGO usually deal with several women's groups but often have to decide to choose one of them. The selection of the latter thus becomes a strategic decision that has a crucial impact on the sustainable development of countries. When making this choice, it is often necessary to take into account several criteria simultaneously.

Several applications of Multi-Criteria decision support models exist in the literature. In this article, the AHP method presented by Thomas L. Saaty has been used to apply it to a multidimensional choice of women's groups. This Multi-Criterion classification approach has been applied to prioritize women's groups in order to support them financially and technically according to their specific needs..

Keywords: women's groups, decision support, Multi-Criterion classification, AHP method.

1. Introduction

In Burkina Faso, in cases where groups or the entire community have to endure a difficult situation (war, famine, pandemic, etc.), it is women who generally bear the heaviest burdens. It should therefore be recognized that most Burkinabe women are to be classified among the most disadvantaged groups of the population. Moreover, it has been shown that specific actions in favour of women have always been beneficial for families and society. To achieve development goals, it is necessary to choose target groups carefully in order to initiate appropriate actions to improve their situation. When identifying this, it is necessary to take into account simultaneously several often conflicting criteria thus making the choice very difficult.

In the literature, there are several Multi-Criterion help methods dedicated to solving this type of problem. In this article, the AHP method presented by Thomas L. Saaty has been used to apply it to a multidimensional choice of women's groups. Thus, in section 2 we present a review of the literature on some applications of the AHP method, we will present the details of the application of AHP on a multidimensional choice of women's groups. After successively, a summary, an introduction, a review of the literature, hypotheses and objectives, the presentation of our application, its limits, a conclusion, will followune bibliographie.

2. State of the art on AHP

In the presence of a single evaluation criterion, the choice of women's groups would be obvious. However, the simultaneous consideration of several criteria has made this task a little more complicated. Several models have been presented in the literature for the Multi-Criteria Classification (MCC) that could be used for the classification of women's groups.

We will focus in the following on the AHP method (Analytic Hierarchy Process) developed in 1980 by Saaty (1980). AHP is recommended to solve complex problems with a multi-criteria decision. The strength of this approach (Al-Harbi, 2001) (Skibniewski et al, 1992) is that it organizes factors in a structured way while giving a relatively simple solution for decision-making problems. It makes it possible to dissect a problem in a logical way by going from a higher level to a lower level until a simple comparison is made for each pair of criteria, then we can go back to the next level for decision-making.

In the application of the AHP, the relative importance or weight of the criteria is determined after consultation with experts or the organization of interviews or group meetings. At this level, the criteria should be compared in pairs separately using a qualitative or quantitative assessment approach. In general, a nine-point numerical scale, called the Saaty scale, is recommended for comparisons. This scale is detailed in Table I.

Table 1: Saaty Scale

Weight or intensity of the comparison	***Verbal judgment of preference***
1	Same importance
3	Moderate importance
5	High importance
7	Very high importance
9	Extreme importance or absolute importance
2, 4, 6, 8	Used for intermediate judgments compared to those listed above.

In the hierarchical analysis process, the relative importance of component or criterion i with respect to component j is determined using the Saaty scale and is assigned to the (i,j)th position of the pairwise comparison matrix. Automatically, the inverse of the assigned number is associated with the (j,i)th position according to the following rule (Chang et al, 2007):

$$a_{ij} > 0\ ,\ a_{ji} = \frac{1}{a_{ji}}\ ,\ \ a_{ii} = 1$$

Once the pairwise comparison matrix is formed, the eigenvalues associated with this matrix are determined. The choice will then be made on the highest eigenvalue. For the latter it is a question of determining the associated eigenvector. The terms of this column matrix constitute the weights or coefficients of importance of the different criteria. It should be noted that the calculation procedure described by Wabalickis (1987) and Cheng et al (2001) is used to obtain the eigenvector. Using this procedure, it is possible to identify standardized

coefficients of importance with a sum equal to 1 or 100% if they will be expressed in percentages. A weighted score is then calculated for each individual in order to rank them in descending order according to this score. Each individual's S_i score is calculated as a weighted score. Thus we take into account the coefficients or eigenvalues λ_j relating to each classification criterion and also the priority values y_{ij} as follows:

$$S_i = \sum_{j=1}^{n} \lambda_j * y_{ij}$$

In this hierarchical approach to classification, it is also possible to verify the consistency of our approach by calculating the consistency or consistency ratio (CR). The latter is a test of acceptance of the weights of the different criteria. This step aims to detect possible inconsistencies in the comparison of the importance of each pair of criteria. The CR consistency ratio is calculated as follows:

$$CR = \frac{CI}{RI}$$

With CI, the consistency index and RI, a randomized index. The consistency index is calculated as follows:

$CI = \frac{\lambda_{max} - n}{n-1}$; λ_{max} : maximum eigenvalue; n : number of criteria

The randomized index is a value that depends on the size of the matrix, i.e. the number of criteria envisaged:

Table 2: The Randomized Index

Matrix size	3	4	5	6	7	8	9	10
RI	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

According to the work of Yurdakul et al (2004), the CR value must be less than 0.1 to conclude that pairwise comparison judgments are consistent. On the other hand, if the CR value is greater than 0.1 the coefficients of the matrix are inconsistent and cannot be referred to for further analysis (Wong et al, 2007).

AHP has been applied in several areas such as car purchasing (Byun, 2001), supplier selection (Tam el al, 2001) and computer software supplier selection (Mamaghan, 2002). Also, Yurdakul (2004), adopted the AHP approach to the choice of production machines. This was also the case for the multi-criteria choice of the location of a factory by Chan et al (2004).

In our case we will apply the AHP method for the classification of suppliers of a dairy plant in Tunisia.

3. Assumptions / Objectives

Carry out a ranking of the most deserving women's groups with a view to encouraging them to:

- achieve more good performances in the various activities carried out;
- diversify the fields of activity.

4. Research Design and Methodology

Choice of criteria

In Burkina Faso, the activities that are possible and likely to guarantee sustainable development are: the processing of raw products into semi-finished or finished products, agriculture, handicrafts, the marketing of local products.

Table 3: Criteria and sub-criteria

Criteria	**Description/Sub-criteria**
Processing of raw products into semi-finished or finished products: C1	C11 : The transformation of cotton into yarn, C12 : The transformation of shea nuts into butter, C13 : The transformation of néré grains into soumbala.
Agriculture : C2	C21 : Practice of the cultivation of millet, C22 : Practice of peanut cultivation, C23 : Practice of cowpea cultivation, C24 : Practice of sesame cultivation.
Craftsmanship : C3	C31 : Pottery, C32 : Basketry, C33 : Weaving.
Marketing of local products: C4	C41 : The sale of cotton yarn, C42 : The sale of shea butter, C43 : The sale of soumbala, C44 : The sale of agricultural products and handicrafts.

Choice of actions

Burkina Faso, there are more than 400 women's associations and groups. As the country has very limited resources, it is very difficult to provide adequate assistance to all women's groups. A preliminary pre-selection of women's groups was carried out in order to select only those with a wide field of activities. This step made it possible to select 6 women's groups (see figure below).

The multidimensional classification of groupings was carried out according to four criteria, each multiplied into sub-criteria and presented in Table 1. Data for the six groupings are presented in Table 2.

Women's Group: G1

Women's Group: G2

Women's Group: G3

Women's Group: G4

Women's Group: G5

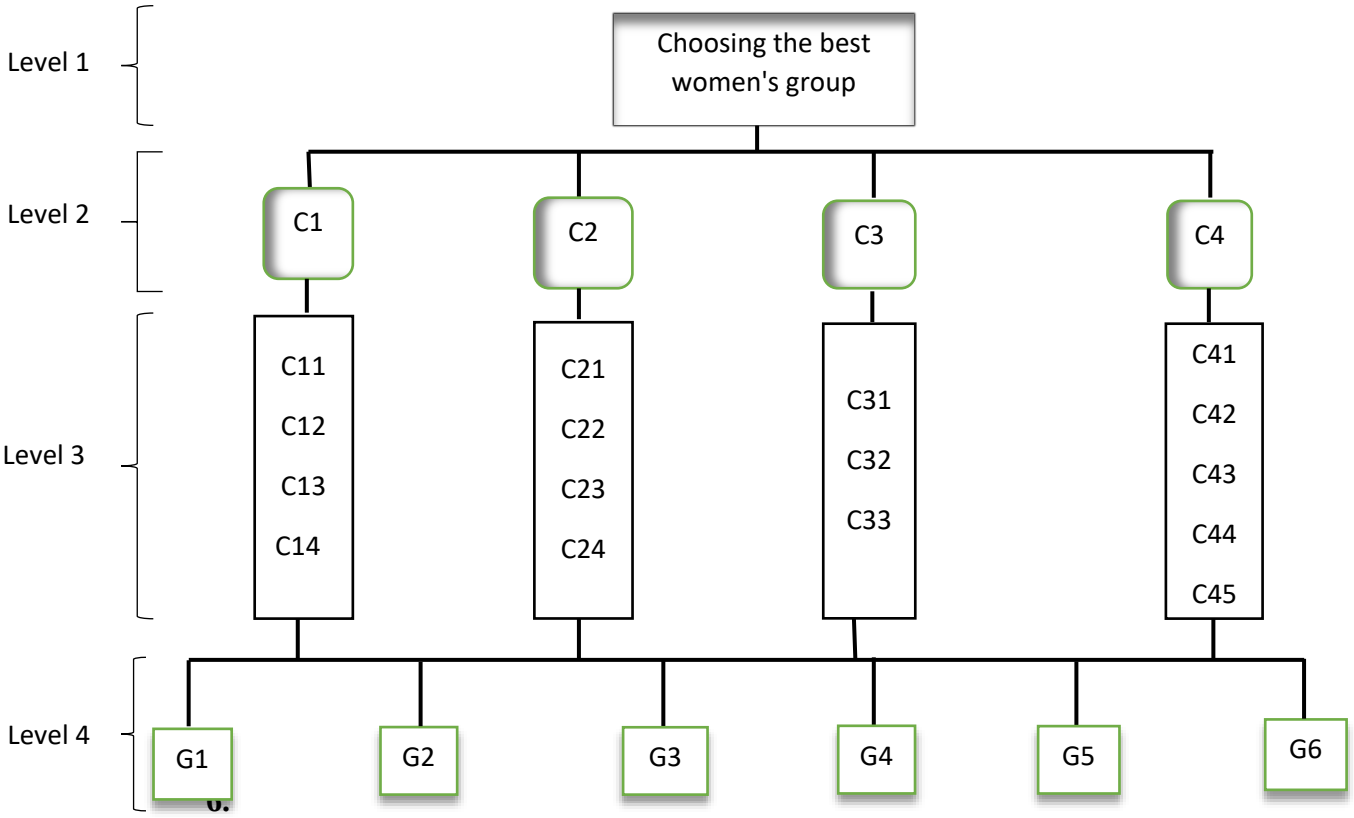
Women's Group: G6

Table 4: The six women's groups selected

Grouping /Criterion	C1	C2	C3	C4
G1	C11 : 1 ton of cotton C12 : 0.6 ton of shea nuts C13 : 2 tons of néré grain	C21 : 25 tons of millet C22 : 13 tons of groundnuts C23 : 4 tons of cowpea C24 : 1 ton of sesame	C31 : 1800 pots C32 : 14050 baskets C33 : 50000 fabrics	C41 : 500000FCFA of cotton yarn C42 : 1200000FCFA of shea butter C43 : 2000000FCFA of soumbala C44 : 1600000FCFA of agricultural and artisanal product
G2	C11 : 1.5 ton of cotton C12 : 0.8 ton of shea nuts C13 : 1 tons of néré grain	C21 : 10 tons of millet C22 : 1513 tons of groundnuts C23 : 7 tons of cowpea C24 : 2 tons of sesame	C31 : 500 pots C32 : 21050 baskets C33 : 400 fabrics	C41 : 608000FCFA of cotton yarn C42 : 1400100FCFA of shea butter C43 : 2000000FCFA of soumbala C44 : 800000FCFA of agricultural and artisanal product
G3	C11 : 3 ton of cotton C12 : 0.2 ton of shea nuts C13 : 0.5 tons of néré grain	C21 : 14 tons of millet C22 : 2913 tons of groundnuts C23 : 4 tons of cowpea C24 : 0.6 t ton of sesame	C31 : 1800 pots C32 : 14050 baskets C33 : 50000 fabrics	C41 : 1804000FCFA of cotton yarn C42 : 400000FCFA of shea butter C43 : 2800000FCFA of soumbala C44 : 400000FCFA of agricultural and artisanal product
G4	C11 : 0.6 ton of cotton C12 : 1 ton of shea nuts C13 : 1.3 tons of néré grain	C21 : 6 tons of millet C22 : 1313 tons of groundnuts C23 : 4 tons of cowpea C24 : 27 tons of sesame	C31 : 1520 pots C32 : 14050 baskets C33 : 1355 fabrics	C41 : 290000FCFA of cotton yarn C42 : 1200000FCFA of shea butter C43 : 2000000FCFA of soumbala C44 : 908000FCFA of agricultural and artisanal product
G5	C11 : 1 ton of cotton C12 : 1 ton of shea nuts C13 : 4 tons of néré grain	C21 : 15 tons of millet C22 : 0.813 tons of groundnuts C23 : 3 tons of cowpea C24 : 4 tons of sesame	C31 : 1600 pots C32 : 12050 baskets C33 : 5407 fabrics	C41 : 470000FCFA of cotton yarn C42 : 1500000FCFA of shea butter C43 : 2090000FCFA of soumbala C44 : 3900000FCFA of agricultural and artisanal product
G6	C11 : 0.3 ton of cotton	C21 : 12 tons of millet	C31 : 2100 pots C32 : 1213 baskets	C41 : 200000FCFA of cotton yarn

	C12 : 0.6 ton of shea nuts C13 : 0.8 tons of néré grain	C22 : 1313 tons of groundnuts C23 : 4 tons of cowpea C24 : 0.2 ton of sesame	C33 : 453 fabrics	C42 : 1600000FCFA of shea butter C43 : 900000FCFA of soumbala C44 : 1728000FCFA of agricultural and artisanal product

Organizational chart



7. Data Analysis/Model

The preferences of decision-makers with regard to the criteria have been translated into matrix form as follows:

Table 5: Comparison matrix of criteria pairs and priority

Criterion	C1	C2	C3	C4	Priority
C1	1	1/7	1/2	3	0.11
C2	7	1	3	9	0.61
C3	2	1/3	1	6	0.23
C4	1/3	1/9	1/6	1	0.05
Sum	10.33	1.58	4.66	19	1

The consistency ratio found is 0.02, a value smaller than 0.10.

It can therefore be concluded that the degree of consistency in comparisons is acceptable.

Table 6: Summary of sub-criteria into criteria

Grouping / Criterion	C1	C2	C3	C4
G1	3.6 tons	43 tons	65850 valuables	5.300.000 FCFA
G2	3.3 tons	34 tons	1110 valuables	4.808.100 FCFA
G3	3.7 tons	47.6 tons	39850 valuables	5.404.000 FCFA
G4	2.9 tons	50 tons	16925 valuables	4.398.000FCFA
G5	6 tons	22.8 tons	19057 valuables	7.960.000 FCFA
G6	1.7 tons	29.2 tons	3766 valuables	4.428.000 FCFA

$$m_j = \frac{max\{g_{ij}\} - min\{g_{ij}\}}{n}$$

If the Cj criterion is to be maximized then:

$$J_{ij} = \begin{cases} arr\left(\frac{|g_{ij}-g_{ij}|}{m_j}+1\right) \; si \; g_{ij} > g_{lj} \\ \frac{1}{arr\left(\frac{|g_{ij}-g_{lj}|}{m_j}+1\right)} \quad otherwise \end{cases}$$

If criterion Cj is to be minimized then:

$$J_{ij} = \begin{cases} arr\left(\frac{|g_{ij}-g_{ij}|}{m_j}+1\right) \; si \; g_{ij} < g_{lj} \\ \frac{1}{arr\left(\frac{|g_{ij}-g_{lj}|}{m_j}+1\right)} \quad otherwise \end{cases}$$

Table 7: Matrix of comparisons of actions against criterion C1

Grouping	G1	G2	G3	G4	G5	G6	Priority
G1	1	2	1/2	2	1/5	4	0.13
G2	1/2	1	1/2	2	1/5	4	0.11
G3	2	2	1	3	1/5	4	0.17
G4	1/2	1/2	1/3	1	1/6	3	0.07
G5	5	5	5	6	1	7	0.48
G6	1/4	1/4	1/4	1/3	1/7	1	0.04
Sum	9.25	10.75	7.58	14.33	1.90	23	1

The consistency ratio found is 0.01, a value smaller than 0.10.

It can therefore be concluded that the degree of consistency in comparisons is acceptable.

Table 8: Matrix of comparisons of actions against criterion C2

Grouping	G1	G2	G3	G4	G5	G6	Priority
G1	1	3	1/2	1/3	6	4	0.18
G2	1/3	1	1/4	1/5	4	2	0.09
G3	2	4	1	1/2	7	5	0.26
G4	3	5	2	1	7	6	0.38
G5	1/6	1/4	1/7	1/7	1	1/3	0.03
G6	1/4	1/2	1/5	1/6	3	1	0.06
Sum	6.75	13.75	4.09	2.34	28	18.33	1

The consistency ratio found is 0.009, a value smaller than 0.10.

It can therefore be concluded that the degree of consistency in comparisons is acceptable.

Table 9: Matrix of comparisons of actions against criterion C3

Grouping	G1	G2	G3	G4	G5	G6	Priority
G1	1	7	4	6	6	7	0.49
G2	1/7	1	1/5	1/3	1/3	1/2	0.04
G3	1/4	5	1	3	3	5	0.22
G4	1/6	3	1/3	1	1/2	3	0.09
G5	1/6	3	1/3	2	1	3	0.11
G6	1/7	2	1/5	1/3	1/3	1	0.05
Sum	1.87	21	6.06	12.66	11.16	19.5	1

The consistency ratio found is 0.05, a value smaller than 0.10.

It can therefore be concluded that the degree of consistency in comparisons is acceptable.

Table 10: Matrix of comparisons of actions against criterion C4

Grouping	G1	G2	G3	G4	G5	G6	Priority
G1	1	2	1/2	3	1/6	3	0.13
G2	1/2	1	1/2	2	1/7	2	0.08
G3	2	2	1	3	1/6	3	0.15
G4	1/3	1/2	1/3	1	1/7	1	0.05
G5	6	7	6	7	1	7	0.54
G6	1/3	1/2	1/3	1	1/7	1	0.05
Sum	10.16	13	8.66	17	1.76	17	1

The consistency ratio found is 0.003, a value smaller than 0.10.

It can therefore be concluded that the degree of consistency in comparisons is acceptable..

Table 10: Summary matrix of priorities and scores

Grouping / Criterion	C1	C2	C3	C4	Score
Weight	0.11	0.61	0.23	0.05	
G1	0.13	0.18	0.49	0.13	0.24
G2	0.11	0.09	0.04	0.08	0.08
G3	0.17	0.26	0.22	0.15	0.23
G4	0.07	0.38	0.09	0.05	0.26
G5	0.48	0.03	0.11	0.54	0.12
G6	0.04	0.06	0.05	0.05	0.05

The ranking of women's groups from best to worst is: Women's Group 4, Women's Group 1, Women's Group 3, Women's Group 5, Women's Group 2, Women's Group 6.

8. Limitations

The sincerity of the information received during the interviews was not verified. Therefore, the results presented in this article should be considered with reservation. Also, when summarizing the above-criteria into criteria, the weighted sum was used, which has many shortcomings including the compensation of weak sub-criteria by strong ones.

9. Conclusion

The application of the AHP method for the Multi-Criterion classification of women's groups made it possible to include, in addition to the classic criteria, sub-criteria. This further reinforces Multi-Criterion decision-making in the choice or selection of women's groups.

Also, the authority in charge of development will be able to set up a targeted reward policy according to the performance of each women's group. By also considering the calculated scores, which incorporate sub-criteria, the authority could support women's groups through technical assistance or other services.

This AHP approach to multi-criterion classification of women's groups remains flexible through either the change of evaluation criteria or the integration of new criteria to better select or prioritize groups..

Finally, as an extension to this research work, a sensitivity analysis can be conducted by slightly changing the coefficients of the pairwise comparison matrix and see the impact at the level of the classification of groupings. This will make it possible to detect the subjective impact of setting the comparison coefficients per pair..

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