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Geographical indications for supporting rural development in the context of the Green Morocco Plan: Oasis dates

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Details on the AHP technique

Before using the Analytical Hierarchy Process (AHP) technique, a multivariate analysis is conducted at two stages. First, a factor analysis is used to reduce the dimensions of the data. A cluster analysis serves for identifying consumer types. This technique categorizes a set of observations into a given number of groups. This grouping is based on the idea of similarity between observations, which is quantified by some distance measure. The objective is to segment the observations into homogeneous groups of individuals based on a set of characteristics.

The AHP technique starts by the construction of the decision hierarchy and priority settings. It then checks the logical consistency of the analysis (Saaty 1984). AHP begins with the establishment of the hierarchy. The top level of the hierarchy contains the main objective which is the final goal of the analysis. The intermediate levels are the criteria to be evaluated. The elements of the same level must be mutually independent but still comparable (Udo 2000). To realize the binary comparisons and determine the intensity of preferences for each option, it is necessary to compare all criteria for a given level of the hierarchy by pairs (Saaty 1984). To implement this comparison, Saaty (1980) proposed the use of a 9 points scale.

The procedure can be formalized as follows. The symbol W in Equation (2) denotes the relative weight of attributes (A_n) and levels ($L_{n.p}$) where $n = 1, ..., N$ is the number of attributes and $p = 1, ..., P$ is the number of levels. These weights quantify

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the relative importance of each attribute. They are obtained from pair-wise comparisons of a given attribute with all other ones. As a result, a matrix with the following structure is generated for each individual k = 1, ..., K interviewed is known as a Saaty matrix:

$$S_k = \begin{bmatrix} a_{11k} & a_{12k} & \dots & a_{1Pk} \\ a_{21k} & a_{22k} & \dots & a_{2Pk} \\ \dots & \dots & a_{npk} & \dots \\ a_{N1k} & a_{N2k} & \dots & a_{NPk} \end{bmatrix} \quad (1)$$

where: a_{npk} – the value obtained from the comparison between attribute n/level p and attribute n^*/level p^* for each individual k.

This matrix has two basic properties. First, all elements of its main diagonal take unity ($a_{npk} = 1\ \forall n = p$). Second, the pair-wise comparisons (off-diagonal elements) are reciprocal (if $anpk = x$ then $apnk = 1/x$). In the case that a decision maker has perfectly consist preferences, then $anhk \times ahpk = anpk$ for all n, p and h ($h \in N$ and $h \in P$). This condition implies that values given for pair-wise comparisons represent weights given to each objective by a perfectly rational decision-maker $anpk = wnk/wpk$ for all n and p. Consequently, this matrix can also be specified as follows:

$$S_k = \begin{bmatrix} \frac{w_{1k}}{w_{1k}} & \frac{w_{1k}}{w_{2k}} & \dots & \frac{w_{1k}}{w_{Nk}} \\ \frac{w_{2k}}{w_{1k}} & \frac{w_{2k}}{w_{2k}} & \dots & \frac{w_{2k}}{w_{Nk}} \\ \dots & \dots & \frac{w_{nk}}{w_{pk}} & \dots \\ \frac{w_{Nk}}{w_{1k}} & \frac{w_{Nk}}{w_{2k}} & \dots & \frac{w_{Nk}}{w_{Nk}} \end{bmatrix} \quad (2)$$

The k weights (w_{Nk}) for each attribute and K weights (w_{Pk}) for each level can be easily determined from the $N(N-1)/2$ values and $P(P-1)/2$ values for $a_{npk,}$ respectively.

Giving that some degree of inconsistency is always present; several alternatives have been proposed to estimate the weights vector that better represents the decision-maker than the observed weights vector. Saaty (1980 and 2003) proposes the geometric mean and the main eigenvector, that is, the principal eigenvector corresponding to the main eigenvalue. Laininen and Hämäläinen (2003) propose alternatives based on regression analysis or goal programming (Bryson 1995). Following Aguarón and Moreno-Jiménez (2000) and Kallas et al. (2011) the geometric mean is chosen since no consensus has been reached regarding which alternative outperforms the others (Fichtner 1986).

For this specification, the weights assigned by each individual to each attribute and level are obtained using the following expression:

$$w_{nk} = \sqrt[N,P]{\prod_{n=1}^{n=N,P} a_{npk}} \qquad \forall n, k \quad (3)$$

Using the geometric mean, the corresponding individual weights (w_{nk}) are aggregated across subjects to obtain a synthesis of weights for each attribute and level (w_n).

Following Forman and Peniwati (1998), the weights for each attribute and level can be expressed as follows:

$$w_n = \sqrt[K]{\prod_{k=1}^{k=K} w_{nk}} \qquad \forall n \quad (4)$$

Following Malvinas et al. (2005), the global weights of each of the levels and of each of the attributes ($W_{G\_Ln.p}$) are calculated by multiplying aggregated levels' weights (w_n for each level L_{np}) by its corresponding weight (w_n) of attribute (A_{n}):

$$w_{G\_Ln.p} = w_{An} \times w_{L} \quad (5)$$

where:

$$\sum w_{G\_Ln.p} = 1$$

When the hierarchy has several levels, priorities are called global options. They are then calculated by multiplying the local priorities of a group of factors by the percentage assigned to each category (Forman and Gass 2001). In this way, the overall priorities for the entire hierarchy are obtained as well as an order of preferences related to the analyzed options (Liang 2003).