Example of construction of the GNH

The whole process of GNH after initial data collection is demonstrated here for the purpose of illustrating both, its mathematical and scientific soundness, and resulting complexity. In this example, matrix -data consists:

Rows 1-4: Psychological dimension; life satisfaction, emotional well-being, spirituality, and reduction of stress

Rows 5-9: Cultural dimension; *sense of identity; core values, beliefs, norms and customs; and participation in various cultural activities*

Results for this example have been collected from a subjective questionnaire. Sufficiency cutoffs are determined, for example, by screening questionnaires carried over population. Single cutoff is the determined point where the effect of, for example, planned project results in neutral or positive outcome in that measurable GNH –dimension viewed.

Step 1. Apply sufficiency cutoff to obtain insufficiency headcounts

Matrix A:

$$\begin{bmatrix} 1 & 3 & 30 & 4 & 3 & 4 & 3 & 1 & 2 \\ 1 & 2 & 30 & 3 & 3 & 10 & 2 & 2 & 2 \\ 1 & 2 & 24 & 3 & 3 & 50 & 2 & 2 & 1 \\ 1 & 3 & 30 & 4 & 3 & 10 & 2 & 2 & 2 \end{bmatrix}$$

Sufficiency cutoff

[3 3 26 3 3 11 2 2 2]

A measured factor is insufficient if in a given indicator the achievement is less than the respective cutoff.

Whether the data are cardinal or ordinal, matrix A is constructed, where results are presented in numbers and compared to their respective cutoffs. By comparison, recoded entries are changed into either 1 i.e. if they fall below the sufficiency cutoffs and into 0 if they have achieved equal or above the cutoffs.

Step 2. Calculation of distance from cutoff

For the above example, the matrix A would therefore give the following matrix B.

Matrix B:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}$$

The distances from cutoffs are calculated for the entries of variables that are measured insufficient (denoted by 1) by using the following formula:

-For variables where minimum are zeros such as voluntary days and amount donated, distance from cutoff is calculated by (sufficiency cutoff- actual) / (sufficiency cutoff). For variables where minimum is one, distance from cutoff is calculated by (sufficiency cutoff- actual) / (sufficiency cutoff) – (one). For example, variable located at column 3 row 3 gives therefore (26-24) / (24)-(1) = approximately 0,08

This way, the height (meaning distances from the cutoffs) will rise if any single factor inside variable moves further from the sufficiency cutoff. After applying the calculation of distances from the cutoffs, Matrix B would generate Matrix C:

Step 3. Squaring distance from the cutoff

Matrix C:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0.64 & 0 & 1 & 0 \\ 1 & .50 & 0 & 0 & 0 & 0.09 & 0 & 0 & 0 \\ 1 & .50 & 0.08 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0.09 & 0 & 0 & 0 \end{bmatrix}$$

-In order to give a greater weight to high and low achievements, and place a stronger value on equality, the distances from the cutoffs of each indicator may also be squared prior to aggregation to emphasize the severity of possible insufficiencies.

Step 4. After squaring, the GNH Index is computed.

Matrix D:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & .40 & 0 & 1 & 0 \\ 1 & .25 & 0 & 0 & 0 & .01 & 0 & 0 & 0 \\ 1 & .25 & .01 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & .01 & 0 & 0 & 0 \end{bmatrix}$$

-Squaring reflects the possible *inequality*, for example, of achievements among the diversified persons, above or below the cutoffs, thereby placing attention also to achievements outside average.

Step 4a. GNH Index = 1- Squared Distance from Cutoff

Matrix E:

$$\begin{bmatrix} 0 & 1 & 1 & 1 & 1 & .60 & 1 & 0 & 1 \\ 0 & .75 & 1 & 1 & 1 & .99 & 1 & 1 & 1 \\ 0 & .75 & .99 & 1 & 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 1 & .99 & 1 & 1 & 1 \end{bmatrix}$$

Step 4b. GNH Index = Average(1- squared distance from cutoff) or 1- Average squared distance from cutoff.

Hence in this case GNH Index is:

=(1+0.75+0.75+1+1+1+0.99+1+1+1+1+1+1+1+1+1+0.60+0.99+1+0.99+1+1+1+1+1+1+1+1+1)/36 = 0.808

Matrix D:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & .40 & 0 & 1 & 0 \\ 1 & .25 & 0 & 0 & 0 & .01 & 0 & 0 & 0 \\ 1 & .25 & .01 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & .01 & 0 & 0 & 0 \end{bmatrix}$$

Matrix D comprises of the squared distances from cut-offs. In order to give equal weights to each dimension, each of the four indicators in psychological well being is assigned a weight of 0.25 and similarly, each of the five indicators in culture is assigned 0.2.

Then the weighted Matrix D is as follows:

$$\begin{bmatrix} .25 & 0 & 0 & 0 & 0 & .08 & 0 & .2 & 0 \\ .25 & .0625 & 0 & 0 & 0 & .002 & 0 & 0 & 0 \\ .25 & .0625 & .0025 & 0 & 0 & 0 & 0 & 0 & .2 \\ .25 & 0 & 0 & 0 & 0 & .002 & 0 & 0 & 0 \end{bmatrix}$$

Next, the average squared distance from cutoff is calculated for each indicator in each dimension.

[.25   .03125   .000625   0   0   .021   0   .05   .05]

So, GNH Index for psychological wellbeing is 1 Sum of squared distances from cutoffs for four psychological wellbeing indicators. Here, instead of average the sum of squared distances from cutoffs are calculated because the weights add up to 1 in each dimension.

=1- (.25+.03125+.000625+0)   Likewise, for culture:
=1- .281875   =1- (0+.021+0+.05+.05)
=.718   =1- .121
                                    =.879

To calculate the percentage contribution by each dimension to the final GNH index, one sums the squared distances from cutoff in each dimension and divides this sum by the total squared distances from cutoff experienced in the example. Results are used to measure development of the perceived GNH and are seen relational. The new methodology for Gross National Happiness Index consist of

(I) A cutoff identification method that identifies sufficiency both in terms of achievements in each dimension, and achievements across a range of dimensions and

(II) An aggregation methodology that satisfies a range of desirable properties including decomposability. (http://www.grossnationalhappiness.com)