

Measuring the Quality of Life Using Multiple Factor Analysis for Contingency Tables

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Abstract: The aim of this study is to measure European countries of the quality of life scores compared to a demographic variables of gender using multiple factor analysis for contingency tables (MFACT). The goal of multiple factor analysis (MFA) is to integrate different groups of variables describing the same observations. MFA is used in very different domains. For example, when a quality of life survey is performed in different countries, specific problems arise, ranging from obtaining equivalent questionnaires to managing the comparison of social features. In this study we showed the use of MFACT applied to a quality of life survey conducted by Eurofound (2003). We took European countries of the quality of life survey in analysis. We analyzed four variable categories (Afford, Attitude, Satisfaction and Quality) according to countries and gender by MFA. The results of the MFA started with the analysis of the eigenvalues of the weighted principal component analysis (PCA). We had almost 71% of the variability in the first two factors. We found that it wasn't important gender for quality of life. It was obtained EU member countries were very close, acceding countries were very close and candidate countries are very close according to country groups. We examined quality of life survey's variables in four categories according to gender in this study. It can be examined variables according to the other demographic variables like education level, age and etc.

Keywords: Life Quality, Multiple Factor Analysis, Contingency Tables, Correspondence Analysis, European Union

INTRODUCTION

Quality of life, which has gained prominence in social research study since the 1970s, is a broad concept concerned with overall well-being within society [1]. The term "quality of life" is extremely complex; it is affected by a number of factors, and in the literature is interpreted in different ways. It should be noted that the history of the term itself depends on the work of economists and sociologists [2]. In the last decades, scientists offered several alternative approaches to defining and measuring quality life: social indicators such as health and levels of crime, subjective well-being measures (assessing people's evaluative reactions to their lives and societies, and economic indices [3]. Also there are main approaches as philosophical for determining quality of life [4]. Some authors pointed out relationship among approaches [4, 5].

Three major characteristics are associated with the quality of life concept:

1. Quality of life refers to individuals' life situations. The concept requires a micro perspective, where the conditions and perceptions of individuals play a key role. Macroscopic features relating to the economic and social situation of a society are important for putting the findings at individual level into their proper context, but they do not take center stage.
2. Quality of life is a multi-dimensional concept. As noted above, the notion of quality and the consideration of several areas of life broaden the narrower focus on income and material conditions which prevails in other approaches. Multi-dimensionality not only requires the description of several life domains, but emphasizes the interplay between domains as this contributes to quality of life.
3. Quality of life is measured by objective as well as subjective indicators. Subjective and attitudinal perceptions are of particular relevance in identifying individual goals and orientations. Individual perceptions and evaluations are most valuable when these subjective evaluations are linked to objective living conditions. Applying both ways of measuring quality of life gives a more complete picture [6].

Generally it is used six indicators area for measuring quality of life in data base. These are:

- Employment
- Economic resources
- Family and households
- Community life and social participation

- Health and health care
- Knowledge, education and training.

Our study purpose is to measure quality of life indicators. We use some of the six indicators mentioned above. It is used MFACT to measure quality of life indicators.

Firstly, we explained MFACT and correspondence analysis (CA) in method. Secondly we determined our data and analyzed in application. Then we obtained the results of analysis. We have mentioned conclusions in the last section.

METHOD

MFA [7] analyzes observations described by several “blocks” or sets of variables. MFA seeks the common structures present in all or some of these sets. MFA is performed in two steps. First a PCA is performed on each data set which is then “normalized” by dividing all its elements by the square root of the first eigenvalue obtained from of its PCA. Second, the normalized data sets are merged to form a unique matrix and a global PCA is performed on this matrix. The individual data sets are then projected on to the global analysis to analyze communalities and discrepancies.

MFA is used to analyze a set of observations described by several groups of variables. The number of variables in each group may differ and the nature of the variables (nominal or quantitative) can vary from one group to the other but the variables should be of the same nature in a given group. The analysis derives an integrated picture of the observations and of the relationships between the groups of variables.

The goal of MFA is to integrate different groups of variables describing the same observations. In order to do so, the first step is to make these groups of variables comparable. Such a step is needed because the straightforward analysis obtained by concatenating all variables would be dominated by the group with the strongest structure. A similar problem can occur in a non-normalized PCA: without normalization, the structure is dominated by the variables with the largest variance. For PCA, the solution is to normalize (*i.e.*, to use Z-scores) each variable by dividing it by its standard deviation. The solution proposed by MFA is similar: To compare groups of variables, each group is normalized by dividing all its elements by a quantity called its *first singular value* which is the matrix equivalent of the standard deviation. Practically, this step is implemented by performing a PCA on each group of variables. The first singular value is the square root of the first eigenvalue of the PCA. After normalization, the data tables are concatenated into a data table which is submitted to PCA [8].

CA is usually extended to multiple contingency tables by using simple CA on concatenated tables (see Fig. 1) [9-12].

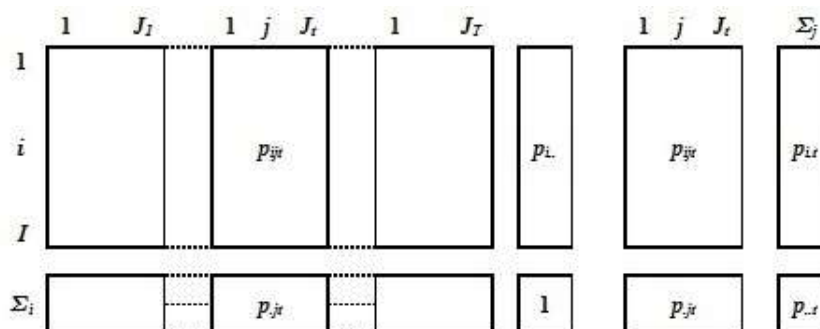


Fig-1: Notation for multiple contingency tables

When the sums along the rows (row margins) are not proportional through all the tables, the column subclouds do not have the same centroids and the inertia between subclouds is not zero. This between tables inertia, frequently due to different quotas imposed on the samples, as in our example, must not intervene in the study of the association between rows and columns. Furthermore, some tables can play a dominating role, which contradicts the aim of a simultaneous analysis to study the tables jointly in an equitable manner. Lastly, the representation of rows corresponds to the whole set of concatenated tables, without any reference to the row structure induced by each table. To solve these difficulties, we have proposed [13, 14] a methodology for a global analysis of several contingency tables, called multiple factor analysis for contingency tables (MFACT).

MFACT combines internal correspondence analysis, as a solution to the difference between margins, and MFA in order to balance the influence of the different tables in a global analysis as well as to provide tools to compare the row structures induced by each table in a Procrustean way. There are two steps of the MFA methodology as first step: pseudo separate analysis and second steps: global analysis [15].

MFA is used in very different domains such as

Survey: An individual is a person; a variable is a question. Questions are gathered according to the different themes of the questionnaire. Each theme defines one set.

Sensory analysis: An individual is a food product. A first set of variables includes sensory variables (sweetness, bitterness, etc.); a second one includes chemical variables (pH, glucose rate, etc.).

Ecology: An individual is an observation place. A first set of variables describes soil characteristics; a second one describes flora.

Time series: Several individuals are observed at different dates. In such a case, there is often two ways of defining sets of variables: generally, each set gathers variables observed at one date; but, when variables are the same from one date to the other, each set can gather the different dates for one variable [16]. We used MFA as survey domain in this study. Our data obtained from the quality of life survey. There were questions for different themes in quality of life survey. Also all questions were related to above explain six indicators.

Application

In application of this study we used European Quality of Life Survey was carried out by Intomart GFK in 28 countries: the 15 EU Member States before May 2004 (EU15); the 10 acceding countries which became Member States in May 2004 (NMS); and the three candidate countries Bulgaria, Romania and Turkey (CC3). Around 1.000 persons aged 18 and over were interviewed in each country, except for the 'smaller' countries – Cyprus, Estonia, Luxembourg, Malta and Slovenia – where around 600 interviews were conducted. The questionnaire was developed by a research consortium and covers a broad spectrum of life domains with an emphasis on employment and working conditions, housing, family, social and political participation, quality of society, and subjective well-being [1]. Also there were demographic variables in questionnaire like gender, age.



Fig-2: Life satisfaction across Europe satisfaction means

DATA

In this study we demonstrate the use of MFACT applied to a quality of life survey conducted by Eurofound [1]. In our application the data correspond to determine quality of life in 28 Europe countries according to gender variable. Since gender is an important demographic variable to explain relationship with the other questions in quality of life

survey, we choose gender variable. The data set comprises 56 observations and 45 dimensions in Table 1. The dimensions can be grouped into 4 categories.

Table-1:Data Set

<i>Country-Gender</i>	<i>a1</i>	<i>a2</i>	<i>a3</i>	<i>a4</i>	<i>a5</i>	...	<i>Qa</i>	<i>Qb</i>	<i>Qc</i>	<i>Qd</i>	<i>Qe</i>
Austriam	0,3863	0,6014	0,5095	0,4145	0,2652	...	8,0540	7,9928	7,1091	7,4632	5,1679
Austriaf	0,1904	0,5523	0,7256	0,4221	0,2802	...	8,0245	8,0455	7,2968	7,6035	5,1915
Belgiumm	0,1786	0,3324	0,3569	0,7956	0,6531	...	7,5438	7,2798	6,2816	7,0238	6,5455
Belgiumf	0,2201	0,3910	0,4370	0,7037	0,5174	...	7,5577	7,4010	6,6111	7,1443	6,5714
Bulgariam	0,2645	0,4182	0,4939	0,7893	0,1913	...	3,4397	4,5093	4,7565	3,2381	3,0762
Bulgariaf	0,2994	0,4063	0,3979	0,8865	0,1574	...	3,7059	4,5700	4,9437	3,9694	3,4619
...
Swedenm	0,3811	0,7083	0,4334	0,4445	0,1506	...	6,5813	6,5158	6,4074	5,9366	5,2060
Swedenf	0,3757	0,9296	0,2721	0,3689	0,1262	...	6,8212	6,9071	6,9374	6,2152	5,3080
Turkeym	0,6476	0,6145	0,4658	0,3350	0,0803	...	3,7484	4,1935	4,7780	4,0347	4,1656
Turkeyf	0,6658	0,5415	0,4626	0,3392	0,1829	...	3,9340	4,6850	5,0689	4,4435	4,4874
Portugalm	0,5869	0,4804	0,4354	0,3416	0,4336	...	4,9613	5,3687	5,5822	5,0630	5,1861
Portugalf	0,3501	0,5484	0,8096	0,3278	0,0941	...	4,8724	5,4264	5,5037	5,1636	5,2077

The first variables are related to afford (There are some things that many people cannot afford, even if they would like them. For each of the following things on this card, can I just check whether your household can afford it if you want it? Yes, can afford. No, cannot. Don't know). There are some questions under first variable like; Keeping your home adequately warm, Paying for a week's annual holiday away from home, Replacing any worn-out furniture, A meal with meat, chicken or fish every second day if you wanted it, Buying new, rather than second-hand, clothes, Having friends or family for a drink or meal at least once a month.

The second variables are related to attitude (Please tell me whether you agree completely, agree somewhat, disagree somewhat or disagree completely with each statement. Agree completely. Agree somewhat. Disagree somewhat. Disagree completely). There are some questions under second variable like; Health services, education system, public transport, social services, state pension system.

The next variables are related to satisfaction (All things considered, how satisfied would you say you are with your life these days? For this question Fig. 2 shows Europe satisfaction means. Could you please tell me on a scale of one to 10 how satisfied you are with each of the following items, where one means you are very dissatisfied and 10 means you are very satisfied?). There are some questions under this variable like; I am optimistic about the future, In order to get ahead nowadays you are forced to do things that are not correct, I feel left out of society, Good luck is more important than hard work for success.

The last variables related to (In general, how would you rate the quality of each of the following public services in country? Please tell me on a scale of one to 10, where one means very poor quality and 10 means very high quality) There are some questions under last variable like; Your education, Your present job, Your present standard of living, Your accommodation, Your family life, Your health, Your social life.

The main goal of this application is to understand how country relate to each other, and to identify which criteria seem to agree or disagree and see how the quality life of Europe countries is explained in several tables of different type variables. So we use MFACT in XLSTAT Statistical software for analyze these variables groups. Separate analyses are run on each table. If the table includes quantitative variables, the analysis that is performed is a PCA. For tables with qualitative variables, an MCA is performed. So in our case, an MCA is run, followed by 4 PCAs. The results of these preliminary analyses are then used in the final analysis, the second phase of the MFA.

Analysis

The results of the MFA start with the analysis of the eigenvalues of the weighted PCA. We can see Table 2 that with the first two factors we have almost 71% of the variability. After we analyzed the correlation map of the variables, we can see this map in Fig. 3. It shows that the Afford Y variables are highly related to a few variables (Quality c, Satisfaction a for example), and they are correlated with the first factor. We can also confirm the fact that the a few

variables (Quality e, Satisfaction b for example) are highly correlated with the first axis. Last, the Afford N variables are highly correlated with a few Attitude variables.

Table-2: MFACT Eigenvalues

	F1	F2	F3	F4	F5
Eigenvalue	3,528	0,604	0,385	0,294	0,176
Variability (%)	60,546	10,357	6,600	5,054	3,012
Cumulative (%)	60,546	70,903	77,503	82,556	85,568

The map of the partial axes in Fig. 4 allows seeing how the factors generated by the separate analyses of the first phase are related to the MFA factors. We can see that there is quite a significant relationship between the initial factors and the factors of the MFA.

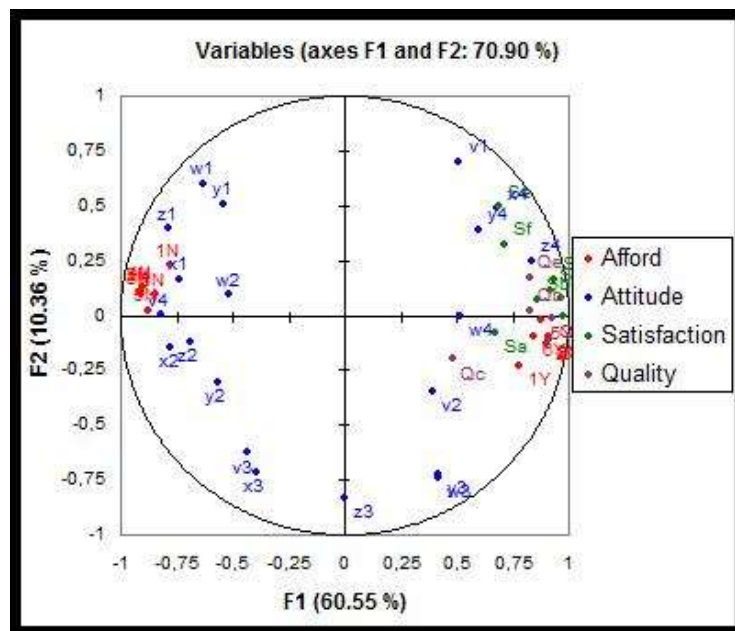


Fig-3: The Correlation map

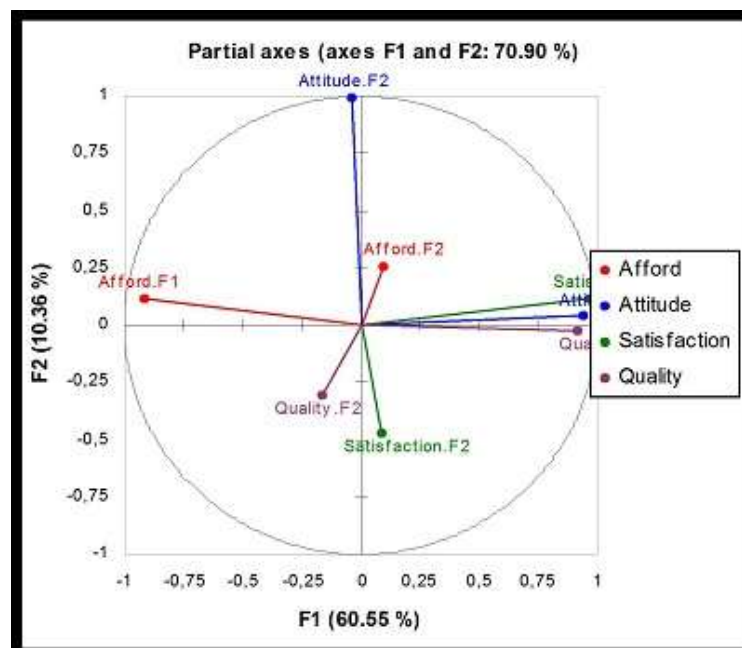


Fig-4: The map of the partial axes

Fig. 5 shows display of observation. We can see all European countries & gender in this figure. It can be seen that females and males of every country are very close in Fig. 5.

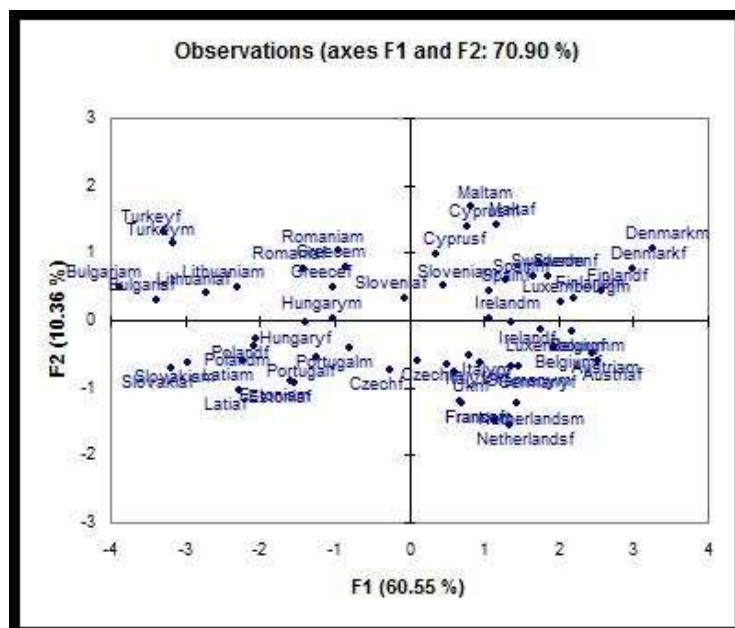


Fig-5: Display of observation

CONCLUSION

As a conclusion, MFACT is an interesting and rich method because it makes it possible to analyze complex data sets, and because it provides many graphical results: we can visualize tables (in which variables are grouped), the variables themselves, and the observations. In quality of life example, it allowed us to quickly position country and gender on a map, while being able to quickly interpret their position.

According to MFACT results; those who say yes to Affordvariable are close Quality of variable a and c (Health services - Public transport) are close. Also they have a relationship with Satisfaction variables a (Your education).

Those who say no to Affordvariable are close to those who completely agree with Attitude variable.

Satisfaction variables b, d, e, f, and g (Your present job, Present standard of living, Family life, Health and social life) are close Quality of variable e and b (Education system - State pension system). Also they have a relationship with Satisfaction variables a (Your education).

Those who say agree somewhat and disagree somewhat in attitude variables are together in general.

In general there isn't important gender for quality of life. Because they have almost same quality of life characteristics for every countries.

It can be seen some countries are close as observation in a group. It is seen 4 country groups: 1. Group: Turkey, Romania, Bulgaria, Lithuania, Greece and Hungarian. 2. Group: Finland, Denmark, Malta, Cyprus, Sweden and Spain. 3. Group: Belgium, Netherlands, Italy, Germany, Austria and Ireland. 4. Group: Poland, Portugal, Czech and Latvia. It may be said EU member countries are very close, acceding countries are very close and candidate countries are very close according to country groups.

We examined quality of life survey's variables in 4 categories according to gender in this study. It can be examined variables according to the other demographic variables like education level, age and etc. Also it can be updated quality of life survey for years. Then it can be compared results according to years and see how data of quality of life survey has changed for years.

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