Construction and analysis of a composite quality of life index for a region of South Africa

Talita Dalton-Greyling and Fiona Tregenna

ERSA working paper 481

November 2014

Economic Research Southern Africa (ERSA) is a research programme funded by the National Treasury of South Africa.
The views expressed are those of the author(s) and do not necessarily represent those of the funder, ERSA or the author's affiliated institution(s). ERSA shall not be liable to any person for inaccurate information or opinions contained herein.

Construction and analysis of a composite quality of life index for a region of South Africa*

Talita Dalton-Greyling and Fiona Tregenna†

November 21, 2014

Abstract

This study employs a novel approach to measure and analyse quality of life in the Gauteng City-Region of South Africa. A comprehensive composite index is constructed. Comparing the quality of life of different groups, groups such as Africans, residents in urban informal settlements and females scoring relatively low. The weighting of the dimensions of quality of life is compared across groups, with 'housing and infrastructure' and 'social relationships' explaining the most variance for groups with lower and higher quality of life respectively. The findings emphasise the unevenness of wellbeing. The study provides a basis for measuring and analysing quality of life in other countries.

Key words: *quality of life, wellbeing, composite indices, Gauteng City-Region, measuring instruments*

JEL classification codes: *C38, I31, O15, O18, R11*

1 Introduction

Quality of life has gained increasing prominence, both in the academic literature and in policy discourse. This derives in part from growing recognition of the inadequacy of economic growth as a measure of progress.

The improvement of the quality of life of all people in South Africa is high on the policy agenda at both national and regional levels (see for instance National Planning Commission, 2012 and Gauteng Planning Commission, 2012). However, quality of life is more amorphous, multi-faceted and difficult to measure than economic growth. Recognition of the importance of improving quality of life thus points to the importance of reliable and appropriate ways of measuring it. For both analytical and policy purposes, there is a need for a composite index of quality of life, which can measure the overall quality of life of people as well as tracking it over time and comparing it across different groups or areas.

*Acknowledgements: We thank the Gauteng City-Region Observatory for access to the GCRO Quality of Life Survey data set and for financial support.

†University of Johannesburg. Corresponding author e-mail: talitag@uj.ac.za

Such a measure could identify those demographic and socio-economic groups with relatively low quality of life as well as identifying the specific dimensions of quality of life which should be prioritised in order to improve overall wellbeing.

This article analyses quality of life in the Gauteng City-Region (GCR) of South Africa. There are three key contributions to the literature First, we construct a composite index of quality of life which is objectively weighted and which includes objective and subjective as well as economic and non-economic measures. To construct the composite index we adapt and extend the method developed by Nicoletti, Scarpetta and Boylaud (2000), which was developed for the construction of composite indices in the field of market regulations, and for the first time apply it to the field of quality of life. Second, this constructed composite index is used to calculate and compare the quality of life of different demographic and socio-economic groups in the GCR. This is particularly important in the light of the high inequality and uneven development within this region. Third, the relative explained variance of the various dimensions of quality of life is compared for different demographic and socio-economic groups. This is accomplished by conducting separate Categorical Principal Components Analysis (CATPCA) for each group

With 22% of the national population (11.2 million inhabitants), the Gauteng city-region is the largest and richest region in South Africa, contributing to one-third of national GDP (OECD, 2011). The area encompasses a series of connected cities, including Johannesburg and the national capital of Tshwane (formerly Pretoria), that function as a single, integrated region. Gauteng has been South Africa's growth engine: for every additional 1% growth in population in the province, 1.6% is added to its contribution to national growth, implying higher productivity than in other parts of the country. Nevertheless, the city-region's growth potential is constrained by deep socio-economic challenges, including high unemployment (26.9%)[1] and low productivity growth (OECD, 2011). Its rapid demographic and economic development has also reinforced the spatial segregation instituted under apartheid.

The remainder of this paper is structured as follows Section 2 reviews the relevant literature on quality of life, and the data used is described in section 3. Section 4 sets out the methodology used to construct the composite index. In section 5 we discuss the constructed composite index and section 6 compares the quality of life of different groups in the GCR using this index Section 7 analyses which components of quality of life explain the most variance in the quality of life of the different demographic and socio-economic groups Section 8 concludes

2 Literature on quality of life measures

We begin by reviewing the international literature on composite quality of life indices and on the measurement of quality of life. Thereafter, we discuss existing measures and literature on quality of life in South Africa as well as findings

[1] The narrow unemployment rate of the Gauteng city-region (OECD, 2011).

comparing the quality of life of different socio-economic and demographic groups in the country

2.1 Composite indices of quality of life

There is no standard definition of quality of life According to Sumner (2004), the definition of quality of life has evolved from a purely economic to a multi-dimensional concept. Influential contributors to the development of the theory of quality of life include Sen, 1985; Nussbaum, 1988; Cummins, Mc Cabe, Romeo & Gullone, 1994; Narayan, Chambers, Shah & Petesch, 2000; Alkire, 2002; Alkire & Foster, 2007 and Alkire & Santos, 2013.

As the theoretical approaches to quality of life advanced, so did the measurement of the concept. Quality of life was originally measured or proxied by a single economic indicator, GDP. This approach has been replaced by broader measures of wellbeing (Larson, 1979) Attempts to measure quality of life going beyond GDP have traditionally included two approaches. The first is an 'objective' approach in which various social indicators were used to complement GDP, for example literacy rates or life expectancy. The second approach is subjective in nature, using measures that are personal judgments of objective conditions expressed as satisfaction or happiness (Möller & Schlemmer, 1983).

Since the 1990s there has also been a movement to construct composite indices of quality of life that are multi-dimensional. According to Sharpe and Smith (2005, p.7) a composite index is 'the aggregation of individual indicators into a single index or bottom line using a certain weighting scheme'. Selection of the indicator variables and the weighting of the index are regarded as two of the main challenges in the construction of composite indices (McGranahan, Richard-Proust, Sovani & Subramanian 1972). The indicators included in the index and the weighting method should address the research questions, the index should be acceptable to policy-makers as well as the people whose quality of life is assessed, and it should be a true reflection of the measured quality of life.

Probably the best known and most widely used composite index is the Human Development Index (HDI) of the United Nations (UN) Human Development Program (UNDP), which is based on Sen's (1985) 'capabilities and functionings' theory of human development. It combines indicators of life expectancy, educational attainment and income into a composite index (United Nations Development Programme (UNDP), 2010). The main criticisms of this measure are that it includes only three quality of life dimensions, the dimensions are exclusively objectively measured and the dimensions are equally weighted (Dowrick, Dunlop & Quiggin, 2003). Other composite indices which are frequently either used or referenced in the international literature or in policy include the Physical Quality of Life Index (Morris, 1979), the Quality of Life Index (Dasgupta & Weale, 1992), the Comprehensive Quality of Life Survey (Cummins, et al., 1994), the Combined Quality of Life Indices (Diener, 1995), the Index of Economic Wellbeing (Osberg & Sharpe, 2000) and the Economist Intelligence Unit's Quality of Life Index (Economist Intelligence Unit, 2005).

Interest in the measurement of quality of life heighted with the publication of

the Report on the Measurement of Economic Performance and Social Progress (Stiglitz, Sen & Fitoussi, 2009). The report argued that GDP is not an adequate measure of economic progress and drew attention to the importance of developing a multi-dimensional measure of quality of life In the same vein, the World Happiness Report (United Nations, 2012) also emphasised the shortcomings of an income measure to measure wellbeing and underscored the importance of subjective measures of happiness to measure progress.

Measures of wellbeing have also been developed for individual countries and country groups The first of these indices was developed by the Kingdom of Bhutan measuring Gross National Happiness instead of Gross National Product (Centre for Bhutan Studies, 2008). A number of composite indices followed including 'Beyond GDP' (European Commission, 2007), the Canadian Wellbeing Index (University of Waterloo: Faculty of Applied Health Science, 2009) 'Your Better Life Index' (Organisation for Economic Co-operation and Development (OECD), 2011) and the Happiness Index of the United Kingdom (UK) (Office for National Statistics of the United Kingdom, 2012). Other countries including the USA, Australia, Brazil, Canada, Denmark, New Zealand, South Korea, Japan and China, have announced their intention to follow the wellbeing and happiness initiatives to measure development (United Nations, 2012)

Similar dimensions of quality of life tend to be consistently used in most international quality of life indices. These common dimensions are: housing, income, employment, community involvement, education, civic engagement, good governance, health, life satisfaction, safety, culture, work life balance, an environmental dimension and certain demographic variables. These dimensions are used as a guideline in the selection of the domains to be included in a composite quality of life index developed for the GCR in this study.

2.2 Quality of life in South Africa

There are a number of existing quality of life indices and measures of wellbeing in South Africa. These include the South African Development Index of the South African Institute of Race Relations (2011) and the Quality of Life Index of the Gauteng City-Region Observatory (GCRO) (2011) the Everyday Quality of Life Index (Higgs, 2007) the Quality of Metropolitan City Life in South Africa (Naudé, Rossouw & Krugell, 2009) and the Non-Economic Quality of Life Index at Sub-National Levels (Rossouw & Naude, 2008) Living Standard Measure (LSM) Index produced by the South African Audience Research Foundation (SAARF) (2013) The oldest initiative on the measurement of quality of life in South Africa is the Quality of Life Trends Project (Möller, 2012) which commenced in 1983 While these indices provide important information on quality of life, they are mostly not comprehensive measures, in that they measure only objective or subjective quality of life or economic or non-economic quality of life. Of the existing composite indices, the dimensions of quality of life are mostly equally weighted, which is not generally appropriate or optimal.

Furthermore, of the few composite indices of quality of life that have been constructed for South Africa none fulfil the criteria deemed desirable for quality

of life indices as derived from the literature and critique on existing measures of quality of life (Stiglitz, et al., 2009). These derived criteria are: objective weighting, with heavier weighting of those dimensions regarded as having more influence on quality of life (OECD, 2008); the inclusion of both subjective and objective indicator measures (Cummins, 1996); and the inclusion of both economic and non-economic indicator measures of quality of life (Stiglitz, et al., 2009). This study addresses this gap in the literature by developing an objectively weighted composite index of quality of life for the GCR, which is weighted according to the variance in the data and which includes objective and subjective, as well as economic- and non-economic indicator variables.

Several studies compare quality of life amongst different racial groups in South Africa. As would be expected, African households are found to be worse off than other groups (see Möller and Schlemmer, 1883; Klasen, 2000; Möller, 2002; Higgs, 2007; Posel & Casale, 2011; GCRO 2011; Möller, 2012 and the Human Sciences Research Council, 2013). These findings reflect South Africa's apartheid history and the ongoing legacy thereof There are only a few studies comparing quality of life for demographic and socio-economic groups other than race. This literature finds women, people in rural areas and people over the age of 46 to have poorer levels of quality of life than others (see Klasen, 2000; Higgs, 2007; Rossouw & Naudé, 2008; GCRO, 2011).

Finally the literature regarding which factors that play the biggest roles in influencing wellbeing in South Africa generally identify important factors as housing, basic services, social relationships, education, health, employment and safety. Amongst these factors, housing and basic services, employment and education are found to contribute most to the wellbeing of people (see Kingdon and Knight, 2003; Bookwalter, Fuller and Dalenberg, 2006; Higgs, 2007; Hinks & Gruen, 2007; GCRO, 2011; Posel & Casale, 2011; Möller, 2012; Greyling, 2013; Human Sciences Research Council 2013).

3 Data

This study utilises a data set that was collected by the GCRO (2009) specifically to measure quality of life in the Gauteng CityRegion. The survey covered many dimensions of quality of life including both objective and subjective indicator variables, rendering it ideal for this analysis. The only notable omission is of variables to measure the environmental dimension of quality of life The GCRO used a stratified sampling method to collect the data. The sample was stratified by municipality to ensure significant coverage. A total of 6639 respondents in 602 wards in 17 different municipalities were interviewed (GCRO, 2011). The data is regarded as broadly representative of the population of the GCR.

Table 1 summarises the demographic and socio-economic characteristics of the sample population. The vast majority of the respondents in the sample resided in urban areas, indicating the degree of urbanisation in the GCR. The low level of household income for the majority of respondents is apparent.[2] The

[2] The income figure includes salaries, grants, pensions and any other source of income.

share of the income of the lowest decile of income earners in the GCR was only 0.2% compared to the top decile earners' share which was 67.7% (GCRO, 2011) This reflects the considerable skewness of the income distribution in the GCR The sample broadly represents the demographic distribution of South Africa, with approximately 80% of the respondents being African.

4 Methodology

4.1 Overview

The methodology used discussed in three parts, corresponding to the three aspects of the research and the presentation of results. Firstly, Section 4.2 discusses the steps followed to construct the composite index of quality of life. This entailed the selection of appropriate indicator variables to be included in the composite quality of life index (see section 4.2.1), the weighting and aggregation of the composite index and a brief description of Categorical CATPCA (see section 4.2.2) and correlation analyses to test the robustness of the composite index. Secondly, this index was used to compare quality of life for different population sub-groups in the region; the methodology for this is explained in section 4.3. Thirdly, separate CATPCAs are run for population sub-groups to determine the dimensions of quality of life which explain the most variance in the data for the specific group (see section 4.4).

4.2 Methodology used to construct the composite index

The general procedure in the construction of a composite index is to select and prepare the indicator variables to include in the composite index, to weight and aggregate the indicator variables and to test the robustness of the composite index (OECD, 2008). Each of these steps is discussed in turn here. The results from this part of the analysis are presented in section 5.

4.2.1 Selection and preparation of indicator variables

Selection of the indicator variables to be included in the composite index of quality of life was guided by the dimensions used in existing international and South African indices and identified as important in the relevant literature. The dimensions of quality of life most often included in the indices are: housing and infrastructure (basic services), social relationships, an economic dimension, education, health, governance, civic engagement, safety, satisfaction with life and an environmental dimension. Based on the availability of indicator variables

Household income was used in the analysis as neither individual income nor a continuous income variable were available in the survey. An individual income measure was calculated, converting bracket midpoints to a per capita measure. This was found to be highly correlated with the household income measure. The estimated per capita measure was also used in the analysis as a robustness check, and the results were highly consistent with those from the household measure, which was preferred. R1 is approximately US$0.9 (March 2014).

in the data set to measure the dimensions, a range of relevant indicator variables were selected, from which the final selection was made. Unfortunately the data set had no relevant indicator variables on the environment.

All ordinal variables were recoded to have the same direction of coding, such that one indicated the most 'negative'. Nominal variables were transformed into dichotomous variables with a value of either one or zero (see Appendix A for coding of variables).

The selection of indicator variables was refined into a parsimonious set of variables giving a good representation of the data through successive rounds of PCA (see section 4.2.2). Different combinations of the indicator variables were used to eliminate those variables with the lowest communalities (amount of variance in the indicator explained by the component). The final selection of indicator variables explains the most variance in the data set. The selected indicator variables and their descriptive statistics are shown in Table 2.

4.2.2 Weighting and aggregation of the composite index

Here we discuss the different methods of weighting indices and briefly explain the statistical methods PCA and CATPCA, a type of PCA which is used to analyse categorical data. Furthermore we discuss the method of Nicoletti et al. (2000) as adapted to construct composite indices of quality of life.

Most studies use equal weighting in constructing composite indicators (Hagerty & Land, 2007), avoiding the need to attach different importance to the various dimensions. Alternative methods of weighting composite indices have been developed to improve on the method of equal weighting (Njong & Ningaye, 2008). One approach is the use of subjective weighting methods, which depend on a researcher's own judgement or the judgement of experts or participatory methods (OECD, 2008). Although subjective weighting is an improvement on equal weighting, these methods might not be rigorously constructed and may not have credibility among either the communities being analysed or policymakers.

Multivariate statistical methods can also be used to weight and aggregate variables in a composite index. An advantage of these methods is that they require no a priori assumptions on the weights of the different dimensions. According to Booysen (2002) PCA and Factor Analysis (FA) are the most frequently used multivariate statistical techniques used in the weighting of composite indices. In selecting between the two methods Tabachnick and Fidell (2007) recommend the use of PCA if the researcher needs an empirical summary of the data set that explains the maximum variance with a unique mathematical solution and the use of FA if the researcher is interested in a theoretical solution without error variability or without a unique mathematical solution.

PCA is a multivariate statistical technique that reduces the observed variables to a number of orthogonal principal components that explain as much of the variance in the data as possible.[3] The extracted components reveal which variables are highly correlated and form coherent subsets. The variables that

[3] For a detailed explanation of PCA methods see Tabachnick and Fidell (2007).

are highly correlated have high factor loadings on a specific component. These components are expected to reveal the underlying latent components that have created the correlation among the variables (see Tabachnick & Fidell 2007) for a comprehensive explanation of PCA). This feature of PCA is very useful to identify the underlying dimensions of quality of life and the variables which measure the different dimensions. Therefore it is a useful method to select the variables that should be included in a composite index (Somarriba & Pena, 2009). Each consecutive extracted component explains less of the variance in the data set. This feature of PCA contributes to understanding the dimensions of quality of life which explains the most variance for specific demographic and socio-economic groups.

In PCA the weights are derived from the factor loadings of the measurement indicators on each of the extracted components and are fixed across all groups. Therefore it is an ideal method to use to weight composite indices constructed for the purpose of comparing the quality of life of different socio-economic and demographic groups The standard method when applying PCA as a weighting technique is to use the factor loadings of the measuring indicators on the first component (Klasen, 2000) The first component is generally sufficient to adequately represent the original variables (Ram, 1982). However, if the explanatory value of the first component is not sufficient to represent the data these methods do not lead to the construction of representative composite indices.

To address this shortcoming, we use the method developed by Nicoletti et al., (2000). This method considers the factor loadings of the first extracted component as well as the factor loadings of the consecutive extracted components to weight a composite index. The benefit of this method is that a higher proportion of the variance in the data set is explained.

The method of Nicoletti et al. (2000) was developed to construct composite indices in the study field of 'market regulations' in which the data incorporated in the indices is continuous, therefore standard PCA was used to extract the principal components.

However, standard PCA has two important limitations: it assumes that the relationships between variables are linear and that the data is scaled at the numeric level of either a ratio or an interval scale of measurement. These limitations make standard PCA to underperform in the analysis categorical data used here. Nonlinear PCA methods have been developed to address these limitations of standard PCA (see Linting, Meulman, Groene, Van der Kooij, 2007 and for more details on the mathematics of nonlinear PCA see Gifi, 1990 and Meulman, Van der Kooij & Heiser, 2004). Nonlinear PCA converts categorical variables into numeric variables and therefore is also known as categorical PCA (CATPCA).

CATPCA quantifies the categorical variables through the process of 'optimal scaling', with the quantified categorical variables referred to as category quantifications. The category quantifications for a variable together form that variable's transformation. Optimal quantification replaces the category labels with category quantifications so that the maximum possible variance in the

quantified variables is accounted for, similar to the analysis of continuous variables in standard PCA.

As standard PCA underperforms in the analysis of categorical data we adapted the methodology of Nicoletti et al. (2000) and used CATPCA to extract the principal components. Because CATPCA performs better than standard PCA in the analyses of categorical data the results often explain more variance than using standard PCA. This implies improved representation of the original data set.

Individual measuring indicators with the highest factor loadings on a specific extracted component were grouped into intermediate composite indices. The weighting of each of the variables in the intermediate composite index is derived by squaring the factor loadings of the variables and scaling it to unity sum within each intermediate composite index. The squared factor loadings represent the proportion of the total variance of the indicator which is explained by the component. Once the intermediate composite indices have been constructed, they are aggregated by allocating a weight to each of them equal to the proportion of the explained variance of the component in the data set. The weight of each consecutive intermediate composite index in the composite index falls as the explained variance of the component decreases.

In mathematical terms the aggregation of the intermediate composite indices to derive at the composite index of quality of life (CIQ) is as follows:

$$CIQ_i = \sum_{i=1}^{5} (ICI_i w_i)) \; x \; 100 \tag{1}$$

Where CIQ is the composite index of quality of life, ICI_i = Intermediate Composite Index (i=1...5), and $w_i$is the weight of the i^{th}ICI determined by the explained variance of the intermediate composite index (extracted component) in the data set

The last step in the construction of a composite index is to test the robustness the index. We used correlation analyses to test the robustness of the composite index (see Groh & Wich, 2009). The degree and statistical significance of the correlation between the composite index and traditional single-dimensional measures of quality of life such as income or subjective wellbeing give an indication of the robustness of the composite index.

4.3 Method used to derive and compare the quality of life scores for different groups

We next used the newly constructed composite index to calculate and compare the mean quality of life scores of the different demographic and socio-economic groups. Furthermore we investigated possible reasons to explain the variation of quality of life scores between the groups. The findings from this part of the analysis are presented in section 6.

4.4 Method for comparing the order of the extracted components of quality of life for different demographic and socio-economic groups

Finally we used CATPCA to extract the principal components of the different demographic and socio-economic groups in the region to highlight the dimensions of quality of life which explained the most variance in the data of the different groups. According to the methodology of Nicoletti et al. (2000) the dimension which explains the most variance in the data carries a bigger weight in the composite index. Therefore based on the weighting method of Nicoletti et al. (2000) we can make certain assumptions about the order of the priorities of the different groups. These results are discussed in section 7.

5 A composite quality of life index

To construct the composite index of quality of life we followed the steps explained in the methodological section and firstly ran a CATPCA on the selected indicator variables. The first step in running a CATPCA is to determine the number of components to extract. There are three techniques that guide the decision to the number of components to extract namely the Kaiser rule[4], the scree plot rule[5] and the interpretability of the rotated component matrix[6] Considering all three the guidelines we decided to extract five components. Due to the orthogonal (uncorrelated) nature of the data we used the varimax method to rotate the data[7]

The rotated data reflected a simpler and a better interpretable component structure

The five extracted components explained more than 59% of the variation in the data set, which was an acceptable value of explained variance to be used in further analyses (for comparative studies see Vyas & Kumaranayake, 2006; Rossouw & Naudé, 2008; Naudé et al., 2009; Lewer, Pacheco & Rossouw, 2009 and Rossouw & Pacheco, 2012).

Table 3 shows the pattern and structure matrix of the five extracted components with varimax rotation using CATPCA. To construct the intermediate composite the indicator variables with the highest factor loadings on a component (in bold) were grouped together and weighted according to the squared

[4] The Kaiser rule, known as the Kaiser's criterion or the eigenvalue rule, is related to the eigenvalue of each principal component. The eigenvalue (variance) for each principal component indicates the percentage of variation explained in the total data set. Using this rule, components with an eigenvalue of 1.0 or more are extracted.

[5] The scree plot shows each of the eigenvalues of the components. According to the scree plot rule the number of components to extract can be determined by identifying the point on the scree plot at which the shape of the curve changes direction and becomes horizontal. All the components above this point can be retained.

[6] The extracted components after rotation must be interpretable.

[7] Components are rotated to minimise the number of individual variables that have a high loading on a specific component.

factor loadings scaled to unity sum (as explained in section 4.2.3). Each of the intermediate composite indices was given a descriptive name.

The indicator variables with the highest factor loadings on the first extracted component were 'piped water on premises' (0.669), 'electricity used for lighting' (0.805) and 'type of dwelling' (0.836). After the factor loadings of each of the indicator variables were squared and scaled to unity sum (see right hand side of Table 3), the weights of the indicator variables in the intermediate composite index were: 'piped water on premises' (27%), 'electricity used for lighting' (35%) and 'type of dwelling' (38%) These indicator variables were aggregated to derive an intermediate composite index designated 'housing and infrastructure'. The 'housing and infrastructure' intermediate composite index explains 35% of the variance in the data set Therefore it has the highest weight in the composite index of quality of life (see table 3 under the heading 'total percentage of explained variance'). The indicator variables included in the 'housing and infrastructure' intermediate composite index vary greatly among the respondents and have an important role in accounting for the different levels of quality of life.

Economically, this dimension represents one of the basic needs of people. According to Maslow's (1943) hierarchy of needs, it is one of the first needs that people need to fulfil. The finding concerning the importance of this dimension is consistent with previous research (see for instance Bookwalter et al., 2006; Hinks & Gruen, 2007; Richards, O'Leary & Mutsonziwa, 2007; GCRO, 2011, Möller, 2012). These studies show that the fulfilment of basic needs such as living in a house and having access to basic services are some of the biggest contributors to the quality of life and subjective wellbeing of the people living in South Africa.

The variables 'satisfied with time available for family' (0.821), 'satisfied with time available for own things' (0.746) and 'satisfied with time available for friends' (0.692) had the highest factor loadings in the second component. In the same manner as described for the construction of the 'housing and infrastructure' intermediate composite index an intermediate composite index labelled 'social relationships' was constructed. After the factor loadings of the indicator variables were squared and scaled to unity sum the derived weight of each of the indicator variables included in the intermediate composite index was 36% for the indicator variable 'were satisfied with time available for family', 34% for the indicator variable 'satisfied with time available for own things' and 30% for the indicator variable 'satisfied with time available for friends'. Social relationships are also a need described by Maslow (1943), who argued that people need to be loved and cherished and to feel part of a community. This dimension explained the second most variance in the data set and carried a weight of 22% in the quality of life composite index.

In the third component the variables with the highest factor loadings were 'work' (0.765), 'income' (0.684), 'level of education' (0.622) and 'satisfaction with life' (0.483) which carried weights of 35%, 28%, 23% and 14% respectively in the intermediate composite index. These variables are related to economic issues, with education playing an important role in employment and income (Berenger, 2007). Furthermore, 'satisfaction with life' is highly correlated with

economic variables These indicator variables were weighted and aggregated to form an intermediate composite index designated 'socio-economic status'. This dimension explained the third most variance in the data set, and carried a weight of a 16.9% in the composite quality of life index.

'How often does health prevent you from taking part in social activities' (0.846) and 'satisfaction with health' (0.629) were the two variables with the highest factor loadings on the fourth component. We weighted and aggregated the two health indicator variables in the same manner as previously explained with weights of 51% and 49%. The intermediate composite index was labelled 'health'. This dimension is related to the basic functioning of people, as health is essential to fulfil the end goals of human life and is integrally related to virtually all other aspects of life. This dimension explained 14.4% of the variance in the data set and had a corresponding weight in the composite index of quality of life.

In the fifth component the variables with the highest factor loadings were 'feel safe at home' (0.568), 'satisfaction with local government' (0.660) and 'judiciary is free' (0.738); these indicators reflect functionings of a higher order. The weight allocated to each of the indicator variables included in the intermediate composite index was 22%, 34% and 43% respectively. We labelled the intermediate composite index 'governance and safety'. This dimension explained 11.7% of the variance in the data and carried this weight in the composite index of quality of life. In the literature it has been shown that satisfaction with the government of a country is highly correlated with wellbeing (Dasgupta & Weale, 1992)

Finally we constructed the composite index of quality of life by weighting and aggregating each of the intermediate composite indices with the explained variance in the data set Note that the weighting of each consecutive intermediate composite index contributed less to explaining the variance in the data set, decreasing from 35% to 11.7%.

After the construction of the composite index, we tested the robustness of the index through correlation analysis (see section 4.4.). We correlated the values of the composite index to traditionally used single-dimensional measures of quality of life, namely income and satisfaction with life, using the income and life satisfaction variables from the data set.

The composite quality of life index was positively and strongly correlated with both income (correlation 0.553) and satisfaction with life (correlation 0.659), with both of these coefficients statistically significant at the 1% level. The correlation between the composite quality of life index and each of income and satisfaction with life is of course not perfect, as the index is more comprehensive and holistic than either of these individual measures. It also needs to be borne in mind that both income and life satisfaction are amongst the variables included in the composite index. Nonetheless, the positive and statistically significant correlation coefficients are indicative as to the robustness of the composite index.

6 Comparison of the quality of life scores of different groups

The newly constructed quality of life index can be used to compare the quality of life scores of different demographic and socio-economic groups within the GCR. Figure 1 shows the quality of life scores for the different groups Quality of life is compared here by geographical area comparing formal and informal urban areas[8], income category, race, sex and age. Within these categories, the groups with the lowest quality of life scores were respondents living in informal areas, respondents in a household earning less than R800 per month, African respondents and people over the age of 65

The results for each of these categories can be considered in turn in more detail. In terms of area, the finding that the quality of life of informal residents is lower than that of formal residents is consistent with previous findings (see Klasen 2000; Higgs, 2007 and Rossouw & Naudé 2008). By way of interpretation, the differences between informal and formal areas could possibly be explained by the lower income levels reported by respondents in informal areas (R2 400 compared to R4 800 per month for formal residents), lower levels of employment (35% compared to 46% of the group) and less access to formal housing and infrastructure (calculations based on GCRO data (GCRO, 2009)) In formal areas almost all the respondents resided in formal dwellings (95%) and had electricity for lighting (93%) and the majority had water on their premises (79%). By contrast, only 77% of the informal respondents resided in formal dwellings, 84% had electricity for lighting and only 60% had water on their premises

Measuring the quality of life scores based on different income groups, the lowest quality of life score was for households in the lowest income bracket. Interestingly quality of life increases as income increases up to the second highest income bracket, but declines in the highest income bracket. This finding of an 'inverted-U' relationship between income and quality of life corresponds with the findings of Easterlin (1974) concerning subjective wellbeing. He finds that as income increases subjective wellbeing increases up to a certain point, after which it starts to decline. It is noteworthy that our findings on quality of life, a multi-dimensional measure, accord with Easterlin's findings on subjective wellbeing, a single-dimensional measure Descriptive analysis of the data suggests that the dip in quality of life for the top bracket of income earners is associated with the lower levels of 'satisfaction with time spent with family and friends', 'satisfaction with leisure time' and lower levels of overall 'life satisfaction'.

The positive relationship between income and quality of life up to a point is arguably related to the important role of income in financing the meeting of basic needs and in enhancing capabilities. Low income is also associated with unemployment (or underemployment), as well as with low levels of education, both of which have a negative association with quality of life. Only 4% of the

[8] Rural and traditional areas were excluded from the analysis as the frequencies within these groups were too low for statistically robust analysis, indicative of the highly urbanised nature of the GCR.

lowest income groups had tertiary training compared to almost 62% among the income group earning more than R51 000 per month (GCRO, 2009). Comparing dwelling types and infrastructure, almost all the higher income group respondents lived in formal housing, had electricity for lighting and had piped water on premises. In the income group earning less than R800, almost 30% lived in informal housing, 16% did not have water on their premises and approximately 4% did not have electricity for lighting.

Only 20% of the lowest income groups reported being satisfied or very satisfied with life. Probing deeper the quality of life survey (GCRO, 2009) in an additional question provided certain explanations for people's dissatisfaction with life of which they had to choose the most appropriate option. The options most often selected by the lowest income groups were a lack of income, high costs of living and a shortage of employment opportunities (GCRO 2009). In comparison 75% of the wealthier respondents reported being either satisfied or very satisfied with life (GCRO, 2009)

Whites and Asians are found to have higher average levels of quality of life than Africans and Coloureds. This finding was to be expected based on the apartheid history of South Africa and is consistent with other studies. Patterns among the other relevant variables shed further light on these racial differences in quality of life. The income variable, the life satisfaction variable and the variables related to social relationships differed markedly between African and White respondents. The average income of African households is approximately R2 200 per month compared to R9 500 for Whites (calculated from GCRO, 2009). Only 38% of the African respondents reported to be employed compared to approximately 59% of the White respondents. Furthermore, many of the employed African respondents reported being employed in low-skilled jobs.

The life satisfaction variable differed distinctly between the race groups (GCRO, 2009). Almost 84% of Asians and Whites reported being either satisfied or very satisfied with life compared to only 35% of Africans and 50% of Coloureds. Posel and Casale (2011), Möller (2012), Higgs (2007) and the City-Region Review of the GCRO (2011) came to similar conclusions. The main reasons mentioned by respondents not being satisfied with life across all race groups were economic in nature.

Conversely, the 'social relationships' variables of Africans were on average higher than that of Whites and Asians, implying that the former were more satisfied with for instance the time that they had available to spend with their family and friends as well as for leisure time. This could be related in part to greater availability of time due to high rates of unemployment, and in part to closer ties of family, kinship and community.

The quality of life score of men was slightly higher than that of women. According to our analysis of the GCRO data, the variables 'employment' and 'income' showed marked differences between the sexes. These results were similar to those found by Klasen (2000), and the Gauteng City-Region Review (2011) Men are 20% more likely to have worked in the past seven days than women. Part of the explanation for this could be the lower levels of female education reported in the GCRO survey as well as reasons listed by female respondents

for not finding employment such as that they had to look after children or family members and that they live too far away from employment opportunities (GCRO, 2009) as well as gendered segmentation and possible discrimination in the labour market. The average income earned by women is slightly less than the average income earned by men (GCRO, 2009)

Finally, quality of life is quite consistent between the different age groups, although quality of life declines slightly for the older age groups. This finding is inconsistent with the common finding in the subjective wellbeing literature of a U-shaped relationship between age and wellbeing with the young and the old having higher levels of wellbeing than middle-aged persons (Diener, Suh, Lucas, Smith, 1999). The finding that older persons in Gauteng have slightly lower levels of quality of life might reflect the deteriorating health and difficult economic situations of many of the older respondents (GCRO, 2009). Declining quality of life of for older people were also shown in the results of a study by Hansen and Slagsvold (2012) for Norway.

7 Comparison of the order of the extracted components (dimensions of quality of life) of different groups

The previous section compared quality of life for different groups according to the composite quality of life index that was constructed. Here, we run CATPCAs separately for the various demographic and socio-economic groups within the GCR. This is to determine which dimensions of quality of life explain the most variance in the data set for each individual group As the objective is to compare the components that explain the most variance in the data set, the focus here is on the comparison of the first three extracted components since this is where significant differences in the order are apparent.

The first three extracted components for each group are shown in Table 4 The ranking of the components for each group shows which component explains the most variance in the data for that group.

For most groups, the most variance in the data was explained by the 'housing and infrastructure' component. This implied that the indicator variables 'type of dwelling', 'piped water on premises' and 'electricity for lighting' (which make up this component) vary considerably within these groups

For the groups Coloureds, Asians and Whites, respondents with a monthly income above R51 201 and urban formal dwellers, the dimension 'social relationships' explained the most variance in the data set. This implied that the indicator variables 'satisfaction with time to spend with friends', 'satisfaction with time to spend with family' and 'satisfaction with time available for own things' varied the most within these groups As 'social relationships' explained most of the variance in the data set, the other dimensions such as 'housing and infrastructure' were more uniform among these respondents, with the majority of the respondents living in formal housing, having electricity and water. It is

possible that the basic needs of many members of these groups have already been met.

The component 'socio-economic status' ranked within the top three positions for most of the groups. While not explaining the most variance in the data set for each group, this component explained a considerable proportion of the variance for the majority of groups This may imply that this dimension has an important effect on the quality of life across the population of the GCR, and varied considerably between all respondents. Economic reasons were also mentioned as some of the main reasons influencing the subjective well-being of those persons dissatisfied with life (GCRO, 2009)

Based on the calculated quality of life scores of the different demographic and socio-economic groups (presented in section 6), and the findings of section 7 on the components which explained the largest proportion of the variance in the data set we found that the groups in which 'social relationships' explained the most variance in the data set were generally the groups with the highest quality of life scores. Thus we could argue that to improve the wellbeing of people that had higher quality of life scores the 'social relationship' component should be addressed (although this component is to a significant extent beyond the reach of public policy interventions)

The groups experiencing lower levels of quality of life corresponded with those groups in which 'housing and infrastructure' explained the most variance in the data set. Thus a case could be made that to improve the wellbeing of people with lower levels of quality of life – who should arguably be the primary concern of policymakers – the component 'housing and infrastructure' should be addressed. This component included the indicator variables 'housing type', 'electricity for lighting' and 'water on premises', though it could be assumed that any indicator variable closely related to these variables such as 'sanitation' and 'electricity for cooking' should also be addressed.

Furthermore, as 'socio-economic status' explained a considerable portion of the variance in the data set of all the groups and was highlighted by the majority of groups as a concern which influences their quality of life, addressing this component could contribute to the wellbeing of all people in the GCR (see Stroup & Stephen, 1992)

8 Conclusion

Development goes far beyond economic production, and also beyond a narrow set of additional health and education indicators. Improving quality of life is increasingly being recognised as an important public policy objective. Making progress in this regard, and being able to quantify and evaluate such progress, requires appropriate measurement of the quality of life. This is not straightforward, given the multi-dimensional nature of the concept of quality of life. A composite quality of life index is required, which can assess each dimension of quality of life and weight and aggregate these dimensions in a meaningful and scientific way.

This article contributes to the literature on the measurement of quality of life by constructing an objectively weighted composite index of quality of life for the GCR, applying this index to compare quality of life across various groups in the GCR, and determining which components explained the most variance in the data set of the different groups.

We extended and adapted the novel method developed by Nicoletti et al. (2000) to construct the composite index of quality of life, this incorporated not only the first principal component to weight the index, but also additional components to achieve a better representation of the data. The constructed index included the relevant dimensions of quality of life for the region. These include both objective and subjective indicator variables as well as economic and non-economic variables. This is the first measure of this type constructed for the GCR or used in South Africa.

Guided by our review of the literature and the existing composite quality of life indices as well as the availability of data we identified the components of quality of life to be included in a composite index for the GCR. PCA was used to select a set of fifteen indicator variables to measure the important dimensions of quality of life. These indicator variables explained, relative to other sets of indicator variables, the most variance in the data and thus gave the best representation of the data. Using the selected indicator variables in a CATPCA five components were extracted, each of which represents a different dimension of quality of life. These components were designated 'housing and infrastructure', 'social relationships', 'socio-economic status', 'health' and 'safety and governance'. Corresponding to the extracted components we constructed five intermediate composite indices. These intermediate composite indices were aggregated by weighting each according to the percentage of variance explained by the component. The index was found to be robust.

South Africa, including the GCR, has a highly diverse population. In addition, inequality is extremely high by international standards. Aggregate measures can thus mask significant differences amongst groups within the region. These differences include disparities in overall quality of life, as well as distinct patterns in the 'composition' of quality of life (in the sense of which dimensions of quality of life matter most). Recognition of these differences underscores the importance of disaggregating the analysis of quality of life for separate sub-groups, as presented here.

One aspect of this is the comparison of the quality of life of these sub-groups using a single (appropriately constructed) index of quality of life, in order to identify groups with relatively high and low quality of life. The quality of life scores of the following categories of demographic and socio-economic groups were lower than others within the respective categories: urban informal dwellers, low income earners, females, Africans and the youngest and the oldest respondents.

The second aspect is the comparison of the order of the extracted components for each demographic and socio-economic group. We ran a CATPCA separately for each different group. The first extracted component and the order of subsequent components varies across the groups. For African respondents, informal urban residents, the majority of age groups, both sexes and low income

earners, the component 'housing and infrastructure', which represents a basic need, explains the most variance in the data set and therefore has the highest weight in their composite indices. For White, Coloured and Asian respondents as well as for high income earners and respondents in urban areas, the dimension designated 'social relationships' which is a higher order need, explains the most variance in the data set Basic needs, such as shelter and access to water, are already largely fulfilled for these groups. Furthermore, the dimension 'socio-economic status' represents a considerable proportion of the explained variance of all the groups.

Considering together the results from the different parts of the empirical analysis yields interesting insights. In the groups with relatively low overall quality of life scores the dimension 'housing and infrastructure' explained the most variance in the data set. Therefore it might follow that to improve the quality of life of these groups the variables 'type of dwelling', 'electricity for lighting' and 'piped water on premises' as well as the variables closely associated with these such as 'sanitation' and 'electricity for cooking' should be prioritised.

The groups with higher quality of life scores largely corresponded with the groups in which it was found that 'social relationships' explained the most variance in the data set. Therefore it might follow that to increase the quality of life of these groups the indicator variables 'time with family and with friends' as well as 'leisure time' should be addressed insofar as possible. Within all the groups the dimension 'socio-economic status' explained a considerable proportion of the variance in the data set This dimension was identified as contributing to lower levels of quality of life. Therefore we can argue that improved 'socio-economic status' can directly improve the wellbeing of all groups of people in the GCR

In addition to shedding light on quality of life issues in South Africa, this study sets out an approach to the measurement and analysis quality of life that can be helpful in similar studies in other countries (or regions thereof).

References

[1] Alkire, S. (2002). Dimensions of Human Development. *World Development,* 30(2),181-185.

[2] Alkire, S. & Foster, J. E. (2007). Counting and Multidimensional Poverty Measurement. *OPHI Working Paper,* No 7.

[3] Alkire, S. & Santos, E., (2013). A Multidimensional Approach: Poverty Measurement and Beyond. *Social Indicators Research,* 112, 239-257.

[4] Berenger, V. (2007). Multidimensional measures of well-being: standard of living and quality of life across countries. *World Development,* 35, 1259-1276.

[5] Bookwalter, J. & Dalenberg, D. (2002). Subjective Well-Being and Household Factors in South Africa. *Social Indicators Research,* 65(3), 333-353.

[6] Bookwalter, J. T., Fuller, B. S. & Dalenberg, D. R. (2006). Do household heads speak for the household? A research note. *Social Indicators Research,* 79, 405–419.

[7] Booysen, F. (2002). An overview and evaluation of composite indices of development. *Social Indicators Research,*59 , 115-151.

[8] Centre for Bhutan Studies. (2008). *Gross National Happiness.* Retrieved from http://www.bhutanstudies.org

[9] Cummins, R. A. (1996). The domains of life satisfaction: An attempt to order chaos. *Social Indicators Research,* 38(3), 303-328.

[10] Cummins, R. A., Mc Cabe, M. P., Romeo, M. P. & Gullone, E. (1994). The comprehensive quality of life scale instrument development and psychometric evaluation on tertiary staff and students. *Educational and Psychological Measurement,*54, 372-388.

[11] Dasgupta, P. & Weale, M. (1992). On measuring the quality of life. *World Development,* 20, 119-131.

[12] Diener, E. (1995). A Valued Based Index for Measuring National Quality of Life. *Social Indicators Research,* 36, 107-127.

[13] Diener, E., Suh, E. M., Lucas, R. E. & Smith, H. L. (1999) Subjective Well-being: Three Decades of Progress. *Psychological Bulletin,* 125(2), 276-302.

[14] Dowrick, S., Dunlop, Y. & Quiggin, J. (2003). Social Indicators and Comparisons of Living Standards. *Journal of Development Economics,* 70, 501-29.

[15] Economist Intelligence Unit. (2005). *Economist Intelligence Unit.* Retrieved from http://www.economist.com/topics/economist-intelligence-unit [Accessed 16 February 2013].

[16] European Commission. (2007). *Beyond GDP.* Retrieved from http://www.beyond-gdp.eu/indicatorList.html?indicator=Well-being [Accessed 30 July 2012].

[17] Gauteng City-Region Observatory (GCRO). (2009). *GCRO Quality of Life Survey (data set),* Johannesburg: Global Print.

[18] Gauteng City-Region Observatory (GCRO). (2011). *The City-Region Review,* Johannesburg: Global Print.

[19] Gauteng Planning Commission. (2012). *Gauteng 2055: A discussion document on the long-term development plan for the Gauteng City-Region,* Johannesburg: Gauteng Provincial Government Republic of South Africa.

[20] Gauteng Provincial Government. (2010). *Socio-economic Review and Outlook.* Retrieved from http://www.gautengonline.gov.za/Publications%20and %20Reports/Socio_Economic_Review_and_Outlook_2010.pdf

[21] Gifi, A., 1990. *Nonlinear multivariate analysis.* Chichester, England: Wiley.

[22] Greyling, C. T. (2013). *Measurement and analysis of quality of life of the diverse population of the Gauteng City-region* (PhD Thesis). Johannesburg. University of Johannesburg.

[23] Griffin, J. (1986). *Well-Being: Its Meaning, Measurement and Moral Importance.* Oxford: Oxford University Press.

[24] Groh, A. P. & Wich, M. (2009). A composite measure to determine a host country's attractiveness for foreign direct investment. *Working paper-833 of IESE Business School ,* 1-28.

[25] Hagerty, M. R. & Land, K. C. (2007). Constructing summary indices of quality of life, a model for the effect of heterogeneous importance weights. *Sociological Methods and Research,* 35(40), 455-496.

[26] Hansen , T. & Slagsvold, B. (2012). The age and subjective well-being paradox revisited:A multidimensional perspective. *Norsk Epidemiologi ,* 22(2), 187-195.

[27] Higgs, T. (2007). Measuring and understanding the wellbeing of South Africans: Everyday Quality of Life in South Africa. *Social Indicators Research,* 81, 331-356.

[28] Hinks, T. & Gruen, C. (2007). What is the Structure of South African Happiness Equations? Evidence from Quality of Life Surveys. *Social Indicators Research,* 82(2), 311-336.

[29] Human Sciences Research Council. (2013). *South African Social Attitudes Survey (SASAS).* Retrieved from http://www.hsrc.ac.za/en/departments/sasas

[30] Kingdon, G. G. & Knight, J. (2003). Well-being poverty versus income poverty and capabilities poverty. *Centre for the Studies of African Economies: Working Paper 2003-16.*

[31] Klasen, S. (2000). Measuring Poverty and Deprivation in South Africa. *Review of Income and Wealth,* Series 46, Number 1(March), 33-58.

[32] Larson, D. (1979). The physical quality of life index: a useful indicator?. *World Development,* 7, 581-584.

[33] Lewer, J. J., Pacheco, G. & Rossouw, S. (2009). Do Non-Economic Quality of Life Factors Drive Immigration?. *The Institute for the Study of Labor (IZA): Discussion Paper No. 4385.*

[34] Linting, M., Meulman, J., Groenen, P. J. & Van der Kooij, A. J. (2007). Nonlinear principal components analysis. Introduction and applications. *Psychological methods,* 12(3), 336-358.

[35] Maslow, A. H. (1943). A Theory of Human Motivation. *Psychological Review,* 50(4), 370-396.

[36] McGranahan, D. V., Richard-Proust, C., Sovani, N. V. & Subramanian, M. (1972). *A Staff Study of the United Nations Research Institute for Social Development (UNRISD).* New York: Praeger Publishers.

[37] Meulman, J. J., Van der Kooij, A. J. & Heiser, W. J. (2004). Principal components analysis with optimal scaling transformations for ordinal and nominal data. In: D. Kaplan, ed. *The Sage handbook of quantitative methodology for the social sciences.* London: Sage, 49-70.

[38] Möller , V. & Dickow, H. (2002). The Role of Quality of Life Surveys in Managing Change in Democratic Transitions: The South African Case. *Social Indicators Research,* 58(1/3), 267-292.

[39] Möller, V. (2012). South African Quality of Life Trends Over Three Decades, 1980-2010. *Social Indicators Research,* published online. http://dxdoi:10.1007/s11205-012-0120-y.

[40] Möller, V. & Schlemmer, L. (1983). Quality of Life in South Africa: Towards an instrument for the assessment of quality of life and basic needs. *Social Indicators Research,* 12, 225-279.

[41] Morris, D. (1979). *Measuring the Conditions of the World Poor, the Physical Quality of Life Index.* New York: Pergamon Press.

[42] Narayan, D. R., Chambers, M., Shah, K. & Petesch, P. (2000). *Voices of the Poor: Crying Out for Change.* New York: Oxford University Press for the World Bank.

[43] The National Planning Commission. (2012). *The National Planning Commission.* Retrieved from http://www.npconline.co.za. [Accessed 5 April, 2013]

[44] Naude, W., McGillivray, M. & Rossouw, S. (2009). Measuring the Vulnerability of Subnational Regions in South Africa. *Oxford Development Studies,* 37(3), 249-276.

[45] Naude, W., Rossouw, S. & Krugell, W. (2006). *The quality of metropolitan city life in South Africa,* Potchefstroom: North West University.

[46] Naude, W., Rossouw, S. & Krugell, W. (2009). The Non-monetary Quality of City Life in South Africa. *Habitat International,* 33, 310-326.

[47] Nicoletti, G., Scarpetta, S. & Boylaud, O. (2000). *Summary indicators of product and market regulation with an extension to employment protection legislation.* Retrieved from www.oecd.org/eco/eco

[48] Njong, A. M. & Ningaye, P. (2008). Characterizing weights in the measurement of multidimensional poverty: An application of data-driven approaches to Cameroonian data. *Oxford Poverty and Human Development Initiative (OPHI) Working Paper,* 2008 (August).

[49] Nussbaum, M. C. (1988). Nature, Function and Capability. *Oxford Studies in Ancient Philosophy,* Supplement 1, 145-184.

[50] OECD. (2008). *Handbook on constructing composite indicators: Methodology and user guide.* Paris: OECD Publishing.

[51] OECD. (2011). *Your Better Life Index.* Retrieved from http://www.oecdbetterlifeindex.org/ [Accessed 19 August 2011].

[52] OECD. (2011). *OECD Territorial Reviews: The Gauteng City-Region, South Africa 2011*, OECD Publishing.

[53] Office for National Statistics of the United Kingdom. (2012). *Office for National Statistics.* Retrieved from http://www.ons.gov.uk/ons/guide-method/user-guidance/well-being/index.html [Accessed 8 August 2013].

[54] Osberg, L. & Sharpe, A. (2000). *International comparisons of trends in economic well-being,* New York: Paper presented at the annual meeting of the American Economic Association.

[55] Posel, D. R. & Casale, D. M. (2011). Relative standing and subjective well-being in South Africa: The role of perceptions, expectations and income mobility. *Social Indicators Research,* 104, 195-223.

[56] Powdthavee, N. (2003). Is the structure of happiness equations the same in poor and rich countries: The case of South Africa. *Warwick Economic Research Papers.*

[57] Ram, R. (1982). Composite indices of physical quality of life, basic needs fulfilment, and income. A Principal Component Representation. *Journal of Development Economics,* 11, 227-247.

[58] Richards, R., O'Leary, B. & Mutsonziwa, K. (2007). Measuring Quality of Life in Informal Settlements in South Africa. *Social Indicators Research,* 81, 375-388.

[59] Rossouw, S. & Naude, W. (2008). The Non-Economic Quality of Life on a Sub-National Level in South Africa. *Social Indicators Research,* 86, 433-452.

[60] Rossouw, S. & Pacheco, G. (2012). Measuring Non-Economic Quality of Life on a Sub-National Level; A Case Study of New Zealand. *Journal of Happiness Studies,* 13, 439-454.

[61] Sen, A. (1985). Well-Being, Agency and Freedom: The Dewey Lectures. *Journal of Philosophy,* 82 (4), 169-221.

[62] Sharpe, A. & Smith, J. (2005). *Measuring the impact of research on well-being,* Ottawa: Centre for the Study of Learning Standards.

[63] Somarriba, N. & Pena, B. (2009). Synthetic Indicators of Quality of Life in Europe. *Social Indicators Research,* 94(1), 115-133.

[64] South African Audience Research Foundation. (2013). *Development Index.* Retrieved from http://www.saarf.co.za/amps/developmentindex.asp. [Accessed 15 February 2013].

[65] South African Institute for Race Relationships. (2011). *The South African Development Index.* Retrieved from www.sairr.org.za

[66] Stiglitz, J., Sen, A. & Fitoussi, J. P. (2009). *Report by the Commission on the Measurement of Economic Performance and Social Progress.* Retrieved from www.stiglitz-sen-fitoussi.fr/en/index/html

[67] Stroup, M. D. & Stephen , F. (1992). Economic freedom, democracy, and the quality of Life. *World Development,* 20, 119-131.

[68] Tabachnick, B. G. & Fidell, L. S. (2007). *Using multivariate statistics.* 5 ed. Boston: Pearson education.

[69] United Nations Development Progamme. (2010). *Human Development Report,* New York: UNDP.

[70] United Nations. (2012). *The World Happiness Report,* New York: The Earth Institute.

[71] University of Waterloo: Faculty of Health Science, 2009. *Canadian Index of Well-being.* Retrieved from http://www.ciw.ca/en/Home.aspx. [Accessed 19 August 2013].

[72] Vyas, S. & Kumaranayake, L. (2006). *How to do (or not to do)....Constructing Socio-economic Status indices: how to use principal components analysis.* Oxford: Oxford University Press.

Table 1: Socio-economic and demographic descriptive statistics

	Frequency (*N*)	% of Sample
Area		
Urban formal (built-up town or city area)	4 156	62.6
Urban informal	1 654	24.9
Peri-urban (mostly informal/smallholding)	609	9.2
Tribal settlement	82	1.2
Farming	92	1.4
Income Groups*		
R0-R800	885	14.7
R801-R1 600	1 345	22.3
R1 601- R3 200	1 442	24.0
R3 201- R12 800	1580	26.2
R12 801-R204 800	768	12.8
Race		
African	5 452	82.2
Asian/Indian	79	1.2
Coloured	246	3.7
White	859	13.0
Sex		
Male	2 708	40.8
Female	3 928	59.2
Age		
18-20	460	7
21-30	1 971	30
31-40	1 604	24
41-50	1 120	17
51-65	934	14
66-75	347	5
75+	133	2

Source: Authors' calculations based on Quality of Life Survey (GCRO, 2009).
* Average household income per month

Table 2: Indicator variables included in the analyses

Variable	Type of data	Min	Max	Mean	Std. dev.
Type of dwelling	Dichotomous	0	1	0.851	0.357
Piped water on premises	Dichotomous	0	1	0.916	0.277
Electricity used for lighting	Dichotomous	0	1	0.905	0.004
Satisfied with time available for family	Ordinal	1	5	3.999	0.888
Satisfied with time available for friends	Ordinal	1	5	3.753	1.016
Satisfied with time available for own things	Ordinal	1	5	3.501	1.071
Work conditions*	Ordinal	1	5	3.512	1.159
Level of education	Ordinal	1	5	3.659	0.013
Income category	Ordinal	1	5	2.931	0.932
Satisfaction with life	Ordinal	1	5	3.172	0.015
Satisfaction with health	Ordinal	1	4	3.212	0.704
How often does health prevent you from taking part in social activities	Ordinal	1	4	3.190	0.872
Feel safe at home	Ordinal	1	5	4.287	0.213
Satisfied with local government	Ordinal	1	5	2.914	0.014
Judiciary is free from government influence	Ordinal	1	5	3.110	1.090

Source: Authors' calculations using GCRO data (GCRO, 2009).
*Work conditions refers to satisfaction with working environment

Table 3:Factor loadings used in the calculations to weight the composite index of quality of life

	Extracted components					Squared factor loadings, scaled to unity sum				
	1	2	3	4	5	1	2	3	4	5
Piped water on premises	**.699**	-.016	.223	.057	.060	**.270**	.000	.000	.000	.000
Satisfied with local government	.043	.262	-.019	-.055	**.660**	.000	.000	.000	.000	**.340**
Satisfaction with life	.311	.364	**.483**	-.011	.129	.000	.000	**.140**	.000	.000
Satisfied with time available for friends	.021	**.692**	-.033	.190	-.050	.000	**.340**	.000	.000	.000
Work conditions	-.115	-.070	**.765**	.004	.061	.000	.000	**.350**	.000	.000
Electricity used for lighting	**.805**	.025	.046	-.018	.027	**.350**	.000	.000	.000	.000
Type of dwelling	**.836**	.042	.054	-.015	.000	**.380**	.000	.000	.000	.000
Income category	.334	.106	**.684**	.071	-.031	.000	.000	**.280**	.000	.000
Satisfaction with health	.015	.039	.197	**.629**	.026	.000	.000	.000	**.490**	.000
How often does health prevent you from taking part in social activities	-.006	.144	.022	**.846**	.056	.000	.000	.000	**.510**	.000
Feel safe at home	.101	.080	.157	.185	**.635**	.000	.000	.000	.000	**.220**
Judiciary is free from government influence	-.053	-.143	-.115	.006	**.738**	.000	.000	.000	.000	**.430**
Satisfied with time available for own things	.028	**.746**	.005	.034	.176	.000	**.300**	.000	.000	.000
Satisfied with time available for family	.024	**.821**	.104	.055	-.004	.000	**.360**	.000	.000	.000
Level of education	.159	.071	**.622**	.221	-.082	.000	.000	**.230**	.000	.000
Explained variance (Eigenvalue)	3.111	1.966	1.512	1.282	1.046					
Total percentage of explained variance	0.350	.220	.169	.144	.117					

Source: GCRO data set (GCRO, 2009).
Note: Factor loadings in bold indicate the highest factor loadings on a specific component.

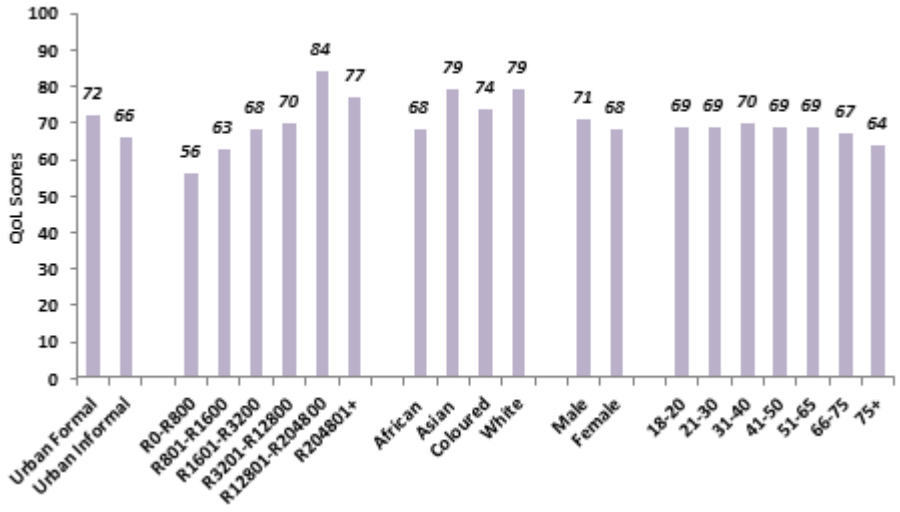
Table 4: The order of the first three extracted components

Group	Components		
	1	2	3
Race			
Africans	Housing and infrastructure (15.386)	Social relationships (13.563)	Health (12.110)
Coloureds	Social relationships (22.666)	Housing and infrastructure (12.699)	Socio-economic status (11.555)
Asians and Whites	Social relationships (16.366)	Socio-economic status (11.687)	Safety and governance (10.932)
Income			
R0 – R800	Housing and infrastructure (17.61)	Social relationships (13.14)	Health (9.75)
R801 – R1 600	Housing and infrastructure (18.34)	Social relationships (12.74)	Socio-economic status (9.02)
R 1 601 – R3 200	Housing and infrastructure (19.65)	Social relationships (12.23)	Socio-economic status (8.87)
R3 201 – R12 800	Social relationships(20.75)	Housing and infrastructure (13.103)	Socio-economic status (10.077)
R12801 – R204800	Social relationships(19.65)	Housing and infrastructure (12.23)	Socio-economic status (8.97)
Age			
18-35	Housing and infrastructure (16.768)	Social relationships (13.333)	Socio-economic status (12.626)
36-48	Housing and infrastructure (14.888)	Socio-economic status (13.112)	Social relationships (12.932)
49+	Housing and infrastructure (14.111)	Socio-economic status (13.675)	Social relationships (12.688
Sex			
Male	Housing and infrastructure (14.988)	Social relationships (12.678)	Socio-economic status (12.011)
Female	Housing and infrastructure (14.656)	Social relationships (13.001)	Health (12.854)
Area			
Urban formal	Social relationships (13.339)	Socio-economic status (12.456)	Health (11.878)
Urban informal	Housing and infrastructure (17.323)	Social relationships (14.553)	Health (12.564)

Source: Authors' own analysis using GCRO data (GCRO, 2009).

Notes: Values in parentheses indicate the percentage of total explained variance of each component.
Asians and Whites and certain of the age groups are combined due to the small number of the former, in order to ensure statistical robustness of the analysis.

Figure 1: Quality of life scores of different demographic and socio-economic groups



Source: Authors' Source: Authors calculations using GCRO data (GCRO, 2009).

Note: Scores are shown as a percentage, with 100% the maximum possible score. To attain a 100% score, each respondent within a group would have to score the highest value for each indicator variable within each dimension of quality of life.

APPENDIX A
RECODING OF NOMINAL VARIABLES

The recoding of the nominal variables was based on the guidelines provided in the Reconstruction and Development Programme[1] (1996) as well as the cut-off points used in the poverty index compiled by the GCRO Review (GCRO, 2011).

Table A.1: Coding of variables

Variable	Type of variable	Coding	Description
Type of dwelling	Dichotomous	0	Informal dwelling
		0	Traditional dwelling
		1	House or formal structure
		1	Flat
		1	Town/cluster/semi-detached
		1	Unit in retirement village
		1	Room/flatlet in main dwelling
		1	Hostel
Piped water on premises	Dichotomous	0	Water not piped and not on premises
		1	Piped – in dwelling
		1	Piped – yard tap
Electricity used for lighting	Dichotomous	0	Gas/LPG
		0	Paraffin
		0	Wood
		0	Candles
		0	Solar energy
		1	Electricity
Type of sanitation	Dichotomous	0	Septic tank
		0	Pit latrine
		0	Chemical toilet
		0	Communal toilet
		0	Neighbours
		0	Bush
		0	Bucket
		0	No toilet
		1	Full waterborne (flush toilet)
Satisfaction with dwelling	Dichotomous	0	Neither satisfied nor dissatisfied
		0	Dissatisfied
		0	Very dissatisfied
		1	Very satisfied
		1	Satisfied
Education	Ordinal	1	0 years
		2	1-4 years
		3	5-8 years
		4	9-12 years
		5	Tertiary training

[1]The Reconstruction and Development Plan was developed by the first democratic government to address South Africa's development challenges. It set out guideline standards for service delivery, which are used here.

APPENDIX B

Table B: Indicators from which final selection was made

Variable	Type	Min	Max	Mean	SD*
Housing and infrastructure					
Type of dwelling	Dichotomous	0	1	0.8505	0.3566
Piped water on premises	Dichotomous	0	1	0.9160	0.2774
Electricity used for lighting	Dichotomous	0	1	0.9050	0.0036
Type of sanitation	Dichotomous	0	1	0.8529	0.3543
Satisfaction with dwelling	Dichotomous	0	1	0.6240	0.4994
Social relationships					
Satisfied with time available for family	Ordinal	1	5	3.9985	0.8878
Satisfied with time available for friends	Ordinal	1	5	3.7534	1.0157
Satisfied with time available for own things	Ordinal	1	5	3.5010	1.0707
Satisfied with marriage	Ordinal	1	5	4.1561	0.0424
Economic Variables					
Work conditions	Ordinal	1	5	3.5117	1.1588
Level of education	Ordinal	1	5	3.6589	0.0127
Income category	Ordinal	1	5	2.3907	0.9315
Satisfaction with standard of living	Ordinal	1	5	3.1952	1.1448
Satisfied with money available	Ordinal	1	5	2.3627	0.0137
Perceived social status	Ordinal	1	5	1.8340	0.8870
Satisfaction with life	Ordinal	1	5	3.1718	0.0153
Education					
Level of education	Ordinal	1	5	3.6589	0.0127
Health					
Satisfaction with health	Ordinal	1	4	3.2115	0.7039
How often does health prevent you from doing your daily work	Ordinal	1	4	3.1700	0.9370
How often does health prevent you from taking part in social activities	Ordinal	1	4	3.1900	0.8720
Safety					
Feel safe in area where you live in the day	Ordinal	1	5	3.9325	0.0140
Feel safe in area where you live after dark	Ordinal	1	5	2.2876	1.3280
Feel safe at home	Ordinal	1	5	4.2874	0.2125
Governance					
Satisfied with local government	Ordinal	1	5	2.9142	0.0144
Politics is not a waste of time	Ordinal	1	5	3.7079	1.0897
Judiciary is free	Ordinal	1	5	3.1100	1.0900
Country is going in the right direction	Ordinal	1	5	3.4100	1.0940
Election was free and fair	Ordinal	1	5	3.9300	0.9360

Source: GCRO (2009)

*SD = standard deviation