

## Fuzzy Logic Methods to Evaluate the Quality of Life in the Regions of Ecuador

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### ABSTRACT

**Purpose:** The aim of this paper is to propose a methodological framework that calculates a synthetic indicator of satisfaction of citizens of the nine geographical areas of planning and development of Ecuador (zones).

**Methodology/Approach:** The methodology is based on fuzzy logic and the degree of similarity to ideal solutions. The information is obtained through the application of a structured survey based on the European Social Survey to the Ecuadorian society. The analysis is based on eight different dimensions of satisfaction, namely: (1) Life; (2) Economy; (3) City Government; (4) Transparency; (5) Education; (6) Health System; (7) Roads; and (8) National Government.

**Findings:** The results obtained help different stakeholders to have important insights about how the citizens' quality of life and satisfaction depend to some extent on important public services that form the pillars of the social welfare, education and health system. However, our results also suggest that other areas of Ecuador can also benefit from the improvement of the policies developed by the local governments.

**Research Limitation/implication:** An important research limitation is based on the limited number of segment variables used in the study, the geographical zones. Thus, an important venue for future research can be envisaged including other interesting traits analyzed by other scholars, like access to the internet, the social class or the size of the city.

**Originality/Value of paper:** The analysis of individual satisfaction and citizens' quality of life is paramount by the existing interdependence with social cohesion that exists nowadays in Ecuador.

**Category:** Research paper

**Keywords:** satisfaction; quality of life; social welfare; fuzzy logic; TOPSIS

## 1 INTRODUCTION

According to the World Health Organization (WHO), quality of life is the perception that an individual has of their social relationships and their relationship with their environment<sup>1</sup>. Slottje, et al. (1991) argue that concepts such as quality of life (QOL), individual or social welfare are subjective multidimensional constructs. Zhu (2001) does not define the QOL but nevertheless determines how to calculate it, by a finite set of dimensional attributes that can be measured objectively and is finally weighted by some metric. Slottje (1991) conducts a review of the literature on the QOL and concludes that the basic needs measured by a set of variables that analyse the level of health and education are not sufficiently determined by the variable gross domestic product per capita. Ram (1982) was one of the first authors to argue that the QOL cannot be analysed by a single indicator as the GDP per capita, not only because of the intrinsic difficulties of the measurements of these indicators, but rather by the existing philosophical digression between income and welfare. Tonon (2015, p.11) associated QOL with "life satisfaction for enjoyment, to" do what I like "and, in doing so, with the possibility of personal fulfillment". Also, individual satisfaction is associated with democracy of the people, either because of their orientation, the relationship with the regime, or the implemented economic system (Berggren, et al., 2004; Kestilä-Kekkonen and Söderlund, 2015).

There are numerous studies that have analysed the relationship between poverty, health and education in isolation, and they all come to the conclusion that there is a causal relationship between them. However, since some previous work as Burkett (1985), it is known that high levels of industrialization and per capita income are not sufficient or necessary condition to meet the basic needs of the population. So sometimes, QOL is studied not only under the perspective of the basic needs of the population but also to what extent these basic needs are or are not fulfilled. Thus, for example, Azizi, Momeni and Taghinia (2011) analyse the basic needs of the population of Tehran with a disability according to the following dimensions: (1) residence; (2) food; (3) energy; (4) economic resources; (5) facilities; (6) equipment; (7) communications; (8) education.

In spite of the general consensus that the QOL cannot be measured by a simple economic indicator per capita, most international organizations do still use one single indicator to see if the living conditions of citizens have improved or not. For example, the OECD Better Life Index serves to rank the performance of OECD countries across a number of social, environmental and other indicators that include eleven different categories (Petrosillo, et al., 2013). Bloom, Craig and Malaney (2001) argue that the construction of robust indicators to measure

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<sup>1</sup> This concept is not quite precise, so it is necessary to try to complete it with an empiric work.

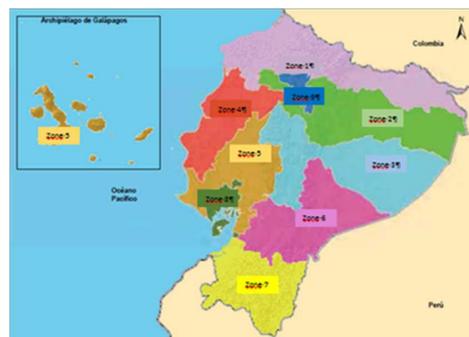
the QOL is very problematic because there is no consensus on how to measure the theoretical concept that encompasses the QOL. Rahman, Mittelhammer and Wandschneider (2011) delve more on this difficulty separating four different areas: (1) the method for calculating the QOL itself; (2) the dimensions of human existence that must be included in the analysis; (3) when making an individual or group analysis; and (4) how to deliver results that have a practical value for the stakeholders who need to use them, for comparing these on individuals, groups or dynamically.

On the second point mentioned above, it can be said that variables such as life expectancy, literacy levels and indicators of mortality and morbidity have been used in many of the empirical studies that analyse the QOL. Two composite indicators that have been analysed and have some prestige in this literature are the human development index (HDI - human development index) that performs United Nations through the program unit development and the physical indicator of the quality of life proposed by Morris (1979). These two alternatives were a step forward considering more dimensions of the QOL, but are subject to other problems related to the arbitrariness of the weights chosen when determining the metric.

It has already been discussed above as the QOL has been studied in relation to economic growth. It has been tried, without much success, to obtain a decisive causal relationship between the QOL and economic growth. In addition, there are different currents about which economic growth that increases inequality does not improve the QOL of individuals, although it is not easy to determine how to prioritize the needs of the different segments of the population (Mayne and Hakhverdian, 2016). Other studies analyse aspects that influence negatively on the QOL of some individuals, such as political oppression, gender or ethnicity, may decrease with economic growth (Boone, 1996). Thus, when the demands of these disadvantaged groups are addressed, representative democracy is strengthened and governments can perform better, since the political and ideological consistency is achieved in the social elements (Gómez Vilchis, 2014; Mayne and Hakhverdian, 2016). Democratization allows citizens to trust their governments and to participate most in electoral processes. But this does not happen at all time, since each country has historical, cultural and institutional differences, and, therefore, the calculation of the democratic satisfaction level is not straightforward (Ezrow and Xezonakis, 2016).

This article contributes significantly to the branch of literature that analyses the QOL. A method based on fuzzy logic and ideal solutions are proposed in order to determinate the QOL in the nine geographic areas of planning and development in Ecuador (Fig. 1). The dimensions considered when determining the QOL of citizens are as follows: (1) life; (2) the economy; (3) the city government; (4) transparency; (5) education; (6) the health system; (7) roads; and (8) the national government. Three main contributions to the literature are made: (1) on the one hand, the QOL of the nine geographic areas in Ecuador is calculated for the first time; (2) they are obtained individually for each geographic region so it can be

seen the best and the worst score for every attribute considered, which allows to obtain the greater or lesser observed heterogeneity; (3) the elasticity of the QOL is obtained regarding each of the dimensions analysed to see what dimensions are considered more or less important in Ecuador. These results are crucial for different social agents when determining the best course to improve the QOL of Ecuadorian citizens.



*Figure 1 – Administrative Ecuadorian zones*

The rest of the present article is structured as follows. The second section reviews the literature describing previous studies that have analysed the QOL of citizens. In the third section, the dataset and the structured survey, based on the European Social Survey applied to the Ecuadorian society, are explained. In the fourth section, the fuzzy logic methodology is presented and the ideal solutions to calculate the QOL are obtained. The fifth section shows and analyses the results, and finally, the sixth section concludes presenting new future research avenues.

## 2 LITERATURE REVIEW

Tonon and Rodriguez de la Vega (2016) attribute the study of QOL to Pigou, in the early 30s, when he first referred to the need to quantify public spending in relation to social services. Then, several authors, mainly in the Nordic countries, have proposed a series of analysis in relation to the QOL, such as standard conditions of life, social needs and satisfaction, which were the embryo of what is now known as the welfare state. In the 70s, Estes introduces the concepts of social progress index or national social vulnerability index to measure the capacity of social services to satisfy the basic needs of citizens (Estes, 1999). In the 90s, the ISQOLS (The International Society for Quality of Life Studies) is created, a non-profit society in order to promote studies of the QOL from a multidisciplinary approach that includes diverse fields such as politics, social aspects, medicine or environment.

Dasgupta and Weale (1992) argue that the QOL should be studied for five different reasons: (1) it is needed an aggregate to determine in a macro level the results of the economic policies of a country; (2) to compare results at different territorial levels, ethnic groups or different time horizons; (3) to compare the

social welfare dynamically at different time points; (4) to analyse the conditions of life standard that supports an economy according to the different economic measures that support it; and (5) to assess changes that occur when new economic measures are introduced.

Two of the most used indexes in this type of studies -the human development index and the physical quality of life index, are now analysed. The first is developed by United Nations and is used to analyse the QOL of the nations since 1990, and while it has been criticized the GDP per capita is the preferred one because it shows in a better way some aspects of the basic needs of the citizens (Haq, 1995). The dimensions that conform the index are: (1) life expectancy; (2) academic instruction; (3) income per capita. The second was proposed by Morris (1979) as a weighted average of the following variables: literacy, infant mortality with less than a year and life expectancy. These three variables are assumed to reflect a distribution related to the wealth of nations that is internationally comparable. Both indices have been criticized because of the uniform weights used for each of the three variables involved.

There are many cities that have established objective and subjective data collection systems that allow them to study the QOL of citizens. In most cases, the systems become true barometers that measure the satisfaction of citizens on the main aspects that influence the life of the citizens. One of the most developed systems today is the Urban Audit Eurostat system that collects information from more than 300 indicators for a set of 357 European cities. The variables collected baseline information on demography, housing, health, crime, work, rent, utilities, education, environment, tourism, ICTs and culture (Feldman, 2008).

Recent studies with disaggregated data analyse how the QOL influences market prices of homes in a hedonic way (Lora, 2016). The author argues that individual opinions of citizens on some aspects of cities and their own life can be very useful to identify and prioritize policy areas that citizens consider vital to their own development, from access to public transport, green areas or security itself (p. 273). Hoque, et al. (2016) analyse the introduction of the health card and how this produces greater satisfaction in the field of health. In addition, it is shown that also has an important impact on the health system itself in terms of time and cost of care, resulting in greater efficiency.

The internet access, namely the interconnection, plays an increasingly important role in the QOL of the individuals in our society. For a large part of the activities we do during our free time, such as watching shows or TV series, listening to music, listening to the radio, reading, playing a video game, or just surfing on the Internet, we need access to the Internet. Thus, access and digital literacy must be provided universally and should be incorporated into the agenda of all countries (Lissitsa and Chachashvili-Bolotin, 2016).

The last contemplated aspect in this review is the analysis of the QOL of social classes. The segregation of neighbourhoods may not be optimal as citizens of lower classes may favour having access to public services that are in the

neighbourhoods of wealthier classes (Cheung and Lucas, 2016; Cutler, Nueser and Nyblade, 2013). This issue is of vital importance to the formation of school districts that may have an impact on the future development of citizens. Linares, et al. (2016) spatially analyse the composition of neighbourhoods and find that the configuration of neighbourhoods influences the QOL as citizens show non-random patterns of location. In their analysis, the authors conclude that smaller cities seem to show a better QOL. However, they do not indicate to what extent this result is generalizable.

### **3 DATA**

This section shows the data obtained in 2015 through a survey adapted from the European Social Survey (ESS) that was administered to a group of Ecuadorian residents. The ESS is carried out since 2001 in Europe, and is characterized by a broad academic participation of different European countries, allowing homogenize the information obtained on issues that are very difficult to measure, and which have a high social interest. The ESS is adapted to the singularities of Ecuador to analyse different aspects of quality of life, individual satisfaction and democratic consolidation. Surveys are conducted at the level of the nine geographical areas of planning in Ecuador.

The survey covers different dimensions that influence individual satisfaction of Ecuadorian citizens, as trust in institutions, national identity, ethics, religion, ethnic component, nationality, political commitment, welfare, health, security, socio-political values, demographic composition, moral and social values, education, occupation and social capital. A random sampling by provinces with proportional allocation regarding the geographic area, gender, education level and age is done, to represent the population over 15 years living in private households.

It is emphasized that the survey implemented in Ecuador uses the Likert scale of 11 points (from 0 to 10) with verbal anchors at the ends, where 0 means that the person is not at all satisfied and 10 means that is extremely satisfied with the important public services and dimensions included in the survey.

Ecuador is located in the Northwest of South America, one of the smallest countries on the continent and bisected by the Equator from which comes its name. The internal political and social context of Ecuador currently reflects positions of confrontation. The analysis of the QOL can be considered crucial to understanding this. The QOL is analysed through the answers to the level of satisfaction, in relation with each of the eight dimensions considered in this investigation: (1) life; (2) the economy; (3) the local government; (4) transparency; (5) education; (6) the health system; (7) roads; (8) and the national government.

Tab. 1 shows the frequency of responses obtained in the individual satisfaction module in the nine zones analysed. It can be seen that about four hundred sixteen

Ecuadorian citizens answered to the pillars of the system of social welfare, the education and health, mentioning that only two of the eight dimensions reach it all (416); that means that they have greater representability, the next five dimensions are in the middle range (411-414), finally the transparency dimension has a greater rate of no response (409). This may be due to two different facts, because the interviewed persons could have taken the decision not to make the effort, or because the transparency dimension is the most difficult to assess and the citizens did not know how to answer.

*Table 1 – Responses divided by geographical zones and QOL dimensions*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Zone 1</b>	32	32	31	31	31	31	32	31
<b>Zone 2</b>	26	26	26	26	26	25	26	26
<b>Zone 3</b>	46	46	46	44	46	46	46	46
<b>Zone 4</b>	52	52	51	51	52	52	52	52
<b>Zone 5</b>	56	56	56	56	55	55	56	56
<b>Zone 6</b>	28	28	27	27	27	27	26	27
<b>Zone 7</b>	43	43	43	43	43	43	43	43
<b>Zone 8</b>	81	81	81	80	81	81	81	80
<b>Zone 9</b>	52	52	51	51	51	51	52	51
<b>Total</b>	416	416	412	409	412	411	414	412

Source and explanation: Own elaboration. (1): Life. (2): Economy. (3): Local Government. (4): Transparency. (5): Education. (6): Health system. (7): Roads. (8): National Government.

Tab. 2 shows the total of responses that each dimension obtained according to what Ecuadorian citizens answered, which means the frequency table of each one of the Likert states represented. It can be seen that the respondents answered to be very satisfied with the quality of life they have; while in the remaining dimensions the citizens express to have an adequate relation with the public services given to satisfy their basic needs. Certainly, the arithmetic mean of the values show the following relationship with the degree of individual satisfaction: first respondents report that they are very satisfied with the quality of life; so after Tonon (2015), it can be concluded that the citizens are satisfied with the material conditions (social welfare) and their psychosocial conditions (personal welfare); Now people feel moderate satisfaction to the road development that currently exists in the country, education, the economy of Canton, the central government and the health system; on the other hand, people in connection with the action of the municipal authority (Local Government) and his way of doing politics at the level of the municipalities of the nine areas, externalized little satisfaction. Listhaug (1984) finds that the personal satisfaction of individuals influences significantly and consistently the institutional trust.

*Table 2 – Total responses by QOL dimensions*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Extremely unsatisfied</b>	9	17	35	28	9	12	4	23
<b>1</b>	2	5	9	3	5	10	3	8
<b>2</b>	3	21	21	20	9	20	6	21
<b>3</b>	9	23	23	24	22	28	13	32
<b>4</b>	13	31	41	44	34	40	34	32
<b>5</b>	32	75	61	73	58	62	52	51
<b>6</b>	40	72	65	62	59	57	51	41
<b>7</b>	93	87	56	66	97	87	75	64
<b>8</b>	98	59	51	48	71	64	89	50
<b>9</b>	47	15	24	19	28	17	50	38
<b>Extremely satisfied</b>	70	11	26	22	20	14	37	52
<b>Total</b>	<b>416</b>	<b>416</b>	<b>412</b>	<b>409</b>	<b>412</b>	<b>411</b>	<b>414</b>	<b>412</b>

Source and explanation: Own elaboration. (1): Life. (2): Economy. (3): Local Government. (4): Transparency. (5): Education. (6): Health system. (7): Roads. (8): National Government.

#### 4 FUZZY LOGIC AND THE IDEAL SOLUTIONS

The linguistic term satisfaction is often vague. For example, linguistic expressions such as extremely satisfied, satisfied, normal, extremely unsatisfied and dissatisfied are interpreted as a natural representation of preferences, or judgments or perceptions of people. The proposed methodology to determine the level of personal satisfaction is based on studies of quality of service proposed by the literature. Lewis and Booms (1983) define the quality of service as a measure of how the service provided is adjusted to the consumer expectations and by a translation can determine how the QOL depends to some extent that public services meet the expectations of the citizens.

In this paper, the imprecise nature of the responses was analysed by a combined method that integrates the methodology of fuzzy sets with the technique of similarity to ideal solution TOPSIS<sup>2</sup>. This method has been applied in the area of business management (Hutchinson, 1998; Viswanathan, 1999; Xia, Wang and Gao, 2000), and is gaining acceptance in analysing the quality of service (Benitez, Martín and Román, 2007; Büyüközkan and Cifci, 2012; Choudhury, 2015; Karimi, et al., 2015; Sun and Lin, 2009; Tsaur, Chang and Yen, 2002; Yeh and Kuo, 2003).

<sup>2</sup> TOPSIS is an acronym that comes from the English following term: techniques for order preference by similarity of the ideal solution. It is about to establish an algorithm for extracting the relevant information by similarity to positive ideal solutions or difference of the negative ideal solutions.

Zadeh (1965) spelled out some basic results associated with the development of fuzzy sets. The origin of the theory is that many of the sets found in reality have no defined levels that clearly separate its membership function. In our case study, the existence of citizens who are not at all satisfied or extremely satisfied with their life shows this uniqueness. The concept of approximate reasoning based on uncertain perceptions have better development from fuzzy logic (Mamdani and Assilian, 1975; Zadeh, 1975)

In this work the triangular fuzzy numbers TFNs are used. These TFNs are defined by a triplet  $(a_1, a_2, a_3)$  of real numbers. Each linguistic term is characterized by a triangular fuzzy number to represent its approximate value range between 0 and 100<sup>3</sup>, and denoted as  $(a_1, a_2, a_3)$ , where  $0 \leq a_1 \leq a_2 \leq a_3 \leq 100$ . Tab. 3 shows the set of TFNs that have been chosen for this investigation. One can see that by removing the endpoints that served to anchor with verbal language the intensity scale, the range of all triangular numbers is equal to 20 and are centred on the most likely value symmetrically. Likewise, it is observed that the ends are degenerated TFNs at these points and have a lower degree than the previous on ten units. For each segment of analysis, the arithmetic mean of the TFNs is calculated according to the algebra of TFNs (Buckley, 1985).

The TOPSIS method needs a matrix of information of real numbers, so it is necessary to clarify the information obtained through fuzzy logic. There are multiple methods to achieve this goal, as for example, the "middle-of-maximum", "centre-of-area" and the "alpha-cut" method (Zhao and Govind, 1991).

In this paper, the average proposed by Chen (1996) using  $v_{\bar{A}} = (a_1 + 2a_2 + a_3) / 4$  has been finally preferred. This method has a number of advantages over other proposals for its simplicity and because the prior establishment of a judgment of the investigator is not required.

Once the clarified matrix information is obtained, the application of the method TOPSIS (Hwang and Yoon, 1981; Zeleny, 1982), which is based on the ideal alternatives: positive and negative, is now possible. The positive ideal alternative is one that maximizes all the criteria associated with benefit and minimizes all the criteria associated with cost; whereas ideal negative alternative is based on the opposite logic. The optimal observation is the one that is closest to the positive ideal alternative and farthest from the negative ideal alternative. The ranking of alternatives in TOPSIS is performed taking into account "the relative similarity of any alternative to the observed alternatives."

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<sup>3</sup> Other ranges as (0-7) o (0-10) are also valid.

*Table 3 – Triangular Fuzzy Numbers TFNs.  
Representatives of the Likert scale*

Linguistic term	TFNs
Extremely unsatisfied (0)	(0, 0, 10)
1	(0, 10, 20)
2	(10, 20, 30)
3	(20, 30, 40)
4	(30, 40, 50)
5	(40, 50, 60)
6	(50, 60, 70)
7	(60, 70, 80)
8	(70, 80, 90)
9	(80, 90, 100)
Extremely satisfied (10)	(90, 100, 100)
Source: Own elaboration	

The ideal solutions are computed as:

$$PIS = \left\{ \left( \max V_{ij} \mid j \in J \right), i = 1, 2, \dots, m \right\} \quad (1)$$

$$NIS = \left\{ \left( \min V_{ij} \mid j \in J \right), i = 1, 2, \dots, m \right\} \quad (2)$$

Where the positive *PIS* and negative *NIS* ideal solutions are the vectors of those segments that are the most and least satisfied with each of the dimensions considered in the study.

Once the ideal solutions have been obtained, the synthetic QOL for each zone is determined through (by) the Euclidean distances between ideal solutions and each segment vector, and the relative closeness to the positive ideal solution as:

$$S_i^+ = dist(V_i, PIS) = \sqrt{\sum_{j=1}^n (V_{ij} - PIS_j)^2} \quad i = 1, 2, \dots, m \quad (3)$$

$$S_i^- = dist(V_i, NIS) = \sqrt{\sum_{j=1}^n (V_{ij} - NIS_j)^2} \quad i = 1, 2, \dots, m \quad (4)$$

$$QOL_i = \frac{S_i^-}{S_i^+ + S_i^-} \quad i = 1, 2, \dots, m. \quad (5)$$

Thus, a set of alternatives can be ordered according to this ratio in descending order. This approach has been widely used in different contexts decision (see, for example, Athanassopoulos and Podinovski, 1997; Awasthi, et al., 2011; Bin, et al., 2015; Chang and Yeh, 2001; Chen and Hwang, 1991; Hossain, et al., 2015; Hou and Xiao, 2015; Mir, et al., 2016; Saeida Ardakani, et al., 2015; Yeh, Deng and Chang, 2000; Zeleny, 1998; Zlateva, Velev and Raeva, 2015). These examples come from different fields of social research, however, to our knowledge is the first time that is applied to analyze the QOL.

The methodology calculates also the elasticity to quantify the degree of sensitivity of the QOL towards changes in each of the dimensions considered in the analysis. The elasticity is usually understood or defined as the percentage change variation. In mathematical notation, the elasticity can be calculated for each segment  $i$  and each QOL dimension  $j$  as:

$$\eta_{ij} = \frac{\Delta\%QOL_i}{\Delta\%V_{ij}} = \frac{dQOL_i}{dV_{ij}} \frac{V_{ij}}{QOL_i}. \quad (6)$$

Elasticity values are usually obtained to help different stakeholders, like policymakers or politicians, to determine the most critical dimensions that determine the QOL. The knowledge of these dimensions is crucial and important to develop adequate policies that improve the QOL experienced by the citizens which is usually an important factor to achieve an adequate level of social cohesion.

## 5 RESULTS

Tab. 4 shows the positive and negative ideal solutions result of the analysis of the different segments analysed by socio-demographic variables. The table is divided into six columns. The eight dimensions investigated are shown in the first column. In the second and third, the value of the positive ideal solution and the segment with the greatest degree of individual satisfaction experienced are shown respectively. It is demonstrated that the higher frequency according to the segmentation carried out is literacy Centre (EBA) in most dimensions; excelling the satisfaction with their life and the road system and public works of the province.

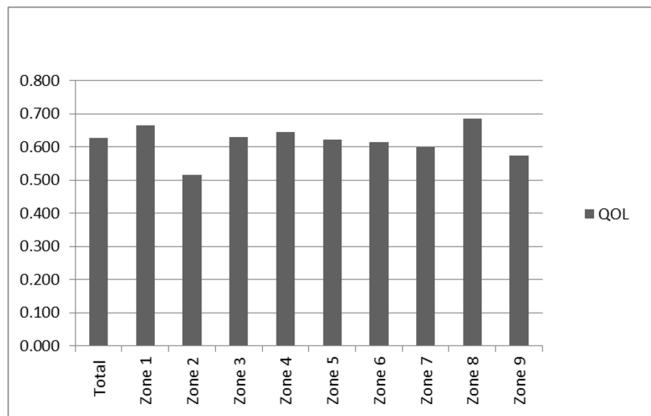
*Table 4 – Ideal solutions*

<b>Dimension</b>	<b>PIS</b>	<b>Segment</b>	<b>NIS</b>	<b>Segment</b>	<b>% Var</b>
Life satisfaction	97.50	'literacy centre (EBA)'	2.50	'NSC'	3,800.00 %
Satisfaction. Economy	90.00	'literacy centre (EBA)'	2.50	'My city is the place to live (2).'	3,500.00 %
Satisfaction. Local Government	97.50	'NSC'	2.50	'My city is the place to live (2).'	3,800.00 %
Satisfaction. Transparency	97.50	'My city is the place to live (2).'	18.75	'My city is the place to live (3).'	420.00 %
Satisfaction. Education	90.00	'literacy centre (EBA)'	2.50	'My city is the place to live (2).'	3,500.00 %
Satisfaction. Health System	75.71	'Immigration affects the cultural life (10).'	2.50	'NSC'	2,928.57 %
Satisfaction. Roads	97.50	'literacy centre (EBA)'	39.29	'My city is the place to live (5).'	148.18 %
Satisfaction. National Government	90.00	'literacy centre (EBA)'	2.50	'NSC'	3,500.00 %

Source: Own elaboration

Analysing the fourth and fifth columns, it is contemplated that the segmentation made for the city site to live appears more frequently. Finally, the sixth column records the change percentage between the ideal solutions allowing obtaining a classification of those dimensions of the QOL observed as more or less heterogeneous. You can see how satisfaction with their life and the Local Government are more heterogeneous, while dimensions on transparency and roads are more homogenous.

The TOPSIS indicator allows obtaining the synthetic degree of individual satisfaction for each of the analysed segments. Fig. 2 shows the results obtained for the total of citizens and, for each of the nine zones of Ecuador. It can be seen dividing by areas that the citizens from zone two corresponding to Napo, Orellana, and Pichincha are less satisfied with their QOL, followed by the opinions of the citizens of the ninth area that contains the Metropolitan District of Quito. While the extreme of citizens with a higher QOL observed is in the eighth zone (the cantons of Guayaquil, Samborondon and Duran). The eighth zone is characterized by a point of confrontation between local and national government, so a dispute exists for making and inaugurate works that benefit society; they are also political leaders who are about three periods in their positions and it is considered the second most important area in number of voters so vital in national elections.



*Figure 2 – Individual satisfaction. Total and by geographical zone*

Tab. 5 shows the value of the elasticity of the QOL for the total of citizens analysed, and for each of the nine planning zones of Ecuador examined in this investigation.

*Table 5 – Individual satisfaction Elasticity by geographical area*

Dimensions	Total	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9
Life	0.167	0.153	0.209	0.164	0.157	0.169	0.167	0.172	0.161	0.185
Economy	0.138	0.137	0.151	0.138	0.133	0.138	0.135	0.132	0.140	0.138
Local Government	0.155	0.160	0.124	0.155	0.145	0.154	0.146	0.145	0.165	0.152
Transparency	0.141	0.147	0.113	0.142	0.138	0.140	0.137	0.132	0.154	0.131
Education	0.141	0.137	0.137	0.141	0.135	0.139	0.139	0.144	0.136	0.146
Health System	0.100	0.094	0.113	0.100	0.094	0.101	0.101	0.103	0.094	0.106
Roads	0.125	0.127	0.125	0.125	0.118	0.125	0.121	0.119	0.130	0.119
Central Government	0.140	0.137	0.138	0.141	0.133	0.142	0.141	0.137	0.142	0.133

Source: Own elaboration

It can be seen that the QOL is inelastic with respect to each of the included dimensions, although the degree of magnitude is very different. For example, the first column shows that the respondents have a higher elasticity with respect to their subjective well-being or life and the local government, and less elasticity with respect to the health system and existing roads in the country. Analysing the specificities of the areas, it can be concluded that results vary imperceptibly at the level of each zone. Thus, for example, in the two, three, four, five, six, seven, nine will be more sensitive to changes experienced regarding to the satisfaction that people have with their respective life. Finally, the areas one and eight are more elastic towards the performance of the local government. On the contrary,

in areas one, three, four, five, six, seven, eight and nine will be less sensitive to changes experienced regarding the individual satisfaction with the health system, the same way that in the zone two in relation to the dimensions formed by the health system and transparency.

## 6 CONCLUSIONS

Our analysis is based on the European social survey, adapted to the Ecuadorian society, where QOL is measured by analysing eight dimensions that have great influence because some of them are the fundamental pillars of the social welfare system: (1) Life; (2) Economy; (3) The Local Government; (4) Transparency; (5) Education; (6) Health System; (7) The roads; and (8) the National Government. The first seven are more related to the local and provincial levels that are usually nearest to the citizens, while the last dimension corresponds to the work done by the Central Government at a national level.

This article presents a methodological proposal that calculates a synthetic index to measure the QOL of Ecuadorian citizens living in the nine areas of territorial planning. These indexes are needed to evaluate and make decisions on the provision that are offering the main public services, and how the QOL is affected by each of the analysed dimensions. This analysis is an appropriate tool to implement conducive policies that improve the citizens' QOL and enhance the consolidation of democratic societies.

The results allow to conclude that the road system, public works in his province and transparency have a higher level of individual satisfaction; at an intermediate level are the local economy, education and the work done by the central government; while the worst valued dimensions are education and transparency. The results are not homogeneous analysing each of the nine geographical areas. Thus, according to the zones, citizens who live in the areas eighth, first and fourth experience a higher QOL; while citizens of zone 2 and 9 experience the worst QOL. The results are interesting to analyse the present situation of Ecuador, considering that currently the Central Government has created new secretaries of state to improve the quality of life, and the country is less than a year from a National Government election.

This analysis is complemented by the sensitivity degree shown in elasticity values, which can be used as a guide for governmental entities with respect to the examined dimensions and will serve to improve the services provided, to thereby improve the Ecuadorians QOL. For example, in the zones two, three, four, five, six, seven, and nine the QOL is more sensitive to changes experienced regarding their own subjective life satisfaction. The areas one and eight show more elasticity towards the local government. On the contrary, in areas one, three, four, five, six, seven, eight and nine will be less sensitive to changes experienced regarding the individual satisfaction with the health system, the same way that in the zone two in relation to the health system and transparency.

These values raise the possibility that public services which form the pillars of the system of social welfare, education and health, propound that citizens improve their way of living by improving these two important dimensions. However, these results should be properly balanced as in other regions of the country, it is even more necessary to improve the work done by the local governments of these cantons. There must be an active work on the part of those involved to improve those dimensions that indicate a greater elasticity.

This study is not exempt from some important limitations, for example, it does not develop any causal relationship model to see to what extent the QOL affects or is affected by other variables. Another important drawback is based on the limited number of segment variables used in the study, the geographical area. Thus, an important venue for future research can be envisaged including other interesting traits analysed by other scholars, like access to the internet, the social class or the size of the city. Another future line of research is to extend and compare with data from the Barómetro de las Américas at the level of frontier countries that Ecuador has such as Colombia and Peru, countries with similar customs and traditions, while different economic models.

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