

BEST CITY TO INVEST IN: EUROPEAN CITIES QUALITY INDEX

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Abstract

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In this paper, we propose an index to measure the quality of the most important European cities. Using collected data from 66 cities belonging to the 28 countries within the European Union and applying the principal components analysis method, we construct the European Cities Quality Index (ECQI) as a combination of eight dimensions: (1) Public health, (2) Education, (3) Employment and incomes, (4) Environment, (5) Gender equality, (6) Leisure and entertainment, (7) Housing and safety and (8) Transport and mobility, that are in turn made up of 40 distinct variables. We find that London, Aarhus, and Berlin are the cities with the highest scores in the index, with northern European cities performing the best. At the other end of the spectrum, Sofia, Plovdiv, and Bucharest, with severe deficiencies in every dimension, scored worst on the study. The comparisons with the Sustainable Cities Index (Arcadis), the Global Power City Index (Institute for Urban Strategies), Cities in Motion (IESE), the Cities Prosperity Index (UN), and Dynamic Cities (Savills) help us understand the potential use of this new index and its purpose as a tool for assessing public policy. The ECQI could be used to assist public policies designed to improve perception in regions where it is needed.

Keywords: City Quality, Principal Components Analysis, Quality of Life, European Cities Quality Index

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1. INTRODUCTION

The emergence of the concept of "quality of life" and the concern about its scientific and systematic evaluation is recent. After World War II, American researchers conducted the first studies on people's perceptions of whether they had a good life or whether they felt financially secure (Urzúa & Caqueo-Urizar, 2012). The idea began to become

popular in the 1960s until it became a concept used today in a wide range of fields, such as health, education, economics and politics (Gómez-Vela & Sabe, 2000). It is precisely this wide range of disciplines and conceptions that make it difficult to define the quality of life in a precise and accurate way (Cummins, 2000; Haas, 1999).

In an attempt to delimit and measure human trends, social sciences began the development of

social indicators, indices that allow measuring different aspects of societies (Gómez-Vela & Sabeh, 2000). Indicators have become one of the most widely used tools by experts in different fields to carry out measurements and evaluations ranging, for example, from pollution levels indices (Khanna, 2000) to infant mortality indices (Kaempffer & Medina, 2006).

There are several indicators and rankings of countries, regions, and cities in all areas of knowledge. For example: in reputation, there are the Nation Brand Molecule (Rojas-Méndez, 2013), Country Brand Strength (Fetscherin, 2010), Country Brand (FutureBrand, 2007, 2012, 2015), Nation Brands (Anholt, 2005a, 2005b, 2006, 2008; Anholt & GfK Custom Research, 2012), Country RepTrak (Reputation Institute, n.d.), and the Fombrun-RI Country Reputation (Passow, Fehlmann, & Grahlow, 2005); in competitiveness and economic development there is the Global Competitiveness Index (CGI) by the World Economic Forum (Schwab, 2014); in living standard, there are the Human Development Index (HDI), the Inequality-adjusted Human Development Index, the Gender Inequality Index, the Gender Development Index, and the Multidimensional Poverty Index by the United Nations (United Nations Development Programme, 2014); in appeal for business and foreign investment there is the Foreign Direct Investment Confidence Index by AT Kearney (Laudicina, Peterson, & McCaffrey, 2018); in talent, human capital and tourist appeal there is the Travel and Tourism Competitive Index (TTCI) by the World Economic Forum (Blanke & Chiesa, 2007, 2008, 2009, 2011); in corruption there is the Corruption Perception Index (CPI) (Transparency International, 2011); and in contribution to the common good there is the Good Country Index.

By 2050, more than two-thirds of the world's population is expected to live in cities, considering that in many geographical areas, this is already a reality. This trend makes the analysis of cities' characteristics of the utmost importance.

Although most of the world's economic and social growth takes place in cities, they face many challenges. Economic crises generated by unemployment or inflation, pollution and depletion of resources, demographic trends that are difficult to control such as the ageing of the population or migration waves and social divisions resulting from inequality and segregation are some of the examples.

As a consequence of these phenomena, politicians, managers, and leaders must review, update and optimise urban strategies in order to ensure, guarantee and maintain the quality of life's standards.

In order to obtain an accurate overview of the current status of the cities' quality, there are indicators developed by agencies that have been able to make reliable comparisons between them, renewing themselves year after year. Some of them are:

- OMS Health Indices: The WHO Healthy Cities.
- World Bank economic indicators: Doing Business Index and Worldwide Governance Indicators.

- Technology indicators sponsored by private companies: Green City Index Europe and Green City Index South America (Siemens).

- Quality of life indicators: Cities in Motion (IESE), Cities Prosperity Index (UN), Dynamic Cities (Savills), Sustainable Cities Index (Arcadis) and the Global Power City Index (Institute for Urban Strategies).

In this paper, we will create a quality index aimed at rating the main European cities based on a rigorous, objective and an interdisciplinary classification. Our main contribution is based on using dimensions that have not been analysed together in a common framework. Using information from 66 cities from 28 nations of the European Union, we compute, via principal components analysis, this European Cities Quality Index (ECQI) as a mixture of 40 factors grouped in 8 dimensions: Health, Education, Employment and income, Environment, Gender equality, Leisure and entertainment, Housing and security and Mobility and transport. We find that London, Aarhus, and Berlin are the cities with the highest scores in the index, with the northern and central European cities performing better than the rest. At the other end of the spectrum, Sofia, Plovdiv and Bucharest, with severe deficiencies in every dimension, scored worst on the study.

The rest of this paper is ordered as follows. Section 2 defines the theoretical framework utilised for the consideration of the dimensions of ECQI and the definition of them, including the evaluated variables. Next, Section 3 presents the methodology used to calculate the index, including the geographical and temporal considerations, the data sources and the obtained ranking. Section 4 and Section 5 describe the results, while the final section concludes this paper.

2. THEORETICAL FRAMEWORK

First of all, the meaning of the word "need" must be defined. A "need" may be a lack of things that are necessary for the conservation of life, a continued lack of food to make you faint, or a danger or risk for which urgent help is needed. The sociological approaches for the definition of the term can be grouped, regarding the origin of the needs, into two positions: relativistic and universalist. Relativists consider that needs are established on the basis of factors such as gender, race, culture and acquired social conditioning. The Universalist position defends the existence of underlying, objective and universal needs, considering that they can be measured in the same way in every human being (Puig Llobet, Sabater Mateu, & Rodríguez Ávila, 2012).

- Maslow's hierarchy of needs (Maslow, 1943).
- The Theory of Need in Marx (Heller, 2018).
- Development to human scale: concepts, applications and reflexions. Matrix of needs (Max-Neef, 2016).
- A Theory of Human Need (Doyal & Gough, 1991).
- Quality of life and urban praxis (Alguacil, 2000).

As a result of the study of the above theories, an index model has been generated based on the

existence of 8 dimensions or categories of quality of life: Health, Education, Employment and income, Environment, Gender equality, Leisure and entertainment, Housing and security and Mobility and transport.

The selection and inclusion of these dimensions have been carried out to provide an accurate representation of the main needs identified in the different theories. In this way, each one of the dimensions corresponds to a need identified, at least, by two authors of the previous theoretical works. By measuring the variables that comprehend every dimension, it is possible to understand the need's satisfaction degree.

For example, the "Public Health" dimension is included as a representation of the following identified needs: Safety in Maslow, Livelihood in Neef, Appropriate health care in Doyal and Gough, and Welfare in Alguacil.

Each of the dimensions is presented below, introducing the variables that compose them.

2.1. Public health

Physical and mental problems, as well as harmful routines and habits, harm people's quality of life, and in some cases, reduce their longevity. Due to the high impact that health has on a person's life, it has historically been considered an acceptable indicator of well-being and has been incorporated into numerous quality of life indices, such as the United Nations Human Development Index or the Better Life Index developed by the Organization for Economic Cooperation and Development (OECD).

Data on life expectancy, infant mortality and causes of death are considered a sufficient set of indicators to measure the health status of populations and determine the priorities of social health systems (Robine, Romieu, & Cambois, 1999). Thanks to improvements in information systems and technologies, this data is available for the vast majority of countries and cities in the European Union (Rothenberg, Stauber, Weaver, Dai, Prasad, & Kano, 2015).

While these objective indicators provide a sound basis for assessing a society's health status, subjective indicators are increasingly being included in the indices as a result of changing health and disease patterns in Western countries.

The increase in the number of years of life is not necessarily related to a good quality of life during this period; the greater survival of the population has generated a higher number of people with some degree of disability or chronic illnesses, people who suffer the effects of their condition and the treatment (Velarde-Jurado & Avila-Figueroa, 2002). At the same time, the normalisation of unhealthy habits such as smoking, obesity or alcoholism is another factor to include in contemporary studies.

In a study published by Hunt and McEwen (Hunt & McEwen, 1980), the importance of doctor-patient communication is stressed, emphasising the importance of individual perception of symptoms and their description to the professional in order to obtain a correct diagnosis.

Consequently, in recent years many writers have proposed the development of such indicators in the hope that they will be able to measure

effectively and reliably health conditions that are not reflected in purely statistical census data (Hunt, McEwen, & McKenna, 1985).

From an economic point of view, a poor state of health of the population inhibits the development of a society since it implies that part of the population is incapable of bringing benefits to progress through active participation, thus diminishing productive human capital.

Because of all these data, the PUBLIC HEALTH dimension incorporates four variables to achieve an accurate representation that includes the different essential aspects that a health system must entail. The four chosen variables are:

1. *Healthy life expectancy*. It is calculated as the average number of healthy years of life a person can expect at birth in a given country, both women and men (World Health Organization, 2018).

2. *Public expenditure on health care*. Percentage of national Gross Domestic Product (GDP) allocated to Health (OECD, 2017).

3. *Number of beds available in hospitals*. Beds available in hospitals at a regional level (Eurostat, 2017).

4. *Access and coverage of the health system*. Index provided by The Lancet, which scores the different countries' health systems on various issues such as the price and access to the system or the diseases covered by it (Barber et al., 2017).

2.2. Education

Education is defined as the formal process by which society, through schools, colleges, universities and other educational institutions, deliberately transmits cultural heritage, accumulated knowledge, values and skills to future generations.

The majority of teaching professionals support free and universal education on the premise that people with a developed education enjoy a better quality of life. Historically, the population with a complete education shows a better state of health, lower unemployment and more stable social relations (Ionescu, Ionescu, & Jaba, 2013). However, relatively little is known about the mechanisms through which better education contributes to the overall satisfaction of society (Powdthavee, Lekfuangfu, & Wooden, 2015).

In the majority of scientific publications, the focus on the impact of education on people's lives has been done from an economic perspective. For example, on how the income and other socio-economic variables allow obtaining a better education (Headey, Muffels, & Wooden, 2004). Another study analyses how education contributes to well-being by favouring the possibility of obtaining quality work that yields a more considerable amount of income, thus increasing the sense of control over one's own life and access to stable social (Ross & Van Willigen, 1997).

All these conclusions have led to education being placed at the centre of many of the political discussions and debates. The prevailing view is that if a country invests money in education, income will grow proportionately so that the investment can be recovered and is profitable.

Experts in the field have long since developed theories and mechanisms to demonstrate this relationship. Nelson and Phelps (Nelson &

Phelps, 1966) comment on how a more educated and educated workforce will be able to imitate cutting-edge technology more quickly. Benhabib and Spiegel (1994) complemented this work by stating that education also increases the capacity for innovation. Lucas (1988) observed how human capital accumulation increases productivity.

In a more recent study, the difference in growth between Europe and the United States in the last decades of the twentieth century is given as an example. The European Union allocated 1.1% of its gross domestic product to education budgets, compared to 3% invested by the North American country (Sapir, 2005).

While the fact that many years ago, many specialists saw education as a local competence linked to the specific context limited the ambition of improvement initiatives, the situation has changed radically in recent times. Progress in statistical techniques, data collection and processing methods has allowed the launch of pilot initiatives that have generated significant advances in educational communities. By adding the intensification of relations between European countries, a fertile base has been generated on which educational plans have been created and updated at all levels of training.

From reports and studies comparing the performance of different education systems to obtain information and lessons about experiences in different countries, to exchange programmes, shared curricula and intercultural and multilingual education, European education systems interact to enable their pupils to gain skills and competencies that they would otherwise not be able to achieve.

A clear example of an international initiative that has been accepted and implemented by a wide range of states is the European Educational Model.

To compare the quality and performance of the education level of the different cities, the ECQI has incorporated the dimension EDUCATION, made up of four variables.

While the first and the third variables focus on the secondary level of education, the other two focus on higher or university education, thus covering the entire spectrum of training available.

1. *Population with secondary education.* Percentage of the population aged 20-24 who completed secondary education (Eurostat, 2016).

2. *Population with tertiary/superior studies.* Values collected on the percentage of the population aged 25-64 with a higher education qualification, whatever their duration (Eurostat, 2016).

3. *PISA score.* The score obtained by the country to which the city belongs in the International Student Assessment Programme (PISA) (OECD, 2016).

4. *QS University Ranking.* This value is calculated by introducing the QS ranking data in the following expression. This calculation not only takes into account the presence of university centres in cities but also their quality and reputation (Top Universities, 2016).

Being:

X = Number of universities present in the ranking.

Y = Number of universities in the top 500.

Z = Number of universities in the top 200.

As can be seen, it has been decided not to include variables in the index that reflect figures on

the first period of education, early childhood education. To date, on average, around 90% of school enrolment has been achieved in European countries. For this reason, it has been decided to ignore information on this period, considering it to be a problem that is close to being overcome and without great value as a comparative measure.

2.3. Employment and incomes

All the needs models analysed previously present needs whose satisfaction depends on the economic capacity of the individual. Although there are some needs whose dependence is not exclusive, such as friendship, affection or personal development, the authors accept that, as our society is considered, their degree of coverage is a function of the quality of employment and income flows.

Work is one of the most critical variables to explain the quality of life of the adult population since, far from only affecting wages and working hours, it configures people's daily life (Navarro, Llinares, & Montañana, 2010). The living conditions of a grocer are far from those of an investment bank manager. While the former has to cope with harsh physical conditions and lower wages, the latter has high levels of stress and family reconciliation problems.

In addition to conditioning our environment, we receive a salary as a reward for the work done. Taking a look in the Internet, studies abound on how income affects health (Araya, Lewis, Rojas, & Fritsch, 2003; Benzeval et al., 2014), social status (Hollingshead, 2011), satisfaction (Clark & Oswald, 1996), self-esteem (Mandara & Murray, 2000) and many other areas of people's lives.

It is concluded that for an individual to enjoy prosperous levels of quality of life, he must have a job and a salary that allows him to pay the price of it.

Secondly, there is the question of the quality of work. Currently, almost a quarter of the poor (22%) are employed. The precariousness of contracts and the low relationship between wage developments and the cost of living have undesirable social consequences: increased indebtedness, pressure on pensions, psychological impact, growing inequalities, and social exclusion (Den Belder, García, & Jansen, 2006).

At the same time, inequalities among the population are increasing. Over the years, wealth is concentrated in a small percentage of people, diluting the concept of the middle class and increasing the risk of many social groups with few resources.

The EMPLOYMENT AND INCOME dimension incorporates the following four variables into the index:

1. *Unemployment rate.* Regional variable representing the percentage of the population aged between 16 and 75 years who fulfill three conditions simultaneously: lack of a job, ability to work and active job search (Eurostat, 2015).

2. *Ease of doing business.* Ranking in which the economies of the countries are classified according to the regulatory environment for doing business. A rating closer to 1 means more liberal economies, with fewer trade barriers (World Bank, 2015).

3. *Gini coefficient of inequality*. The Gini coefficient assumes a value of 0 for a situation of perfectly equal income distribution and a value of 100 for those where one person hogs the total (OECD, 2015).

4. *Weekly working hours*. Average weekly working hours (Eurostat, 2018).

2.4. Environment

The creation of cities and the activities carried out in them have generated a series of effects on the natural environments in which they are located. These effects, consequences of the initiatives to satisfy the needs of the population, have caused a series of negative impacts that affect the quality of life of the inhabitants.

Initially, the notion of urban ecosystem starts from a black box model in which the city appears as an organism that devours resources of all kinds "inlets" and dumps a large volume of waste "outlets", a source of pollution.

Environmental impact studies are very numerous: land use and corruption, the increase of CO₂ and greenhouse gases in the atmosphere, the alteration of the hydrological cycle, noise, energy consumption, and transport systems or waste management (Corellano, 1997).

The degradation of living conditions in industrial cities has led to a review of environmental issues, moving from a purely ecological issue to a factor that has a full impact on the quality of life (Hernández Aja, 2009).

The effects of the environment on the society's well-being are varied. Air pollution represents a significant health risk. According to WHO, lower levels of air pollution in countries can reduce the burden of disease from strokes, asthma, lung cancers, and chronic and acute lung diseases. Also, the quality of drinking water has a direct influence on the state of health of populations since a poor water quality leads to the appearance of infectious and intestinal diseases.

In another dimension, the use of renewable energies, the adequate management of the waste produced, and the existence of environmental regulations improve the environmental sustainability of modern cities, increasing their quality and collaborating in the protection of the environment.

In order to understand and account for the performance of European cities in these fields, the ECQI's dimension ENVIRONMENT incorporates eight variables from different fields in order to obtain a complete study of the state of the environment:

1. *Air quality*: PM 2.5 and PM 10. Density of airborne particles in cities (Thunis et al., 2018).

2. *Waste*: untreated waste and recycled waste. Quantity (kilograms) per capita of untreated and recycled waste respectively (Eurostat).

3. *Energy and emissions*: greenhouse gas emissions (Eurostat, 2016) and renewable energy, calculated as the percentual difference between the renewable energy target for 2020 and the current status.

4. *Environmental management and policies*: the Environmental Performance Index (EPI). Ranking that classifies countries according to their environmental protection and management policies. This classification is made by scoring the country in

nine areas composed of more than 20 indicators that measure the performance of countries in meeting internationally established and agreed goals (SEDAC, 2016).

5. *Water*: quality of water for consumption. Percentage of population with access to optimal treatment systems (World Bank, 2016).

2.5. Gender equality

Women account for approximately half of the world's population and, consequently, half of its potential. The concept of gender refers to the social, behavioural and cultural attributes, expectations and norms associated with being female or male.

Gender equality refers to how these aspects determine how women and men relate to each other and the resulting differences between them. It implies that men and women should receive the same benefits, sentences, and treatment. The principle of equality and non-discrimination on the basis of sex is an obligation under general international law.

Today, many studies and reports argue that, in addition to the human dimension, gender equality is crucial to achieving higher levels of development, prosperity, and progress.

As stated in the UN Development Programme's Sustainable Development Goals, ending discrimination is crucial to accelerating development. Equality has a multiplier effect and helps to promote global economic growth and development (Sanahuja, 2015).

For Unesco, equality in relations between women and men has a positive impact on all aspects of development. In addition, a society that does not guarantee equal opportunities to all citizens generates social distancing dynamics and capacities that erode and impede their cohesion.

The European Institute for Gender Equality (EIGE) is an independent EU body established to contribute to and strengthen equal rights and opportunities for both genders.

In its publication "Gender Equality Index 2017" (Pillinger, Barbieri, & Franklin, 2017), the organisation measures gender equality for all European countries from 2005 to 2015. The project aims to provide politicians, managers and directors of public administrations and private companies with databases and indicators to help them develop gender policies and strategies to reduce social differences. The Gender Equity Index is a composite indicator that quantifies the progress and results of member states' equality policies. The indicator includes six social domains in its analysis: *Work, Money, Health, Power, Time* and *Knowledge*. In turn, each domain is divided into several sub-domains covering different specific aspects. Every country is rated from 1 (full inequality) to 100 (full equality). By summing up every domain punctuation, a final grade is obtained. Finally, the participant countries are listed in a ranking.

The work domain measures the ability of women and men to benefit from equal opportunities and working conditions. It consists of two sub-domains: Participation and Segregation and Quality of Work. The economic domain measures inequalities in access to financial resources and the economic situation of men and women. It assesses,

on the one hand, net income and, on the other, the risk of poverty and inequality at extremes, low and high wages. The education category measures participation, attainment and educational segregation by gender. The time domain quantifies differences in the time spent on domestic, labour and social tasks. Time spent on activities related to caring for others and time spent on activities of a social nature. In the case of the power domain, three sub-domains are evaluated according to the proportion of men and women in high positions within the political, social and economic sectors. Finally, the health category shows the differences with respect to health access, habits, and health status.

It has been decided to include this index as the GENDER EQUALITY dimension in the ECOI. In this way, six more variables are included in the index.

2.6. Leisure and entertainment

So far, all dimensions of the index focus on quantifying the quality of life based on factors external to the citizen himself. This is what is known as objective well-being or well-being.

For some years now, the authors of the theoretical trend called positive psychology (Diener, 1994; Diener, Suh, Lucas, & Smith, 1999; Diener, 2004) have been stressing the importance of another type of well-being, subjective well-being, in the concept of quality of life. Subjective well-being is the assessment that people make of their own lives, analysing affective-emotional and cognitive-value aspects.

Unlike all the above variables, this measure is subjective, with its criterion residing in individual experience. It should also be noted that in this case, the absence of negative factors is not sufficient, but it is positive experiences that reinforce self-evaluation (Diener, 1984).

Leisure has been identified as a fundamental component of subjective well-being. Leisure activities have been shown to contribute to the subjective perception of satisfaction and well-being and therefore improve the quality of life of the person (Badia Corbella & Longo Araújo de Melo, 2009). For Argyle (2013), an adequate level of leisure, together with interpersonal relationships and recognized work are objective facts that cause personal satisfaction.

Because of this, it is considered necessary to include a dimension that reflects the contribution that a city can make to the subjective well-being of its inhabitants through access to leisure and free time.

It is not common to find data on this particular field in sociological literature and indices. While there are abundant surveys and censuses on one's perception of the quality of life, it is not very easy to find information on the quality of leisure and entertainment that a city, region or country can provide.

Taking as inspiration the use of the number of museums and art galleries as a variable in the human capital indicator of the Cities in Motion Index (IESE, 2017), it was decided to construct the set of variables "Socio-cultural Offer".

These variables, based on data from the website TripAdvisor, allow evaluating the cultural

possibilities that each city provides to its inhabitants and visitors. In an attempt to cover a sufficiently wide range, the dimension LEISURE AND ENTERTAINMENT comprises the following six variables:

1. *Places of interest*. This category includes monuments, buildings of interest, viewpoints, views and everything that is worth visiting.
2. *Museums*, e.g., museums and exhibition halls, both public and private.
3. *Theatres*, e.g., theatres, operas, and cabarets.
4. *Nightlife*, e.g., clubs, pubs, and casinos.
5. *Parks and green spaces*, e.g., parks, gardens, and zoos.
6. *Outdoor activities*, e.g., bicycle rides, tourist tours, sports activities, and boat trips.

Once they have been counted individually, the total value is added together and divided among the city's population in order to know the socio-cultural offer per capita. This value is multiplied by 100000 for a better display. Finally, it is multiplied by a factor that increases with the size of the city's population to take into account aspects derived from the size of the city such as greater availability of timetables, higher frequency of performances and sessions or greater options diversity.

2.7. Housing and security

Housing is a universally recognized fundamental right. The dwelling should not be thought only as a physical space where the inhabitants of a family stay, but as a space for interaction where the members carry out daily activities individually and in groups. These activities are directly related to the satisfaction of personal needs, the characteristics of housing condition, the generation of well-being, or the deterioration of the quality of life (Benítez, 2015).

As a consequence of the Industrial Revolution, the construction of factories on the outskirts of cities gave rise to the emergence of working-class neighbourhoods with minimal housing conditions that degenerated into suburbs with typologies radically opposed to the existing bourgeois residential neighbourhoods in the city centres. These differences contributed to increasing social inequality, harming the quality of life of a large percentage of the population.

Over the years, technical professionals and political managers have joined forces to design and implement urban plans that help integrate all parts of the city, improving the condition of older buildings and the connection of different parts of the city. At the same time, another aspect of the state of housing at the local level is related to the economy. After the global crisis, with a robust real estate component, the price of housing and the cost of rent are at record highs.

Finally, and derived from deficient urban planning, the existence of peripheral neighbourhoods generates security problems. It contributes to an increase in criminal cases in the cities, giving rise to severe events that worsen the well-being of the population and make foreign companies and visitors less attractive.

Thus, the five variables that make up the HOUSING AND SECURITY dimension are:

1. *Age of the dwelling.* Percentage of dwellings built since 1980 (European Statistical System).

2. *Housing price.* Ratio between the price of housing according to the city and the average wage in the country (Numbeo).

3. *Mortgage cost.* The “Mortgage as a Percentage of Income” indicator developed by Numbeo.com is a ratio resulting from dividing the monthly mortgage cost by the average household income (Numbeo).

4. *Rental price.* The “Price to Rent Ratio” indicator provided by Numbeo.com defined as the ratio between the purchase price of the dwelling and the average income obtained from renting the dwelling (in the case of purchasing the apartment for rent) or the monthly payments that would be paid in the case of renting (in the case of buying for living) (Numbeo).

5. *Crime rate.* The Crime Rate is an estimate of the level of crime in a city so that, depending on the results, cities are classified in different degrees of security according to the score obtained in surveys conducted (Numbeo).

The survey questions collect information on a wide range of situations, events, and characteristics: security during the day, security at night, breaking and entering, car thefts, physical attacks, insults, ethnic, social or religious crimes, drug problems, violent crimes and crimes against property.

2.8. Transport and mobility

The ability to move efficiently between different areas of a city is a positive value when it comes to qualifying it. In the field of mobility, efficiency is understood as the combination of three factors: the safety and reliability of the road system, the cost and extension of the public transport system and the capacity of the network to guarantee journeys between points in the city without delay.

In order to account for all three aspects, it has been decided to include three variables in the TRANSPORT AND MOBILITY dimension:

1. *Lethal traffic accidents.* Fatal accidents per 100,000 inhabitants (WHO).

2. *Price of gasoline.* Ratio between the price of one litre of petrol and the national average wage (Numbeo).

3. *Traffic index.* Ranking of European cities with the best and worst traffic flows based on data such as average congestion or daytime and night-time traffic peaks (TomTom).

2.9. Summary of dimensions and variables

Thus, the index is made up of 40 numerical variables, grouped into eight thematic dimensions that offer information on the different aspects of the concept of quality of life in the main cities of the European Union. All of them are summarised in the following table.

Table 1. Dimensions and variables of the European Cities Quality Index

<i>Public health (A)</i>					
Healthy life expectancy (A1)	National health expenditure (A2)	Available hospital beds (A3)	Health system access and coverage (A4)		
<i>Education (B)</i>					
Population with secondary education (B1)	Population with tertiary education (B2)	PISA score (B3)	Ranking universities (B4)		
<i>Employment and incomes (C)</i>					
Unemployment rate (C1)	Ease of doing business (C2)	Gini inequality coefficient (C3)	Weekly working hours (C4)		
<i>Environment (D)</i>					
PM 2.5 (D1)	PM 10 (D2)	Greenhouse emissions (D3)	Untreated waste (D4)		
Recycled waste (D5)	EPI (D6)	Renewable energy (D7)	Water for consumption (D8)		
<i>Gender equality (E)</i>					
Work (E1)	Money (E2)	Education (E3)	Time (E4)	Health (E5)	
<i>Leisure and entertainment (F)</i>					
Places of interest (F1)	Museums (F2)	Theatres (F3)	Nightlife (F4)	Parks and green areas (F5)	Outdoor activities (F6)
<i>Housing and security (G)</i>					
Age of the dwelling (G1)	Housing price (G2)	Mortgage cost (G3)	Rent price (G4)	Crime rate (G5)	
<i>Mobility and transport (H)</i>					
Traffic fatalities (H1)	Gas price (H2)		Traffic rate (H3)		

3. METHODOLOGY

3.1. Geographical and temporal coverage

The sample for analysis in the ECQI consists of 66 cities belonging to the current 28 countries of the

European Union (including the United Kingdom) plus Iceland. All the data used for the study refer to the year 2015, the most recent year for which complete and reliable data are available.

The participating cities are listed in Table 2.

Table 2. ECQI participant cities

DE	Berlin	SP	Saragossa	IT	Milan
DE	Cologne-Bonn	SP	Malaga	IT	Rome
DE	Hamburg	SP	Murcia	IT	Naples
DE	Munich	ES	Tallinn	IT	Turin
AU	Vienna	FI	Helsinki	IT	Palermo
BE	Brussels	FR	Paris	LA	Riga
BE	Antwerp	FR	Lyon	LI	Vilnius
BU	Sofia	FR	Marseille	LU	Luxembourg
BU	Plovdiv	FR	Lille	MA	Valletta
CY	Nicosia	FR	Toulouse	NE	Amsterdam
CR	Zagreb	UK	Cardiff	NE	Rotterdam
DK	Copenhagen	GR	Athens	NE	The Hague
DK	Aarhus	GR	Thessaloniki	PO	Katowice
UK	Edinburgh	HU	Budapest	PO	Warsaw
UK	Glasgow	UK	London	PO	Krakow
SK	Bratislava	UK	Birmingham	PR	Lisbon
SL	Ljubljana	UK	Manchester	PR	Porto
SP	Madrid	UK	Leeds	CR	Prague
SP	Barcelona	UK	Liverpool	CR	Brno
SP	Valencia	IR	Dublin	RO	Bucharest
SP	Seville	UK	Belfast	SW	Stockholm
SP	Bilbao	IC	Reykjavik	SW	Gothenburg

3.2. Data sources

To approve the inclusion of a variable in the index, three premises must be met: (1) the information must come from a recognised source, and it must be possible to explain and track its origin; (2) the information must apply to the year 2015, the year analysed in this study; (3) the information must be available for every city (in the case of local data) or, in the case of national data, for every country involved in the index.

The numerical data used to carry out the calculation of the index have been obtained from reliable sources available in the Internet, always prioritising the use of studies and databases from renowned international organisations such as the OECD, Eurostat, WHO or World Bank. In those cases in which this has not been possible, data from private companies that are professionally and socially recognised, such as TripAdvisor or Numbeo, has been included.

3.3. Index construction

Once the variables have been chosen, and their data collected, the index is calculated. The formula that will determine the score obtained is a sum of weighted variables such that:

$$ECQI_j = \sum_{i=1}^{40} k_i X_i; \quad j = 1,2,3, \dots, 66 \text{ cities} \quad (1)$$

k_i \equiv weight of the variable i ,
 X_i \equiv variable i .

The variables, with data greater and less than zero, enter the formula by adding or subtracting according to the criteria acquired for each one. Those that increase the quality of the city will have a positive sign while those that reduce the well-being of the inhabitants will be accompanied by a negative sign.

In order for an index to be robust, it is necessary to carry out a series of statistical procedures that make it exhaustive, that is to say, it must make the most of the information provided by the variables that make it up, without redundancy and in a useful way.

This exhaustiveness is achieved by obtaining the weighting factors (weights) and filtering the variables; both processes carried out by applying the Principal Component Analysis (hereinafter referred to as PCA), methodology described in the OECD handbook (OECD, 2008). PCA is a statistical technique that allows the extraction of significant data from a multivariate table and its later representation as a set of main components (Shlens, 2014). These new components correspond to a linear combination of the previous variables and are constructed according to the order of importance in terms of the total variability that they collect from the sample. It is a widely used method in the literature (Bellido, Gimenez-Nadal, & Ortega, 2011; Fernandez-Crehuet, Gimenez-Nadal, & Reyes Recio, 2016; Fernandez-Crehuet, Gimenez-Nadal, & Danvila del Valle, 2017; Fernandez-Crehuet, Rosales-Salas, & Barragán, 2019; Fernandez-Crehuet, Rosales-Salas, & Navarro, 2019; Fernandez-Crehuet, Rosales-Salas, & Ramos, 2019; Jemmali & Sullivan, 2014; Lai, 2003).

The objectives of this method are:

- Reduce the dimensionality of multivariate data to fewer main components than the number of original variables.
- Eliminate redundant information by reducing the impact of information redundancy as it does not take into account the accumulation of covariance among primitive variables.
- Capture in the new components part of the total variance, with a minimum loss of information, assuring the maximum discriminating power between them.

One of the requirements for a correct application of PCA is that variables must be measured on the same scale. There are several

methods for normalising data, such as the range of observations, standardisation, distance from or to a reference, or by means of indicators below or above the mean (OECD, 2008). We select standardisation as the method of normalisation, which uses the variable's z-scores. By using the mean (μ) and standard deviation (σ) of the variables, we find the "z-scores" value, according to $Z = (X-\mu)/\sigma$ ('x' is the value of the variable).

Following Spector (1992), the number 3 is established as a minimum of variables per dimension, taking into account that three elements by category must be seen as a minimum, not as optimal. All established groups have at least three elements, so this restriction is met.

To assign weights to the variables, we identify the main components for every dimension. Several criteria exist to pick the number of components, according to OECD (2008), are applied together:

- Those that have their own values (or self-values) associated greater than one.
- Those that individually provide an explained variance of more than 10%.
- Those presenting an accumulated explained variance more significant than 60% of the total explained variance.

The number of dimensions is 8: Public health, Education, Employment and incomes, Environment, Gender equality, Leisure and entertainment, Housing and safety, and Transport and mobility.

Secondly, the factor loads given by the PCA (through the matrix of components rotated) are used to allocate the variables to each component by the highest absolute value of the factor load.

Thirdly, following the OECD (2008) in its calculation of the index, a matrix is constructed with the squared factor load value. Then, all factors are added to the square of each component, and the squared factor loads are divided over the sum. This results in the indicator's percentage of the total unit variance.

As a final step, using the proportion of the variation that every component can account for, we corrected the squared factor loads of the variables, thus obtaining the ultimate variable weight.

4. RESULTS

After the calculations, the results of the index are shown in Table 3, Table 4 and Figure 1.

The analysis of the ranking leads to several conclusions. On the one hand, from each of the individual cities' punctuation, a series of local characteristics are extracted, dragging up the cities' strengths and weaknesses. Without carrying out comparisons between participants, the index position by itself, either at the top or at the bottom provides an idea of the current state of a city in the

different dimensions studied. For example, taking a look at the results of two French cities, it can be concluded that, while Paris has problems relating to housing prices and public safety, Lille has a fully developed and adequate transport system.

Drawing attention to the top positions of the ranking, London results first. His achieved grade is boosted by its good educational figures, with high percentages of schooling and a wide range of universities and study centres, and by the largest leisure and entertainment offer in Europe. Its excellence in these two fields compensates for the prohibitive price of housing and the growing wage inequality. Aarhus, a Danish city with a population of approximately 300,000 inhabitants, takes the second place. It has some deficiencies in its health system and does not have many cultural options, but its regularity in the other dimensions allows it to obtain a high score. This leads to the conclusion that although the capitals and large metropolises hold the top spots, it is possible to break through with fewer resources. Berlin completes the podium. With positions above 25 in all dimensions, its excellent results in equality stand out. In order to improve the quality of the city, efforts in improving the housing and transport current status must be made. The rest of the top 10 finalists are Amsterdam, Gothenburg, Helsinki, Stockholm, Paris, Munich and Copenhagen.

At the other end of the index, Sofia, Plovdiv, and Bucharest have earned the worst scores, concluding that they present serious deficiencies in many of the systems on which they apply the variables studied. An interesting finding can be observed here. While there are exceptions such as the over-average leisure offer in Bucharest or the good quality of the housing stock in Plovdiv, the cities at the lower end of the ranking tend to score similarly on all dimensions. This is not the case in the top of the rank, where cities with high quality fail in one or more dimensions. It follows that although cities have specific characteristics as a result of their own circumstances such as the historical development model or the policies exercised by public managers, they are all conditioned by the level of development of the country to which they belong. This point leads to a second approach to analysis, the similar ranking positions of cities in the same geographical area.

As can be seen, northern European cities predominate, with the Nordic countries as a whole having the best index scores. In contrast, the Eastern European countries and the Baltic countries (Estonia, Latvia, and Lithuania) have the lowest scores. As shown in Figure 1, the differences between the different regions of the European continent are significant, leading to serious inequalities between citizens of the European Union.

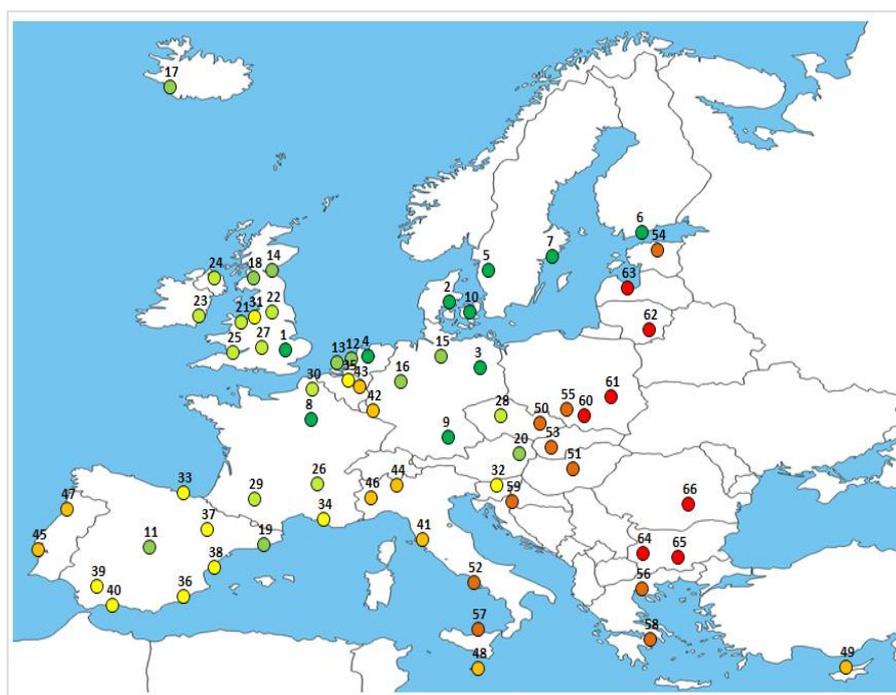
Table 3. Top 10 cities overall and per dimension - European Cities Quality Index

	<i>Public health</i>	<i>Education</i>	<i>Employment and income</i>	<i>Environment</i>	<i>Gender equality</i>	<i>Leisure and entertainment</i>	<i>Housing and security</i>	<i>Transport and mobility</i>	<i>TOTAL</i>
1 ^o	Rotterdam	London	Aarhus	Stockholm	Gothenburg	London	Nicosia	Bilbao	London
2 ^o	The Hague	Paris	Copenhagen	Helsinki	Stockholm	Rome	Murcia	Amsterdam	Aarhus
3 ^o	Marseille	Helsinki	Helsinki	Gothenburg	Berlin	Prague	Malaga	Aarhus	Berlin
4 ^o	Toulouse	Dublin	The Hague	Copenhagen	Munich	Barcelona	Thessaloniki	Copenhagen	Amsterdam
5 ^o	Amsterdam	Edinburgh	Amsterdam	Aarhus	Hamburg	Madrid	Reykjavik	Gothenburg	Gothenburg
6 ^o	Lille	Glasgow	Gothenburg	Porto	Cologne	Paris	Belfast	Rotterdam	Helsinki
7 ^o	Lyon	Tallinn	Rotterdam	Copenhagen	Aarhus	Berlin	Luxembourg	Murcia	Stockholm
8 ^o	Vienna	Stockholm	Manchester	Edinburgh	Copenhagen	Milan	Seville	Saragossa	Paris
9 ^o	Paris	Cardiff	Munich	Glasgow	Luxembourg	Amsterdam	Porto	Leeds	Munich
10	Munich	Lyon	Reykjavik	Madrid	London	Aarhus	Saragossa	Birmingham	Copenhagen

Table 4. Overall ranking and dimension ranking - European Cities Quality Index

City	Public health	Education	Employment and Income	Environment	Gender equality	Leisure and Entertainment	Housing and Security	Transport and Mobility	TOTAL
London	39	1	50	22	10	1	65	35	1
Aarhus	35	40	1	5	7	10	15	2	2
Berlin	16	16	18	25	3	7	25	24	3
Amsterdam	5	12	5	44	19	9	23	3	4
Gothenburg	14	20	6	2	1	60	28	5	5
Helsinki	30	3	3	3	27	33	14	23	6
Stockholm	15	8	25	1	2	36	49	14	7
Paris	9	2	43	32	28	6	61	42	8
Munich	10	22	9	13	4	21	19	28	9
Copenhagen	34	17	2	4	8	42	44	4	10
Madrid	28	25	53	10	34	5	50	17	11
Rotterdam	1	29	7	47	20	52	16	6	12
The Hague	2	30	4	46	21	53	12	20	13
Edinburgh	40	5	23	8	11	17	17	36	14
Hamburg	12	36	14	24	5	20	34	31	15
Colonia	11	27	13	19	6	39	22	32	16
Reykjavik	18	61	10	16	23	12	5	26	17
Glasgow	41	6	20	9	12	23	54	16	18
Barcelona	20	35	47	30	35	4	47	29	19
Vienna	8	13	37	26	26	15	35	34	20
Liverpool	42	23	16	15	13	31	27	19	21
Leeds	43	21	17	27	14	45	37	9	22
Dublin	36	4	24	41	22	11	36	44	23
Belfast	44	24	11	18	15	32	6	38	24
Cardiff	45	9	15	20	16	51	53	13	25
Lyon	7	10	26	38	29	49	20	27	26
Birmingham	46	26	19	36	17	38	52	10	27
Prague	52	14	35	40	49	3	48	46	28
Toulouse	4	38	31	23	30	59	13	22	29
Lille	6	39	29	37	31	63	24	15	30
Manchester	47	15	8	28	18	40	60	30	31
Ljubljana	49	18	21	39	42	30	18	21	32
Bilbao	24	45	36	7	36	50	45	1	33
Marseille	3	33	30	33	32	44	33	43	34
Antwerp	17	31	12	53	24	58	32	37	35
Murcia	25	49	48	11	37	61	2	7	36
Saragossa	22	50	41	12	38	55	10	8	37
Valencia	29	51	54	31	39	35	11	12	38
Seville	31	57	61	29	40	18	8	18	39
Malaga	32	58	62	34	41	34	3	11	40
Roma	23	56	49	58	44	2	66	50	41
Luxembourg	48	54	34	49	9	54	7	47	42
Brussels	13	11	57	48	25	25	58	48	43
Milan	19	47	38	60	45	8	64	39	44
Lisbon	50	34	52	17	56	14	26	58	45
Turin	21	59	39	64	46	22	59	25	46
Oporto	51	52	51	6	57	48	9	49	47
Valletta	33	64	44	35	33	64	56	40	48
Nicosia	55	53	56	65	43	56	1	33	49
Brno	53	42	22	42	50	62	31	59	50
Budapest	58	43	33	55	52	16	51	52	51
Naples	27	60	58	57	47	13	63	41	52
Bratislava	57	44	32	51	51	37	40	45	53
Tallinn	60	7	42	45	61	27	38	54	54
Katowice	54	28	28	63	53	66	30	51	55
Thessaloniki	38	55	65	21	58	57	4	55	56
Palermo	26	62	63	52	48	19	62	53	57
Athens	37	46	66	14	59	28	39	61	58
Zagreb	56	48	46	50	60	41	29	56	59
Krakow	59	32	27	66	54	24	41	63	60
Warsaw	61	19	40	61	55	26	46	62	61
Vilna	64	37	55	43	62	43	43	61	62
Riga	66	41	45	54	63	46	55	57	63
Sofia	63	65	60	59	64	47	42	65	64
Plovdiv	62	66	64	56	65	65	21	64	65
Bucharest	65	63	59	62	66	29	57	66	66

Figure 1. Overall ranking - European Cities Quality Index



5. DISCUSSION

In order to put our results in perspective, there is a need to compare our index to other city-related indices used around the world. For this purpose, we will use the Sustainable Cities Index (Arcadis, 2016),

the Global Power City Index (Institute for Urban Strategies, 2018), Cities in Motion (IESE, 2017), the Cities Prosperity Index (UN), and Dynamic Cities (Savills, 2018). Results of each ranking can be seen in Table 5.

Table 5. Indices comparison by overall ranking

Ranking \ Index	ECQI	Sustainable Cities Index	Global Power City Index	Cities in Motion	Cities Prosperity Index	Dynamic Cities
1°	London	Zurich	London	New York	Oslo	London
2°	Aarhus	Singapore	New York	London	Copenhagen	Cambridge
3°	Berlin	Stockholm	Tokyo	Paris	Stockholm	Paris
4°	Amsterdam	Vienna	Paris	Tokyo	Helsinki	Amsterdam
5°	Gothenburg	London	Singapore	Reykjavik	Paris	Berlin
6°	Helsinki	Frankfurt	Amsterdam	Singapore	Vienna	Dublin
7°	Stockholm	Seoul	Seoul	Seoul	Melbourne	Munich
8°	Paris	Hamburg	Berlin	Toronto	Montreal	Oxford
9°	Munich	Prague	Hong Kong	Hong Kong	Toronto	Basel
10°	Copenhagen	Munich	Sydney	Amsterdam	Sydney	Stockholm
11°	Madrid	Amsterdam	Stockholm	Berlin	Berlin	Zurich
12°	Rotterdam	Geneva	Los Angeles	Melbourne	Milan	Edinburgh
13°	Hague	Edinburgh	San Francisco	Copenhagen	Amsterdam	Lausanne
14°	Edinburgh	Copenhagen	Toronto	Chicago	Brussels	Copenhagen
15°	Hamburg	Paris	Frankfurt	Sydney	Tokyo	Luxembourg
16°	Colonia	Hong Kong	Zurich	Stockholm	Manchester	Bristol
17°	Reykjavik	Berlin	Vienna	Los Angeles	Prague	Frankfurt
18°	Glasgow	Canberra	Copenhagen	Wellington	London	Vienna
19°	Barcelona	Rotterdam	Chicago	Vienna	Osaka	Oslo
20°	Vienna	Madrid	Boston	Washington	Zurich	Madrid
21°	Liverpool	Sydney	Vancouver	Boston	Lisbon	Barcelona
22°	Leeds	Rome	Madrid	Helsinki	Madrid	Brussels
23°	Dublin	Vancouver	Beijing	Oslo	New York	Geneva
24°	Belfast	Barcelona	Barcelona	Zurich	Hong Kong	Bern
25°	Cardiff	Manchester	Brussels	Madrid	Dublin	Prague

Composite indices entail a subjectivity as a consequence of the freedom of choice of the variables that make them up. As pointed out in this paper, the concept of quality is broad and can be addressed through different approaches. Although there are variables that have been historically considered as reliable indicators, being often

included in city-related indices, each index incorporates variables depending on the criteria of its author. The fact that the indices' results vary from one to another does not detract from the validity of the results obtained.

Since the ECQI groups up variables from very diverse fields, we suggest, as a possible

improvement, to consult experts and specialists with advanced knowledge in the different fields included. This will allow the validity of the results obtained to be enhanced.

At the same time, the statistical treatments performed on the data sample can vary as well, resulting in a situation in which two identical data sets can generate distinct results if the calculations are carried out in a different way. It is noteworthy that the city with the best score in the global index, London, only manages to access the Top 10 in three of the eight dimensions, obtaining deficient scores (≤ 50) in two of the eight dimensions. The reason for this is the normalisation process according to which the normalised variable is calculated as a function of the distance to the mean, resulting in a non-symmetrical normalised sample. This mechanism rewards the excellence of cities in specific fields and does not penalise poor performance in other fields. To solve this problem, it is suggested to calculate the final punctuation as the arithmetic mean of the dimensions' scores.

Against this, the fact that several cities repeat in the higher positions of the different indices can be taken as a proof of the ECQI validity. Cities such as London, Amsterdam, Berlin, Munich or Madrid which have obtained excellent scores in the ECQI repeat in every new index consulted. It is not possible to find more differences between the ECQI and the rest than between two consulted indices.

The second observation of this particularity is the absence of atypical cities in the top positions of every ranking. It is logical to think that this sort of rankings, designed for international publications and public, only consider the main cities of the selected countries, whether the capital city or those with large populations, since the analysis of these one carries, in a more significant number of use-cases, a higher value. This annotation is also supported, in turn, by the fact that it is easier to find reliable data on large cities than on medium and rural populations.

Although this index has successfully presented another view of city classification, it does not mean that it is without limitations. The main limitation presented in this index is its temporality for its composition on successive occasions. As more data become available, the index can be updated in subsequent analyses, which would improve our understanding of the phenomenon. In addition, the

use of national variables in the absence of local variables leads to the grouping of cities in the same country, slightly diminishing the precision of the results.

6. CONCLUSION

We propose the European Cities Quality Index as an instrument to measure the problems and possibilities cities have in improve their image. Thus, the creation of an index for city comparisons, and to discern differences in a range of factors, should be of great interest to politicians, employers, and individuals.

Here we adopt a global perspective, using a set of variables to evaluate the conditions for having perception based on several topics in Europe. The index is a combination of eight dimensions: (1) Public health, (2) Education, (3) Employment and incomes, (4) Environment, (5) Gender equality, (6) Leisure and entertainment, (7) Housing and safety and (8) Transport and mobility. This index is comprised of 40 distinct variables. We find that London, Aarhus and Berlin are the cities with the highest scores in the index, with northern European cities performing better. At the other end of the spectrum, Sofia, Plovdiv and Bucharest, with serious deficiencies in every dimension, scored worst on the study. The ECQI could be used to assist public policies designed to improve perception in regions where it is needed.

The comparisons with the Sustainable Cities Index (Arcadis), the Global Power City Index (Institute for Urban Strategies), Cities in Motion (IESE), the Cities Prosperity Index (UN), and Dynamic Cities (Savills) help us understand the potential use of this new index and its purpose as a tool for assessing public policy.

In this way, a new index on the quality of urban life is added to the catalogue of available tools. With an academic background based on well-known sociological theories, the ECQI is guaranteed to be independent and to have, as its sole purpose, the obtention of an objective reference that can be useful to guide the implementation of policies, measures, and initiatives that serve to improve the quality of life and reduce the differences of the citizens of the European Union.

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