IESE Business School
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Center for Globalization and Strategy

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IESE CITIES IN MOTION
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About Us

IESE Cities in Motion Strategies is a research platform launched jointly by the Center for Globalization and Strategy and the Department of Strategy at the IESE Business School.

The initiative unites a worldwide network of experts on cities and specialized private companies with local administrations from around the world, with the objective of developing valuable ideas and innovative tools that can lead to more sustainable, smarter cities and promote changes at the local level.

The platform's mission is to promote the model of Cities in Motion, which includes an innovative approach to the governance of cities and a new urban model for the twenty-first century based on four main factors: a sustainable ecosystem, innovative activities, equality among citizens and a well-connected territory.

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Introduction: The Need for a Global Vision

The purpose of this document is to develop a model for the creation of a compound index that makes it possible to measure the future sustainability of the largest cities in the world and their inhabitants' standard of living. The theoretical model of this compound indicator includes 10 dimensions which, once synthesized and weighted into a single value, allow us to perform a comparison between cities in terms of their sustainability and standard of living, as well as the changes in each city over time.

In this study, we have taken into account the 10 dimensions listed below. They encompass various aspects that make a city sustainable and improve the standard of living for its people:

1. Governance and Citizen Participation
2. Urban Planning
3. Public Management
4. Technology
5. The Environment
6. International Outreach
7. Social Cohesion
8. Mobility and Transportation
9. Human Capital
10. The Economy

Research into the aspects that characterize cities as a social collective, both in the present and for the future, shows that the above dimensions, though they may not include every factor in the complex life of cities, do encompass the aspects that we intend to measure in this study to a great extent. The methodology for creating and selecting the model, the dimensions and the indicators is described in the following sections.

The period examined in the study includes the years 2011, 2012 and 2013 for all of the cities. This time interval was selected on the basis of the availability and quality of the data needed to create the index. The selected base year is 2011, a choice that responded to its relative economic and social stability and to the fact that a greater amount of information was available for that year, compared with other years.

The compound or synthetic Cities in Motion Index (ICIM) focuses on the population of capital cities and other important cities in the largest countries around the world. The inclusion of cities is directly related to the size of the population and to criteria of economic and cultural relevance within the international arena, so as to determine which cities to include in the study and how much significant information is available.

The indicators representing each of the different dimensions in the ICIM are selected based on a theoretical perspective, in order to determine their relevance for the specific dimension we intend to measure, and from a practical perspective, to ensure that the available information has an acceptable level of quality.

The following section provides a description and a critical analysis of the inputs used to create comparable indicators at the international level.

Background Information

In recent decades, national and international entities have performed studies focused on the definition, creation and use of indicators with various objectives in mind. In each of them, the definition of the indicators and the process for their creation are determined by the features of each study, by the statistical and econometric techniques that are best adapted to the theoretical model and available data, and the analysts' preferences. Due to this large heterogeneity, which makes it clear that there is not just one single procedure for creating synthetic indicators, in this report we highlight certain methodologies with the objective of selecting the techniques that are best adapted to the ICIM study from within them.

At present, there are a large number of "urban" indicators, though many of them have not been standardized or they are not consistent or comparable among cities.

In the past, numerous attempts have been made to develop indicators for cities, on a national, regional or international scale. However, few have been sustainable in the medium term, because they were derived from studies intended to meet the specific information needs of certain entities whose existence depended on how long their financing might continue. In other cases, the system of indicators depended upon the political agenda of the moment, so its creation came to a halt when political priorities changed or new authorities came into power.

However, there are also indicators specifically created by international entities that aim to achieve the consistency and strength necessary for comparing cities. The most notable ones are as follows:

a. Indicators created by the UN Global Urban Observatory (GUO) on the basis of two main factors: the Millennium Development Goals and the Habitat Agenda.

b. Global City Indicators, by the World Bank, which are a complement to the preceding indicators.

c. The World Health Organization (WHO) system of indicators: Healthy Cities project.

d. UNESCO's indicators for evaluating municipal policies aimed at fighting racism and discrimination.

e. The City Mayors website: an independent project developed by international experts.

f. Other indices sponsored by consulting firms (such as Mercer and McKinsey) and private companies (such as the Green City Index, by Siemens).

With the goal of building an indicator that "surmounts" these difficulties, in the sense that its thoroughness, properties and comparability, and the quality and objectivity of the information included, make it capable of measuring the sustainability of the largest world cities with an eye to the future, as well as their inhabitants' standard of living, we briefly point out the characteristics of some of the indicators from the past that have attempted to achieve similar objectives. The next chapter will discuss the methodological aspects used to create the methodology that was designed specifically for Cities in Motion.

Critical Analysis of Indicators

a. *Indicators created by the UN Global Urban Observatory (GUO) on the basis of two main factors: the Millennium Development Goals and the Habitat Agenda*. One of the purposes of the Urban Observatories, created by the UN and coordinated by UN-Habitat, is to "generate data and information and stimulate integrated analysis so that this agreement of role-players can move proactively towards surmounting urban poverty, in a close relationship with the Millennium Development Goals and the gradual implementation of the Habitat Agenda and Agenda 21." Within this framework, UN-Habitat considers urban indicators to be a set of management tools that make it possible to identify the urban reality and serve as a foundation for determining policies, programs and projects that can improve it on an ongoing, sustainable basis. The set of urban indicators is currently created on the basis of two analytical guidelines: the Millennium Development Goals and the Habitat Agenda.

   The Millennium Development Goals, agreed upon in the year 2000, are monitored on the basis of 35 sector-based indicators. UN-Habitat is in charge of performing the tracking of Target 11 of Goal 7, which establishes the commitment to "substantially improve, up to the year 2020, the living conditions of at least one hundred million people who are living in precarious settlements (slums)."

As for the tracking indicators of the Habitat Agenda, they are subdivided into seven dimensions: generalities, socioeconomics, housing, services, the environment, local management and transportation.

As for the indicators related to the Millennium Goals, it has been observed that they are measurements with very specific objectives related only to Target 11 of Goal 7, which involves just one very specific aspect of the problems of cities, that of precarious settlements (slums). The tracking indicators of the Habitat Agenda include important dimensions in the life of cities, but they are not sufficient to perform a comparison of the future sustainability of cities and their inhabitants' standard of living. Though this section of our proposal is not intended to be comprehensive, we might point out that certain aspects of society are not included in the dimensions of these indicators, such as culture, or creating and retaining talented people; also relevant is the analysis of innovative activities in the local economic sub-system, technology and aspects of urban planning. These are not considered among the indicators monitored in the Habitat Agenda. The aspects excluded by these indices are fundamental when it comes to evaluating the sustainability and standard of living in cities.

b. *Global City Indicators, by the World Bank*. The World Bank program that advocates the creation of these indicators is based on a considerable number of existing works, above all the previously mentioned UN-Habitat Urban Indicators Program, through the Global Urban Indicators Database and the GUOs, to which we refer in the preceding section. The program proposes the creation of an index based on these and other programs in order to promote the development of a set of standardized urban indicators. This program focuses mainly on cities with populations of approximately 100,000 inhabitants. The indicators are proposed for cities with the first and most direct level of municipal government. The program is arranged around 22 "topics" which are, in turn, divided into two broad categories: urban services and standard of living. The first includes services that are usually considered to be public goods and are therefore provided by local governments or third parties: education, energy, fire and emergency response, governance, health care, entertainment, security, social services, solid waste disposal, transportation, urban planning, sewers and drinking water. The second category includes aspects related to citizen participation, culture, the economy, the environment, housing, social equality, subjective welfare, and technology and information. This program is Internet based, with participation from the local governments of the cities taking part, who are invited to share their indicator programs as well as their results in the categories of urban services and standard of living. Each participating city is responsible for making contributions and updating its own indicators, using the website created for this purpose. In principle, this program can be considered "complete" in terms of the dimensions it covers, though work could be put toward a proposal for improvement that would also include aspects of a city's "international heritage." Moreover, aspects related to the city's competitiveness and energy use are not taken into account. One important problem with this program – despite the fact that, to a certain extent, this may be beneficial for building new databases – is that the data is provided directly by governments or local entities on the website, which may be a hindrance to the indicator's sustainability in the medium to long term, given that, in some ways, the responsibility of uploading the data produced in each city ends up depending on temporary political decisions.

Along these same lines, the contribution of indicators by local governments may be counterproductive in terms of the quality of the information and the comparison of cities, due to the particularities and differences in the manner and means used to gather data, which, in the best of cases, will require very high monitoring and verification costs. The lack of standards and the disparity in the availability of information is no minor aspect. For instance, the gathering of data tends to be of higher quality in developed cities, and therefore there is bias in any indicator that is meant to be comparable.

c. *The World Health Organization (WHO) system of indicators: Healthy Cities Project*. These are local indicators on the population's health and the health system, which include more than 1,400 cities and towns, mainly in Europe. The WHO establishes target values in order for a city to be considered as "healthy," and it periodically monitors these cities and towns. In this case, it involves the measurement of just one dimension in a city's reality, with the advantage that it is comparable among jurisdictions. The disadvantage of this system of indicators lies in the fact that the information is available for cities that are located, for the most part, only on the continent of Europe. However, in addition to this, it includes no selection criteria for cities, and therefore there are indicators for both small cities and large cities. Comparing aggregate dimensions and relative importance levels that are so distant may make sense only if we manage to study the health conditions of a population and its sustainability in this respect. However, it is not so if we are talking about an integrated indicator of a city's standard of living and future prospects.

d. *UNESCO's indicators for evaluating municipal policies aimed at fighting racism and discrimination*. This is an important aspect in terms of local governments' public policies, though they are indicators of just one aspect of society. This may be included to measure a city's standard of living and is very relevant when comparing different cities around the world.

e. *The City Mayors website: an independent project by international experts*. This site promotes strong cities with good local governments; it has a system of 40 indicators divided into five categories: stability, health, culture, the environment, education and infrastructure. However, the number of indicators grows year after year.

The cities used in these indicators are located in more than 200 countries, including their capital cities and the most important cities in each of them.

However, these indicators do not foresee all of the relevant dimensions in cities in terms of comparing their sustainability and their inhabitants' standard of living. Moreover, there is no compound or aggregate indicator for each city. In terms of the data sources, one must bear in mind that they are not official in certain cases. The objective of these indicators is to promote good governance, and they are developed only with a view to that goal.

The index proposed in this report is intended to be more complete and not to focus exclusively on aspects that make a local government more capable. Instead, it is focused on a good standard of living in cities and on their sustainability in the long term.

f. *Other indices sponsored by consulting firms and private companies: The Urban Sustainability Index (McKinsey & Company) and the Quality of Living Survey (Mercer).* Among those developed and sponsored by companies or organizations, with the objective of analyzing certain aspects that define a city's "intelligence," such as the cost of living, sustainability, standard of living or investment in green spaces, are the following: Green City Index (Siemens), Eco2 Cities (World Bank), The Global City Competitiveness Index (Citi for Cities, by Citigroup), Global Liveability Ranking and Report (Economist Intelligence Unit), The Livable Cities Index (C40 Cities Climate Leadership Group), CDP Cities (Carbon Disclosure Project) and the Global City Indicators Facility. Each of these indicators differs in terms of focus, areas covered and methodology. In no case do they offer a broad overview of the different dimensions that make up a city, as is the case with the ICIM.

In addition to these indicators at the worldwide and continental levels, there are certain systems of indicators that are relevant at the level of the main cities in a particular country or region. In general, these indicators measure the performance of an urban aggregate related to one single dimension - or at most four - usually related to the environment, technology, public finance, the economy and demographic or health-related indicators. The most important of these indicators include: Toronto Economic Indicators, Urban Indicators of Bogotá, British Columbia, Toronto Municipal Performance, Bristol Performance Plan, Cool Indicators Mississauga, Financial Indicators, Berkeley Indicators, Salisbury Performance, Liverpool Performance Office, Prague Indicators, Albuquerque Indicator Office, American City Indicators, Finance Best Practices and Dallas Indicators.

Cities in Motion: A Synthetic Indicator

The indicator that is the subject of this study, the ICIM, is synthetic and as such it is a function of the partial indicators that are available.

The basic model on which the process for creating the indicator is based is the weighted aggregation of partial indicators representing each of the 10 dimensions that make up the ICIM. These dimensions were selected to describe the reality of the cities in terms of their sustainability and their inhabitants' standard of living, both in the present and for the future. The 10 dimensions are as follows: Governance and Citizen Participation (hereafter referred to as "Governance"), Urban Planning, Public Management, Technology, The Environment, International Outreach, Social Cohesion, Mobility and Transportation, Human Capital and The Economy.

The partial indicators that make up each dimension also fall within the category of synthetic indicators, defined as "weighted aggregates of all the selected indicators representing different factors within each dimension."

The function for calculating the synthetic indicators, including both the sub-indicators representing each dimension and the ICIM overall, should possess certain desirable properties in order to serve as an ideal model (Pena, 2009); this must be taken into consideration when selecting the calculation methodology and the techniques used therein:

a) Existence of the indicator and determination for the full set of partial indicators.

b) Monotonicity with respect to the variations in the partial components; in other words, given a positive change in one of the partial indicators, all else being equal, the synthetic indicator must display movement in the same direction.

c) Uniqueness for the partial components, in such a manner that, given a specific situation, the synthetic indicator leads to a single result, for which purpose the property of non-variance must be fulfilled.

d) Homogeneity of degree one, in such a manner that, when multiplying each partial indicator by a constant, the synthetic indicator is multiplied by that same constant.

e) Transitivity, such that, given a set of indicator values for three different situations, if situation one is better than situation two, and situation two is better than situation three (the highest indicator), then situation one is better than situation three.

f) Completeness, in terms of making use of the information provided by the partial indicators, thereby avoiding duplication of the information.

In the upcoming sections, alternative calculation methodologies for the ICIM are described, as well as the indicators used in each of the dimensions and the techniques for standardizing variables and replacing variable values that are identified as missing for a specific city or set of cities due to the non-availability of data.

The cities for which the ICIM was completed are shown in Table 1 by regions.

Table 1
Geographic Areas Covered

Africa	Asia	Eastern Europe
Alexandria-Egypt	Beijing-China	Linz-Austria
Cairo-Egypt	Chongqing-China	Vienna-Austria
Cape Town-South Africa	Guangzhou-China	Brussels-Belgium
Durban-South Africa	Harbin-China	Copenhagen-Denmark
Johannesburg-South Africa	Shanghai-China	Helsinki-Finland
Pretoria-South Africa	Shenyang-China	Lille-France
Western Europe	Shenzhen-China	Lyon-France
Sofia-Bulgaria	Suzhou-China	Marseille-France
Herzegovina-Sarajevo-Bosnia	Tianjin-China	Nice-France
Prague-Czech Republic	Wuhan-China	Paris-France
Budapest-Hungary	Jakarta-Indonesia	Berlin-Germany
Riga-Latvia	Osaka-Japan	Cologne-Germany
Warsaw-Poland	Tokyo-Japan	Duisburg-Germany
Wroclaw-Poland	Kuala Lumpur-Malaysia	Frankfurt am Main-Germany
Ljubljana-Slovenia	Manila-Philippines	Hamburg-Germany
Ankara-Turkey	Moscow-Russia	Munich-Germany
Bursa-Turkey	St Petersburg-Russia	Stuttgart-Germany
Istanbul-Turkey	Busan-South Korea	Athens-Greece
Latin America	Daegu-South Korea	Dublin-Ireland
Buenos Aires-Argentina	Daejeon-South Korea	Florence-Italy
Córdoba-Argentina	Seoul-South Korea	Milan-Italy
Rosario-Argentina	Kaohsiung-Taiwan	Naples-Italy
La Paz-Bolivia	Taichung-Taiwan	Rome-Italy
Belo Horizonte-Brazil	Tainan-Taiwan	Turin-Italy
Brasllia-Brazil	Taipei-Taiwan	Amsterdam-Netherlands
Curitiba-Brazil	Bangkok-Thailand	Eindhoven-Netherlands
Fortaleza-Brazil	**Middle East**	Oslo-Norway
Porto Alegre-Brazil	Haifa-Israel	Lisbon-Portugal
Recife-Brazil	Tel Aviv-Israel	Porto-Portugal
Rio de Janeiro-Brazil	Doha-Qatar	Barcelona-Spain
Salvador-Brazil	Jeddah-Saudi Arabia-	Madrid-Spain
Sao Paulo-Brazil	Riyadh-Saudi Arabia	Seville-Spain
Santiago-Chile	Abu Dhabi-United Arab Emirates	Valencia-Spain
Bogota-Colombia	Dubai-United Arab Emirates	Gothenburg-Sweden
Cali-Colombia	**North America**	Stockholm-Sweden
Medellín-Colombia	Montreal-Canada	Basel-Switzerland
Santo Domingo-Dominican Republic	Ottawa - Gatineau-Canada	Geneva-Switzerland
Quito-Ecuador	Toronto-Canada	Zurich-Switzerland
Guadalajara-Mexico	Vancouver-Canada	Birmingham-United Kingdom
Mexico City-Mexico	Baltimore-USA	Glasgow-United Kingdom
Monterrey-Mexico	Chicago-USA	Leeds-United Kingdom
Lima-Peru	Dallas-USA	Liverpool-United Kingdom
Montevideo-Uruguay	Houston-USA	London-United Kingdom
Caracas-Venezuela	Los Angeles-USA	Manchester-United Kingdom
Oceania	Minneapolis-Saint Paul-USA	Nottingham-United Kingdom
Melbourne-Australia	New York-USA-	
Sydney-Australia	Philadelphia-USA	
Auckland-New Zealand		

Selection of Techniques for Calculation of the Synthetic Indicators

Based on a thorough study of the available methodologies, as well the background information at the worldwide level regarding the calculation of synthetic indicators, and bearing in mind their desirable properties, three alternative calculation techniques have been selected, each with its own advantages and disadvantages:

a. Indicators of simple weighting factors
b. Participatory
c. DP2 Technique

a) *Indicators of Simple Weighting Factors*

At present, a significant portion of the work aimed at creating synthetic indicators uses one-dimensional linear projections that generate simple weighted averages, some being different from others only in terms of the technique used for the standardization of the sub-indicators that comprise the indicator. This methodology is very widespread due to its simplicity of use and interpretation. In this type of method, each sub-indicator is assigned the same relative weight and the weighting and aggregation are performed in stages. In the case of the ICIM, the indicators were aggregated in each dimension using identical weighting factors that add up to one; in the subsequent stage, these indicators were also weighted using equivalent weighting factors for the creation of the ICIM.

Therefore, the indicator for a dimension i calculated using this methodology would be defined as follows:

$$\boldsymbol{S_i = w_i\, NI_{i1} + w_i\, NI_{i2} + \cdots + w_i\, NI_{in_l}} \qquad (1)$$

in which $w = 1/n_l$, the weight assigned to the standardized indicators; NI_{ij} is the standardized value of the indicator j for dimension i; and nl is the number of indicators in dimension i.

Likewise, all of the sub-dimensions are to be aggregated:

$$\boldsymbol{Cities\ in\ Motion \;= q\, S_1 + q\, S_2 + \cdots + q\, S_m} \quad (2)$$

in which $q = 1/m$ is the weight assigned to the standardized indicators; Si is the value of the synthetic indicator for dimension i; and m is the number of dimensions, which in this case is 10.

The main problem with this method, aside from the fact that it does not allow for assigning different weights to the indicators or the dimensions, is that the real weight that is assigned to each indicator may not be equal – as was intended – because, if the number of indicators in each sub-dimension is different, then the weight of each individual indicator in the synthetic indicator will also differ (Domínguez Serrano et al., 2011). Therefore, in the case of equation (1), it could occur, for instance, that $n_1 > n_2$ and therefore the relative weight of each of the indicators within dimension one will be less than the value of dimension two, when the index is created using equation (2). In accordance with this, by assigning the same importance to all of the indicators, one cannot do away with the risk that, if there are variables with strong correlations between them, there may be a duplication of information that could distort the model.

As one might conclude, the use of this technique necessarily entails the standardization of variables; the techniques used for standardization will be described in the next section of this document.

The inclusion of this methodology in the study, despite the disadvantages mentioned above, has the practical justification that it serves as a parameter for comparing the indicators' sensitivity to the application of more sophisticated techniques, which include, for example, methods to eliminate duplicated information or to place greater importance on specific dimensions.

b) Participatory Methods

The methodologies based on participatory methods propose the creation of synthetic indicators defined as weighted sums, in which the relative weights or weighted factors are created on the basis of subjective evaluations undertaken by a set of reference individuals. Among the most widespread participatory methods, the most notable are the public opinion method and the panel of experts method (Jesinghaus, 1997; Hermans, Bossche and Wets, 2007). In both, the weighted factors are determined on the basis of scores assigned by the group of individuals, either from the community or experts, whichever is appropriate. Last of all, the synthetic indicator is calculated by aggregating the indicators and the dimensions using the relative weights that have been calculated.

The formulas for calculation are as follows in this case:

$$\boldsymbol{S_i = w_{i1}\, NI_{i1} + w_{i2}\, NI_{i2} + \cdots + w_{in}\, NI_{in_l}} \quad (3)$$

in which w_{ij} is the weight assigned to the standardized indicators; NI_{ij} is the standardized value of indicator j for dimension i; and n_l is the number of indicators in dimension i.

And:

$$\boldsymbol{Cities\ in\ Motion} = \boldsymbol{q_1\, S_1 + q_2\, S_2 + \cdots + q_n\, S_m} \quad (4)$$

in which q_i = is the weight assigned to the standardized indicators; S_i is the value of the synthetic indicator for dimension i; and m is the number of dimensions, which in this case is 10.

For the case studied herein, any of these techniques could be applicable in principle, bearing in mind the disadvantages associated with this type of technique. The first inconvenience involves the reliability of the weighting factors, given the subjectivity inherent in personal evaluations; and the second involves the consistency of the individual scores, because it has been demonstrated that it is impossible to assign scores to a system of more than 10 indicators simultaneously without falling prey to inconsistencies (Sajeva et al., 2005).

c) DP2 Technique

The DP2 technique is a methodology based on distances: in other words, the difference between one given value of an indicator and another value used as a reference or target. Such techniques solve the problem of measurement unit heterogeneity. The use of some distance techniques requires that the aforementioned indicators fulfill some of the main properties.

Among these techniques, the most commonly used at the international level, and the most appropriate given the type of indicator to be calculated and the available data, is the DP2 technique.

This technique attempts to correct the dependence among partial indicators, which would artificially increase the indicator's sensitivity to variations in one specific partial value. The correction consists of applying the same factor to each partial indicator, assuming a linear dependence function.

Given the partial indicators, the correction factors are determined by the complement of the coefficient of determination (R^2) of each indicator with respect to the remaining partial indicators.

For instance, if *x1, x2, x3,..., xn* are the partial indicators, and *d1, d2, d3,..., dn*, are the distances between the value of the indicator and a reference value of that indicator, then the indicator calculated using this technique will be determined by the following formula:

$$\boldsymbol{DP_{2i} = \sum_{j=1}^{n} \frac{d_{ij}}{\sigma_j} \left(1 - R^2_{j,j-1,j-2,\dots,1}\right)} \quad (5)$$

in which d_{ij} is the distance between the value of indicator j of dimension i and the unit of reference established for indicator j of the same dimension; σ_j is the standard deviation of indicator j; $R^2_{j,j-1,j-2,\dots,1}$ is the multiple coefficient of determination of the linear regression of indicator *Ij* with respect to the indicators that precede it in the order of input *Is*, in which $s \in \{j-1, j-2, \dots, 1\}$, and $R_1^2 = 0$.

Similarly, the dimensions are to be aggregated in order to calculate the synthetic indicator:

$$\textit{Cities in Motion} = \sum_{i=1}^{n} \frac{d_i}{\sigma_i} \left(1 - R^2_{i,i-1,i-2,\ldots,1}\right) \quad (6)$$

The advantages of this technique, the most commonly used for the indicators presented herein, are as follows:

1. It does not require a procedure for standardization of variables because, when dividing the distance between the standard deviation of each indicator, the values are expressed in a non-dimensional scale, such that the contribution of each distance to the value of the index is inversely proportional to its dispersion.
2. The correction factor weights the differences between the indicators and their reference values by the proportion of "new" information that each indicator provides upon being included within a dimension (or a dimension of the synthetic indicator).
3. It is not variable in different reference situations.
4. It is easy to interpret the results.

However, when using this methodology, the value of the synthetic indicator is affected by the order in which the indicators are introduced, which may be solved by way of an iterative process that makes it possible to establish an order on the basis of the amount of information they provide.

Calculation Methodologies

1. Indicators

Governance

Governance, a term commonly used to refer to the effectiveness, quality and proper orientation of state intervention, is represented by the following indicators in this report: the Strength of Legal Rights Index (SLR) and the Corruption Perceptions Index (CPI), the latter having been calculated by the organization Transparency International. The SLR was included with a positive bearing. It is a function that national or local states cannot delegate, whose purpose is to create the proper conditions or to pursue the effective fulfillment of the people's rights and those of the companies located in their territory. The perception of the fulfillment of legal rights influences every aspect of a country's or a city's life, such as the business climate, incentives for investment and legal security, among others.

As for the Corruption Perceptions Index, it is a way of measuring the quality of governance in that, if society has a high perception of corruption in public bodies, it is an indication that the state's intervention is not efficient from the perspective of social economics, because public services – understood in a broad sense – bear greater costs compared with those they would entail if corruption did not exist. Moreover, the incentives to invest or settle in countries or cities with a high perception of corruption will be less than in others with low levels, thereby exerting a negative influence on the country's or city's sustainability. In the case of the ICIM, it is used as an explanatory indicator of the dimension of Governance, with a positive bearing, due to the manner in which the index is calculated by the organization Transparency International, which assigns a value of zero for countries with a high corruption level and 100 for very transparent countries.

Urban Planning

A city's urban planning involves various sub-dimensions and is closely related to a city's sustainability. Deficient urban planning leads to a decrease in people's standard of living in the medium term and also has a negative effect on investment incentives, because a city that has not been planned or is poorly planned creates difficulties and increases the costs of logistics and employee transportation, as well as affecting other factors.

On the basis of the information available, the measurement of Improved Sanitation Facilities (ISF), which is highly correlated with urban planning, is included as an indicator in this dimension, because it can be demonstrated that deficient planning unavoidably leads to health care problems in the short and long term.

Furthermore, from an urban planning or residential point of view, a city with adequate urban planning displays few or no problems of overcrowding in households in general, because housing policies, in keeping with estimated urban population growth, are normally a decisive factor in urbanization plans. For this reason, the number of occupants per household (OCC) was considered among the explanatory indicators of this dimension, with a negative bearing.

Public Management

In this report, public management is understood to be highly correlated with a city's or a country's state of public finance. In this sense, public accounts have a decisive effect on people's standard of living and on the sustainability of a city, insofar as it determines the level of present and future taxes that the people and system of production must pay, the expected increase in the general level of prices, the potential public investment in basic social infrastructure and the incentives aimed at private investment. Moreover, if the state has a need for funds as a result of a weak public finance system, it will compete with the private sector for the funds available in the financial system, thereby affecting investment.

The indicators that represent this dimension in this report are the ratio of taxes in relation to commercial profits, the level of central bank reserves and the level of reserves per capita. The indicator related to the taxation system, with a negative bearing on the value of the synthetic indicator of this dimension, encompasses aspects of the status of public finance because the greater the relative tax pressure is, the weaker a city's public accounts will become.

As for the level of total reserves, it is an indicator of the short- to medium-term strength of the public finance system, its ability to deal with changing economic cycles and the strength and sensitivity of the economic structure as regards the state.

Technology

Technology, as a dimension of the ICIM, is an aspect of society that improves the current standard of living, and its level of development or widespread usage is an indicator of a society's achieved or potential quality of life. Moreover, technological development is a dimension that allows cities to be sustainable over time, and to maintain or expand the competitive advantages of their production system and the quality of employment. A city that is technologically outdated has comparative disadvantages with other cities, both from the standpoint of safety, education and health – which are fundamental aspects in a society's sustainability – and from the standpoint of the productive system, which ends up with outmoded production tasks that make it difficult to achieve competitiveness without protectionism, a factor that has a negative effect on the city's ability to consume and to invest, in addition to reducing productivity in the workplace.

The indicators selected to measure the cities' performance in terms of the scope of technology and its growth in cities are the number of fixed broadband Internet subscribers per 100 inhabitants (FIS) and the Innovation Cities Index published by the Innovation Cities Program (IIC). The first of these figures has a strong correlation with a city's general technological advancement, because it implies the technological development of applications and devices for efficient use. As for the IIC index, it is calculated by carrying out assessments on the basis of several factors involving technological innovation in cities in sectors such as health care, the economy or the population in general, as well as others. It is currently the most thorough indicator for measuring cities' degree of development in terms of innovation, divided methodologically into three aspects or dimensions: cultural assets, human infrastructure and interconnected markets.

The Environment

Sustainable development in a city may be defined as "development that meets the needs of the present without jeopardizing the ability of future generations to meet their own needs."[1] In this sense, the environment is very important because sustainability over time, which makes it possible for future generations to meet their needs, is very closely related to this dimension. As the ICIM also intends to measure the sustainability of cities, the environment is included as one of the aspects to be measured.

The indicators selected for this dimension are CO_2 emissions, improved water sources as a percentage of the total urban population with access (H_2O), PM10 particles, the EPI index and methane emissions (MET).

As can be deduced, the first two indicators selected include measurements of air pollution sources and the quality of water in cities, which are indicators of their inhabitants' standard of living, as well as the sustainability of their production system and urban planning. CO_2 and methane emissions are the main measurements regularly used to determine the degree of air pollution because these substances are closely linked to the greenhouse effect. In fact, a decrease in the values of these indicators is included as an objective in the Kyoto Protocol.

Another very important indicator of air pollution in cities is PM10, the name given to small solid or liquid particles consisting of dust, ash, soot, metallic particles, cement or pollen dispersed into the atmosphere with a diameter of less than 10 micrometers. They are mainly made up of inorganic compounds such as silicates and aluminates, heavy metals and organic material associated with carbon particles (soot). This indicator is used a great deal in the indices that attempt to measure the status of environmental pollution.

Last of all the EPI (Environmental Performance Index), calculated by Yale University, is an indicator based on two overall dimensions related to the environment: environmental health and ecosystem vitality. The first is divided into three sub-dimensions: the effects of air pollution on human health, the effect of water quality on human health and the environmental burden of diseases. Ecosystem vitality has seven sub-dimensions: the effects of air pollution on the ecosystem; the effects of water quality on the ecosystem; biodiversity and habitat; forestation; fish; agriculture; and climate change. Given the thorough nature of this indicator – as it includes nearly all of the aspects involving the measurement of a city's environmental status and changes in a city's environment, complemented by the other four indicators that are included in the ICIM – the dimension of The Environment is considered to have been represented in a well-proportioned manner.

The indicators that represent PM10 particles and CO_2 and methane emissions are considered to have a negative bearing on this dimension, whereas the remaining indicators have a positive effect on The Environment.

International Outreach

Cities may have greater or lesser international outreach when compared with cities in other countries, but this factor is not independent from the degree of the country's openness. This dimension attempts to include these differences and measure the cities' international outreach on the basis of international tourism and the potential that each city offers for holding congresses and meetings of an international nature, given the restricted nature of current information.

In this sense, the following indicators have been included: international tourist arrivals (ITA), number of airline passengers (AEP), and number of meetings (MIT), according to data from the International Congress and Convention Association. This last figure is an important indicator of a city's international outreach, bearing in mind that such events regularly take place in cities that have

[1] Definition used in 1987 by the United Nations World Commission on Environment and Development, created in 1983.

international hotel and restaurant services, rooms especially prepared for such purposes, good frequency of international flights and adequate security measures.

Social Cohesion

Social Cohesion is a sociological dimension of cities, defined as the degree of consensus of the members of a social group or the perception of belonging to a common project or situation. It is a measurement of the intensity of social interaction within the group. We decided to measure social cohesion through the use of the different indicators that are available, having selected the following: the number of deaths per 1,000 inhabitants (QEP); the Gini coefficient (GIN); the unemployment rate (UER); and the consumer expenditure on housing per capita, in millions of constant dollars per inhabitant in 2013 (CEV).

This selection of indicators attempts to include all of the sociological sub-dimensions that Social Cohesion contains. For example, health and the future expectations of society are, in this case, measured using the number of deaths for every 1,000 inhabitants, with a negative bearing. Employment is a fundamental aspect within societies, to such an extent that the lack thereof may break the implicit consensus or social contract, according to historical evidence, and therefore the unemployment rate is included with a negative bearing when creating the indicator of this dimension. GIN is a measurement of social inequality, which takes values ranging from zero in the case of a perfectly equitable income distribution, to one in the case of a very inequitable income distribution, and therefore it is included within the indicator of the dimension Social Cohesion with a negative bearing, because a higher value of this index (in other words, greater social inequality) has a negative influence on cohesion, in a manner similar to what occurs with unemployment.

As for the per-capita consumer spending on housing, it bears a positive relationship with the indicator of this dimension because the possibility of gaining access to a higher consumption level, above subsistence values, increases the incentives for belonging to the society of a specific city. In turn, if similar cities are compared, higher spending on housing is an indication of the degree to which people feel rooted in the city and have a sense of belonging to the city where they have decided to locate their households.

Mobility and Transportation

Mobility and Transportation – in terms of both highway and road infrastructure and the automobile fleet and public transportation – affect the standard of living of a city's inhabitants and may be vital to the sustainability of cities over time. However, perhaps the most important is not this, but rather the externalities that are produced in the productive system due both to the labor force's need to commute and the need for production output. As a result, and always on the basis of the available indicators, the indices of logistical performance – in terms of both commercial aspects and the infrastructure related to trade (LGT) and to logistics overall (LGP) – are considered representative of this dimension, as shown in Table 1. These indicators provide a measurement of the effects that this dimension could have on the production process and, as a result, on people's income and standard of living. As a measurement of the efficiency and safety of highways and public transportation – which, if it is effective and has a good infrastructure, promotes a decrease in vehicular traffic on highways – we included, with a negative bearing, the number of deaths due to traffic accidents according to the World Health Organization (WHO), after weighting by the number of inhabitants and vehicles in each city.

Human Capital

Used as representative in this dimension are the indicators related to the international flow of mobile students in each city or country (IFS), the consumer expenditure on leisure and recreation (CER) and the highest level of studies completed. Although the Human Capital dimension includes factors that make it much too broad to be measured using these indicators, there is an international consensus that educational level and access to culture are very useful factors for rating human capital. In fact, one of the foundations of human development is human capital, and if we bear in mind that the Human Development Index published annually by the United Nations Development Program (UNDP) includes education and culture as dimensions, it is valid to use these indicators as explanatory of the differences in human capital in a city or country.

In the case of the ICIM, the factors of population by higher educational attainment (HEP) and secondary educational attainment (SEP), along with IFS are included with a positive bearing, and with a negative bearing, the population with only primary educational attainment (PEP) is figured in. Moreover, as a measure of access to culture, the spending on entertainment goods and services was considered, bearing a direct relationship to the indicator.

The Economy

The indicators used to represent the economic performance of the cities are as follows: the time required to open a business, measured in days; the gross domestic product (GDP) in millions of dollars at constant prices of 2012; labor productivity, measured in dollars according to the labor force (LPR); and total early-stage entrepreneurial activity (TEA), defined as the percentage of the population between the ages of 18 and 64 who are incipient entrepreneurs or who are proprietors/administrators of a new business (no more than 42 months old).

Bearing in mind that the ICIM attempts to measure the future sustainability of the largest cities in the world and the standard of living of their inhabitants through many different dimensions, real GDP is one measurement of a city's economic power and the income of its inhabitants, which, in turn, is an important measurement of the quality of life in cities. In numerous studies, GDP is considered to be the only measurement or the most important measurement of a city's or a country's performance. However, in this report, it is not considered to be exclusive or the most relevant factor, rather it is considered to be one further indicator among the 10 dimensions included in the ICIM. Therefore, its share in the total is similar to that of other indicators, if not the same, depending upon the technique that is applied. For example, if a city with a high or relatively high GDP does not have a good performance level in other indicators, it may not be placed among the top ranks. For instance, a highly productive city that has problems with transportation, inequality, weak public finance or production processes that use polluting technology will probably not occupy a top position in the ranking.

As for LPR, it is a measurement of the strength, efficiency and technological level of the production system, which, as regards local and international competitiveness, will obviously affect real salaries, the return on capital and business profits – all reasons why it is very important to include it within the dimension of The Economy, because different productivity levels may explain differences in the standard of living of a city's workforce – and the sustainability of the productive system over time.

The other two indicators selected as being representative of this dimension make it possible to measure certain aspects of a city's business world, such as the time required to open a business or the entrepreneurial capabilities and potential of the city's inhabitants (such as TEA). These last two indicators measure the city's capacity for sustainability over time as well as its potential for improving its inhabitants' standard of living.

Described in Table 2, in the form of a summary, are the indicators used in each of the dimensions, a description thereof, the units of measurement and the sources of information from which they were taken.

Table 2
Indicators

Indicator	Abbreviation	Unit of Measurement/Description	Dimension/Cluster	Source
Time required to start a business	TSB	Days	The Economy	World Bank
Total GDP	GDP	Millions of USD at prices of 2012	The Economy	Passport
Labor productivity	LPR	USD/occupied person	The Economy	Passport
Total early stage entrepreneurial activity	TEA	Percentage of the population aged 18-64 years	The Economy	Global Entrepreneurship Monitor
International flows of mobile students at the tertiary level	IFS	Number of people	Human Capital	UNESCO
Population by educational attainment [higher]	HEP	Thousands of people	Human Capital	Passport
Population by educational attainment [secondary]	SEP	Thousands of people	Human Capital	Passport
Population by educational attainment [primary]	PEP	Thousands of people	Human Capital	Passport
Consumer expenditure on leisure and recreation per capita	CER	Millions of USD/inhabitant at prices of 2012	Human Capital/Country Cluster	Passport
Strength of Legal Rights Index	SLR	Index (from 0 = low, to 10 = high)	Governance	World Bank
Corruption Perceptions Index	CPI	Index (from 0 = very corrupt, to 100 = very transparent)	Governance	Transparency International
Fixed broadband Internet subscribers	FIS	Number of new subscriptions/100 inhabitants	Technology	World Bank
Innovation Cities Index	IIC	Index (from 0 = no innovation, to 60 = much innovation)	Technology	Innovation Cities Program
Road traffic deaths per capita, by car	RTD	Number of deaths in accidents/inhabitant/vehicle	Mobility and Transportation	Global Health Observatory
Logistics Performance Index: overall	LGP	Index (from 1 = low, to 5 = high)	Mobility and Transportation	World Bank
Logistics Performance Index: trade	LGT	Index (from 1 = low, to 5 = high)	Mobility and Transportation	World Bank
CO_2 emissions (kt)	CO_2	kt	The Environment	World Bank
PM10 24-hour mean micrograms per cubic meter	PM10	Micrograms per cubic meter (daily measurement)	The Environment	Passport
Methane emissions	MET	Equivalent kt of CO_2	The Environment	World Bank
Improved water source, urban (% of urban population with access)	H_2O	Percentage of the total urban population with access	The Environment	World Bank
Environmental Performance Index	EPI	Index (from 1 = bad, to 100 = good)	The Environment	Yale University
Unemployment rate	UER	Percentage of population that is active	Social Cohesion	Passport
Gini Index	GIN	Index (from 0 to 100)	Social Cohesion	Passport
Consumer expenditure on housing per capita	CEV	Millions of USD/inhabitant at prices of 2012	Social Cohesion/Country Cluster	Passport
Death	QEP	Thousands of people	Social Cohesion	Passport
Airline passengers	AEP	Thousands of passengers	International Outreach	Passport

Indicator	Abbreviation	Unit of Measurement/Description	Dimension/Cluster	Source
International tourist arrivals	ITA	Thousands of tourists	International Outreach	Passport
Numbers of meetings	MIT	Number of meetings	International Outreach	International Congress and Convention Association
Improved sanitation facilities (% of population with access)	ISF	Percentage of population with access	Urban Planning	World Bank
Occupants per household	OCC	Number of people/household	Urban Planning	Passport
Total reserves	RBCT	Millions of current USD	Public Management	World Bank
Total reserves per capita	RBCH	Millions of current USD /inhabitant	Public Management	World Bank
Total tax rate (% of commercial profits)	TAX	Percentage of commercial profits	Public Management	World Bank
Consumer expenditure on hotels and catering per capita	CEH	Millions of USD/inhabitant at prices of 2012	Country Cluster	Passport
Annual disposable income	DIN	Millions of USD at prices of 2012	City Cluster	Passport
Households	HOU	Thousands of households	City Cluster	Passport
Average household annual disposable income by decile (decile 1)	DE1	USD 2012	City Cluster	Passport
Average household annual disposable income by decile (decile 2)	DE2	USD 2012	City Cluster	Passport
Average household annual disposable income by decile (decile 3)	DE3	USD 2012	City Cluster	Passport
Average household annual disposable income by decile (decile 4)	DE4	USD 2012	City Cluster	Passport
Average household annual disposable income by decile (decile 5)	DE5	USD 2012	City Cluster	Passport
Average household annual disposable income by decile (decile 6)	DE6	USD 2012	City Cluster	Passport
Average household annual disposable income by decile (decile 7)	DE7	USD 2012	City Cluster	Passport
Average household annual disposable income by decile (decile 8)	DE8	USD 2012	City Cluster	Passport
Average household annual disposable income by decile (decile 9)	DE9	USD 2012	City Cluster	Passport
Average household annual disposable income by decile (decile 10)	DE10	USD 2012	City Cluster	Passport
Employment rate	EMP	Percentage	Country Cluster	Passport
Consumer expenditure on education per capita	CEE	Millions of USD/inhabitant at prices of 2012	Country Cluster	Passport
Consumer expenditure on health goods and medical services per capita	CEM	Millions of USD/inhabitant at prices of 2012	Country Cluster	Passport

2. Base Period

On the basis of the available information and criteria of economic and social stability, the year 2011 was selected as the base period.

3. Standardization of Variables

In the event that the technique used requires the standardization of variables to unify the units of measurement of the full set of variables included in the model, the indicators are then converted to a common scale with a mean of zero and a standard deviation of one.

In the case of the DP2 technique, as can be deduced from the description of the technique provided in the previous section, standardization is not necessary because the method itself is based on relative distances, thereby standardizing the values of the variables on its own.

4. Assignment of Missing Values. Clusters.

Because the ICIM is an index of cities calculated for a series of years, three potential non-existent or "missing" values may exist:

a. Non-existent values of a variable for one city or a specific set of cities, in one specific year, but with valid values for other years in the series being considered. In this case, the assignment of the missing values is performed by way of a simple linear extrapolation by average value or an interpolation of the values of all the cities for which the problem exists, using the data on the same variable for the periods in which data does exist.

b. Non-existent values of a variable for any city, but with valid values at the level of the country in which each city is geographically located, as is the case of those variables whose source is the World Bank database. In these cases, depending upon the variable in question, the same variable value is assigned at the country level for each of the cities, or it is distributed among the cities in each country using some other theoretically related variable.[2]

c. Non-existent values of a variable for one city or a specific set of cities throughout the entire period being considered. In this case, two situations may arise:

I. The missing values correspond to a variable for which there is valid data for another set of cities.

II. The missing values correspond to a variable for which there is valid data at the country level.

In both cases, the cluster analysis that is described below will be used to assign values, with the difference that, in Case II, the technique described in point b must later be applied.

Weighted-average hierarchical cluster analysis is used to assign values in the cases of point c.

Hierarchical cluster methods consist of grouping clusters together and forming a new cluster or dividing one already in existence to form another two, in such a way that, if this process is carried out successively, some distance is minimized or some measure of similarity is maximized so as to assign an average value of the same variable to the missing value for "similar cities," in accordance with the clustering criteria.

Hierarchical methods are subdivided into divisive and agglomerative types, with a large number of strategies or variants in each of these subdivisions.

For the case studied here, the agglomerative hierarchical technique will be used. It begins with as many agglomerates as there are cities, and the clusters are gradually formed in an ascending order based on the criteria of minimizing the distances between the elements that make up each cluster, until one single group is created. By doing this, one can create

[2] This is the case with entertainment consumption, household consumption, traffic accidents and the city's financial reserves.

a dendrogram, a tool that makes it possible to determine the optimal number of clusters at which the iterative process should end.

The technique used in this iterative process is known as cluster weighted-average linkage, which merges, in each stage, those clusters that have the least weighted average distance. The distance used in this technique is the Euclidean distance. The weighting factors or weights are determined on the basis of the number of elements contained in the clusters that are clustered in each iterative step.

Therefore, given two clusters C_i and C_j, and assuming that cluster C_i is made up of two clusters, C_{i1} and C_{i2} originating from the preceding step in the process, with n_{i1} and n_{i2} each being elements, $n_i = n_{i1} + n_{i2}$ being the number of elements or observations of C_i and n_j the number of elements in C_j, the weighted average distance – noting $x_i \in C_i$; $x_{i1} \in C_{i1}$; $x_{i2} \in$, $x_j \in C_j$ and $d(C_i, C_j)$ as the Euclidean average of distances – will be as follows:

$$d(C_i, C_j) = \frac{1}{(n_{i1}+n_{i2})n_j} \sum_{i=1}^{n_i} \sum_{J=1}^{n_j} d(x_i, x_j) =$$

$$= \frac{1}{(n_{i1}+n_{i2})n_j} \sum_{i=1}^{n_{i1}} \sum_{J=1}^{n_j} d(x_{i1}, x_j) + \frac{1}{(n_{i1}+n_{i2})n_j} \sum_{i=1}^{n_{i2}} \sum_{J=1}^{n_j} d(x_{i2}, x_j) =$$

$$= \frac{n_{i1}}{(n_{i1}+n_{i2})n_j n_{i1}} \sum_{i=1}^{n_i} \sum_{J=1}^{n_j} d\; x_i, x_j + \frac{n_{i2}}{(n_{i1}+n_{i2})n_j n_{i2}} \sum_{i=1}^{n_i} \sum_{J=1}^{n_j} d(x_i, x_j) =$$

$$= \frac{\boldsymbol{n_{i1}}}{\boldsymbol{(n_{i1}+n_{i2})n_j n_{i1}}} \boldsymbol{d(C_{i1}, C_j)} + \frac{\boldsymbol{n_{i2}}}{\boldsymbol{(n_{i1}+n_{i2})n_j n_{i1}}} \boldsymbol{d(C_{i2}, C_j)} \quad \textbf{(7)}$$

Therefore, the distance $d(C_i, C_j)$ is the weighted average of the distances of each of the two preceding clusters, C_{i1} and C_{i2} with respect to cluster C_j.

The variables used to create the clusters and the number of clusters formed shall be specified as the process for calculation of the synthetic indicators is developed.

Calculation Process

I. Initial Stage: Missing Values

As we have already mentioned above, there are three cases of missing values. In the case of non-existent values of a variable for a city or specific set of cities in one specific year but with valid values for other years in the series considered, the interpolation or extrapolation of values is performed in such a way that, taking a variable x for which there is no data for the period t, the value assigned to that period will be:

$$\boldsymbol{X_t = (X_{t-1} + X_{t+1})/2} \textbf{ interpolation} \quad \textbf{(8)}$$

$$\boldsymbol{X_t = (X_{t-2} + X_{t-1})/2} \textbf{ extrapolation} \quad \textbf{(8.1)}$$

In the second case, when there are non-existent values for any city or set of cities but there are valid values at the level of the country in which the city is geographically located, as is the case with the variables whose source is the World Bank database, we proceeded to assign the value of the variable at the country level to all of the cities located in the country geographically. There are three special cases: a) the variable "road traffic deaths" (RTD), which only contains data at the country level and for which the assignment of values to each city was performed in accordance with the city's proportion of the population out of the whole country; b) the variable "number of broadband Internet subscriptions," for which data is only available at the country level and therefore each city was assigned a portion of the total for the country, also using the city population/country population ratio; and c) the amount of central bank reserves, which is assigned to each city in accordance with its share in the GDP out of the total for the whole country as a measure of the economic importance of each subnational division.

In the third case of missing values, when there are non-existent values of a variable for a specific city or set of cities throughout the entire period considered, the clustering technique described above was used. The variables used to form each cluster, to determine whether the cities belonged to each cluster, or their similarity, were as follows:

City Clusters:

- Annual disposable income for the base year, at constant value in millions of dollars (DIN), at 2012 prices, per capita.
- Average household annual disposable income for each one of the deciles in constant dollars (10 variables: DE1-DE10).
- Number of households (HOU), in thousands, per capita.

Country Clusters:

- Unemployment rate (UER).
- Consumer expenditure on education, per capita (CEE).
- Consumer expenditure on health goods and medical services, per capita (CEM).
- Consumer expenditure on hotels and food services, per capita (CEH).
- Expenditure on housing, per capita (CEC).
- Consumer expenditure on leisure and recreation, per capita (CER).

Once the clusters were formed, the average of the variable that contains the missing value is assigned to the cluster that includes the city for which no valid value existed for that same variable. It should be pointed out that this process of calculation is the same for all of the methods.

a) Simple Weighting Method: Calculation

The methodology for calculating the index using this method is completed in stages, which are described below:

Stage I: Standardization

As pointed out above, the method of simple weighting factors first requires the standardization of variables. In this case, the z-scores technique was used:

$$\boldsymbol{Z_x} = \left(\frac{x-x}{\sigma_x}\right) \qquad (9)$$

in which Z_x is the standardized value of variable x, x is the average of the variable x for all of the cities and years available and σ_x is the standard deviation of the variable x.

Stage II: Calculation of the Synthetic Index for Each Dimension

Once the values were standardized, we proceeded to calculate the synthetic indicators of each dimension for each of the cities, using equal weighting factors to weight each variable as explained above; in other words, the weighting factor of each variable will be $1/nd$, in which nd is the number of indicators contained by the synthetic index for dimension d. The formula applied for the indicator on the z-scores scale for the period t is as follows:

$$\boldsymbol{I_{d,t}} = \sum_{i=1}^{n_d} \boldsymbol{x_{i,d}\, w_d} \qquad (10)$$

in which $I_{d,t}$ is the synthetic indicator on the z-scores scale, for dimension d in period t, $x_{i,d}$ is the variable i of dimension d and w_d is the identical weighting factor for each variable in dimension d.

Stage III: Calculation of the ICIM

Once the 10 synthetic indicators were calculated for each of the dimensions in the ICIM on the z-scores scale, we proceeded to perform its calculation as a weighted sum of the indicators in the dimensions ($I_{d,t}$), the relative weights of which will be identical and equal to 0.10. For instance, the formula for calculating the synthetic indicator for period t is:

$$\boldsymbol{CIM_t} = \mathbf{0.10} \cdot \sum_{d=1}^{10} \boldsymbol{I_{d,t}} \qquad (11)$$

b) DP2 Technique: Calculation

Stage I: Calculation of the Synthetic Index for the Dimension

As explained in the preceding sections, the use of the DP2 technique keeps us from needing to perform the standardization of variables, because the formula for calculation itself is based on distances corrected by standard deviation. However, the order in which the variables are included within the indicator may influence the index value due to the formula for calculating the weighting factors.

The formula for calculating the synthetic indicators of each dimension *d* for the period *t* is as follows:

$$\boldsymbol{ID_{d,t}} = {}_{j=1}^{n} \frac{d_{djt}}{\sigma_j} \left(1 - R^2_{j,j-1,j-2,\ldots,1}\right) \qquad (12)$$

in which d_{ij} is the distance between the value of the variable *xj* in dimension *d* and the unit of reference established for the variable *xj* in the same dimension, which in this case is the minimum value of each variable and therefore the values of the distance *d* will be positive; σ_j is the standard deviation of the variable *xj*; $R^2_{j,j-1,j-2,\ldots,1}$ are the coefficients of multiple determination of the linear regression of the variable *xj* with respect to the variables *xs*, in which $s \in \{j\text{-}1, j\text{-}2, \ldots, 1\}$ and $R_1^2 = 0$. The regressions from which $R^2_{j,j-1,j-2,\ldots,1}$ are calculated, for each dimension *d*, are calculated in successive stages using the following models:

$$x_{2_d} = x_{1_d}\,\beta_{1_d} + \mu_{2_d} \qquad (13)$$

$$x_{3_d} = x_{1_d}\,\beta_{1_d} + x_{2_d}\,\beta_{2_d} + \mu_{3_d} \qquad (14)$$

$$\vdots$$

$$x_{n_d} = x_{1_d}\,\beta_{1_d} + + x_{2_d}\,\beta_{2_d} + \cdots + x_{n_d}\,\beta_{n_d} + .\,\mu_{n_d} \qquad (15)$$

The sub-indices *1, 2, 3, … n* represent the order in which the variables were included in each stage for calculating the weighting factors. In order to determine the order, the theoretical importance that each variable holds in measuring each dimension was taken into consideration. The order is as follows:

Governance

(1) Corruption Perceptions Index; (2) strength of Legal Rights Index.

Urban Planning

(1) Number of occupants per household; (2) improved sanitation facilities (% of total population with access).

Public Management

(1) Total tax rate (% of commercial profits); (2) total central bank reserves per capita; (3) total central bank reserves.

Technology

(1) Innovation Cities Index; (2) number of fixed broadband Internet subscribers (per 100 inhabitants).

The Environment

(1) EPI; (2) CO2 emissions; (3) methane emissions; (4) improved water source, as a percent of the total population with access; (5) PM10.

International Outreach

(1) Number of airline passengers; (2) thousands of international tourist arrivals; (3) number of meetings, congresses and conferences.

Social Cohesion

(1) Gini coefficient; (2) unemployment rate; (3) expenditure on housing; (4) number of deaths (per 1,000 inhabitants).

Mobility and Transportation

(1) Road traffic deaths; (2) overall Logistics Performance Index; (3) Logistics Performance Index in terms of trade and infrastructure related to transportation.

Human Capital

(1) Consumer expenditure on leisure and recreation; (2) population by higher educational attainment; (3) population by secondary educational attainment; (4) population by primary educational attainment; (5) international flows of mobile students at the tertiary level.

The Economy

(1) GDP at constant value in millions of dollars; (2) labor productivity; (3) total early stage entrepreneurial activity; (4) time required to start a business, in days.

Stage II: Calculation of the ICIM

In the same way as in the preceding stage, the calculation of the ICIM is performed by applying the formula of the DP2 technique, in which, in this case, the synthetic indicators of each dimension are weighted by the factor $(1 - R^2_{j,j-1,j-2,\ldots,1})$.

$$\boldsymbol{CIM_t = \sum_{j=1}^{10} \frac{d_{jt}}{\sigma_{jt}} (1 - R^2_{10,9,8,\ldots,1})} \tag{16}$$

in which d_{jt} is the distance between the value of the synthetic indicator of dimension j for period t *(IDjt)* and the minimum value of that indicator; σ_j is the standard deviation of the synthetic indicator of dimension j; $R^2_{10,9,8\ldots,1}$ are the coefficients of multiple determination of the linear regression of the indicator of dimension j, with respect to the indicators *IDs*, in which $s \in \{9,8,7,\ldots,1\}$ and $R_1^2 = 0$. The regressions whose R^2 are used to calculate the weighting factors of the ICIM are also calculated in successive stages, using the following models:

$$\boldsymbol{ID_2 = ID_1\beta_1 + \mu_1} \tag{17}$$

$$\boldsymbol{ID_3 = ID_1\beta_1 + ID_2\beta_2 + \mu_2} \tag{18}$$

$$\vdots$$

$$\boldsymbol{ID_{10} = ID_1\beta_1 + ID_2\beta_2 + \cdots + ID_9\beta_9 + \mu_9} \tag{19}$$

The order in which the indicators of each dimension were included, as well as their relative weight *(1-* R_j^2) in the ICIM are as follows:

1. The Economy: 1
2. Human Capital: 0.4794
3. Mobility and Transportation: 0.6290
4. The Environment: 0.7040
5. Social Cohesion: 0.6317
6. International Outreach: 0.6731
7. Technology: 0.3057
8. Urban Planning: 0.2572
9. Public Management: 0.8818
10. Governance: 0.3321

Although the order in which each synthetic index of each dimension is included influences the value of the ICIM, the sensitivity studies carried out conclude that there are no significant variations therein.

c) Mixed DP2-Participatory Method: Calculation

This method combines the two techniques described above: DP2 and the participatory technique. Stage I, in which the synthetic indicators are calculated for each dimension, is identical to DP2.

Stage II, corresponding to the final calculation of the ICIM, is also an aggregation of the synthetic indicators in each one of the dimensions, using the same formula as in DP2; however, the values of the weights for each of them $(1 - R^2_{10,9,8,\ldots,1})$ are assigned in accordance with subjective criteria, taking into consideration the following aspects:

a. The synthetic indicators in the dimension in question, created using variables or partial indicators for which data is only available at the country level, have less of a weight. Likewise, those synthetic indicators that are combinations of variables with data at the city level and other data at the country level will have a greater weight than the first, but less weight than those that are aggregates of variables with data exclusively at the city level.

b. The larger the number of variables with full information within a dimension, the greater the weight of the synthetic indicator that represents it in the calculation of the ICIM.

In accordance with these criteria, the relative weights used for this calculation are as follows:

1. The Economy: 1.00
2. Human Capital: 0.70
3. Mobility and Transportation: 0.90
4. The Environment: 0.60
5. Social Cohesion: 0.90
6. International Outreach: 0.50
7. Technology: 0.90
8. Public Management: 0.05
9. Urban Planning: 0.80
10. Governance: 0.50

II. Final Stage: Changing the Scale of the Indicators

As a result of the procedures selected, which are described above, both the synthetic indicators of each dimension and the ICIM are expressed in values corresponding to the standardizations (z-scores, in the case of the indicators calculated using the simple weighting factor method, and in the case of the DP2 technique, the distance with respect to the minimum value corrected by standard deviation). However, it is recommendable to express them on a scale that makes it possible to note the differences between each value of the indicator more intuitively, thereby facilitating interpretation of the results and values, as well as the differences existing between the values of the indicators among the various cities and their changes over time.

In order to modify the scale of each indicator, its maximum value for the base year (2011) was considered and it was assigned the number 100, with the number zero assigned to the minimum value of the same indicator for the same period.

The transformation of the scale for the synthetic indicator of dimension *d*, for city *i*, is carried out by way of the following successive stages:

(1) Auxiliary values are calculated for the indicators, in such a way that:

$$\boldsymbol{ID_{d,0}^{a,i} = ID_{d,0}^{i} - ID_{d,0}^{min,i}} \qquad (20)$$

In other words, the auxiliary value of each indicator in dimension *d*, for city *i* and the base year, is equal to the value of the indicator of the same dimension for the same city and year, expressed on a standardized scale, plus the absolute value of the minimum value that indicator takes on in the base year.

(2) On the basis of this auxiliary indicator, the final value is calculated for the indicator $ID_{d,0}^{f,i}$:

$$\boldsymbol{ID_{d,0}^{f,i} = \frac{ID_{d,0}^{a,i}}{ID_{d,0}^{max}} \cdot 100} \qquad (21)$$

in which $ID_{d,0}^{f,i}$ is the final synthetic indicator of dimension *d*, for city *i* in the base period; $ID_{d,0}^{a,i}$ is the indicator of dimension *d*, for city *i*, calculated in accordance with (19) and $ID_{d,0}^{max}$ is the maximum value taken on by the indicator in standardized values for the base year, in dimension *d*. This is also common to all of the techniques for calculation of the index.

Stage III: Selection of Cities to Include in the Calculation

During the process prior to calculating the indicators, sufficiency and completeness tests were carried out so that the inclusion of cities would be performed in a way that ensures the quality of the end product, in addition to the analysis of the cities' relevance, in accordance with the criteria described in Chapter I.

Information was analyzed on 851 cities for which there was data for at least one variable for the base year, regardless of whether it was later selected for the calculation.

As a first measure, criteria for the selection of cities were applied based on population size and the economic, political or cultural importance of the cities within the countries where they are located. If, as a result of this process, any city was excluded for which there was sufficient and complete data, the city was included in the study universe once again.

After this, a prior cluster analysis was carried out to assign the missing values of the variables selected for the calculation, and on the basis thereof cities were excluded when there was no data for any of them, or they could not be assigned using agglomerative techniques, because there were no cities with the valid data in the cluster in which they were included when using the optimal cluster size, not even by making it flexible to acceptable limits.

As a result of this process, 135 cities were included in this study.

Cities in Motion Index

Methodology of calculation	DP2
Number of dimensions	10
Number of variables	49
Number of cities	135
Period	2011, 2012 and 2013

Sensitivity Analysis

In order to analyze the sensitivity of the indicator to different calculation methodologies and mainly to the diverse values of the weighting factors used on the different indicators, modifications were made in the indicators of the various dimensions.

Furthermore, the index was recalculated without including the dimensions of The Economy, Governance and Urban Planning, because these three dimensions exert a strong influence upon the variables at the country level.

(1) Cities in Motion: Methodology of Simple Weighting Factors

Comparing the results of the ICIM calculated by the method of simple weighting factors, one can see that there are differences compared with the DP2 index in terms of both the relative rank of each of the cities and the average values of the indicators. For instance, one can see in Tables 3 and 4 that the proportion of cities with "high" and "relatively high" performance, which amounts to 28.8%, is higher than that found using the DP2 Technique. In the medium and low ranges, the percentage of cities included is reduced, slightly increasing the number of cities with a "very low" performance rating. It is important to bear in mind that this indicator does not eliminate the problem of duplicate information, and therefore the result described was predictable.

However, in the top places within the ranking, there were no significant changes, with Tokyo, London, New York, Paris and Zurich remaining in those positions. The only change took place in the city that ranked fourth, which is Paris if we use this methodology, pushing Zurich back one place to the fifth position.

Table 3

Ranking	City	Performance	ICIM	Ranking	City	Performance	ICIM
1	Tokyo-Japan	A	100,0	37	Frankfurt am Main-Germany	RA	61,0
2	London-United Kingdom	A	91,4	38	Gothenburg-Sweden	RA	60,9
3	New York-USA	RA	85,3	39	Hamburg-Germany	RA	60,3
4	Paris-France	RA	83,8	40	Nice-France	M	59,5
5	Zurich-Switzerland	RA	81,8	41	Glasgow-United Kingdom	M	59,4
6	Geneva-Switzerland	RA	77,7	42	Duisburg-Germany	M	58,8
7	Seoul-South Korea	RA	72,5	43	Birmingham-United Kingdom	M	58,8
8	Philadelphia-USA	RA	72,5	44	Lille-France	M	58,7
9	Osaka-Japan	RA	72,2	45	Leeds-United Kingdom	M	58,3
10	Basel-Switzerland	RA	72,0	46	Vancouver-Canada	M	58,3
11	Los Angeles-USA	RA	71,3	47	Tel Aviv-Israel	M	58,1
12	Oslo-Norway	RA	71,2	48	Montreal-Canada	M	57,5
13	Copenhagen-Denmark	RA	71,2	49	Brussels-Belgium	M	57,0
14	Eindhoven-Netherlands	RA	70,9	50	Dublin-Ireland	M	56,0
15	Dallas-USA	RA	70,4	51	Auckland-New Zealand	M	55,1
16	Amsterdam-Netherlands	RA	69,8	52	Lyon-France	M	54,8
17	Stockholm-Sweden	RA	69,7	53	Barcelona-Spain	M	53,7
18	Sydney-Australia	RA	68,8	54	Marseille-France	M	53,5
19	Chicago-USA	RA	67,9	55	Madrid-Spain	M	52,8
20	Baltimore-USA	RA	67,7	56	Kuala Lumpur-Malaysia	M	51,4
21	Berlin-Germany	RA	66,8	57	Daejeon-South Korea	M	50,9
22	Minneapolis-Saint Paul-USA	RA	66,4	58	Prague-Czech Republic	M	50,7
23	Melbourne-Australia	RA	66,4	59	Rome-Italy	M	50,5
24	Munich-Germany	RA	65,4	60	Daegu-South Korea	M	50,1
25	Linz-Austria	RA	65,4	61	Milan-Italy	M	49,6
26	Vienna-Austria	RA	65,2	62	Florence-Italy	M	48,9
27	Helsinki-Finland	RA	64,6	63	Busan-South Korea	M	48,1
28	Nottingham-United Kingdom	RA	63,1	64	Dubai-United Arab Emirates	M	47,8
29	Houston-USA	RA	63,1	65	Beijing-China	M	47,7
30	Toronto-Canada	RA	62,5	66	Valencia-Spain	M	47,7
31	Haifa-Israel	RA	61,9	67	Porto-Portugal	M	46,9
32	Manchester-United Kingdom	RA	61,3	68	Budapest-Hungary	M	46,8
33	Stuttgart-Germany	RA	61,3	69	Turin-Italy	M	45,7
34	Liverpool-United Kingdom	RA	61,2	70	Bangkok-Thailand	M	45,6
35	Ottawa- Gatineau-Canada	RA	61,2	71	Seville-Spain	M	45,4
36	Cologne-Germany	RA	61,1	72	Shanghai-China	M	45,4

Table 3 (Continued)

Ranking	City	Performance	ICIM	Ranking	City	Performance	ICIM
73	Warsaw-Poland	M	45,0	109	Mexico City-Mexico	B	22,7
74	Doha-Qatar	B	44,3	110	Pretoria-South Africa	B	22,6
75	Wroclaw-Poland	B	43,5	111	Lima-Peru	B	22,1
76	Abu Dhabi-United Arab Emirates	B	43,1	112	Wuhan-China	B	22,1
77	Riyadh-Saudi Arabia	B	41,2	113	Shenyang-China	B	22,0
78	Lisbon-Portugal	B	41,0	114	Johannesburg-South Africa	B	21,7
79	Naples-Italy	B	40,6	115	Chongqing-China	B	21,6
80	Istanbul-Turkey	B	38,8	116	St Petersburg-Russia	B	21,3
81	Riga-Latvia	B	37,6	117	Harbin-China	B	21,2
82	Santiago-Chile	B	36,7	118	Rio de Janeiro-Brazil	B	19,5
83	Jeddah-Saudi Arabia	B	36,6	119	Alexandria-Egypt	B	18,9
84	Ljubljana-Slovenia	B	36,5	120	Shenzhen-China	B	16,9
85	Taipei-Taiwan	B	35,6	121	Manila-Philippines	B	14,8
86	Bursa-Turkey	B	35,4	122	Quito-Ecuador	B	13,9
87	Sofia-Bulgaria	B	34,6	123	Cairo-Egypt	B	13,8
88	Moscow-Russia	B	32,0	124	Suzhou-China	B	13,3
89	Guangzhou-China	B	32,0	125	Salvador-Brazil	MB	12,2
90	Athens-Greece	B	31,5	126	Porto Alegre-Brazil	MB	11,9
91	Durban-South Africa	B	30,6	127	Belo Horizonte-Brazil	MB	11,6
92	Ankara-Turkey	B	30,6	128	Brasilia-Brazil	MB	10,4
93	Rosario-Argentina	B	29,4	129	Herzegovina-Sarajevo-Bosnia	MB	10,1
94	Tainan-Taiwan	B	28,3	130	Caracas-Venezuela	MB	9,9
95	Tianjin-China	B	28,2	131	Recife-Brazil	MB	9,9
96	Córdoba-Argentina	B	28,2	132	Fortaleza-Brazil	MB	9,4
97	Monterrey-Mexico	B	27,9	133	Jakarta-Indonesia	MB	7,5
98	Kaohsiung-Taiwan	B	27,1	134	La Paz-Bolivia	MB	6,0
99	Curitiba-Brazil	B	26,6	135	Santo Domingo-Dominican Republic	MB	0,0
100	Taichung-Taiwan	B	26,5				
101	Montevideo-Uruguay	B	26,4				
102	Buenos Aires-Argentina	B	26,4				
103	Cali-Colombia	B	26,3				
104	Sao Paulo-Brazil	B	26,2				
105	Medellin-Colombia	B	24,6				
106	Guadalajara-Mexico	B	24,3				
107	Cape Town-South Africa	B	22,9				
108	Bogota-Colombia	B	22,9				

Table 4

City	2011	2012	2013	2011-2012	2012-2013
Tokyo-Japan	1	1	1	⇨ 0	⇨ 0
London-United Kingdom	2	2	2	⇨ 0	⇨ 0
New York-USA	3	3	3	⇨ 0	⇨ 0
Paris-France	4	4	4	⇨ 0	⇨ 0
Zurich-Switzerland	5	5	5	⇨ 0	⇨ 0
Geneva-Switzerland	7	6	6	⇧ 1	⇨ 0
Seoul-South Korea	11	9	7	⇧ 2	⇧ 2
Philadelphia-USA	10	10	8	⇨ 0	⇧ 2
Osaka-Japan	9	8	9	⇧ 1	⇩ -1
Basel-Switzerland	17	11	10	⇧ 6	⇧ 1
Los Angeles-USA	16	15	11	⇧ 1	⇧ 4
Oslo-Norway	8	7	12	⇧ 1	⇩ -5
Copenhagen-Denmark	6	12	13	⇩ -6	⇩ -1
Eindhoven-Netherlands	12	13	14	⇩ -1	⇩ -1
Dallas-USA	15	16	15	⇩ -1	⇧ 1
Amsterdam-Netherlands	14	18	16	⇩ -4	⇧ 2
Stockholm-Sweden	13	17	17	⇩ -4	⇨ 0
Sydney-Australia	18	14	18	⇧ 4	⇩ -4
Chicago-USA	19	19	19	⇨ 0	⇨ 0
Baltimore-USA	21	20	20	⇧ 1	⇨ 0
Berlin-Germany	25	21	21	⇧ 4	⇨ 0
Minneapolis-Saint Paul-USA	22	23	22	⇩ -1	⇧ 1
Melbourne-Australia	24	22	23	⇧ 2	⇩ -1
Munich-Germany	27	24	24	⇧ 3	⇨ 0
Linz-Austria	20	25	25	⇩ -5	⇨ 0
Vienna-Austria	23	27	26	⇩ -4	⇧ 1
Helsinki-Finland	30	26	27	⇧ 4	⇩ -1
Nottingham-United Kingdom	29	28	28	⇧ 1	⇨ 0
Houston-USA	28	29	29	⇩ -1	⇨ 0
Toronto-Canada	37	30	30	⇧ 7	⇨ 0
Haifa-Israel	26	38	31	⇩ -12	⇧ 7
Manchester-United Kingdom	35	35	32	⇨ 0	⇧ 3
Stuttgart-Germany	36	32	33	⇧ 4	⇩ -1
Liverpool-United Kingdom	31	34	34	⇩ -3	⇨ 0
Ottawa- Gatineau-Canada	33	31	35	⇧ 2	⇩ -4
Cologne-Germany	38	33	36	⇧ 5	⇩ -3
Frankfurt am Main-Germany	39	36	37	⇧ 3	⇩ -1
Gothenburg-Sweden	32	37	38	⇩ -5	⇩ -1
Hamburg-Germany	44	40	39	⇧ 4	⇧ 1
Nice-France	40	39	40	⇧ 1	⇩ -1
Glasgow-United Kingdom	41	42	41	⇩ -1	⇧ 1
Duisburg-Germany	48	45	42	⇧ 3	⇧ 3
Birmingham-United Kingdom	47	44	43	⇧ 3	⇧ 1
Lille-France	42	41	44	⇧ 1	⇩ -3
Leeds-United Kingdom	46	46	45	⇨ 0	⇧ 1
Vancouver-Canada	45	43	46	⇧ 2	⇩ -3
Tel Aviv-Israel	34	48	47	⇩ -14	⇧ 1
Montreal-Canada	50	47	48	⇧ 3	⇩ -1
Brussels-Belgium	49	50	49	⇩ -1	⇧ 1
Dublin-Ireland	51	49	50	⇧ 2	⇩ -1
Auckland-New Zealand	43	51	51	⇩ -8	⇨ 0

(2) Cities in Motion: Mixed Methodology

This methodology combines the two techniques described above: the DP2 technique and the participatory technique. Stage I, in which the synthetic indicators are calculated for each dimension, is identical to DP2.

Stage II, corresponding to the final calculation of the ICIM, is also an aggregation of the synthetic indicators in each of the dimensions using the same formula as in the DP2 technique, but the values for the weights assigned to each of them $(1 - R^2_{10,9,8,\ldots,1})$ are assigned in accordance with subjective criteria, bearing in mind the following aspects:

a. The synthetic indicators of the dimension, created using variables or partial indicators for which data is only available at the country level, are weighted less. Likewise, those synthetic indicators that are combinations of variables, with data at the city level and others at the country level, will have a greater weight than the first, but less weight than those that are aggregates of variables with data exclusively at the city level.

b. The greater the number of variables with complete information within a dimension, the greater the weight of the synthetic indicator that represents it in the calculation of the ICIM.

The results, which are shown in Tables 5 and 6, reflect the changes in the value of the ICIM caused by the change in the weights assigned to the dimensions' indices, when maintaining the weighting factors of each variable among the dimensions.

One can observe an increase in the value of the CIM Index for most of the cities, and a notable increase in the number of cities with a "high" or "very high" performance and a decrease in those rated as having a performance of "medium" or "very low."

Table 5

Ranking	City	Performance	ICIM	Ranking	City	Performance	ICIM
1	Tokyo-Japan	A	100,0	37	Hamburg-Germany	RA	72,9
2	London-United Kingdom	A	99,1	38	Gothenburg-Sweden	RA	72,3
3	New York-USA	A	98,7	39	Liverpool-United Kingdom	RA	71,7
4	Paris-France	A	94,6	40	Ottawa- Gatineau-Canada	RA	71,6
5	Philadelphia-USA	RA	86,6	41	Haifa-Israel	RA	70,9
6	Eindhoven-Netherlands	RA	85,5	42	Glasgow-United Kingdom	RA	70,5
7	Oslo-Norway	RA	84,3	43	Lyon-France	RA	70,3
8	Los Angeles-USA	RA	84,2	44	Brussels-Belgium	RA	70,1
9	Dallas-USA	RA	83,9	45	Duisburg-Germany	RA	68,9
10	Sydney-Australia	RA	83,1	46	Birmingham-United Kingdom	RA	68,7
11	Stockholm-Sweden	RA	83,1	47	Leeds-United Kingdom	RA	68,7
12	Baltimore-USA	RA	82,6	48	Vancouver-Canada	RA	68,5
13	Zurich-Switzerland	RA	82,3	49	Montreal-Canada	RA	67,9
14	Amsterdam-Netherlands	RA	82,2	50	Marseille-France	RA	67,4
15	Chicago-USA	RA	81,5	51	Tel Aviv-Israel	RA	66,4
16	Minneapolis-Saint Paul-USA	RA	81,1	52	Milan-Italy	RA	65,4
17	Linz-Austria	RA	80,5	53	Florence-Italy	RA	65,4
18	Melbourne-Australia	RA	80,5	54	Dublin-Ireland	RA	65,4
19	Geneva-Switzerland	RA	79,3	55	Rome-Italy	RA	64,1
20	Munich-Germany	RA	78,6	56	Auckland-New Zealand	RA	63,7
21	Copenhagen-Denmark	RA	78,0	57	Barcelona-Spain	RA	62,5
22	Seoul-South Korea	RA	77,1	58	Madrid-Spain	RA	62,1
23	Vienna-Austria	RA	77,1	59	Prague-Czech Republic	RA	61,8
24	Osaka-Japan	RA	76,9	60	Turin-Italy	RA	61,7
25	Berlin-Germany	RA	76,8	61	Porto-Portugal	M	59,5
26	Helsinki-Finland	RA	76,7	62	Valencia-Spain	M	59,4
27	Houston-USA	RA	76,1	63	Daejeon-South Korea	M	57,3
28	Nice-France	RA	74,9	64	Budapest-Hungary	M	56,4
29	Nottingham-United Kingdom	RA	74,2	65	Daegu-South Korea	M	56,3
30	Frankfurt am Main-Germany	RA	74,0	66	Naples-Italy	M	55,9
31	Stuttgart-Germany	RA	73,9	67	Kuala Lumpur-Malaysia	M	55,8
32	Toronto-Canada	RA	73,8	68	Beijing-China	M	55,5
33	Cologne-Germany	RA	73,5	69	Warsaw-Poland	M	55,2
34	Basel-Switzerland	RA	73,1	70	Busan-South Korea	M	55,1
35	Lille-France	RA	73,1	71	Seville-Spain	M	55,1
36	Manchester-United Kingdom	RA	73,1	72	Dubai-United Arab Emirates	M	54,9

Table 5 (Continued)

Ranking	City	Performance	ICIM	Ranking	City	Performance	ICIM
73	Abu Dhabi-United Arab Emirates	M	53,1	109	Wuhan-China	B	32,2
74	Lisbon-Portugal	M	51,3	110	St Petersburg-Russia	B	31,7
75	Wroclaw-Poland	M	51,2	111	Shenyang-China	B	31,6
76	Shanghai-China	M	50,6	112	Chongqing-China	B	30,8
77	Doha-Qatar	M	50,5	113	Harbin-China	B	30,4
78	Istanbul-Turkey	M	48,3	114	Rio de Janeiro-Brazil	B	29,6
79	Bangkok-Thailand	M	48,0	115	Alexandria-Egypt	B	29,0
80	Taipei-Taiwan	M	47,9	116	Shenzhen-China	B	27,1
81	Ljubljana-Slovenia	M	47,5	117	Lima-Peru	B	25,7
82	Rosario-Argentina	M	47,2	118	Cape Town-South Africa	B	25,5
83	Bursa-Turkey	M	45,9	119	Pretoria-South Africa	B	24,3
84	Córdoba-Argentina	M	45,7	120	Cairo-Egypt	B	23,8
85	Riga-Latvia	B	44,1	121	Johannesburg-South Africa	B	22,8
86	Athens-Greece	B	43,0	122	Suzhou-China	B	22,5
87	Santiago-Chile	B	42,9	123	Manila-Philippines	B	21,4
88	Sofia-Bulgaria	B	42,7	124	Quito-Ecuador	B	20,3
89	Buenos Aires-Argentina	B	42,1	125	Caracas-Venezuela	B	20,1
90	Ankara-Turkey	B	41,0	126	Salvador-Brazil	B	20,1
91	Guangzhou-China	B	41,0	127	Porto Alegre-Brazil	B	19,0
92	Tainan-Taiwan	B	40,9	128	Belo Horizonte-Brazil	B	19,0
93	Kaohsiung-Taiwan	B	39,5	129	Bras¡lia-Brazil	B	18,9
94	Taichung-Taiwan	B	38,6	130	Recife-Brazil	B	17,8
95	Cali-Colombia	B	38,5	131	La Paz-Bolivia	B	17,4
96	Moscow-Russia	B	38,4	132	Fortaleza-Brazil	B	17,2
97	Monterrey-Mexico	B	37,9	133	Jakarta-Indonesia	B	13,7
98	Curitiba-Brazil	B	37,7	134	Herzegovina-Sarajevo-Bosnia	MB	7,8
99	Riyadh-Saudi Arabia	B	37,6	135	Santo Domingo-Dominican Republic	MB	0,0
100	Tianjin-China	B	37,3				
101	Jeddah-Saudi Arabia	B	37,1				
102	Medellín-Colombia	B	36,9				
103	Sao Paulo-Brazil	B	36,1				
104	Mexico City-Mexico	B	34,4				
105	Bogota-Colombia	B	34,1				
106	Guadalajara-Mexico	B	33,5				
107	Durban-South Africa	B	33,2				
108	Montevideo-Uruguay	B	32,2				

Table 6

City	2011	2012	2013	2011-2012	2012-2013
Tokyo-Japan	1	1	1	→ 0	→ 0
London-United Kingdom	2	2	2	→ 0	→ 0
New York-USA	3	3	3	→ 0	→ 0
Paris-France	4	4	4	→ 0	→ 0
Philadelphia-USA	5	5	5	→ 0	→ 0
Eindhoven-Netherlands	6	7	6	↓ -1	↑ 1
Oslo-Norway	7	6	7	↑ 1	↓ -1
Los Angeles-USA	10	11	8	↓ -1	↑ 3
Dallas-USA	8	10	9	↓ -2	↑ 1
Sydney-Australia	15	8	10	↑ 7	↓ -2
Stockholm-Sweden	11	9	11	↑ 2	↓ -2
Baltimore-USA	14	14	12	→ 0	↑ 2
Zurich-Switzerland	9	12	13	↓ -3	↓ -1
Amsterdam-Netherlands	12	13	14	↓ -1	↓ -1
Chicago-USA	16	15	15	↑ 1	→ 0
Minneapolis-Saint Paul-USA	17	17	16	→ 0	↑ 1
Linz-Austria	13	16	17	↓ -3	↓ -1
Melbourne-Australia	20	18	18	↑ 2	→ 0
Geneva-Switzerland	19	19	19	→ 0	→ 0
Munich-Germany	22	20	20	↑ 2	→ 0
Copenhagen-Denmark	18	21	21	↓ -3	→ 0
Seoul-South Korea	29	25	22	↑ 4	↑ 3
Vienna-Austria	21	24	23	↓ -3	↑ 1
Osaka-Japan	23	22	24	↑ 1	↓ -2
Berlin-Germany	27	23	25	↑ 4	↓ -2
Helsinki-Finland	26	26	26	→ 0	→ 0
Houston-USA	24	28	27	↓ -4	↑ 1
Nice-France	25	27	28	↓ -2	↓ -1
Nottingham-United Kingdom	30	29	29	↑ 1	→ 0
Frankfurt am Main-Germany	33	31	30	↑ 2	↑ 1
Stuttgart-Germany	32	30	31	↑ 2	↓ -1
Toronto-Canada	34	35	32	↓ -1	↑ 3
Cologne-Germany	35	33	33	↑ 2	→ 0
Basel-Switzerland	28	32	34	↓ -4	↓ -2
Lille-France	31	34	35	↓ -3	↓ -1
Manchester-United Kingdom	37	36	36	↑ 1	→ 0
Hamburg-Germany	41	37	37	↑ 4	→ 0
Gothenburg-Sweden	39	39	38	→ 0	↑ 1
Liverpool-United Kingdom	40	40	39	→ 0	↑ 1
Ottawa- Gatineau-Canada	36	38	40	↓ -2	↓ -2
Haifa-Israel	38	44	41	↓ -6	↑ 3
Glasgow-United Kingdom	42	42	42	→ 0	→ 0
Lyon-France	43	41	43	↑ 2	↓ -2
Brussels-Belgium	44	43	44	↑ 1	↓ -1
Duisburg-Germany	48	46	45	↑ 2	↑ 1
Birmingham-United Kingdom	49	48	46	↑ 1	↑ 2
Leeds-United Kingdom	46	47	47	↓ -1	→ 0
Vancouver-Canada	45	45	48	→ 0	↓ -3
Montreal-Canada	50	49	49	↑ 1	→ 0
Marseille-France	51	50	50	↑ 1	→ 0
Tel Aviv-Israel	52	54	51	↓ -2	↑ 3

(3) Alternative Calculation with Seven Dimensions

Using this sensitivity analysis, we attempt to see the variation that occurs in the calculation of the index when certain dimensions are lacking. To do so, we excluded The Economy, Governance and Urban Planning, given the large weight these variables hold at the country level.

Table 7 shows the index with seven dimensions.

Table 7

Ranking	City	Performance	ICIM	Ranking	City	Performance	ICIM
1	London-United Kingdom	A	100,00	37	Haifa-Israel	RA	64,85
2	New York-USA	A	97,96	38	Basel-Switzerland	RA	64,82
3	Paris-France	A	97,95	39	Brussels-Belgium	RA	64,39
4	Tokyo-Japan	A	97,74	40	Milan-Italy	RA	64,25
5	Los Angeles-USA	RA	80,71	41	Gothenburg-Sweden	RA	63,24
6	Philadelphia-USA	RA	80,68	42	Frankfurt am Main-Germany	RA	63,21
7	Dallas-USA	RA	79,27	43	Liverpool-United Kingdom	RA	62,79
8	Oslo-Norway	RA	77,22	44	Hamburg-Germany	RA	62,29
9	Sydney-Australia	RA	76,15	45	Lyon-France	RA	61,13
10	Chicago-USA	RA	75,77	46	Manchester-United Kingdom	RA	61,05
11	Eindhoven-Netherlands	RA	75,47	47	Barcelona-Spain	RA	61,03
12	Amsterdam-Netherlands	RA	75,11	48	Turin-Italy	RA	60,81
13	Baltimore-USA	RA	74,50	49	Madrid-Spain	RA	60,79
14	Zurich-Switzerland	RA	73,81	50	Dublin-Ireland	RA	60,29
15	Stockholm-Sweden	RA	73,77	51	Duisburg-Germany	RA	60,20
16	Linz-Austria	RA	73,17	52	Glasgow-United Kingdom	M	59,99
17	Minneapolis-Saint Paul-USA	RA	72,88	53	Marseille-France	M	59,99
18	Melbourne-Australia	RA	72,19	54	Tel Aviv-Israel	M	59,81
19	Seoul-South Korea	RA	71,62	55	Vancouver-Canada	M	59,63
20	Geneva-Switzerland	RA	70,95	56	Birmingham-United Kingdom	M	59,43
21	Houston-USA	RA	70,46	57	Leeds-United Kingdom	M	58,87
22	Osaka-Japan	RA	70,18	58	Beijing-China	M	58,52
23	Vienna-Austria	RA	70,18	59	Montreal-Canada	M	58,29
24	Munich-Germany	RA	68,83	60	Prague-Czech Republic	M	57,23
25	Berlin-Germany	RA	68,44	61	Kuala Lumpur-Malaysia	M	56,72
26	Lille-France	RA	67,84	62	Porto-Portugal	M	56,62
27	Nice-France	RA	67,18	63	Naples-Italy	M	55,87
28	Copenhagen-Denmark	RA	66,58	64	Auckland-New Zealand	M	55,18
29	Helsinki-Finland	RA	66,33	65	Bangkok-Thailand	M	54,16
30	Rome-Italy	RA	66,08	66	Dubai-United Arab Emirates	M	53,98
31	Toronto-Canada	RA	65,96	67	Valencia-Spain	M	53,95
32	Ottawa- Gatineau-Canada	RA	65,52	68	Doha-Qatar	M	53,68
33	Cologne-Germany	RA	65,39	69	Istanbul-Turkey	M	53,12
34	Nottingham-United Kingdom	RA	65,18	70	Shanghai-China	M	52,76
35	Stuttgart-Germany	RA	65,13	71	Daejeon-South Korea	M	52,19
36	Florence-Italy	RA	65,11	72	Abu Dhabi-United Arab Emirates	M	51,88

Table 7 (Continued)

Ranking	City	Performance	ICIM
73	Budapest-Hungary	M	51,16
74	Daegu-South Korea	M	51,10
75	Seville-Spain	M	50,72
76	Taipei-Taiwan	M	50,21
77	Lisbon-Portugal	M	49,77
78	Warsaw-Poland	M	48,96
79	Rosario-Argentina	M	48,33
80	Busan-South Korea	M	48,00
81	Córdoba-Argentina	M	47,46
82	Bursa-Turkey	M	45,77
83	Buenos Aires-Argentina	M	45,26
84	Cali-Colombia	B	44,89
85	Wroclaw-Poland	B	44,75
86	Riyadh-Saudi Arabia	B	44,71
87	Athens-Greece	B	44,24
88	Guangzhou-China	B	44,15
89	Santiago-Chile	B	43,12
90	Tainan-Taiwan	B	42,73
91	Moscow-Russia	B	42,67
92	Medellín-Colombia	B	42,52
93	Ljubljana-Slovenia	B	42,41
94	Monterrey-Mexico	B	42,25
95	Ankara-Turkey	B	42,02
96	Bogota-Colombia	B	41,64
97	Taichung-Taiwan	B	40,90
98	Kaohsiung-Taiwan	B	40,87
99	Curitiba-Brazil	B	40,64
100	Sao Paulo-Brazil	B	40,51
101	Riga-Latvia	B	40,33
102	Guadalajara-Mexico	B	39,64
103	Sofia-Bulgaria	B	37,68
104	Mexico City-Mexico	B	37,58
105	Tianjin-China	B	37,31
106	Jeddah-Saudi Arabia	B	36,10
107	Durban-South Africa	B	32,99
108	Wuhan-China	B	32,63
109	Shenyang-China	B	32,50
110	Harbin-China	B	32,07
111	Rio de Janeiro-Brazil	B	31,81
112	St Petersburg-Russia	B	31,80
113	Chongqing-China	B	31,70
114	Alexandria-Egypt	B	31,44
115	Lima-Peru	B	30,62
116	Montevideo-Uruguay	B	29,02
117	Manila-Philippines	B	27,83
118	La Paz-Bolivia	B	27,08
119	Caracas-Venezuela	B	26,99
120	Cairo-Egypt	B	26,47
121	Shenzhen-China	B	25,73
122	Quito-Ecuador	B	25,38
123	Suzhou-China	B	25,09
124	Cape Town-South Africa	B	23,88
125	Johannesburg-South Africa	B	23,51
126	Pretoria-South Africa	B	23,38
127	Salvador-Brazil	B	22,63
128	Jakarta-Indonesia	B	22,39
129	Belo Horizonte-Brazil	B	21,73
130	Porto Alegre-Brazil	B	21,45
131	Brasilia-Brazil	B	20,76
132	Fortaleza-Brazil	B	20,65
133	Recife-Brazil	B	20,64
134	Herzegovina-Sarajevo-Bosnia	MB	3,45
135	Santo Domingo-Dominican Republic	MB	0,00

As you can see, the greatest variation occurs in the cities of Switzerland, which show significant variation within the ranking. However, there are no relevant changes in the lowest positions.

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