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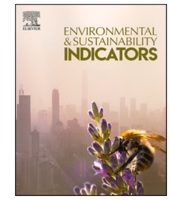

On the construction of a Composite Index to assess holistically the sustainability of the evolution of a country

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ABSTRACT

Economists establish a clear-cut distinction among the ideas of *Economic Growth* (EG) and *Economic Development* (ED) and *Sustainable Development* (SD). However, the definition of the second and third ones tends to be fuzzier than it is for the first one, giving room to misunderstandings and a wrong use and manipulation of ED and SD concepts. In this article, the authors propose an analysis of a territory's evolution on the basis of a composite indicator that combines both streams of thought aligned with environmental and sustainability aspects as well as economic and society factors. To reach this goal a composite indicator with a more comprehensive architecture is designed. It includes concepts of EG and ED, as well as terms of sustainable development and social welfare. The essence of the application of this indicator is to gauge the quality of a country's evolution beyond economic or development terms solely.

With this aim, economic, environmental, sustainability and social fields are considered to account in the country's economic evolution computation. To obtain results, a framework to assess key relationships among society fields, a methodology which includes entropy to select best indicators and also a MCDM method to compute the Composite Indicator to Measure a Country Evolution (CIMCE) are provided.

The results show that this composite index based on a robust methodology supported by the application of a MCDM method is suitable for the holistic assessment and sustainable management of the evolution of a country as a way for contributing to several Sustainable Development Goals.

1. Introduction

Is it a quality economic growth when forests are razed for the production of wood?

Economic growth can be defined as the increase in the capacity of an economy to produce goods and services compared from one period of time to another, so it occurs whenever people take resources and rearrange them in ways that make them more valuable (Romer, 1986). On the basis of this simple but specific definition, it turns out that the most accurate way of ascertaining economic growth would be to calculate it as a numerical value. In general, a country's economic growth is usually computed as an increase in that country's gross domestic product (GDP). Therefore, the authors find that GDP is the result of applying an economic model that reflects the value of a country's output.

This index represents an aggregate measure of a country's economic growth and was developed by Kuznets in 1933. Despite its success as a suitable measure to carry out international comparisons it has received many warnings in its use and application, starting from Kuznets himself when he stated that a "distinction must be kept in mind between quantity and *quality of growth*, and between the short and the long run. Goals for more growth should specify more growth of what and for what" (Kuznets, 1962).

In this sense, one simple criticism to a growing GDP is its interpretation of a stronger economy and societal improvements. Most economists from Simon Kuznets (1962) have warned against using GDP as a measure of social welfare. This misleading interpretation of GDP might be in part due to the frequently forgotten fact that economic growth, in its definition, does not take into consideration some adverse effects. Among them, the most prominent is environmental degradation, since most of the raw materials used in wealth creation for economic growth are non-renewable being the world slowly depleted of its resources (Serageldin, 1996).

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Additionally, the GDP does not consider externalities, nor resources depletion, that are paramount in sustainability and in the natural capital of a country.

As an example, the economic effects of environmental degradation are an input for gauging economic development which were not considered when gauging the economic growth. Hence, it is clear that economic growth is different to economic development or, in short, the increase in citizens' quality of life. The authors want to emphasize that, despite the clear distinction between the two concepts, at least from the Economics perspective, many people use these terms in an interchangeably, utilizing therefore the GDP as a measure for the economic development of a country (Parris and Kates, 2003). A myopic reading of the literature on neoclassical economic growth models consistent with economic development (Lucas, 1988; Backhaus, 2002) might be one reason. But, it has also been found an additional reason for this mistake in the intrinsic difficulties in providing a clear measure for economic development[11], contrary to what happens in the case of economic growth with GDP, which has led in not few cases to the use of GDP as a proxy for economic development.

From the Economics perspective, economic development is a multidimensional concept that includes not only economic growth but also many other aspects ranging from a nation's environmental care, the development of human capital, increases in literacy ratios, the improvement of important infrastructures and also in health and safety, and many other areas like health and education, aimed at increasing the general welfare of the citizens (Jaffee, 1990). All these anthropogenic activities are related, at least for their contribution to a sustainable socioeconomic development, interacting and feeding back information, problems, results and actions in a very complex scenario. However, the literature considers all these factors acting as isolate elements and not interacting among them as it is in reality, facilitating indexes to measure a country evolution without considering this fact which is to the authors' opinion a weakness in most research.

Hence, different and complementary viewpoints can be adopted when it's analized in this work. One important consequence is that this definition is vague and more inaccurate compared to economic growth and this is also the case for the measures and indices designed to capture and gauge holistically a country's evolution.

Undeniably there have been major advances in the design and application of economic development subfields (Costanza et al., 2009), such as the *'Green GDP'* linked to the environment, as well as other partial subfields for example the *'Human Development Index* (HDI)[1], (Diener and Suh, 1997; Sharpe and Osberg, 2005), the Gini Coefficient[2], the *'Environmental Performance Index'*(EPI)[3] (Rogge, 2012) and others, but they are rather specific and do not reflect, let alone assess holistically, the state of a country.

However, most of the studies apply conventional methods that imply an excessive simplification of reality and forgetting relations between their determinants (Luczak and Just, 2021). In this article, the authors propose an analysis of a territory's evolution on the basis of a composite indicator that combines both streams of thought, aligned with environmental and sustainability aspects as well as economic and society factors to meet with the goal of a holistic evaluation of the quality evolution for a country.

When compared to the different research, the presented study is characterized by its new and original approach to measure the quality of a country evolution. The main factors that determine its originality are the following.

Firstly and as it was said, there is a scarcity of works in the literature to assess this evolution in a holistic manner. To tackle this issue, CIMCE considers some aspects from both, the Economic Growths and Economic Development and also takes into account a wide spectrum of anthropogenic elements such as Economy, Society, Environment, Education, Health, Natural Resources, Safety, Technology, Externalities, etc., which have influence in the quality of a country evolution in sustainable, environmental, economic and social terms.

Moreover, this broad group of anthropogenic elements are not evaluated independently without relationships between them and this is the main essence of this work: the creation of a network of relationships to correlate these elements in a holistic way as it works in reality. Through the evaluation of a panel of experts, this network will reflect how each indicator interacts with the objectives that have been established for each of the subfields that make up each field, forming the basis of the decision matrix. This matrix will subsequently be computed through a MCDM method to obtain results. To the authors' knowledge, and unlike other indicators in similar tasks, this methodology is the first time it has been applied in the construction of a composite index in this field.

As it was mentioned, the dynamics of the economic development process have to be taken into account in order to highlight and reflect how those different elements contributing to economic development interact one another and can change along time. In order to capture these dynamics it's has been developed an innovative methodology based on multicriteria decision technique. According to Brodny (2023b), the selection of an appropriate method for a given decision-making problem leads to a problem that can be solved by using an MCDM method. In this study and for the first time, the SIMUS (Sequential Interactive Model for Urban Systems) method (Munier, 2011) developed for one of the authors has been selected to measure the Sustainable and Socioeconomic development of a country for its capacity to tackle a complex scenario with a large amount of variables. This method has been widely applied in more than 20 research works in different fields as sustainability, transport, agriculture, etc. Is worthy noting that conversely to other research like Brodny et al. (2023,b) where the entrophy method is used to obtain weights to be computed in the MCDM techniques applied, SIMUS method do not require weights to obtain results which leads to obtain more objective results. In this research, the authors used entrophy to filter a vast number of suitable indicators for the assesment of the different anthropogenics elements and their relationships described previously. This filtering based on entrophy allows the selection of those indicators according to the quantity if information they may contain when assessing different fields. This procedure to obtain best indicators, was succesfully proved in Munier (2011) when selecting a set of urban sustainability indicators.

Based on the description regarding the construction of CIMCE, may be cleary appreciated that the fact of considering broad aspects of a Sustainable Socioeconomic Development and their relationships, makes difficult that the designed indicator may be used as a tool for comparing countries. This is a crucial difference with other researchs, offering this work a composite indicator and an innovative methodology to asses the quality evolution of a single country in order to track its advance as function of time, by determining a coefficient (CIMCE) that can be annually updated. It is not designed for comparing countries and shows advances and declines, and able to identify those fields that should be improved and supporting managers when making public policies to contribute to SDGs.

As a result of this work, the authors offer a holistic view of the quality of a country's evolution summarized in our composite indicator with clear implications in terms of its different contributions, which is helpful to determine the path in that dynamic process and therefore the goals in terms of socioeconomic policy to be pursued and fostered by any government.

To achieve this goal, the paper is structured as follows. After the

[1] HDI - Developed by the United Nations Development Programme.

[2] GINI Index - Developed by Corrado Gini, Italian demographer, sociologist and statistician.

[3] (EPI)- Environmental Performance Index ranks how well countries perform on high-priority environmental issues in two broad policies areas protection of human health from environmental harm and protection of ecosystems (Global Metrics for the Environment).

introduction, it is discussed the literature supporting the development of comprehensive indicators to measure economic growth and development as well as the application of a Multi Criteria Decision Making (MCDM) methodology for the development of such indicators. Next, in Section 3, CIMCE as an accurate and global measurement of a country's evolution is proposed. Section 4 presents a network to assess relationships among fields and subfields in order to measure the most important ones for a country progress. Based on the network and the experts' opinions a decision matrix to handle mathematically the problem through SIMUS which is a MCDM (Multi Criteria Decision-Making) method is shown. The work finalizes with the obtained results and discussion in Section 5 and some conclusions in Section 6.

2. Literature review

One of the main concerns of the Economics discipline has been, since its origins, to establish measures and standards to analyze, compare and rank the resources pderformance. To this end, indicators have been developed that allow us to establish patterns of growth and improvement in the territories and to compare the behavior of the territories in light of the way in which the various resources influence growth patterns.

2.1. Economic growth, economic development and sustainability

The concept of economic growth is at the roots of the development of economic discipline under the capitalist perspective. Such a concept, already studied by classical economics, arises at the beginning of the industrial revolution (Mokyr, 2017). But it was Simon Kuznets who finally gave it explicit content by setting the elements by which it could be measured and thus establishing a first standard measure of economic growth: gross domestic product (GDP). According to Kuznets "a country's economic growth may be defined as a long-term rise in capacity to supply increasingly diverse economic goods to its population, this growing capacity based on advancing technology and the institutional and ideological adjustments that it demands" (Kuznets, 1973). Kuznets himself warns of the danger of applying the idea of economic growth to all the economies of the planet, as he identifies 6 elements that characterize the patterns of modern economic growth and by which economies that are in the development stage, cannot be compared simply by employing this economic growth indicator (Kuznets, 1973). Thus, after World War II, world leaders considered it urgent to provide aid for the "development" of less advanced countries, with which the idea of Economic Development began to take shape as a broader concept for comparison and measurement. Thus, its definition evolved from the simple exploitation of resources in a colonial context to the improvement in material well-being due to an increase in the flow of goods and services and an increase in *per capita* income. At this time, the concept of economic growth and economic development can be said to be synonymous. From the 1970s onwards, the first environmental movements began to emerge which, little by little, resulted in the emergence of the idea of sustainable growth and sustainability as broader concepts that allow us to establish patterns of comparison among territories even when their development stages are uneven (Purvis, el at., 2019). Therefore, the development of indicators and metrics that allow us to establish performance patterns in the territories, comparisons and rankings has evolved and continues to do so with the aim of making room for situations and circumstances that arise at all times and thus being able to give a holistic image of the process of economic change in the territories. An example of this evolution is marked by the United Nations Conference of 1972 in which economic development and the impact of human beings on environmental integrity is debated, which until then had been considered as something incompatible. It is at this point that more inclusive indicators emerge, including eco-development as a great novelty. These new ideas have been evolving up to the point of merging creating the concept of sustainable development that as it's used nowadays on a regular basis. In short, the way in which the evolution of a territory can be measured continues to be an area to be explored and in which improvements in the application of concepts lead us to a more holistic understanding of the entire process. Therefore the authors consider that contributions in this field have to be welcomed in order to increase the knowledge with respect to the mechanisms in which an economy can evolve along time.

2.2. Methods and techniques in the design of economic and sustainable development indicators

In this research it's assumed as good the idea of building sustainable development on the three pillars of economics, environment and society (Purvis et al., 2019), and as a consequence, the construction of indices measuring sustainable development have to take into account elements that reflect the territory's performance regarding those three elements. There is abundant literature that collects many efforts in the design and construction of indicators that take into account these elements (Moldan et al., 2015). Some of that literature is devoted to the design itself of new holistic and comprehensive indicators. It can be found an analisys of how those different indices perform with respect to the three pillars at the same time (Strezov et al., 2016). Other works have focused on the possible application of comprehensive indices in the definition and design of policies, plans and programmes for environmental strategic planning (Sebestyén et al., 2019) and for the SDG objectives set by United Nations (Lucia et al., 2022). Another brick in the wall regarding sustainability is proposed by Grisolia et al. (2020) who presented a bioeconomic indicator. Other stream of literature have focused on the design of measures to helping in the definition of policy goals for sustainable energy production (Brodny and Tutak, 2021; Brodny and Tutak, 2023a; Pérez-Gladish et al., 2021) among others, with an interesting characteristic which represents the application of Shannon entropy concept as it's presented in our definition of the CIMCE index.

Other stream of literature has focused on the application of comprehensive indices designed under an MCDM-base methodology (Ricciolini et al., 2022) and applying TOPSIS methodology as well (Luczak and Just, 2021). From the analisys of these diverse sources, it's strongly supported the design of the CIMCE index based on a MCDM-based methodology. To do so, it's have applied the SIMUS (Sequential Interactive Model for Urban Systems) technique (Munier, 2011). SIMUS works using fundamentally Linear Programming (LP), applying the Simplex algorithm (Dantzig, 1948), as well as Outranking procedures. It is the only MCDM method, together with Goal Programming, based on Mathematical Programming, and for this reason is completely different to other MCDM methods. SIMUS starts from a decision matrix as most methods. It sequentially uses each criterion as objective, gets a results (if it exists), saves it in a matrix called 'Efficient Results Matrix' (ERM), returns the equation used as objective to the decision matrix, and selects another criterion repeating the procedure until all criteria are utilized. The final ERM is a Pareto efficient set of solutions.

As said, SIMUS repeats once and again the same procedure, that computes efficient values for each different objective. The model stops after each of these partial solutions for the decision maker and his group to have a look at the result, examine and analyze it and take actions if necessary, such as accept, reject, or amend cardinal data as well as actions (Maximize, Minimize, Equalize) and operators ($\geq$, $\leq$, $=$) in any combination of actions and operators.

The authors wish to highlight the fact that the idea underlying the indicator is to show the extent to which a given territory evolves in accordance with the components and the relationships among them with which the territory is identified. Consequently, the resulting indicator, CIMCE, cannot be used as a mechanism for inter-territorial comparison. Each area is determined by a specific combination of factors with its own characteristics, a certain proportion and a series of relationships between these factors that make it different from the rest. This fact provides an analytical singularity: that of serving as an intra-territorial evolutionary indicator, which makes it a complementary mechanism, not a substitute, for the analysis of the socioeconomic development of the territory.

3. Research methods

Due to the complexity of the problem this work aims to tackle, a research methodology has been deployed and shown in Fig. 1. This methodology is divided in the 3 stages the authors have followed until the end when some conclusions are presented.

The first stage comprises a literature review in line with some aspects regarding Economic growth and economic development. As a consequence of the analysis of literature, the authors establish the research goal dealing with the necessity of the construction of a Composite Indicator to measure the quality of a country evolution in a broder and holistic way than existing ones.

With this aim, in the second stage of this research a design of this composite index was undertaken. Due to the importance of this stage, Section 3.1 is devoted to the explanation about how CIMCE was built. This section also introduces a procedure (Fig. 2) to calculate CIMCE coefficients step by step.

Once CIMCE is built, a network that links paramount fields and subfields to be computed in the composite index is described in Section 4. For a better understanding about the concept of fields and subfields, in this work 8 fields are considered: Economic Growth (GDP), Social Capital, Society, Public Health, Sustainability, Environment, Natural Capital and Education. Each of these fields, are composed by one or several subfields, i.e., field "Environment" is composed by 2 subfields: CO_2 Emissions and Aquifers' Contamination. To measure these subfields some indicators are proposed.

This network of relationships and further decision matrix, together with the designed CIMCE is computed in order to work out its performance. To achieve this goal, a MCDM method called SIMUS is applied, finishing this Stage 2.

In Stage 3 results are presented, as well as the discussion and conclusions of this research.

3.1. Determination of CIMCE coefficients

To assess the quality evolution of a country and considering the multidimensionality of the problem, the authors develop a 'Composite index' (Sharpe and Andrews, 2012; Alam et al., 2016), where individual subfields are compiled into a single index, on the basis of an underlying model of the multi-dimensional concept that is being measured by Organization for Economic Cooperation and Development (OECD, 2001, 2003, 2004)[4].

Considering this purpose, a methodology is proposed and according to Baster (1972), *Three different but overlapping approaches to the definition of subfields are distinguished: the definition of subfields in the context of theoretical models of development, socio political as well as economic; the use of subfields in the empirical study of interrelations between economic and non-economic factors; and the development of subfields for policy and planning.* This paper attempts to dwell on these approaches since the authors consider that the integration of multiple types of variables and the identification of systemic relations between them depends on the progress along the three above mentioned approaches.

In this respect, the largest hurdle consists in assigning coefficients values to this index. This is the main problem the authors want to address devising a composite index where its components have duly justified coefficients and which signs are congruent to reality, since some coefficients may increase the growth value while others may decrease it. A further and consensual development of the index proposed would represent a step forward in the definition of subfields as Baster suggests.

Moreover, former fields and subfields have also relationships with a wide spectrum of society elements that should be considered as it's done in this work with the development of a Network in Section 4. For example, in the field Social Capital, CIMCE builds subfields that consider these relationships and their performance. It is based on considering the impact between many different anthropogenic activities regarding Economy, Society, Environment, Education, Health, Natural Resources, Safety, Technology, Transportation, External Debt, Externalities, etc., that have influence in the quality of a country evolution. Fig. 2 depicts the procedure to research methodology that is explained in this section and to ease its understanding, a practical example step by step when calculating CIMCE will be provided at Section 4.

3.2. First part

Refers to the left hand side of Fig. 2 and contains 7 steps.

Step 1. Consists of an analysis of a large set of subfields which number may vary according to the specific needs of a country when considering different fields of society. To tackle this goal, a literature review was performed and several subfields regarding this work's goals were collected.

Step 2. Since it is impossible to work with such a quantity of information, it needs to be reduced to a manageable set of no more that 20 or 25 of them. However, this reduction implies loosing information from the initial set. For this reason our methodology incorporates the concept of entropy (Shannon, 1948) in such a way that the final set contains the maximum amount of information with the minimum loss (Munier, 2011). The final output obtained in this work is a set of 17 indicators to measure these subfields.

Step 3. Former 17 indicators have to be linked to goals which were extracted from the Millennium Development Goals (MDG) (United Nations, 2008). In this step sixteen goals referring to areas as Education, Social, Public Health, Sustainability, Environment, Economy and the OECD Framework (OECD, 2003) were selected to evaluate these indicators.

Step 4. Indicators and goals are examined by experts in each area, indicator by indicator, with the purpose of finding their relationship either by correlation or by estimates and then assessing the value of this relationship. Positive and negative correlation is indicated with the corresponding signs.

Step 5. For computation purposes absolute values are considered in each column, because correlation values are important in both senses. Values in each column are added up giving the Raw Indicators Weight or RIW.

Step 6. Taking into account the number of times an indicator is related with a goal it is possible to determine the number of 'coincidences' or *'Participation Factor'* (PF), which is the ratio between coincidences and the total number of goals. These values are normalized and then getting the *'Normalized Participation Factor'* (NPF). Finally, this NPF is multiplied by RIW; this product indicates the weight of each indicator.

Step 7. Next step is using Linear Programming (LP) (Kantorovich, 1939), and the Simplex algorithm (Dantzig, 1948). It is a Multi Criteria Decision-Making model that finds, if it exists, an optimal solution. In this case the initial decision-making table is built in Excel and the problem solved by the 'Solver' software (Frontline System-Solver, 2016).

[4] OECD - Organisation for Economic Co-operation and Development. For information on a variety of applications as well as sustainability, consult the following authors: (Freudenberg, 2003; Gaye, 2007; Sharpe and Osberg, 2005; Munda and Nardo, 2003; Tarantola, 2010), OECD/JRC Handbook for constructing composite subfields), (Gallego-Álvarez et al., 2015; Sébastien and Bauler, 2013; Alam et al., 2016; Otoiu et al., 2014).

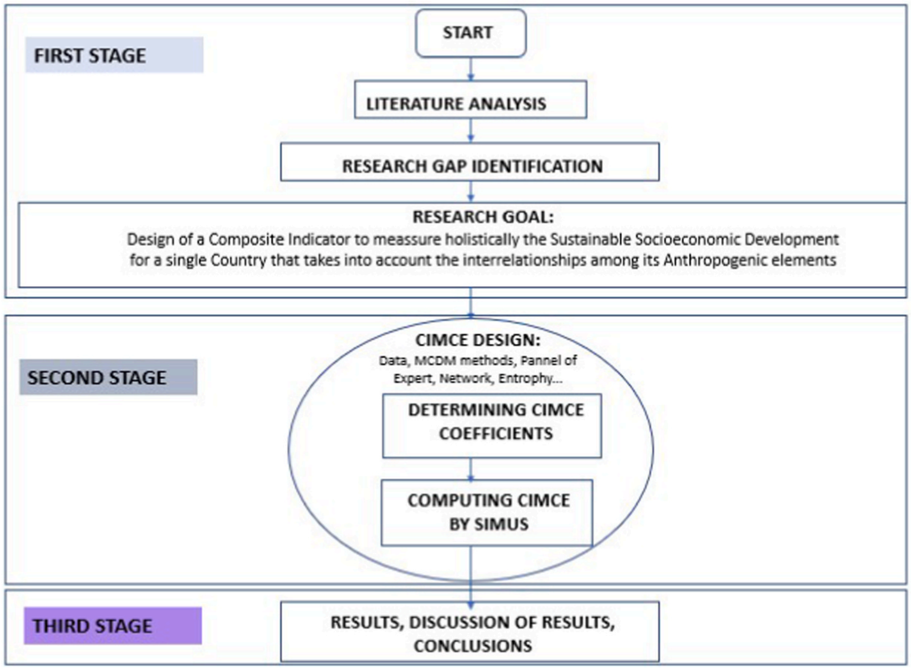

Fig. 1. Research methodology.

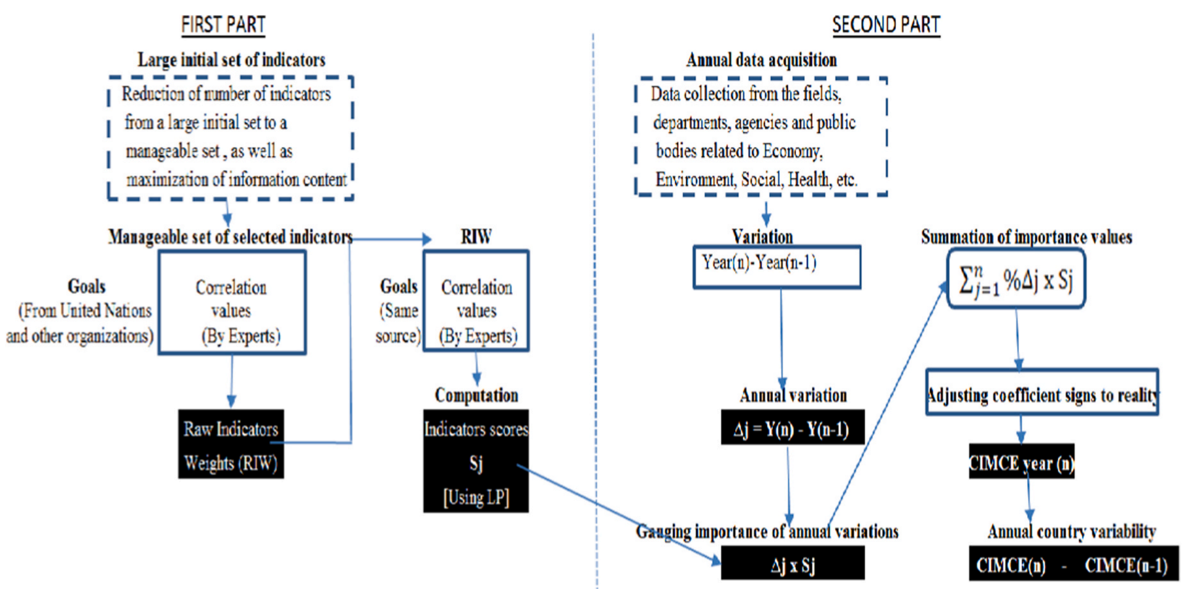

Fig. 2. Procedure to determine CIMCE coefficients.

Regarding Step 7, is worth noting that LP considers simultaneously all interactions between indicators and goals; thus, it replicates the network portrayed in Fig. 3 and by linking all indicators finds the set of indicators and produces scores (Sj) for each one, that optimize an objective function, which in this case consists in maximizing indicator's weights. The greater the score value the better and thus determining the relative importance of each indicator; these scores of the composite indicator are related mathematically and correspond to trade-off values between indicators.

3.3. Second part

Refers to the right hand side of Fig. 2 and contains 4 steps.

Step 8. Once a year (or any other period), data about the performance of these indicators is collected. This information comes from different sources as indicated at the Second Stage of Fig. 1 or Second Part of Fig. 2. Since the performance of each indicator for the last year (n-1) is known, it is possible to compute its variation regarding actual year (n), which can be positive or negative. Positive refers to an increase; however, it does not mean that forcefully it is beneficial for the country; a positive variation or increase in crime rate evidently is detrimental for the country. Negative value refers to a decrease; however, it does not mean that it is detrimental for the country like the decrease in contamination levels.
Step 9. Former variation is then multiplied by the corresponding score for the indicator (Sj), and in so doing the importance of that variation is measured individually.

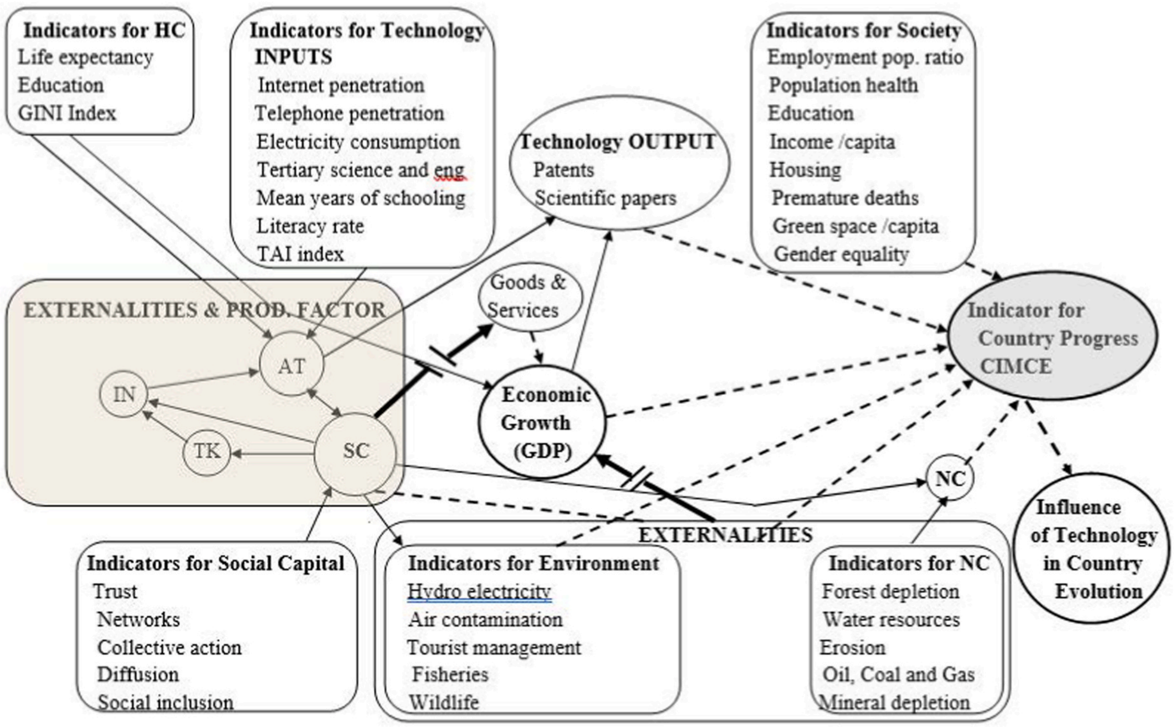

Fig. 3. Network of relationships Network of relationships between elements with influence on a country evolution.

Step 10. Summation of these products gives the CIMCE index, however it is necessary to verify that coefficients signs are in correspondence with reality. That is, if an indicator shows an increase in deforestation, it can not be added up but deducted since it is detrimental for the country; consequently its sign is reversed. Similarly if an indicator shows a decrease in aquifers contamination; this is beneficial for the country and then its sign is reversed to positive.

Step 11. CIMCE for year (n) will show a value that can be larger than the CIMCE for year (n-1). This will indicate an increase in country development. If the CIMCE (n) is smaller than CIMCE (n-1), it will indicate detrimental regarding country evolution.

4. Constructing the network of relationships

The network is a way to hint the extent of the multiplier effect that a new idea can bring to the progress of the country due to a new development in Medicine, Education, Construction, Income, etc. In this work the multidimensional aspect of the problem is considered, and aims at proposing a method able to put a value to these relationships, in an effort to identify which are the more important indicators to measure a country evolution.

All anthropogenic activities are related, at least for their contributions to a country evolution, interacting and feeding back information, problems, difficulties, results, willingness to cooperate, and actions in a very complex social scenario. For this reason, an index for measuring the quality of a country evolution should consider this fact and probably the best way to portray and analyze interrelationships is by a network (see Fig. 3) where nodes or clusters of activities are linked. Similarly, activities within the clusters are linked with themselves. The network does not contain values only concepts, and te arrows do not indicate dependency but interrelationships. It is believed that it is a useful device to understand the magnitude of the problem; this is the reason by which the authors believe than actual indexes are very valuable, they give worthy information, but they are not connected as they should, consequently they give information that is not integrated. For instance, how an increase in the Human Development Index (HDI) contributes in improving the quality of the country evolution or the Economy Development?

If an indicator such as that can be devised, then periodic performance variations can be taken into account and thus learning about the progress on two consecutive periods. The authors believe that these concepts reveal the essence of this work.

4.1. Network construction

Fig. 3 identifies and considers if not all at least a large part of elements and their dependencies that directly or indirectly intervene and impact the quality of the evolution of a country. Several institutions around the world such as the OECD, United Nations, The World Bank, The World Resources Institute, etc., as well as many researchers at individual level have been working on characterizing and quantifying its components.

The OECD has even advanced a little more by establishing values for the relationships between some elements, using statistics and other mathematical tools. This paper takes advantage of this identification process and attempts to relate them in this network, which, needless to say, is only an approximation of the reality. Elements of the network are in some sort of hierarchy formed by indicators, sub clusters, and clusters, and linked with inputs, outputs and feedbacks as explained above for our network.

In general it appears that there is a consensus, based on the repetition of the same elements from several sources that everything revolves around the *'Social Capital'* (SC) field and its subfields.

Assuming that everything orbits around the (SC), it can be considered formed by subfields such as *'Trust', 'Networks', 'Collective action', 'Diffusion', 'Social inclusion'*, (defined in Table 1) and others. (SC) is the

Table 1
Characteristics of indicators.

FIELD (Number and name of indicators)	SUBFIELD (Beneficial "B" or Detrimental "D")	UNITS	DESCRIPTION
ECONOMIC GROWTH (1)	J1- Capital and labour factors (GDP) (B)	Euros	Sum of goods and services produced in the country in a certain period, normally a year
SOCIAL CAPITAL (6)	J2- Trust (B)	Percentages from questionnaires and surveys	Associated with people relations and it refers to the confidence placed on another person and the government
	J3- Groups & networking (B)		Groups: cluster of people with similar interests. When groups are combined they form a network.
	J4- Diffusion (B)	Structural based performance metrics and dynamic performance metrics- (Król Darius, Wroclaw University of Technology, Poland)	The sociological theory of diffusion is the study of the diffusion of innovations throughout social groups and organizations
	J5- Social inclusion (B)	It's measured considering 7 dimensions: poverty, employment, education, health, gender, living conditions and social participation – European Social Watch Report 2010	Social inclusion is a process of improving the terms on which people take part in society(The World Bank)
	J6- Collective actions (B)	Using qualitative and quantitative techniques	Refers to action taken together by a group of people whose goal is to enhance their status and achieve a common objective.
SOCIETY (3)	J7- Percentage population less min, food/energy (D)	Percentage	Percentage of country population below minimum level that dietary energy (United Nations)
	J8-Cellulars per 100 inhabit. (B)	Percentage	Percentage of population using cellular phones per 100 inhabitants- Gives an idea of public acceptance of advanced technology
	J9-Percentage of women in parliament (B)	Percentage	Percentage of women elected to represent people in parliament
PUBLIC HEALTH (2)	J10- Public Health (B)	Several dimensions must be used: Mortality and life expectancy; Morbidity and Health; Related Quality of Life; Summary Measures of Health	Science of protecting/improving the health of communities through promotion of healthy lifestyles, research for disease and injury prevention, etc (CDC Foundation)
	J11- Percentage of maternal death (D)	Percentage	% of "women while pregnant or within 42 days of termination of pregnancy from any cause related to the pregnancy but not from accidental or incidental causes (World Health Organization)
SUSTAINABILITY (1)	J12- Forest area (B)	Percent of land area	Number of km2 of natural and created forest area in a country. Forest definition: In UK, woodland is the land under stands of trees with a canopy cover of at least 20%
ENVIRONMENT (2)	J13- CO2 emissions (D)	Ppm (Parts per million)	Carbon Dioxide emissions into the atmosphere is one of the most responsible of global warming
	J14-Aquifers contamination (D)	Measured in terms of concentration using different units as PPH (Parts per hundred). (Michigan Environmental Education Curriculum Groundwater Contamin.)	Groundwater pollution (also called groundwater contamination) occurs when pollutants are released to the ground and make their way down into groundwater
NATURAL CAPITAL (1)	J15- Depletion of oil reserves (D)	Millions barrels/day or in millions of m3/day	Depletion of a non-renewable resource, in this example, oil due to exploitation.
EDUCATION (2)	J16- Rate of enrolment, in elementary school (B)	Percentage	Gross Enrolment Ratio: used by the UN in its Education Index to determine students enrolled in school at several different grades
	J17- Students not finishing high school (D)	Percentage	Students that having started HS dropout before termination

main element in a cluster labeled as *'Externalities*[5] *and Production Factors'*. It outputs information to other elements such as *Tacit Knowledge'* (TK)[6]and *'Innovation'* (IN)[7], which in turn intervene as important factors for measuring *'Advanced Technologies'* (AT)[8].

Regarding clusters (AT), Human Capital (HC)[9], and Technology Inputs (T)[10], and just as a reference, the OECD and European Commission (2008) have computed the correlation coefficients between Royalties, Internet, Exports, Telephone, Electricity, Schooling and University. For instance, correlation between Schooling and Internet amounts to 0.63, which evidences the link between (HC) and (T) as shown in our scheme as both are linked to AT.

Continuing our analysis, (AT) delivers a figure for *'Technology Output'* (TO)[11] in the form of *'Patents'* and *'Scientific papers'*. Naturally, (TO) is also dependent on the economic condition of a country (GDP) either by generating technology or by importing it from more advanced countries. In addition, people produce services and manufacture goods, and then (SC), also receiving input from (HC), is the main responsible for the production of goods and services, that is, the components of the (GDP). Thus, taking as an illustration our water consumption example, it can be seen that it is related with (SC) considering that better uses of water can be obtained through *'Collective action'*, i.e. groups of people concerned about its right use.

Within this context, an aspect such as (TK), is fundamental, as well as (IN), both very important amd also, it's evident the connection between (IN) and (AT) in the sense that the latter may allow for the first to have a practical application.

'Society' (S) is not well represented nowadays; however, it is one of the most important factors for a country's evolution. Therefore, the

[5] (EX) Externality - A consequence of an economic activity that does not have economic value. For instance erosion produced by forest logging, water contamination produced by industry, etc.

[6] (TK) Tacit Knowledge - Information we have but that we don't know it.

[7] (IN) Innovation- Process of implementing new ideas to create value for an organization) (Yale Information Technologies Services).

[8] (AT) Advanced Technologies - Refers to High technology.

[9] (HC) Human Capital (Jacob Mincer)- Stock of knowledge, habits, social and personality attributes, to produce economic value.

[10] (TI) Technology input - Use and effect of technology in people's life.

[11] (TO) Technology Output - Consequences, effects, materialized in new development using new technology.

Table 2
Scale to convert linguistic variables in cardinal numbers.

Score	Relationship
1	Weak
3	Moderate
5	More than moderate
7	Strong
9	Very strong
10	Perfect relationship

CIMCE index must also consider a series of indicators related with different areas of society such bas *'Public Health', 'Public Education', 'Per Capita Income*[12]*'*, etc. Needless to say, none of this is reflected in the actual GDP measure.

Data from the *'Environment'* (ENV) condition is imputed to (SC) and decisions imputed back to (ENV), since most alterations and damage to the environment are due to anthropogenic action and it must then have a large importance in the composite indicator. *'Externalities'* (EX), are nowadays completely ignored in calculating country growth; aspects such as *'Deforestation'*, *'Water contamination'*, as well as depletion of non-renewable resources such *'Oil', 'Coal' and 'Gas'*, and *'Mining'*. There is an apparent dichotomy here, because all of these consequences are a result of commercial and/or industrial ventures that contribute positively to the GDP, that is, they are beneficial for country growth, and as so they are considered nowadays. However, this same positive exploitation produces a negative effect because they reduce the *'Natural Capital'* (NC) of the country, and this must also be accounted for in a country's development measure.

The main conclusion from here is that all of these effects should be accountable in the country's economic evolution computation, and consequently they are incorporated into the model.

In this work it is assumed that for designing a composite indicator one must consider all anthropogenic 'elements' that interact in order to express their influence in country progress. Naturally, it is quite impossible to take into account all activities involved, however, social science deems appropriate to group them in sectors or clusters, which in turn contain sub- clusters and many different sub elements. For this reason, this study contemplates that the following elements must be considered and connected, even imperfectly.

- Economic growth, probably the most developed, and with the GDP as its distinctive indicator. This indicator is being used for most countries and its components are more or less well defined and assumedly standard, which allows for making international comparisons. Therefore, getting information on this indicator is relatively easy.
- Social Capital, an extremely important concept that involves aspects such as Tacit Knowledge, Innovation, Advanced Technologies.

As a sub clustersome of its components should be considered such as:

✓ Trust in government,
✓ People networks that transmit ideas and knowledge,
✓ Collective action, that calls for grouping people that can make visible their needs, complaints and ideas,
✓ Diffusion, of ideas and knowledge and that develops over space and time,
✓ Social inclusion, indicating the degree of people involvement activities that affect country functioning, materialized by people adherence to discussion and approval of laws on every aspect.

[12] Per capita income - Average income earned per person in a given area in a specified year.

Of course these are elemental definitions, just to give an idea of their scope.

- Another sub-cluster that interacts, feeding and receiving information is Environment which components are:
  ✓ Electrical generation in all its forms, namely Hydro, Nuclear, Thermal, etc.
  ✓ Air, soil and water contamination produced by spewing chimneys, large oil leaks in water and soil, etc.
  ✓ Tourism management, which must regulate the not always judicious exploitation of forests, uses of lakes, meadows, mistreatment of animals, etc.
  ✓ Fisheries, that can contaminate large areas in ports especially by treatment plants to produce fish flour, and of course illegal captures, etc.
  ✓ Wildlife, which day by day is left with less and less territory to make room for logging, roads and agriculture.
- Externalities is a disregarded issue although it has a tremendous impact in Natural Capital, but nobody seems to notice.
- Natural Capital is one of the most critical aspects in country development, simply because its decrease has been never considered. It may be composed by:
  ✓ Forest depletion like the Amazonia.
  ✓ Water resources are used indiscriminately, as the Ogallala aquifer in USA.
- Another important cluster is Human Capital, where aspects such as the Human Development Index, Education and the Gini index play an important role.
- Advanced Technologies play nowadays a very important role that affects many economy levels and has important social consequences, good and bad.
- Another very important cluster, Society has many components such as:
  ✓ Employment population ratio,
  ✓ Population health,
  ✓ Per capita income,
  ✓ Housing and people living in shanty houses,
  ✓ Green space *per capita*,
  ✓ Gender equality, etc.

All of these issues interact and feedback between themselves and it is believed by these authors that they should be considered to generate a composite index for sustainable socioeconomic development to measure country progress.

Fig. 3 attempts to link them all, and on this interrelations ships, is based our proposal to develop CIMCE to measure the quality of the evolution of a country and different to all those indexes measuring EG or/and ED.

Given the characteristics in the construction of the index, it is obvious that a territory at a given moment in time would be defined by the proportion of elements that contribute to its socioeconomic development process as well as by the way in which these elements are interrelated in a systemic manner in that development process. Consequently, the result obtained is not a value that allows establishing a point of comparison of that development with another territory, but a point of evolutionary comparison of the territory and of the mix that defines it in the process of development within the territory.

4.2. Building the decision matrix

Using relationships from former network as well as quantitative values from experts, the decision matrix is built. For this aim, the network is analytically replicated as a matrix, which has indicators in columns and goals extracted from United Nations in rows. In this way information can be handled mathematically.

For the sake of clarity, take into account the differences between weights, scores and coefficients as follows:

A *weight* for an indicator is absolute and quantifies its importance; it is fixed and independent in the sense that does not influence others.

A *score* for an indicator is relative and indicates its contribution in forming the composite index. It is fixed but not independent because there is trade-off with others.

A *coefficient* for the composite index is relative and reveals the importance of each indicator.

All information is loaded into the decision matrix (Table 3), which construction is as follows:

Indicators: There are 17 indicators that are assumed to be the result of the first part, Fig. 2. Description and characteristics of indicators are in Table 1.

Beneficial and detrimental indicators: An indicator may be beneficial (*Public Health)* or detrimental (*Depletion of oil and gas reserves)*. This is indicated by letters 'B' and 'D' respectively. In the first case the indicators will have a positive value meaning that it increments CIMCE while it reduces CIMCE in the second.

However, even a detrimental indicator such as 'Depletion of gas reserves' may be beneficial for the country. In this case, if for whatever reasons there has been no exploitation or the exploitation rate has decreased, the value will be respectively zero or negative between two consecutive years.

Goals: Can be as many goals as necessary to represent more faithfully this complex scenario. Nevertheless, once a country has decided which of them will use, these must be kept constant; otherwise it could be impossible to compare different periods. Another issue that demands carefully examination is how the goals are distributed by fields. In this work goal fields selected are Education, Social, Public Health, Sustainability, Environment, Economy, and OECD framework.

4.3. Construction of the decision table

Table 3 shows the decision table with indicators in columns and goals in rows and as can be seen, there are values in each column that specify numerically the relationships between indicators and goals. These values derive form experts in each field and are grounded on two sources: Expert estimate, based in a 1 to 10 scale, as seen in Table 2, and correlation from studies made by OECD, The World Bank, United Nations and others. Estimates are integers or decimal and correlation are multiplied by 10 to get uniform values. These values are an average of different experts, and consequently more than one expert may contribute; estimates or correlations denote a positive or inverse relationship expressed by their sign. For instance, for indicator 17 *'Students not finishing high school'*, correlation analysis shows that the larger this value the lesser the chances for people to get more *'Input per capita'* (Goal 3), as they are inversely correlated (– 0.7).

This system was tested by one of the authors when determining for a federal agency in Canada, most appropriate environmental indicators (Munier, 2011).

4.4. Computation of the decision table

When Table 3 is complete all values in a column are added-up considering absolute values, and its sum is known as the '*Raw Indicator Weight'* (RIW) for each indicator. Next step is the determination of the number of 'coincidences', or 'hits', that is, the number of times an indicator has a value in coincidence with a goal. This number, known as *'Participation Factor'* (PF), is then divided by the total number of goals (16 in this case), getting the *'Normalized Performance Factor'* (NPF).

As an example to easy Table 3 understanding, the *'Groups and networking*' (indicator 3 which is shaded), has RIW = 43, and shows a cardinal value or coincidence of 6 out of 16 goals and a ratio of 6/16 = 0.38 (PF). Normalization can be done using any system (this work have used the sum of all (PFs) values in the row), and for indicator 3 it is 0.09. Last step is the multiplication of (RIW) by (NPF) and its result indicates the weight of indicator 3 as (3.70) as shown in the solid black row which represents its importance or normalized weight. As can be seen in this construction the (RIW) is related with all the goals with which an indicator is associated and it's independent of other weights.

Now, using these weights as an objective to be maximized it can be found their interrelationships (Table 4) through Linear Programming (SIMUS). This method gives as a result the *score* of each indicator which is in reality a trade-off value and consequently, all scores are linked. These scores can be seen in row *'Linear score coefficients using weights'* (Sj), and this is the end of the first part as indicated in Fig. 2, Section 3.1.

The second part is data mining and periodical, since each year the performances of each indicator is collected from a large number of sources. For instance: Row *'Annual percentage difference'* shows comparison to equivalent data from the precedent year, and then a variation is found. This variation is then multiplied by the corresponding score (Sj) (last row); the result is the *relative importance of a variation related to other variation*. Consequently, a very large variation may have great or little importance, depending on the score, which is a constant. On the opposite, if there is a little positive variation in an important indicator, its importance in economic development is very important. In our example, the indicator '*Public health'* has the biggest relative score (1.06), which means that its significance in the country development is large.

4.5. Analysis of computed values

Examining shaded column in Table 3 regarding normalized weight (SC x NPF) note that:

- The highest value, by far, corresponds to (GDP) (7.36), something expected.
- The following value pertains to the (SC) cluster, with high values for '*Collective actions* (6.40), *'Social inclusion'* (4.80), *'Groups and networking'* (3.70) and *'Diffusion* (3.51).
- Outside this cluster it is important to observe indicator 13, *'Total CO_2 emissions'* with a weight of (1.86), and indicator 7, '*% of population with less that minimum food energy'* (1.83).

Let's see how the analysis of a column works through an example, for instance for indicator 3 that is, *'Groups & networking'* (shaded), included in the Social Capital cluster.

* No relationships have been found and agreed by the expert's team for goals 1, 2 and 3, meaning that no links have been detected or found relevant between this indicator and *'Level of education', 'Gender differences at work'* and '*Income per capita'*.
* A moderate dependency (6) is found to exist between '*Groups'* and' *People sufficiency'*, because it is believed that groups encourage people to participate, which boost their self-esteem, feeling that they are doing something that will benefit the country.
* No links are found for goals 5, 6, 7 and 8. The reasons are that those goals need to be addressed by the corresponding City Hall agencies.
* Regarding goal (9), aiming at *'Reducing global warming'*[13], it is assigned a −6 value, because it is believed that a more than moderate citizens' action may lead to the adoption of local measures to reduce global warming.
* No links were found significant for goal 10 *'Reduced acid rain'*[14].

[13] Global warming – An increase in the earth's average atmospheric temperature that causes corresponding changes in climate and that may result from the greenhouse effect ictionary.com).

[14] Acid Rain -Precipitation, as rain, snow, or sleet, containing relatively high concentrations o acid forming chemicals.

Table 3
Computing weights for single CIMCE's indicators.

Fields of the Composite Indicator		ECONOMIC. GROWTH	SOCIAL CAPITAL					SOCIETY			HEALTH		SUST.	ENVIRONMENT		NC	EDUCATION	
Indicator I.D.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Subfields name		Capital and labor factors (GDP)	Trust	Groups & net working	Diffusion	Social inclusion	Collective Actions	% populat. under min. food energy	Cellular phones per 100 inhab.	Percent of women in parliament	Public health	% maternal death	Forest area	Total $C0_2$ emissions	Aquifers contami nation	Deplet. Oil Reserv	Enrollm. High School	Students not finishing high school
(B) 'Beneficial' - (D) 'Detrimental'		B	B	B	B	B	B	D	B	B	B	D	B	D	D	D	B	B
Goal fields	**Goals**	**Expert's evaluation of each subfield participation in each goal**																
Education	**1. Enhance all levels of Education**					7	7					8					8	−7
Social	**2. Min. gender**					9	−7			7								
	diff. at work	9						8	8									−7
	3. Maximize income/capital 4.Max. people sufficiency	−7		6		5	6	8										
Health	**5. Reduce child**										8							
	deaths							8			9	6						
	6. Improve maternal health 7. Fight infectious diseases										9			8				
Sustainability	**8. Guaranty sustainability**				8								9	9		7		
Environment	**9. Reduce global**			−6	4	7	5						7	7		8		
	warming				7									9		8		
	10. Reduce acid rain																	
Economy	**11. Improve**	8	8	8	7	7	7		7						8			5
	productivity	−8	8	7		6	9								8			8
	12. Diversify the economy 13. Increase exports	8		8			7											
OECD framework	**14. Pressure**	9		8	−8										6		7	
	15. State	8	9					8					8				8	
	16. Response	9			7	7	8											
Raw indicator weight (RIW)		**64**	**25**	**43**	**41**	**48**	**56**	**32**	**15**	**7**	**26**	**14**	**24**	**33**	**22**	**23**	**23**	**27**
	Coincidence	**8**	**3**	**6**	**6**	**7**	**8**	**4**	**2**	**1**	**3**	**2**	**3**	**4**	**3**	**3**	**3**	**4**
PF		**0.50**	**0.19**	**0.38**	**0.38**	**0.44**	**0.50**	**0.25**	**0.13**	**0.06**	**0.19**	**0.13**	**0.19**	**0.25**	**0.19**	**0.19**	**0.19**	**0.25**
NPF		**0.11**	**0.04**	**0.09**	**0.09**	**0.10**	**0.11**	**0.06**	**0.03**	**0.01**	**0.04**	**0.03**	**0.04**	**0.06**	**0.04**	**0.04**	**0.04**	**0.06**
RIW x NPF		**7.36**	**1.07**	**3.70**	**3.51**	**4.80**	**6.40**	**1.83**	**0.43**	**0.10**	**1.09**	**0.40**	**1.03**	**1.86**	**0.94**	**0.99**	**0.99**	**1.54**

Table 4
Processing the initial matrix to get CIMCE.

Elements intervening in CIMCE	GDP	SC	SOCIAL CAPITAL DIMENSIONS					AT		TK	IN	HC						NC	
Fields of the Composite Indicator		ECONOMIC. GROWTH	SOCIAL CAPITAL						SOCIETY			HEALTH		SUST.	ENVIRONMENT		NC	EDUCATION	
Indicator I.D.		1	2	3	4	5	6		7	8	9	10	11	12	13	14	15	16	17
Subfields name		Capital and labor factors (GDP)	Trust	Groups & net working	Diffusion	Social inclusion	Collective Actions		% populat. under min. food energy	Cellular phones per 100 inhab.	Percent of women in parliament	Public health	% maternal death	Forest area	Total CO_2 emissions	Aquifers contami nation	Deplet. Oil Reserv	Enrollm. High School	Students not finishing high school
Annual percentage difference (%)		**3.5**	**1.1**	**0**	**0.041**	**0**	**0.036**		**−0.008**	**0.8**	**−0.25**	**1.5**	**1.1**	**0.035**	**0.16**				
(B) 'Beneficial' - (D) 'Detrimental'		**B**	**B**	**B**	**B**	**B**	**B**		**D**	**B**	**B**	**B**	**D**	**B**	**D**	**D**	**D**	**B**	**B**
Goal fields	**Goals**			**Expert's evaluation of each subfield participation in each goal**															
Education	**1. Enhance all levels of Education**					7	7						8					8	−7
Social	**2. Min. gender diff. at work**					9	−7				7								
	3. Maximize income/ capital	9							8	8									−7
	4. Max. people sufficiency	−7		6		5	6		8										
Health	**5. Reduce child deaths**											8							
	6. Improve maternal health								8			9	6						
	7. Fight infectious diseases											9			8				
Sustainability	**8. Guaranty sustainability**				8									9	9		7		
Environment	**9. Reduce global warming**			−6	4	7	5							7	7		8		
	10. Reduce acid rain				7										9		8		
Economy	**11. Improve productivity**	8	8	8	7	7	7			7						8			5
	12. Diversify the economy	−8	8	7		6	9									8			8
	13. Increase exports	8		8			7												
OECD framework	**14. Pressure**	9		8	−8											6		7	
	15. State	8	9						8					8				8	
	16. Response	9			7	7	8												
Raw indicator weight (RIW)		**64**	**25**	**43**	**41**	**48**	**56**		**32**	**15**	**7**	**26**	**14**	**24**	**33**	**22**	**23**	**23**	**27**
Coincidence		**8**	**3**	**6**	**6**	**7**	**8**		**4**	**2**	**1**	**3**	**2**	**3**	**4**	**3**	**3**	**3**	**4**
PF		**0.50**	**0.19**	**0.38**	**0.38**	**0.44**	**0.50**		**0.25**	**0.13**	**0.06**	**0.19**	**0.13**	**0.19**	**0.25**	**0.19**	**0.19**	**0.19**	**0.25**
NPF		**0.11**	**0.04**	**0.09**	**0.09**	**0.10**	**0.11**		**0.06**	**0.03**	**0.01**	**0.04**	**0.03**	**0.04**	**0.06**	**0.04**	**0.04**	**0.04**	**0.06**
RIW x NPF		**7.36**	**1.07**	**3.70**	**3.51**	**4.80**	**6.40**		**1.83**	**0.43**	**0.10**	**1.09**	**0.40**	**1.03**	**1.86**	**0.94**	**0.99**	**0.99**	**1.54**

* A strong link (8) was found for goal 11 *'Improve productivity'* because for instance, the action of a small farmers' group may lead to the creation of cooperatives to purchase a sowing-machine.
* A high correlation (7) was found for goal 12 *'Diversify the economy'*, and 13 *'Increase exports'* (8) due to similar analysis.
* Goal 14 refers the '*Pressure'* that is, when anthropogenic action is affecting the local environment. It is assigned a high value (8) since it is believed that citizens' actions can help in this endeavor.

4.6. Determining scores for indicators to compute CIMCE

Table 4 shows the result after applying LP. The values are not longer independent by related and indicating trade-off.

Let's start with indicator (1) *'GDP'*. Observe that now its linear score is 0.25 and not the highest, because indicator (10) *'Public heath'* is worth 1.06.

Observe now that the Δ variation for both is the same in absolute values, since $\Delta_1 = 0.0015$ and $\Delta_{15} =$ - 0.0015, or 0.015%. This means for the GDP an increase of 0.15% and then favoring the country. For the same token the same variation for Depletion, being negative, also means an increase of 0.15% because it favors the country.

When these variations are multiplied by the scores, the *CIMCE coefficients* for the composite indicator are obtained. Observe that in this case the GDP benefits the country by 0.004 while this benefit doubles for Depletion with 0.008. This analysis points out the influence in the quality of a country evolution in making a more rational use of its natural resources. It appears to be a non-sense that environmental consideration may have more consequences than economic ones, however, look at this true fact: In 2007 China tried to implement the *'Green GDP'* that is, a GDP that incorporated deduction because contamination. Regarding that effort researchers Fengiu and Damaneh (2013) reported that: *As an experiment in national accounting, the Green GDP (effort in China) collapsed in failure in 2007, when it became clear that the adjustment for environmental damage had reduced the growth rate to politically unacceptable levels, nearly zero in some provinces. In the face of mounting evidence that environmental damage and resource depletion was far more costly than anticipated, the government withdrew its* support *for the Green GDP methodology*"

Let us now investigate indicator (2) *'Lost of trust'*, where $\Delta_2 =$ - 0.013; its negative value means benefit for the country, since lost of trust has decreased. Another indicator such as (6) *'Collective action'* also shows a negative variation with $\Delta_6 = -0.008$; however, since this is a beneficial indicator this result is negative for the country. Another indicator such as (12) *'Forest area'* shows positive variation with $\Delta_{12} = 0.057$, and then, positive for the country, and so on.

Another very important addition to this new table is located at its right where four columns are added. Their meanings are: *'Action for goal'*: This indicates which the action for each goal or objective is. Thus, for instance, for the first goal *'Enhance all levels of education'*, it is obvious that it must be maximized, that is, the authors need for it to evaluate indicators on the condition that they make the maximum contribution to education in the country. Consequently, 'MAX' is placed on this row.

Observe that, according to the cardinal values this goal is related to *'Social Inclusion'* gauged with (7), to *'Collective action'* gauged with (7), to *'Percentage of maternal death'* gauged with (8), and to *'Rate of enrollment in elementary school* gauged with (8).

All of these, except for indicator *'Students not finishing high school'* gauged with −7, have a positive cardinal value that indicate that the higher the education, the higher the benefits in different fields, with the exception of the last one that shows that the higher the education goal the lower students abandoning studies. Therefore, *'Education,'* a part of *'Human Capital',* and as a goal, relates with Social Capital, Society, Health, and Elementary Education, just as shown in Fig. 3.

The (B) column '*Limits for goals* 'informs about the superior or inferior limits for each criterion. This is necessary since people do not live in a limitless world; quite the opposite, there are limits for everything in life.

These (B) values are normally difficult to determine because their subjective quality; for this reason, if they are absent, the model automatically assigns a value related to the maximum and minimum cardinals, according to the action. Thus, for the first goal a value of (8) is placed in this column and on the first row. This value corresponds to the maximum cardinal because the action calls for maximization, but for indicating that this maximization has an upper limit than cannot be surpassed, the operator '≤' (Lower or equal than …) is placed, to inform the model about that circumstance.

If action calls for minimization (MIN) as in the second goal, the model places (−7) in the (B) column because that is the minimum cardinal on that row, and uses the operator '≥ '(Greater or equal than …) to inform the model that as a minimum the lower limit must be equal or greater than (−7). The same can be done for a goal using the ' = ' operator, for instance if there is fixed budget for this study.

The second column *'Results for computation'* reveals after processing the values the model found for (Bs) in accordance with the corresponding operators. Check that in this example all values in this column and the values in the (B) column satisfy the operators of the third column. That is, all criteria comply with the corresponding limits imposed. For instance, for goal (3) *'Maximize income per capita'* the value in the second column is (1.76) which is lower that the value in column (1) (9.00). Since it this relationship the operator is '≤' (lower or equal than) the criterion is within its limits. This very important aspect is verified in all cases and this fact indicates that the model has reached a Pareto efficient solution, that is, all values in the black row are optimal.

Therefore, the CIMCE index is obtained as shown by formula (4).

$$\text{CIMCE Index} = Max \sum_{j=1}^{16} \text{Sj x}\Delta\text{j} = 0.042\ \forall_{\text{j}} \tag{4}$$

Meaning that the country has improved 4.2% from year (n-1) to year (n).

5. Analysis of results and discussion

Quantitative coefficients have been obtained for the composite index; however it is necessary to check their sign with reality, something that was hinted in Section 4.6. Continuing with our example, the Table 5 summarizes the results and their explanation. The reason for this analysis is checking that everything tallies with reality. As we said before, this indicator therefore represents the evolving path for a certain territory. However, in no case can this indicator be used to compare the evolutionary rhythm of the territory for which it was calculated with that of any other territory, since the constituent elements and the way they are related for each territory are specific.

On the contrary, these results have some advantages with respect to other comprehensive indicators for sustainable development analysis: on the one hand they reflect a dynamic process as we can observe variations on the index's components. They also contribute to isolate the reasons for a poor performance of a certain component, with the possibility of introducing variation in policy to reorient the evolving path. However these advantages, they can also be taken on the opposite direction, since the index is constructed on the basis of the experts' knowledge which clearly represents a subjectivity source in the interpretation of facts. Despite that MCDM methods do incorporate this idea, the action of doing politics is never exempt from subjectivity and from the value judgments of the human being.

The resulting CIMCE value for our calculations represents how this territory has evolved from one year to the next. The result achieved represents the proportion (a growth of 4.2% in this case) in which the territory has changed over the course of a year. The results themselves are of interest not only objectively (they give us a clear idea of whether the territory is improving, worsening or simply changing its constitutive structure), but this result is of great value in order to be able to correctly focus future policies designed to influence the sustainable development

Table 5
CIMCE coefficients and their signs.

Coefficients								
Indicator	Name	AAnnual variation Δj	SScore Sj	RRaw final value	SSign	Beneficial or Detrimental	*Analysis of values and their signs*	Corresponding action
J = 1	**GDP**	0.015	0.25	0.004	+	Beneficial	Final value (0.004) is positive and since a growth of the GDP is beneficial (B) for the country it has to be added. Therefore, its sign is correct (C)	Value added
J = 2	**Trust**	−0.013	0.23	- 0.003	–	Beneficial	Final value (- 0.003) is negative, it is then detrimental (D) for the country and has to be deducted. Sign (C).	Value deducted
J = 3	**Groups and networking**	0.041	0	0		Beneficial	Final value is 0 meaning that it has not been selected by the model as important	0
J = 4	**Diffusion**	0.018	0.48	0.009	+	Beneficial	Final value (0.009) is, positive, then is (B) and has to be added. Therefore, its sign is correct.	Value added
J = 5	**Social inclusion**	0.036	0	0	+	Beneficial	Final value is 0, no important.	0
J = 6	**Collective action**	−0.008	0	0		Beneficial	Final value is 0, no important.	0
J = 7	**% of pop. without enough food energy**	0.035	−0.07	−0.002	–	Detrimental	Final value is −0.002, so it's (D) and has to be deducted.	Value deducted
J = 8	**Number of cellular phones**	0.16	0	0		Beneficial	Final value is 0, no important.	0
J = 9	**Percentage of women in Parliament**	0.019	0	0		Beneficial	Final value is 0, no important.	0
J = 10	**Public health**	0.024	1.06	0.026	+	Beneficial	Final value is 0.026 which is beneficial for the country. Sign (C)	Value added
J = 11	**Percentage of maternal health**	−0.012	0	0		Detrimental	Final value is 0, no important.	0
J = 12	**Forest area**	0.057	0.2 3	0.013	+	Beneficial	Final value is 0.013, so it's (B) since it shows and increase in the forest area. Sign correct.	Value added
J = 13	**Total CO2 emissions**	−0.017	−0.08	0.001	–	Detrimental	Final value is 0.001, so it's (B) since it means a reduction in emissions. Sign (C)	Value added
J = 14	**Aquifers contamination**	0.009	0	0	–	Detrimental	Final value is 0, no important.	0
J = 15	**Depletion of reserves**	−0.015	0.54	−0.008	–	Detrimental	Final value is −0.008, so it's (B) because it shows decreasing extraction and then saving natural resources; its score (0.54) is positive; therefore, since their product is negative, its sign must be changed to positive to consider this aspect, and then added.	Value sign to be changed
J = 16	**Roll on enrolment**	0.011	0.27	0.003		Beneficial	Final value is 0.003, so it's (B) since its means a reduction in emissions. Sign (C)	Value added
J = 17	**Students not finishing**	−0.021	0	0		Detrimental	Final value is 0, no important.	0

process of the territory or educational or health policies. In short, CIMCE is a representative indicator of the way in which a territory interrelates its most representative elements of its evolutionary process, with that systemic vision that undoubtedly represents the aforementioned process much more faithfully. It cannot be used, therefore, to establish inter-territorial comparison mechanisms, but it is the basis for assessing intra-territorial evolution and, on that basis, to be able to design policies, strategies and mechanisms in accordance with its evolutionary process for the future. The result is therefore of great value for politicians who must take decisions regarding territorial development in the short, medium and even long term.

6. Conclusions

The process of measuring and computing the economic development is a huge task that many international institutions and governments in developed and developing countries have been carrying out. However, it remains an unfinished activity due in part to the difficulties in accurately defining what economic development means even for economists. If the researchers of this work have assumed that they are facing a multidimensional concept with many facets and alternative viewpoints for tackling it, then readers can imagine that the task of developing accurate measures to gauge is of the same dimension.

On the other hand, the economic growth can be easily measured by the GDP. However, it doesn't take into account the negative impact an uncontrolled growth could have in the environment, society, etc.

This paper is aiming at opening up a forum on the actual design, pursuing a cultural change and awarening society when measuring the evolution of a country just considering economic issues and neglecting fields like Sustainability, Environment, Natural Capital, Social Capital, Society, Public Health, and Education aspects.

CIMCE indicator considers some aspects from the Economic Growth and Development as well as Sustainable Development concepts and also takes into account the relationship of a wide spectrum of anthropogenic elements such as Economy, Society, Environment, Education, Health, Natural Resources, Safety, Technology, Transportation, External Debt, Externalities, etc., which have influence in the quality of a country evolution going beyond the three pillards of the SDG principles.

The obtained results in line with reality, validates several strengths of this innovative research work like the design of a robust methodology or the network of relationships with influence in a country evolution. Additionally, the use of the concept of information entrophy to select a hughe number of indicators or the application of a MCDM method to compute CIMCE makes this composite indicator a disruptive tool different than others.

However, it shouldn't be correct to lose sight of the fact that the index is built on the basis of information gathering. This process is particularly sensitive, since it depends almost exclusively on the ability of experts to determine the best ways of measuring a given fact and thus use the most accurate indicators in the composition of the index. Such participation, as we said, can be understood as a limitation. We understand that it can also be seen as an opportunity to generate a common knowledge base with which to set certain standards in both the collection and processing of information. Since one of the main criticisms that is usually argued in relation to statistical information is precisely the robustness of the source data for the elaboration of the indicators, this method establishes a sequential process that could well represent a standard and avoid, to a certain extent, this loss of robustness in obtaining the source data.

On the other hand, this indicator is currently limited to use in a specific territory, and cannot be used to compare territories. This point would represent a substantial advance for the standardization of this and any other indicator.

CIMCE is thus a quantitative measure of a country evolution or retreat respecting the precedent year and to the authors belief, it provides a mathematically sound method to compute the quality of a country evolution.

In any case, it is necessary to highlight the current limitations in the use and application of the indicator designed. For its correct use, it is essential to be able to use contrasted and quality information whose definition is beyond any doubt. Otherwise, the possibility of using the indicator as a comparison mechanism in the future would be called into question. Among the authors' future lines of research is precisely the possibility of applying the indicator with real data in a specific territory, so as to obtain results that can be evaluated in the light of other indicators that have been designed for a similar or equal purpose. The intention is precisely to contrast the value provided by CIMCE with that provided by other indicators. The ultimate objective, as it cannot be otherwise, is to contrast the quality of the results it offers with the intention of providing an integral measure of the sustainable development process in a territory.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors are unable or have chosen not to specify which data has been used.

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