RBGDR

SUSTAINABLE DEVELOPMENT INDEX (IDS): CALCULATION FOR MUNICIPALITIES IN THE METROPOLITAN REGION OF CAMPINAS, SP

ÍNDICE DE DESENVOLVIMENTO SUSTENTAVEL (IDS): CÁLCULO PARA MUNICÍPIOS DA REGIÃO METROPOLITANA DE CAMPINAS, SP

SUSTAINABLE DEVELOPMENT INDEX (IDS): CALCULATION FOR MUNICIPALITIES IN THE METROPOLITAN REGION OF CAMPINAS, SP

ÍNDICE DE DESENVOLVIMENTO SUSTENTAVEL (IDS): CÁLCULO PARA MUNICÍPIOS DA REGIÃO METROPOLITANA DE CAMPINAS, SP

Celso Fabrício Correia de Souza[1] | Josué Mastrodi Neto[2]

Daniel Massen Frainer[3] | Celso Correia de Souza[4] | Yuzo Iano[5]

[1] Master in Environment and Regional Development (UNIDERP).
Professor at the Pontifical Catholic University of Campinas. Campinas – SP, Brazil.
Email: celsofabricio36@gmail.com

[2] PhD in Law (USP).
Professor at the Pontifical Catholic University of Campinas. Campinas – SP, Brazil.
Email: mastrodi@puc-campinas.edu.br

[3] PhD in Economics (UFRGS).
Professor at the State University of Mato Grosso do Sul. Dourados – MS, Brazil.
Email: danielfrainer@gmail.com

[4] PhD in Electrical Engineering (UNICAMP).
Professor at Anhanguera University – Uniderp. Campo Grande – MS, Brazil.
Email: csouza939@gmail.com

[5] PhD in Electrical Engineering (UNICAMP).
Professor at the State University of Campinas. Campinas – SP, Brazil.
Email: yuzo@decom.fee.unicamp.br

ABSTRACT

The construction of indices in subnational units is extremely important to provide detailed information for assessing the situation and monitoring public policies considering aspects of sustainability. Indices and indicators are fundamental, as they serve as a guide for decision making at various levels, allowing to measure progress and the achievement of the strategic goals established in government actions. This research aims to find evidence on the sustainability of municipalities in the Metropolitan Region of Campinas (RMC) through the construction and evaluation of the Sustainable Development Index (IDS). It was undertaken in the form of applied research with a quantitative, exploratory and documentary approach, by the types of data collected and by using statistical procedures. In the results, unsatisfactory performance was detected in the Metropolitan Region of Campinas, while all the municipalities are in a situation of "alert" in terms of the sustainability of development for a set of 209 indicators. This unprecedented application for the RMC is expected to point out situations (diagnoses) to guide the manager to put into practice clear and direct corrective measures (straight to the target), which serve as a reference for the formulation and application of more effective public policies for municipal/regional development, in addition to enabling the creation of a strategic information database (system of indexes and indicators) for monitoring and assessing development sustainability.

RESUMO

A construção de índices em unidades subnacionais é de extrema importância para fornecer informações pormenorizadas para avaliação da situação e acompanhamento de políticas públicas considerando aspectos da sustentabilidade. Os índices e indicadores são fundamentais, porquanto servem como guia para tomadas de decisão em vários níveis, permitindo mensurar o progresso e o atingimento dos objetivos estratégicos estabelecidos em ações governamentais. Esta pesquisa visa encontrar evidências sobre a sustentabilidade dos municípios da Região Metropolitana de Campinas (RMC) mediante a construção e avaliação do Índice de Desenvolvimento Sustentável (IDS). Empreendida sob a forma de pesquisa aplicada com abordagem quantitativa, exploratória e documental, pelos tipos de dados coletados e por utilizar procedimentos estatísticos. No resultado, detectou-se o insatisfatório desempenho na Região Metropolitana de Campinas, ao passo que todos os municípios se mostram em situação de "alerta" na ótica da sustentabilidade do desenvolvimento para um conjunto de 209 indicadores. Espera-se com esta aplicação inédita para a RMC, um apontamento de situações (diagnósticos) para nortear o gestor a pôr em prática medidas corretivas claras e diretas (direto ao alvo), que sirvam de referência para formulação e aplicação de políticas públicas de desenvolvimento municipal/regional mais eficazes, além de possibilitar a criação de um banco estratégico de informações (sistema de índices e indicadores) para monitoramento e avaliação da sustentabilidade do desenvolvimento.

INTRODUCTION

The United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992, also known as "The Earth Summit/ECO-92", was one of the main milestones of "Sustainable Development". Its main contributions include the creation of the Earth Charter, the document called Agenda 21 and the three conventions: protection of biodiversity, reduction of desertification and climate change, as well as the two declarations: the Rio declaration on the principles of forest management and the Rio declaration on Environment and Development.

The creation of the Sustainable Development Commission (CDS) was another key contribution of Agenda 21, whose purpose would be to monitor global progress with regard to sustainability. One of the needs expressed in Agenda 21 would be the formulation of sustainable development

indicators and, from there, the creation of appropriate instruments for decision-making (UN, 2001).

Another historic milestone concerns the workshop called "Indicators for Sustainable Development for Decision Making" held in Ghent (Belgium), in 1995. It aimed to disseminate the use of sustainable development indicators and generate greater acceptance, by the scientific community and politicians about the use of these indicators (Bellen, 2006).

Currently, supervisory activities in government bodies require much more than measuring compliance with budget execution and expenditure regularity standards; citizens legitimately demand more access to information, so that they can evaluate the results of public managers' actions and their adequacy to the commitments they have made to society. In other words, they demand accountability from the government, as democratic participation derives from the exercise of voting (TCESP, 2018).

The processes of data collection and construction of comparative analyzes, at regional levels, significantly minimize the incidence of sampling errors and make the results more consistent with reality (Santana e Barreto, 2016).

The choice of a municipal index is related to the goals of regional development policies. The index is a more effective instrument for monitoring regional policies (Souza *et al.*, 2020).

In this context, a successful development style requires the coordination of a local/regional power capable of transcending sector particularities, engaging in all dimensions of development and considering the complementarity of the various actions undertaken (Sachs, 1994).

Thus, the need to carry out research and studies to measure and evaluate the level of sustainability in subnational units emerges. The Sustainable Development Index (IDS), the object of this research, is considered a synthetic indicator (or index) that aggregates multiple sources of information to assess the sustainability of development.

The proposal for this research considers the twenty municipalities of the Metropolitan Region of Campinas (RMC) as the object of study. The RMC extends over an area of 3,791 km², which corresponds to 0.04% of the Brazilian surface and 1.47% of the territory of the state of São Paulo. It is the second largest metropolitan region in the State of São Paulo in terms of population, with more than 3.2 million inhabitants (IBGE estimate in 2018), and accounts for 8.75% of the state's

GDP (SEADE, 2019), which includes the municipality of Paulínia, with the highest *per capita* GDP in Brazil and the municipality of Campinas, which ranks 3rd in São Paulo's GDP and 11th in the national ranking (based on 2017 data, released by IBGE in 2019). The region also has a modern and diversified industrial park made up of complementary sector segments. It is also worth mentioning the presence of innovative centers in scientific and technological research, in addition to a prominent university complex installed.

This study assumed that municipalities of the RMC would have a high level of sustainability due to local and regional dynamism. However, in searches carried out via virtual media (internet) and through bibliometric research, no type of systematic measurement was observed in the region (Souza *et al*., 2019). There are no actions to build development indexes, whether in the public or private sphere. From these considerations, the following questions were formulated: based on the economic, social, environmental and institutional dimensions, what would be the level of sustainability of the development of RMC municipalities? How important is it to create the IDS?

The general purpose of this study was to find evidence on the sustainability of RMC municipalities through the construction and evaluation of the IDS. Specifically, the aim is to select variables to make up the economic, social, environmental and institutional dimensions; structure a system of indicators for the composition of the IDS; calculate the IDS and evaluate the degree of sustainability in the dimensions; create a ranking and establish comparisons between municipalities.

With this unprecedented application for the RMC, a change in organizational culture in institutions is expected, as indices and indicators are considered management instruments. You can only manage what you can measure. Measuring is essential. Most of the indicators used are related to programs and projects – they indicate effort and quality. As a result, an organization's decision-making process is supported, especially in achieving sector goals and strategic objectives.

The public benefiting from the research results is, as follows: the academic environment itself, public bodies, companies and society in general. Thus, we can cite as main contributions: technical notes (diagnoses) to guide managers to put into practice clear and direct preventive and corrective measures in their municipalities (straight to the target); reference for public agents in

the formulation and application of public policies for local/regional development; creation of an information database (panel of indexes and indicators/observatory) for monitoring and evaluation; basis for other studies related to the theme of sustainability, enabling micro-regional selections or by group of other municipalities; possibilities of replicating the methodology according to sector needs, especially in Metropolitan Development Agencies, for other municipalities and regions of the country, and even being used by the private sector for marketing actions.

As this is a series of "ID" development indices, it is worth stressing that the theoretical and methodological basis is unique, and is even presented in other scientific articles: the Social Development Index (ISD): calculation for municipalities in the Metropolitan Region of Campinas/SP (Souza *et al.*, 2020); the Economic Development Index (IDE): calculation for municipalities in the Metropolitan region of Campinas/SP (Souza *et al.*, 2020); the Institutional Development Index (IDI): calculation for municipalities in the Metropolitan region of Campinas, SP (Souza *et al.*, 2020); the Environmental Development Index (IDI): calculation for municipalities in the Metropolitan Region of Campinas, SP (Souza *et al.*, 2023); and, finally, the IDS, the result of submission to this journal.

For better understanding and analysis, the study is structured into sections. In addition to this introduction, a second section includes a discussion on the themes of sustainable development and sustainability; another subitem that presents the concepts of indicator and index depending on the discourse, nature and characteristics of action; and a last item that deals with aspects of regional/local development. The third section presents the methodological bases and attributions that guide the construction and evaluation of the IDS. The fourth section presents the analysis and discussion of the data and the conclusions of the article are presented in the fifth section.

THEORETICAL FOUNDATION

Ecodevelopment, sustainable development, globalization, green economy, global bioeconomy, development sustainability, are themes characterized as milestones in world history as shown in Figure 1.

Figure 1 | Main milestones regarding the sustainable development

Source: Adapted from SBPC (2019).

SUSTAINABLE DEVELOPMENT X SUSTAINABILITY

For Bellen (2006), the concept of sustainable development specifies a new way for society to relate to its environment in order to guarantee its own continuity and that of its external environment.

In his assessment, Boff (2016, p. 17) points to a perspective that emphasizes the local, regional, national and global levels: "Sustainability is a way of being and living that requires aligning human practices with the limited potential of each biome and the needs of present and future generations".

It is in recognizing the limits of ecosystems that the greatest possibilities for the development process lie. Furthermore, last but not least, innovation promotes this contribution. Therefore, the need for sustainability-oriented innovation systems is currently being addressed (Abramovay, 2012).

On the other hand, to fight the causes of "unsustainable" development, a group of scientists developed 8 (eight) principles for assessing and measuring sustainability, characterized as the "new" Bellagio STAMP, which included: (1) guiding vision; (2) essential considerations; (3) adequate scope; (4) structure and indicators; (5) transparency; (6) effective communications; (7) broad participation;

and (8) continuity and capacity Put differently, adopting a high-performance system that has transparency, reliability and quality, in an integrative approach (multidimensionality) of the concept of sustainable development (Pintérd *et al.*, 2012).

Hardi and Barg (1997) state that measurements are essential for the concept of sustainable development to become operational. Thus, an empirical and quantitative basis for performance assessment is provided and allows comparisons in time and space. With the same reasoning, Martins and Cândido (2008) point out the need to measure and evaluate the situation of a given municipality in relation to sustainability.

Therefore, the so-called assessment tools are useful for decision makers and are characterized, in the planning function, as useful for the development of public policies (Moldan and Bilharz, 1997).

Finally, sustainable development can be identified based on an ideal level of sustainability, in other words, in the so-called "Ideal Point of Development Sustainability", which is based on the indices of Economic Sustainability (SE), Social Sustainability (SS), Environmental Sustainability (SA) and Institutional Sustainability (SI), as shown in Figure 3.

Figure 2 | Ideal Point of Development Sustainability (DS)
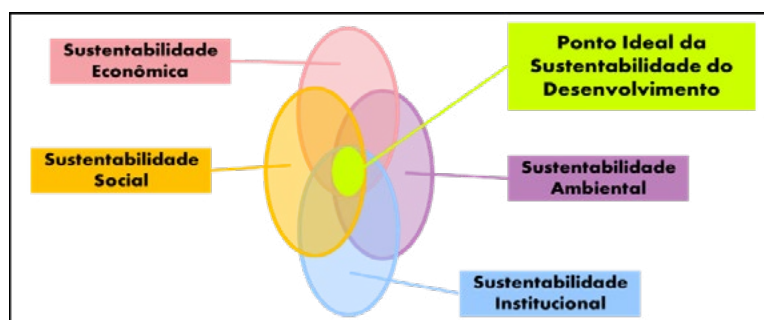
Source: Souza *et al.* (2020).

INDICATORS X INDICES

In this section, we will discuss indicator and index terminologies, since they may have an informative object, similarity in their development and operationalization, but when we analyze them in more technical detail, many differences are found (Chart 1).

Chart 1 | Main definitions regarding indicator and index from the perspective of some authors

Indicator	The word indicator derives from the Latin verb *indicare*, meaning to discover, point out, announce, estimate… the indicators communicate or inform about the attainment and/or direction to a determined goal, that is, its progress towards the "target". It is also understood as a resource that makes a trend or phenomenon that is not immediately detectable more visible.	HAMMOND *et al*. (1995).
	An indicator is a measure of the system's behavior in terms of expressive and perceptible attributes.	HOLLING (1978)
	In addition to informational functions, indicators also play a role in evaluation and decision-making as they can be used as a reference for the construction of objectives, goals and strategies.	SIEDENBERG (2003)
	An indicator measures the variation of the variable in relation to a specific base, i.e. it has a certain level of aggregation.	GALLOPIN (1996)
	An indicator is, therefore, an observable variable used to account for a non-observable reality.	BOULANGER (2008)
Index	Indices are composite indicators that condense information obtained by aggregating values.	BELLEN (2006)
	A simple indicator is not able to show the reality of a situation. As an example, the author mentions GDP, showing how limited this indicator is and does not reflect the whole reality.	BOSSEL (1999)
	Some researchers prefer to use a list of indicators related to specific problems. However, for sustainability monitoring purposes, the need for indicators with a certain degree of aggregation, which are able to discern problems in a clear and concise manner, is essential.	BELLEN (2006)
	In order to obtain data on sustainable development, aggregated or interconnected indicators are needed.	GALLOPIN (1996)
	As regards the word index, it designates a synthetic indicator constructed by aggregating other basic indicators.	BOULANGER (2008)

Source: Elaborated by the Authors.

In a superficial analysis, index and indicator have the same meaning. The difference lies in the fact that an index is the final aggregated value of a calculation procedure in which indicators are used as the variables that make up the calculation (Khanna, 2000).

Boulanger (2008) states that more often than not indicators do not have the same degree of precision and are not measured with similar units, which obviously complicates the process of aggregation of measurements into a synthetic indicator. The author argues that aggregation is the operation consisting in condensing the information contained in each criterion into one single item of information and, therefore, to become aggregated, indicators must be capable of expression in a common unit.

Therefore, indicators can support public planning actions and the design of social policies at different levels of government, and enable the systematization of living conditions and the well-being of the population by public authorities and the civil society (Jannuzi, 2005).

The development of sustainability assessment indices supports public and private management, allowing them to focus on the specific needs of different local actors (Macedo *et al.*, 2016).

Over the last few decades, there has been an increase in the number of composite indicators developed by various national and international agencies. Unfortunately, individual indicators are sometimes selected in an arbitrary manner with little attention paid to the interrelationships between them. This can lead to indexes that overwhelm, confuse and mislead decision-makers and the general population. This environment is characterized by some analysts as "indicator rich but information poor" (OECD, 2008).

However, there is not just one way to measure sustainable local development. It is necessary to assess different development and sustainability indicators to find the best way to quantify them, as stated by Nourry (2008).

LOCAL/REGIONAL DEVELOPMENT

When examining the evolution of the concept of development, we initially come across a crucial challenge: the frequent confusion between "development" and "growth". An in-depth analysis of the literature on the subject reveals that these terms are not interchangeable, as "growth" is largely associated with the economic sphere, neglecting essential elements such as ecological, social, cultural and territorial aspects, which play a crucial role in the development. Obviously, growth does not always generate development, especially if it is only economic growth,

as it may cause damage to the environment, intensify social and regional disparities, thus proving unsustainable in the long term (Montibeller, 2001).

In the Brazilian context, the local space is the municipality, a fundamental unit of social organization and, at the same time, the region where people live. Local power, defined as local authority, is not related to the transformations associated with decentralization, debureaucratization, participation and the so-called new urban technologies (Dowbor, 1999).

The effective participation of local communities in outlining development strategies implies identifying their needs, recognizing productive potentials and organizing team sports. To enable the active participation of the local population in development planning, preparatory education is essential, which makes the population aware of the essential aspects of this process and provides first-rate information (Sachs, 1986).

This management model allows local managers, community organizations and other local influencers to seek practical approaches best suited to their needs, encouraging innovation, the formation of partnerships and the review of conditional decision-making traditions. The elaboration of local development policies and plans, as well as the collaboration between different actors to implement them, depends on the ability to negotiate proposals, strategies, plans and projects (Filippim *et al*., 2005).

Over the last four decades, the country's regional development process has undergone significant transformations, both regarding regional dynamics and public policies, which have influenced this process. These changes led to the search for solutions through regional development plans and programs, promoting more balanced regional development through the integration of economies (Filippim *et al*., 2005).

It can be said that participation in Intermunicipal Consortia, in a regional approach, is capable of providing a more effective inclusion of subordinate groups at the local level when compared to more comprehensive bodies, such as the state and federal spheres. This closer action, also adapted to local specificities, allows for a better understanding of the community's needs, promoting decisions and actions that are more aligned with the specific realities of each region (Randolph, 2018).

Furthermore, the success of this model is also linked to other factors, such as the understanding of regional culture and the ability to structure it around a program defined and constructed jointly by various public and private agents. The referred model must also be able to take advantage of local potentials, have the ability to operate in market niches not involved by the private sector and discernment to balance regional development measures with endogenous potential SEBRAE, 2003).

SCIENTIFIC METHODOLOGY

This is an applied research, with a quantitative, exploratory and documentary approach, due to the type of data collected and because statistical procedures are used.

The methodology proposed in this research considered the twenty municipalities of the Metropolitan Region of Campinas as the object of study, focusing on the research of secondary data, collected for the purpose of constructing and evaluating the IDS.

The RMC, also known as Grande Campinas, was created by State Complementary Law no. 870, of June 19, 2000, comprising 20 municipalities, as follows: Americana, Artur Nogueira, Campinas, Cosmópolis, Engenheiro Coelho, Holambra, Hortolândia, Indaiatuba, Itatiba, Jaguariúna, Monte Mor, Morungaba, Nova Odessa, Paulínia, Pedreira, Santa Bárbara d'Oeste, Santo Antônio de Posse, Sumaré, Valinhos e Vinhedo, as shown in Figure 3 below.

Figure 3 | Map of the state of São Paulo, highlighting the Metropolitan Region of Campinas
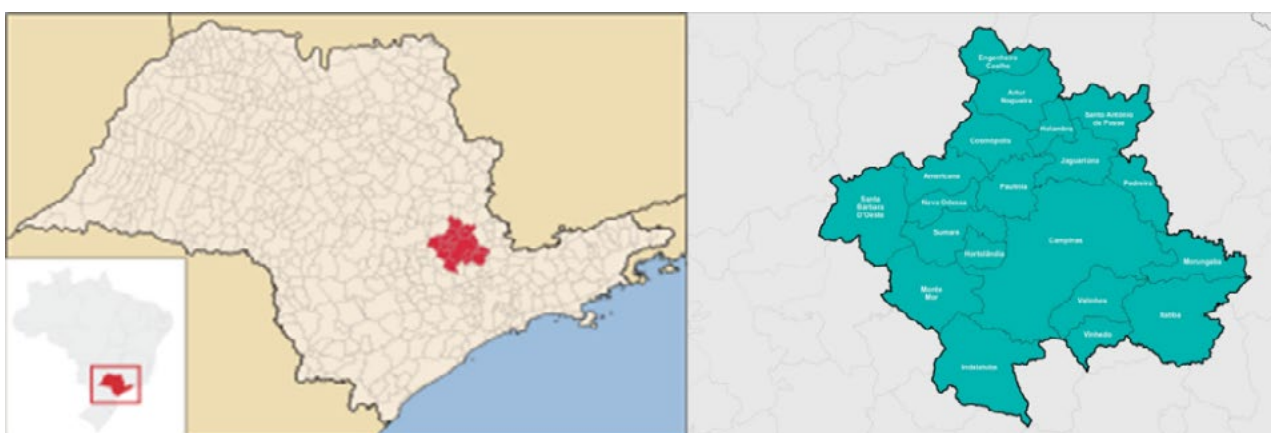
Sources: SinBiota (2019); Emplasa (2019).

In line with the objectives of this study, a search for scientific research related to the construction of development indices was carried out. Twenty publications were cited from the bibliometric research on the CAPES Portal, carried out in April 2019; in 12 of these studies, the subject investigated was described in the title of the scientific paper, and these studies were considered for tabulation purposes, being read and analyzed (Souza *et al.*, 2019).

Furthermore, the report "Sustainable Development Indicators: Brazil 2017", prepared by IBGE, is considered an important guide for the construction of indices that allow a more complete assessment of sustainability, considering the peculiarities and characteristics of the RMC. In this edition, the IDS was developed based on 132 indicators that allow the monitoring of phenomena over time and the examination of their occurrence in the national territory (IBGE, 2017).

Considering the IDS research as unprecedented for the RMC, we assigned a list of relevant variables and indicators to better qualify the work and, thus, provide greater coverage of issues essential to sustainable development. A total of 209 indicators (sum of all dimensions) were used in this research, which is therefore considered extremely relevant for the municipalities of the RMC.

In this research, the latest available database for each variable was used, which is included in the system of indicators of the four dimensions of sustainable development. Data collection took place from July to October 2019.

The set of variables according to the dimensions is presented below:

a) Economic variables: GDP, *per capita* GDP; added value; balance of formal jobs, planted area; trade balance; income from work; Gini index, energy, transport, private investments, among others (34 indicators).

b) Social variables: fertility; birth; mortality rate; households; population growth; migration balance; hospital beds; rate of physicians per inhabitants, population aging index, schooling; literacy; education; illiteracy; age-grade distortion; IDEB; HDI; murder; theft; Social Responsibility Index, among others (62 indicators).

c) Environmental variables: degree of urbanization; density of rays; water extraction, consumption and quality; sewage collection and treatment; access to urban and rural waste collection; drainage; selective collection; solid waste, among others (56 indicators).

d) Institutional variables: voters, banking institutions, social security and legislative indicator; planning; transparency; quality of management; municipal expenses, tax revenue, fiscal result, indebtedness, ability to save, investments, among others (57 indicators).

Data survey was carried out through search at the city halls, IBGE, SEADE Foundation, STN, TCE-SP, regulatory agencies, institutes, etc.

In data processing, Excel (electronic spreadsheets) was used for formatting information, in the process for elaboration and assessment of IDS based on the levels of development sustainability, considering international criteria for the selection of indicators and the specificities of the local/ regional development focus.

For Martins and Cândido (2008), considering each of the selected indicators, the following characteristics deserved attention: a) is significant for the reality investigated and for the focus of the study; b) is relevant to decisions that guide public policies; c) reflects temporal changes; d) allows an integrated and systemic approach; e) uses measurable variables; f) is easy to interpret and communicate and; g) has a well-defined, transparent and objective methodology for the purposes of the investigation.

Adapted by Souza *et al*., (2020), the steps for determining and evaluating the IDS correspond to: (i) the construction of a database (system of indicators) for sustainable development issues, selecting themes within the environmental, social, economic and institutional dimensions; (ii) the normalization of variables to make them comparable and capable of being aggregated into a synthetic indicator in each of the dimensions; (iii) the calculation of a development index for each pillar - in the economic dimension, the Economic Development Index-IDE was constructed; in the social dimension, the Social Development Index-ISD was elaborated, in the environmental dimension, we have the Environmental Development Index-IDA; finally, in the institutional dimension, the formulation of the Institutional Development Index-IDI; (iv) the calculation of the arithmetic mean of the indexes - IDE, ISD, IDA and IDI - for final determination of the IDS; (v) the results obtained by municipality, and classified to create an IDS ranking for assessment and analysis of the level of sustainability of development.

Normalization is necessary before any data aggregation, as indicators in a data set often have different units of measurement (OECD, 2008). There are several normalization methods (Freudenberg, 2003; Jacobs *et al*., 2004).

According to the method suggested by Sepúlveda (2005), as soon as the first stage of indicator selection was carried out, the selected variables were normalized, with the transformation of indicators into indices. This allowed the comparability of variables from different units, in addition to normalizing the data into a number that varies from 0 to 1, so that the closer the number is to 1, the more favorable the municipality's situation regarding sustainability of development.

As proposed by Sepúlveda (2005), the IDS can be calculated by the weighted mean of the indexes for each dimension, obtained by the weighted mean of the variables considered (transformed into indices to allow aggregation). However, if the variables have the same weight in each dimension, and all dimensions have the same weight in the composition of the IDS, the weighted mean is the same as the arithmetic mean.

Therefore, based on Waquil *et al*. (2010), as there are no clear arguments for assigning different weights in the present operation, equal weights were applied to all variables, so as not to generate any bias in the final calculation. Thus, the IDS was calculated by the simple arithmetic mean of the four dimensions investigated and all the variables that compose them.

From this perspective, it was also necessary to consider that there are positively correlated indicators and others negatively correlated, i.e. the so-called polarity. In an aggregation, all indexes must point to a positive relationship to be able to be aggregated and thus generate a synthetic indicator. Synthetic or composite indices are indexes with different compositions (e.g. health, education, environment, safety, among others) in a single indicator (Moraes *et al*., 2016).

In the normalization procedure, if the indicator has a positive or negative influence (polarity) on the dimension, it must be analyzed separately according to equations (1) and (2), respectively. Theoretically, for a positive indicator, in (1), the maximum observed value will have a value of 1 as a score, that is, the higher the indicator, the better the index will be; and the lower the indicator, the worse the index will be (minimum value zero). As for the negative indicator, in (2), the higher the

indicator, the worse the index will be (minimum value zero); and the lower the indicator, the better the index will be (maximum value 1), according to the following formulas:

$$I_{(+)} = \frac{x - \text{mín}}{\text{máx} - \text{mín}} \qquad (1)$$

$$I_{(-)} = \frac{\text{máx} - x}{\text{máx} - \text{mín}} \qquad (2)$$

Where:

$I_{(.)}$ = normalized index, calculated for each municipality; x = value observed in each municipality; min = minimum value of the indicator for all municipalities; max = maximum value of the indicator for all municipalities.

The minimum and maximum values of each indicator analyzed were assigned according to each selected indicator, regardless of its measurement unit. Thus, it was possible to normalize data to a comparable basis.

In short, sustainability is measured through development indices that summarize a set of indicators that involve the four dimensions of sustainable development. Therefore, in accordance with the proposed method, the IDS is calculated by the simple arithmetic mean of the development indices, according to the following equation:

$$IDS = \frac{IDE + ISD + IDA + IDI}{4}$$

In terms of sustainability assessment, for each index generated in the four dimensions, a classification by levels (steps) that underlie its state of the art is proposed, as shown in Figure 4 below.

Figure 4 | Degrees of sustainability
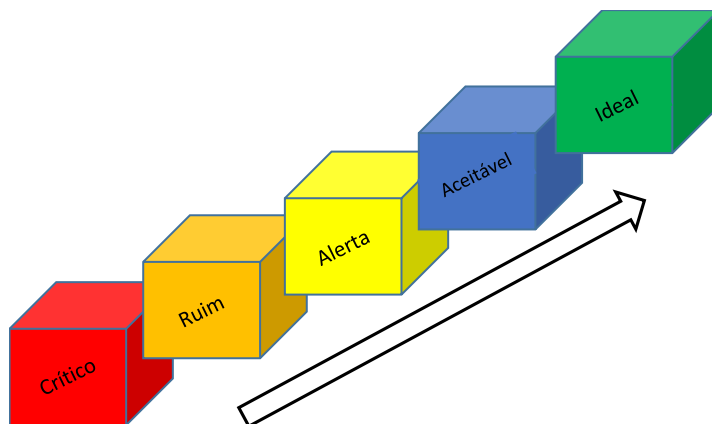
Source: Souza *et al*. (2020).

Based on the results obtained by municipality, an IDS ranking was created to evaluate and analyze the level of development sustainability. So, the assessment model has five intervals of 0.2 tenths each, in which the levels (steps) of sustainability can be distributed in a decreasing manner, starting with the best level, the "ideal", then the "acceptable" situation, of "alert" or "attention", "bad" and, finally, the lowest grade, called "critical" (Souza *et al*., 2020). The levels of development sustainability are represented in Table 1.

Table 1 | Classification of the level of sustainability of development

index (1 – 0)	Level
1.0000 – 0.8001	Ideal
0.8000 – 0.6001	Acceptable
0.6000 – 0.4001	Alert
0.4000 – 0.2001	Bad
0.2000 – 0.0000	Critical

Source: Souza *et al*. (2020).

RESULTS OBTAINED

In line with the general objective of this study, which was to find evidence on the sustainability of municipalities in the RMC through the construction and evaluation of the Sustainable Development Index (IDS), a system of 209 indicators was used (sum of all dimensions), with a high degree of relevance, for each municipality in the region, thus totaling 4,180 municipalized data (Table 2). It should be noted that, for comparison purposes, the SDGs (UN Agenda 2030) have 231 indicators and the IDS (IBGE) encompasses 132 indicators.

Table 2 | Number of indicators and data per dimension

RMC - Região Metropolitana de Campinas	IDE - Índice de Desenvolvimento Econômico	ISD - Índice Social de Desenvolvimento	IDA - Índice de Desenvolvimento Ambiental	IDI - Índice de Desenvolvimento Institucional	IDS - ÍNDICE DE DESENVOLVIMENTO SUSTENTÁVEL
Nº INDICADORES	34	62	56	57	209
Nº MUNICÍPIOS	20	20	20	20	20
Nº DADOS	680	1.240	1.120	1.140	4.180

Source: Elaborated by the Authors.

The general panel (Table 3) reports the indices obtained by municipality and by dimension, classified by level of sustainability. In this global view, records of municipalities at "ideal" and "critical" levels are not observed in the set of dimensions.

Table 3 | General panel of indexes by dimension and final IDS

Nº	RMC - Região Metropolitana de Campinas	IDE - Índice de Desenvolvimento Econômico	ISD - Índice Social de Desenvolvimento	IDA - Índice de Desenvolvimento Ambiental	IDI - Índice de Desenvolvimento Institucional	IDS - ÍNDICE DE DESENVOLVIMENTO SUSTENTÁVEL
1	AMERICANA	0,4518	0,5833	0,6253	0,3573	0,5044
2	ARTUR NOGUEIRA	0,4151	0,4251	0,5751	0,3420	0,4393
3	CAMPINAS	0,6220	0,6671	0,6071	0,3970	0,5733
4	COSMÓPOLIS	0,3680	0,4354	0,6053	0,2477	0,4141
5	ENGENHEIRO COELHO	0,3490	0,3075	0,6602	0,3532	0,4175
6	HOLAMBRA	0,3924	0,5053	0,6058	0,5539	0,5143
7	HORTOLÂNDIA	0,4029	0,4549	0,7320	0,3925	0,4956
8	INDAIATUBA	0,5025	0,5795	0,6457	0,5139	0,5604
9	ITATIBA	0,4437	0,4987	0,6624	0,3538	0,4896
10	JAGUARIÚNA	0,4566	0,5788	0,6059	0,4908	0,5330
11	MONTE MOR	0,3525	0,3553	0,5851	0,3600	0,4132
12	MORUNGABA	0,3493	0,3591	0,6817	0,3822	0,4431
13	NOVA ODESSA	0,4274	0,5234	0,6346	0,3712	0,4892
14	PAULÍNIA	0,5413	0,5275	0,6905	0,5998	0,5898
15	PEDREIRA	0,3697	0,4893	0,6826	0,3801	0,4804
16	SANTA BARBARA D´OESTE	0,4560	0,4889	0,6103	0,3165	0,4680
17	SANTO ANTÔNIO DE POSSE	0,4159	0,2872	0,5776	0,4588	0,4349
18	SUMARÉ	0,4222	0,4208	0,5766	0,2819	0,4254
19	VALINHOS	0,4334	0,5944	0,6565	0,3970	0,5203
20	VINHEDO	0,4358	0,6148	0,6345	0,4645	0,5374

Source: Elaborated by the Author.

Table 4 presents the average indices obtained in each dimension. It can be seen that the average IDA stands out compared to others and reaches an "acceptable" level in environmental sustainability. The other indices are in an "alert" status, showing that the average IDA is close to a "bad" level.

Table 4 | Average development index by dimension

RMC - Região Metropolitana de Campinas	IDE - Índice de Desenvolvimento Econômico	ISD - Índice Social de Desenvolvimento	IDA - Índice de Desenvolvimento Ambiental	IDI - Índice de Desenvolvimento Institucional
MÉDIA DA DIMENSÃO	0,4304	0,4848	0,6327	0,4007

Source: Elaborated by the Authors.

In the end, the twenty municipalities in the RMC were ranked in descending order of the IDS and classified according to the sustainability of development, as shown in Table 5, below.

Table 5 | Final ranking of the municipalities based on IDS

RMC - Região Metropolitana de Campinas	IDS - Índice de Desenvolvimento Sustentável	Ranking
PAULÍNIA	0,5898	1º
CAMPINAS	0,5733	2º
INDAIATUBA	0,5604	3º
VINHEDO	0,5374	4º
JAGUARIÚNA	0,5330	5º
VALINHOS	0,5203	6º
HOLAMBRA	0,5143	7º
AMERICANA	0,5044	8º
HORTOLÂNDIA	0,4956	9º
ITATIBA	0,4896	10º
NOVA ODESSA	0,4892	11º
PEDREIRA	0,4804	12º
SANTA BARBARA D´OESTE	0,4680	13º
MORUNGABA	0,4431	14º
ARTUR NOGUEIRA	0,4393	15º
SANTO ANTÔNIO DE POSSE	0,4349	16º
SUMARÉ	0,4254	17º
ENGENHEIRO COELHO	0,4175	18º
COSMÓPOLIS	0,4141	19º
MONTE MOR	0,4132	20º
Média final	0,4872	-

Source: Elaborated by the Authors.

The final mean obtained was an index of 0.4872, which indicates "alert" level in the sustainability of development for the RMC. The values of the minimum and maximum IDS varied within a range of around 42.74%, which demonstrates the wide range of local realities.

Calculation of the IDS showed that no municipality reached the "ideal" and "acceptable" levels, with all municipalities in an "alert" situation in terms of development sustainability, as shown in Table 5. It should be noted that Paulínia (0.5898), Campinas (0.5733) and Indaiatuba (0.5604) were the best ranked municipalities and close to an "acceptable" situation; on the other hand, the municipalities of Monte Mor (0.4132), Cosmópolis (0.4141) and Engenheiro Coelho (0.4175) are closer to a "bad" situation.

FINAL CONSIDERATIONS

A specific analysis of the IDS reveals the fragility in the Metropolitan Region of Campinas. All municipalities reached an "alert" level in development sustainability for a set of 209 selected indicators.

In other words, the research points to a state of vulnerability in the RMC, despite holding 8.75% of the state's GDP and comprising a modern and diversified industrial park, with a specialized agro-industrial structure, in addition to being a remarkable consumer and university center in Brazil. However, the region has peculiarities and different realities that determine a high disparity between the municipalities surveyed, especially when assessed in each of the four dimensions (economic, social, environmental and institutional).

Most likely, the lack of research in the RMC on the construction of development indices that are appropriate for carrying out measurements justifies the municipalities' non-compliance with economic, social, environmental and institutional realities. Likewise, understanding this reality through the IDS allows the elaboration of public policies that promote sustainable development and, consequently, the management of risks and the mitigation of any aspect that interferes with the well-being of the population and the development of future generations.

The intense fight against corruption is very noticeable, as this is in fact an evil to be overcome with vehemence and obstinacy. However, there is another evil, as pernicious as corruption, which has been draining public resources and hence taking money away from those sectors that really matter to society – education, health, security and infrastructure. We are referring to poor public management, which is not even linked to corruption, but is closely related to incompetence and neglect. To put it another way, a lot is spent and it is spent badly, especially because the lack of measurements prevents the understanding of reality and the implementation of strategic planning to transform this reality efficiently.

It can be said that lack of planning is one of the most serious problems when it comes to wasting public resources in the country. Mismanagement often causes irreversible damage to the budgetary-financial plan, in terms of the amount of financial resources lost, which is even greater than corruption.

Finally, the proposal for a Sustainable Development Index (IDS) aims to allow additional conditions for public managers to propose and promote preventive and corrective actions, in the short/medium/long term, mainly concerning indicators that require special attention, to leverage municipal (and metropolitan) performance in order to achieve ideal levels of development sustainability. The research also encourages managers to create an information database (panel of indexes and indicators/observatory/situation room) for monitoring, evaluating and formulating effective public policies that could bring immediate benefits to the citizens.

This research is a sort of starting point, an unprecedented study for the RMC, a local/regional diagnosis, with direct notes on municipal strengths and weaknesses. The next step would be to raise awareness among municipal public managers, through effective actions to promote sustainable development, taking into account the level of sustainability of development and the positioning (as a result of comparability) of the municipalities that participated in the research.

Initiatives such as enhancing the cooperation strategy and coordination of social actors in a network structure that integrates projects and allows the sharing of knowledge, using the current bases of the Campinas Metropolitan Agency (AGEMCAMP). Another key aspect would be the implementation of a customized local observatory guided by regional objectives. Regional action through Intermunicipal Consortia is another important strategy aimed at facilitating the implementation of development strategies more adapted to local needs, which could result in more effective and inclusive solutions, contributing to sustainable development at a regional level.

This study is characterized as a historic landmark for the municipalities of the RMC, both for its originality and for ensuring strategic information amidst the countless debates regarding sustainable development. It certainly provides the best conditions to hit the target more quickly, avoiding wasted time and money. The key issue is to enable further research on this subject, and this can be done through an agreement between the academic environment, the municipalities, or the State, so that it is not forgotten and becomes an important tool that allows us to leave a better world for the next generations.

ACKNOWLEDGMENTS

REFERENCES

ABRAMOVAY, R. **Muito além da economia verde**. São Paulo: Ed. Abril, 2012, 248 p.

BELLEN, H. M. van. **Indicadores de sustentabilidade: uma análise comparativa**, 2 ed., São Paulo-SP: Editora FGV, 2006, p. 41-62.

BOFF, L. **Sustentabilidade: o que é – o que não é**. 5 ed. Revista e ampliada, Petrópolis, RJ: Vozes, 2016, p. 17.

BOSSEL, H. **Indicators for Sustainable Development: Theory, Method, Applications: A report to the Balaton Group.** Winnipeg: IISD, 1999.

BOULANGER, P. M., **Indicadores de desenvolvimento sustentável: um desafio científico, uma questão democrática.** SAPIEN.S [Online], 1.1 | 2008, on-line desde 23 de dezembro de 2008, conexão em 24 de abril de 2020. URL: http://journals.openedition.org/sapiens/166.

DOWBOR, L. **O que é poder local**. São Paulo: Brasiliense, 1999.

EMPLASA – Empresa Paulista de Planejamento Metropolitano S/A. **Pesquisa 2019**. Disponível em: <https://emplasa. sp.gov.br/RMC>. Acesso em: agosto, 2019.

FILIPPIM, E. S.; ROSSETTO, C. R.; HERMES, F. M. F. A gestão do desenvolvimento regional: análise de uma experiência no Meio-Oeste catarinense. EBAPE.BR 3 (2), Jul 2005 - https://doi.org/10.1590/S1679-39512005000200002

FREUDENBERG, M. **Composite indicators of country performance: a critical assessment.** OECD, Paris, 2003.

GALLOPIN, G. C. **Environmental and sustainability indicators and the concept of situational indicators.** A system approach. Environmental Modelling & Assessment, n. 1, p. 101-117, 1996.

HARDI, P.; BARG, S. **Measuring sustainable development: review of current practice**. Winnipeg: IIDA, 1997.

HAMMOND, A., *et al*. **Environmental indicators: a systematic approach to measuring and reporting on environmental policy performance in the context of sustainable development.** Washington, D.C.: World Resources Institute, 1995.

HOLLING, C. S. (Ed.) **Adaptive environmental assessment and management.** Chichester: John Wiley & Sons Ltd., 1978.

IBGE - Instituto Brasileiro de Geografia e Estatística. **Indicadores de Desenvolvimento Sustentável: Brasil 2017**. Rio de Janeiro: IBGE, 2017.

IBGE - Instituto Brasileiro de Geografia e Estatística. **Pesquisa 2019**. Disponível em: <https://www.ibge.gov.br/ estatisticas/economicas/contas-nacionais/>. Acesso em: agosto, 2019.

JACOBS, R.; SMITH, P.; GODDARD, M. **Measuring performance: an examination of composite performance indicators.** Center for Health Economics, Technical Paper Series 29, 2004.

KHANNA, N. **Measuring environmental quality: an index of pollution**. *Ecological Economics*, v. 35, n. 2, nov. 2000, p. 191-202.

MACEDO, L. O. B; CÂNDIDO, G. A.; COSTA, C. G. A.; SILVA, J. V. F. **Avaliação da sustentabilidade dos municípios do estado de Mato Grosso mediante o emprego do IDSM – índice de desenvolvimento sustentável para municípios.** Revista Brasileira de Gestão e Desenvolvimento Regional, v. 12, n. 03, p. 333-335, 2016, Taubaté-SP. ISSN 1809-239X.

MARTINS, M.F.; CÂNDIDO, G. A. **Índice de Desenvolvimento Sustentável para Municípios (IDSM): metodologia para análise e cálculo do IDSM e classificação dos níveis de sustentabilidade – uma aplicação no Estado da Paraíba**. João Pessoa-PB: SEBRAE, 2008.

MOLDAN, B.; BILHARDZ, S. (Eds.). **Sustainability indicators: report of the project on indicators of sustainable development.** Chichester: John Wiley & Sons Ltd., 1997.

MONTIBELLER, G. **O mito do desenvolvimento sustentável**. Florianópolis: UFSC, 2001.

MORAES, D. E. *et al*. **Indicadores Sintéticos de Qualidade de Vida e o Conceito de Natureza/Ambiente.** Caminhos de Geografia Uberlândia v. 17, n. 58, p. 123–135 Página 1, Junho/2016.

NOURRY, M. **Measuring sustainable development: some empirical evidence for France from eight / alternative indicators.** Ecological Economics, v. 67, n. 3, p. 441-456, 2008. Disponível em: <http://www.sciencedirect.com/science/journal/09218009/77/supp/C>.

OECD - Organization for Economic Cooperation and Development. **Handbook on Constructing Composite Indicators: Methodology and user guide.** OECD, 2008. ISBN 978-92-64-04345-9.

ONU - Organização das Nações Unidas. **Indicators of Sustainable Development: Framework and Methodologies**. New York: NU, 2001.

PINTÉRD, L; HARDIB, P.; MARTINUZZIC, A.; BELLAGIO, J. H. STAMP: **Principles for sustainability assessment and measurement. Ecological Indicators**, n. 17, 2012, p. 20-28.

RANDOLPH, R. **Políticas Públicas e Desenvolvimento Regional: Desafios e Potencialidades no Brasil**. G&DR • v. 14, n. 3, p. 426-445, mai-ago/2018, Taubaté, SP, Brasil.

SACHS, I. **Ecodesenvolvimento: crescimento sem destruir**. São Paulo: Vértice, 1986.

SACHS, I. **Em busca de novas estratégias de desenvolvimento**. Estudos Avançados, v. 9 n. 25, 1994.

SANTANA, A. S.; BARRETO, R. C. S. **Qualidade institucional e desempenho econômico: análise empírica dos municípios brasileiros, 2010**. Revista Brasileira de Estudos Regionais e Urbanos, v. 10, n. 2, p. 253-271, 2016.

SBPC - Sociedade Brasileira de Economia Ecológica (EcoEco). **MC-28: Bioeconomia: Ferramentas para o Desenvolvimento Sustentável**. Minicurso, 71ª Reunião Anual da SBPC, Campo Grande-MS, 22-25.7.2019.

SEADE - Fundação Sistema Estadual de Análise de Dados. **Pesquisa 2019**. Disponível em:<http://www.seade.gov.br/>. Acesso em agosto, 2019.

SEBRAE - Serviço Brasileiro de Apoio às Micro e Pequenas Empresas/SC; IEL - Instituto Euvaldo Lodi/SC. **Revista Programa Catarinense de Desenvolvimento Regional e Setorial.** Florianópolis, 2003.

SEPÚLVEDA, S. **Desenvolvimento Microrregional Sustentável: métodos para planejamento local**. Tradução de Dalton Guimarães. Brasília: IICA. 2005, 296 p.

SIEDENBERG, D. R. **Indicadores de desenvolvimento socioeconômico: uma síntese. Desenvolvimento em Questão.** Ano 1, n. 1, p. 45-71, jan./jun. 2003.

SINBIOTA - Sistema de Informação Ambiental do Programa Biota/Fapesp. **Pesquisa 2019**. Disponível em: <http://sinbiota.biota.org.br/>. Acesso em: agosto, 2019.

SOUZA, C. F. C.; MASTRODI, J; LONGO, R. M. **Estudo Bibliométrico sobre Índice de Desenvolvimento Sustentável Municipal (IDSM), disponibilizados no Portal de Periódicos CAPES**. Meio Ambiente e Desenvolvimento Sustentável [recurso eletrônico] / Organizadoras Juliana Thaisa Rodrigues Pacheco, Juliana Yuri Kawanishi, Rafaelly do Nascimento. – Ponta Grossa, PR: Atena Editora, 2019, v.1.

SOUZA, C. F. C.; MASTRODI, J; SOUZA, C. C., FRAINER, D. M. **Índice de Desenvolvimento Econômico (IDE): cálculo para municípios da região metropolitana de Campinas/SP.** In: Anais do I SUSTENTARE - Seminários de Sustentabilidade. Anais… Campinas, SP, Brasil. PUC-Campinas, 2019. ISBN: 978-65-86687-00-2

SOUZA, C. F. C.; MASTRODI NETO, J; SOUZA, C. C., FRAINER, D. M. **Índice Social de Desenvolvimento (ISD): cálculo para municípios da região Metropolitana de Campinas/SP.** Revista Ibero-Americana de Ciências Ambientais, v.11, n.1, p.445-459, 2020. DOI: http://doi.org/10.6008/CBPC2179-6858.2020.001.0039

SOUZA, C. F. C.; MASTRODI NETO, J; SOUZA, C. C., FRAINER, D. M. **Índice de Desenvolvimento Econômico (IDE): cálculo para municípios da região Metropolitana de Campinas/SP.** Revista Brasileira de Gestão e Desenvolvimento Regional, G&DR. V. 16, N. 3, P. 17-30, set-dez/2020. Taubaté, SP, Brasil. ISSN: 1809-239X.

SOUZA, C. F. C.; MASTRODI NETO, J; SOUZA, C. C.; FRAINER, D. M.; IANO, Y.; REIS, V. S. **Índice de Desenvolvimento Institucional (IDI): cálculo para municípios da região metropolitana de Campinas, SP**. In: Anais do II SUSTENTARE e V WIPIS - Workshop Internacional sobre Sustentabilidade, Indicadores e Gestão de Recursos Hídricos. Anais...Campinas, SP, Brasil. PUC-Campinas/EESC-USP, 2020. ISBN: 978-65-5941-063-7.

SOUZA, C. F. C.; MASTRODI NETO, J; SOUZA, C. C.; FRAINER, D. M.; IANO, Y.; REIS, V. S.; SOUZA, S. L. M. C.; SOUZA, M. E. M. C.; SOUZA, E. F. M. C.; SOUZA, J. M. C.; ALVES, M. C.; PAIVA, A. L. G.; FERNADES. M. A. R. **Environmental Development Index (IDA): Calculation for Municipalities in the Metropolitan Region of Campinas – SP**. Journal of Agricultural Sciences Research. ISSN 2764-0973 - DOI 10.22533/at.ed.973312230408, v. 3, n. 12, 2023.

TCESP – Tribunal de Contas do Estado de São Paulo. **Índice de Efetividade de Gestão Municipal (IEGM): Manual 2019**. TCESP, dezembro de 2018.

WAQUIL, P.; SCHNEIDER, S.; FILIPPI, E.; RÜCKERT, A.; RAMBO, A.; RADOMSKY, G; CONTERATO, M.; SPECHT, S. **Avaliação de desenvolvimento territorial em quatro territórios rurais no Brasil.** Redes, v. 15, n. 1, 2010, p. 104-127.

Acesso em Sites:

Site:<https://nacoesunidas.org/pos2015/agenda2030/>. Acesso em Agosto, 2019.

Site:<https://sidra.ibge.gov.br/pesquisa/ids/tabelas>. Acesso em Agosto, 2019.

Site:<https://cidades.ibge.gov.br/brasil/panorama>. Acesso em: Agosto, 2019.

Site:<https://meumunicipio.org.br/>. Acesso em: Agosto, 2019.

Site:<http://www.agemcamp.sp.gov.br/investimento/>. Acesso em: Agosto, 2019.

Site:<https://www.infopedia.pt/dicionarios/lingua-portuguesa/indicador>. Acesso em: Janeiro, 2020.

Site:<https://www.infopedia.pt/dicionarios/lingua-portuguesa/indice>. Acesso em: Janeiro, 2020.

Site:< https://www.significadosbr.com.br/>. Acesso em: Janeiro, 2020.

Site:< https://www.dicio.com.br/>. Acesso em: Janeiro, 2020.>. Acesso em: Janeiro, 2020.

Site:<https://www.senado.leg.br/atividade/const/con1988/con1988_26.06.2019/art_174_.asp>. Acesso em: Janeiro, 2020.

Site:<http://www.tesouro.fazenda.gov.br/-/infracoes-da-lei-de-responsabilidade-fiscal-e-suas-penalidades>.Acesso

em: Janeiro, 2020.

Site:< https://www12.senado.leg.br/noticias/entenda-o-assunto/lrf>. Acesso em: Janeiro, 2020.

Site:<https://nacoesunidas.org/pnud-explica-transicao-dos-objetivos-do-milenio-aos-objetivos-de-desenvolvimento-sustentavel/>. Acesso em: Abril, 2020.

Site:< https://www.br.undp.org/content/brazil/pt/home/post-2015.html>. Acesso em: Abril, 2020.