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# URBAN SUSTAINABILITY ASSESSMENT METHODOLOGIES: A COMPARATIVE ANALYSIS

*Metodologias de avaliação da sustentabilidade urbana: uma análise comparativa*

*Metodologías de evaluación de la sostenibilidad urbana: un análisis comparative*

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## ABSTRACT

This study aims to comparatively analyze the main urban sustainability assessment methodologies available for use at a global, national, regional, and local levels, offering subsidies in order that municipal managers be able to choose the most appropriate tool for the situation of the municipality to which they are linked. The methodological procedure is qualitative, exploratory, descriptive, and explanatory. It was carried out a bibliographic and documental survey through which main methodologies for assessing urban sustainability currently available were listed and presented. The existence of eight available and more relevant instruments for measuring urban sustainability was verified. Furthermore, it was also observed that the differences among these tools are significant, as well as that the character of the data survey (qualitative or quantitative), the themes or indicators contemplated, and the scope of these tools may vary.

**Palavras-chave:** Sustainable development; Public policy; Municipal Management.

**RESUMO**

O objetivo deste estudo é analisar comparativamente as principais metodologias de avaliação da sustentabilidade urbana disponíveis para a utilização em âmbitos global, nacional, regional e local, oferecendo subsídios para que os gestores municipais possam escolher a ferramenta mais adequada para a situação do município ao qual estão vinculados. O procedimento metodológico é qualitativo, de caráter exploratório, descritivo e explicativo. Realizou-se um levantamento bibliográfico e documental por meio dos quais foram listadas e apresentadas as principais metodologias de avaliação da sustentabilidade urbana disponíveis atualmente. Verificou-se a existência de oito instrumentos de mensuração da sustentabilidade urbana mais relevantes e disponíveis. Ademais, observou-se que as diferenças entre essas ferramentas são significativas, podendo variar o caráter dos dados levantados (qualitativo ou quantitativo), os temas ou indicadores contemplados e a abrangência dessas ferramentas.

**Keywords:** Desenvolvimento sustentável; Gestão Municipal; Políticas públicas.

**RESUMEN**

El objetivo de este estudio es analizar comparativamente las principales metodologías de evaluación de la sostenibilidad urbana disponibles para su uso a nivel mundial, nacional, regional y local, ofreciendo subvenciones para que los gestores municipales puedan elegir la herramienta más adecuada a la situación de la población. municipio cuando están vinculados. El procedimiento metodológico es cualitativo, exploratorio, descriptivo y explicativo. Se realizó un levantamiento bibliográfico y documental a través del cual se enumeraron y presentaron las principales metodologías de evaluación de la sostenibilidad urbana disponibles actualmente. Se verificó la existencia de los siete instrumentos más relevantes y disponibles para medir la sostenibilidad urbana. Además, se observó que las diferencias entre estas herramientas son significativas, pudiendo variar el carácter de los datos recopilados (cualitativos o cuantitativos), los temas o indicadores contemplados y el alcance de estas herramientas.

**Palabras clave:** Desarrollo sostenible; Políticas públicas; Gerencia Municipal.

## 1 INTRODUCTION

The quest for sustainability is one of the greatest challenges faced by contemporary society. The proposal for sustainable development that emerged in 1987 with the Brundtland Report has led to significant mobilization of governments through global, regional, and local agreements and agendas in support of this matter (CÂMARA, 2013). From this perspective, the constant pursuit to establish a relationship based on sustainability between society, economy, and environment through the implementation of public policies, especially in Brazil's large urban centers, is a reflection of this global scenario. Nevertheless, questions are raised about how to measure the progress generated by these legal instruments.

The Brundtland Report was requested by the United Nations (UN) searching to better define the relationship between environment and development, as well as to understand the global challenges related to it. This document established the term "sustainable development": a new growth model for countries, with a different approach to environmental

issues. The term then gained prominence at national and international levels through the United Nations Conference on Environment and Development (UNCED), known as Eco-92, held in Rio de Janeiro (Pereira; Curi, 2012).

Motivated by an international situation based on the alleged globalization phenomenon, several countries, including Brazil, signed agreements and planned national agendas in order to establish and implement robust public policies and environmental legislation, aiming for a sustainable growth wherever possible. These legal instruments seek to minimize, at best, the damage caused to the environment and align government actions with the current discourse on a world stage. Following the global trend, Brazilian states and municipalities have also established public policies in regional and urban agendas in favor of sustainability.

In addition, in large urban centers, due to a higher population rate and disordered urbanization, these socio-environmental problems are accentuated, becoming a relevant concern for municipal public governance. According to Figueiredo (2017), disordered urban growth is now a global problem, thus performance evaluation, through sustainable urban development certification instruments, has emerged as a decision-making tool for municipal managers.

Given the above, there is an emerging need to evaluate the performance of the decisions made by public authorities by using methodologies that make it possible to monitor public policies, especially through the use of sustainability indicators in urban centers. These tools are intended to verify the effectiveness of plans, programs, and projects developed at local level in varied areas of sustainable development.

Therefore, considering that public policies are relevant government instruments for promoting more sustainable development, and given that methodologies for evaluating actions implemented by public governance are essential for preserving both environment and quality of life in urban centers, the following questions arise: what are the main methodologies available for measuring urban sustainability? What are the similarities and differences between these instruments?

In order to answer these questions, the general aim of this study is to present the main methodologies available for assessing urban sustainability and describe the main characteristics of each instrument found, such as: qualitative or quantitative nature, indicators, scope, and the cities in which these tools have already been applied.

In addition to this introduction, the article is structured in four more sections. The second section, dedicated to the literature review, presents relevant concepts for

contextualizing the subject of this study, such as: urban sustainability, methodologies for measuring it, and public policies. The third section describes the methodology used in the research, while the fourth section presents and discusses the results of the work. Finally, the fifth section contains the final considerations.

## 2 LITERATURE REVIEW

According to the UN-Habitat report (2016), written at the Third United Nations Conference on Housing and Sustainable Urban Development, it is expected that, by the year 2050, the world's urban population continues to grow exponentially. Along the same lines, according to the document Revision of World Urbanization Prospects, published in 2018 by the UN (United Nations), by 2050, around 68% of humans will live in cities, which means an increase of 13%, representing around 2.5 billion more people living in urban areas (ONUBR, 2018).

This global scenario is no different from the outlook for Brazil. The process of urban expansion in this country intensified in the 20th century, especially since World War II. This expansion has been disorganized over time, especially in large and medium-sized cities (Guerra; Lopes, 2015). In the current decade, around 84% of Brazilians, approximately 190 million inhabitants, live in urban centers (IBGE, 2012), with São Paulo, Rio de Janeiro, Salvador, Brasília, Fortaleza, Belo Horizonte, Manaus, Curitiba, Recife, and Porto Alegre being the ten biggest cities in the country (IBGE, 2012).

Given the above, it is understood that the growth of Brazilian cities has been happening not only at an accelerated rate, but also in an unplanned way over the last few decades, a fact that has resulted in both significant environmental degradation and increase in social inequality in urban centers. This scenario creates obstacles to achieving sustainability, in terms of making resources such as housing, infrastructure, health, education, employment, and security available to all (UN-HABITAT, 2016).

Furthermore, maintaining environmental sustainability also faces challenges in urban settlements due to the large number of activities carried out in these places, which, unless managed correctly, also promotes environmental degradation. On this subject, the OECD (2010) says that human settlements have caused the most diverse environmental impacts. The effects are reflected in climate change itself, through the direct and indirect emission of greenhouse gas, whether through large circulation of vehicles, urbanization process, or removal of vegetation cover to build homes.

The 21st century is considered to be the century of cities, and consequently, the great challenge regarding these places is to outline sustainable development (Leite, 2012). Currently, two-thirds of the world's energy consumption comes from urban areas, 75% of the waste is produced there, and it is also in cities that the problem of depleted water resources and excessive consumption of drinking water is found. Sustainable development is forcing cities to intelligently and inclusively reinvent themselves, meeting the social, environmental, political, cultural, economic, and physical objectives required to maintain a quality of life for both population and environment (Leite, 2012).

The scale and speed of the urbanization process are detrimental, since this process is carried out in a disorderly manner. According to Grostein (2001), during the growth of cities, some important variables were overlooked, such as the way the territory was occupied, availability of inputs for its operation (i.e. water), correct destination and treatment of solid and liquid waste, quality of the population's mobility within the urban space, meeting housing needs, availability of social facilities and services, and quality of public spaces.

According to Rogers and Hall (2015), as well as representing the cradle of civilizations, cities also drive human cultural development and, although sometimes it is a place that challenges the realization of a good life, they are also sources of inspiration. Therefore, it is understandable that it is in cities that sustainable development should be treated as emerging, given that these places consume the greatest resources on the planet and, likewise, produce the greatest amounts of waste. However, although it is in urban centers that major challenges are concentrated, it is also them - centers that produce culture, politics, leadership, and economic growth - that lead the way in terms of their ability to better tackle these issues, when compared to rural areas (Leite, 2012).

Ahvenniemi et al. (2017) point out that today's cities are increasingly concerned with sustainability issues, as they are progressively looking for options to preserve economic and natural resources. Thus, in recent decades, what has been observed in urban centers is a greater interest in the sustainable management of these spaces, which can be explained by an awareness of the population in general due to the strong influence of international agendas, such as Agenda 30, which contains a specific objective on urban settlements, and SDG 11, namely to make cities and human settlements inclusive, safe, resilient and sustainable.

Rossetto (2003) points out that, as Brazilian urbanization has been characterized by an accelerated and unplanned process, management actions were usually only corrective in nature, aiming to solve the economic and social problems already established as a result

of local, regional, and national urban policies, without addressing the dimensions of sustainable urban development in any depth. However, the duality between the paradigm of growth and sustainability has turned the management of these spaces into a very arduous task (Rossetto, 2003).

Merico (2001) asserts that municipalities have restricted legislative competence in the environmental area, since they can only develop laws relating to local issues. In contrast, this does not apply to material or administrative competence, also known as executive or implementing competence. Nevertheless, Article 23 of the Federal Constitution is clear in attributing common competence to the federated entities to protect the environment, as well as to combat all forms of pollution, in addition to preserving the country's forests, flora, and fauna (BRASIL, 1988).

Souza et al. (2009) explain that one of Brazil's characteristics is the constitutional distribution of competencies, which ensures the autonomy of the federated entities and the balance of the federation itself. The 1988 Federal Constitution determined the distribution of powers based on the alleged “principle of predominance of interest”. Fiorillo (2001), when addressing this issue, states that the Magna Carta highlighted the role of the Municipality, particularly concerning Brazilian environmental law, since it is based on this that individuals can exercise their rights and use the alleged environmental goods.

The first step towards overcoming the current ecological crisis and building a balanced relationship with nature, especially in cities, is recognizing that current economic and social policies no longer respond to the challenges they are facing (Merico, 2001). Merico (2001) points out that there are at least three premises for building sustainable public policies: intra-generational equity, i.e. reducing the exacerbated social inequality evidenced especially in large urban centers; inter-generational equity, which is concern to ensure that future generations have the capacity to meet their needs; and the acceptance of irreversibilities and uncertainties, the conformation that there is no fully understanding regarding the complex natural behavior, thus the environment has to be taken into account during the decisions-making process, in order to avoid serious damages.

Thus, strengthening municipal management processes is necessary and can be of great help in rescuing and maintaining a sustainable lifestyle in the urban environment, i.e. preserving the conditions of sustainability concomitantly with local development (Guerra; Lopes, 2015). As complex systems, cities face sustainability challenges and threats, as well as the need to find effective solutions to these issues through transportation, water, energy, and communication systems, thus becoming smarter (Dirks; Keeling, 2009).

As a result of these issues, cities around the world, including those in Brazil, have been developing policies and implementing innovative actions to improve urban services for citizens, while taking into account environmental preservation for future generations (BACHENDORF, 2018). As Nam and Pardo (2011) point out, in the face of accelerated urbanization, in order to avoid a crisis, cities need to be managed in an innovative way.

It is important to note that both planning and implementation of sustainable urban development policies require innovative models from the collaboration between government and society. Moreover, it involves various actors, including companies, which need to work through a transparent and inclusive cooperative process from the initial stages of formulating urban development policies (CEBDS, 2016). These public policies have a significant impact on the local space, and currently, several Brazilian municipalities are developing different plans, programs, and projects involving the various social sectors. There is an ample opportunity to promote environmental management at a municipal level to create the conditions for advancing sustainability, with the role of the municipalities and all its sectors being an imperative for change in Brazilian environmental standards (Merico, 2001).

However, Merico (2001) believes that cities will implement effective public policies if they consider three fundamental elements: a well-designed legal framework, conducive to the development of programmatic actions that induce sustainability; an administrative structure capable of motivating the implementation of legal instruments, programs, and projects that together constitute effective public policies that interfere with the society and economic activity; and finally, the definition of environmental indicators that allow a minimum of constant assessment of the progress of the implemented measures, which is essential for the evaluation of these public policies and, if necessary, the remodeling of what has been done.

The growing trend in Brazilian cities to draw up and implement sustainability-oriented public policies is that public governance in these places adopts methodologies capable of assessing the progress and setbacks caused by the actions that have been already carried out. Hence, Massimini and Gonçalves (2016) state that the development of methods to assess the sustainability or action of a given location is extremely important to ensure the effectiveness of the measures taken, and so to guarantee an environmentally sustainable trend in the built environment.

According to Leite (2012), any planning that promotes changes begins by establishing a good diagnosis. In the case of the system of urban sustainability indicators, the evaluation methodologies based on these measurement tools are an essential tool for building a

panorama of the city's situation, allowing the public authorities to see the whole, complex system.

## 3 METHODOLOGY

This work has a qualitative approach. The fundamental concern of qualitative studies is to analyze the empirical world in its natural environment (Godoy, 1995). The author also states that the written word plays a key role in this approach. In addition, the description of the main methodologies for assessing urban sustainability adopted in Brazil was also developed on an exploratory and descriptive basis.

As for the exploratory nature, according to Gil (2008), research of this nature is the first stage of a broader investigation, aimed at improving ideas and discovering pre-established assumptions. Also according to Gil (2008), this type of study aims to provide greater familiarity with the subject, in order to make it clearer, and it is common for these studies to be carried out using the following procedures: a bibliographical survey, interviews with people who have had practical experience with the problem being researched, and analysis of examples that stimulate understanding of the phenomenon being studied. The main goal of exploratory research is to improve ideas, given that its planning is very flexible and makes it possible to consider the most varied aspects concerning the studied fact (Minayo et al., 2006).

Regarding the descriptive perspective of the work, Gil (2008) explains that descriptive studies have as their central focus the exposition of the characteristics of certain populations, phenomena, or the verification of relationship between certain variables. The author also points out that some studies of this type go beyond verifying the existence of a relationship between variables, for they also seek determining the nature of this relationship.

The search for the different types of available urban sustainability indicator systems was carried out by reading scientific articles, documents published by relevant municipal bodies, and information available on websites of organizations responsible for disseminating urban sustainability. Among these institutions is the United Nations Human Settlements Program (UN-Habitat) in Brazil.

UN-Habitat Brazil is an organization present in more than 90 countries and its mission is "to promote transformative changes in cities and human settlements through knowledge, policy advice, technical assistance and collaborative action" (UN-HABITAT BRASIL, 2020). Concerning this, with a view of gaining a theoretical basis on the subject of urban

sustainability measurement methodologies used in the country, information on this topic was requested via e-mail from UN-Habitat Brazil (2020).

In response, formalized by email in January 2020, the organization explained: "we work with various methodologies related to SDG 11, since our mandate is to work with all issues related to sustainable urban development". Among these tools, the organization highlighted the Urban Prosperity Index (CPI) and two initiatives to publicize Brazilian urban sustainability: the Sustainable Cities Consultation and the Global Urban Observatory.

The exploratory study also found other indicator systems, such as the Sustainable Cities Program, the Sustainable Development Indicators (SDI), NBR ISO 37120: 2017, the Blue Green Municipality Program (PMVA), and the Fortaleza Observatory. The latter is used in the city of Fortaleza to manage the Fortaleza 2040 Plan, the implementation of the SDGs at municipal level, and also the municipality's Multiannual Plan.

Therefore, in order to achieve the aim of this research, the following stages were established: (i) The collection of secondary data, specified by keywords, of the main methodologies that assess urban sustainability; (ii) And the description of the methodologies found, in detail, in order to provide a descriptive study of the sustainability theme covered by them, their scope, the number of indicators, as well as the Brazilian municipalities or regions that use each cited methodology.

## 4 RESULTS AND DISCUSSION

Each of these methodologies will be presented and described below, showing their history, themes or dimensions, indicators, and scope

### 4.1 Urban Prosperity Index (CPI)

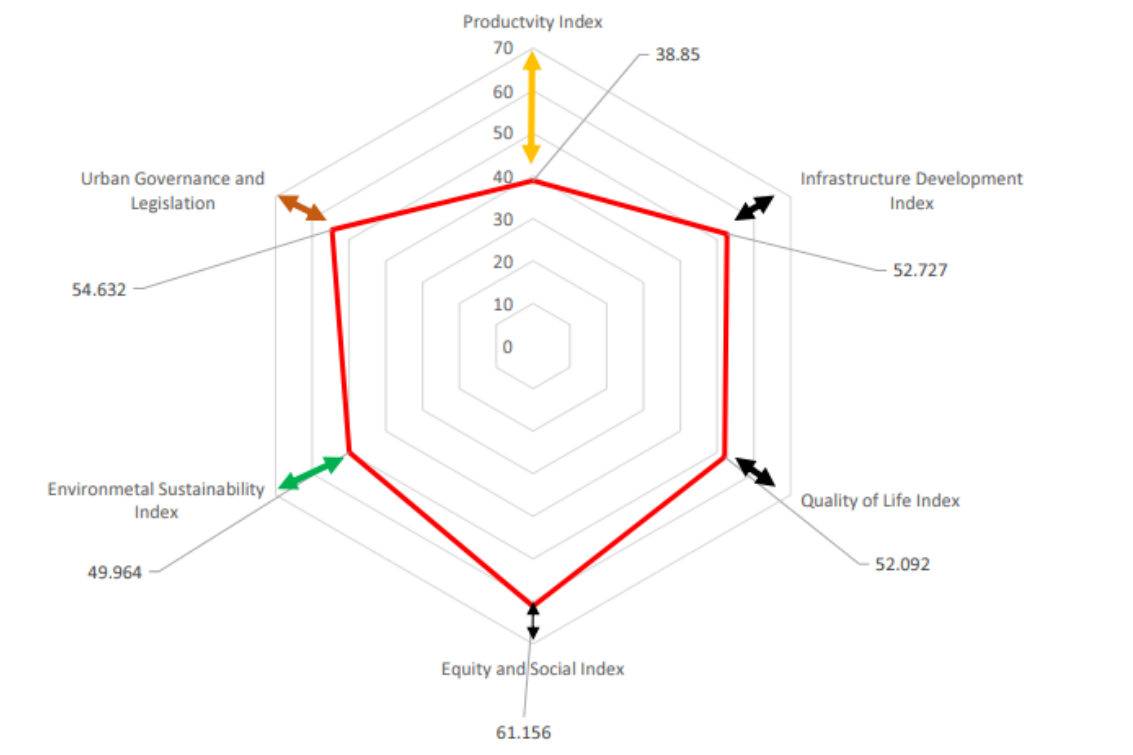
The Urban Prosperity Index (CPI) is a tool that assesses development in urban areas across six dimensions: productivity, infrastructure, quality of life, equality, environmental sustainability, and urban governance. The CPI aims to identify opportunities and potential areas for prosperity in order to support decision-makers in designing public policies (UN-HABITAT-BRAZIL, 2020).

This tool generates, for each city where it is applied, a conceptual matrix called the Urban Prosperity Circle, composed through the application of a qualitative survey based on citizens' perception of the sustainable development concept in the city, with questions related to the six dimensions of the instrument. The Urban Prosperity Index (CPI) ranges

from 0 to 100, in which the maximum value consists of a solid level of prosperity, which implies, according to the methodology developed, success, wealth, prosperous conditions, well-being, confidence in the future, and opportunities for all (Bencke; Perez, 2018).

Figure 01 shows an example of the Urban Prosperity Circle for different cities on the African continent, where the methodology has already been applied by UN-Habitat. It should be noted that this Index has a global scope and can be used to make comparisons between cities in common geographical regions. According to UN-Habitat data from 2017, this instrument for measuring urban sustainability has already been applied in approximately 400 cities around the world. In Brazil, in 2020, it had already been applied in some cities in the Metropolitan Region of São Paulo, Pará and Maceió.

**Figure 01 –** Example of a circle of urban prosperity




**Source:** Un-Habitat (2020).

This methodology offers a number of management tools for those involved in sustainable projects, which contribute to the planning, implementation, control, and monitoring of sustainability policies. These include the previously presented Urban Prosperity Circle, which shows the population's perception of each of the dimensions covered by this tool. Another device is the City Profile Report, which provides more detailed information on urban development aspects and the relationship between them and the

dimensions of urban sustainability. Finally, the City Action Plan, which is a product of this methodology, proposes interventions aligned with the needs found in the diagnosis.

The process of applying the Urban Prosperity Index to a municipality consists of the stages illustrated in figure 02:

**Figure 02** - Urban Prosperity Index application process


**Source:** Prepared by the authors (2022) based on information from Un-Habitat Brasil (2020).

The process begins with the measurement stage, where the perception survey is carried out and the Urban Prosperity Circle for the municipality is obtained; then, in the planning stage, data is collected and a City Profile Report is presented. From this report, the change stage begins, in which an Action Plan is structured for the city in question, taking into account results of subsequent stages and also good practices already developed by the organization in other cities with similar characteristics. Finally, the monitoring stage begins, where all the planned and implemented actions, as well as the progress of the index, are monitored.

### 4.2 Global Observatory

The Global Observatory, according to UN-Habitat (2020), consists of a public consultation initiative on the sustainability indices of Brazilian cities, which aims to "monitor the progress of the New Urban Agenda and the SDGs in cities through indicators". Also according to UN-Habitat (2020):

> The Global Urban Observatory Network (GUO-Net) is a global information and capacity building network established by the United Nations Human Settlements Program (UN-HABITAT) to help implement the New Urban Agenda at national and local levels. GUO-NET consists of national and

> municipal institutions that operate as National and Local Urban Observatories (UN-HABITAT, 2020, p. 2)

Moreover, the objectives of this initiative are: to improve the collection, management, and use of information for the development of more effective public policies; to continuously improve the flow of information from Brazilian municipalities regarding sustainability; to stimulate consultative processes of municipalities and promote the dissemination of good sustainable practices; and to create a global network of local, national, and regional platforms for sharing information, among others (UN-HABITAT, 2020).

Among the benefits listed for users of this tool are: training and capacity-building focused on this methodology; participation in events with network members to discuss relevant issues and exchange good practices; access to databases of urban indicators and urban practice systems; and also access to carried out data for evaluations of municipalities and the publication of these results on a regular basis (UN-HABITAT, 2020).

UN-HABITAT (2020) emphasizes that the established objectives are achieved through regional and local networks, as well as with the contribution of partner institutions in this project. This tool has already been used in regions of Africa and Asia. The organization also reported that, in Brazil, one of the outstanding experiences occurred in the Millennium Observatory in Belo Horizonte (UN-HABITAT, 2020). Cities participating in this initiative can update their information in the Global Observatory by filling in a questionnaire on the website and sending it to an email address provided by the organization.

### 4.3 Sustainable Cities Consultation

According to a response from UN-HABITAT Brazil (2020), the Sustainable Cities Consultation is "a national public consultation that assesses the population's perception of the progress of SDG 11 in Brazilian cities" and is carried out in partnership with Colab, a start-up that combines Public Management and technology. Also according to this institution, another edition of the consultation was held in 2020 and scheduled to be published in 2021. In addition, this consultation is held annually (UN-HABITAT Brazil, 2020). As stated by Colab (2019), in the Public Consultation report (2018-2019), this initiative aims to:

> To measure, through a digital questionnaire, the perception of the Brazilian population living in cities about the achievement of Sustainable Development Goal 11, Sustainable Cities and Communities, in their municipality. This is a partnership signed in May 2018 between Colab and UN-Habitat, and the first

> edition of the evaluation was carried out between October 2018 and February 2019, with the participation of almost 10,000 citizens (COLAB, 2019, p. 21).

According to the company, the initiative consists of a qualitative study that aims to ascertain the social perception of the development of their cities in relation to the 10 goals of SDG 11 (COLAB, 2019). In order to increase the reach and speed of the process, an app was used to apply the questionnaire. This form was also available on a web page, which could be accessed from any browser.

The applied questionnaire consisted of 30 multiple choice questions that followed the Likert Scale, ranging from strongly agree to strongly disagree, providing an analysis of the perception of the public that is responding. There were also yes/no questions. The questions were related to the topics covered by SDG 11, namely: sustainable and resilient buildings, urban life, heritage protection, housing and basic services, the environmental impact of cities, transparency, public spaces, accountability, disaster resilience, access to transport, inclusive and sustainable urbanization, and adaptation to climate change. On the first page, before starting the survey, there was a brief contextualization of SDG 11 and these themes.

The 2019 consultation had 9606 participants from 829 different municipalities. The results obtained were classified by different contexts and variants, such as: territorial, age group, gender, and level of education. In the report, it is possible to see a general result for Brazil, as well as specific results for some Brazilian municipalities

### 4.4 The Sustainable Cities Program

The Sustainable Cities Program consists of an agenda for urban sustainability that includes the following dimensions in municipal planning: social, environmental, economic, political, and cultural (PCS, 2020). This program was created in 2012, with the main objective of raising awareness and mobilizing municipal governance managers to implement, control, and monitor local public policies with a focus on sustainability.

The Sustainable Cities Program has 12 thematic axes "inspired by the Aalborg Commitments, a political agreement signed in 2004 by authorities of more than 700 cities to strengthen sustainable development agendas at a local level" (PCS, 2012, p. 1). In total, the axes cover a set of 260 indicators, which are aligned with the Sustainable Development Goals, making the Sustainable Cities Program a viable and assertive way to contribute to the implementation of the 2030 Agenda at a municipal level.

The seven axes of the Sustainable Cities Program are: local action for health; common natural goods; responsible consumption and lifestyle; culture for sustainability; from local to global; local, dynamic, creative and sustainable economy; education for sustainability and quality of life; equity, social justice and a culture of peace; local management for sustainability; governance; better mobility and less traffic, planning and urban design.

Thereby, the Sustainable Cities Program is an important management tool for Brazilian municipal managers. For the municipalities that are signatories to this project, a tool has been developed and made available to fill in the 260 indicators included in the 12 axes of this initiative. This tool provides a sustainability diagnosis for the signatory cities, allowing for more assertive action planning and more effective control and monitoring of what is being developed. Almeida and Gonçalves (2018) state that more than 100 indicator observatories have been created as part of the Sustainable Cities Program aiming to better monitor and plan public policies in the short, medium, and long term, bringing transparency to the population in cities.

### 4.5 Sustainable Development Indicators (SDIs)

The Sustainable Development Indicators (SDI) are a set of metrics collected and published by the Brazilian Institute of Geography and Statistics (IBGE), with the aim of making sustainability a reality and providing information to society and public managers on this subject, to aid decision-making (IBGE, 2015).

These indicators have been collected and published since 2002, and IBGE last published them in 2015. According to IBGE (2015, p. 2), by publishing the IDS, the institute "reaffirms its commitment to providing society with a set of information on Brazilian reality, in its environmental, social, economic, and institutional dimensions".

Regarding the social dimension, there are seven themes: Atmosphere, Land, Freshwater, Oceans, Seas and Coastal Areas, Biodiversity, and Sanitation. These seven themes include 19 indicators related to the objectives of preserving and conserving natural assets and restoring environmental quality.

The economic dimension has four themes: resource use and depletion, waste production and management, energy use, and macroeconomic and financial performance. These four themes are linked to 11 indicators, which are interconnected with objectives of better management of financial resources.

Finally, the institutional dimension is divided into two themes: political orientation and the capacity and effort to implement the changes necessary for sustainable development to become concrete and consolidated. These two themes are related to 12 indicators, which contribute directly to the objective of implementing sustainability.

According to IBGE (2015), the Sustainable Development Indicators provide support for monitoring sustainability in Brazilian municipalities in each of its environmental, social, economic, and institutional dimensions, helping to present a comprehensive overview of the Brazilian reality and promoting the correct exercise of citizenship, planning and formulating public policies for sustainable development.

### 4.6 ISO 37120: 2017 model

ISO 37120 was published in January 2017 by the Brazilian Association of Technical Standards (ABNT) and is the first Brazilian technical standard to focus on urban sustainability, focusing in defining and establishing a set of sustainability indicators aimed at sustainable urban development, with a view of improving the quality of life in cities and contributing to the control and monitoring of sustainable practices in urban centers. According to Almeida and Gonçalves (2018, p.47), ISO 37120/2017 "is […] identical in technical content, structure, and wording to ISO 37120:2014, which was drawn up by the Technical Committee Sustainable Development in Communities (ISO/TC 268)".

ISO 37120/2017 is aimed at any city or local governance body that is committed to measuring its performance in order to make a comparison or check its progress or setbacks. It is not restricted to a specific location, size, or level of urban development.

For Bencke and Perez (2018), the focus of this methodology is to help cities measure the performance management of municipal services and the quality of life of individuals, making checking and comparing over the years possible. The standard also facilitates learning from one city to another, as it allows comparison across a wide range of performance measures and the sharing of best practices (Bencke; Perez, 2018).

According to ISO 37120/2017, the advantages of adopting its standards include: more effective governance and service provision; international benchmarks and targets; local comparison and planning; decision-making support; learning through sharing city information; leverage for funding and recognition in international bodies; a framework for sustainability planning; and transparency and open data for investment attractiveness.

ISO 37120 establishes 17 themes related to city services and quality of life for individuals, namely: economy, education, energy, environment, finance, fire and emergency response, governance, health, recreation, safety, housing, solid waste, telecommunications and innovation, transportation, urban planning, sewage, water, and sanitation. Altogether, these themes add up to around 100 indicators, 46 of which are called core indicators and 54 are considered supporting indicators.

Gonçalves and Almeida (2018) explain that the leading indicators are those considered indispensable for directing and evaluating the performance of urban service management and quality of life, and are therefore essential in implementingthis standard. Similarly, the supporting indicators only have the complementary function of improving practices, and it is appropriate that they are also applied.

In Brazil, the Brazilian Network of Intelligent and Human Cities (RBCIH) is the institution responsible for creating the Brazilian Index of Intelligent and Human Cities and for formulating and implementing the Certifying Seal with rules that reflect whether the municipality is following the step-by-step list of actions to be implemented, based on the ISO 37120/2017 standards.

### 4.7 Blue Green Municipality Program (PMVA)

The Blue Green Seal Municipality Program was created by the São Paulo state government in 2007 to decentralize the actions of the state's Environmental Policy and to measure and support the sustainability agendas of state's municipalities. The main objective of the Blue Green Municipality Program is to encourage and help municipal governments in São Paulo to plan and implement strategic policies focused on sustainable development and to help control and monitor the carried out actions.

This program allows for an annual assessment of all 645 municipalities that make up the state of São Paulo, guiding their municipal planning towards sustainability in 10 guidelines proposed by the Program, which encompass 73 strategic actions. The 10 guidelines of the Blue Green Municipality Program are: treated sewage, solid waste, biodiversity, urban forestry, environmental education, sustainable city, water management, air quality, administrative structure, and environmental council.

At the end of the implementation period, all municipalities must send a report to the state government with all the actions implemented, as well as all the documents needed to prove that the activities have legitimately been carried out. Based on the analysis of this

report, a score of 0 to 100 is generated. If the municipality has any environmental liabilities, the score achieved in the report is deducted. Finally, if the municipality achieves a final score of 80 or higher, it is eligible to receive the Blue Green Municipality seal or certification.

Also, the top 50 in the Blue Green Municipality Program ranking benefit from a financial incentive passed on by FECOP - the State Fund to Combat Pollution, which finances the municipalities in the acquisition of equipment needed to carry out the actions. Municipalities that do not take part in the certification process are sanctioned in losing their right to the benefit. It consequently becomes an incentive to all São Paulo cities to contribute to more sustainable development.

### 4.8 Fortaleza's city observatory

The Fortaleza Observatory is a system for managing the actions of the Fortaleza 2040 Plan. On the observatory's digital platform, it is possible to check the progress of the plan's activities, as well as the Multiannual Municipal Plan, and have access to the indicators and metrics used by the municipal public administration. It should be noted that:

> The Fortaleza Observatory is the strategic point of a knowledge network aimed at producing, disseminating, and providing access to information on public policies, generating a confluence of ideas, promoting dialog, and exchanging experiences with society. It seeks to influence social, political, economic, cultural, and scientific transformations, qualifying municipal governance and contributing to making Fortaleza a more accessible, fair, welcoming, and creative city (PREFEITURA DE FORTALEZA, 2020, p. 1).

Still in this context, the Fortaleza City Hall (2020, p. 1) points out that the mission of the Fortaleza Observatory is to "produce, disseminate, and promote access to knowledge about public policies, offering subsidies for public managers in decision-making processes, thus contributing to the qualification of municipal governance." It also points out that the Observatory's task is to "produce indicators capable of demonstrating the effectiveness, efficiency, and effectiveness of municipal public policies, in line with the Fortaleza 2040 Plan".

The indicators can be found on the Observatory's website and are divided into six categories: SDG Indicators, General Indicators of the Fortaleza 2040 Plan, Sector Indicators of the Fortaleza 2040 Plan, Strategic Indicators of the Multi-Year Plan, Thematic Indicators of the Multi-Year Plan, and Program Indicators of the Multi-Year Plan.

SDG indicators are in total 78 and are related to the 169 goals proposed by the 2030 Agenda. The General Indicators of the Fortaleza 2040 Plan and the sectoral indicators are in total 27 and 145, respectively. The second one is subdivided into the seven strategic axes of the Fortaleza 2040 Plan.

On the Observatory's website, it is also possible to obtain relevant information about each one of the indicators, such as the concept, the formula used, and those responsible for both quantifying the data and making it available on the platform. The general indicators include historical data from different years. In addition, this digital platform also offers the option of a "Virtual Tour" through all the available data. Finally, it is possible to access graphs and infographics that associate different classes of indicators, highlighting the relationship between them thus confirming that the axes of sustainability are integrated and indivisible.

### 4.9 Overview of the urban sustainability methodologies found

Table 01 provides an overview of the methodologies for measuring urban sustainability presented in this topic. This table describes the name of each methodology, covered dimensions, the number of indicators used, and their scope.

**Table 01** – Methodologies for measuring urban sustainability

| Methodology | Dimensions | Indicadors/ Themes | Coverage | Access |
|---|---|---|---|---|
| Urban Prosperity Index (CPI) | Productivity; Infrastructure; Quality of life; Equality; Environmental sustainability; Urban governance. | 22 themes | Mondial | Available in: https://cpi.unhabitat.org |
| Global Observatory | 17 ODS. | 169 indicators | Mondial | Available in: https://unhabitat.org/guo |
| Consult Sustainable Cities | ODS 11: Sustainable Cities. | 12 themes | National | Available in: https://unhabitat.org/sites/default/files/2019/08/livro_cidades_sustentaveis_-_completo_0.pdf |
| Sustainable Cities Program | Local action for health; Common natural goods; Responsible consumption and lifestyle; Culture for sustainability; From local to global; Local, dynamic, creative, and sustainable economy; | 260 indicators | National | Available in: https://www.cidadessustentaveis.org.br/ |

| | | | | |
|---|---|---|---|---|
| | Education for sustainability and quality of life; Equity, social justice, and culture of peace; Local management for sustainability; Governance; Better mobility and less traffic and urban planning and design. | | | |
| ISO 37120/2017 | Economy; Education; Energy; Environment; Finance; Response to fires and emergencies; Governance; Health; Recreation; Security; Housing; Solid waste; Telecommunications and innovation; Urban transport planning; Sewers; Water and sanitation. | 100 indicators | National | Available in: https://www.abntcatalogo.com.br/norma.aspx?ID=366389 |
| Green Blue Municipality Program | Treated sewage; Solid waste; Biodiversity; Urban afforestation; Environmental education; Sustainable city; Water management; Air quality; Environmental structure; Environmental Council. | 73 actions | State | Available in: https://www.infraestruturameioambiente.sp.gov.br/verdeazuldigital/ |
| Fortaleza Observatory | 17 ODS | 78 indicators | Municipal | Available in: <https://observatoriodefortaleza.fortaleza.ce.gov.br/>. |
| | Strategic axes of the Fortaleza 2040 Plan. | 10 | | |

**Source**: Prepared by the authors (2020).

Regarding the scope, if considered to be national, the indicator system in question can be applied to various municipalities and provide a ranking of Brazilian cities classified by their sustainability. Regional coverage applies to municipalities located in the same region of the country, as is the case of the Blue Green Municipality Program, which classifies municipalities in the state of São Paulo in terms of sustainability. Finally, the municipal scope implies a system of indicators used to measure sustainability at a local level, and as presented in this research, the Fortaleza Observatory can be named as an example. It consists of a set of sustainability indicators aimed at controlling and monitoring the Fortaleza 2040 Plan, one of the sustainability policies developed in the municipality and the target of this study.

## 5 FINAL CONSIDERATIONS

This study discussed the relevance of the issue of sustainability nowadays, especially with regard to large urban centers. It is a fact that the accelerated urbanization of Brazilian cities, coupled with the significant growth in the population living in these places in recent years, has led to a number of social and environmental maladjustments that are detrimental to the quality of life of these individuals, as well as the achievement of more sustainable development for these spaces.

Furthermore, the management of municipal natural assets is currently a challenge for governance, as the built environment of cities is competing for space with a pre-existing natural one, which is often submitted to an accelerated degradation process by unbridled urbanization, with the occurrence of deforestation and soil, water, and air contamination, among other practices, leading to an increased socio-environmental vulnerability in these biological systems.

In this scenario, it is urgent and necessary for municipal managers to plan and carry out actions by drawing up and implementing public sustainability policies to mitigate both negative social and environmental impacts that affect cities and, furthermore, to promote a more sustainable urban environment. However, in order to effectively achieve the objective of promoting sustainable development, it is necessary to control and monitor the policies that are proposed and developed in urban spaces through the use of methodologies for measuring urban sustainability.

Therefore, the different systems of indicators for evaluating the progress and setbacks of sustainable practices in cities are indispensable tools for municipal public management. For this reason, it is necessary for government officials to have access to these instruments and apply them in their management, in order to contribute to the decision-making of municipal action strategies.

Hence, this research presents the main methodologies for measuring urban sustainability available at global, national, regional, and municipal level. Therefore, a total of eight measurement tools that are extremely relevant to the decision-making of municipal managers were described, since they make it possible to use urban sustainability indicator systems to assess the occurred progress and setbacks over the course of the actions proposed by the sustainability policies implemented.

In this sense, it is important to emphasize that municipal governance must carefully analyze the urban sustainability indicator systems available for use in the municipality to

which they are linked, in order to choose the one that best suits the local reality, as well as offering indicators in line with what has been planned and implemented for the city in question.

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