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# Prioritizing Urban Sustainability Indicators: A Participatory Analysis Based on the Sustainable Cities Program Methodology

**Maria Lucineide Gomes da Silva**
Master, PRODEMA-UFPB, Brasil
lucineidegmd@gmail.com
https://orcid.org/0000-0003-0579-8456

**Gesinaldo Ataíde Cândido**
Professor, PhD, UFPB, Brasil
gacandido01@gmail.com
https://orcid.org/0000-0002-3112-0254

**Eduardo Rodrigues Viana de Lima**
Professor, PhD UFPB, Brasil
eduvianalima@gmail.com
https://orcid.org/0000-0003-1116-9090

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# Priorizando Indicadores de Sustentabilidade Urbana: Uma Análise Participativa com Base na Metodologia do Programa Cidades Sustentáveis

**RESUMO**

**Objetivo** - Este trabalho tem como objetivo a priorização de indicadores de sustentabilidade urbana mais relevantes que melhor evidenciem as singularidades de um importante aglomerado urbano do estado do Ceará, a partir de um processo participativo.

**Metodologia** - Em termos metodológicos, este trabalho trata-se de uma pesquisa, de natureza aplicada, exploratória e descritiva, que para alcançar o objetivo proposto adotou uma metodologia baseada no Programa Cidades Sustentáveis (PCS), inicialmente foram selecionados os indicadores mais aderentes ao contexto urbano da região. Em seguida, foi realizada uma consulta pública com habitantes locais maiores de idade e com ensino fundamental completo, reduzindo-se o conjunto a 20 indicadores com maior homogeneidade nas respostas. Estes foram, posteriormente, submetidos à análise de atores sociais diretamente ligados à gestão municipal e aos indicadores, sendo aplicada a ferramenta Diagrama Mudge para determinar a ordem de importância dos indicadores.

**Originalidade/relevância** - O estudo se insere no debate teórico sobre a importância da integração entre indicadores validados pela sociedade e instrumentos de gestão urbana em cidades médias de países em desenvolvimento. Destaca-se pela ênfase em metodologias participativas e pela escassez de estudos que articulam indicadores sustentáveis à realidade de municípios do interior nordestino.

**Resultados** - Os resultados apontam para a priorização de indicadores sociais, com ênfase em saúde, educação e infraestrutura urbana, evidenciando os principais campos de atenção para o desenvolvimento sustentável no CRAJUBAR.

**Contribuições teóricas/metodológicas** - A utilização do Diagrama de *Mudge* revelou-se uma ferramenta eficaz para organizar e hierarquizar os indicadores a partir da percepção dos atores sociais, reforçando a viabilidade de métodos participativos no contexto da gestão urbana local.

**Contribuições sociais e ambientais** - O estudo oferece subsídios relevantes para políticas públicas mais responsivas às necessidades reais da população, contribuindo para a construção de cidades mais inclusivas, saudáveis e ambientalmente sustentáveis.

**PALAVRAS-CHAVE**: Urbano. Cidades. Sustentabilidade. Indicadores

# Prioritizing Urban Sustainability Indicators: A Participatory Analysis Based on the Sustainable Cities Program Methodology

**ABSTRACT**

**Objective** – This study aims to prioritize the most relevant urban sustainability indicators that best highlight the unique characteristics of an important urban agglomeration in the state of Ceará, based on a participatory process.

**Methodology** – In methodological terms, this study is an applied, exploratory, and descriptive research project. To achieve its objective, it adopted a methodology based on the Sustainable Cities Program (PCS). Initially, the indicators most relevant to the urban context of the region were selected. Next, a public consultation was held with local residents of legal age who had completed elementary school, reducing the set to 20 indicators with greater homogeneity in the responses. These were then submitted to analysis by social actors directly linked to municipal management and the indicators, using the Mudge Diagram tool to determine the order of importance of the indicators.

**Originality/Relevance** – The study is part of the theoretical debate on the importance of integrating indicators validated by society and urban management tools in medium-sized cities in developing countries. It stands out for its emphasis on participatory methodologies and the scarcity of studies that link sustainable indicators to the reality of municipalities in the northeastern interior.

**Results** – The results point to the prioritization of social indicators, with an emphasis on health, education, and urban infrastructure, highlighting the main areas of attention for sustainable development in CRAJUBAR.

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**Theoretical/Methodological Contributions** – The use of the Mudge Diagram proved to be an effective tool for organizing and prioritizing indicators based on the perceptions of social actors, reinforcing the viability of participatory methods in the context of local urban management.
**Social and Environmental Contributions** – The study offers relevant insights for public policies that are more responsive to the real needs of the population, contributing to the construction of more inclusive, healthy, and environmentally sustainable cities.
**KEYWORDS:** Urban. Cities. Sustainability. Indicators.

## Priorización de indicadores de sostenibilidad urbana: un análisis participativo basado en la metodología del Programa Ciudades Sostenibles

**RESUMEN**
**Objetivo** – El objetivo de este trabajo es priorizar los indicadores de sostenibilidad urbana más relevantes que mejor evidencien las singularidades de una importante aglomeración urbana del estado de Ceará, a partir de un proceso participativo.
**Metodología** – En términos metodológicos, este trabajo es una investigación de naturaleza aplicada, exploratoria y descriptiva que, para alcanzar el objetivo propuesto, adoptó una metodología basada en el Programa Ciudades Sostenibles (PCS). Inicialmente, se seleccionaron los indicadores más adecuados al contexto urbano de la región. A continuación, se realizó una consulta pública con habitantes locales mayores de edad y con estudios primarios completos, reduciendo el conjunto a 20 indicadores con mayor homogeneidad en las respuestas. Posteriormente, estos fueron sometidos al análisis de actores sociales directamente vinculados a la gestión municipal y a los indicadores, aplicándose la herramienta Diagrama Mudge para determinar el orden de importancia de los indicadores.
**Originalidad/Relevancia** – El estudio se inscribe en el debate teórico sobre la importancia de la integración entre los indicadores validados por la sociedad y los instrumentos de gestión urbana en ciudades medianas de países en desarrollo. Destaca por su énfasis en las metodologías participativas y por la escasez de estudios que articulen indicadores sostenibles con la realidad de los municipios del interior del nordeste.
**Resultados** – Los resultados apuntan a la priorización de los indicadores sociales, con énfasis en la salud, la educación y la infraestructura urbana, poniendo de manifiesto los principales campos de atención para el desarrollo sostenible en CRAJUBAR.
**Contribuciones Teóricas/Metodológicas** El uso del diagrama de Mudge resultó ser una herramienta eficaz para organizar y jerarquizar los indicadores a partir de la percepción de los actores sociales, lo que refuerza la viabilidad de los métodos participativos en el contexto de la gestión urbana local.
**Contribuciones Sociales y Ambientales** – El estudio ofrece subsidios relevantes para políticas públicas más receptivas a las necesidades reales de la población, contribuyendo a la construcción de ciudades más inclusivas, saludables y ambientalmente sostenibles.

**PALABRAS CLAVE:** Urbano. Ciudades. Sostenibilidad. Indicadores.

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**GRAPHICAL ABSTRACT**

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## 1 INTRODUCTION

The search for more sustainable, human and resilient cities represents one of the main challenges for urban managers today. The consolidation of an urbanization process without previous planning has put great pressure on natural resources, making the global search for solutions that minimize the impacts of this process a priority. Furthermore, it is urgent to develop and implement models that integrate population and economic growth with environmental preservation, guiding human activities through sustainability.

In the path to sustainability in different contexts, the indicators are essential tools in the process of measuring and monitoring the desired levels of sustainability. In the urban space context, the use of indicators is defended, as they are capable of grouping, quantifying, qualifying and synthesizing a set of information regarding the reality being analyzed (Jubanski; Knorek; Pedrassani, 2019). In particular, at local level they can communicate the state of practice, assess the planning, aid government decision-making and are an important means to identify which actions or strategies promote local sustainability (Manso; Caeiro; Pardo, 2019).

Emphasizing that urban spaces are highly heterogeneous, complex systems with many variables, which requires a holistic approach that considers the interaction of the multiple dimensions and parts that make up these spaces (Salati, Bragança and Mateus, 2022). Besides its physical and geographical configuration, the city is configured as a dynamic fabric of social functions, relationships and patterns of use, shaped by the interaction of its inhabitants with the existing infrastructure (Lefebvre, 1991). In this recognition of urban complexion context, the creation of indicators to track and promote sustainable development has gained a significant momentum, especially since the 2030 Agenda, which seeks to integrate the social, economic and environmental dimensions. This movement has resulted in a vast set of urban sustainability data and indicators systems (Salati, Bragança e Mateus, 2022;Yuassa;Gonçalves, Guerreiro,2025).

In Brazil, many systems have been developed in order to assess and track urban sustainability, such as the Urban Sustainability Index (SISU), the Quality of Urban Life Index for Brazilian Municipalities (IQVU-BR), the National City Information System (SNIC), the Integrated Urban Environment Management System (SIGAU), the Sustainable Development Index for Municipalities (IDSM) and the Sustainable Cities Program (PCS).

Among these, the Sustainable Cities Program (PCS) stands out due to its comprehensive structure, comprising 12 thematic axes and 260 indicators aligned with the Sustainable Development Objectives (ODS). The Initiative demonstrates greats potential by offering digital platforms and resources that facilitate the application and dissemination of indicators, promoting transparency and empowering municipal governments. However, it can be seen that the PCS implementation adopts a mostly top-down approach, in which the selection of the indicator is made by representatives of the municipalities. This characteristic limit the participation of civil society, which might result in the negligence of relevant local particularities and, as a consequence, impact on the representativeness of the results of the sustainability analysis in each municipal context.

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The participation of key actors and civil society emerges as a crucial element in the design of sustainability indicators systems, in particular in the identification of priority themes and areas, as well as in the selection and validation of indicators. Indicators defined with the contribution of the target audience tend to be more significant and reflect the needs and desires of the population, therefore they are consequently more relevant in guiding public policies (Manso, Caeiro and Pardo, 2019; Silva and Branchi, 2020). A participatory process enables the incorporation of values, objectives and concerns shared by the community. This perspective is supported by the Bellagio principles, which in their eighth principle advocate broad representation of the key public in the process of sustainability assessment, covering various segment such as professionals, technicians and the community, including young people, women and indigenous people, in order to guarantee recognition of the plurality and dynamics of value (Hardi and Zdan, 1997).

The inclusion of different social actors and civil Society in the PCS application can significantly contribute to strengthening the sense of citizenship, as well as reinforcing the development of a participatory urban planning capable of meeting and understanding the real need of the residents of a given area.

As a study locus for this research, the CRAJUBAR region was chosen, located in the south of the state of Ceará. It's an important conurbation formed by the cities Crato, Juazeiro do Norte and Barbalha. With strong economic and social, this region is an important urban center in the northeastern interior, which has undergone and is undergoing a process of accelerated urbanization, without previous planning, a process similar to what happens in many urban centers in developing countries, and therefore ends up facing common challenges in terms of accelerated urban growth, urban mobility, public safety and the provision of public services.

In light of the above, this study, which is the result of a PhD research project, seeks to highlight the potential contribution and enrichment that the inclusion of diverse social actors in the process of selecting sustainability indicators has in analyzing sustainability in different spatial and temporal scopes.

## 2 OBJECTIVE

This study aims to prioritize the most relevant urban sustainability indicators that best highlight the unique characteristics of an important urban agglomeration in the state of Ceará, based on a participatory process.

## 3 METHODOLOGY

The research is of an applied nature and has exploratory and descriptive objectives, seeking to understand and describe a given phenomenon, and establishing relationships between different variables, in order to identify the most relevant PCS indicators to be used in the territorial scope of the research, CRAJUBAR, considering the perception of local social actors.

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This study was based on the Sustainable Cities Program (PCS) methodology which includes 260 indicators. Given this quantity of indicators, it would not be feasible to produce a questionnaire, as well as the fact that some of these indicators are not related to the characteristics of the study area. In order to operationalize the research, the first methodological stage consisted of selecting the indicators that best matched the urban context of CRAJUBAR. This pre-selection was based on the guidelines of the Bellagio Principles, urbanization dynamics of the study area, the social and environmental challenges, along with available data, resulting in 62 indicators.

Following this, a survey was conducted with the local population, involving 321 participants who are residents of the region, over the age of 18 and have completed elementary school. Through an electronic quest, structured on *Google Forms*, the selected indicators were presented, and the participants were able to point out the ones they deemed to be more relevant for local urban development. The period of data collection occurred between August 7 and November 14, 2023.

At this stage, a quantitative approach was adopted, by using a five-point Likert Scale, meaning that, the respondent had to indicate the level of importance for each indicator, considering: 1 – Not Important, 2 – Important, 3 – Medium Importance, 4 – Very Important and 5 – Extremely Important. The data was analyzed through descriptive statistics, with the aid of the R statistical software, when the arithmetic mean, coefficient of variation and standard deviation measures were extracted, used for central tendency and dispersion analyses ( Box 1).

Box 1 – Statistical procedures used.

| Measures | Applied Formulas | Analysis of the value for each measure | |
|---|---|---|---|
| Arithmetic mean (Md) | Rr1+Rr2+ Rr+ .... Rrn/Ntr<br>Where: - Rr1; Rr2; Rr3 ...; Rrn are the answers of each respondent in a set of observed answers. These answers may vary between 1,2,3,4 and 5.<br>- Ntr is the total number of respondents, that is, the sample of subjects researched. | 1≤Md<1,8 | On average, participants consider the indicator to be of no importance |
| | | 1,8≤Md≤2,6 | On average, participants consider the indicator to be important |
| | | 2,6<Md≤3,4 | On average, participants consider the indicator to be of medium importance |
| | | 3,4<Md≤4,2 | On average, participants consider the indicator to be very important |
| | | 4,2<Md≤5 | On average, participants consider the indicator to be of extremely importance |
| Standard Deviation (Dp) | $Dp(x) = \sqrt{Var(x)}$ Where: X is the variable that corresponds to a set of observed answers. | The Standard Deviation is used to calculate the coefficient of variation, which is the measure that provides an analysis of the homogeneity of the data collected. | |
| Coefficient of variation (CV) | CV= (Dp/Md) where, Dp → is the standard deviation Md → is the mean of data CV → is the coefficient of variation | 0≤CV< 15% - low dispersion: very homogeneous data<br>15≤CV<30% - medium dispersion: data is homogeneous.<br>CV>30% - high dispersion: data is heterogeneous | |

Source: Adapted from Morettin & Bussab (2013).

After calculating and analyzing the measures, it was possible to verify the homogeneity or heterogeneity of the data obtained. To identify the indicators with the most homogeneous responses, two parameters were used together, a mean greater than 4.2 and a coefficient of variation of less than 15%, which covered the data with the lowest level of dispersion.

These indicators were, then, submitted to a second round of consultation, this time with social actors who are directly linked to the indicators, and especially to the city

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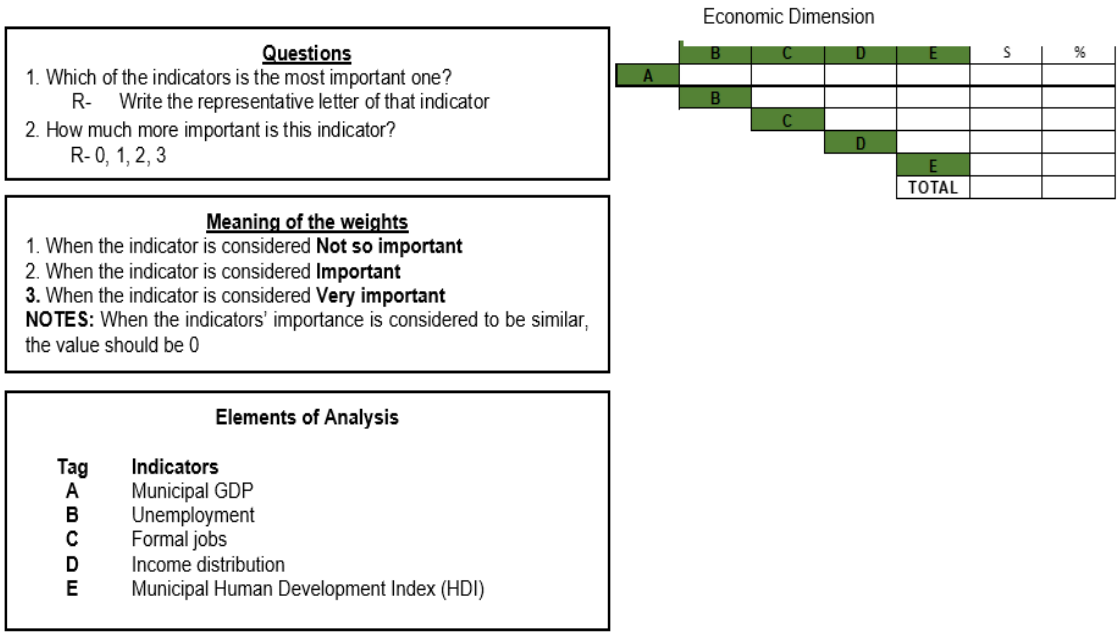
management. Were consulted representatives from the Technical Assistance and Rural Extension Company of Ceará (Ematerce), the Integrated Rural Sanitation System (SISAR), the Rural Workers' Union, the shopkeepers, the Diocese of Crato, the Christian Base Association (ACB), the School Factory, the educational institutions, the Federal Institute of Education, Science and Technology of Ceará (IFCE), the Federal University of Cariri (UFCA) and the Regional University of Cariri (URCA); and the following municipal secretariats: of Human Rights, of Education, of Health, of Tourism, of Women, of Works and Urbanism, of Urbanism and Environment, of Agrarian Development, of Environment and Public Services. This stage had the voluntary participation of 43 participants, who assigned weights to each of the indicators. The weights were attributed according to their judgments of the degree of priority of the indicators, where 1 indicates that the indicator is considered not so important; 2 important; and 3, very important, always in comparison to the other indicator.

To reach the intended objective, we adapted the *Mudge* method, an important tool used to compare and prioritize the requirements, which can be adapted and applied to different contexts, procedures, projects and decision-making. The Mudge method was chosen due to its capacity to integrate multivariate statistical techniques, offering in-depth data analysis, while at the same time offering a clear visual representation of the relationship between the elements, resulting in a fuller understanding of the problem and more accurate decision-making.

To the participants, a matrix questionnaire was presented. To answer it the participant was guided by two basic questions: the first, “which of the indicators is the most important one?” and the second “How much more important is this indicator?”. Then, the participant would write the representative letter of that indicator and its priority degree (1, 2 or 3). When the indicators’ importance Is considered to be similar, the value should be 0. Figure 1 presents an outline of the applied questionnaire, as an example of the Mudge diagram for the economic dimension indicator.

Figure 1 – Example of a questionnaire using the Mudge Diagram.




Source: Authors (2025).

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The data collection for this stage was between April 17 and May 9, 2025. To calculate the weight, a data spreadsheet structured in Microsoft Excel Software was used, with specific algorithms for coding the Mudge Diagram, and afterwards the weighted values for each indicator were calculated. To define the weight for each indicator, the gained points were added together and divided into the sum of all of the points in the table.

The approach used provided information about aspects that civil society considers important and the level of priority the key social actors, related to these indicators, gave them.

## 4 RESULTS

The civil society of CRAJUBAR elected 20 indicators as extremely important, based on the homogeneity of the answers, which can be grouped into three major sustainability dimensions: social, environmental and economic. The social dimension showed the biggest concentration of indicators, most of them related to health care and education, followed by the economic dimension, with five indicators, and finally the environmental dimension with three indicators directly related to the issue of access to basic sanitation (Table 1).

Table 1 - Indicators selected by civil society and the sustainability dimensions covered.

| Dimension | Indicators | Indicators measures | | | Data Dispersion | Homogeneity of Responses | Level of Importance |
|---|---|---|---|---|---|---|---|
| | | Mean | Standard Deviation | Coefficient of variation (CV) | | | |
| Social | Vaccine coverage | 4,85 | 0,47 | 9,78 | Low | Very homogeneous | Extremely Important |
| | Hospital beds | 4,83 | 0,53 | 10,86 | Low | Very homogeneous | Extremely Important |
| | Basic Health Units | 4,83 | 0,49 | 10,11 | Low | Very homogeneous | Extremely Important |
| | Maternal Mortality | 4,82 | 0,52 | 10,73 | Low | Very homogeneous | Extremely Important |
| | Fully literate children by the age of 8 | 4,82 | 0,52 | 10,73 | Low | Very homogeneous | Extremely Important |
| | Child mortality (children under 5 years of age) | 4,82 | 0,52 | 10,77 | Low | Very homogeneous | Extremely Important |
| | Population assisted by family health teams | 4,81 | 0,53 | 11,07 | Low | Very homogeneous | Extremely Important |
| | Functional illiteracy of the population | 4,78 | 0,55 | 11,54 | Low | Very homogeneous | Extremely Important |
| | Dengue fever mortality | 4,78 | 0,63 | 13,16 | Low | Very homogeneous | Extremely Important |
| | Households with access to electricity | 4,77 | 0,62 | 13,06 | Low | Very homogeneous | Extremely Important |
| | Higher education completed | 4,69 | 0,68 | 14,49 | Low | Very homogeneous | Extremely Important |
| | Families enrolled in the Single Registry for social programs | 4,62 | 0,66 | 14,22 | Low | Very homogeneous | Extremely Important |
| Environmental | Sewage treated before it reaches the sea, rivers and streams | 4,83 | 0,54 | 11,27 | Low | Very homogeneous | Extremely Important |
| | Access to domestic waste collection service | 4,79 | 0,59 | 12,36 | Low | Very homogeneous | Extremely Important |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Permanent and sustainable access to drinking water | 4,90 | 0,41 | 8,36 | Low | Very homogeneous | Extremely Important |
| **Economic** | Municipal Human Development Index (HDI) | 4,80 | 0,50 | 10,37 | Low | Very homogeneous | Extremely Important |
| | Unemployment | 4,73 | 0,60 | 12,78 | Low | Very homogeneous | Extremely Important |
| | GDP of the municipality | 4,71 | 0,65 | 13,77 | Low | Very homogeneous | Extremely Important |
| | Income distribution | 4,64 | 0,68 | 14,57 | Low | Very homogeneous | Extremely Important |
| | Formal Jobs | 4,66 | 0,70 | 14,98 | Low | Very homogeneous | Extremely Important |

Source: Authors (2025).

This Organization of indicators by dimension facilitates an integrated analysis of the urban sustainability aspects and allows a more holistic vision of the desires of CRAJUBAR'S Social actors. On this premise, we will analyze below which indicators were considered to be the highest priority by the social actors connected to the city management and the indicators of each dimension.

The social dimension had the highest number of indicators, and the ones with the highest levels of importance were, "Population assisted by family health teams" (1st place, 11,49%), "Vaccine coverage" (2nd place, 11,00%) and "Fully literate children by the age of 8" (3rd place, 10,55%). The indicators with the lowest level of importance, within the context presented, were "Higher education completed" (10th place 4,48%) and "Households with access to electricity" (11th place, 3,87%). It should be noted that the indicators "Families enrolled in the Single Registry for social programs" and "Functional illiteracy of the population" share 9th place, both with a 6,02% weight, meaning that these 2 indicators were considered by the participants to be of equal priority (Table 2).

Table 2 - Prioritization of social dimension indicators.

| Dimension | Indicator | Total | Weight | Order of importance |
|---|---|---|---|---|
| Social | Population assisted by family health teams | 17,349 | 11,49% | 1st |
| | Vaccine coverage | 16,605 | 11,00% | 2nd |
| | Fully literate children by the age of 8 | 15,930 | 10,55% | 3rd |
| | Maternal Mortality | 15,767 | 10,45% | 4th |
| | Child mortality (children under 5 years of age) | 14,907 | 9,88% | 5th |
| | Basic Health Units | 14,442 | 9,57% | 6th |
| | Hospital beds | 13,116 | 8,69% | 7th |
| | Dengue fever mortality | 12,047 | 7,98% | 8th |
| | Families enrolled in the Single Registry for social programs | 9,093 | 6,02% | 9th |
| | Functional illiteracy of the population | 9,093 | 6,02% | 9th |
| | Higher education completed | 6,767 | 4,48% | 10th |
| | Households with access to electricity | 5,837 | 3,87% | 11th |

Source: Authors (2025).

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The high prioritization of indicators related to primary health reflects a central concern with the population's well-being and quality of life, which is consistent with the growing emphasis on the quality of public health, human capital and well-being, as one of the foundations for sustainable urban development (Corburn, 2009; Sharifi, 2021). Ensuring access quality to health and inclusive education is essential for building resilient and equal cities (Santos and Castañon, 2022; Sharifi, 2020). Another indicator that stands out is the third place, which deals with children's literacy, ensuring that they are fully literate by the age of 8. The main importance of this indicator stems from the fact that education is the basis for human development and reduction of inequalities in the long term (Sachs, 2018).

Meanwhile, the lower prioritization of the indicator "Higher education completed" indicates a perception by the participants that, given the more immediate challenges of health and literacy, higher education receives less urgency in the assignment of efforts and resources. A similar result was seen for the indicator "Households with access to electricity", which was also given lower priority, suggesting that the relatively wide coverage of this service in the assessed region shifts the focus to other more critical needs identified by the participants. In general, even though these indicators are important, they are considered relatively less urgent or are at a more satisfactory level in comparison to the basic needs of health and fundamental education.

The equal prioritization of the indicators "Families enrolled in the Single Registry for social programs" and "Functional illiteracy" points to the recognition of the interconnection between socioeconomic vulnerability and educational challenges in the region, reinforcing the importance of considering social inequalities when assessing urban sustainability, a central theme in contemporary discussions (UN-Habitat, 2021; Yu and Huang, 2021In order to achieve sustainable urban development, social disparities and the assurance of equitable opportunities for all citizens must necessarily be addressed.

Considering CRAJUBAR'S characteristics, an urban agglomeration in a northeastern Brazilian state that has historically faced socioeconomical challenges, the high prioritization of primary health indicators and child literacy reflects the most pressing needs of the population. The strong appreciation of primary health care and vaccination coverage demonstrates the quest to reduce health vulnerabilities, while the focus on child literacy signals an investment in the region's future human capital. The lower priority given to higher education and access to electricity indicates that, in the local context, other issues are considered more urgent to improve the quality of life of the majority of the population. The concern about families enrolled in the Single Registry and functional illiteracy indicates a recognition of the challenges of social inclusion and the need for policies aimed at the most vulnerable population in the search for a more sustainable and fair urban development for CRAJUBAR.

In the economic dimension the indicator with the highest level of importance was the "Municipal Human Development Index (HDI)" in 1$^{st}$ place with a 30,80% weight. Followed by, "Income distribution" in 2$^{nd}$ place, with 26,25%, and " Unemployment " in 3$^{rd}$ place, with 18,33%. The indicators with the lowest level of importance were "Formal Jobs" (4$^{th}$ place, 17,90%) and, the lowest priority, was the "GDP of the municipality" (5$^{th}$ place, 6,72%) (Table 3).

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Table 3 - Prioritization of economic dimension indicators

| Dimension | Indicator | Total | Weight | Order of importance |
|---|---|---|---|---|
| Economic | Municipal Human Development Index (HDI) | 6,605 | 30,80% | 1st |
| | Income distribution | 5,628 | 26,25% | 2nd |
| | Unemployment | 3,930 | 18,33% | 3rd |
| | Formal Jobs | 3,837 | 17,90% | 4th |
| | GDP of the municipality | 1,442 | 6,72% | 5th |

Source: Authors (2025).

The strong prioritization of the "municipal HDI" reflects a comprehensive view of development that goes beyond purely economic growth, with other dimensions present in society having to be incorporated and worked on in a balanced way, besides applying public policies effectively and comprehensively (Caldatto *et al.*, 2021; Fagundes *et al.*, 2024). The high importance attributed to the "Income distribution" indicator emphasizes the growing concern with economic equity as an essential component of urban sustainability, recognizing that economic growth by itself does not guarantee sustainable development (Schröder *et al.*, 2019). The prioritization of the "Unemployment" indicator in third place highlights the relevance of generating job opportunities for social and economic stability in cities. On the other hand, the lower priority given to the "GDP of the municipality" indicator signals that, in the participants' perception, aggregate economic growth is less crucial in itself than the way wealth is distributed and the level of human development achieved. The slightly lower position of the "Formal jobs" indicator in relation to unemployment reflects a greater concern with the lack of opportunities than with the mere formalization of existing jobs.

The results obtained are related to the tendency to work on urban sustainability, where there is an appreciation of indicators that not only reflect in the economic production, but essentially equity, efficiency and quality of life (Bibri, 2021; Martins e Cândido, 2015; Silva *et al.*, 2022). The centrality of the "municipal HDI" as a priority indicator, reflects the idea that development should be measured focusing on the human well-being. The high priority of income distribution aligns with the growing emphasis on social justice and urban justice, involving democracy, equity and diversity as an integral part of urban sustainability (Fainstein, 2014). The concern about unemployment is also connected to social stability and the individual's capacity to fully participate in urban life. The lower priority in GPD, in comparison with other indicators, suggests an approach that seeks a more qualitative and inclusive development than a purely quantitative one.

Given the CRAJUBAR's characteristics, the high prioritization of the municipal HDI and income distribution indicates a sensitivity to the challenges of social inequality and the search for development that will effectively improve the population's quality of life. The lower priority of GPD, in comparison with the HDI and income distribution, stems from the fact that the focus is more on how development translates into concrete improvements for people than merely gross economic growth. The prioritization of formal jobs indicates the importance of job quality in local economic sustainability. These results reflects the priorities of an urban agglomerate

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that seeks fairer economic development, focusing on its citizen's well-being.

The environmental dimension had three indicators, with the one with the highest level of importance being "Permanent and sustainable access to drinking water", in 1st place, with a considerable weight of 67,65%. In second place, with a weight of 24,71%, is the "Sewage treated before it reaches the sea, rivers and streams" indicator. The indicator with the lowest level of importance was "Access to domestic waste collection service", with a weight of just 7,65%, coming in 3rd place (Table 4).

Table 4 - Prioritization of environmental dimension indicators

| Dimension | Indicator | Total | weight | Order of importance |
|---|---|---|---|---|
| Environmental | Permanent and sustainable access to drinking water | 2,674 | 67,65% | 1st |
| | Sewage treated before it reaches the sea, rivers and streams | 0,977 | 24,71% | 2nd |
| | Access to domestic waste collection service | 0,302 | 7,65% | 3rd |

Fonte: Authors (2025).

The high prioritization of the "Permanent and sustainable access to drinking water" indicator reflects a recognition of water as an essential resource for life and urban sustainability, showing the growing global concern about water security in the light of climate changes and populational growth (UNESCO, 2022). The secondary importance given to "Sewage treated before it reaches the sea, rivers and streams", highlights the importance of adequate sanitary for the protection of aquatic ecosystems and public health in the urban areas (WHO, 2019). In addition, these two indicators are directly associated with a reduction in morbidity and mortality from different types of infectious diseases, meaning that better sanitation conditions have a direct impact on a country's health indicators and economic development (Heller, 1998; Veloso Correia *et al.*, 2021). The lower priorization of the "Access to domestic waste collection service" indicator, which although fundamental for its hygiene and waste management, indicates that, in the CRAJUBAR context, this service is perceived as already existing or less critical compared to access to drinking water and sewage treatment.

Regarding the achievement of urban sustainability, the results of the environmental dimension place greater emphasis on aspects related to water resource and sanitation. The prioritization of access to drinking water is in line with the view that ensuring this basic right is fundamental for resilience and livability in cities. This indicator, as well as sanitation, electricity and garbage collection, are some of the parameters used to assess the adequacy of Brazilian urban homes (FJP, 2021; Virginio and Bezerra, 2024).

The importance given to sewage treatment reflects the growing awareness of the impacts of water pollution on ecosystems and human health. The lower priority given to waste collection, which although important, indicates that the other environmental challenges related to water are considered more urgent, considering the local reality. This prioritization defines strategies to focus on interventions that address the most critical needs related to water quality and availability.

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Considering CRAJUBAR's reality, the high prioritization of access to drinking water reflects historical and current challenges related to water availability and security in the semi-arid region of Ceará. The importance given to sewage treatment indicates concern with the pollution of local water resources, which are particularly sensitive in a context of scarcity. The lower priority of household waste collection service shows that this is a service with relatively greater coverage or with problems perceived as less urgent compared to water and sewage issues. This prioritization of environmental priorities translates as a direct response to the specific environmental vulnerabilities of CRAJUBAR, focusing on ensuring access to a vital resource and protecting water ecosystems.

By analyzing the three dimensions (social, economic and environmental), a complex hierarchy of concerns for CRAJUBAR is revealed. In the social dimension, primary health and child literacy emerge as the highest priorities, indicating a focus on immediate well-being and human capital development. In the economic dimension, the municipal HDI and income distribution lead, signaling a search for development that goes beyond economic growth, incorporating quality of life and equity. In the environmental dimension, access to drinking water receives the highest priority, reflecting the criticality of this resource, especially in the semi-arid context, followed by sewage treatment, crucial for environmental and public health. This priority distribution suggests an approach that seeks to balance human basic needs, social justice, and natural resources sustainability, highlighting areas in which the challenges are perceived as most urgent.

In general, the results of the prioritization of urban Sustainability indicators in CRAJUBAR pointed to an integrated vision, although with different weights of the dimensions of sustainable development. The strong emphasis on health, basic education, access to drinking water, and income distribution, suggests a prioritization of the basic fundamental human needs and inequalities reduction, crucial elements for building more resilient and egalitarian. The lower priority given to aspects such as formal employment (in the economic dimension) and garbage collection (in the environmental dimension) indicates that, in the context of CRAJUBAR, in the view of the participants and compared to the other evaluated indicators, other challenges are considered more urgent. This analysis offers an overview of local priorities, showing that the indicators that point to the areas of greatest interest and need for action are those that reflect the aspirations of the local population, meaning that the set of indicators chosen in a participatory way, can be key elements in the orientation of public policies and investments in the region.

## 5 CONCLUSION

By identifying through a participatory process, the prioritization of the most relevant urban sustainability indicators to highlight the singularities of the urban agglomeration of CRAJUBAR, this article has achieved its main objective. The application of the methodology of the Sustainable Cities Program (PCS), enriched by consultation with the local population and hierarchical analysis through the Mudge Diagram, with social actors directly connected to city

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management and indicators, demonstrated the potential of a bottom-up approach to complement the top-down structure traditionally associated with PCS. This research contributes significantly to the theme of urban Sustainability indicators, demonstrating how the inclusion of the perspective of the citizens and local managers improves the selection and weighting of indicators, making the analysis of urban sustainability more representative of the reality and specific priorities of the territorial scope of study. The participatory process of prioritizing indicators highlights the importance of involving different segments of society in the construction of an efficient and democratic urban planning. By applying the PCS methodology in a participatory manner in CRAJUBAR, it was possible to clearly identify the most critical areas in the region that require immediate intervention.

CRAJUBAR'S civil society identified 20 PCS sustainability indicators of extreme importance, which were subsequently prioritized by various social actors connected to city management and indicators. The results of this prioritization reveal critical areas for achieving sustainability in the region, distributed in the social, environmental and economic dimensions. In the social sphere, primary health care and child literacy emerged as central focuses, with indicators such as "Population assisted by family health teams", "Vaccine coverage" and "Fully literate children by the age of 8" receiving high relevance. In the economic sphere, the urgency of a development that prioritizes quality of life and equity is indicated by the importance attributed to the municipal "Human Development Index (HDI) " and the "Income Distribution". Noticeably, in the environmental dimension, "Permanent and sustainable access to drinking water" stood out as the most pressing area for CRAJUBAR's sustainability, followed by sewage treatment. This prioritization points to the need for interventions aimed at improving health and basic education, reducing socioeconomic inequalities and, crucially, ensuring access to safe drinking water and adequate sanitation in the region.

The relevance of this research is in its ability to integrate the technical issue of PCS with the practical knowledge and perception of civil Society and local decision makers. The use of the Mudge diagram allowed us to structure collective decision-making, revealing a consensus on the relative importance of different aspects of Sustainability. The participation of various social actors, from inhabitants to city managers, enriched the process, ensuring that community values and needs were considered in the identification of priority indicators. The results obtained provide subsidies for participatory urban planning in CRAJUBAR, directing the focus to the areas considered most critical by the population itself and those responsible for the management of the city.

For future studies, it is suggested to deepen the analysis of the perception of different social actors in relation to each dimension of sustainability, investigating possible divergences and convergences in their prioritization. In addition to that, it would be relevant to monitor the implementation of public policies informed by this prioritization of indicators, assessing their real impact on CRAJUBAR's urban sustainability. Other research could also explore the application of this participatory methodology in other Brazilian urban contexts, comparing results and seeking to identify patterns or singularities in sustainability priorities in different realities.

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## DECLARATIONS

### CONTRIBUTION OF EACH AUTHOR

When describing each author's participation in the manuscript, use the following criteria:

- **Study Concept and Design:** Maria Lucineide Gomes da Silva; Gesinaldo Ataíde Cândido; Eduardo Rodrigues Viana de Lima.
- **Data Curation:**: Maria Lucineide Gomes da Silva; Gesinaldo Ataíde Cândido.
- **Formal Analysis:** Maria Lucineide Gomes da Silva.
- **Funding Acquisition**: Maria Lucineide Gomes da Silva; Eduardo Rodrigues Viana de Lima.
- **I Investigation:** Maria Lucineide Gomes da Silva.
- **Methodology**: Maria Lucineide Gomes da Silva; Gesinaldo Ataíde Cândido; Eduardo Rodrigues Viana de Lima
- **Writing - Initial Draft**: Maria Lucineide Gomes da Silva.
- **Writing - Critical Review**: Maria Lucineide Gomes da Silva; Gesinaldo Ataíde Cândido; Eduardo Rodrigues Viana de Lima.
- **Review and Final Editing**: Maria Lucineide Gomes da Silva; Gesinaldo Ataíde Cândido; Eduardo Rodrigues Viana de Lima.
- **Supervision**: Gesinaldo Ataíde Cândido; Eduardo Rodrigues Viana de Lima.

### DECLARATION OF CONFLICTS OF INTEREST

We, **Maria Lucineide Gomes da Silva; Gesinaldo Ataíde Cândido and Eduardo Rodrigues Viana de Lima**, declare that the manuscript entitled "**Prioritizing Urban Sustainability Indicators: A Participatory Analysis Based on the Sustainable Cities Program Methodology**":

1. **Financial ties:** We have/do not have financial ties that could influence the results or interpretation of the work. This work was funded by the Paraíba State Research Support Foundation (FAPESQ) through a grant awarded to the first author.
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3. **Personal Conflicts:** No personal conflicts of interest related to the content of the manuscript. No personal conflicts related to the content were identified.