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ANALYZE AND PROPOSE IN THE MUNICIPAL PUBLIC MANAGEMENT OF AN AMAZONIAN CITY THE APPLICATION OF THE INDICATORS WITH THE WATER THEME OF ABNT NBR ISO 37120:2021. CASE STUDY: BELÉM DO PARÁ

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ABSTRACT

Through technical standards, it was possible to research and understand the application of specific indicators for "Sustainable Cities and Communities". This includes a set of eight ISO standards developed by the Technical Committee on Sustainable Development in Communities (ISO/TC 268), adopted in the context of ABNT/CEE-268. Within these standards is ABNT NBR ISO 37120:2021, which certified 93 indicators in 19 themes, among which is the "water" theme, with seven indicators researched and validated. By analyzing and proposing the application of the indicators to a city in the Amazon, directing to the city of Belém do Pará, it was possible to compare the results with another municipality and at the level of Brazil, and how the municipality of Belém has been offering the population urban services with quality of life through the theme "water", by the SDGs, specifically SDG 6, which deals with the availability and sustainable management of water and sanitation for all, also integrating SDG 11, which deals with Sustainable Cities and Communities. The results pointed out great challenges for the city of Belém, which are related to the improvement of its 7 indicators. More than 50% of the indicators of Belém do Pará were below the certified city, São José dos Campos, and at the level of Brazil. By proposing a public management committed to the reality of each municipality, it is possible to identify and point out the failures of the services and propose improvements, with integration and partnership of the communities, showing the benefits and care that everyone should have with public services, to obtain a quality of life and well-being for people at any age, thus ensuring sustainable development.

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INTRODUCTION

The United Nations (UN) highlights in its studies that, currently, 55% of the world's population lives in urban areas, as indicated by the 2019 Sustainable Cities Program (PCS) report (Brasil, 2019). This number is projected to increase to 68% by the year 2050. According to the most recent data from the Brazilian Institute of Geography and Statistics (IBGE, 2022), from 2010 to 2022, the Brazilian population grew by 6.5%. When compared with the 2010 census, the increase in the population living in urban concentrations in Brazil was 9.2 million people, which represents a significant growth in the country. These 2022 data corroborate previously released research, including a 2018 study by the Institute of Applied Economic Research (IPEA), which projected a growth of the Brazilian population to around 206 million inhabitants by 2050 (IPEA, 2018).

In addition, information provided by the Sustainable Cities Program, in collaboration with CITinova (Integrated Planning and Technologies for Sustainable Cities), highlights recent research on this trend of migration of the world's population to urban areas. A specific study by CITinova from 2022 illustrates these observations in Figure 1.

Figure 1 - Global and national population data

Source: CITinova, 2024.

As information emerges, such as those presented in Figure 1, where there is a great growth for urban areas in Brazil and, globally, a large concentration of people in urban areas by 2050, with a consequent increase in CO2 emissions, the need for research that uses tools capable of offering clear and objective results on how to improve the quality of life of people in urban areas grows, without harming the environment. At the same time, it is crucial to keep the population always informed about their basic needs, such as access to drinking water, sewage, and transportation, with quality care, promoting cities and human settlements that are inclusive, safe, resilient, and sustainable. In this way, it contributes to achieving the goals established by Sustainable Development Goal 11 (SDG

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11), as well as SDG 6 – Ensure the availability and sustainable management of water and sanitation for all, emphasizing the importance of integrating sustainability into urban development.

Within this urban context, Brazilian standards, ABNT NBR ISO 37120:2021, stands out when it demonstrates through its indicators the importance of water in Brazil and for Brazilians, within the National Sanitation Policy, which deals with the public services of the network, called "Activities related to water supply and sewage services – Guidelines for the evaluation and improvement of the service provided to users". The seven NBR indicators related to the theme "Water" can be evaluated and compared as to their applicability and measurement of values.

When analyzing and proposing indicators for sustainable cities and communities in municipal public management, it is necessary to investigate the applicability of these indicators in the standardization of a series of NBR ISO - ABNT/CEE-26 standards used to classify "More sustainable and intelligent cities."

Searching for information in the literature on "Smart and Sustainable Cities" has increased considerably both nationally and internationally, driven by the insights that such data can offer in the evaluation of the management and performance of urban services and quality of life over time, as in the case of the city under study, Belém do Pará. This addition of information underlines the importance of investigating how cities can adjust their indicators to the specific reality of municipal management.

According to Giffinger et al. (2007), the challenges faced by cities do not depend exclusively on their size since even medium and small cities can exhibit remarkable competencies in this area.

The indicators of the water sector within the 19 themes of ABNT NBR ISO 37120:2021 can be measured and accounted for, aiming at an incentive for public policies to act and improve the percentage of urban services and quality of life offered to the population of Brazil. Data from the IBGE (2022), which gathers information on the municipalities and states of Brazil, currently accounts for a total of 5,570 municipalities in the country.

The construction of a data measurement model represents an opportunity rich in scientific discoveries, as the indicators can accurately capture the reality of each municipality, allowing an accurate assessment of the current state of the city based on the indicators defined in the regulations. The framework provided by the UN-SDG and its

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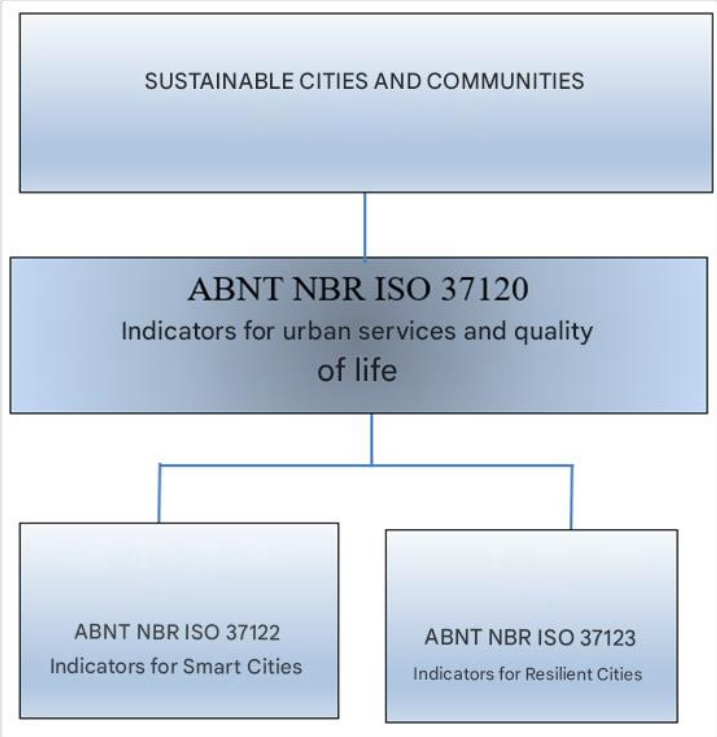
partners aims to make cities and human settlements inclusive, safe, resilient, and sustainable by outlining 17 interlinked goals that address key global development challenges, including 169 targets covered by 12 thematic axes and 260 indicators. Notably, SDG 11 (Sustainable Cities and Communities), aligned with ISO 37120, 37122, and 37123, highlights specific indicators for this purpose.

Figure 2 shows the hierarchical representation of these indicators, which are part of a series of eight ISO standards prepared by the Technical Committee for Sustainable Development in Communities (ISO/TC 268), adopted in the context of ABNT/CEE-268.

Figure 02 - Integration of the indicators of ABNT NBR ISO 37122 prepared by the Special Study Committee on Sustainable Cities and Communities (ABNT/CEE-268).



Source: ISO 37122, 2020.

The integrated use of indicators, in line with ABNT NBR ISO 37120, makes it easier for cities to identify additional indicators for smart cities, as established by ABNT NBR ISO 37122:2020. These indicators serve as essential management tools to measure, quantify, or calculate the performance of certain processes or objects of study. The focus of this research is on the research of indicators within the theme "Urban Services and Quality of Life", motivated by the NBR ISO 37120 and 37122 standards, which provide updated and

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relevant information. Thus, the objective focuses on the development of a measurement model for more sustainable and intelligent cities.

As a reference, the ABNT NBR ISO 37120:2021 and 37122:2020 standards were used. It is important to note that these standards reflect a global perspective of indicators for urban services and quality of life. Therefore, the application of these indicators must be aligned with current Brazilian standards and legislation, especially regarding definitions, metrics, and methods for obtaining the indicators.

As highlighted in ISO 37120:2021, compliance with this standard does not automatically confer a particular *status*. A city that adapts to this standard, with regard to the measurement of indicators for urban services and quality of life, can only claim compliance in this specific aspect.

Being in compliance with the ABNT NBR ISO standards represents a commitment to the pursuit of conformity and performance evaluations through normative documents. This effort contributes to competitiveness and sustainability in the service market, both domestic and foreign, fostering scientific and technological development and environmental protection (ABNT, 2022).

After collecting and selecting the main indicators to be studied in the context of sustainable and smart cities, an analysis between cities is proposed, using as a reference a city already recognized for its "certification". This method aims to monitor the performance of the selected indicators in the cities studied.

Currently, a diversity of indicator frameworks and tools are available to assess sustainability and urban intelligence. Aragão (2020) observes that the standardization of these indicators is carried out by ISO, meeting the specifications of the United Nations in line with the SDGs.

A contemporary example of the evaluation of these indicators can be seen in the city of São José dos Campos (PQTEC, 2022), which underwent a certification process considering 276 indicators. This rigorous evaluation process culminated in the granting of São José dos Campos the right to use the ABNT Conformity Mark (2022), marking the city as the first in Brazil to obtain Smart Cities certification.

Case studies represent a valuable tool in research for the selection of indicators. Garau and Pavan (2018) conducted a study on the selection of indicators, using a shortlist based on the frameworks and CityKeys applied to the historic center of Cagliari, Italy. The ultimate goal of this case study" was to promote the improvement of quality of life and

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establish stronger correlations between urban quality and the perception of well-being and resilience in cities.

Exploring the indicators can also involve a comparative analysis between the different standards adopted for "Smart Cities". According to Huovila *et al.* (2019), the definition of goals, performance evaluation, and monitoring by municipal managers, for example, require clear and precise indicators.

The IDSC-BR (2022) makes it possible to classify cities based on an overall score, which reflects progress toward full compliance with the 17 SDGs. The scoring scale goes from 0 to 100, where 100 represents the full achievement of the Sustainable Development Goals.

A practical example of the use of the IDSC-BR is shown in **Figure 03**, where the city of Belém do Pará is classified according to the index.

Figure 03 - Classification of the IDSC-BR -Belém do Pará.

Source: Sustainable Cities Institute, 2024a.

In this evaluation, it is possible to verify the performance of the city of Belém do Pará regarding the SDGs. Belém needs to make significant progress in more than 50% of the objectives and indicators. Currently, the city is considerably far from being a sustainable and smart city. In SDG 6 - Drinking water and sanitation, Belém has an average score between 50 and 59.99; this portrays the reality presented by the indicators of the Sustainable Cities Institute (2024).

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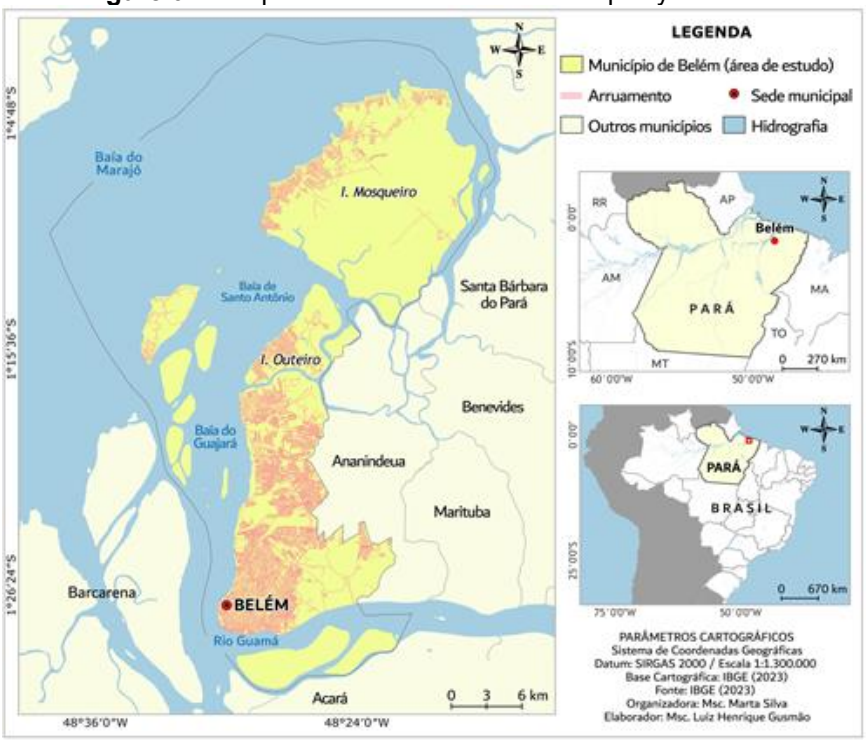
CHARACTERISTICS OF THE CITY OF BELÉM DO PARÁ

To explore the challenges faced by cities in achieving sustainable development goals and objectives, the largest Brazilian municipality in the Amazon region, located in the state of Pará, the city of Belém, was chosen.

Belém, located in the north of Brazil, in the state of Pará, covers a territorial area of approximately 1,059.466 km² and has a population of 1,303,403 inhabitants, with a GDP per capita of R$ 22,216.33, according to IBGE data (2022).

Figure 04 shows the location of the municipality of Belém and its regions, including local communities.

Figure 04 - Map of the location of the municipality of Belém.



Source: Author, 2023.

By analyzing the MAP of Brazil by region, in figure 05, through the City Development Index (IDSC-BR, 2024), it is possible to observe how far the North Region of Brazil is from achieving the score that measures the total progress of cities towards achieving the sustainable development goals. Cities are ranked by overall score, measuring total progress in meeting the 17 SDGs. The score ranges from 0 to 100, where 100 is the maximum limit and indicates an optimal performance in meeting the SDGs.

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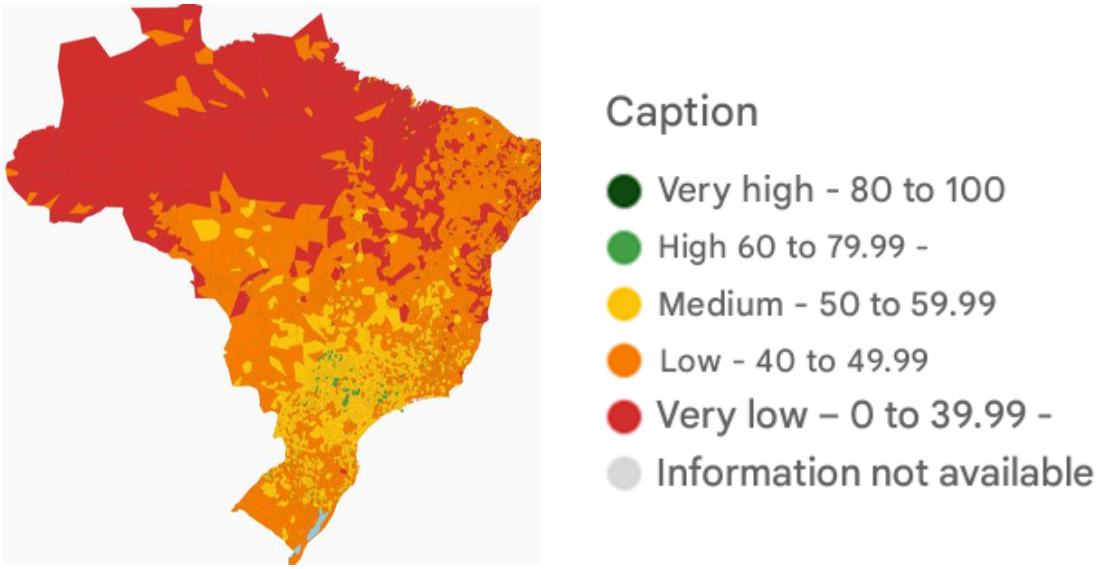
Figure 05 - View of the overall score of Brazilian capitals.



Source: Adapted from SDG INDEX, 2024.

The performance in meeting the SDGs in all regions of Brazil shows the need for cities to improve their performance according to the UN goals. It also allows for a series of analyses that go beyond municipal limits. Allowing comparisons and groupings between large and small regions, such as between municipalities and metropolitan regions.

METHODOLOGY

The methodology was adopted to investigate the variables of interest within the standards of ABNT NBR ISO 37120:2021 related to sustainable cities and communities. They are aligned with the methodological model used in the research. Figure 6 illustrates the methodological model used in the research.

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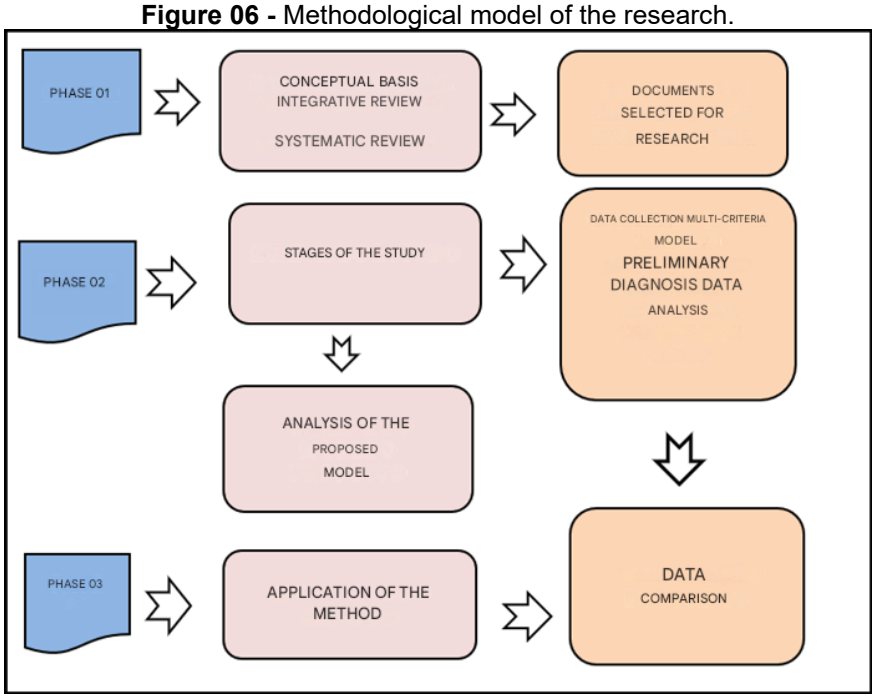
Figure 06 - Methodological model of the research.



Source: Author, 2024.

In the initial phase of the research on the study variables, an investigation was carried out to understand the concept of sustainable and smart cities, their temporal evolution and publications, as well as national and international standards related to the theme. A systematic review of the literature addressing "*Smart Cities*", "Smart Cities", "Indicators for Smart Cities", "SDGs", "Sustainability Tools", "Sustainable Cities and Communities" and the NBR and ISO standards regarding "Sustainable and Smart Cities" allowed the selection of publications relevant to the case study of the municipality of Belém do Pará.

The indicators chosen that were the object of a case study for the municipality of Belém do Pará are those certified by the municipality of São José dos Campos, which, after a careful selection process, obtained the certification of 128 indicators, among these the indicators of the theme "Water", where 07 indicators were certified. Figure 07 shows the process of studying the certified indicators.

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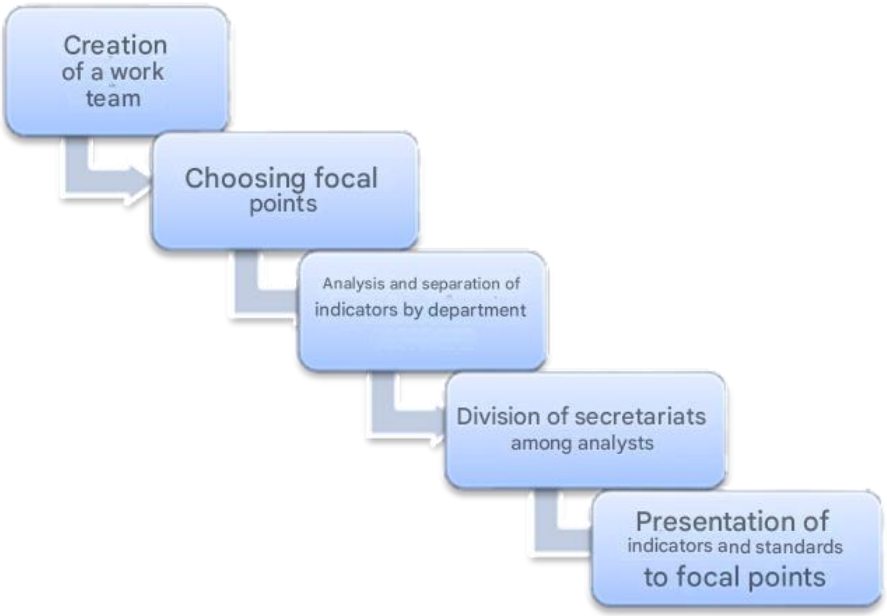
Figure 07 - Process of study of certified indicators.



Source: Adapted from PQTEC, 2022.

The data related to the city of São José dos Campos, used as a reference in this research, were analyzed, refined, and classified based on a methodology that allows evaluating their applicability in different types of cities. This approach was especially focused on the case of the municipality of Belém do Pará.

As with all Brazilian capitals, the North region contributes significantly to the "2030 Agenda for Sustainable Development". The municipality of Belém, as well as other capitals in Brazil, acts as a hub of economic development and carries a significant responsibility in relation to the well-being of the population. The city has a growth in the supply of work, education, cultural equipment, and public and private services.

In the search for evidence of the real situation of the indicators related to the "water" theme, the data collection involved searches for information from municipal and state public agencies and with the use of online resources from official entities. Data collection faced significant challenges, as not all the information was available on the official websites of each agency surveyed. Despite the difficulties in finding consolidated and accurate sources, it was possible to quantify the 07 indicators of the Water theme, as described in when 01.

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Table 01 – Indicators of ABNT NBR ISO 37120. Water Theme. City of São José dos Campos.

No.	Indicator	Un	Quant
01	Percentage of the city's population with drinking water service	%	100,00
02	Percentage of the city's population with sustainable access to a source of water suitable for consumption.	%	100,00
03	Total domestic water consumption per capita (liters/day)	per capita(liters /day)	139,15
04	Drinking water quality compliance rate	%	99,84
05	Total water consumption per capita (liters per day)	liters/day	175,04
06	Average duration of interruption of water supply, in hours per household per year	hours/year	33,11
07	Percentage of water losses (non-revenue water)	%	32,58

Source: Adapted from Parque Tecnológico São José dos Campos, (2022)

The importance of applying a methodology in field research is unquestionable, even when it is based on documents, public consultations, and testimonies collected through interviews. Vida and Lopes (2020) highlight that approaches that use multiple methods provide a concrete view of each city analyzed.

The research methods and technical procedures employed show that research can be based on documentary and narrative analyses. In this context, detailed case studies and documented samples serve as guiding elements for the construction of meaningful reports.

With the availability of open data on government platforms, it was possible to gather data on the general situation in Brazil regarding the water theme. For a more comprehensive analysis of data comparison, between the reference city São José dos Campos and the researched city Belém do Pará.

As highlighted by Pereira et al. (2018), the scientific method begins with the organized observation of facts, followed by the execution of experiments, logical deductions, and the scientific validation of the results obtained. This systematic process aims to find answers to the questions investigated, paving the way for the formulation of scientific theories.

RESULTS

The results of the research with the indicators of ABNT NBR ISO 37120:2021, after qualitative and quantitative analysis, within the methodology applied to the municipality of São José dos Campos, can be proposed to the municipal public management of the municipality of Belém do Pará, within the theme Water, considering an evaluation that allows adapting to the local reality, among the information presented during data collection,

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which were of paramount importance in gathering all references pertinent to the Amazonian reality. The data at the Brazilian level were relevant for a global and local analysis among the municipalities. Table 1 shows the quantities of the field research on the theme "water".

Table 01 - Indicators of ABNT NBR ISO 37120 selected for analysis of the water theme.

No.	Description of the ABNT NBR ISO 37120 Indicator	Researched Data				Research sources
		Un	Brazil	Bethlehem	São José dos Campos	
01	Percentage of the city's population with drinking water service.	%	82,32	74,96	100,00	https://anuario.belem.pa.gov.br/wp-content/uploads/2020/12/Tabela-8-Saneamento-Ambiental.pdf -2018 Access: http://www.ipea.gov.br/portal/publicacoes Volume 6 - Strategic vision for the future of basic sanitation in Brazil -plansab -page 213
02	Percentage of the city's population with sustainable access to a water source suitable for consumption	%	97,9	79,00	100,00	https://anuario.belem.pa.gov.br/wp-content/uploads/2020/12/Tabela-16-Saneamento-Ambiental.pdf source: IBGE Indicators Platform. Available at: <https://ods.ibge.gov.br/>. Accessed on: 3 Apr. 2023. Access: http://www.ipea.gov.br/portal/publicacoe
03	Total household water consumption per capita	per capita(liters/day)	116,00	94,70	139,15	https://anuario.belem.pa.gov.br; https://www.redesocialdecidades.org.br/br/PA/belem/regiao/+aura/consumo-total-de-agua; https://agenciadenoticias.ibge.gov.br/agencia-sala-de-imprensa/2013-agencia-de-noticias/releases/27607-em-2017-o-brasil-consumia-6-3-litros-d-agua-para-cada-r-1-gerado-pela-economia
04	Drinking water quality compliance rate.	%	-	-	99,84	https://www.cosanpa.pa.gov.br/
05	Total water consumption per capita.	liters/day	152,10	158,00	175,04	http://www.ipea.gov.br/portal/publicacoes page 08 SDG 6.1 Booklet
06	Average duration of interruption of water supply, in hours per household per year.	hours/year	-	-	33,11	https://www.cosanpa.pa.gov.br/
07	Percentage of water losses (non-revenue water).	%	39,2	45	32,58	http://www.ipea.gov.br/portal/publicacoes page 08 SDG 6.1 Booklet
No.	Description of the ABNT NBR ISO 37120 Indicator	Researched Data				Research sources
		Un	Brazil	Bethlehem	São José dos Campos	
01	Percentage of the city's population with drinking water service.	%	82,32	74,96	100,00	https://anuario.belem.pa.gov.br/wp-content/uploads/2020/12/Tabela-8-Saneamento-Ambiental.pdf -2018 Access: http://www.ipea.gov.br/portal/publicacoes Volume 6 - Strategic vision for the future of basic sanitation in Brazil -plansab -page 213
02	Percentage of the city's population with sustainable access to a water source suitable for consumption	%	97,9	79,00	100,00	https://anuario.belem.pa.gov.br/wp-content/uploads/2020/12/Tabela-16-Saneamento-Ambiental.pdf source: IBGE Indicators Platform. Available at: <https://ods.ibge.gov.br/>. Accessed on: 3 Apr. 2023. Access: http://www.ipea.gov.br/portal/publicacoe

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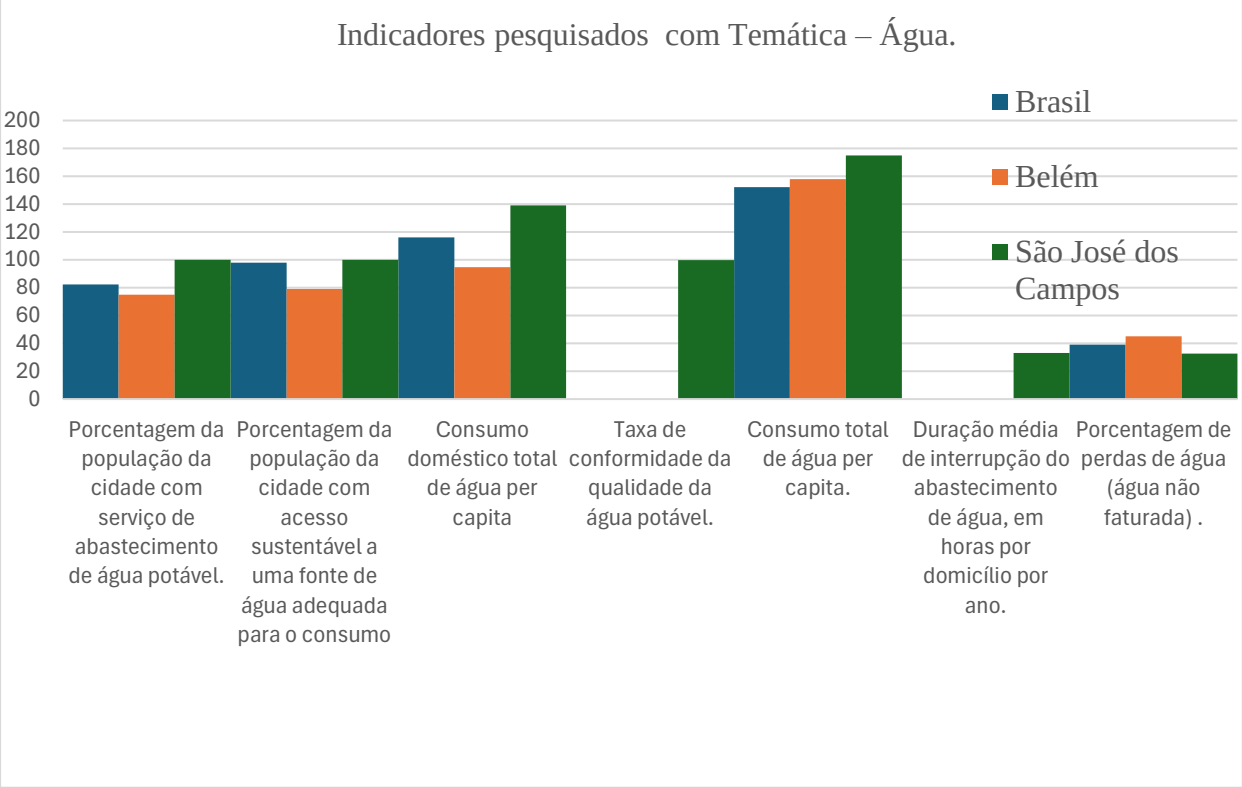
03	Total household water consumption per capita	per capita(liters/day)	116,00	94,70	139,15	https://anuario.belem.pa.gov.br; https://www.redesocialdecidades.org.br/br/PA/belem/regiao/+aura/consumo-total-de-agua; https://agenciadenoticias.ibge.gov.br/agencia-sala-de-imprensa/2013-agencia-de-noticias/releases/27607-em-2017-o-brasil-consumia-6-3-litros-d-agua-para-cada-r-1-gerado-pela-economia
04	Drinking water quality compliance rate.	%	-	-	99,84	https://www.cosanpa.pa.gov.br/
05	Total water consumption per capita.	liters/day	152,10	158,00	175,04	http://www.ipea.gov.br/portal/publicacoes page 08 SDG 6.1 Booklet
06	Average duration of interruption of water supply, in hours per household per year.	hours/year	-	-	33,11	https://www.cosanpa.pa.gov.br/
07	Percentage of water losses (non-revenue water).	%	39,2	45	32,58	http://www.ipea.gov.br/portal/publicacoes page 08 SDG 6.1 Booklet

Source: Author, 2024.

Figure 08 shows the analysis of the water theme for the municipality of Belém as a result of the investigation of the ABNT NBR ISO 37120 indicators used to classify smart and sustainable cities.

Figure 08 – Indicators surveyed with Theme – Water.



Source: Author, 2024

The analysis of the indicators related to the water theme in figure 03, when comparing the results of the municipality of Belém with the reference city São José dos

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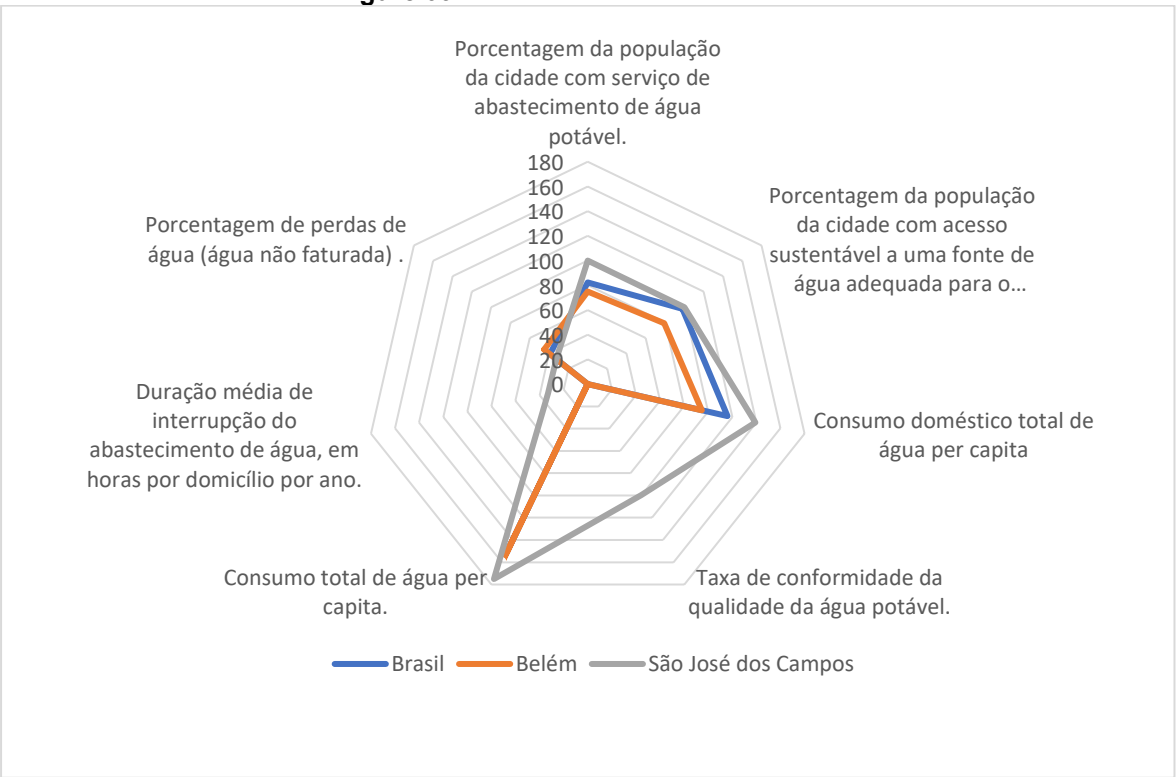
Campos, Belém reveals a challenging panorama in all seven indicators evaluated. The result of indicator 07 – Percentage of water loss is the only indicator, which when compared shows a greater approximation of closer percentage values. The national data, at the level of Brazil, which represents the 5,570 municipalities in the country, presents a better result when compared to the municipality of Belém in all 07 indicators.

In figure 09, the radar map presents an analysis of the behavior of the indicators about what would be desirable to achieve results with higher percentages for urban services and quality of life offered to the population, in the case under study, the city of Belém.

Figure 09 - Distribution of water indicators.



Source: Author, 2024

The radar graph shows, through the colors gray, orange, and blue, the number achieved in each city: Belém in orange, the reference city São José dos Campos in gray, and Brazil in blue. To be considered a more sustainable and smarter city in the theme "water", the city of Belém do Pará needs to achieve better results for each service demonstrated through the indicators. This result also reflects the need for the evolution of all services at the level of Brazil.

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FINAL CONSIDERATIONS

The questions proposed regarding the applicability of indicators with the theme "water" for a city in the Amazon, through a certifying standardization of the NBR ISO series of ABNT/CEE-26, were answered with an analysis of the values. The objectives of the research with the indicators of ABNT NBR ISO 37120 were achieved, reaching values with greater evidence, which demonstrates how far the city of Belém is from achieving the development of urban services and quality of life efficiently. In the IDSC-BR – Belém do Pará classification, shown in figure 03, the need for progression of SDG indicators is confirmed. Among the 17 SDG indicators, one of the main objectives is to ensure the availability and sustainable management of water, and by 2030, ensure universal and equitable access to safe and affordable drinking water.

The city of Belém, when compared to the city taken as a reference – São José dos Campos – shows a panorama with many challenges in all seven indicators evaluated in the survey. Indicator 07 "Percentage of water losses (non-revenue water)" represents a concern in Brazil, in Belém it could not be different, presenting a percentage of 45% of water loss, for various reasons, including old registers, with wear or defects, leaks in the pipes, clandestine connections or even measurement failures. This evidence can be resolved through public management with greater commitment to the reality of each municipality, studying solutions, adaptations and education, seeking a partnership with communities, showing the benefits and care that everyone should have with public services, to obtain a quality of life and well-being for people at any age, thus ensuring sustainable development.

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