UNIVERSIDADE ESTADUAL DO OESTE DO PARANÁ
PROGRAMA DE PÓS-GRADUAÇÃO EM ADMINISTRAÇÃO
MESTRADO PROFISSIONAL

WESTERN PARANÁ STATE UNIVERSITY
PROFESSIONAL MASTER'S IN ADMINISTRATION

EIXOS DE SUSTENTABILIDADE DO PROGRAMA/PLANO CIDADES SUSTENTÁVEIS DE CASCAVEL: ANÁLISE DA CONFORMIDADE COM A NORMA ABNT ISO 37120/2017

SUSTAINABILITY AXES OF THE SUSTAINABLE CITIES PROGRAM/PLAN OF CASCAVEL: ANALYSIS OF COMPLIANCE WITH THE ABNT ISO 37120/2017 STANDARD

[TRADUÇÃO INGLESA]

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CASCAVEL/PR
2024

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SUSTENTABILIDADE AXES OF CASCAVEL'S SUSTAINABLE CITIES PROGRAM/PLAN: ANALYSIS OF COMPLIANCE WITH ABNT ISO STANDARD 37120/2017

Dissertation presented in partial fulfilment of the requirements for the degree of Master of Science in Administration in the Department of Administration, Western Paraná State University.
Advisor: Dr Geysler Rogis Flor Bertolini
Co-advisor: Dra Paula Regina Zarelli

Dissertação apresentada ao Programa de Pós-Graduação em Administração (PPGAdm) – Mestrado Profissional da Universidade Estadual do Oeste do Paraná, como requisito parcial para obtenção do grau de Mestre em Administração.
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CASCAVEL/PR
2024

International Cataloging-in-Publication Data
UNIOESTE Library System

Teske, Kamyla Taysa.
Sustentabilidade axes of Cascavel's sustainable cities program/plan: analysis of compliance with ABNT ISO standard 37120/2017. /Kamyla Taysa Teske; advisor: Geysler Rogis Flor Bertolini; Co-advisor: Paula Regina Zarelli; [Translation of Henrique Ferreira Borges de Carvalho], 2024.
132 f.

Dissertation (Degree in of Master of Science in Administration) – Department of Administration, Western Paraná State University, 2024

1. Sustainable cities. 2. Sustainability indicators. 3. ISO 37120/2017. 4. Sustainable.5. Cities Program.6. Sustainable development. I. Bertolini, Geysler Rogis Flor. II. Zarelli, Paula Regina. III. Carvalho, Henrique Ferreira Borges de. IV.Title.

unioeste
Universidade Estadual do Oeste do Paraná
Reitoria

PARANÁ
GOVERNO DO ESTADO

CNPJ 78.680.337/0001-84

Rua Universitária, 1619, Jardim Universitário Tel.: (45) 3220-3000 - www.unioeste.br

CEP: 85819-110 - Cx. P.: 701

ATA DA DEFESA PÚBLICA DA DISSERTAÇÃO DE MESTRADO DE KAMYLA TAYSA TESKE, ALUNO(A) DO PROGRAMA DE PÓS-GRADUAÇÃO EM ADMINISTRAÇÃO DA UNIVERSIDADE ESTADUAL DO OESTE DO PARANÁ - UNIOESTE, E DE ACORDO COM A RESOLUÇÃO DO PROGRAMA E O REGIMENTO GERAL DA UNIOESTE.

Ao(s) 2 dia(s) do mês de agosto de 2024 às 10h00min, no(a) Sala de Reuniões do CCSA, realizou-se a sessão pública da Defesa de Dissertação do(a) candidato(a) Kamyla Taysa Teske, aluno(a) do Programa de Pós-Graduação em Administração - nível de Mestrado, na área de concentração em Competitividade e Sustentabilidade. A comissão examinadora da Defesa Pública foi aprovada pelo Colegiado do Programa de Pós-Graduação em Administração. Integraram a referida Comissão os(as) Professores(as) Doutores(as): Aline Dario Silveira, Sílvio Roberto Stéfani, Paula Regina Zarelli, Geysler Rogis Flor Bertolini. Os trabalhos foram presididos pelo(a) Geysler Rogis Flor Bertolini. Tendo satisfeito todos os requisitos exigidos pela legislação em vigor, o(a) aluno(a) foi admitido(a) à Defesa de DISSERTAÇÃO DE MESTRADO, intitulada: "Eixos de Sustentabilidade do Programa/Plano Cidades Sustentáveis de Cascavel: Análise da Conformidade com a Norma ABNT ISO 37120/2017". O(a) Senhor(a) Presidente declarou abertos os trabalhos, e em seguida, convidou o(a) candidato(a) a discorrer, em linhas gerais, sobre o conteúdo da Dissertação. Feita a explanação, o(a) candidato(a) foi arguido(a) sucessivamente, pelos(as) professores(as) doutores(as): Aline Dario Silveira, Sílvio Roberto Stéfani, Paula Regina Zarelli. Findas as arguições, o(a) Senhor(a) Presidente suspendeu os trabalhos da sessão pública, a fim de que, em sessão secreta, a Comissão expressasse o seu julgamento sobre a Dissertação. Efetuado o julgamento, o(a) candidato(a) foi aprovado(a). A seguir, o(a) Senhor(a) Presidente reabriu os trabalhos da sessão pública e deu conhecimento do resultado. E, para constar, o(a) Coordenador(a) do Programa de Pós-Graduação em Administração, da Universidade Estadual do Oeste do Paraná – UNIOESTE - Campus de Cascavel, lavra a presente ata, e assina juntamente com os membros da Comissão Examinadora e o(a) candidato(a).
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DEDICATION

I dedicate this work, first and foremost, to God, who strengthened and enlightened me at every step of this journey. To my dear family, who, with love, patience, and unconditional support, were always by my side, sustaining me through the most challenging moments and celebrating each small victory with me.

This work is also dedicated to all who believe in the transformative power of sustainability.To the cities, which go beyond urban spaces; they are the living reflection of our collective choices.

May this study contribute to the development of fairer, more resilient, and sustainable cities, where progress walks hand in hand with respect for the environment and social well-being.

Finally, I dedicate this effort to the professionals, public managers, researchers, and citizens who, with determination and hope, are committed to building a more responsible future for the next generation.

ACKNOWLEDGEMENTS

First and foremost, I thank God, the source of all my strength, health, and perseverance, for guiding and sustaining me throughout this important journey.

To my dear family, my safe harbor, I am grateful for all the love, patience, and unconditional support they offered me at every moment. To my parents, who always believed in me and pushed me forward, even during the most challenging phases. To my friends, who understood my absences, supported me unconditionally, and were always by my side, I offer my eternal gratitude.

To my advisor, Dr. Geysler Rogis Flor Bertolini, and my co-advisor, Dr. Paula Regina Zarelli, I am deeply grateful for the knowledge generously shared, for their always valuable guidance, and for their constant support. Your dedication and patience were the foundation that made this work a reality.

To the professors of the Postgraduate Program in Administration at Unioeste, I am thankful for the invaluable lessons that accompanied me throughout the course, and to the program secretary, José Paulo Tasca, for his patience and constant support in resolving doubts.

To the members of the thesis approval committee, Dr. Aline Dario Silveira and Dr. Silvio Roberto Stéfani, I thank you for your suggestions, which deeply enriched this work.

To my classmates, who, with their ideas, constructive criticism, and words of encouragement, made this journey lighter and more enriching. The time spent with you was a gift during this journey. To my friends, who, despite my absences, were always by my side, offering understanding and affection.

To the public managers and specialists who participated in this research, my sincere gratitude. Your generosity in sharing your time and knowledge was essential for the development of this study and for understanding the challenges faced in your fields.

Finally, to all those who, in some way, directly or indirectly, contributed to the realization of this work, I offer my most sincere and heartfelt thanks.

RESUMO

Teske, K. T. (2024). **Eixos de Sustentabilidade do Programa/Plano Cidades Sustentáveis de Cascavel: Análise da Conformidade com a Norma ABNT ISO 37120/2017**. Dissertação de Mestrado, Universidade Estadual do Oeste do Paraná, Cascavel, PR, Brasil.

O crescimento das cidades e a busca por equilíbrio entre crescimento econômico, qualidade de vida e preservação do meio ambiente têm tornado a sustentabilidade uma prioridade nos ambientes urbanos. Para orientar políticas públicas nesses sentindo, várias métricas e sistemas de indicadores foram desenvolvidos. No entanto, muitos desses focam apenas em partes específicas da sustentabilidade, ou são difíceis de interpretar. Assim, este estudo se concentra na avaliação dos pilares de sustentabilidade presentes no Plano Cidades Sustentáveis (PCS) em Cascavel, com o intuito de alinhar esses aspectos aos critérios estabelecidos pela Norma ISO 37120/2017. Para alcançar esse objetivo, foi realizada uma pesquisa de natureza aplicada e qualitativa, utilizando ferramentas específicas para avaliar a possível certificação da cidade seguindo os padrões da ISO 37120/2017. O método envolve uma abordagem de estudo de caso, concentrando-se na avaliação da sustentabilidade municipal e inclui etapas como pesquisa bibliográfica e documental, tabulação dos indicadores da ISO 37120/2017, além da validação empírica através do instrumento entrevistas semiestruturadas com especialistas. A análise dos dados foi conduzida usando o software Iramuteq. Os resultados indicam que Cascavel possui pontos fortes como uma economia diversificada, altas taxas de matrícula escolar, e gestão eficaz dos recursos hídricos. No entanto, áreas críticas como a qualidade do ar, tratamento de esgoto, e a promoção de áreas verdes urbanas necessitam de melhorias urgentes. A pesquisa destaca a importância da governança participativa e de parcerias estratégicas para o desenvolvimento sustentável. A implementação da ISO 37120/2017, com um sistema de monitoramento contínuo e a capacitação de equipes, é essencial para assegurar um desenvolvimento urbano sustentável e transparente. Este estudo oferece uma análise detalhada dos indicadores de sustentabilidade urbana em Cascavel, sugerindo ações específicas para a certificação e promoção de um modelo de cidade sustentável e resiliente.

Palavras-chave: Cidades sustentáveis; indicadores de sustentabilidade; ISO 37120/2017; Programa Cidades Sustentáveis; desenvolvimento sustentável;

ABSTRACT

Teske, K. T. (2024). **Sustainability Axes of Cascavel's Sustainable Cities Programme/Plan: Analysis of Compliance with ABNT ISO Standard 37120/2017**. Master's degree dissertation, Western Paraná State University, Cascavel, PR, Brasil.

The growth of cities and the pursuit of a balance between economic development, quality of life, and environmental preservation have made sustainability a priority in urban environments. To guide public policies in this regard, various metrics and indicator systems have been developed. However, many of these focus solely on specific aspects of sustainability or are difficult to interpret. Thus, this study focuses on evaluating the sustainability pillars present in Cascavel's Sustainable Cities Plan (PCS), aiming to align these aspects with the criteria established by ISO Standard 37120/2017. To achieve this objective, applied and qualitative research was conducted, using specific tools to assess the potential certification of the city in accordance with ISO 37120/2017 standards. The methodology involves a case study approach, focusing on municipal sustainability assessment, and includes steps such as bibliographic and documentary research, tabulation of ISO 37120/2017 indicators, and empirical validation through semi-structured interviews with experts. Data analysis was conducted using Iramuteq software. The results indicate that Cascavel has strengths such as a diversified economy, high school enrollment rates, and effective water resource management. However, critical areas such as air quality, sewage treatment, and the promotion of urban green spaces require urgent improvement. The research highlights the importance of participatory governance and strategic partnerships for sustainable development. The implementation of ISO 37120/2017, with a continuous monitoring system and team capacity building, is essential to ensure sustainable and transparent urban development. This study provides a detailed analysis of urban sustainability indicators in Cascavel, suggesting specific actions for certification and the promotion of a sustainable and resilient city model.

Keywords: Sustainable cities; sustainability indicators; ISO 37120/2017; Sustainable Cities Program; sustainable development;

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LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYMS	DESCRIPTION
ABNT	Brazilian Association of Technical Standards
ACIC	Commercial and Industrial Association of Cascavel
CBMPR	Fire Department of Paraná
DATA SUS	Department of Information and Informatics of the Unified Health System
GPS	Sustainable Public Management Guide
IBAM	Brazilian Institute of Municipal Management
IBGE	Brazilian Institute of Geography and Statistics
IPARDES	Parana Institute of Economic and Social Development
IPEA	Institute for Applied Economic Research
MDG	Millennium Development Goals
SDG	Sustainable Development Goals
WHO	World Health Organization
UN	United Nations
PCS	Sustainable Cities Program
GDP	Gross Domestic Product
SESP	Municipal Department of Public Security

SUMMARY

1. INTRODUCTION

The process of urban expansion in Brazil has intensified since the 20th century, but this expansion has occurred in a disorderly manner, leading to a scenario of environmental and social degradation, especially in large and medium-sized cities. The lack of infrastructure, the rapid process of urbanization, and the absence of city planning capable of meeting the population's needs without degrading the environment have caused severe damage to urban systems (Ribeiro, 2019).

In contemporary times, the economic development model adopted, which is based on the growth of production and consumption relations, leads to the degradation of natural resources (Lopes, 2016). Environmental degradation has been exacerbating pollution, industrialization, traffic congestion, waste generation, and the chaotic expansion of cities in pursuit of unchecked growth, damaging the planet (Dubou, Denardim, Bichueti & Oliveira, 2021). One of the greatest challenges facing cities today is reconciling economic development with environmental sustainability.

In response to this scenario, the concept of sustainable development and sustainability emerged, seeking to address these issues by understanding the weaknesses of the current model and the urgent need for a new approach to development that is fair, ecological, and equitable (Sachs, 2002). The term "sustainable development" was first discussed in 1983 at the World Commission on Environment and Development, created by the United Nations. It proposed that economic development should be integrated with environmental issues, meaning that sustainable development aims to meet the needs of the present without compromising the ability of future generations to meet their own needs (Corrêa & Passini, 2022). In 1992, the UN launched Agenda 21, which resulted in a global action plan to reconcile economic and social growth with environmental preservation. Since then, the concept has adapted and evolved.

In 2015, the UN established the Sustainable Development Goals (SDGs), consisting of 17 goals to be achieved by 2030. The SDGs make it clear that there is concern for social and environmental issues in urban areas (UN, 2015). Among these goals, one aligns directly with the objective of this research: sustainable cities and communities. SDG 11 highlights concerns about urbanization, the lack of city planning, and the need for public policies to address these problems. The future of our planet and its inhabitants is closely linked to the development of cities. These urban spaces hold the key to human progress,

so it is essential that they provide conditions for people to develop their creative and innovative abilities, ensuring a more promising future for all (Urban Systems, 2022).

Cities are places where resources, people, goods, services, and knowledge are concentrated (Stefani, Correa & Procidonio, 2022). They are both a problem and a solution to global challenges related to sustainable development (Guevara, Marinho & Eterovic, 2020). While cities' importance to the success of the sustainable development agenda is recognized, this reality remains distant for most Brazilian cities. Therefore, it is crucial to analyze cities as living, sustainable entities capable of reducing social and environmental impacts, where economic development aligns with sustainable development.

This gives rise to discussions about sustainable cities, which aim to mitigate urban problems by prioritizing waste reduction, cleaner and higher-quality public transportation, alternative energy sources, and pollution reduction, ultimately creating more sustainable and efficient urban spaces (Souza, Ramos, da Silva & Mendes, 2003). According to Spiri-Ferreira et al. (2024), this is a model of urbanization that prioritizes efficiency, innovation, and respect for the environment, ensuring a high quality of life for its inhabitants while significantly contributing to minimizing global challenges associated with sustainable development.

Thus, sustainable cities seek to maximize social and economic benefits while respecting the environment (Mori & Yamashita, 2015). They are seen as more durable human settlements, capable of providing an acceptable standard of living without harming ecosystems (Stefani, Correa & Procidonio, 2022). The concept of sustainable cities requires a new logic of functioning, management, and growth. Every sustainable city develops from a suitable, respectful, and considerate connection between the built environment and physical geography. Therefore, the idea of sustainable cities is not only an opportunity for urban development but also a way to conserve natural resources, extending the longevity of cities and the people who live in them (Gasparelo, Stefani & Schmidt, 2022).

Considering the concept of sustainable cities as a growing necessity, it is essential to evolve urban assessment systems. The development of these systems, whether to categorize cities as smart or sustainable (Ahvenniemi et al., 2017), results in a lack of standardization that, over time, prevents greater similarity between cities. In this context, the development of suitable tools to assist researchers in incorporating sustainable development practices into society is indispensable. These tools are composed of

sustainability indicators, allowing for the evaluation of a situation, its potential development, and monitoring. Indicators are analytical tools that aid decision-makers in formulating public policies.

The origins of debates on sustainability indices highlight the need to simultaneously assess ecosystem resilience, quality of life, and economic performance (Veiga, 2010). Similarly, Yigitcanlar & Kamruzzaman (2018) stress the importance of providing information that allows for reconciliation with sustainable development. However, Rosales (2011) notes that the difficulty of measuring sustainability indicators is amplified by the existence of many systems, which encompass at least three distinct views on cities: "one that considers it as an ecosystem, another that is concerned with its effects on larger ecosystems, and a third that focuses on its capacity to create a healthy environment within and outside its borders" (Chang, 2018, p. 33). Research on the challenges of formulating public policies for sustainable cities, conducted by the Brazilian Municipal Management Institute (IBAM) in partnership with the Ministry of Science, Technology, Innovation, and Communication (MCTIC), highlights the need to develop holistic strategies for intersectoral, federal, and territorial integration.

Among these tools, we can mention the Pressure-State-Response (PSR) Model, the Sustainability Barometer, the Sustainability Panel, Ecological Footprint, among others (Rohan, Branco, & Soares, 2018). However, tools that analyze more specific indicators for sustainability in cities or neighborhoods are considered rare. In this context, the Sustainable Cities Program and the ISO 37120/2017 standard emerge as important references in promoting urban sustainability, providing guidelines and indicators for performance evaluation.

The Sustainable Cities Program (PCS) is an urban sustainability agenda that encompasses five dimensions: social, environmental, economic, political, and cultural in municipal planning (GPS, 2013). The PCS aims to assist municipal management in implementing tools for planning public policies that work with sustainability in projects and actions of municipal executive and legislative powers, as well as the commitment of local private sectors and society (GPS, 2013).

The ABNT NBR ISO 37120/2017 is the first technical standard in Brazil for the sustainable development of communities—Indicators for urban services and quality of life. It contains detailed indicators that help municipalities measure and compare their performance (ABNT, 2017). ISO 37120 is an international standard developed by the International Organization for Standardization (ISO), which establishes a set of indicators

to measure the performance of urban services and quality of life in urban areas, as well as evaluate indicators that encompass a wide range of key areas in cities, including transportation, education, health, environment, governance, security, among others. It is known as "indicators for Sustainable Cities" and its first version was published in 2014, with subsequent revisions, such as the ISO 37120/2017 version, which allows cities to improve their performance in relation to sustainable development and quality of life goals (ABNT, 2017). The importance of ISO 37120/2017 lies in establishing a set of universally recognized indicators that help cities measure their performance and progress toward sustainability, enabling them to improve the most effective policies for the well-being of their inhabitants.

Thus, evaluating the alignment between the sustainability axes of the PCS and the key indicators of the ISO 37120/2017 standard is crucial for guiding urban policies, promoting more effective actions, achieving global sustainability goals, and ensuring more sustainable and resilient cities for the future.

1.1 RESEARCH PROBLEM

Life in cities has been the subject of various debates in recent decades, reflecting demographic, environmental, social, and economic issues. Cities are recognized as cultural, intellectual, technological, and productive centers, functioning as engines of human and social development.

According to the World Cities Report (2022), the forecast is that the global population will be 68% urban by 2050. However, it is essential to plan for this growth, as humanity is currently operating at the maximum capacity for the utilization of natural resources. The solution to the problems caused by rapid urban growth, such as social inequality and global warming, does not lie in reducing urbanization rates, but in promoting a significant transformation. This involves building and managing urban spaces to ensure sustainable growth, making cities safe, sustainable, and resilient, while also ensuring access to housing, basic sanitation, infrastructure, urban mobility, employment, and security (UN-HABITAT, 2022).

In this context, the pursuit of sustainable cities has become a global priority, driven by the recognition of the environmental, social, and economic challenges inherent in rapid urban growth. Corrêa & Passini (2022) highlight that cities are privileged spaces

capable of facilitating connections between local, national, and global environments, promoting a more comprehensive approach to sustainable development that considers the particularities of each region. Thus, municipalities become key agents in the quest for sustainable development. The municipality of Cascavel presents itself as a suitable field for in-depth analysis of the indicators of ISO 37120/2017.

Cascavel, like many other urban areas, faces significant challenges, from the effective management of natural resources to promoting equitable quality of life for its residents. The choice of this municipality is justified by the dynamic transformation of the space, as the city is considered the economic hub of the western region of Paraná. In recent years, Cascavel has modernized and sought to improve its social, environmental, and economic aspects. With a population of 348,051, it ranks as the twelfth largest city in the southern region of Brazil (IBGE, 2023). The city boasts a privileged topography and relatively planned development, with wide streets and well-distributed neighborhoods, placing it fourth in the national urban planning ranking (Connected Smart Cities Ranking, 2020). In 2020, Cascavel was awarded second best city in Brazil at the Band Excellent Cities Award, which recognizes good management practices to transform the reality of Brazilian municipalities and improve public services offered to citizens (Municipal Government of Cascavel, 2020). The city continues to stand out for its efficient and innovative management, being a finalist in the 2024 state stage of the Band Excellent Cities Award (Municipal Government of Cascavel, 2024).

In this context, a critical analysis of the sustainability axes outlined in the Sustainable Cities Program (PCS) emerges as a strategic tool for understanding the effectiveness of local urban policies. This also provides an objective basis for decision-making aimed at continuous improvement. By adopting ISO 37120/2017 as a reference, this research aims not only to assess Cascavel's current performance in terms of urban sustainability but also to contribute to the creation of a global overview, enabling meaningful comparisons with other cities that have adopted similar standards.

The importance of studying sustainable cities is further enhanced by identifying critical gaps highlighted by different researchers. Mizutani (2019) emphasizes the need to consolidate the culture of sustainability within public agencies and the development of clear goals. Bencke (2020) points out the lack of engagement from local governments in discussing the results of urban rankings, as well as the absence of standardization and methodological diversity, which hinder transparent comparisons and evaluations. Neiva & Martignago (2021) highlight the need for more in-depth research focused on specific

categories of sustainable cities, such as energy, greenhouse gas emissions, water resources, access to public goods and services, governance, transparency, social equity, security, and urban mobility. Viante (2021) analyzes NBR ISO 37120/2017 and notes the difficulty in finding essential indicators from the standard, as well as the limited knowledge of stakeholders about these indicators.

The authors Stefani, Correa & Procidonio (2022) reinforce the importance of local governments and the public's engagement in discussing sustainability indicators, as well as pointing out methodological diversity and the lack of transparency in evaluating these indicators. Gasparelo, Stefani & Schmidt (2022) highlight that, although sustainable strategies for cities exist, they are often discussed in small groups and poorly disseminated, resulting in widespread ignorance of the proposed actions and goals. Couto et al. (2023) work with models for evaluating urban sustainability based on NBR ISO 37120/2017, which has global indicators, and the Sustainable Cities Program, which addresses themes in greater detail but with limited scope. The authors emphasize the importance of rigor and reliability in the models, as well as the need for specific data for Brazilian cities, and point out that active governance participation can enhance the interpretation of indicators.

Thus, analyzing the sustainability of a municipality like Cascavel in Paraná is crucial, as it, like many other cities, faces economic, social, and environmental challenges. In terms of environmental issues, assessing the sustainability of the municipality allows for the identification of areas for improvement in natural resource management, preservation of green areas, and reduction of the carbon footprint. On the social front, a sustainable city is concerned with the quality of life of its inhabitants. Analyzing Cascavel in this context allows for the evaluation of aspects such as access to healthcare services, education, efficient public transport, security, leisure, and cultural spaces, all of which directly influence the well-being of the population. Evaluating Cascavel's sustainability also involves examining its economic development. This includes promoting sustainable businesses, green investments, incentives for sustainable business practices, and development policies that do not compromise future resources.

Studying the sustainability of Cascavel not only improves the quality of life for its inhabitants but also positions the city favorably to face future challenges, promote equitable development, and align with global sustainability goals. By understanding and enhancing the sustainability axes of the PCS in accordance with international standards, this research aims to contribute to the continuous development of public policies in

Cascavel, guided by a comprehensive vision of sustainability, providing tangible benefits for citizens and strengthening the city's positioning as an inspiring example of sustainable progress.

1.2 RESEARCH QUESTION

Considering the indicators of the Sustainable Cities Program (PCS), what actions should be implemented in the municipality of Cascavel based on the ISO 37120/2017 standard in order to obtain certification?

1.2 OBJECTIVES

1.2.1 General

In order to answer the research question, this study aims to analyze the sustainability axes of the PCS in the municipality of Cascavel with a view to meeting the ISO 37120/2017 standard.

1.2.2 Specific

To achieve the general objective and guide the development of this research, the following specific objectives were defined:

a. Identify through the literature the necessary elements for the application of the ISO 37120/2017 standard in cities;
b. Identify the sustainability actions already established in the city of Cascavel;
c. Conduct a diagnosis of the current situation in Cascavel regarding the ISO 37120/2017 indicators, identifying gaps and priority areas for intervention;
d. Evaluate the capacity of the municipality of Cascavel to obtain ISO 37120/2017 certification;
e. Propose actions for certification based on the indicators identified as critical in the municipality.

1.3 JUSTIFICATION AND CONTRIBUTION OF TECHNICAL PRODUCTION

This research is justified by the need to study sustainability in cities due to the relevance of the topic in contemporary society, as social, environmental, and economic problems have been intensifying. The accelerated urban growth of recent decades has resulted in significant challenges for planning and managing the quality of life in cities. As the global population continues to migrate to urban areas, the need to develop efficient and sustainable cities has become a global priority.

Furthermore, this study is directly aligned with the United Nations Sustainable Development Goals (SDGs), particularly with SDG 11, which aims to make cities and human settlements inclusive, safe, resilient, and sustainable (UN, 2015). Research on these issues contributes to achieving global targets and strengthening cities' commitment to sustainability, as cities face increasingly complex challenges such as climate change, population growth, social inequalities, and resource scarcity.

Research on sustainable cities and the use of indicators allows for a deeper understanding of these challenges, as well as the identification of innovative solutions to address them.Research in this field can have direct impacts on local urban policies and practices, resulting in significant improvements in the quality of life of urban residents. This includes promoting sustainable mobility solutions, efficient resource use, improving air quality, promoting social inclusion, and much more, as Ribeiro (2019) states that sustainable cities seek to balance economic growth, social equity, and environmental protection in order to provide quality of life for their inhabitants without compromising the well-being of future generations.

In a world of constant urbanization, research on sustainable cities and the use of indicators plays a crucial role in promoting responsible urban development and mitigating complex issues associated with city growth. This research not only contributes to advancing knowledge but also provides valuable information for decision-making and the creation of cities that are more livable, equitable, and environmentally friendly. In this sense, the interest in analyzing the sustainability axes of the Sustainable Cities Plan (PCS) in the municipality of Cascavel, from the perspective of meeting the standards established by the ISO 37120/2017 standard, is supported by various crucial reasons that align with the principles of sustainable development and the pursuit of best practices in urban governance. Alignment with international sustainability standards, such as those

proposed by ISO 37120/2017, can enhance the attractiveness of Cascavel to investors who value cities committed to efficient and sustainable urban management practices. This can result in greater financial support and partnerships for projects aimed at sustainable development. Furthermore, the standard emphasizes the importance of transparency and efficiency in urban governance, which are important factors for attracting investments to the municipality.

Therefore, it is essential to conduct studies in this area to promote a more sustainable future for present and future generations. Additionally, through information on sustainability indicators, public management can seek ways to improve aspects that are deficient and work to maintain the indicators considered good, thereby improving quality of life, employment, health, urban mobility, and enhancing the relationship with the environment in their municipalities. In this sense, the importance of the study is demonstrated as the search for more sustainable urban environments becomes increasingly prominent.

1.4 STRUCTURE OF THE DISSERTATION

This dissertation is structured as follows: Chapter 1 presents the introduction within the theme of sustainable cities and the use of indicators in management, starting with the indicators established in ISO 37120/2017, the research problem, and the objectives to be achieved, along with the justification for the research. Based on the outlined objectives, the development of the research can be accomplished. The second chapter presents the theoretical framework regarding the concept of Sustainable and Smart Cities, models/rankings for classifying sustainable cities, the Sustainable Development Goals (SDGs) established in the 2030 Agenda with a focus on SDG 11, the Sustainable Cities Program, and finally ISO 37120/2017. Chapter 3 presents the methodological process, as well as the presentation of the study area delineation.

Following this, Chapter 4 presents the study area, while Chapter 5 provides the data obtained from the case study in the city of Cascavel. Chapter 6 concludes the study with final considerations and improvement proposals, followed by references and appendices used.

In general, it is believed that this work will contribute to future academic research, serving as a resource for public administration, the private sector, the academic community, and civil society interested in the subject.

2 THEORETICAL FRAMEWORK

The search for sustainable urban solutions has gained global relevance, driven by the need to address environmental, social, and economic challenges in urban areas. This theoretical framework aims to explore the comprehensive concept of sustainable cities, aligning it with the Sustainable Development Goals (SDGs) established by the UN, as well as examining the impact and objectives of the Sustainable Cities program. Additionally, ISO 37120/2017 will be addressed, which defines essential indicators for measuring urban sustainability. This review has guided the understanding of the need to consider the incorporation of sustainability and sustainable development in municipalities and for understanding the methodological tools that evaluate sustainability, as well as providing general information on the topic.

This chapter deals with the entire theoretical foundation regarding the themes: Sustainable and Smart City, evaluation models/rankings for sustainable and smart cities, the SDGs, the Sustainable Cities Program, and ISO 37120/2017.

2.1 SUSTAINABLE AND SMART CITIES

The concept of sustainable cities emerged as a response to the environmental, economic, and social challenges faced by urban areas worldwide. The idea of a sustainable city involves the development of urban environments that balance economic growth with quality of life, environmental conservation, and social justice (Leite & Awad, 2012). In this sense, the idea of developing sustainable cities has its roots in social and environmental movements that gained prominence in the latter decades of the 20th century. Initially, the idea was to develop urban areas in a way that meets the needs of the present generations without compromising the ability of future generations to meet their own needs (WCED, 1987; Flores & Teixeira, 2017).

During the 1970s, there was increasing international attention directed toward issues of urbanization, environmental quality, and poverty, highlighting the need to protect the environment and promote more sustainable practices in urban clusters in order to reduce negative impacts and improve the quality of life for the urban population (Bulkeley & Betsill, 2005). Rapid urban growth, disorderly expansion, pollution, and the depletion of natural resources led to an understanding that traditional approaches to city development were unsustainable.

In this sense, significant efforts have been made to promote sustainable development, focusing on urban environments. Many challenges are being discussed in various sustainable development agendas in cities, such as generating cleaner energy, adequate solid waste management, urban mobility, preserving green areas, and promoting the health and well-being of the population. The United Nations seeks to encourage the commitment of member countries of the international community to promote the environment (Bichueti et al., 2016). In this context, the term sustainability began to be widely used from the 1980s. The year 1987 was marked as the beginning, recognized in literature, of discussions about sustainable development. The Brundtland Report, prepared by the World Commission on Environment and Development, conferred relevance to cities as a crucial pathway to addressing the challenge of sustainable development (Corsi et al., 2022).

Thus, discussions about urban sustainable development began to consolidate; however, early studies showed that the major concerns were environmental and economic dimensions. Scientists argued that urban design and infrastructure should not cause adverse impacts. Instead of focusing on adverse effects on the environment, they prioritized promoting energy efficiency and responsible use of natural resources. To improve environmental and economic indicators, it is crucial to reduce energy consumption, which will result in an improvement in citizens' quality of life (Capello, 1998; Capello, Nijkamp, & Pepping, 1999; Gibbs, 1994; Girardet, 1992; Ryn & Calthorpe, 1986).

In this sense, the quest for more sustainable and resilient environments has become a topic of academic discussion and public management. However, these concerns have been intensified, given that estimates indicate that 55% of the population lives in urban areas, and the UN report projects that by 2050, 70% of the population will live in urban areas (UN, 2018). According to the UN (2018), Brazil already has an urbanization rate of 87%, with projections that it will reach 92.5% by 2050, making it one of the highest in the continent, as shown in Figure 1.

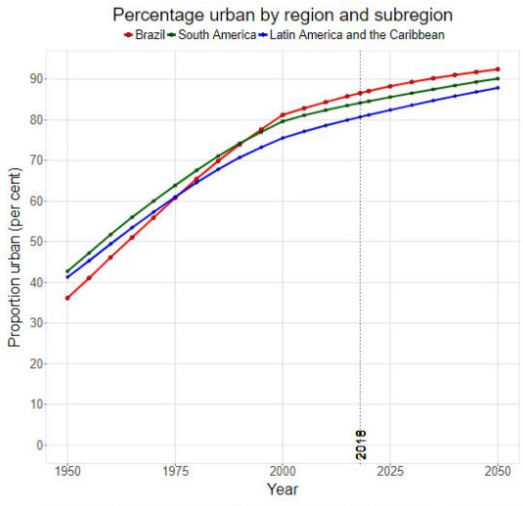

Figure 1- Urban Population from 1950 to 2050 Brazil, South America, Latin America, and the Caribbean.

Source: United Nations Report 2018 - World Urbanization Prospects Edition

Note: The projection is in percentage from the years 1950 to 2050.

As cities grow in size and population, the challenges of maintaining spatial, social, and environmental balance also increase (Kniess, Oliveira & Conti, 2019). In this sense, cities face the challenge of addressing urban problems in an attempt to improve the quality of life for their inhabitants. Therefore, cities can be considered complex and dynamic systems, where planning requires methods capable of formulating, understanding, modeling, and predicting strategies to enhance their future (Geertman, Allan, Pettit & Stilwell, 2017; Prestes, 2018).

Cities also concentrate a large part of the population, wealth, and global productive activities; however, they are also responsible for social and environmental problems. Thus, it can be observed that cities absorb natural resources, products, and human capital, which end up producing pollution and harmful waste in the environment (Viante, 2021). In this context, it is important to reconsider the urban space model, present new perspectives, and find ways to align with ideal aspects that improve the quality of life for residents and other stakeholders.

Thus, with the application of technological methods and the use of renewable energies, new discourses began to emerge, bringing forth new names for cities, such as: sustainable cities, green cities, digital cities, intelligent cities, smart cities, information cities, resilient cities, and low-carbon cities. Jong et al. (2015) propose that the terms presented for cities are all linked to the general understanding of the development and

restructuring of urban environments, where the sustainability tripod is balanced, seeking reciprocal benefits. Furthermore, cities differ from one another based on size, population, ideology, culture, and structure (Sofeska, 2016). Thus, there are characteristics that define them equally; one of these is the growing pursuit of sustainable development that brings better quality of life to the population while sustaining these lifestyles for an indefinite period.

In this sense, the terminology of sustainable cities evaluates urban spaces that need to meet social, environmental, political, and cultural objectives, while also aligning the economic and physical goals of their citizens, making efficient use of all available resources (Kobayashi et al., 2017). A sustainable city can also be defined as one that is sustainable in the long term, emits little pollution while meeting social, cultural, environmental, and political needs, without neglecting economic development and physical aspects, impoverishing or risking the resources of surrounding cities. Additionally, a sustainable urban community requires an understanding of the links between the economy, society, and the environment (Flores & Teixeira, 2017). It must promote equality and social inclusion, be economically productive, have its constructions in harmony with nature, preserve historical roots, and be maintained for all generations (Batten, 2016; Flores & Teixeira, 2016; Dubou, Denardim, Bichueti & Oliveira, 2021).

Moreover, they must be designed to meet the needs of current generations without compromising the ability of future generations to meet their own needs, promoting public policies and actions that positively impact sustainability, ensuring urban development that preserves the environment and guarantees the well-being of its inhabitants (Spiri- Fereira et al. 2024). Frame 1 summarizes the definitions of sustainable cities presented in this section.

Frame 1 Definitions and Interpretations of Sustainable Cities

Source	Definition / Interpretation
Suzuki H. et al. - 2010	The principle of a sustainable city is to improve the well-being of its citizens and society in general through the integration of urban planning and environmental management to utilize the benefits of the ecosystem, protecting and nurturing it for future generations.
Leite – 2012	A sustainable city is a dynamic organism that operates without waste, balancing the essential resources for its functioning and the waste produced therein. Leite explains that this new model of city should be a joint action between organized civil society, the corporate sector, and

	public agencies in search of new ways of operation, management, and growth, using parameters derived from compact cities.
Leite & Awad – 2012	A sustainable city recognizes social, political, environmental, cultural, physical, and economic issues of a dynamic and responsive society that swiftly adapts to changes in the globalized world while avoiding waste.
Loureiro & Gregori - 2013	Sustainable cities must be just, ethical, and sustainable, abandoning the idea of transformations only coming from governments, and instead believing in the development of actions that integrate citizens in the pursuit of sustainability.
Gehl - 2013	Sustainable cities seek to develop an economy that sustains the prosperity of human systems and ecosystems.
Ferreira, Aguiar, Cortese, Kniess, Quaresma & Pasch – 2015	A characteristic of a sustainable city is its resilience, where increasing the resilience of cities is linked to poverty reduction and the preparation that the city has for climate impacts, reducing their severity and magnitude.
Batten - 2016	A sustainable city can also be defined as one that is sustainable in the long term, emits little pollution while efficiently meeting the needs of its citizens, providing quality of life.
Flores & Teixeira – 2016	Furthermore, a sustainable urban community requires an understanding of the links between the economy, society, and the environment. This must promote equality and social inclusion, bring economic efficiency, have constructions in harmony with nature, preserve historical roots, and be maintained for all generations.
Lopes - 2016	A sustainable city can be considered, among other factors, as one that presents balanced development, is well-planned, ensuring respect for environmental, social functions, and human dignity; it guarantees the right to quality education, health, land, housing, environmental sanitation, proper waste management, urban infrastructure, transportation, work, leisure, green area incentives, and an ecologically balanced environment for current and future generations.
Lopes - 2016	The compact city stands out in the sustainable context, as it aims to reduce distances, prioritizing proximity to main social functions such as housing, schools, work, and leisure. It generates energy and transportation efficiency, as it reduces displacements, emphasizes public transport, preserves natural resources, and presents social opportunities and quality of life.
Kobayashi et al. – 2017	Sustainable cities are seen as urban spaces that need to meet social, environmental, political, and cultural objectives while also aligning with the economic and physical objectives of their citizens, making efficient use of all available resources. They state that the concepts of sustainable

	cities and smart cities have developed in parallel until converging into a common concept.
Bibri and Krogstie – 2017	A sustainable city can be understood as a set of approaches that utilize sustainable urban knowledge and technology in its planning and design.
Ribeiro, Cortese, Kniess & Conti - 2018	The concept of Sustainable Cities includes the notion that the urban environment must be able to guarantee the population's basic needs, such as housing, hygiene, and transportation. This is difficult to ensure, especially in developing countries, where overpopulation is common, and the lack of resources to meet everyone's needs can lead to various consequences, including power outages, as seen in Brazil.
Bento, Conti, Baptista & Ghobril - 2018	Sustainable cities are those that preserve green spaces and natural ecosystems within the urban environment, contributing to the improvement of quality of life through the protection of air quality, climate, and restoration of water systems.
Dubou, Denardim, Bichueti e Oliveira - 2021	Sustainable cities are those that can meet social, cultural, environmental, and political needs without neglecting economic development and physical aspects, without putting the city's resources at risk in its surroundings. At the same time, they must ensure equitable access to all services.

Source: prepared by the researcher with data from the research (2023).

In summary, a sustainable city, as described by various authors, must integrate planning and environmental management to enhance the well-being of its citizens (Suzuki et al., 2010), operate efficiently without waste (Leite, 2012), and be adaptable to global changes (Leite & Awad, 2012). Additionally, it should promote justice, ethics, and social inclusion (Loureiro & Gregori, 2013), develop a prosperous economy (Gehl, 2013), be resilient and prepared for climate impacts (Ferreira et al., 2015), and maintain low emissions while efficiently meeting the needs of its citizens (Batten, 2016). It is also essential to understand the connections between economy, society, and the environment, preserving historical roots and ensuring quality of life for all generations (Flores & Teixeira, 2016). A sustainable city is well-planned, ensuring fundamental rights and encouraging green spaces (Lopes, 2016), as well as promoting energy and social efficiency through a compact structure (Lopes, 2016). The concept involves meeting social, environmental, political, and cultural objectives while using resources efficiently and converging with the idea of smart cities (Kobayashi et al., 2017; Bibri & Krogstie, 2017). Finally, it must guarantee the basic needs of the population and preserve green spaces to enhance quality of life (Ribeiro et al., 2018; Bento et al., 2018; Dubou et al., 2021).

Thus, it is possible to observe that the concept of sustainable cities includes the idea that the urban environment must be capable of providing the population with basic needs such as housing, sanitation, and transportation (Ribeiro et al., 2018; Stefani, Correa & Procidoni, 2022). This is challenging to ensure, especially in developing countries where overcrowding and lack of resources to meet all needs can have a variety of effects, including power outages. Therefore, local managers need strategies to protect and develop environmental practices and to implement measures through short-, medium-, and long-term sustainability goals. Furthermore, it is evident that the concept of sustainable cities has been analyzed from different research fields, particularly through studies in architecture and urbanism aimed at achieving more sustainable, resilient, and equitable urbanization that can provide a better quality of life for residents.

From this perspective, the conception of sustainable cities can no longer be seen as merely ideal; it needs to be effectively implemented worldwide. Sustainable urban planning is a relatively recent approach, in which cities seek to integrate actions aimed at sustainable development into their strategic plans (Sustainable Cities International, 2012; Bond & Morrison-Saunders, 2011; Neiva & Martignago, 2021). Sustainable cities represent a new model on a global scale for advancing sustainable development worldwide.

It is understood that a sustainable city is characterized by its ability to maintain sustainable practices in the long term, minimizing the emission of pollutants while efficiently meeting the needs of its inhabitants, thereby promoting a high quality of life (Batten, 2016). Therefore, ensuring sustainable development in urban areas is an essential factor for preserving human life on the planet (Neiva & Martignago, 2021).

It is important to highlight the interconnection and, at the same time, the confusion between the concepts of sustainable cities and smart cities. The concepts have evolved toward a common understanding. However, Junior & Duenhas (2020) highlight existing gaps between smart and sustainable cities, as this separation results in an intelligent pursuit of a path toward sustainable development. In this context, the authors suggest adopting the term “sustainable smart cities” as an alternative that replaces and unifies the concepts of smart cities and sustainable cities.

In this sense, smart and sustainable cities have emerged as an effort by researchers to integrate the approaches of smart cities with the concept of sustainability, or to incorporate intelligence into the concept of sustainability, or still, to incorporate intelligence into existing sustainability models and sustainable development goals (Bibri,

2019). These cities aim to adapt intelligently and sustainably, exploring ways to interact with new technologies, particularly regarding the design of urban infrastructure. Given the rapid urban growth and new demands of the century, it is crucial to address the concern that cities need to undergo an innovation process, whether in infrastructure, services, or the management of their economies (Saraiva et al., 2018).

The concept of smart and sustainable cities represents the union of the concepts of smart cities and sustainable cities (Flores & Teixeira, 2017). Thus, while the concept of smart cities is associated with Information and Communication Technologies (ICTs), with urban systems that utilize these technologies to achieve efficiency and better communication to promote the improvement of people's quality of life, the concept of sustainable cities is related to optimizing resources to meet political, social, and economic demands (Bibri, 2018; Bibri & Krogstie, 2017; Hojer & Wangel, 2015; Kobayashi, Kniess, Serra, Ferraz & Ruiz, 2017; Leite & Awad, 2012).

A smart and sustainable city is an urban environment designed and operated with technology to reduce environmental impacts, improve the quality of life of its inhabitants, and promote economic development. These cities employ innovative solutions such as energy efficiency; sustainable transportation; waste management; intelligent use of resources; technology and connectivity; integrated urban planning; and citizen participation (Corsi et al., 2022). These elements, when combined, create an urban environment that not only reduces environmental impact but also improves quality of life, promoting resilience, social inclusion, and sustainable economic development.

However, it is important to note that, unlike smart cities, smart and sustainable cities place greater emphasis on sustainability, meaning that sustainability carries more weight in the composition of their dimensional characteristics (Beck, 2020). Otherwise, smart cities that do not align their objectives with sustainable goals become just another model of cities that contribute only to existing social problems and inadequate infrastructure.

Thus, a sustainable and smart city is one capable of applying innovative technologies to enhance urban services, resulting in improved quality of life for citizens, as well as fostering economic development, making society more equitable, with a more livable and sustainable surrounding environment (Corsi et al., 2022). However, building a sustainable and smart city involves an integrated and holistic approach, combined with urban planning, technology, community engagement, and public policies, as represented in Figure 2.

Figure 2 -Structures and/or domains for building a sustainable and smart city.
Source: prepared by the researcher 2023.

For a city to be sustainable and smart, it needs sustainable urban planning that considers efficient use of space, green areas, accessibility, and supportive infrastructure (Caragliu et al., 2011). Clear goals and strategies for sustainability are essential, capable of utilizing development strategies that incorporate energy efficiency, waste management, sustainable transport, and resource conservation, employing technology and innovation to monitor and manage urban services. This includes IoT sensors, data analysis, smart energy grids, and efficient transportation systems (Beck et al., 2020).

Additionally, it is necessary to develop infrastructure that uses renewable energy sources, such as solar and wind power, implement efficient water treatment systems, and promote the construction of green and energy-efficient buildings. Smart transportation should encourage the use of public transport, create cycling networks, promote electric vehicles, and establish policies that reduce the use of private cars (Beck & Conti, 2021). For this to work, community participation is important, involving all citizens from the outset, seeking their feedback and active participation in planning and projects, as well as developing policies and regulations that encourage sustainable practices, such as tax incentives, energy efficiency regulations, and building standards. In other words, it is essential to educate residents about sustainable practices, encouraging conscious

consumption, waste separation, and efficient resource use, while establishing mechanisms to monitor progress toward sustainability goals (Corsi et al., 2022).

Thus, the communication of these elements contributes to the creation of an urban environment that not only reduces environmental impact but also improves quality of life, promoting resilience, social inclusion, and sustainable economic development. Building a sustainable and smart city requires a continuous commitment from various stakeholders, from local governments to businesses, communities, and individuals. The integration of technological solutions with sustainable practices and active community participation is essential for the success of these cities.

2.2 OBJECTIVES OF SUSTAINABLE DEVELOPMENT - SDGs

In 2015, the UN, along with the United Nations Environment Programme (UNEP), held the Sustainable Development Summit, resulting in the 2030 Agenda, which is nothing more than a plan of action for people, the planet, and prosperity for the next 15 years. Its objective is to provide a roadmap with goals to guide the world toward a sustainable and resilient path, continuing the Millennium Development Goals (MDGs) established at the Millennium Summit in 2000 and expanding its scope due to the emergence of new challenges. This process resulted from a participatory effort lasting more than two years (2012-2015), coordinated by the UN (UN, 2015).

The 2030 Agenda encompasses themes related to the environmental, social, economic, and institutional dimensions of sustainable development (Kronemberger, 2019). It consists of 17 Sustainable Development Goals (SDGs), as shown in Figure 3, which are: 1) no poverty; 2) zero hunger and sustainable agriculture; 3) good health and well-being; 4) quality education; 5) gender equality; 6) clean water and sanitation; 7) affordable and clean energy; 8) decent work and economic growth; 9) industry, innovation, and infrastructure; 10) reduced inequalities; 11) sustainable cities and communities; 12) responsible consumption and production; 13) climate action; 14) life below water; 15) life on land; 16) peace, justice, and strong institutions; 17) partnerships for the goals. The SDGs include 169 targets and 232 indicators, along with a Declaration (vision, principles, and shared commitments). In other words, the SDGs represent an inclusive agenda that seeks to tackle the roots of global problems by proposing positive changes, contributing to a more prosperous and sustainable world (Mizutani, 2019).

Figure 3- 17 SDGs - Sustainable Development Goals.
Source: UN - Brazil 2023.

The 2030 Agenda and the SDGs represent a significant opportunity for the benefit of the current generation and future generations, establishing analogous strategies for sustainable and integrated development. The SDGs created challenges, and even though some of them may be achieved, society is invited to mobilize and face new challenges in the coming years. In this sense, cities play an important role, as the implementation of goals occurs on a local scale; thus, it is essential to ensure dialogue with public authorities and local civil societies to achieve the goals and objectives (UN, 2016).

Among the 17 SDGs, the focal point of this research is SDG 11, which addresses the commitment to "make cities and human settlements inclusive, safe, resilient, and sustainable" (UN, 2015). This SDG advocates that all people live in safe and resilient housing to face climate change, mitigate disasters, and have access to basic services such as sanitation and health. Furthermore, SDG 11 aims for a place that offers opportunities for economic, cultural, and social development, where there are nearby jobs and sources of income, accessible and quality public transportation, access to adequate food, and increased inclusive and sustainable urbanization in cities. To achieve these goals, SDG 11 is broken down into seven targets related to the specific achievement of the SDG and three implementation targets in the Agenda 2030 document, which can be seen in Frame 2.

Frame 2- Goals and Main Indicators of SDG 11

SDG 11 Goals	Main Indicators

11.1 By 2030, ensure access for all to safe, adequate, and affordable housing, basic services, and upgrade slum settlements.	Proportion of urban population living in precarious settlements, informal settlements, or inadequate housing.
11.2 By 2030, improve road safety and access to the city through more sustainable, inclusive, efficient, and equitable urban mobility systems, prioritizing mass public transport and active transportation, paying special attention to the needs of vulnerable people, such as those with disabilities, reduced mobility, women, children, and the elderly.	Proportion of the population with adequate access to public transport, disaggregated by sex, age, and disability status.
11.3 By 2030, increase inclusive and sustainable urbanization, enhancing capacities for planning, social control, and participatory, integrated, and sustainable management of human settlements across all federative units.	Rate of land consumption relative to population growth rate. Proportion of cities with a structure for direct civil society participation in urban planning and management that operates regularly and democratically.
11.4 Strengthen initiatives to protect and safeguard Brazil's natural and cultural heritage, including its material and immaterial heritage.	Total per capita public and private expenditure on the preservation, protection, and conservation of all cultural and natural heritage, by type of heritage (cultural, natural, mixed, and designated by the World Heritage Center), government level (national, regional, and local), type of expenditure (current/investment expenses), and type of private funding (in-kind donations, nonprofit private sector, and sponsorships).
11.5 By 2030, significantly reduce the number of deaths and the number of people affected by natural disasters of hydro-meteorological and climatological origin, as well as substantially decrease the number of people living in risk areas and the direct economic losses caused by these disasters in relation to GDP, with particular attention to	Number of deaths, missing persons, and directly affected individuals due to disasters per 100,000 inhabitants. Direct economic losses in relation to GDP, including damages caused by disasters to critical infrastructure and the interruption of basic services.

the protection of low-income and vulnerable people.	
11.6 By 2030, reduce the per capita environmental impact of cities, improving air quality indices and solid waste management; and ensure that all cities with over 500,000 inhabitants have implemented air quality monitoring systems and solid waste management plans.	Proportion of urban solid waste regularly collected and disposed of properly relative to total urban solid waste generated, by city.
11.7 By 2030, ensure universal access to safe, inclusive, accessible, and green public spaces, particularly for women, children and adolescents, the elderly, and people with disabilities, as well as other vulnerable groups.	Proportion of built-up area that is open public space accessible to all, disaggregated by sex, age, and disability status. Proportion of the population who have experienced physical or sexual harassment, disaggregated by sex, age group, disability status, and location of occurrence, in the last 12 months.
11.a Support economic, social, and environmental integration in metropolitan areas and between urban, peri-urban, rural areas, and twin cities, considering the territories of traditional peoples and communities through inter-federative cooperation, reinforcing national, regional, and local development planning.	Proportion of the population residing in cities that implement urban and regional development plans that include population projections and resource assessments, by city size.
11.b By 2030, significantly increase the number of cities that have developed and implemented policies and plans for climate change mitigation, adaptation, resilience, and integrated disaster risk management, in accordance with the Sendai Framework.	Number of countries adopting and implementing national disaster risk reduction strategies aligned with the Sendai Framework for Disaster Risk Reduction 2015-2030. Proportion of local governments that adopt and implement local disaster risk reduction strategies aligned with national disaster risk reduction strategies.
11.c Support least developed countries, including through technical and financial assistance, for sustainable and resilient construction, prioritizing local resources.	Proportion of financial support to least developed countries directed at the construction and modernization of sustainable, resilient, and resource-efficient buildings using local materials.

Source: Adapted from Stefani, Correa & Procidonio, 2022.

Goal 11.1 refers to housing, a right recognized in the Universal Declaration of Human Rights in 1948, and is considered essential for people's well-being. According to the UN, the concept of adequate housing goes beyond the physical structure, encompassing other dimensions that influence the health maintenance of residents and their access to the opportunities that cities offer (UN, 2015). This goal highlights the proportion of the urban population living in precarious, informal settlements or inadequate housing. This indicator showed a rate of 40%, according to the source from the 2022 demographic census, considering a sample collection (IBGE, 2023).

Goal 11.2 emphasizes the role of transportation and urban mobility policies as necessary instruments for promoting safer, more socially inclusive, and environmentally sustainable cities (UN, 2015). Meanwhile, Goal 11.3 aims to highlight the participation in planning and managing policies aimed at sustainable urbanization. However, this goal still does not present a clear consensus on how to measure sustainable urbanization, as, if already constructed urban areas were more densely populated, cities would be more compact, leading to shorter distances and lower pollution, as well as better use of existing infrastructure (Stefani, Correa & Procidonio, 2022).

Goal 11.5 seeks to highlight issues related to natural disasters and the minimization of exposure to these risks, while Goal 11.6 aims to assess air quality and solid waste management, and Goal 11.7 seeks to ensure safe and inclusive public spaces. In other words, SDG 11 specifically addresses the importance of ensuring safe housing for the population (Guevara, Marinho & Eterovic, 2020).

Considering cities as centers involved in commerce, culture, science, and productivity, they are essential for the social and economic development of people. Even in the face of the challenge to create jobs and promote prosperity without compromising the environment, cities are crucial for human progress (Ribeiro, 2019). To ensure a sustainable urban future, it is essential to create equal opportunities for all to access basic services, energy, housing, transportation, and health care. The Sustainable Development Goals (SDGs) from 2016 highlight the importance of SDG 11, which aims to contribute to sustainable development through city planning and management, promoting inclusion and ensuring a livable environment for all.

From a global to a local perspective, this is a critical issue in Brazil, where one in five Brazilians lives in precarious conditions. According to the Brazilian Institute of Geography and Statistics (IBGE), data shows that 45.2 million people live in households with at least one major housing inadequacy. Of this population, 13.5 million are white,

and 31.3 million are black or brown (IBGE, 2023). Thus, the effective improvement of SDG 11 in Brazil requires integrated approaches and public policies that address not only housing but also urban resilience, proper city planning, environmental management, and social inclusion. These actions are essential for improving quality of life and ensuring a safe and sustainable environment for all Brazilians.

Moreover, in Brazil, it is the responsibility of local governments to promote economic, social, and environmental integration in metropolitan areas and urban regions. Understanding inequality is a crucial step toward establishing public policies that contribute to improving the quality of life of the population.

2.3 MEASUREMENT AND EVALUATION MODELS OF SUSTAINABILITY IN CITIES

Sustainability is essential for ensuring the quality of life for current and future generations. Evaluation systems help cities align their development goals with the environmental, economic, and social targets necessary to create sustainable cities. The assessment of sustainable cities plays a crucial role in urban management and development. Evaluation systems enable cities to measure their progress toward sustainable development. They provide metrics and indicators, helping to identify areas that need improvement and track the impact of policies and actions implemented over time.

Having solid data and quantifiable metrics available is fundamental for informed decision-making by governors, urban managers, and stakeholders. This allows them to prioritize investments and policies that address the specific challenges of their cities. Through evaluation, cities can more effectively direct financial, human, and natural resources, optimizing the use of scarce resources to meet the needs of the population and ensure sustainable urban growth (Alexandre, De Alexandria & Braga, 2020).

The assessment of sustainable cities often involves active participation from the local community, promoting civic engagement and social inclusion. Cities can involve residents in setting goals, identifying problems, and seeking solutions, thereby strengthening the sense of belonging. However, the tools for measuring this performance face many challenges. The first challenge is the selection and definition of metrics, and the second is the use of these metrics by many cities (Fox, 2015). To fill this gap, systems for evaluating sustainable cities have been developed. These systems are created by

governments, organizations, research institutions, and city rankings that aim to understand the correlation between successful cities, their fundamental attributes, and their economic success, which is an important part of public policy analysis.

In addition to these factors, it is evident that cities' sustainability objectives align with global agreements, such as the United Nations Sustainable Development Goals (SDGs) and the Paris Agreement. Evaluation systems help cities measure their progress toward these international commitments (Bencke & Perez, 2018).

However, given the variety of city ranking indices available, there are multiple perspectives on how cities are ranked, viewed, and evaluated by external companies, academics, political leaders, and individuals. These indices can reward and certify cities that meet evaluation criteria, helping cities to make their sustainable development goals more concrete. However, it is worth noting that rankings come with some disadvantages. Bencke & Perez (2018) list two: rankings are widely celebrated by the "winners" to enhance their public image, while the "losers" tend to disregard the data; the second disadvantage is that most rankings consist of a broad approach, meaning most aim to rank cities based on overall attractiveness.

In light of this situation, indicators emerge as tools for analyzing and monitoring the ranking and scoring processes of sustainability aspects in cities. Additionally, sustainability indicators can be used as instruments for mobilizing stakeholders to contribute to measuring sustainability (Lopes, 2016).

Sustainability indicators are measures used to assess the performance of an organization, community, project, or activity concerning environmental, social, and economic issues (Van Bellen, 2006). They are used to monitor and communicate the process toward sustainable goals and to aid in informed decision-making that promotes sustainable development (Bencke & Perez, 2018). Among the main objectives and functions of sustainability indicators are environmental performance, which evaluates the impacts of human activities on the environment, such as greenhouse gas emissions, consumption of natural resources, air and water pollution, among others. Another factor is evaluating social performance, which considers aspects related to people, such as working conditions, health and safety, diversity and inclusion, quality of life, and impacts on local communities, as well as helping to ensure that an organization's practices are socially responsible (Jong, 2010).

In this sense, indicators contribute to informed decision-making; that is, sustainability indicators provide objective data that aid informed decisions regarding

policies, business strategies, investments, and effective resource allocation. They also demonstrate accountability and transparency, as the disclosure of sustainability indicators allows organizations to demonstrate their commitment to environmental, social, and economic responsibility while providing transparent information to stakeholders, such as investors, customers, regulators, and the community (Moldan, Bilharz & Matravers, 1997).

Moreover, monitoring progress toward sustainability goals helps set clear targets and track progress. Indicators are important tools for guiding sustainable development and ensuring that current actions do not compromise future ones.

Through the composition of these indicators and indices, reports and rankings are formulated that classify cities based on their sustainability and quality of life. These classifications are often used to evaluate the performance of cities in areas such as the environment, economy, infrastructure, quality of life, social equality, among other aspects. Some of the most well-known reports and rankings include:

United Nations Sustainable Cities Index: This is a global report assessing cities' performance across a wide range of sustainability indicators, including environmental, social, and economic issues. It is published by the UN Sustainable Development Solutions Network (UN, 2023).

a. Mercer Quality of Living Index: This is an annual ranking conducted by Mercer, a global human resources consulting firm. The main objective of the index is to assess and compare the quality of life in various cities worldwide, providing valuable insights for multinational companies, governments, and stakeholders wanting to understand living conditions in different locations. While not strictly a sustainability index, this report ranks cities worldwide based on quality of life, considering factors such as cost of living, education, safety, environment, infrastructure, economic stability, political and social environment, and availability of public services. Based on the assessment of these factors, Mercer assigns a score to each city and ranks them in terms of quality of life (Campos et al., 2021).
b. Green Cities Index: This is a survey conducted by The Economist Intelligence Unit, a division of The Economist magazine, focusing on evaluating the environmental sustainability index of cities worldwide, considering factors such as air quality, water supply, waste management, energy efficiency, public transport, green spaces, and natural areas, emissions reduction policies,

renewable energy use, and measures to combat climate change. Based on these assessments, cities are compared regarding their sustainability practices. However, the green cities index aims to highlight best practices and the challenges faced by cities in pursuing a cleaner, healthier, and more sustainable urban environment (Harder et al., 2006).

c. IESE Business School Smart Cities Index: This index assesses the development of smart cities worldwide, considering technology, governance, mobility, environment, quality of life, human capital, social cohesion, economy, and governance (IESE Business School, 2022).

d. Excellence City - Instituto Áquila: This award is given to cities to recognize pioneering initiatives in municipal public management, encourage the implementation of improvement projects in the public sphere, share references and management solutions to inspire other municipalities, and value public servants who act proactively for the benefit of the population. The award utilizes the IGMA as an evaluation instrument, developed by Instituto Áquila, which uses big data concepts and compiles the most up-to-date public information from all cities in the country. A total of 62 indicators are evaluated in a single final score based on six pillars: governance, fiscal efficiency and transparency; education; health and well-being; infrastructure and urban mobility; sustainability and socioeconomic development; and public order (IGMA, 2023).

e. European Model – European Smart Cities: This is a European project aimed at assessing the intelligence of medium-sized European cities. It was funded by European Union funds and conducted by the Vienna University of Technology in collaboration with the University of Ljubljana and Delft University of Technology. This tool compares the "intelligence" characteristics of cities with populations under 500,000 inhabitants, assessing areas such as economy, mobility, environment, people, and governance. Each evaluation area consists of indicators totaling 90. There are two models: Version 3.0 (2014) for cities with populations between 100,000 and 500,000 inhabitants, comprising 28 domains with a total of 81 indicators; and Version 4.0 (2015) for cities between 300,000 and 1 million inhabitants, which must have 80% of the available indicators and be part of the Urban Audit Database.

Both models are standardized and have a weighting scheme (Russo et al., 2016).

f. In addition to these models that use sustainability indicators as tools, there are programs developed by private and philanthropic initiatives in various countries, commonly aligned with the ISO 3720/2017 standard. In Brazil, the initiative Brazilian Network of Intelligent and Human Cities (RBCIH) is dedicated to creating the Brazilian Index of Intelligent and Human Cities, using indicators to analyze municipalities within the process of implementing their actions, based on ISO 37120 (RBCIH, 2016).

g. The Sustainable Cities Program (PCS), carried out by the Nossa São Paulo Network, the Brazilian Social Network for Just and Sustainable Cities, and the Ethos Institute for Companies and Social Responsibility, published in 2012 the document Sustainability Goals for Brazilian Municipalities (MSMB) and in 2013, the Guide to Sustainable Public Management (GPS), aimed at contributing to municipal management to implement planning and execution instruments for public policies focused on sustainability (Lopes, 2016).

Another Brazilian indicator system is the Green Blue City Program (PMVA), launched by the Government of the State of São Paulo in 2007. This program classifies municipalities according to ten specific directives, namely: Sustainable Municipality; Environmental Structure and Education; Environmental Council; Biodiversity; Water Management; Land Use; Urban Forestry; Treated Sewage; and Solid Waste (de Almeida Couto, 2021). The global position of the municipality is determined based on the evaluation of the Environmental Assessment Indicators (IAA).

However, it is necessary to emphasize that the criteria and methodologies used in each report may vary, and the classifications may differ depending on the specific objectives of each index. Therefore, it is important to consider multiple sources of approach to evaluate the sustainability and quality of life of a city. A distinct feature of the indicators used for Brazilian cities lies in the fact that, in general terms, they are more closely related to the concept of Smart Cities than to Sustainable Cities (Machado Júnior et al., 2018). The indicators intended to assess smart cities should address not only the three pillars of sustainability but also the digital aspect. According to Machado et al. (2018), studies show that covering small, medium, and large cities, there is a trend to prioritize the digital aspect at the expense of the environmental aspect.

Regarding the comparative analysis, Frame 3 demonstrates a compilation of the European Model in international and national aspects, the Sustainable Cities Program, and the ABNT NBR ISO 37120:2017 standard concerning the number of indicators and the platform on which each of the rankings is analyzed.

Frame 3- Models and Indicators

	European Smart Cities Model	**Sustainable Cities Program**	**ABNT NBR ISO 37120:2017**
Year of Creation	2017	2011	2017 (in Brazil)
Application	Medium-sized European cities	Brazilian cities	Cities, municipalities, and local governments around the world
Number of Indicators	90	260	128
Thematic Axes	06	12	19
Frequency	Annual	Annual	Annual
Type of Indicators	-	Quantitative (81%) and qualitative (19%)	Quantitative (100%)
Information	There are 2 models - Version 3.0 (2014): cities with populations between 100,000 and 500,000. This model has 28 domains with a total of 81 indicators. This model has versions 2.0 and 1.0. - Version 4.0 (2015): cities with populations between 300,000 and 1 million, which have	Formulas; relationship with the SDGs and targets of the 2030 Agenda; global examples of good practices (by axis)	Formulas; detailed definitions; data sources; notes adapted for Brazil

	80% of the available indicators and are part of the Urban Audit Database. Both models are standardized and have a weighting scheme.		
Platform	Website	Sustainable Cities Platform	WCCD

Source: Prepared by the researcher, adapted from Couto, Gregorio, Valle, Haddad, and Soares 2023.

Therefore, sustainable city assessment systems are essential tools to ensure that urban areas grow in a sustainable, equitable, and resilient manner, meeting present needs without compromising the ability of future generations to meet their own needs. They empower cities to monitor, adjust, and continuously improve their performance towards a more sustainable future.

It is also emphasized that, according to Melo and Van Belle (2019), sustainability indicators play a crucial role as a management and governance instrument. They condense and assess trends and information in a parameterized manner concerning the proposed goals and objectives. This is done descriptively and normatively to provide guidance for public decision-making and, at the same time, for civil society; the main purpose of these indicators is to communicate and inform progress regarding specific targets.

The Brazilian Association of Technical Standards (ABNT) warns of the lack of standardization of indicators generally adopted by public authorities, which often results in inconsistency (ABNT, 2017). Moreover, it is important to note that each city has its own characteristics, whether environmental, cultural, or economic. Therefore, the selection and application of indicators should occur at the local level, including municipal regional specifications (Li-Shen, Ochoa, Shah & Zang, 2011; Tanguay; Mizutani, 2019).

Indexes and indicators must be measurable and easy to understand and assimilate, not only by public authorities but also by society at large. They play an important role as tools for monitoring and evaluating municipal management, as well as instruments for community engagement (Bachendorf, Santos, Pezarico & Silva, 2018).

2.4 PROGRAM SUSTAINABLE CITIES – PCS

The Sustainable Cities Program was created in 2007, involving 700 civil society organizations and influenced by the Aalborg commitments made in Denmark in 1994, which was a political agreement for sustainable development, and the SDGs. The Sustainable Cities Program (PCS) comprises 12 axes, as represented in Figure 4. Its configuration was adapted from the European experience, which is composed of 10 commitments: 1) governance; 2) local management for sustainability; 3) natural commons; 4) responsible consumption and lifestyle choices; 5) urban planning and design; 6) better mobility and less traffic; 7) local action for health; 8) dynamic and sustainable local economy; 9) equity; and 10) social justice and from local to global. For the Brazilian context, two more commitments were added: "education for sustainability and quality of life" and "culture for sustainability," completing the 12 axes of PCS (Barroso & Rezende, 2016; Lopes, 2016).

Figure 4- Axes of the Sustainable Cities Program - PCS.
Source: PCS, 2023

The PCS indicators are more specific than the European model due to their methodologies supporting public management and integrated urban planning, as well as mechanisms for social control and the encouragement of public participation (PCS, 2023).

The Sustainable Cities Program - PCS is an urban sustainability agenda that covers five dimensions: social, environmental, economic, political, and cultural in municipal planning. The PCS was created by a group of institutions such as the Nossa São Paulo

Network, the Ethos Institute, and the Brazilian Social Network for Fair and Sustainable Cities, following four structuring lines: tools, mobilization, commitments, and benefits for participating cities (Melo & Van Bellen, 2019; PCS, 2023). Since 2012, the program has emerged with the objective of "raising awareness, mobilizing, and offering tools for Brazilian cities to achieve sustainable economic, social, and environmental development" (Rede Nossa São Paulo, 2012, p. 3).

The guide was designed to guide municipal department teams responsible for local management in developing a Master Plan with strategic priorities and a Goal Plan focused on sustainable development (Lopes, 2016). The program seeks to contribute to municipal administrations by implementing tools for planning public policies that incorporate sustainability into projects and actions by municipal executive and legislative branches, as well as the commitment of private sectors and local societies (GPS, 2013).

To participate in PCS, cities must register on the website and complete the questionnaire by providing information collected from various institutions such as IBGE, IPEA, the State System of Data Analysis (SEADE), federal, state, and municipal departments, among others. In 2017, the PCS had 285 Brazilian municipalities participating, contributing to the creation of 105 observatories in these municipalities, thus enabling the inclusion of innovative public policies and the exchange of experiences (Navacinsk, 2018). Among the tools offered by PCS, we can mention the Sustainable Cities Platform, which is an agenda for the sustainability of participating cities, encompassing the 12 axes presented in Figure 4, fully incorporating social, environmental, economic, political, and cultural dimensions, addressing the 17 SDGs within its axes and data on sustainable development provided by IBGE (Melo & Van Bellen, 2019; Bencke & Perez, 2018). The main characteristics of PCS (PCS, 2019) are:

1. Use of metrics and indicators to track goals;
2. Support for integrated sustainable urban planning with collaborative tools, methodologies, software, and technical guidance documents;
3. Mechanisms for social control and encouragement of public participation;
4. Municipal financing mechanisms;
5. Facilitated access to integrated data;
6. Training programs;
7. Participatory interface;
8. Collection and sharing of best practices and case studies;

9. Partnerships with universities and research institutes;
10. Promotion of partnership opportunities with the private sector;
11. Access to informative content on urban sustainability;
12. Agenda of national and international events.

The benefits for participating cities or signatories of the commitment letter, or adhesion letter, include visibility on the program's website and in promotional materials, visibility of actions, projects, and programs of the city that contribute to sustainability, exchange of experiences and information with other participating cities in the program. Additionally, there is technical support for promoting meetings on urban sustainability. Another motivating factor is that cities that join the program receive a participant city seal and are eligible to apply for the Sustainable Cities Award (PCS, 2012). Within the platform, there are 260 indicators and 169 goals associated with the 12 axes, as well as exemplary national and international cases integrating the city indicators demonstrated in Frame 4.

Frame 4 - Indicators and SDGs per PCS axis

Axis	**Total Indicators**	**SDGs**
Governance	30	5; 10; 16
Natural Commons	21	2; 6; 11; 12; 14; 15
Equity, Social Justice, and Peace Culture	43	1; 3; 5; 9; 10; 11; 16
Local Management for Sustainability	8	11; 12; 16; 17
Urban Planning and Design	9	11
Culture for Sustainability	8	4; 11
Education for Sustainability and Quality of Life	37	4
Dynamic, Creative, and Sustainable Local Economy	35	2; 7; 8; 9; 12
Responsible Consumption and Lifestyle Choices	15	6; 7; 11; 12
Better Mobility and Less Traffic	13	3; 11
Local Action for Health	29	2; 3; 5
From Local to Global	11	7; 11; 13

Source: Compiled by the researcher with data from PCS, 2023.

The indicators proposed by the PCS can serve as a basis for public policies, as they allow for the analysis of location through a set of variables involving social, economic, political, environmental, and cultural dimensions. The calculation method specified on the platform provides a table composed of axes, indicator, description, variables that make up the indicator, calculation method, and reference target. Therefore, the Sustainable Cities Initiative was chosen to support this study as it provides the necessary tools to measure representative variables of the city, outlining the diagnosis of the actual situation presented by the variables through the use of sustainability indicators (PCS, 2023).

2.5 ISO 37120/2017

With the aim of promoting sustainable development by 2030, cities around the world have adopted the implementation of sustainable policies to create a better urban environment. Cities need to assess progress, validate performance, and compare changes and challenges to develop public policies and inform decision-making (UN, 2016).

The International Organization for Standardization (ISO) developed international standards for cities in 2014 to promote sustainable development and energy analysis (ISO, 2017). In November 2013, the ISO technical committee, numbered ISO/TC 268-Uban, was created. This committee was created to develop sustainable technologies for this purpose, including the development of management requirements, design, guidelines, methods, and tools to assist communities (UN, 2013).

The Brazilian Association of Technical Standards (ABNT) established the ISO/TC 268 mirror commission, named ABNT/CEE-268 - Special Study Commission on Sustainable Development in Communities (Ribeiro, 2019). It was approved by ABNT's Technical Council, at the request of the Brazilian Council for Sustainable Construction (CBCS) to meet the needs of participating in the development of international standards and adopt them as Brazilian Standards to collaborate with city management, providing indicators for sustainable development (ABNT, 2017).

The commission had partnerships with various institutions such as the Basic Sanitation Company of the State of São Paulo (SABESP); Ministry of Cities; Housing and Urban Development Council of the State of São Paulo (CDHU); Brazilian Council for Sustainable Construction (CBCS); Paulista Metropolitan Train Company (CPTM); Tecnisa; Dersa; Metro SP; Brazilian Chamber of Construction Industry (CBIC); ABNT;

Federation of Industries of the State of São Paulo (FIESP); Amazon; Federal University of Goiás (UFG); Housing and Condominium Union (SECOVI); Concremat; Uninove; CCBR; Caixa Econômica do Brasil; Romanel, among others (Ribeiro, 2019).

ISO 37120/2017 was the first Brazilian technical standard for Sustainable Development of Communities, formulated with rigorous indicators for municipalities to measure and compare their sustainable performance (ABNT, 2017). The standard consists of a set of indicators covering a wide range of key areas of the city, including transport, education, health, environment, governance, and security, enabling cities to improve their performance concerning sustainability goals and quality of life.

ISO 37120/2017 defines a city as an urban community within specific administrative boundaries, such as a municipality or local government (ISO, 2017, p. 1). Its main objective is to create a standard adapted for cities, focused on evaluating management, performance, and quality of life. In addition, ISO seeks to establish indicators linked to sustainable development, offering a methodology to measure the performance of urban services and quality of life (Ribeiro, 2019).

In this sense, ISO aims to guide cities, municipalities, or local governance entities committed to measuring their performance in a comparable and verifiable way, regardless of their size, location, or level of development. It contains indicators in various areas such as economy, education, energy, environment, finance, emergency services, health, leisure, safety, waste, transportation, telecommunications, water, urban planning, among others (Viante, 2021). ISO 37120 indicators can be used as a management tool for decision-making and for guiding planning and management policies.

ISO 37120/2017 defines with precision 19 themes related to urban services and quality of life. Each topic has a set of indicators, with a total of 128 items, from section 5 to 22 of the standard, of which 45 are essential indicators that must be followed in the implementation of this standard, and 59 are supporting indicators that should be followed in the implementation of this standard (ISO, 2017). In addition, there are 24 profile indicators that describe the characteristics of the city. All essential indicators must be collected annually to promote best practices so that cities can present supporting indicators in the same section (ISO, 2018). Each essential, supporting, and profile indicator has a specific number, and the calculation methodology for each indicator is presented in a simplified manner in Annex A, which uses the same division presented by the standard by sections.

As mentioned earlier, the indicators present distinctions between themselves. Those classified as essential are fundamental for guiding and evaluating urban performance management. On the other hand, supporting indicators are suggested for adoption, while profile indicators aim to provide context for interpreting the city's results, thus being informative (Azevedo, 2022).

The standard is a technical document that evaluates a city's ability to assess its performance. In this sense, to achieve certification through ISO 37120/2017, it is based on the number of indicators measured by the city, not necessarily on the quality or value of the indicator (ABNT 2021, 2022). Certifications can be obtained by qualifying 100 indicators – 46 essential and 54 supporting, recognized worldwide and consisting of four types of classifications: Bronze to Platinum, as illustrated in Figure 5. This classification is globally valid and assesses the quality, safety, and efficiency of cities, observing the performance of cities regardless of their size, but evaluating the effectiveness of government management (Mizutani, 2019).

Figure 5- Certification Levels and Required Number of Indicators
Source: WCCD 2023.

The criteria for each certification are as follows:

- Aspirant: between 30 and 44 essential indicators;
- Bronze: between 46 and 59 indicators, with 45 or more essential indicators and 0 to 14 supporting indicators;
- Silver: between 60 and 74 indicators, with 45 or more essential indicators and 15 to 29 supporting indicators;
- Gold: between 75 and 89 indicators, with 45 or more essential indicators and 30 to 44 supporting indicators;
- Platinum: between 90 and 104 indicators, with 45 or more essential indicators and 45 to 59 supporting indicators.

Since certification is an evolving process, certified cities can request the evaluation of additional indicators to obtain a higher certification level (ABNT, 2023). The indicators defined by ISO 37120/2017 cover a wide range of sectors related to urban sustainability, providing significant contributions to cities in three key areas: evaluating performance in urban service management and quality of life; enabling comparisons through successful practices from other cities; and sharing information and best practices between different locations (Ribeiro, 2019).

These city indicators can serve as an integrated monitoring tool, aiming to assess and recommend specific goals for city improvement through quantitative and/or qualitative data (ISO, 2017). The adoption of ISO can result in advantages for governance and efficient service delivery, as well as the adoption of international standards and goals. It can also facilitate planning and comparisons of actions at the local level, supporting decision-making and promoting information sharing among cities. Additionally, it aids in accessing funding and recognition by international organizations, contributing to sustainability planning and providing transparency through open data that can attract investments (Ribeiro, 2019).

The indicators established by ISO 37120/2017 contribute to the evaluation of cities, measuring their performance and progress. In this sense, the effort to ensure quality of life and sustainability through the implementation of policies, programs, and projects that meet the needs of their citizens requires cities to have standardized, consistent, and comparable indicators to measure their performance (ABNT, 2017).

3. METHOD AND RESEARCH TECHNIQUES

This section details the methodological procedures to be employed to address the research problem and achieve the proposed objectives. It describes the nature and characteristics of the study, as well as the data collection stages necessary to meet the objectives. Thus, this dissertation classifies the research based on the taxonomies presented by several authors (Eisenhardt, 1989; Minayo, 1992; Corrêa, 2008; Crewell, 2010; Prodanov & Freitas, 2013; Yin, 2015; Marques & Freitas, 2018).

3.1 RESEARCH DESIGN

This dissertation is an applied research study of a qualitative and exploratory nature, using case study and document analysis as technical procedures. Figure 6 demonstrates how the methodology was structured.

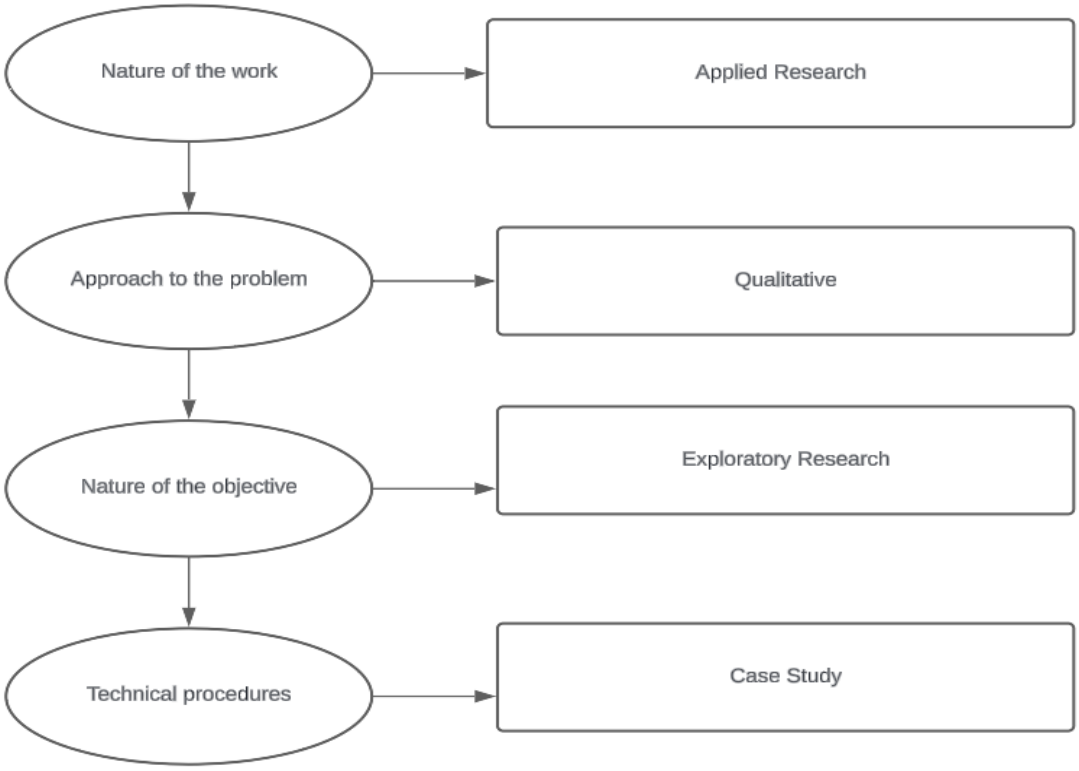

Figure 6- Methodological Structure
Source: Research Data (2024).

The nature of this work is classified as applied research, aimed at providing a practical proposal of knowledge and improving the tools to support the certification of a sustainable city in Cascavel, following the criteria of ISO 37120/2017 (Corrêa, 2008). Regarding the approach, this dissertation is considered qualitative research. Following the precepts of Creswell (2010), qualitative research is understood as a means to explore and understand the meaning that individuals attribute to a social or human problem. In other words, qualitative research relates the real object to the subject, mediating between methodological theory and reality. It focuses on specific issues in the social sciences, exploring aspects of reality that cannot be quantified. It investigates meanings,

motivations, values, and attitudes, delving into deeper relationships that cannot be summarized solely through numerical variations (Minayo, 1992).

Regarding the objectives, this dissertation is exploratory research due to the researcher's lack of knowledge about the research question. It analyzes the sustainability axes of the PCS in the municipality of Cascavel, aiming to meet the standard of ISO 37120/2017. Based on the literature review, it aims to provide greater familiarity with the problem, making it clearer (Corrêa, 2008). This was necessary because it is a new or little-addressed topic in the field of applied social sciences (Prodanov & Freitas, 2013).

To achieve a deeper understanding of reality and expand comprehension of the problem situation, a case study was conducted. This type of study involves a thorough analysis of a specific situation, allowing for an in-depth investigation that provides insights into the aspects addressed in this dissertation (Eisenhardt, 1989; Yin, 2015). Additionally, the case study can be limited to one or several units. These units may be defined as individuals, organizations, communities, institutions, or events. Therefore, this research is characterized as a case study, as it evaluates the sustainability of the municipality of Cascavel - PR (Yin, 2015).

As for the technical procedures, a bibliographic review was conducted to gather the necessary information to elucidate the research problem from scientific articles and academic papers, as well as a document analysis of the PCS report and ISO 37120/2017 (Corrêa, 2008). Sá-Silva et al. (2009) highlight the importance of documents in scientific research, emphasizing their richness in historical and socio-cultural information. Documents are fundamental in case studies as they provide support and enhance evidence from other data sources (Yin, 2015).

The selection of the city for the case study followed five criteria defined by the author: 1) Medium-sized city; 2) city located in the western region of Paraná State, with more than 100,000 inhabitants; 3) city with representativeness in the region where it is located; 4) city recognized as sustainable and/or smart by research organizations, non-governmental organizations, the media, or local government; 5) city with accessible research opportunities for the author. Based on these criteria, the city of Cascavel was chosen as the object of research.

3.2 DATA COLLECTION PROCEDURES

The data collection procedures aimed at achieving the main objective of analyzing the sustainability of the Municipality of Cascavel, through the PCS and ISO 37120/2017, involved the following activities shown in Figure 7:

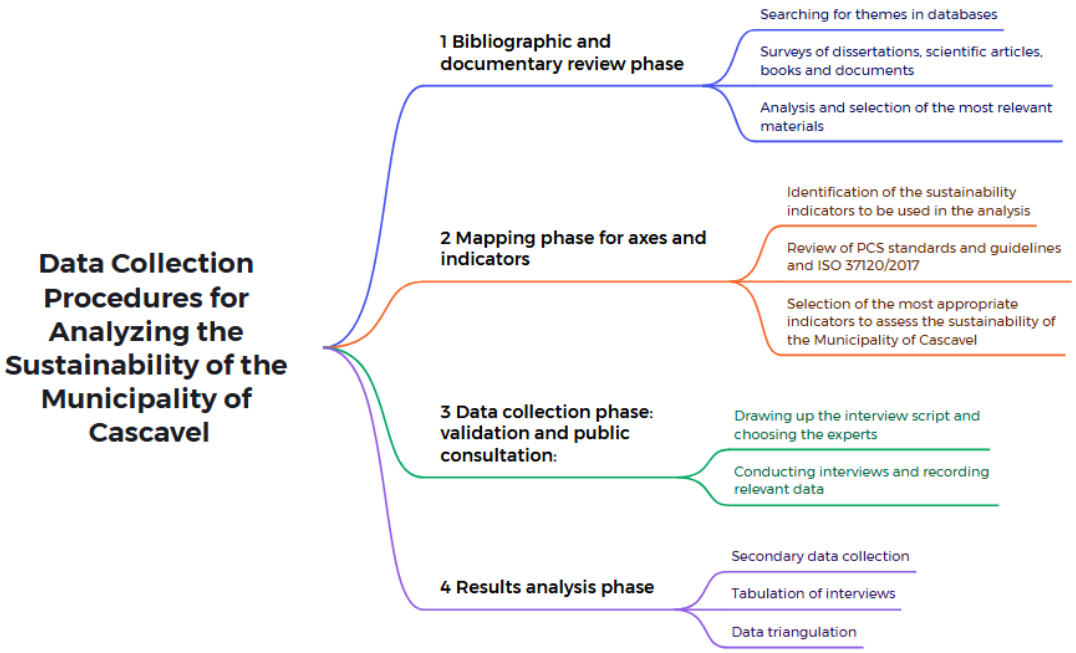

Figure 7 -Structure and methodological procedures
Source: Research data (2024).

The first phase of the research was the literature review. Literature relevant to the topic, covering the period from 2019 to 2024, was selected, focusing the research on the title, objective, and keywords in national and international thesis and dissertation databases. Keywords used included: "Sustainable cities," "Sustainable and smart cities," "Sustainable city indicators," "Sustainability indicators," "Sustainable and smart city rankings," and "Ranking of sustainable and smart cities." The bibliographic research was conducted to provide a solid theoretical foundation and identify the state of the art on the subject of interest.

This allowed an understanding of the conceptualization of a sustainable city, as well as the main indicators and indexes used to measure urban sustainability. Additionally, programs, rankings, and standards that evaluate sustainability were identified, along with similar case studies or experiences of other cities in achieving ISO 37120/2017. Documental research complemented the literature review, using the PCS report and ISO 37120/2017 (Corrêa, 2008). Sá-Silva et al. (2009) emphasized the importance of documents in scientific research, highlighting their richness in historical and sociocultural information.

The second phase of the research involved establishing the main sustainability axes defined by ISO 37120/2017 and adapting these axes to the specific reality of Cascavel, considering local characteristics and urban demands. To measure and respond to the research question, it was decided to evaluate the sustainability indicators based on ISO 37120/2017. The choice of indicators is justified because they encompass various areas such as economy, education, energy, environment, health, leisure, security, waste, transportation, telecommunications, water, and urban planning, among others (Prestes & Pozzetti, 2018). ISO 37120/2017 consists of 19 themes related to urban services and quality of life, with a total of 128 indicators. These data were organized into Excel tables, enabling diagnosis and analysis, and assessing the current position of Cascavel in relation to the ISO standards. Data sources included IBGE, IPEA, RAIS, IPARDES, DATASUS, Cascavel's municipal departments, the Paraná Fire Department, Sanepar, and Copel. This phase helped identify strengths and areas for improvement in each sustainability axis.

To evaluate the sustainable city indicators and explore the possibility of certifying Cascavel through ISO, the research entered the third phase, termed by the author as validation and public consultation. Semi-structured interviews were conducted with experts in the areas and themes of ISO 37120/2017.

The expert opinion procedure was crucial for enriching the qualitative analysis with insights based on practical experience and specialized knowledge on the subject and areas affecting sustainability practices in the municipality. This type of study involves a detailed analysis of a specific situation, allowing for in-depth investigation and acquisition of knowledge about the aspects addressed in this dissertation (Eisenhardt, 1989; Yin, 2015). For this process, a semi-structured interview guide was developed to answer the research question: based on the indicators of the Sustainable Cities Program (PCS), what actions should be implemented in Cascavel to meet ISO 37120/2017 standards and obtain certification? The guide consisted of 21 questions grounded in the

bibliographic research on sustainable cities and ISO 37120/2017. After creating the guide, the experts to be invited to collaborate were selected. Fifteen specialists were chosen based on the following criteria:

1. Identification of experts and professionals with knowledge of urban sustainability, public management, and ISO-related standards;
2. Professional experience, competence in the field, familiarity with ISO methodology or participation in related projects, significant contributions to advancing knowledge, and recognition in their respective fields of expertise. Additionally, they must reside and work in the municipality.

The fourth phase was results analysis, where the first step was to tabulate and compare the selected ISO 37120/2017 indicators with the results obtained from the expert interviews and the theory on sustainable cities. This allowed for data triangulation, which facilitated the development of strategies and improvements.

The methodology, using expert opinion combined with bibliographic and documental research, enabled a comprehensive and in-depth approach to the investigated subject. This methodological combination ensured data triangulation, increasing the validity and reliability of the research results. For Yin (2010), data triangulation is an essential methodological strategy for increasing the validity, reliability, and richness of research. By integrating multiple sources, methods, investigators, or theories, researchers can gain a more comprehensive and profound understanding of the studied phenomenon, resulting in more robust and reliable conclusions. Triangulation not only strengthens the research but also enhances its credibility and acceptance in both academic and practical communities. Insights from the experts provided a valuable practical perspective, complementing the theoretical and documental basis of the research. At this stage, strategies and recommendations were also developed to improve aspects identified as deficient or with potential for enhancement, including specific and feasible actions to elevate Cascavel's performance towards ISO 37120 standards.

3.3 DATA ANALYSIS PROCEDURES

After sending invitations to the 15 specialists, we received effective responses from only 8. Additionally, as the interviews were conducted, a saturation of responses was observed. According to Gaskell (2002), saturation occurs when responses tend to repeat, and new interviews do not offer additional qualitative insights for understanding

the phenomenon under study. This indicates that it is already possible to identify the structure of meaning, that is, the socially shared representations on the topic of common interest.

The semi-structured interview guide aimed to answer the research question: considering the indicators of the Sustainable Cities Program (PCS), what actions should be implemented in the municipality of Cascavel, based on ISO 37120/2017, to obtain certification? This guide consisted of 21 questions (Appendix A), grounded in the bibliographic research on sustainable cities and ISO 37120/2017. After the specialists accepted, in-person and online interviews (via Teams and WhatsApp) were scheduled between February and May 2024. All interviewees' names and positions were kept confidential in accordance with research standards and norms. For this purpose, the research assigned each interviewee a number as shown in Frame 5.

Frame 5- Interviewee Profile

Interviewee	Field of Expertise	ISO 37120 Coverage Area
Interviewee 01	Architecture, Professor	Urban planning, urbanization
Interviewee 02	Public manager	Social conditions, security, and education
Interviewee 03	Basic sanitation	Water and sewage
Interviewee 04	Architecture and urbanism	Urban planning, urbanization
Interviewee 05	Private sector	Finance and economy
Interviewee 06	Public manager	Governance
Interviewee 07	Cooperative manager	Environment and entrepreneurship
Interviewee 08	ESG Cooperative manager	Environment, finance, and agriculture

Source: Research data (2024)

In parallel with the interviews aimed at assessing the experience of each specialist regarding ISO 37120/2017, interviews were conducted with three ISO auditors (none specific to ISO 37120/2017), but experienced in ESG, ISO 9000, and ISO 14000. They answered an open-ended and semi-structured questionnaire consisting of 8 questions related to the costs, advantages, and disadvantages of implementing ISO 37120/2017 in the municipality of Cascavel (Appendix B). After the interview period, all interviews were transcribed using Iramuteq software, which enabled the identification of convergences and divergences in the responses. This facilitated data triangulation

between the literature on Sustainable Cities, the ISO 37120/2017 indicators, and the interview responses (Marques & Freitas, 2018).

In this context, the importance of data triangulation is emphasized, which, according to Minayo (1992), is a methodological approach that supports the validation or complementation of information through the analysis of multiple sources or methods. In the analysis of sustainable cities, triangulating literature, known standard indicators, and interview data provides a broader and more reliable view of the subject. This triangulation allowed for a more holistic and robust analysis, helping to validate the indicators, identify gaps in established standards, and offer more comprehensive insights into the concept of sustainable cities.

3.4 LIMITATIONS OF THE RESEARCH METHODS AND TECHNIQUES

The methodology used in this research, consisting of a bibliographic review and document analysis, has some important limitations that should be considered when interpreting the results. The first phase of the research involved the selection of relevant literature on the topic of sustainable cities, covering the period from 2019 to 2024, and including theses, dissertations, and other academic works. Despite the comprehensiveness and careful selection of materials, this approach has some constraints, such as the temporal restriction. Although the period between 2019 and 2024 was chosen to provide more recent data, relevant studies published outside this interval that contain important concepts and practices of urban sustainability may have been excluded, even though the topic is still relatively new in academic discussions.

Another limitation arises in the second phase of the research, which involved adapting the sustainability axes defined by ISO 37120/2017 to the specific context of Cascavel. This adaptation process, though necessary for local contextualization, also presents limitations. The ISO 37120/2017 standard sets out general sustainability axes that may not capture all the specificities of Cascavel. The attempt to adapt these axes to the local context might have resulted in an approach that, although comprehensive, may not fully reflect all the particularities of the city. Additionally, the use of indicators from different sources, such as IBGE, IPEA, and other databases, may introduce inconsistencies due to methodological differences among these data sources. Another challenge was data availability; not all sections established by the ISO had corresponding

data available for Cascavel, either due to the lack of production of these indicators or their non-publication by the relevant authorities.

Another limitation lies in the interviews conducted with specialists, aimed at enriching the analysis of the indicators. The criteria for selecting the specialists (professional experience, competence in the field, etc.) are subjective and may introduce biases in the choice of interviewees. Moreover, the number of specialists interviewed may not have been sufficient to capture the diversity of opinions and experiences needed for a comprehensive analysis.

The adopted methodology, despite being comprehensive, has inherent limitations that should be considered when interpreting the research results. These limitations include temporal and source selection constraints, the generalization of sustainability axes, and the potential subjectivity in the selection of specialists. Acknowledging these limitations is crucial for a complete and critical understanding of the findings of this research.

4. FIELD OF STUDY

According to Creswell (2007), qualitative research occurs in a natural setting, implying that the researcher moves to the location where the participant is embedded to conduct the investigation. In this research, the unit of analysis is the city of Cascavel, a Brazilian municipality located in the western region of the state of Paraná. It is the fifth most populous city, with 348,051 inhabitants, of which 94.36% live in urban areas and 5.64% in rural areas (IBGE, 2023). It is also the tenth most populous city in the South of the country and one of the most important cities in the region.

Cascavel covers an area of approximately 2,086.385 km², making it one of the largest cities in the state in terms of land area (IPARDES, 2023). It is a planned city structured for the well-being of society, featuring a significant number of universities and a large agricultural production sector. Cascavel combines tradition and modernity (PCS, 2022).

The city has experienced significant urban growth over the past decades, expanding both horizontally and vertically. Urbanization is marked by the presence of residential neighborhoods, commercial areas, and industrial zones. The city consists of 32 neighborhoods, as shown in Figure 8, along with 7 districts and the administrative seat.

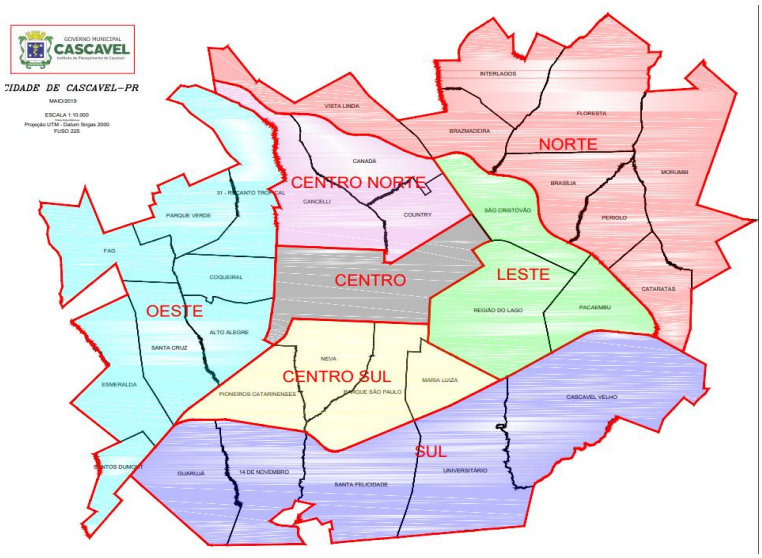

Figure 8 - Map of Cascavel subdivided into neighborhoods.
Source: Geoportal of the Municipality, 2023.

According to the Connected Smart Cities Ranking (2022), the city ranks fifth in the state for urban planning, in addition to receiving high marks for treated water and sewage services. Moreover, the city has been modernizing in recent years, striving to improve social, environmental, and economic aspects.

With the sixth-largest GDP in Paraná, Cascavel's economy is focused on agribusiness, emerging as a strong commercial and services hub, undergoing continuous industrialization (IBGE, 2022). Its notable sectors include wholesale trade, healthcare, higher education, metallurgy, clothing, and food industries. In 2018, IBGE data counted 16,202 companies operating in the municipality, classifying it as the fourth-largest in the state in this regard. Furthermore, the consulting firm Urban Systems ranked Cascavel as the third best city in Paraná and the twenty-third in Brazil for business opportunities. In 2020, it received the award for the second-best city in Brazil according to the Excellent Cities Award, which recognizes and values good management practices to transform the realities of Brazilian municipalities and improve public services provided to citizens (Urban Systems, 2022).

It is worth noting that since 2017, the municipality has been part of the Sustainable Cities Program, monitoring its indicators and promoting good practices for sustainable management. As recognition for its efforts, the municipality has received awards within the PCS framework, including a prize in the medium-sized cities category in the external edition aimed at accelerating the implementation of the 2030 Agenda. These

achievements stem from sustainable initiatives such as the Biogas Plant and the Sustain/Recycling Program (PCS, 2023). These aspects highlight the relevance of the study for the strategic management of the city towards sustainability.

5. ANALYSIS AND INTERPRETATION OF RESULTS

This chapter aims to present the analysis of the situation in the municipality of Cascavel, starting with the analysis of indicators following the standards of the ISO 37120/2017 and the discussion of the municipality's actual situation. Subsequently, the results of interviews with specialists will be presented to verify whether the municipality is capable of obtaining certification like ISO 37120/2017 and what the benefits and obstacles are for the municipality to achieve this certification.

5.1 ANALYSIS OF ISO 37120/2017 INDICATORS IN THE MUNICIPALITY OF CASCAVEL

The construction of sustainable cities is a complex challenge that requires the integration of various areas of knowledge and the participation of multiple social actors. The municipality of Cascavel, like other Brazilian cities, faces significant challenges in the pursuit of sustainable development, which must achieve a balance between economic growth, quality of life, and environmental conservation. This study conducted a triangulation of data derived from urban sustainability indicators based on ISO 37120/2017, adapted to the municipality's reality, semi-structured interviews with specialists, and a theoretical framework on sustainable cities. The analysis aims to provide a comprehensive view of the current conditions in Cascavel and justify the importance of the adopted approaches to improve urban sustainability in order to achieve certification like ISO 37120/2017.

To gather data on the city of Cascavel for this study, various sources were consulted at the municipal, state, and national levels. Public statistics provided by the Brazilian Institute of Geography and Statistics (IBGE), the Paraná Institute of Economic and Social Development (IPARDES), and other governmental and private databases were utilized. Publications, reports, and databases from the municipality of Cascavel and its secretariats, as well as various agencies, were also consulted. Highlights include organizations such as Sanepar, which provided data on water, sewage, and solid waste; the Statistical Booklet of the Municipality of Cascavel in the area of education; the Ministry of Health, through data available on the DATASUS platform, related to health

and mortality; the Superior Electoral Court (TSE) for governance data; and the National Telecommunications Agency (Anatel) for data related to telecommunications, along with the 4th Battalion of the Fire Department for data on emergency responses. Additionally, the municipal government website and its secretariats were utilized.

To reflect more current conditions in the city of Cascavel, this study referenced the years 2022 and 2023, while in some cases, data from 2010 were used due to the demographic census and the absence of more recent published data. Thus, during data collection, efforts were made to ensure that the data referenced the year 2023, or the closest possible time frame.

It is important to highlight that according to the ISO's own description, it was created to assist cities in directing and evaluating the management of urban services and the quality of life of citizens. This standard is applicable to any city, municipality, or local government that wishes to measure its performance in a comparable and verifiable manner, regardless of size or location. The ISO is a non-ranking standard; it helps improve and standardize indicators (ABNT NBR ISO 37120:2017). For data interpretation, the standard recommends that cities consider the local context during the analysis of results, as the institutional environment may influence the capacity to apply the indicators.

Thus, while ISO 37120/2017 provides a standardized international framework for measuring urban sustainability, the Sustainable Cities Program platform adapts these practices to the Brazilian context, promoting community participation and the sharing of local best practices. Both approaches seek to enhance quality of life and sustainability in cities, but they do so through slightly different methods and approaches. The data worked in this section focus solely on the indicators and sections addressed in the ISO.

The values presented in this study were calculated following the methodology of the ABNT NBR ISO 37120:2017 standard, as detailed in Appendix A. Of the 128 indicators described by the standard, 78 indicators were collected for this study. From this total, 40 essential indicators were found (out of the 45 defined in the standard), 29 supporting indicators (out of the 59 defined), and 10 profile indicators (out of the 24 defined). According to the World Council on City Data (WCCD, 1987), a city must have at least 30 essential indicators collected to be certified as an aspirant. Therefore, the city of Cascavel would meet this requirement of ISO 37120/2017 in the aspirant category.

The results are presented in the following tables, maintaining the structure of division by sections as specified in the ABNT NBR ISO 37120/2017 standard. The

classification of indicators is indicated in the tables by the column "N," which corresponds to the specific section of the ISO. The second column classifies the indicators into three categories: essential indicators are represented by the letter "E," supporting indicators by the letter "A," and profile indicators by the letter "P," while the third column details the indicator. The fourth column provides the value of the indicator for the municipality of Cascavel. For indicators whose values could not be obtained, the term "X" was used to indicate this. The absent values highlight areas where data collection needs to be improved or where there were difficulties in obtaining information. The analysis of these results allows for the identification of strengths and critical areas that need attention to improve urban quality of life and the sustainability of cities. The fourth column provides the year and source from which the value for the calculation was obtained.

The first data section of the Standard addresses indicators related to the economy within the city. Regarding the ISO indicators linked to the Economy Section, the results are presented in Table 1.

Table 1: Indicators of ABNT NBR ISO 37120/2017 Adapted for the Municipality of Cascavel – Section 5: Economy

No.	Level	Indicator	Result	Source
5.1	E	Unemployment rate in the city	4,87%	RAIS 2023
5.2		Value of commercial and industrial property as % of total property value	X	
5.3		Percentage of population with full-time employment	95,14%.	IPARDE 2022
5.4		Youth unemployment rate	X	
5.5		Number of businesses per 100,000 inhabitants	3.599,04	IPARDES 2023
5.6		Number of new patents per 100,000 inhabitants per year	X	
5.7		Annual number of overnight stays by visitors per 100,000 inhabitants	X	
5.8	A	Area connectivity (number of direct commercial flights)	81	IPARDES 2023
5.9.1	P	Average Family Income (US$)	R$ 988,84	IBGE 2023

5.9.2	Annual inflation rate based on the average of the last five years	6,61%	IBGE 2023
5.9.3	City product per capita (US$)	R$ 46.976	IBGE 2023
	Gini coefficient of inequality	0,5206	DATA SUS 2023

Source: Research data (2024)

The economy of Cascavel is characterized by a diversified and solid base, with positive economic indicators that point to a prosperous and constantly growing environment. The city's GDP is approximately 15.8 billion reais, with 59.6% of the added value coming from services, followed by the participation of industry (19.5%), public administration (12%), and agriculture (8.9%) (IPARDES, 2024). This data suggests an environment conducive to investments and innovation, crucial aspects for sustainable development as advocated by the United Nations Sustainable Development Goals (SDGs). Promoting a diversified and inclusive economy not only boosts economic growth but also creates opportunities to reduce social inequalities and strengthen urban resilience against future challenges (UN-Habitat, 2015). The municipality continues to attract investments and provide a high quality of life for its residents, consolidating itself as one of the main economic hubs in western Paraná.

With an unemployment rate of 4.87% and 95.14% of the population employed full-time (5.1 and 5.3), the city demonstrates economic stability and a low unemployment rate, essential factors for promoting social inclusion and quality of life. These indicators, besides being fundamental for analyzing the municipality's economic growth, also contribute to the development of urban sustainability. As discussed by Jong et al. (2015), urban sustainability should not be limited to the environmental aspect but also encompasses economic and social dimensions. A robust economy and a stable job market not only promote citizens' well-being but also contribute to the city's capacity to invest in sustainable infrastructure and efficient public services (Mizutani, 2019).

The number of businesses per 100,000 inhabitants (5.5) is an indicator of economic dynamism and entrepreneurship. With over 3,000 companies, the city demonstrates a favorable environment for new businesses and an active private sector, evidenced by the presence of six industrial parks and hubs in full operation (ACIC, 2024). This business density is a vital engine for innovation and job creation in the city.

Another economic factor evaluated is the average family income, a direct indicator of the economic well-being of residents (5.9). Cascavel presents an average family income that reflects the economic prosperity of the city, providing a good quality of life for its inhabitants. The municipality has 122.7 thousand formal jobs, and the average remuneration for formal workers is R$ 3,000, below the state average of R$ 3,300 (IBGE, 2023). The three sectors that employ the most people are public administration (9,004), poultry slaughtering (7,687), and retail trade in supermarkets (4,494) (IPARDES, 2024). Among the characteristic sectors of the city, activities such as bus body manufacturing and poultry slaughtering also stand out.

The annual inflation rate (5.9), based on the average of the last five years, is an indicator of economic stability. In Cascavel, inflation is controlled at 6.61%, contributing to economic predictability and the confidence of investors and consumers. The Gini coefficient, in turn, demonstrates 0.5206, indicating a moderate level of economic inequality. Inequality is a challenge for sustainability, as it can lead to social tensions and exclusion.

Air connectivity, measured by the number of non-stop commercial flights (5.8), is an indicator of Cascavel's accessibility and integration with other regions. A high frequency of non-stop flights is crucial for economic development, facilitating business, tourism, and trade exchanges. Cascavel hosts significant events such as the Show Rural Coopavel, one of the largest agricultural events in Latin America, and motorsport competitions like Stock Car, among others. These events attract not only national visitors but also international ones, promoting networking opportunities that boost the local economy and tourism. Therefore, continuous investments to increase and maintain air connectivity in Cascavel are essential to sustain its role as a dynamic regional center attractive for events and businesses.

Indicators that were not found in the available databases include the value of commercial and industrial property assessments as a percentage of the total assessment of all properties. This indicator directly reflects the economic composition of the city and the health of the commercial sectors. A high value could indicate a strong business sector, essential for job creation and investment attraction. The absence of this data hinders the understanding of wealth distribution and the city's economic development, making it difficult to identify areas needing tax incentives or development policies. Another important economic indicator that was absent was the youth unemployment rate, which points to deficits in effective employment and education policies for youth. The number

of new patents was also not disclosed, which is an indicator that measures the city's innovation and economic dynamism; the lack of this data may hinder the attraction of new investments in technology and innovation.

The next indicators of the ISO are related to the Education section. Thus, the results found are presented in Table 2.

Table 2- Indicators of ABNT NBR ISO 37120/2017 Adapted for the Municipality of Cascavel – Section 6: Education.

No.	Level	Indicator	Result	Source
6.1	E	Percentage of the female population of school age enrolled in schools	14,65%.	SEED 2023
6.2		Percentage of students with completed primary education: survival rate	74874	IPARDS
6.3		Percentage of students with completed secondary education: survival rate	X	
6.4		Student/teacher ratio in primary education	89,21	IPARDS
6.5		Percentage of the male population of school age enrolled in schools	14,36	SEED 2023
6.6	Apoio	Percentage of the population of school age enrolled in schools	92,60%	SEED 2023
6.6		Number of individuals with completed higher education per 100,000 inhabitants	1.176	IPARDS 2022

Source: research data (2024)

The analysis of the education-related indicators in the municipality of Cascavel provides insight into the academic performance within the city. These indicators help evaluate the effectiveness of educational policies, accessibility to education, and the quality of the education offered.

In this aspect, it was possible to verify that 14.65% of the female population enrolled in schools (6.1) is an essential indicator for assessing gender equity in education. In Cascavel, the female enrollment rate demonstrates the municipality's commitment to educational inclusion. This indicator reflects not only the accessibility of education for girls but also the impact of policies promoting female education. When compared to the percentage of the male population of school age enrolled (6.5), it is observed that the rates are quite close (male rate: 14.36%), suggesting a slight predominance of female enrollment. The difference of 0.29 percentage points is small, indicating that, in terms of

access to education, there is no significant gender disparity in Cascavel. This demonstrates a successful effort by the municipality's educational system to provide equal access to education for both sexes, strengthening not only gender equity but also contributing to the social and economic sustainability of the city, in line with the goals of SDG 4 and 5.

Section (6.2) reflects the survival rate in primary education, measured by the percentage of students who complete this stage, serving as an indicator of the effectiveness of the educational system in Cascavel. High survival rates suggest that most students are able to progress through the system without significant interruptions, indicating a favorable educational environment and adequate support both at the school and family levels. Similarly, the survival rate in secondary education (6.3) is vital for assessing educational continuity and preparation for higher education or the job market. However, in this analysis, we could not obtain the results due to the absence of published data on completed enrollments in the available databases, which may raise a flag for the educational system regarding the need for policies targeting youth and the job market.

The student/teacher ratio in primary education (6.4) shows the quality of education, with a rate of 89.21. Cascavel represents a balanced ratio, suggesting that teachers can offer individualized attention and adequate support to students. A favorable student/teacher ratio is associated with better educational outcomes, as it allows for a more interactive learning environment that focuses on students' needs.

It can be observed that the high enrollment rates of 92.60% indicate that the majority of children and adolescents are receiving formal education, which is fundamental for the socio-economic development of the city. The number of individuals with completed higher education in the municipality (6.7) is an indicator that assesses the city's capacity to train qualified professionals, essential for economic growth and innovation. These high rates also relate to Cascavel being known economically as an educational hub, given that it has several higher education centers, including the State University of Western Paraná (Unioeste), the Federal Institute of Paraná (IFPR), and other private colleges that offer both in-person and distance learning (ACIC, 2024).

The educational indicators of Cascavel show a positive relationship, presenting high enrollment rates, survival rates in primary and secondary education, and a favorable student/teacher ratio. These data indicate an inclusive and effective educational system capable of providing a solid foundation for students' personal and professional development. The significant presence of individuals with higher education also

highlights the city as an advanced educational center, prepared to face future challenges and contribute to the socio-economic development of the region.

Section 7 of ISO 37120 deals with indicators related to energy, directly linked to per capita consumption, the share of renewable energy, and energy efficiency in buildings. These are criteria for evaluating the energy progress of cities. Thus, we can consider that energy indicators are linked to urban sustainability, as the efficient and responsible use of energy is fundamental for the sustainable development of cities (Bibri and Krogstie, 2017). The results obtained for the municipality can be verified in Table 3.

Table 3- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel, Section 7 - Energy.

No.	LEVEL	INDICATOR	RESULT	SOURCE
7.1	E	Total residential electricity consumption per capita	159.084	COPEL 2023
7.2		Percentage of city inhabitants with regular supply	70,10%	COPEL 2023
7.3		Final energy consumption of public buildings per year (GJ/m²)	26260,741 mwh	COPEL 2023
7.4		Percentage of total final energy from renewable sources	29,89%	COPEL 2023
7.5	A	Electricity consumption for public lighting per kilometer of lit road (kWh/year)	25830,401 mwh	COPEL 2023
7.7		Average duration of power supply interruption in hours per household per year	X	

Source: Research data (2024)

The indicator in section (7.1) addresses the total per capita residential electricity consumption, which allows for the assessment of the average electricity usage per resident in the municipality. It is an indicator of energy efficiency and the living standards of the inhabitants. Cascavel reported a per capita usage of 159.084, which is considered relatively high. Indicator (7.2) reflects the population's access to regular electricity supply. A value of 70.10% indicates that 30% of the population still has irregular access to electricity, which can affect the quality of life and economic development for this part of the population. Improving this percentage is crucial for social inclusion and quality of life.

When considering energy consumption in public spaces (7.3), it is an indicator that should be monitored, as efforts to reduce it are important for energy efficiency and public resource management. The municipality of Cascavel has around 40,000 public lighting points. As of June 2023, 63.72% of the public lighting system's fixtures were LED technology. This system provides a 63% reduction in energy consumption and a 73% increase in brightness (IPC, 2023). This result is directly related to item (7.5), which addresses electricity consumption for public lighting. The adoption of more efficient lighting technologies, such as LEDs, is a strategy that can significantly reduce energy consumption and operational costs. In this sense, it is possible to verify that public management can invest in practices such as modernizing lighting and air conditioning systems, which can lead to significant savings in both public resources and environmental impact.

Furthermore, it is necessary to consider renewable energy sources, an important alternative for urban sustainability. The municipality of Cascavel has made notable progress in this area. Currently, 29.89% of Cascavel's population utilizes renewable energy sources, a positive value that can still be expanded. Increasing the use of renewable sources would help reduce dependence on fossil fuels and greenhouse gas emissions, promoting environmental sustainability. Since 2008, Cascavel has had an innovative project that uses gases generated in the Municipal Landfill for electricity production. Recently, the municipality began to offset the electricity produced at the landfill in its consumer units according to ANEEL and Copel regulations (PCC, 2023). This project has already resulted in accumulated savings of over R$100,000.00. In addition to the savings, the project has earned awards for the municipality, such as recognition for good practices in the Sustainable Cities Program (PCS) in 2023; this is the second award received by the Biogas Plant. In 2022, the Paraná Public Manager Award (PGP-PR) also recognized the project for generating clean and renewable energy from the biogas of the city's landfill (Municipal Government of Cascavel, 2023). Improving energy efficiency, increasing access to energy, promoting the use of renewable sources, and ensuring supply reliability are essential steps to promote sustainability.

The indicator (7.7) did not have sufficient data for analysis. The absence of this indicator may compromise the reliability of energy supply, which is crucial for the continuous operation of businesses and industries. Frequent interruptions can lead to production losses, reduced productivity, and additional costs. Moreover, frequent

interruptions may indicate problems in the energy infrastructure, resulting in greater waste and negative environmental impact.

Thus, the energy-related indicators demonstrate that the municipality can and should develop targeted strategies to address specific challenges and move toward a more sustainable and resilient city that utilizes clean energy sources and meets the demands of its residents.

Section 8 of ISO 37120/2017 (Table 4) addresses environmental indicators, which are directly related to the emission of harmful gases to the environment, especially those that intensify the greenhouse effect. Additionally, the standard addresses noise pollution, a common problem in urban areas.

Table 4- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel, Section 8 - Environment.

No.	LEVEL	INDICATOR	RESULT	SOURCE
8.1	P	Concentration of fine particulate matter (PM 2.5)	X	
8.2		Concentration of particulate matter (PM 10)	X	
8.3	E	Greenhouse gas emissions, measured in tons per capita	X	
8.4		Concentration of NO2	X	
8.5		Concentration of SO2	X	
8.6	A	Concentration of O3	X	
8.7		Noise Pollution	X	

Source: research data (2024)

For this research, the data related to section 8 were not found. According to the Cascavel Department of Environment, this data is not produced by the municipality (Department of Environment, 2024). The studies by Viante (2021) and Couto (2018) also do not contain information on essential indicator 8.1 or supporting indicators 8.6 and 8.7. In fact, none of the essential or supporting indicators from the Environmental Section were found. This reveals a gap between the ISO data and the data produced by the cities.

When analyzing the indicators related to the financial sector of Cascavel, they show the fiscal health and capacity to invest in sustainability in the municipality, as shown in Table 5.

Table 5- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel, Section 9 - Finance

No.	LEVEL	INDICATOR	RESULT	SOURCE
9.1	E	Debt Ratio	4,08%	IPARDS 2023
9.2		Capital expenditures as a percentage of total expenditures	11,56%	IPARDS 2023
9.3	A	Percentage of own revenue in relation to total revenue	7,39%	IPARDS 2023
9.4		Percentage of taxes collected in relation to taxes charged	28,08%	IPARDS 2023

Source: research data (2024).

The section (9.1) analyzes the debt ratio, which measures the proportion of total debt relative to the municipality's total revenue. A value of 4.08% indicates that the indebtedness is at a manageable level, suggesting that the municipality has the capacity to incur additional loans if necessary. Maintaining a low debt ratio is crucial for financial sustainability, as it allows the municipality to invest in long-term projects, such as infrastructure, energy-efficient linear parks, and initiatives like the acquisition of a sustainable fleet, such as the purchase of electric buses (Municipality of Cascavel, 2023).

In section (9.2), the indicator reflects the amount spent on capital investments, such as infrastructure, compared to total expenditures. This indicator is essential, as capital investments allow for improvements in urban infrastructure; the municipality spends 11.56% on assets. Meanwhile, (9.3) measures the municipality's ability to generate its own revenue relative to total revenue. A high percentage of own revenue indicates financial independence and a solid economic base, allowing for greater autonomy in decision-making. This value also reflects the efficiency in collecting municipal taxes and fees. Section (9.4) shows the efficiency of tax collection; a high percentage indicates that the municipality is effective in collecting due taxes, with a significant rate of 28%, which suggests that the municipality has been securing sufficient resources to finance public services and sustainability projects.

Thus, we can conclude that the financial indicators of the municipality demonstrate a relatively healthy fiscal situation, with a low debt ratio and substantial own

revenues. These favorable conditions allow the municipality greater flexibility to invest in sustainability projects.

Section 10 of the ISO addresses responses to fires and emergencies, providing a framework to assess cities' response capabilities to risk situations (ABNT, 2017). This section encompasses preparation and prevention, as well as the effectiveness of immediate responses to natural disasters. By implementing these indicators, cities can identify weaknesses in the emergency system and improve coordination among emergency services.

Table 6- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel, Section 10 - Fire and Emergency Response

No.	LEVEL	INDICATOR	RESULT	SOURCE
10.1	E	Number of firefighters per 100,000 inhabitants	31,9	CBMPR 2023
10.2		Number of deaths related to natural disasters per 100,000 inhabitants	0	CBMPR 2023
10.3		Number of deaths related to fires per 100,000 inhabitants	0	CBMPR 2023
10.4	A	Number of volunteer and part-time firefighters per 100,000 inhabitants	0	CBMPR 2023
10.5		Emergency services response time from the first call	X	
10.6		Fire Department response time from the first call	9 minutos	CBMPR 2023

Source: research data (2024).

The data provided for Cascavel in Table 6 reveals aspects of the preparation and efficiency of emergency services, especially regarding firefighters. With an average of 31.9 firefighters per 100,000 inhabitants, the city demonstrates a reasonable infrastructure to respond to fire-related emergencies and other disasters. This ratio suggests an adequate presence of trained professionals to handle critical situations, thus promoting a faster and more effective response in times of crisis. The data on volunteer firefighters does not reflect the reality of the municipality, as per the regulations of the Fire Department in Paraná (CBMPR), the participation of volunteer firefighters in the corps is not authorized (CBMPR, 2024).

Moreover, the fact that no deaths related to natural disasters or fires have been recorded is a positive indicator of the efficiency of fire services and the community's capacity to prepare for and respond to such events. This reflects not only the readiness of the firefighters but also the awareness of the population regarding safety and prevention.

The response time of the Fire Department, recorded at 9 minutes from the first call, is another crucial aspect. This relatively short time is fundamental to minimize damage and save lives in emergencies. A quick response increases the chances of success in rescue operations. However, despite the good indicators, it is important to continue monitoring and improving emergency services. This includes ongoing investments in training, modern equipment, and technology to further enhance the efficiency and effectiveness of operations.

Just as it is important to analyze the financial health of the municipality, it is also essential to examine governance aspects. Section 11 of the ISO addresses indicators such as voter participation in the last elections and the representation of women in politics, thus understanding how public administration and citizen participation contribute to local sustainability, as can be observed in Table 7.

Table 7- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel, Section 11 - Governance

No.	LEVEL	INDICATOR	RESULT	SOURCE
11.1		Percentage of voter participation in the last municipal elections	233.753	TSE 2022
11.2	E	Percentage of women elected relative to the total number of elected officials in the city's administration	10%	TSE 2022
11.3		Percentage of women employed in the city's administration	46,8	PCC2023
11.4	A	Number of convictions of public agents in the city for corruption and/or bribery per 100,000 inhabitants	3,64	PCC2023
11.5		Citizen representation: number of local authorities elected per 100,000 inhabitants	6,6	IPARDS 2022
11.6		Population of registered voters relative to the population of voting age	72%	IPARDS 2022

Source: research data (2024)

When analyzing items (11.1) and (11.6), which address voter participation in the last election, it is observed that 72% of the voting population turned out to vote in the last

election. This high voter participation indicates an engaged population that is interested in political decisions, which is essential for implementing sustainable policies that reflect the community's interests. However, when we examine the percentage of elected women (11.2), we see a low rate of female participation in politics. Gender representation in politics is vital to ensuring that public policies meet the needs of the entire population. Therefore, municipalities need to improve female participation in politics. Greater engagement from parties and the establishment of female quotas could help boost these numbers. A higher percentage of elected women could lead to a more inclusive and equitable approach to city management, promoting policies that consider different perspectives and needs.

This situation is also reflected in item (11.3), which assessed the percentage of women employed in public administration in the municipality; representation still does not reach 50% of the positions held. A high percentage of women employed in municipal management suggests a commitment to gender equity, which is an essential component of sustainable development and is correlated with SDG 5, which addresses gender equality.

Thus, when we analyze governance, we can understand the quality of public administration and the level of civic engagement, both of which are essential for sustainability. The active participation of citizens, gender equity, and transparency are fundamental pillars for sustainable development and for building a more just society (Ribeiro, 2019).

Another aspect that the ISO addresses is health indicators. The health indicators for the municipality of Cascavel highlight a relatively positive situation in terms of life expectancy, hospital capacity, medical coverage, and maternal-infant care, data that can be seen in Table 8.

Table 8- Indicators of ABNT NBR ISO 37120/2017 Adapted for the Municipality of Cascavel Section 12 - Health

No.	LEVEL	INDICATOR	RESULT	SOURCE
12.1	E	Average life expectancy	75 anos	IBGE 2023
12.2		Number of hospital beds per 100,000 inhabitants	29,25	IPARDS 2022

12.3	Number of doctors per 100,000 inhabitants	421.46	IPARDS 2022
12.4	Under-five mortality rate	0,971	IPARDS 2022
12.5	Number of nursing and obstetric staff per 100,000 inhabitants	82,16	IPARDS 2022
12.7	Suicide rate per 100,000 inhabitants	0,574	CBMPR 2023

Source: Research data (2024)

The average life expectancy is a comprehensive indicator of the overall health of the population and living conditions (item 12.1). In the municipality, it is 75 years, suggesting that Cascavel has a relatively healthy environment and good health services for its inhabitants, reflecting effective public management for the well-being and longevity of the population. One factor contributing to increasing the life expectancy of residents is the assistance programs for the elderly, such as the "Felicidade do Idoso" Program, which has significantly contributed to this scenario. This program provides a reference space, the "City of the Elderly," where activities are developed to promote healthy aging, autonomy, and sociability for the elderly. By integrating various public policies and forming partnerships with civil society, the program fosters community living, cultural updates, the discovery of new skills, and the reactivation of the social protagonism of the elderly, contributing to active and healthy aging. This program has been recognized as a good practice in the Sustainable Cities Program under the axis of equity, social justice, and a culture of peace (PCC, 2024).

Another important indicator when it comes to health is the number of hospital beds available to meet population demand. Item (12.2) evaluates health infrastructure and the capacity to respond to public health crises. The data from Cascavel indicates a rate of 29 hospital beds for every 100,000 inhabitants, which is considered an adequate number of beds essential for responding to emergencies and providing continuous care. Likewise, item (12.3) contributes by providing the number of doctors serving the Cascavel region. The value of 421.46 doctors for every 100,000 inhabitants indicates reasonable medical coverage, essential for disease prevention and treatment, thus contributing to the sustainability of health services.

When we look at the infant mortality rate, it serves as a sensitive indicator of child health and the effectiveness of maternal and child health services (item 12.4). The

municipality has an infant mortality rate of 0.971, which is relatively low, indicating good health care for mothers and children. Furthermore, infant mortality indicators align with target 3.2 of the Sustainable Development Goals (SDG 5), which aims to end preventable deaths of newborns and children under 5 years old by 2030, reducing mortality to at least 12 per 1,000 live births (UN, 2015).

The suicide rate is an indicator that reflects mental health and social well-being. According to the World Health Organization (WHO), the global average rate is approximately 10.5 per 100,000 inhabitants, while Brazil's rate is around 6.1 per 100,000 inhabitants (WHO, 2024). Cascavel presented a rate of 0.574 suicides per 100,000 inhabitants, which is significantly lower than the national and global averages, suggesting that Cascavel is in a better situation compared to many other regions. However, it is crucial to maintain ongoing efforts to promote mental health and social well-being to ensure that this rate remains low or decreases further.

In this sense, health can be considered one of the pillars of good urban sustainability. Through this analysis, we can conclude that the health indicators of the municipality of Cascavel highlight a relatively positive situation in terms of life expectancy, hospital capacity, medical coverage, and maternal and child care.

Section 13 addresses indicators of recreation related to the availability of recreational spaces open to the public, a factor that directly contributes to leisure and the quality of life of citizens (Viante, 2021).

Table 9- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel, Section 13 - Recreation.

No.	LEVEL	INDICATOR	RESULT	SOURCE
13.1	A	Square meters of covered public recreation space per capita	x	
13.2		Square meters of outdoor public recreation space	x	

Source: research data (2024).

Regarding the Recreation indicators, data for the municipality of Cascavel were not found. Similarly, studies by Viante (2021) and Couto (2018) do not provide sufficient data to meet the support indicators of this section. This once again reveals a gap in the provision of information within public services.

Section 14 presents an overview of the effectiveness of public safety services and the overall security environment experienced by citizens. A well-staffed police force and

quick response times are crucial for ensuring public order and community trust. Low homicide rates and property crimes indicate a safe environment, which is vital for attracting investments, promoting economic development, and improving quality of life. Additionally, reducing violent crimes contributes to social cohesion and stability, both crucial elements for building resilient and sustainable communities. The data found for the municipality of Cascavel follows the data from SESPRO - the Secretary of Public Safety and Community Protection, as well as the IPARDES database (Table 10).

Table 10- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel, Section 14 - Security.

No.	Level	Indicator	Result	Source
14.1	E	Number of police officers per 100,000 inhabitants	86,5	SESPPRO 2023
14.2		Number of homicides per 100,000 inhabitants	18.96	IPARDS 2023
14.3	A	Property crimes per 100,000 inhabitants	3309.77	IPARDS 2023
14.4		Police response time from the first call	14	SESPPRO 2023
14.5		Rate of violent crimes per 100,000 inhabitants	18.96	IPARDS 2023

Source: Research data (2024).

Note: The data regarding the number of police officers and response time refers only to the SESPRO data, which comprises the positions of Municipal Guard (GM) and Civil Guard (GCP); it does not include data from the Military Police and Civil Police.

The essential indicators of Section (15.1) suggest a reasonable presence of public security agents relative to the population. An adequate police force is crucial for maintaining public order and preventing crime. Cascavel reported 86.5 officers per 100,000 inhabitants. If we look at general data that considers a minimum of 100 officers per 100,000 inhabitants (SENASP, 2023), we can consider that Cascavel has a reasonable police force; however, we must take into account that this analysis is based only on the security staff of SESPRO.

On the other hand, the data on homicides (15.2), property crimes (15.3), and violent crimes (15.5) represented significantly high values. Thus, high rates of violent crimes, homicides, and property crimes negatively affect the perception of safety and the

well-being of the population. Reducing these rates is essential for urban sustainability, as crime directly impacts the perception of safety and quality of life. Meanwhile, Section (15.4), with an average response time of 14 minutes, is reasonable, although there is room for improvement. In densely populated urban areas, faster response times are critical to preventing and mitigating crime. Improving this time can increase community trust in the effectiveness of the police and their ability to protect citizens. A quick response time is an essential component of a safe city.

Thus, we can say that Cascavel has some strengths in terms of security; however, there are critical areas that need to be addressed to improve quality of life and ensure a more sustainable urban environment.

Section 15 of the ISO, dedicated to housing, addresses an essential aspect of sustainable urban development. It provides a set of indicators that allow for the evaluation of housing quality. The implementation of these indicators is crucial for identifying deficiencies, promoting improvements, and ensuring that all citizens have access to dignified and safe housing. Through this systematic assessment, it is possible to guide public policies and investments that contribute to the creation of more equitable and resilient communities, directly reflecting the quality of life of the inhabitants. These indicators can be analyzed in Table 11.

Table 11- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel Section 15 - Housing

No.	LEVEL	INDICATOR	RESULT	SOURCE
15.1	E	Percentage of the city's population living in inadequate housing	0,0345%	IPC 2022
15,2		Percentage of the population living in economically affordable housing	7.654	SEASO 2023
15.3		Number of homeless people per 100,000 inhabitants	123,55	SEASO 2023
15.4	A	Percentage of homes without registered property titles	0,461599623	IPARDS 2022
15.5.1	P	Total number of households	146.881	IPARDS 2022
15.5.2		People per household	0,23	IPARDS 2022

15.5.3	Vacancy rate	0.09	IPARDS 2010

Source: research data (2024)

Item (15.1) indicates that approximately 0.0345% of the city's population lives in improvised housing. The existence of inadequate housing can lead to health, safety, and well-being problems, negatively affecting the social sustainability of the municipality. However, there is a noticeable gap between sustainable development and cities, a point reinforced by Souza and Albino (2018), who highlight issues such as informal occupation, social exclusion, lack of green spaces, soil impermeabilization, and lack of accessibility. These factors move away from the dynamics of sustainable development in cities.

On the other hand, data on economically affordable housing, as shown in item (15.2), indicates that 7.64% of Cascavel's population lives in low-cost housing that ensures dignified conditions without excessive financial burden. This data highlights Cascavel's commitment to social equity and poverty reduction, which are fundamental pillars of urban sustainability and targets of the Sustainable Development Goals (SDGs). It was also noted that the number of homeless people in Cascavel is relatively low, at around 0.124% of the total population, indicating that the municipality has effective policies to ensure housing for its citizens, which is essential for social sustainability and community cohesion. Additionally, Cascavel has a low vacancy rate (15.5), indicating that most properties are being utilized, reflecting good management of the housing stock. This is positive for sustainability, as a high vacancy rate can indicate economic or urban planning issues.

However, to achieve greater sustainability in housing, Cascavel must focus on improving housing conditions and ensuring economic accessibility. This is essential for promoting a healthy, safe, and inclusive urban environment.

Section 16 addresses solid waste, as cities are significant generators of solid waste. Therefore, the standard recommends studying the percentages of hazardous waste, incinerated waste, and waste dumped in open areas. Proper management of this waste is associated with better public health and promotes sustainable production, preventing these waste products from negatively impacting the environment by contaminating soil and groundwater (Viante, 2021).

Table 12- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel, Section 16 - Solid Waste

No.	LEVEL	INDICATOR	RESULT	SOURCE
16.1	E	Percentage of the city's population with regular solid waste collection (household)	100%	SNIS 2022
16.2		Total municipal solid waste collection per capita	0,299274	SNIS 2022
16.3		Percentage of urban solid waste that is recycled	2,52%	SNIS 2022
16.4		Percentage of urban solid waste disposed of in sanitary landfills	45,5%	SNIS 2022
16.5		Percentage of urban solid waste treated in waste-to-energy plants	X	
16.6	A	Percentage of urban solid waste that is biologically treated and used as compost or biogas	X	
16.7		Percentage of urban solid waste disposed of in open dumps	0	SNIS 2022
16.8		Percentage of urban solid waste disposed of by other means	53 %	SNIS 2022
16.9		Generation of hazardous urban solid waste that is recycled	X	
16.10		Percentage of hazardous urban waste that is recycled	X	

Source: Research data (2024).

The indicators in section 16 of ISO 37120/2017 reveal that 100% of the city's population has access to regular household waste collection, with a total per capita collection of 0.299274 tons. Section 16.4 shows that 45.5% of urban solid waste is disposed of in landfills, and there is no disposal in open dumps, highlighting the city's commitment to environmentally sound management practices.

However, a significant percentage of 53% of urban solid waste is disposed of by other means. This category may include methods such as composting, biogas production, coprocessing in cement plants, or export for treatment in other jurisdictions. Regarding recycling, 2.52% of the waste generated in the municipality is recycled at the six ecopoints available, with 120 registered waste pickers working in a cooperative system under the environment department. This indicator demonstrates that, in addition to recycling, the municipality addresses environmental and social factors, providing jobs for the city's waste pickers (SNIS, 2024).

Furthermore, it is important to emphasize that Cascavel has shown significant advances in urban solid waste management, particularly with the operation of a biogas

plant integrated with its landfill. The calculation of the percentage of urban solid waste biologically treated and used as compost or biogas (section 16.6), typically expressed as (Amount of solid waste burned) / (Total amount of waste produced) x 100 according to ISO 37120/2017, needs to be adjusted to reflect biological treatment instead of incineration since the municipality does not use incineration (Environment Department, 2024). Since Cascavel does not incinerate waste, the calculation should focus on the production and use of biogas. The municipality has a biogas drainage system at the landfill, where biogas produced from the decomposition of organic waste is collected and utilized. Currently, 20% of the biogas produced is integrated into the local energy distribution system, providing significant savings for the municipality, with average bioenergy production ranging from 90,000 to 100,000 kWh per month and monthly savings of R$ 60,000 to R$ 65,000 (Environment Department, 2022).

To increase biogas production, Cascavel is planning to enhance its capacity to capture and utilize this energy resource (PCS, 2024). This effort will not only contribute to more sustainable management of urban solid waste but will also increase energy efficiency and economic sustainability in the region. With the expansion, it is expected that a larger portion of biologically treated urban solid waste will be converted into biogas, reinforcing the city's commitment to innovative and sustainable environmental practices (PCS, 2024).

The findings highlight both successes and areas for improvement in solid waste management in Cascavel. The practice of using landfills instead of open dumps demonstrates a significant advance in environmental protection and public health. However, the lack of detailed data on recycling and specific treatments points to the need for greater transparency and the development of additional sustainable solutions, potentially increasing recycling and energy recovery from urban solid waste.

Section 17 addresses telecommunications aspects, and these indicators reflect the infrastructure and accessibility of information and communication technologies (ICT) in a city. Table 13.

Table 13- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel section 17 - Telecommunications

No.	LEVEL	INDICATOR	RESULT	SOURCE
17.1	A	Number of internet accesses per 100,000 inhabitants	34.31	IPARDS 2023

17.2	Total number of fixed-line connections per 100,000 inhabitants	21.03	ANATEL 2023
17.3	Number of mobile phone accesses per 100,000 inhabitants	131.85	ANATEL 2023

Source: Research data (2024).

Internet connectivity is essential for economic, social, and educational development (17.1). The rate of 34 per 100,000 inhabitants is considered moderate for the municipality, indicating that there is room for further investment in internet access. A high rate of internet access facilitates access to information, distance education, healthcare services, and other benefits. It promotes digital inclusion, reducing social inequality and improving citizens' quality of life. Access to the internet and mobile telephony is fundamental for digital inclusion, allowing all citizens to fully participate in modern society (UN, 2022). This is vital for reducing social inequality and promoting inclusion.

The municipality has shown a high level of access to mobile telephony (17.3). A high number of mobile phone accesses indicates good coverage and accessibility, which is essential for personal and professional communication. Mobile telephony facilitates access to emergency services, increases economic and social productivity, and improves overall communication. Moreover, mobile telephony can support other technologies, such as mobile internet, which are crucial for innovation and sustainable development.

Fixed-line telephony, on the other hand, has been declining in the overall landscape of Brazilian cities, and this trend is no different in Cascavel, where the rate is 0.021%. This figure indicates that a small fraction of the population has a fixed-line connection, suggesting that it is being replaced by mobile telephony (ANATEL, 2023).

Telecommunication indicators are vital for urban sustainability, as they directly influence social inclusion, economic development, the efficiency of public services, and the resilience of the city. Therefore, investing in robust telecommunication infrastructure is a priority for creating more connected and inclusive cities. The use of technology and innovation plays a fundamental role in this process, enabling the monitoring and management of urban services. This includes the implementation of IoT sensors, data analysis, smart energy grids, and efficient transportation systems (Beck et al., 2020). Thus, when these telecommunication technologies are integrated with sustainability strategies, cities can become smarter, more efficient, and better prepared to face future challenges.

The next section, 18, addresses transportation indicators, which are correlated with more sustainable and resilient urban mobility, Table 14.

Table 14- Indicators of the ABNT NBR ISO 37120/2017 Adapted for the Municipality of Cascavel Section 18 – Transportation

No.	LEVEL	INDICATOR	RESULT	SOURCE
18.1	E	Kilometers of public transport systems per 100,000 inhabitants	2.328.624,99km	TRANSITAR 2023
18.2		Annual number of public transport trips per capita	1,89	TRANSITAR 2023
18.5	A	Percentage of passengers using some alternative form of transportation	X	
18.7		Kilometers of bike lanes and cycle paths per 100,000 inhabitants	4,88 km	CONSELHO ESTADUAL DE TRÂNSITO DO PARANÁ 2023
18.8		Traffic deaths per 100,000 inhabitants	4,60	TRANSITAR 2023
18.9		Air connectivity	81	TRANSITAR 2023
18.4	P	Number of private cars per capita	0,43	IPARDS 2023
18.6		Number of motorized two-wheeled vehicles per capita	0,12	IPARDS 2023

Source: Research data (2024).

The sections (18.1 and 18.2) present public transport data for Cascavel, as reported by the Municipal Autarchy for Mobility, Traffic, and Citizenship - TRANSITAR (2023), revealing that the city has an extremely extensive transport network, with 2,328,624.99 km per 100,000 inhabitants. This data suggests a robust infrastructure, which, according to Santos et al. (2021), is vital for both the quality of life of residents and urban economic development, as it facilitates the movement of people and goods. However, the annual number of trips per capita on public transport is only 1.89, indicating that this resource is being underutilized.

This imbalance between the extent of the network and the effective use of public transport in Cascavel points to the absence of strategies that increase the attractiveness and efficiency of the system. Thus, Santos et al. (2021) argues that a well-developed public transport system is essential to reduce dependence on private cars, thereby decreasing congestion and greenhouse gas emissions. Therefore, for Cascavel, investing in improvements in service quality, awareness campaigns, and incentive policies could

not only optimize the use of the vast existing network but also promote more sustainable and environmentally responsible urban development.

Bicycle infrastructure is essential for encouraging the use of bicycles as an alternative and sustainable means of transport. In Cascavel, significant investments have been made to expand bike lanes through the Integrated Development Program (PDI/BID). One of the goals of this program is to enhance the urban space of the city, increasing the efficiency of the mobility system. Among the works planned in the plan, the reurbanization of Av. Brasil stands out, which includes the expansion and implementation of a new bike lane integrated with other transportation modes to be implemented. This integration will allow users more efficient and sustainable mobility (Master Plan, 2022). The expansion of bike lane kilometers represents a substantial incentive for non-motorized mobility, which, in turn, improves public health and reduces pollution.

The indicator related to traffic deaths indicates that lower traffic mortality rates reflect a safer transport system, which is crucial for citizen well-being and social sustainability. Observing that Cascavel has a rate of 4.6 per 100,000 inhabitants suggests that the city has good indicators related to traffic safety.

Air connectivity is important for the economy, facilitating tourism and business. The municipality has an airport served by three airlines: LATAM, GOL, and Azul, which offer flights to various locations, including Curitiba, Campinas, Guarulhos, and Congonhas, further linking the western region of the state with the main airports in Brazil (TRANSITAR, 2023). Good connectivity can increase the city's attractiveness as a destination for investments and events, contributing to sustainable economic development.

Indicator (18.4) shows the population's dependence on private cars. Lower numbers indicate greater reliance on sustainable alternatives, such as public transport and active mobility (walking and cycling). Motorcycles and other two-wheeled vehicles are popular alternatives, especially in areas with less developed public transport. The number of 0.43 private cars per capita can be considered high for a city aiming for urban sustainability. Therefore, it is crucial to continue investing in alternative transport to reduce dependence on private cars. These initiatives can contribute to a healthier, less congested, and more sustainable urban environment in the long term.

Thus, we can consider that the transport indicators in Cascavel provide a detailed view of the strengths and areas needing improvement to achieve greater sustainability. The focus on public transport, active mobility (bike lanes and cycle paths), traffic safety,

and the reduction of private car usage is essential to create a more sustainable and resilient city.

Section 19 addresses urban planning; these indicators contribute to directing public policies for a sustainable urban environment. The results for the municipality of Cascavel are presented in Table 15.

Table 15- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel Section 19 - Urban Planning

No.	LEVEL	INDICATOR	RESULT	SOURCE
19.1	E	Green areas (hectares) per 100,000 inhabitants	6.498,79 m²	PREFEITURA MUNICIPAL 2023
19.3	A	Percentage of informal settlements as a proportion of the city's total area	X	
19.4		Employment/housing ratio	1,52	IBGE 2023
19.2	P	Number of trees per 100,000 inhabitants	25.423,14	PREFEITURA MUNICIPAL 2023

Source: research data (2024)

The literature indicates that for a city to be sustainable and intelligent, urban planning must consider the efficient use of space, green areas, accessibility, and supporting infrastructure (Caragliu et al., 2011). In this sense, the data (19.1) relates to the amount of green areas, which are fundamental for improving air quality, reducing pollution, and combating climate change, such as the high temperatures that cities have been experiencing lately. Additionally, a reasonable amount of green areas provides essential spaces for the well-being of its inhabitants; they are public spaces used for physical exercise and recreation. The municipality of Cascavel is home to one of the largest urban ecological reserves in southern Brazil, Parque Paulo Gorski (Municipal Lake and Zoo), which has a leisure area of approximately 125 hectares of forest and an artificial lake covering 38 hectares, featuring running tracks, restrooms, a restaurant, a viewpoint, and parking (Municipal Government of Cascavel, 2023).

Other essential indicators for assessing sustainability include adequate access to sanitation and drinking water; a good system is crucial for disease prevention and ensuring public health. Sections 22 and 23 address aspects related to basic sanitation, Table 16.

Table 16- Indicators of ABNT NBR ISO 37120/2017 adapted for the municipality of Cascavel Section 20 - Sewage and Section 21 - Water and Sanitation.

No.	LEVEL	INDICATOR	RESULT	SOURCE
20.1	E	Percentage of the population of the age served by sewage collection and disposal system	95,1 %	IBGE 2023
20.2		Percentage of the city's sewage that receives centralized treatment	100 %	SNIS 2022/ SANEPAR 2023
20.3	A	Percentage of the city's population with access to improved sanitation	88,70%	SANEPAR 2023
21.1	E	Percentage of the city's population with potable water supply services	79,60%	SANEPAR 2023
21.2		Percentage of the city's population with sustainable access to an adequate source of water for consumption	39%	SANEPAR 2023
21.5		Total domestic water consumption per capita (liters/day)	16.893.686	SANEPAR 2023
21.4		Total domestic water consumption per capita	0,35	SANEPAR 2023
21.6	A	Average annual value of water supply interruptions per household	X	
21.7		Percentage of water losses (unbilled water)	0,9537	SANEPAR 2023

Source: research data (2024)

The data related to the sewage collection system showed that a high percentage of the population is served by sewage collection and disposal systems, reaching 95%. This is crucial for both public health and environmental protection. Proper sewage treatment reduces contamination of water bodies, preventing diseases and preserving water resources (SANEPAR, 2023). Furthermore, 100% of the collected sewage receives centralized treatment, according to indicator (20.2), highlighting the efficiency and comprehensiveness of the basic sanitation system in the region. This signifies a significant advancement in the management of liquid waste, contributing to improved quality of life and environmental sustainability. A reliable sewage treatment system is one of the main indicators of the local development level and community health (ABNT,

2017). Centralized treatment is essential to ensure that effluents are treated before being returned to the environment.

Access to potable water is a fundamental human right and a basic necessity for health and well-being. Having nearly 80% of the population with access to potable water services is positive, but there is still room for improvement, as ideally, 100% of the population should have access to potable water.

Another indicator that deserves special attention in section (21) refers to the low water loss index, which indicates efficient management of the distribution system. Minimal losses mean that the infrastructure is well-maintained and that water resources are being used efficiently. Cascavel reported a water loss percentage (unbilled water) of 0.9537%, which is a considerably good result. Water losses refer to water that is produced and distributed but does not reach the final consumer due to leaks, theft, or meter failures (SANEPAR 2023). A loss percentage below 1% is very low and indicates efficient management and a well-maintained and structured water distribution system. Keeping these losses at low levels helps ensure that produced water is effectively used, reducing waste and contributing to the sustainability of water resources.

In this sense, when analyzing the water and sewage indicators in Cascavel, it is possible to identify significant advances but also highlight areas that need substantial improvements. The high percentage of sewage collection is positive. Access to potable water is adequate for most, but sustainable access is limited, suggesting the need for greater investment in infrastructure and water resource management. Improving these indicators is essential for achieving a more sustainable city.

One of the main objectives of ISO 37120:2017, along with the standardization of sustainable development indicators, is to enable the comparison of the performance of urban services and the quality of life offered by cities, through the creation of a learning network among different locations (Abreu & Marchiori, 2020). Data comparison is important in determining the numerical parameters of urban measurements, as the technical standard does not provide reference values for its indicators.

Thus, for a better understanding of the indicators calculated for Cascavel, the present study establishes a comparative analysis with the indicators of other Brazilian cities that also conducted academic studies applying the standard ISO as a tool to analyze urban sustainability.

The cities compared with Cascavel were Guarapuava- PR, Rio de Janeiro- RJ, and Porto Alegre- RS, as can be seen in Table 17.

Table 17- Cities compared

GENERAL INFORMATION			
Cascavel	Guarapuava	Rio de Janeiro	Porto Alegre
State			
Paraná	Paraná	Rio de Janeiro	Rio Grande do Sul
Population			
348 051	182.093	16.055.174	1.332.845
Population Density			
166,44	57,48	366,97	2.690,50
Year of Study			
2024	2021	2019	2021

Source: research data (2024)

Note: The data related to population and demographic density are from the IBGE database, year 2023.

The city of Guarapuava-PR, through the analysis of ISO indicators, did not reach the minimum number of indicators established by the standard, achieving 16 essential indicators and 19 support indicators (Viante, 2021). However, research has advanced on the theme of sustainable and smart cities, highlighting the importance of integrating green technologies and social inclusion. The work defines sustainable cities as those that balance economic, social, environmental, and technological variables to promote holistic and resilient urban development (Viante, 2021). Moreover, studies on Guarapuava highlight the application of new urban development concepts capable of incorporating green technologies and inclusive practices. Another important factor is that the use of ISO indicators can promote participatory governance.

Additionally, Viante (2021) makes a comparison with the study by Couto (2018), which evaluates indicators in the city of Rio de Janeiro. In this regard, it was possible to verify some similar results between the cities, including social issues such as security, hospital beds, and mainly the need for complementary data to ISO indicators to express the real situation of the cities. This was also evident in the study on indicators in Cascavel, where common sections with missing data highlighted the recreation section, which showed a lack of data for all three cities.

Common to both Guarapuava and Rio de Janeiro was the absence of more sections, such as fire response and emergencies, safety, housing, and basic sanitation.

Cascavel also presented some absences of indicators in these sections and, like Guarapuava, could not obtain data on the environment, such as air quality, among others. However, the city of Rio de Janeiro-RJ was classified as an aspirant, just like Cascavel, having 30 essential indicators and 30 support indicators. One of the main difficulties highlighted by Couto (2018) was the collection and analysis of data. The author also argues for the need to standardize indicators, thus suggesting the implementation of a standardized system of indicators that would contribute to the capacity of cities to monitor and report their progress toward urban sustainability (Couto, 2018).

Studies conducted by Mainardi (2021) on the sustainability of the capital of the state of Rio Grande do Sul presented 35 essential indicators and 12 support indicators, also placing the city as an aspirant in the ISO requirements. Furthermore, Mainardi (2021) emphasizes that sustainability issues in Porto Alegre go beyond data disclosure, focusing on the need for public policies aimed at sustainability and highlighting the need for citizen participation. Another aspect raised is related to urban mobility, one of the main challenges for public managers, given the accelerated growth of urban spaces. Porto Alegre faces similar difficulties to Cascavel, with high vehicle rates. Reducing dependence on private vehicles should be a priority to decrease pollutant emissions. The creation of bike lanes and encouragement of bicycle use are pointed out as essential measures to promote more sustainable mobility.

A common factor in all four studies, besides the use of ISO as a parameter to evaluate sustainability, was the gaps in the production and dissemination of indicators. These comparisons highlight the need to improve data collection and transparency in the disclosure of indicators, in addition to revealing specific areas that require greater investment and attention to achieve sustainable urban development and comparability between different municipalities.

Thus, establishing a comparative analysis with other Brazilian cities provides a broader and more grounded view, allowing the identification of good practices and areas for improvement. In this sense, we can consider that Cascavel shows satisfactory performance in several sustainable development indicators, as established by the standard, but still faces challenges in specific areas that require more attention and investment. Continuing to improve data collection and investing in infrastructure are crucial steps for Cascavel to consolidate itself as an example of a sustainable and resilient city.

5.2 INTERVIEW ANALYSIS

To assess whether the municipality of Cascavel, based on the perspective of experts, would be able to obtain certification such as ISO 37120/2017, and what the costs, benefits, and obstacles would be for the municipality to achieve this certification, as well as the necessary actions, thus answering specific objectives c and d of this dissertation, 8 specialists were interviewed, along with 3 ISO auditors. The interviews were semi-structured and analyzed through the Iramuteq software. Upon importing the textual corpus from the interviews into Iramuteq, it was found that the software recognized 24 texts, from which a total of 16,503 words/terms were found, and 7,721 words appeared in unique forms. There are 713 words that appear only once, representing 4.32% of all occurrences and 41.43% of the unique forms known as hapax (unique words). The high percentage of hapax suggests that there is a great diversity of terms used by specialists, possibly due to the variety of perspectives and areas of expertise. The average occurrence per text is 687.62.

The first processing to which the textual corpus was subjected is called classical textual statistics. In this first descriptive statistical analysis, the Zipf diagram was obtained, which represents the frequency of words in a text corpus on a logarithmic scale. This type of graph is common in textual content analyses and is used to verify the distribution of words in a text, confirming Zipf's Law (Lima & Maia, 1973). In the context of analyzing interviews with specialists, this graph provides a better understanding of the most discussed themes.

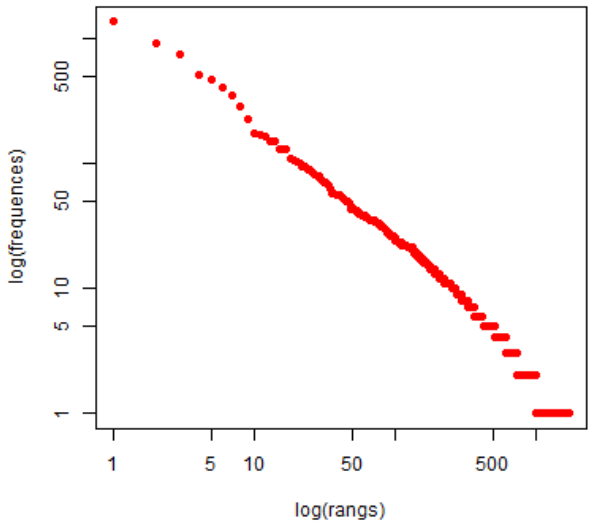

Figure 9- Zipf's Graph

Source: Research data (2024**)**

On the X-axis of the graph, the ranking of words is represented in descending order of frequency on a logarithmic scale, while the Y-axis represents the frequency of the words, also on a logarithmic scale (Lima & Maia, 1973). The graph shows a descending line, confirming Zipf's Law, which predicts that few words are very frequent, while most words occur rarely.

The results of the Zipf graph provide insight into the distribution of words in the interviews, allowing the identification of the main themes and concepts discussed by the specialists (Lima & Maia, 1973). The most frequent words in the graph (to the left, with high frequency) represent the most common topics in the interviews. The sharp decline in the graph indicates that certain key terms dominate the discussion, while many others are used sporadically.

The most frequent words likely relate to the main challenges and solutions discussed. Among these words, the following stand out: sustainability, cities, public, Cascavel, urban, work, program, water, transportation, and social. These terms exhibit a frequency range between 70 and 40, highlighting the most discussed and relevant themes for the research, which can also be verified in the word cloud generated by the software through the Zipf graph.

Figure 10- Word Cloud

Source: Research data (2024).

When analyzing the presence of the words "population" and "urban," it indicates that the feasibility of sustainability is being discussed in the context of urban areas and their relationship with their population. Considering words like “work,” “program,” “water,” and “transport,” the main challenges mentioned relate to the execution of specific programs and the efficient management of water and transportation. Specialists identify these areas as requiring immediate intervention to meet the requirements of ISO 37120/2017 and improve the sustainability of the municipality. Managing water, transportation, and the development of urban areas is critical for ensuring a sustainable, integrated, and resilient city.

Regarding water management, the results from the ISO indicators show a favorable situation concerning access to potable water but with room for improvement, particularly in the sustainability of water sources. Efficient management is reflected in the low water loss rate, yet consumption remains high, which may reflect specialists' concerns. Although 80% of the population has access to potable water services, the ideal would be to reach 100%. This significant difference between access to potable water services and sustainable access to an adequate source for consumption indicates the need to improve the sustainability and security of water sources. Additionally, the total domestic water consumption per capita in the municipality is approximately 16,893,686 liters/day, or around 0.5 liters per capita, which is a significant volume considering the

growing scarcity of potable water globally. Public management must encourage the consistent use of water.

The specialists mentioned several initiatives that could be used to improve these data, such as implementing specific programs to reduce potable water usage, including rainwater harvesting and separating gray water (from bathing and laundry) from black water (sewage). This aligns with the statement of Interviewee 01:

> "Gray water, for example, from bathing or washing clothes, should not be in the same pipeline as black water. It has a greater impact; it's more challenging to clean. So today, in our unified system for treatment, the sewage from our residences or commerce is mixed. If we only carried the black water to a treatment area, we could significantly reduce the amount of wastewater for that treatment system. The gray water could percolate into the soil; it could go directly to a garden; the water from bathing or washing clothes wouldn't cause any contamination."(E01)

The interviews complement this analysis by suggesting practical solutions for improving water management, such as the separation of gray and black water and the use of plants in sewage treatment. These practices not only optimize water use but can also be integrated into sustainable urban planning, promoting a more resilient and resource-efficient city. Therefore, improving access and sustainability of water sources, alongside implementing reuse and ecological treatment practices, are crucial steps toward efficient and sustainable water management.

Concerning transportation, a key issue regarding urban mobility in Brazilian cities, the public transportation data for Cascavel, along with the transportation indicators assessed by section 19 of the ISO, present a complex and interconnected analysis of the efficiency and challenges of the city's transportation system. While the city has an extensive public transportation network, it has not been utilizing it efficiently, either due to a lack of improvements or the high reliance on private vehicles. The existence of 4.88 km of bike lanes per 100,000 inhabitants indicates efforts to promote active transportation, yet it remains insufficient to compete with the dependency on motor vehicles.

In this sense, Santos et al. (2021) argue that a well-planned transportation system is essential for the quality of life of the population and urban economic development. The inefficiency of public transportation in Cascavel, evidenced by low per capita usage, demonstrates the need for public policies aimed at urban mobility. The reliance on private automobiles not only contributes to congestion and greenhouse gas emissions but also poses a significant risk to road safety.

Therefore, when analyzing the transportation indicators for Cascavel alongside the literature, we find that, like Santos et al. (2021), Queiroz et al. (2021) reveal the urgency of finding viable solutions that improve the quality of life for the population. Investing in an efficient and sustainable public transportation system, expanding bike lanes, and promoting public transport can reduce dependency on private vehicles, decrease congestion, and improve road safety. Thus, the municipal public administration must focus on integrated strategies to address these urban mobility challenges, promoting more balanced and sustainable economic and human development. This aspect is also echoed in one interviewee's remarks about urban mobility:

> "...When talking about sustainable urban mobility, it involves implementing various measures that prioritize the use of cleaner, more efficient, and accessible means of transportation. It's a comprehensive topic because it will require investment in public transportation, whether by expanding and improving the quality of public transport, including buses, encouraging active transportation methods like walking and biking, and promoting electric vehicles and car-sharing..."(E8).

These combined efforts are essential for fostering sustainable urban mobility, which not only improves residents' quality of life but also significantly contributes to Cascavel's economic and social development.

The presence of the words “program” and “public” indicates that there are ongoing programs and a significant focus on public participation and policies that involve the public in the process. Furthermore, the specific challenges for implementing the standard seem to be associated with working in urban areas, suggesting that the integration of ISO 37120/2017 standards into the urban context of Cascavel may present particular challenges.

Regarding the programs, several specialists highlighted the programs focused on selective collection, such as the Sustentar/Reciclar é Preciso program, which promotes recycling and supports waste pickers' cooperatives. This program won the Economic category in the 2023 Excellent City Award, reflecting the municipality's commitment to advanced environmental and social practices and significantly contributing to implementing the 2030 Agenda and the Sustainable Development Goals (PCC, 2023).

In this sense, analyzing the highlighted words in the word cloud helps us verify the central themes discussed by the specialists. The frequency of these words reflects the importance of these themes in the responses.

Another source used to interpret the interview results to address the research question was the hierarchical descending classification (HDC), which groups segments of texts into classes based on the similarity of their content. It identifies main themes or patterns

within the textual data, exploring how different groups or categories emerge from the text (Lima & Maia, 1973).

The dendrogram shows the formation of clusters of classes of textual segments. Each branch represents a subdivision in this analysis, which was divided into six classes. These classes characterize a set of words that are more frequent in the interviewees' statements, grouped by their thematic similarity. In Figure 9, it is possible to visualize the percentage of use (%), the result of the chi-square test (X^2), and the main words that formed the six semantic classes identified in the textual corpus. The dendrogram demonstrates the connection between words that are associated with one another, allowing us to interpret the formations of each class, as well as understanding the proximities and distances between the created classes.

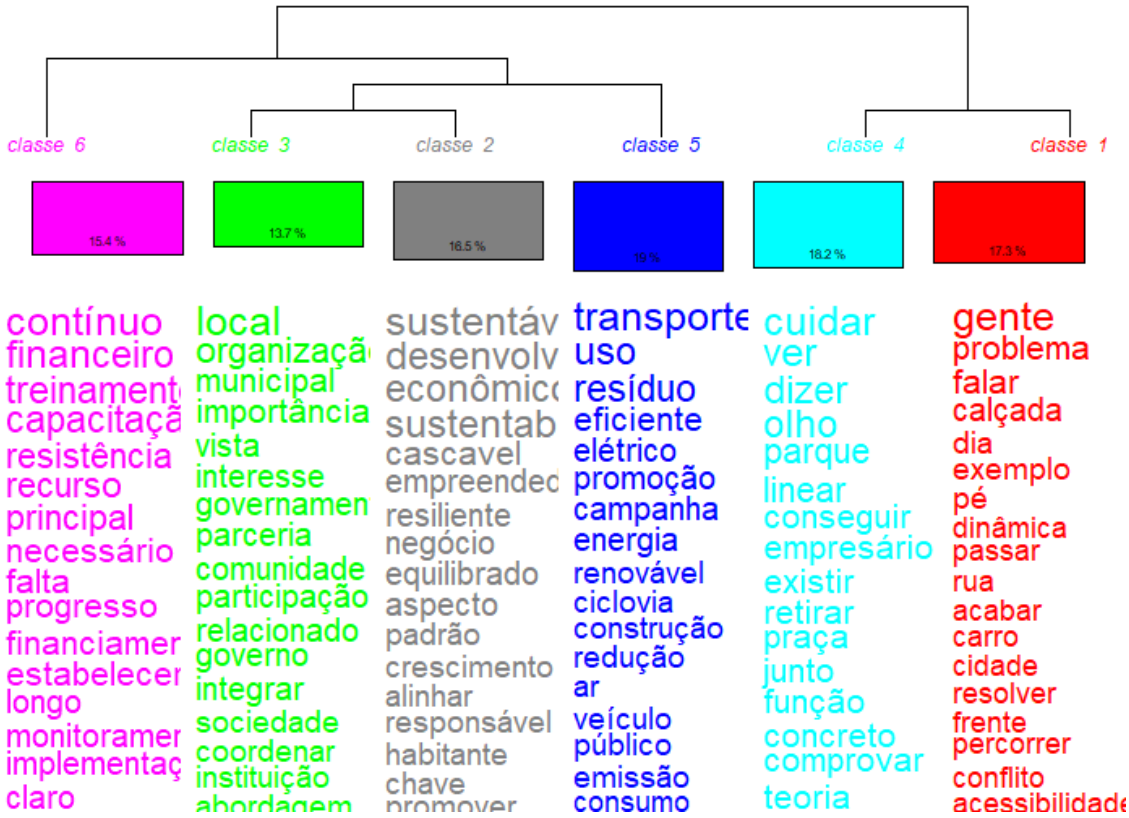

Figure 11- Interview dendrograma

Source: Research data (2024).

In the software processing report, it was verified that class 1 corresponds to 17.3% of the total; class 2 to 16.5%; class 3 to 13.7%; class 4 to 18.2%; class 5 to 19%, and class 6 to 15.4% (Figure 9) of the analyzed text segments. Class 1, represented by the red color, is associated with the following keywords: people, problem, talk, sidewalk, example, day, foot, dynamic, pass, street, car, front, finish, solve, conflict, accessibility. This indicates that class 1 addresses more everyday and practical

issues, such as accessibility and daily urban problems. It is related to urban mobility challenges, a major concern for sustainable cities, given the lack of planning in many cities and the dynamic nature of urban environments, linking to the main challenges for sustainability practices (question 2) and aspects to promote urban mobility (question 14).

The analysis of Class 1 shows that the main challenges faced in implementing sustainable practices in Cascavel are related to community awareness and engagement, the integration of policies, financial and technical resources, and overcoming cultural and economic barriers. Regarding sustainability practices, the interviewees highlighted several points that need to be observed and improved. Among them, they emphasized the importance of raising public awareness and ensuring the engagement of all sectors, whether public, private, or the general community, considering that the biggest challenge is convincing decision-makers of the importance of sustainability.

Thus, it aligns with Fox (2015), who argues that the assessment of sustainable cities often requires the active participation of the local community, promoting civic engagement and social inclusion. This involvement can include setting goals, identifying problems, and seeking solutions from residents, thereby strengthening the community's sense of belonging. However, measuring urban sustainability performance faces several significant challenges. The first challenge is the selection and definition of appropriate metrics. The second challenge is the consistent application of these metrics across different cities. Therefore, the effective implementation of sustainable practices in Cascavel requires not only the active participation of the local community but also a coordinated and integrated approach across all involved sectors, thus aligning with the challenges identified in the literature and corroborated by the interviewees' conclusions.

Urban mobility, in turn, is a crucial component of sustainability in cities, directly influencing the quality of life of residents and economic development. According to Santos et al. (2021), a well-planned transportation system is fundamental for both the population's quality of life and the urban economy, facilitating the movement of goods and people. Cascavel showed reasonable results when analyzing Section 19, which deals with transport indicators. The municipality has approximately 2,328,624.99 kilometers of public transport systems per 100,000 inhabitants, demonstrating broad coverage that facilitates resident mobility. However, the annual number of public transport trips per capita is relatively low, with only 1.89 trips per person, indicating the need to encourage public transport use to reduce dependence on private vehicles.

Furthermore, the percentage of passengers using alternative forms of transport is unavailable, indicating a data collection gap that could be addressed for a better understanding of sustainable mobility trends in the city. Cascavel has 4.88 kilometers of bike lanes and paths per 100,000 inhabitants, promoting the use of bicycles as an alternative means of transportation. However, this number could be increased to further improve cycling infrastructure and encourage bicycle use. Thus, urban mobility in Cascavel shows mixed performance, with strengths such as broad public transport coverage and air connectivity, but also significant challenges such as low public transport usage per capita and the need to expand bike lanes.

In the interviews, experts considered the existing road infrastructure, characterized by wide streets and relatively smooth traffic flow. This can be seen in the interviewee's statement: “efficient and quality public transport, increasing bike lanes, increasing safety measures on roads for cyclists and pedestrians, encouraging alternative transportation. Creating green corridors that give access to the city's industrial areas” (E 05).

Thus, investing in efficient and quality public transport, expanding bike lanes, increasing safety measures for cyclists and pedestrians, encouraging alternative transportation, and creating green corridors are essential actions to improve urban mobility in Cascavel and promote sustainable development. Moreover, active community participation and government transparency are crucial for the effective implementation of urban mobility policies, reinforcing the importance of joint efforts between the public, private sectors, and the general population.

Class 2, represented by the gray color and the following keywords: sustainable, development, economic, sustainability, Cascavel, entrepreneur, resilience, business, balanced, growth, aspect, standard, responsible, inhabitant, key, promote. This class emphasizes economic sustainability and sustainable economic development, linking to questions about ISO sustainability pillars (question 1), strategies for a local economy to promote sustainability (question 9), and specific economic sectors (question 10).

For the interviewees, investing in sustainable practices is essential to ensure balanced and resilient urban development, which not only protects the environment but also promotes population health and well-being. This aligns with Jong et al. (2015), where the presented concepts for cities are intrinsically linked to understanding the development and renewal of urban environments, where social, economic, and environmental dimensions interact in a balanced way for mutual benefit. Furthermore, regarding the

development of a sustainable economy, they highlighted the importance of diversified partnerships, the promotion of sustainable business practices, and green technological innovation as crucial elements, as well as professional training and education for green jobs. Supporting local agricultural production through subsidies and farmers' markets, and promoting the consumption of regional products are widely recommended strategies.

These measures not only encourage the local economy but also promote sustainability and urban resilience. Providing subsidies and creating markets for local producers can reduce dependence on imported food and decrease the carbon footprint associated with long-distance transportation. Promoting the consumption of regional products strengthens the local economy, creates jobs, and keeps resources circulating within the community. Tax incentives, awareness campaigns, and the strengthening of social entrepreneurship and local cooperatives are also essential measures to create a more sustainable and inclusive local economy.

When addressing Cascavel's economic sectors to align with sustainability standards, it is essential to identify and focus on key sectors such as industry, agriculture, transportation, and construction. An integrated approach involving public policies, financial incentives, regulations, and partnerships is crucial. Moreover, to build a more resilient, fair, and environmentally responsible city, it is necessary to educate people about sustainable practices and promote real experiences of urban challenges.

Class 3, represented by the green color, brings the following keywords: local, organization, municipal, importance, view, interest, governmental, partnership, community, participation, related, government, integrate, society, coordinate, institution, approach. This class highlights the importance of local organization and community participation. It relates to questions about local governance (question 13), community involvement (question 6), and necessary partnerships (question 18).

When dealing with the issue of local governance and sustainability, it was observed that, for experts, the effective implementation of sustainability indicators in Cascavel requires a joint effort that involves active community participation, strategic partnerships with educational and non-governmental institutions, and a strong commitment to transparency and information accessibility. This aligns with the indicators in section 11 of ISO on governance. The municipality of Cascavel has a participative electorate, with good community engagement in democratic processes. Clear governance, long-term policies, tax incentives, and simplified bureaucratic processes are essential to create a favorable environment for sustainability.

In the same perspective, Souza and Albino (2018) emphasize that managers, citizens, and civil society organizations, as well as all city stakeholders, interact, share, and promote good urban practices that reduce environmental impact and strengthen social cohesion. Therefore, the participation and action of the government, companies, and other social organizations are essential in the process of building sustainable cities, respecting the attributes of sustainability and current legal norms.

Transparency in governmental actions and the expansion of public hearings can increase trust and public engagement. The indicator in section (11.4) suggests active monitoring and accountability mechanisms to combat corruption. Thus, by promoting open and inclusive governance, Cascavel can strengthen the relationship between citizens and the government, ensuring that sustainability policies are implemented effectively and that decisions reflect the community's needs and desires. In this regard, according to interviewee 08, experts consider public hearings important, with thematic chambers held at ACIC, open meetings where various issues are discussed: "... these thematic chambers are having good openness regarding public management, let's say. What has been raised is still a very open topic..." (E 08). This is a big step towards more transparent and participatory governance. These thematic chambers are a useful space for citizens, experts, and government officials to meet and discuss a variety of issues important to the community.

When experts were asked about partnerships for implementing ISO in the municipality, it was noted that they both highlighted the need for robust and diversified partnerships. Partnerships with universities, the private sector, and NGOs are considered fundamental partners capable of providing intellectual and financial resources.

Class 4, represented by the light blue color and the following keywords: care, see, say, eye, park, linear, get, entrepreneur, exist, remove, square, together, function, concrete, prove, theory. This class focuses on the relationship between caring for urban spaces and the role of entrepreneurs in sustainability, correlating with questions about the role of more sustainable urban spaces (question 13) and the role of the private sector (question 16).

When asked about their area of expertise and aspects for the creation of more sustainable urban spaces, an interconnection between environmental sustainability and social responsibility was observed. Regarding urban spaces, the results of ISO Section 19, urban planning, highlighted the importance of green areas as essential for the inhabitants' quality of life. With an average of 6,498.79 m² of green areas per 100,000

inhabitants, the need to preserve and expand these areas is evident. Thus, creating more sustainable urban spaces requires a joint effort

Between the government, private sector, and civil society, cooperation is essential for the creation of policies that promote environmental sustainability, social responsibility, and economic equity. Policies and programs must be adaptable and enduring, ensuring the active participation of all stakeholders to foster equitable and resilient urban development. One example of such efforts is the municipality's investment in the development of linear parks, such as the Ecopark project. This initiative not only creates public spaces for community recreation but also focuses on caring for the city's streams (Prefeitura Municipal de Cascavel, 2022).

This aligns with the perception of an architecture professional interviewed regarding the importance of green corridors. These corridors would connect industrial areas and integrate urban planning issues, fostering the development of compact, mixed-use neighborhoods where people can live, work, and access services with ease. This approach would help reduce long commutes and alleviate traffic congestion in the municipality, promoting more sustainable and efficient urban development.

In the private sector, interviewees highlighted that changes in business owners' mindsets, encouraged by government policies, are crucial for the implementation of sustainable practices that benefit society as a whole. Authors like Lopes (2016) and Kobayashi et al. (2017) emphasize that urban sustainability depends on an integrated approach, including strategic planning, efficient resource use, and public-private partnerships. Mobilizing the private sector, in alignment with government policies, can accelerate the transition toward sustainable practices.

Class 5, represented by the color blue and keywords such as transportation, use, waste, efficient, electric, promotion, campaign, energy, renewable, bike lane, construction, air, vehicle, public, reduction, paper, focuses on transportation and energy aspects. This highlights an emphasis on sustainable urban mobility and renewable energy, directly relating to question 14 on sustainable transport and strategies for waste management and renewable energy (question 8).

Regarding transportation, already discussed in Class 1, mobility is crucial to achieving urban sustainability goals. Understanding the urban structure, identifying current offerings, and assessing residents' needs are essential for planning mobility actions. Therefore, improving and expanding public transportation, investing in efficient,

accessible, and low-carbon systems, and creating and expanding bike lanes and sidewalks should be priorities when considering sustainable transport.

On environmental issues, the implementation of air quality monitoring programs, the expansion of sewage treatment, and the use of clean technologies in industries were cited by most interviewees as essential. Promoting urban green spaces and encouraging the use of non-motorized transportation are also important actions. All these measures aim to improve urban life quality and promote sustainable mobility that benefits all citizens by reducing environmental impact. However, when comparing the municipality's environmental indicators with ISO Section 8, there is a noticeable data gap, which is concerning when thinking about sustainable cities.

The lack of environmental data, such as fine particulate matter concentration (PM 2.5), particulate matter concentration (PM 10), greenhouse gas emissions, NO2 concentration, SO2 concentration, O3 concentration, and noise pollution, is detrimental to the development of sustainable cities. These indicators are essential to understand and reduce environmental and public health impacts. Without this data, it becomes difficult to implement effective policies and monitor progress, undermining efforts toward sustainability and urban life quality. Therefore, it is important that Cascavel adopts more robust practices for collecting and analyzing environmental data to align with international standards and ensure sustainable development.

Class 6, highlighted in pink with keywords such as continuous, financial, training, capacity, resistance, resource, main, necessary, lack, progress, financing, establish, long, monitor, implement, clear, focuses on financial challenges, the need for continuous training, resources, and resistance faced in implementing sustainable practices. It relates to questions about necessary resources (question 5) and challenges encountered (question 2).

Looking at questions 2 and 5, both address the resources required for successful ISO standard implementation in the municipality, with financial, human, and technological resources standing out. Specialists emphasized the importance of financial resources, which are essential to cover operational expenses, invest in monitoring infrastructure and management technologies. When compared to Cascavel's financial indicators in Section 9 of ISO, the city's financial indicators demonstrate a relatively healthy fiscal situation, with a debt rate of 4.08% and own revenues representing 7.39% of total revenues. These favorable conditions allow for greater flexibility in investing in sustainability projects. Additionally, capital expenditures represent 11.56% of total

expenditures, and the percentage of taxes collected relative to taxes charged is 28.08%. These data show that the city's fiscal health provides a solid foundation for implementing sustainable initiatives, and finances would not hinder investments or the implementation of the standard in the municipality.

Regarding human resources, the need for qualified professionals to execute the standard's requirements was highlighted, along with the importance of continuous team training and capacity building. Cascavel's educational data in ISO Section 6 indicate good performance in basic education, with high enrollment rates and a considerable primary education completion rate. This facilitates the search for qualified labor, as the city has a solid foundation for developing its intellectual capital.

As for technological resources, experts believe that the implementation of sustainable technologies is another common necessity. In this sense, we can consider technologies such as: solar energy, intelligent transportation systems, efficient water distribution networks, and ICT (information and communication technologies).

Main registration units identified in the interviews with the experts.

Frame 6- Summary of the interviews.

Categories	Registration Units	Contextual Unit	Content Analysis
Economic Sustainability	"Investing in sustainable practices is essential to ensure balanced and resilient urban development."	What is the importance of sustainable economic development for Cascavel?	The interviewees emphasize the need for sustainable business practices, green technological innovation, and support for local agricultural production. Strategies like subsidies and promotion of regional products are recommended to boost the local economy and reduce the carbon footprint (SDGs 8 and 12).
Urban Mobility	"Efficient and quality public transport, increasing bike lanes, improving	What are the challenges and needs regarding urban mobility in Cascavel?	There is a significant need to improve public transport and bike lane infrastructure.

	road safety measures."		Enhancing public transport infrastructure, creating bike lanes, and promoting alternative transport options are essential for sustainable urban mobility, reducing reliance on private vehicles, and improving road safety (SDG 11).
Water Management	"Separation of greywater and blackwater, use of plants for sewage treatment."	What are the recommended practices for efficient water management in Cascavel?	Water management is critical for the municipality's sustainability. The interviewees recommend the separation of greywater and blackwater and the use of eco-friendly technologies for treatment, aiming to reduce potable water consumption and improve the sustainability of water sources (SDG 6).
Local Governance	"Active community participation, strategic partnerships, transparency, and information accessibility."	What is the role of local governance in promoting sustainability in Cascavel?	Effective local governance requires active community participation, partnerships with educational and non-governmental institutions, and a strong commitment to transparency and information accessibility to promote sustainability (SDGs 16 and 17).
Community Engagement	"Community engagement, policy	What are the main challenges to	Challenges include community

	integration, financial and technical resources."	community engagement in sustainable practices?	awareness and engagement, policy integration, and overcoming cultural and economic barriers. Community participation is seen as essential for the successful implementation of sustainable practices (SDG 11).
Programs and Incentives	"Sustentar/Reciclar é Preciso Program, support for waste pickers' cooperatives."	What are the existing programs, and how do they contribute to sustainability?	Programs such as Sustentar/Reciclar é Preciso are vital for sustainability, promoting recycling and supporting cooperatives. These programs reflect the municipality's commitment to the 2030 Agenda and the Sustainable Development Goals (SDGs 12 and 13).

Source: Research data (2024)

Each category presented in the summary frame reflects the challenges and opportunities faced by the municipality in critical areas such as economic sustainability, urban mobility, water management, local governance, community engagement, and incentive programs. The suggested practices are grounded in the Sustainable Development Goals (SDGs), providing guidelines and strategies for public policy formulation with an emphasis on promoting a more inclusive and sustainable urban infrastructure.

6. FINAL CONSIDERATIONS

This dissertation addressed the research problem: "Considering the indicators of the Sustainable Cities Program (SCP), what actions should be implemented in the municipality of Cascavel based on ISO 37120/2017 in order to obtain certification?" The main objective was to analyze the sustainability axes of the SCP in the municipality of Cascavel with a view to achieving the ISO 37120/2017 standard. To achieve the proposed objectives, the research project and its theoretical foundation were built on the sustainable cities indicators provided by ISO 37120/2017 and the experts' assessment regarding the implementation of ISO in the municipality.

The evaluation of urban quality of life is crucial for advances in sustainable urban development, covering both sustainability and urban planning. This involves the five pillars of the Sustainable Development Goals: prosperity, peace, partnerships, planet, and people, as well as the three pillars of sustainability: environmental, economic, and social.

To achieve this, it is essential to establish clear goals and measures capable of monitoring urban development progress. The use of tools such as indicators helps ensure transparency and direction in meeting these goals. As evidenced in this study, the application of sustainability indicator methodologies has significant potential to guide a city toward sustainable economic development. For this, the study used the indicators proposed by ISO 37120/2017. These indicators help ensure transparency and direction in achieving sustainability goals, highlighting that the structuring and application of the standard is not just a bureaucratic process, but a guide capable of leading cities toward sustainable development.

However, it is important to emphasize that the path to urban sustainability is not limited to the structuring of indicators. Various other factors influence its performance, including the city's continuous commitment to the adopted methodologies, its historical and socio-economic context, as well as the active participation of the population, which plays a crucial role in this process, alongside efficient and transparent public management.

Thus, to meet the specific objectives, particularly the objective of "conducting a diagnosis of Cascavel's current situation regarding ISO 37120/2017 indicators," a

detailed survey of data on the standard's indicators in the municipality was conducted using publicly available documentary data.

When analyzing the ISO indicators in Cascavel, strengths and areas needing improvement were observed. Among the strengths, Cascavel boasts a diversified and strong economy, with a GDP of approximately R$15.8 billion and an unemployment rate of 4.87%. In the educational sector, Cascavel shows high enrollment rates and a favorable student-teacher ratio, suggesting an inclusive and effective educational system. The significant presence of individuals with higher education highlights the city as a center for advanced education, essential for economic growth and innovation. Furthermore, the city has demonstrated efficiency in aspects such as sewage collection and low water loss in the distribution system, reflecting effective water resource management. Another important factor is that the municipality achieves 100% domestic waste collection in urban areas and exclusively works with sanitary landfills, significantly contributing to environmental preservation, public health, and the promotion of sustainable waste management practices.

However, the analysis also identified critical areas that need attention. In environmental areas, the urgent need to implement programs to monitor air quality and measure city pollution was highlighted. Additionally, promoting urban green spaces and encouraging the use of non-motorized transport were recognized as important measures. The absence of data in some indicators prevents a complete understanding of the distribution. The collection and disclosure of accurate information are essential for the implementation of effective public policies.

In this sense, it can be considered that the ISO indicators are efficient and provide guidance for public management; however, as the standard itself establishes, it does not classify efficiency by the indicator but by the presence or absence of data. This contrasts with the Sustainable Cities Program, which evaluates cities based on their indicators and good practices. Another deficiency found in the application of ISO relates to certain procedures that do not apply to the municipality's actual reality, as in the case of recreation, where the municipality does not work with data on square meters of public space. Perhaps if the assessment considered the number of public spaces dedicated to culture, such as cultural centers, sports courts, libraries, and theaters, it would provide an indicator more accurate to the municipality's reality.

Moreover, there is a lack of data in some indicators, preventing a complete understanding. Some social sustainability indicators are absent from ISO 37120/2017,

such as care for the elderly, children/adolescents, foreigners in the municipality, data on violence against women, and even the Human Development Index (HDI), which could provide a more complete vision. The inclusion of these indicators contributes to a more comprehensive understanding of the municipality's social reality. Social indicators are essential for sustainability as they allow for identifying vulnerabilities and specific needs within the population, guiding the formulation of fairer and more effective public policies. Without a detailed assessment of social aspects, it is difficult to promote sustainable economic development. Thus, the collection and disclosure of accurate information are fundamental to the implementation of effective public policies.

Regarding the specialists' assessment, they highlighted the need for an integrated and collaborative approach to implementing sustainable practices in Cascavel. They reinforced the common strengths and weaknesses with the ISO indicators identified in the municipality, specifically pointing out the obstacles related to cultural resistance to change and the challenges in measuring and monitoring the indicators. The active participation of the community, through educational campaigns and incentives, is essential for the effectiveness of sustainability indicators. Moreover, strategic partnerships with universities and the private sector are crucial for the development and implementation of innovative solutions that leverage available theoretical and practical knowledge.

The specialists also emphasized the importance of participatory governance and clear, long-term public policies to create a favorable environment for sustainability. They suggest that the adoption of innovative technologies and the continuous training of human resources are crucial to overcoming challenges and promoting sustainable development. Thus, a combination of community efforts, strategic partnerships, and effective governance can transform Cascavel into a model of urban sustainability, ensuring a future that balances economic, environmental, and social pillars in a prosperous and equitable way for all its citizens, while adhering to international standards. The experts reiterated the need for clear and robust indicators to monitor progress, ensuring that public policies are based on concrete data and enabling continuous adaptation of strategies to meet community needs and ISO 37120/2017 certification criteria. They also believe that certification brings benefits to the municipality, positioning it better in sustainability and attracting foreign investment.

In this sense, the results of this research provide an assessment of sustainable practices in Cascavel and identify areas in need of improvement. This research advances

existing knowledge by applying ISO 37120/2017 as a tool for assessing urban sustainability. Moreover, it offers information for policy formulation and action, contributing to public managers and researchers by highlighting the actions needed to promote sustainable urban development.

Therefore, although Cascavel has shown significant progress in some urban sustainability indicators, important gaps remain to be addressed to improve the quality of life and sustainability of the city. Continuous investments in infrastructure, innovation, and public policies are essential to consolidating Cascavel as a model of a sustainable and resilient city.

We can consider that the findings of this study have several practical implications. The identification of critical areas, such as the need to improve data collection and dissemination, can guide the implementation of more effective and transparent public policies. Investments in sustainable infrastructure and education can significantly improve the inhabitants' quality of life. The adoption of sustainable practices and compliance with ISO 37120/2017 standards not only sets a model for other cities seeking urban sustainability but also stimulates local economic growth and sustainable development. This increases attractiveness for foreign investment and the establishment of new companies, fostering the city's economy.

This study demonstrates that the application of sustainability indicator-based methodologies has great potential to guide a city toward sustainable development. However, achieving urban sustainability goes beyond simply organizing these indicators. Various factors influence a city's performance, including continuous commitment to the adopted methodology and the integration of indicators into municipal management. Listening to the community is an important metric, as its engagement plays a fundamental role in promoting sustainable development.

Although this study offers an analysis of urban sustainability indicators in Cascavel, it has some limitations. The reliance on secondary data and the absence of information in some key indicators prevent a complete understanding of wealth distribution and the city's economic development. Additionally, the research is limited by the lack of temporal and comparative analysis, which could offer deeper insights into changes over time.

As a suggestion for future research, it is recommended to monitor Cascavel's progress toward urban sustainability over time and compare it with other cities. Additionally, analyzing the population's perception of sustainability aspects in the city is essential.

Investigating more effective methods for data collection and dissemination, as well as exploring other sustainability indicators, is another promising area for future research.

Thus, this study has successfully addressed the research problem and the defined objectives by analyzing the sustainability axes of the SCP in Cascavel and proposing actions for certification based on ISO 37120/2017. We can consider that Cascavel is well-positioned to advance in its journey toward sustainability, with a solid economy, an effective educational system, and efficient use of energy resources. However, continuous efforts are needed to improve data collection and implement inclusive and innovative policies.

We hope that the recommendations presented will inspire concrete and ongoing actions, contributing to a more sustainable and equitable future. Promoting sustainable practices not only enhances the quality of life for citizens but also serves as an inspiring example for other cities facing similar challenges.

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APPENDIX A

Questions for Experts

1. How do you perceive the importance and feasibility of sustainability for the city of Cascavel?
2. Considering your field of expertise, what are the main challenges currently faced in implementing sustainable practices in Cascavel?
3. What actions or policies are already in place in the municipality?
4. Considering the local context, what specific challenges might arise when implementing a standard like ISO 37120/2017 in Cascavel?
5. What resources (financial, human, technological) would be necessary for a successful implementation?
6. How could the local community be effectively engaged to support the implementation of ISO 37120/2017 indicators?
7. Which sectors or specific areas require immediate intervention to meet the standard's requirements and sustainability indicators?
8. Regarding the environmental axis, what specific actions can be implemented in Cascavel to improve air and water quality and reduce negative environmental impacts?
9. What strategies can be adopted to promote a more sustainable and inclusive local economy in Cascavel?
10. Which specific economic sectors of the city need more attention to align with sustainability standards, such as ISO 37120/2017?
11. What educational strategies can be implemented in Cascavel to promote a culture of sustainability and quality of life among citizens? What policies or awareness campaigns would be effective in reducing waste and encouraging conscious consumption in the city?
12. What strategies are needed to ensure the safety, health, and well-being of all citizens of Cascavel, aiming to achieve a sustainable environment?
13. How do you view the role of your profession in promoting sustainability in a city like ours, and what key measures do you consider essential to make urban spaces more sustainable while respecting the balance between urban development and environmental preservation?
14. What improvements in local governance would be necessary to ensure the effective implementation of sustainability indicators in Cascavel?
15. How can sustainable urban mobility be promoted?
16. What is your view on the role of the private sector and entrepreneurship in promoting urban sustainability in Cascavel?
17. What are the benefits of integrating local sustainability initiatives into a global perspective for Cascavel?
18. How can the effectiveness and progress in applying these indicators be evaluated in the short and long term?
19. What internal and external partnerships would be key to the success of these actions' implementation?
20. What are the main obstacles that could hinder the successful implementation of ISO 37120/2017 in Cascavel?

21. What is your perspective on the benefits that ISO 37120 certification can bring to Cascavel, both in terms of international recognition and improving the population’s quality of life?

APPENDIX B

Questions for ISO Experts

1. What would be the ideal approach to start the process of implementing ISO 37120 in a city?
2. How can we identify and overcome the main challenges in implementing ISO 37120 in a city?
3. What is the role of local stakeholders in the successful adoption of ISO 37120 in a city?
4. What are the most common challenges faced by municipal authorities during the ISO implementation process, and how can they be overcome?
5. How would you assess the initial costs involved in implementing ISO 37120 compared to the long-term benefits for a city?
6. How might ISO 37120 impact resource allocation and the municipal budget? Are there specific areas that tend to require more investment during implementation?
7. How can the adoption of ISO 37120 improve governance and the provision of public services in a city?
8. What are the key indicators that municipal managers should consider when evaluating the benefits of implementing ISO 37120?
9. Beyond the obvious benefits, such as transparency and efficiency, what other tangible or intangible outcomes can a city expect to achieve with the adoption of ISO 37120?
10. What is the role of political leadership and community engagement in the successful implementation of ISO 37120 in a city?
11. Based on your experience, what would be your key recommendations for a city considering adopting ISO 37120 in terms of costs and benefits?

ANEXO A

Indicators from ABNT NBR ISO 37120:2017, Section 5 - Economy

5.1 The city's unemployment rate	$\frac{Unemployed\ working\ population}{Total\ workforce}\ x\ 100$
5.2 Assessment value of commercial and industrial properties as a percentage of the total assessment value of all properties	$\frac{Total\ value\ of\ commercial\ and\ industrial\ properties}{Value\ of\ all\ properties}\ x\ 100$
5.3 Percentage of the population below the poverty line	$\frac{No.\ of\ people\ below\ the\ poverty\ line}{Total\ population\ of\ the\ city}\ x\ 100$
5.4 Percentage of the population in full-time employment	$\frac{No.\ of\ people\ in\ full-time\ employment}{Total\ population\ of\ the\ city}\ x\ 100$
5.5 Youth unemployment rate	$\frac{Total\ number\ of\ unemployed\ young\ people}{Total\ youth\ workforce}\ x\ 100$
5.6 Number of companies per 100,000 inhabitants	$\frac{No.\ of\ companies\ in\ the\ city}{100{,}000th\ part\ of\ the\ population}$
5.7 Number of new patents per 100,000 inhabitants per year	$\frac{No.\ of\ companies\ in\ the\ city}{100{,}000th\ part\ of\ the\ population}$

Indicators from ABNT NBR ISO 37120:2017, Section 6 - Education

6.1 Percentage of the female school-age population enrolled in schools	$\frac{No.\ of\ school-age\ women\ enrolled}{Total\ number\ of\ women\ of\ school\ age}\ x\ 100$

6.2 Percentage of students with completed primary education: survival rate	$\frac{No.of\ students\ completing\ primary\ school}{Total\ students\ enrolled} x\ 100$
6.3 Percentage of students with completed secondary education: survival rate	$\frac{No.of\ students\ completing\ secondary\ school}{Total\ students\ enrolled} x\ 100$
6.4 The student/teacher relationship in primary education	$\frac{No.of\ pupils\ enrolled\ in\ elementary\ school}{No.of\ elementary\ school\ teachers}$
6.5 Percentage of school-age male population enrolled in schools	$\frac{No.of\ male\ students\ of\ school\ age\ enrolled}{Total\ number\ of\ men\ of\ school\ age} x\ 100$
6.6 Percentage of school-age population enrolled in schools	$\frac{No.of\ students\ enrolled}{School\ population} x\ 100$
6.7 Number of individuals with completed higher education per 100,000 inhabitants	$\frac{No.of\ people\ with\ complete\ higher\ education}{100{,}000th\ part\ of\ the\ population}$

Indicators from ABNT NBR ISO 37120:2017, Section 7 - Energy

7.1 Total residential electricity use per capita	$\frac{Total\ residential\ electricity\ use\ in\ the\ city}{Total\ population\ of\ the\ city}$
7.2 Percentage of the city's inhabitants with a regular electricity supply	$\frac{No.of\ inhabitants\ in\ the\ city\ with\ a\ network\ connection}{Total\ number\ of\ inhabitants\ in\ the\ city} x\ 100$
7.3 Energy consumption of public buildings per year (kWh/m²)	$\frac{Electricity\ consumption\ by\ public\ buildings}{Total\ area\ of\ public\ buildings}$
7.4 Percentage of total energy from renewable sources, as a share of the	$\frac{Consumption\ of\ electricity\ from\ renewable\ sources}{Total\ energy\ consumption} x\ 100$

city's total energy consumption	
7.5 Total electricity use per capita (kWh/year)	$\frac{Total\ electricity\ use\ in\ the\ city}{Total\ population\ of\ the\ city}$
7.6 Average number of power interruptions per consumer per year	$\frac{Total\ number\ of\ consumer\ interruptions}{Total\ number\ of\ consumers\ served}$
7.7 Average duration of power outages (in hours)	$\frac{Total\ number\ of\ interruptions}{No.of\ interruptions}$

Indicators from ABNT NBR ISO 37120:2017, Section 8 - Environment.

8.1 Concentration of fine particulate matter (PM 2.5)	$\frac{Total\ mass\ of\ particles\ collected}{Volume\ of\ air\ sampled}$
8.2 Concentration of particulate matter (PM 10)	$\frac{Volume\ of\ air\ collected}{Volume\ of\ air\ sampled}$
8.3 Greenhouse gas emissions, measured in tons per capita	$\frac{Total\ amount\ of\ greenhouse\ gases}{Current\ population\ of\ the\ city}$
8.4 NO2 concentration	$\frac{Sum\ of\ concentrations}{365\ days}$
8.5 SO2 concentration	$\frac{sum\ of\ concentrations}{365\ days}$
8.6 O3 concentration	$\frac{Sum\ of\ concentrations}{365\ days}$
8.7 Noise pollution	$Noise\ level\ mapping$

Indicators from ABNT NBR ISO 37120:2017, Section 9 - Finance.

9.1 Debt ratio	$\frac{Total\ cost\ of\ long-term\ debt}{Total\ revenue\ from\ own\ sources}$
9.2 Capital expenditure as a percentage of total expenditure	$\frac{Total\ expenditure\ on\ fixed\ assets}{Total\ expenses}$
9.3 Percentage of own revenue in relation to total revenue	$\frac{Total\ funds\ in\ fixed\ assets}{Total\ income}$
9.4 Percentage of taxes collected as a function of taxes levied	$\frac{Total\ revenue\ generated\ by\ taxes}{Volume\ of\ taxes\ invoiced} x\ 100$

Indicators from ABNT NBR ISO 37120:2017, Section 10 - Fire and Emergency Response.

10.1 Number of firefighters per 100,000 inhabitants	$\frac{Total\ number\ of\ firefighters}{100{,}000th\ part\ of\ the\ population}$
10.2 Number of fire-related deaths per 100,000 inhabitants	$\frac{Total\ number\ of\ fire-related\ deaths}{100{,}000th\ part\ of\ the\ population}$
10.3 Number of deaths related to natural disasters per 100,000 inhabitants	$\frac{Total\ deaths\ related\ to\ natural\ disasters}{100{,}000th\ part\ of\ the\ population}$
10.4 Number of volunteer and part-time firefighters per 100,000 inhabitants	$\frac{Total\ number\ of\ volunteer\ firefighters}{100{,}000th\ part\ of\ the\ population}$
10.5 Emergency services response time from the first call	$\frac{Sum\ of\ call\ times}{No\ of\ emergency\ attendances}$
10.6 Fire Department response time from the first call	$\frac{Sum\ of\ call\ times}{No.of\ Fire\ Department\ calls}$

Indicators from ABNT NBR ISO 37120:2017, Section 11 - Governance.

11.1 Percentage of voter turnout in the last municipal elections in relation to the total number of people eligible to vote	$\frac{No.\,of\ people\ who\ voted\ in\ the\ last\ election}{People\ eligible\ to\ vote}\ x\ 100$
11.2 Percentage of women elected in relation to the total number of elected city officials	$\frac{No.\,of\ women\ elected}{Total\ number\ of\ management\ positions\ in\ the\ city}\ x\ 100$
11.3 Percentage of women employed in city management	$\frac{Total\ number\ of\ women\ in\ city\ management}{Total\ number\ of\ employees\ in\ management}\ x100$
11.4 Number of convictions of civil servants for corruption and/or bribery per 100,000 inhabitants	$\frac{Total\ number\ of\ civil\ servants\ convicted\ of\ corruption}{100{,}000th\ part\ of\ the\ population}$
11.5 Citizen representation: number of local authorities elected to office per 100,000 inhabitants	$\frac{Total\ elected\ local\ authorities}{100{,}000th\ part\ of\ the\ population}$
11.6 Population of registered voters in relation to the voting age population	$\frac{Official\ voter\ registration}{Voting\ age\ population}$

Indicators from ABNT NBR ISO 37120:2017, Section 12 - Health

12.1 Average life expectancy	Average life expectancy
12.2 Number of hospital beds per 100,000 inhabitants	$\frac{No.\,of\ public\ and\ private\ hospital\ beds}{100{,}000th\ part\ of\ the\ population}$
12.3 Number of doctors per 100,000 inhabitants	$\frac{No.\,of\ general\ or\ specialized\ doctors}{100{,}000th\ part\ of\ the\ population}$
12.4 Under-five mortality rate	Under-five mortality rate per 100 live births
12.5 Number of nursing and midwifery staff per 100,000 inhabitants	$\frac{Total\ number\ of\ nurses\ and\ midwives}{100{,}000th\ part\ of\ the\ population}$
12.6 Number of mental health professionals per 100,000 inhabitants	$\frac{Total\ number\ of\ mental\ health\ professionals}{100{,}000th\ part\ of\ the\ population}$
12.7 Suicide rate per 100,000 inhabitants	$\frac{Total\ number\ of\ suicide-related\ deaths}{100{,}000th\ part\ of\ the\ population}$

Indicators from ABNT NBR ISO 37120:2017, Section 13 - Recreation.

13.1 Area in m² of covered public recreational spaces	$\frac{No.of\ m^2\ of\ public\ spaces\ for\ recreation}{Total\ population\ of\ the\ city}$
13.2 Area in m² of public outdoor recreation spaces per capita	$\frac{No\ of\ m^2 of\ public\ space\ for\ outdoor\ recreation}{Total\ population\ of\ the\ city}$

Indicators from ABNT NBR ISO 37120:2017, Section 14 - Security

14.1 Number of police officers per 100,000 inhabitants	$\frac{No.of\ police\ officers}{100{,}000th\ part\ of\ the\ population}$
14.2 Number of homicides per 100,000 inhabitants	$\frac{No.of\ homicides\ recorded}{100{,}000th\ part\ of\ the\ population}$
14.3 Property crimes per 100,000 inhabitants	$\frac{No.of\ property\ crimes}{100{,}000th\ part\ of\ the\ population}$
14.4 Police response time from the first call	$\frac{Sum\ of\ call\ times}{No.of\ calls}$
14.5 Violent crime rate per 100,000 inhabitants	$\frac{No.of\ violent\ crimes}{100{,}000th\ part\ of\ the\ population}$

Indicators from ABNT NBR ISO 37120:2017, Section 15 - Housing.

15.1 Percentage of the population living in slums	$\frac{No.of\ people\ living\ in\ slums}{Total\ population\ of\ the\ city} x\ 100$
15.2 Percentage of dwellings without registered land titles	$\frac{Total\ number\ of\ homeless\ people}{100{,}000th\ part\ of\ the\ population}$
15.3 Percentage of dwellings without registered land titles	$\frac{No.of\ dwellings\ without\ records}{Total\ number\ of\ dwellings} x100$

Indicadores da ABNT NBR ISO 37120:2017, Seção 16 – Resíduos

16.1 Percentage of the city's population with regular solid waste collection (household)	$\frac{No.of\ people\ with\ waste\ collection}{Total\ population\ of\ the\ city} x100$
16.2 Total municipal solid waste collection per capita	$\frac{Sum\ of\ the\ amount\ of\ solid\ waste}{Total\ population\ of\ the\ city}$
16.3 Porcentagem de resíduos sólidos urbanos que são reciclados	$\frac{Amount\ of\ solid\ waste\ recycled}{Total\ amount\ of\ waste\ produced} x100$

16.4 Percentage of municipal solid waste disposed of in landfills	$\frac{Quantities\ of\ solid\ waste\ in\ landfills}{Total\ amount\ of\ waste\ produced} x100$
16.5 Percentage of municipal solid waste treated in waste-to-energy plants	$\frac{Quantity\ of\ solid\ waste\ incinerated}{Total\ amount\ of\ waste\ produced} x100$
16.6 Percentage of municipal solid waste that is biologically treated and used as compost or biogas	$\frac{Amount\ of\ solid\ waste\ burned}{Total\ amount\ of\ waste\ produced} x100$
16.7 Percentage of municipal solid waste disposed of in open dumps	$\frac{Total\ amount\ of\ solid\ waste\ in\ dumps}{Total\ amount\ of\ waste\ produced} x100$
16.8 Percentage of municipal solid waste disposed of by other means	$\frac{Total\ amount\ of\ solid\ waste\ disposed\ of\ by\ other\ means}{Total\ amount\ of\ waste\ produced} x100$
16. 9 Generation of hazardous municipal solid waste that is recycled	$\frac{Quantity\ of\ hazardous\ waste}{Total\ population\ of\ the\ city}$
16.10 Percentage of hazardous municipal waste that is recycled	$\frac{Amount\ of\ hazardous\ waste\ recycled}{Quantity\ of\ hazardous\ waste\ produced} x100$

Indicadores da ABNT NBR ISO 37120:2017, Seção 17 – Telecomunicações e Inovação

17.1 Number of internet connections per 100,000 inhabitants	$\frac{No.\ of\ internet\ connections}{100{,}000th\ part\ of\ the\ population}$
17.2 Number of cell phone connections per 100,000 inhabitants	$\frac{Total\ cell\ phone\ connection}{100{,}000th\ part\ of\ the\ population}$
17.3 Total number of fixed telephone connections per 100,000 inhabitants	$\frac{No.\ of\ fixed\ telephony\ connections}{100{,}000th\ part\ of\ the\ population}$

Indicators from ABNT NBR ISO 37120:2017, Section 18 - Transportation.

18.1 Kilometers of high-capacity public transport system per 100,000 inhabitants	$\frac{Sum\ of\ km\ of\ public\ transport\ system}{100{,}000th\ part\ of\ the\ population}$

18.2 Kilometers of medium-capacity public transport system per 100,000 inhabitants	$\frac{Sum\ of\ km\ of\ public\ system\ in\ the\ city}{100{,}000th\ part\ of\ the\ population}$
18.3 Annual number of public transport trips per capita	$\frac{Total\ trips\ originating\ in\ the\ city}{População\ total\ da\ cidade}$
18.4 Number of private cars per capita	$\frac{Total\ number\ of\ private\ cars\ registered}{População\ total\ da\ cidade}$
18.5 Percentage of passengers who travel to work as an alternative to the private car	$\frac{No.of\ passengers\ using\ other\ means\ of\ transport}{No.of\ business\ trips}$
18.6 Number of two-wheeled motor vehicles per capita	$\frac{Number\ of\ two-wheeled\ vehicles}{Total\ city\ population}$
18.7 Kilometers of bicycle paths and lanes per 100,000 inhabitants	$\frac{Km\ of\ cycle\ paths\ and\ lanes}{100{,}000th\ part\ of\ the\ population}$
18.8 Traffic fatalities per 100,000 inhabitants	$\frac{Quantidade\ de\ mortes\ relacionadas\ ao\ trânsito}{100{,}000th\ part\ of\ the\ population}$
18.9 Air connectivity	Sum of all non-stop commercial flights

Indicators from ABNT NBR ISO 37120:2017, Section 19 - Urban Planning

19.1 Green areas (hectares) per 100,000 inhabitants	$\frac{Total\ green\ area}{100{,}000th\ part\ of\ the\ population}$
19.2 Number of trees planted annually per 100,00 inhabitants	$\frac{Total\ number\ of\ trees\ planted}{100{,}000th\ part\ of\ the\ population}$
19.3 Percentage of informal settlements as a proportion of the city's total area	$\frac{Informal\ settlement\ areas}{Areas\ of\ the\ city\ in\ km^2}$
19.4 Jobs/housing ratio	$\frac{No.of\ jobs}{No.of\ housing\ units}$

Indicators from ABNT NBR ISO 37120:2017, Section 20 - Sewage

20.1 Percentage of the urban population served by sewage collection and disposal systems	$\frac{No.of\ people\ served\ by\ sewage\ collection}{Population\ of\ the\ city} x100$
20.2 Percentage of the city's sewage collection that has not received any treatment	$\frac{Amount\ of\ untreated\ sewage}{Total\ sewage\ produced\ and\ collected} x100$

20.3 Percentage of the city's sewage that receives primary treatment	$\frac{Amount\ of\ effluent\ with\ secondary\ treatment}{Total\ amount\ of\ sewage\ collected} x100$
20.4 Percentage of the city's sewage that receives secondary treatment	$\frac{Amount\ of\ effluent\ with\ tertiary\ treatment}{Total\ amount\ of\ sewage\ collected} x100$
20.5 Percentage of the city's sewage that receives tertiary treatment	$\frac{Amount\ of\ effluent\ with\ tertiary\ treatment}{Total\ amount\ of\ sewage\ collected} x100$

Indicators from ABNT NBR ISO 37120:2017, Section 21 - Water and Sanitation

20.1 Percentage of the city's population with drinking water supply services	$\frac{No\ of\ people\ with\ drinking\ water\ service}{Population\ of\ the\ city} x100$
20.2 Percentage of the city's population with sustainable access to a source of water suitable for consumption	$\frac{No.of\ people\ with\ improved\ water\ services}{Population\ of\ the\ city} x100$
20.3 Percentage of the city's population with access to improved sanitation	$\frac{No.of\ people\ with\ sanitary\ facilities}{Population\ of\ the\ city} x100$
20.4 Total domestic water consumption per capita	$\frac{Total\ amount\ of\ domestic\ water\ consumption}{Population\ of\ the\ city} x100$
20.5 Total per capita water consumption (liters per day)	$\frac{Total\ amount\ of\ water\ consumed\ in\ the\ city}{Population\ of\ the\ city}$
20.6 Average annual number of hours of water supply interruption per household	$\frac{Total\ hours\ of\ interruption}{No.of\ households}$
20.7 Percentage of water losses (unbilled water)	$\frac{Volume\ of\ water\ supplied}{Total\ volume\ of\ water\ supplied}$