



## ARTICLE

**THE TRAJECTORY OF SÃO JOSÉ DOS CAMPOS AS THE FIRST CERTIFIED SMART CITY IN BRAZIL: PROPOSAL FOR A ROADMAP ADAPTABLE TO OTHER INTERESTED MUNICIPALITIES****A TRAJETÓRIA DE SÃO JOSÉ DOS CAMPOS COMO A PRIMEIRA CIDADE INTELIGENTE CERTIFICADA DO BRASIL: PROPOSTA DE UM ROADMAP ADAPTÁVEL A OUTROS MUNICÍPIOS INTERESSADOS**

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**ABSTRACT**

**Purpose:** This study explores the requirements, standards and processes for the international certification of smart, sustainable and resilient cities, based on the empirical case of São José dos Campos (SP), Brazil.

**Methodology/Approach:** Adopting a qualitative, exploratory and descriptive approach, the research analyzed bibliographic and documentary data, focusing on urban performance indicators and evidence of compliance.

**Originality/Relevance:** This research contributes by describing the main processes used to obtain the certification of smart, sustainable and resilient cities, with the main contribution being the proposal of an adaptable roadmap for other municipalities interested in obtaining it.

**Key Findings:** The results detail the structuring process of São José dos Campos, including legal frameworks and investments in infrastructure and innovation, which led it to achieve high levels of certification.

**Theoretical/Methodological Contributions:** the study presents a proposal for a roadmap that can be adapted for other interested municipalities, reinforcing that certification goes beyond a technical seal, acting as a strategic instrument for diagnosis, data-driven planning and urban governance to promote more efficient, sustainable and resilient cities.

**Keywords:** Smart City. Resilient City. Sustainable City. Certification. ISO 3712x Standards. Urban Governance.

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## RESUMO

**Objetivo:** Este estudo explora os requisitos, padrões e processos para a certificação internacional de cidades inteligentes, sustentáveis e resilientes, tendo como base o caso empírico de São José dos Campos (SP), Brasil.

**Metodologia/Abordagem:** Adotando uma abordagem qualitativa, exploratória e descritiva, a pesquisa analisou dados bibliográficos e documentais, focando nos indicadores de desempenho urbano e evidências de conformidade.

**Originalidade/Relevância:** Esta pesquisa contribui ao descrever os principais processos utilizados para se obter a certificação de cidades inteligentes, sustentáveis e resilientes, sendo a principal contribuição a proposta de um *roadmap* adaptável para outros municípios interessados em obtê-la.

**Principais Descobertas:** Os resultados detalham o processo de estruturação de São José dos Campos, incluindo marcos legais investimentos em infraestrutura e inovação, que a levaram a alcançar altos níveis de certificação.

**Contribuições Teóricas/Metodológicas:** O estudo apresenta uma proposta de um *roadmap* adaptável para outros municípios interessados, reforçando que a certificação vai além de um selo técnico, atuando como um instrumento estratégico de diagnóstico, planejamento orientado por dados e governança urbana para promover cidades mais eficientes, sustentáveis e resilientes.

**Palavras-chave:** Cidade Inteligente. Cidade Resiliente. Cidade Sustentável. Certificação. Normas ISO 3712x. Gestão Urbana.

## 1. INTRODUCTION

Cities play a central role in the economic, political, and social development of nations, while simultaneously exerting significant influence over environmental dynamics (Mori & Christodoulou, 2012). Understood as complex, living systems, they are characterized by the interconnection of multiple actors - citizens, businesses, transportation modalities, communication networks, urban services, and utilities - all interacting dynamically and multifunctionally (Kourtit, 2021).

According to data from the 2022 Demographic Census, Brazil reached a population of 207,750,291 inhabitants, approximately 85% of whom reside in urban areas (IBGE, 2022). This process of intense urbanization has been accompanied by the worsening of technical, social, economic, and environmental challenges that compromise urban sustainability and necessitate new approaches to territorial planning and organization (Neirotti et al., 2014; Ålander et al., 2024). In this context, increasing pressure is being placed on public managers to adopt innovative models of urban governance

capable of integrating technology, social participation, and performance indicators as mechanisms for results-oriented management (Luna & Choi, 2023). Such demands have driven the debate on smart cities as an emerging paradigm of urban transformation, underpinned by digital infrastructures and standardized evaluation and certification systems (White, 2021; Kim, Andersen & Lee, 2022).

Pierre and Peters (2020) observe that the success of smart cities relies on building institutional capacities that promote accountability, cross-sector coordination, and long-term planning. Consistent with this, recent research has highlighted the importance of multilevel governance and collaboration among stakeholders for the effective implementation of smart city policies (Gil-Garcia et al., 2020; Pirozzi & Colace, 2023).

In a context of urban competitiveness and attraction, whether for establishing new companies, tourism, or quality of life, it is essential that public policies are well executed, utilizing technical tools and indicators that make cities more appealing and resilient (Cowley, Joss & Dayot, 2018). The role of public administration in promoting urban resilience and adapting to crises, including climate and social issues, has become a subject of growing study (Boin & t'Hart, 2021; Tezel et al., 2020).

Given the multiple challenges imposed by accelerated urbanization, the transformation of urban centers into smart cities has emerged as a relevant strategy to mitigate the impacts of population growth while strengthening urban competitiveness (Chourabi et al., 2012). In recent years, the concept of a smart city has gained prominence across various fields of knowledge, particularly in the formulation and implementation of public policies aimed at modernizing urban management (Scholl & Alnuaimi, 2020). This trend is accompanied by increasing investments in technological solutions, aiming to optimize infrastructures, enhance the population's quality of life, and promote sustainable development (Beck & Conti, 2021; Kim, Andersen & Lee, 2022).

Although the smart city concept is multifaceted and constantly evolving, it was initially conceived as a strategic device to integrate the factors of modern urban production under a common framework, emphasizing the role of Information and Communication Technologies (ICTs) as a driver of transformation and innovation in urban management (Caragliu, Del Bo & Nijkamp, 2011). The classical definition proposed by Caragliu et al. (2009) maintains that a city is smart when investments in human and social capital, traditional and modern transport, and communication fuel sustainable development and high quality of life, coupled with the wise management of natural resources through participatory governance.

For Junckes and Teixeira (2016), smart cities are spaces that articulate innovative capacity with the intellectual output of the population, grounding themselves in knowledge management and communication as means to enhance urban structure and public services. Along the same lines, Batty et al. (2012) argue that the essence of smart cities lies in the capacity to formulate effective responses to social demands, leveraging the potential of digital technologies to reduce response time between public agents and citizens.

It is important to emphasize that the concept is not limited to the intensive use of technologies, nor is it an exclusive approach. Diverse definitions coexist, reflecting approaches that range from focusing on operational efficiency and intelligent infrastructure to more social and participatory emphases (Giffinger, 2017; Ålander et al., 2024). In this sense, Meijer and Bolívar (2016) distinguish between the concept of a smart city, focused on infrastructure, and smart governance, which emphasizes participatory, responsive, and data-driven processes (Gascó-Hernandez & Torres-Coronas, 2022).

The smart city concept is thus associated with the pursuit of integrated solutions that enhance the efficiency of urban services, improve public transport, promote rational land use, and ensure the provision of quality public services. For this model to be effective, Berst (2018) underscores the importance of a systemic and integrated vision of the territory. The absence of this approach can lead to the adoption of mistaken priorities, fragmented projects, and the persistence of isolated solutions - the so-called departmental silos - which impede the capture of synergies, data sharing, and the rationalization of costs and infrastructure. Overcoming these silos and promoting interdepartmental collaboration are central challenges in modern public administration and the implementation of smart city initiatives (Kattel et al., 2022; Esteves et al., 2023).



Beyond technological dimensions, recent approaches advocate for the incorporation of standardized metrics, such as those established by the ISO 37120, 37122, and 37123 standards, as instruments for urban planning, assessment, and governance. These indicators, by enabling continuous monitoring of urban performance and international comparability among cities, are solidifying their position as conceptual pillars in establishing genuinely smart and sustainable cities (White, 2021; Midor & Płaza, 2020). The relevance of ISO standards for the standardization and evaluation of smart cities has been widely discussed in the literature (Naphade et al., 2021; Mora et al., 2023). In this context, the present article aimed to analyze the trajectory of the municipality of São José dos Campos in obtaining the ISO 37122 certification, highlighting the main institutional, technical, and strategic factors that enabled its consolidation as the first certified smart city in Brazil, in addition to presenting a proposal for an adaptable roadmap for other municipalities interested in obtaining the certification.

## 2. LITERATURE REVIEW

This theoretical framework presents the conceptual pillars underlying the analysis of city certification, focusing on the dimensions of smart, resilient, and sustainable cities. The definitions and characteristics inherent to each of these concepts will be addressed, exploring their interconnections and the evolution of their application in the context of contemporary urban management.

Furthermore, the normative framework governing the city certification system in Brazil will be detailed. For this purpose, the main standards of the Brazilian Association of Technical Standards (ABNT) will be presented, specifically ABNT NBR ISO 37120 (Indicators for Urban Services and Quality of Life), ABNT NBR ISO 37122 (Indicators for Smart Cities), and ABNT NBR ISO 37123 (Indicators for Resilient Cities). These standards are developed in line with the guidelines of the International Organization for Standardization (ISO) and in partnership with the World Council on City Data (WCCD), an institution linked to the United Nations.

This set of standards constitutes a robust methodological foundation for measuring, monitoring, and comparing urban performance across multiple dimensions, aligning with the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda. Understanding these concepts and the normative framework is crucial for analyzing the requirements, standards, and processes involved in the international certification of cities, as well as their relevance as a strategic instrument for diagnosis, data-driven planning, and urban governance.

### 2.1 From Sustainable and Resilient City to Smart City

Cities are configured as complex and dynamic systems, characterized by population concentration, diversity of economic activities, and the presence of infrastructures and social interactions in constant transformation. They assume a central role in economic, political, and social development, hosting strategic sectors such as commerce, industry, services, housing, and leisure. In this sense, they can be understood as interconnected networks of citizens, businesses, institutions, and public services (Mori & Christodoulou, 2012; Kourtiti, 2021; Batty, 2021).

According to Hillier (2012), cities are composed of two main dimensions: the physical, referring to the built environment and urban infrastructures, and the human, defined by the activities and social interactions occurring in the urban space. Both overlap and articulate through economic, technological, social, and political systems. Kumar et al. (2020) expand this view by describing cities as permanent human ecosystems that offer multiple services and opportunities to the population. Consequently, it is increasingly relevant for cities to adopt strategies that simultaneously make them more sustainable, resilient, and smart (Angelidou et al., 2021).

The concept of urban sustainability derives from the Brundtland Report (1987), which defines sustainable development as that which meets the needs of the present without compromising the ability of future generations to meet their own. This concept encompasses three interdependent dimensions:

economic, environmental, and social. Romeiro (2007) complements this definition by proposing that sustainable cities are those formed by societies conscious of their transformative role, guided by a synergistic action between ecological prudence, energy efficiency, and socio-spatial equity. The integration of sustainability into urban policies and governance is a central theme in contemporary research (Conti et al. 2019; Pryshchepa et al., 2022).

Within this same debate, the idea of urban resilience gains prominence, understood as the capacity of a system to absorb, adapt to, and rapidly recover from disruptive events, such as natural disasters, climate crises, or pandemics (Francis & Bekera, 2014; Tezel et al., 2020; Conti et al., 2023). Although the concept of resilience varies across disciplines, there is consensus that it involves maintaining functionality in the face of external shocks and stresses. Recent literature, such as that by Cavada et al. (2016), also emphasizes that urban resilience must consider historically accumulated vulnerabilities, including socio-spatial inequalities and territorial exclusions, stressing the importance of adaptive governance to address these challenges (García-Sánchez et al., 2021).

Faced with these challenges, the concept of the smart city emerges as an integrative proposal. Initially linked to the use of Information and Communication Technologies (ICTs), the term expanded to encompass a broader vision of urban governance. According to Chourabi et al. (2012), smart cities are those that utilize ICTs to improve the efficiency of public services, environmental sustainability, and the quality of life for citizens. The focus is on integrating different dimensions, such as mobility, energy, security, environment, governance, and citizen participation, articulated through technological solutions (Allam & Newman, 2021).

Nam and Pardo (2011) expand this approach by proposing three pillars for defining a smart city: technology (digital infrastructure and connectivity), people (human capital, creativity, and education), and institutions (governance, transparency, and innovation capacity). This perspective contributes to understanding smart cities not just as digital systems but as complex socio-technical spaces shaped by human interactions, public values, and organizational culture. In this vein, Meijer and Bolívar (2016) argue that smart cities are adaptive and responsive environments in which digital technologies must be integrated with participatory governance models (Gascó-Hernandez & Torres-Coronas, 2022).

Giffinger et al. (2007) propose a comprehensive definition of a smart city as one that combines human capital, social capital, and technological infrastructure to stimulate economic development, improve public services, and enhance the population's quality of life. Technology, in this sense, is viewed as a means, not an end, and is effective only when articulated with inclusive public policies and civil society engagement. In alignment, Cowley, Joss, and Dayot (2018) affirm that the evolution of smart cities depends on the articulation between institutional agendas and local capacities, moving beyond the technocratic view that reduces cities to systems of sensors and data. Citizen participation and multi-stakeholder collaboration are increasingly recognized as crucial for the legitimacy and effectiveness of smart city initiatives (Conti et al., 2019; Karakostas et al., 2023).

In the Brazilian context, the consolidation of the smart city concept gained momentum with the publication of the Brazilian Charter for Smart Cities (*Carta Brasileira de Cidades Inteligentes*) in 2020. The document, developed collaboratively by various institutional actors, academics, and civil society, establishes strategic guidelines to direct the digital and sustainable transformation of urban centers nationwide. Besides presenting guiding principles and structural objectives, the Charter also proposes an official definition for smart cities in the national scenario. According to the document, smart cities are those:

committed to sustainable urban development and digital transformation, in their economic, environmental, and sociocultural aspects, which operate in a planned, innovative, inclusive, and networked manner; they promote digital literacy, collaborative governance and management, and utilize technologies to solve concrete problems, create opportunities, offer services efficiently, reduce inequalities, increase resilience, and improve the quality of life for all people, ensuring the safe and responsible use of data and information and communication technologies (Brasil, 2020).



This definition broadens the notion of smart cities by emphasizing not only the technological dimension but also commitments to equity, sustainability, and citizen participation. This reaffirms that urban intelligence is not restricted to the digitization of services but depends on an integrated vision, guided by public values and ethical, secure, and collaborative governance (Meijer & Bolívar, 2016; Cowley, Joss & Dayot, 2018). Recent studies reinforce this perspective, highlighting the need for smart governance that prioritizes inclusion and social responsibility in the implementation of urban technologies (Gascó-Hernandez & Torres-Coronas, 2022; Mora et al., 2023).

Among the multiple theoretical contributions that seek to delineate the smart city concept, the pioneering approach by Caragliu, Del Bo, and Nijkamp (2011) stands out. Their comprehensive model, which has informed a series of subsequent studies, is based on five fundamental dimensions:

a) **Advanced Technologies** – The intensive use of emerging technologies, such as urban sensors, high-speed communication networks, big data, artificial intelligence, and the Internet of Things (IoT), enables the continuous collection and analysis of real-time data. These tools facilitate urban management models that are more responsive, personalized, and evidence-driven (Batty, 2012; Kim, Andersen & Lee, 2022). The application of these technologies in public administration is a constantly evolving field, aiming to optimize service delivery and decision-making (Kattel et al., 2022).

b) **Sustainability** – The pursuit of sustainable development occupies a central position, with efforts focused on mitigating carbon emissions, efficiently managing natural resources, and promoting environmentally responsible practices. These principles are supported by the Sustainable Development Goals (SDGs), as well as the parameters set by the ISO 37120 and 37122 standards (Berardi, 2013a; White, 2021). Integrating these environmental and sustainability aspects into urban public policies is essential for the success of smart cities (Naphade et al., 2021).

c) **Connectivity and Mobility** – Smart cities reconfigure their urban infrastructures to ensure broad digital connectivity and efficient, safe, and inclusive transportation systems. Urban mobility is re-envisioned with a focus on integrated solutions, encouragement of active mobility, and the electrification of public fleets (Neirotti et al., 2014; Ålander et al., 2024). The digitalization of transport and the implementation of intelligent mobility solutions are growing themes in urban planning literature.

d) **Participatory Governance** – The model values citizen inclusion through digital platforms, public consultations, and democratic innovation. This promotes more transparent decision-making processes, institutional accountability, and shared responsibility in the formulation and monitoring of public policies (Nam & Pardo, 2011; Meijer & Bolívar, 2016). Current literature emphasizes the importance of citizen participation in building smart cities to guarantee the legitimacy and relevance of initiatives (Karakostas et al., 2023; Pirozzi & Colace, 2023).

e) **Quality of Life** – The final axis concentrates on urban well-being, considering the expansion of quality public services, access to health, education, security, and green spaces. Valuing subjective and relational aspects of urban life reinforces the importance of social capital and a sense of belonging to the territory (Giffinger et al., 2007; Cowley et al., 2018). Improvements in quality of life are frequently linked to the efficiency of public administration and innovation in services.

This expanded vision, which links technological innovation to sustainable practices, citizen participation, and the valuing of social capital, reinforces that urban intelligence must be understood through a systemic and multidimensional approach (Beck & Conti, 2021). Although the smart city concept continues to evolve and there is no single widely consensual definition, the approaches presented here converge in highlighting the centrality of Information and Communication Technologies (ICTs), the strategic use of indicators, and the importance of an integrated urban management model as essential pillars of this new agenda (Kim, Andersen & Lee, 2022; Midor & Plaza, 2020; Mora et al., 2023).

## 2.2 The ABNT Standards - NBR ISO 37120, NBR ISO 37122, and NBR ISO 37123

The Brazilian Association of Technical Standards (ABNT) is a non-profit civil entity, founded in 1940 and recognized as a public utility organization. It functions as the main body responsible for technical standardization in Brazil and is a founding member of the International Organization for

Standardization (ISO). throughout its history, ABNT has played a strategic role in developing and disseminating standards that establish technical benchmarks for various sectors of Brazilian society.

ISO, in turn, is an independent, non-governmental international organization composed of representatives from national standardization bodies in 165 countries. Its mission is to develop technical standards that ensure the quality, safety, efficiency, and interoperability of products, services, and systems on a global scale (ISO, 2018).

In the field of urban management, ABNT, in line with ISO guidelines and in partnership with the World Council on City Data (WCCD) - an institution linked to the United Nations - developed a city certification system based on three complementary standards:

- ✓ ABNT NBR ISO 37120: Indicators for Urban Services and Quality of Life;
- ✓ ABNT NBR ISO 37122: Indicators for Smart Cities;
- ✓ ABNT NBR ISO 37123: Indicators for Resilient Cities.

These standards constitute a robust methodological foundation for measuring, monitoring, and comparing urban performance across multiple dimensions (Mora et al., 2023). Together, they encompass 276 indicators distributed across 19 thematic areas, including economy, education, energy, environment, finance, health, housing, mobility, safety, culture, telecommunications, governance, urban planning, waste management, water, and sanitation, among others.

This indicator set is strongly aligned with the 17 Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda, promoting an integrated vision of the economic, social, and environmental dimensions of urban development. The adoption of these standards by cities of varying sizes and contexts reinforces the commitment to evidence-based governance, guided by transparency, international comparability, and the pursuit of continuous improvement in urban quality of life (Naphade et al., 2021; Sassen, 2022). The application of these standards is viewed as a catalyst for modernizing public management and promoting more sustainable and efficient cities.

Table 1 presents a comparison between the ABNT NBR ISO 37120, 37122, and 37123 standards.

Together, these standards offer a robust technical framework to guide the transformation of traditional cities into smart, resilient, and sustainable ones. Their application represents not only a strategy for administrative modernization but also an effective commitment to the global agenda of sustainable urban development (Naphade et al., 2021; Mora et al., 2023).

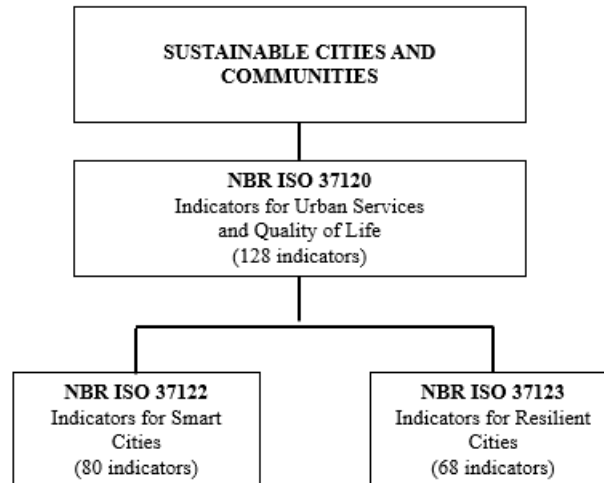
**Table 1.** Comparison of ABNT NBR ISO 37120, 37122, and 37123 standards

Standard	Primary Focus	Indicators	Central Objective	Evaluated Areas (examples)
ISO 37120	Urban services and quality of life	128	To assess the performance of public services and the quality of life in cities	Health, education, safety, environment, mobility, housing, governance, finance
ISO 37122	Smart cities	80	To measure the incorporation of ICTs into the management and operation of urban services	Digital government, urban sensors, energy, innovation, intelligent transport, connectivity
ISO 37123	Resilient cities	68	To assess the city's capacity to prepare for, resist, and recover from adverse events	Risk planning, emergency management, climate resilience, critical infrastructure

Figure 1 presents an illustrative flowchart of the main international standards aimed at promoting urban sustainability, territorial intelligence, and city resilience, highlighting their interrelations and complementarities.

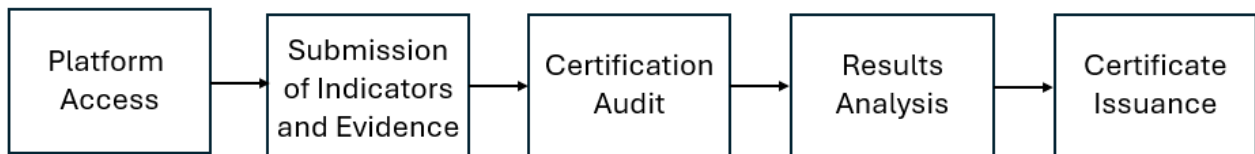
It is also noteworthy that the certification process developed by ABNT adopts an evolutionary approach, structured in four recognition levels: **Bronze, Silver, Gold, and Platinum**. Each level is

assigned based on the quantity and nature of the indicators met, reflecting the city's degree of maturity regarding the parameters established by the ABNT NBR ISO 37120, 37122, and 37123 standards. This tiered structure allows for valuing municipalities in the initial compliance phase as well as those already demonstrating high performance and consolidation of best practices in urban management (Mora et al., 2023; Naphade et al., 2021). The relevance of maturity or level-based assessment systems in public management and urban innovation processes has been emphasized in the literature to allow for adaptability and recognition of different stages of development (Scholl & Alnuaimi, 2020).



**Figure 1.** Flowchart of the main standards focused on sustainability, smart cities, and resilient cities.

Regarding the stages of the certification process, ISO 37122 establishes the following flow, which is presented in Figure 2.



**Figure 2 - Annual Assessment and Maintenance**

The table 2 presents the quantitative criteria required for each certification level, according to the applied reference standard.

**Table 2 – Certification Levels and Necessary Number of Indicators**

	<b>37120</b>	<b>37122</b>	<b>37123</b>
Bronze	45 essential + 0 to 14 supporting	40 to 49	34 to 39
Silver	45 essential + 15 to 29 supporting	50 to 59	40 to 49
Gold	45 essential + 30 to 44 supporting	60 to 69	50 to 59
Platinum	45 essential + 45 to 59 supporting	70 to 80	60 to 68



Based on the above, it is understood that the process of building a smart city is, by nature, evolutionary and continuous. In this context, the certification system implemented by ABNT allows for the possibility of periodic reassessment, enabling certified municipalities to request the analysis of new indicators at any time with a view toward obtaining higher levels of recognition. This dynamic stimulates the continuous improvement of public policies, the expansion of the strategic use of urban technologies, and the refinement of governance mechanisms, consolidating a virtuous cycle of innovation, transparency, and sustainability in municipal management (Mora et al., 2023; Pirozzi & Colace, 2023; Kattel et al., 2022).

### 3. METHODOLOGY

This study adopts a qualitative, basic nature approach, with exploratory and descriptive aims, focused on understanding the paths taken by São José dos Campos (SP) in the certification process as a smart, sustainable, and resilient city. The methodological design is based on bibliographic and documentary research, supported by secondary sources such as scientific publications, official reports, pertinent legislation, and ABNT/ISO technical standards. The choice of a qualitative methodology in case studies concerning urban transformation and public policies is widely recognized for allowing in-depth analysis of complex contexts (Bryman & Bell, 2023; Denzin & Lincoln, 2018).

The bibliographic research was conducted based on national and international references, carefully selected to conceptually underpin the notions of smart, sustainable, and resilient cities. The documentary analysis concentrated on examining institutional materials made available by public bodies, especially the City Hall of São José dos Campos, as well as certifying entities such as the ABNT Certification Body and the World Council on City Data (WCCD).

According to Gil (2010, p. 30), documentary analysis shares points of convergence with bibliographic research, as both utilize pre-existing data. The main distinction lies in the nature of the sources: while bibliography uses texts of a theoretical and scientific nature, documentation covers official records, technical reports, and evidence of institutional practices. The use of documents as a primary source in research on urban governance and policy implementation is a consolidated practice, providing insights into operational and strategic dimensions (Guest et al., 2020).

The analytical procedure adopted was structured documentary analysis, guided by the extraction and categorization of evidence related to the following axes: (i) theoretical foundations of the smart, sustainable, and resilient city concept; (ii) investments and public policies implemented in the municipality; (iii) compliance with the criteria of ISO 37120, 37122, and 37123 standards; and (iv) planning and management strategies utilized to achieve the different certification levels. This systematic approach to documentary analysis is crucial for ensuring the validity and reliability of findings in qualitative research (Bowen, 2009; Hodgkinson & Starkey, 2022).

Additionally, based on the cross-referencing between the collected data and the theoretical frameworks identified in the literature review, a roadmap analytical model for certification was developed, representing the operational and strategic steps adopted by São José dos Campos in its trajectory toward alignment with international standards for smart, resilient, and sustainable cities. Roadmap models are valuable tools in management and public policy research for representing complex processes and facilitating the replication of best practices (Mora et al., 2023).

#### 3.1. The Municipality of São José dos Campos, SP

The municipality of São José dos Campos is located in the Paraíba Valley region (*Vale do Paraíba*), in the interior of the State of São Paulo, and has approximately 700,000 inhabitants, according to 2022 Demographic Census data (IBGE). It is the most populous municipality in the Paraíba Valley, ranking 9th in population in the state of São Paulo, 15th in the Southeast region, and 30th in Brazil.

Nationally recognized for its strategic vocation in science, technology, and innovation, especially in the aerospace sector, with reference institutions such as the National Institute for Space Research (INPE) and the Department of Aerospace Science and Technology (DCTA), the city gathers



a dynamic ecosystem of research, industry, and technology-based services. This characterization of São José dos Campos as an innovation hub is consistent with studies on the role of medium-sized cities in regional technological development.

In 2022, São José dos Campos became the pilot city in Brazil to undergo the international certification process according to ABNT standards. As a result, it was recognized as the first certified Smart City in the country, in addition to also achieving certifications as a Sustainable City and a Resilient City. This pioneering role reinforces the relevance of the case study and justifies its selection as the empirical object of this research. The experience of pioneer cities in adopting international frameworks is a topic of growing interest in the literature on urban management and public policy.

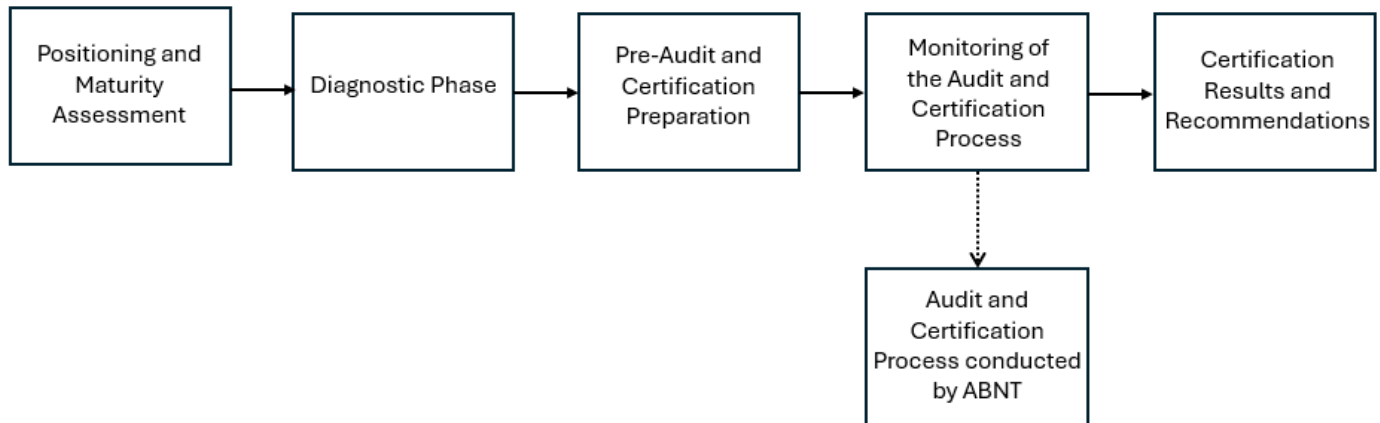
#### 4. RESULTS AND DISCUSSION

The city of São José dos Campos stands out in the national scenario as a hub for urban and technological innovation. In 2021, the municipality initiated a structured process of indicator mapping and evidence systematization, aiming to diagnose opportunities and gaps for obtaining certifications as a Smart, Sustainable, and Resilient City, following the criteria established by ABNT NBR ISO 37120, 37122, and 37123 standards. The proactivity of cities in seeking such certifications reflects a global movement toward urban governance that is more data-driven and aligned with international standards (Mora et al., 2023; Naphade et al., 2021).

The applied methodology was developed through institutional collaboration among three key actors: the São José dos Campos Technology Park Association (*Associação Parque Tecnológico de São José dos Campos*), the specialized consultancy Smart Frees – Smart Cities Consulting, Business and Projects, and the Brazilian Association of Technical Standards (ABNT) itself. This interinstitutional articulation enabled the development of an assessment model adjusted to the local reality, maintaining technical rigor and adherence to international standards promoted by ISO. Collaboration among the public sector, private entities, and standardization bodies is a critical element for the success of urban transformation and digitalization initiatives in public administration (Kattel et al., 2022).

As illustrated in Figure 3, the process was structured in sequential stages, starting with the collection, organization, and validation of secondary data and local evidence. Subsequently, adherence to normative indicators was verified, identifying conformities and non-conformities. Based on these results, the municipality was able to structure corrective actions and define complementary strategies aimed at qualifying the certification process and preparing for the third-party audit, conducted by ABNT Certification Body. Evidence-based management and external auditing are essential mechanisms for accountability and continuous improvement in public administration, especially in contexts of innovation.

This process culminated in the pioneering attainment of the triple certification—as a smart, resilient, and sustainable city—making São José dos Campos the first Brazilian city to achieve this simultaneous recognition. More than a technical seal, the certification symbolizes the consolidation of an innovative institutional agenda, with high replicability potential for other Brazilian municipalities seeking to structure public policies based on evidence, international standards, and sustainable urban planning guidelines. Studying successful cases, like that of São José dos Campos, is fundamental for learning and disseminating best practices in urban governance and territorial development.



**Figure 3.** Certification Process, São José dos Campos Technology Park Association and Smart Frees

The mapping conducted in São José dos Campos assessed the adherence of municipal technological solutions and public policies to the criteria established by ABNT NBR ISO 37120, 37122, and 37123 standards, as well as the Sustainable Development Goals (SDGs) defined by the United Nations (UN). This systematic analysis made it possible to measure the municipality's degree of compliance with international indicators for urban quality of life, territorial intelligence, and resilience, consolidating itself as a preparatory stage for formal certification. Aligning urban performance indicators with the SDGs is a crucial topic for sustainable planning and impact assessment.

As part of the institutional governance of the process, the Municipal Consultative Committee was established via Ordinance No. 001/SIDE/SG/2022, with the function of ensuring intersectoral articulation, securing the integrity of the data provided, and promoting the transparency of information. General coordination was handled by the São José dos Campos Technology Park Association, in cooperation with ABNT and the specialized consultancy Smart Frees. Creating participatory and intersectoral governance structures is fundamental for coordinating complex urban development initiatives.

In March 2022, São José dos Campos became the first Brazilian city to achieve simultaneous certification as a Smart, Sustainable, and Resilient City, according to ABNT criteria. The results were significant: Platinum level in ISO 37120 (with 99 indicators met), Gold level in ISO 37122 (64 indicators), and Gold level in ISO 37123 (57 indicators). Despite the pioneering effort, the results also highlighted opportunities for advancement, which motivated the preparation of a Technical Report of Recommendations, based on technical visits, interviews, institutional records, and documentary and photographic evidence. Continuous monitoring and identifying areas for improvement are essential practices for the long-term sustainability of smart city strategies.

This strategic report served as a guide for the continuous refinement of public policies and resource allocation, being incorporated into budgetary planning instruments, such as the Multi-Year Plan (PPA) and the Annual Budget Law (LOA). Certification, which has annual validity, requires periodic audits for revalidation. In 2023, the city achieved even stronger results: Platinum in ISO 37120 (125 indicators met), Gold in ISO 37122 (65 indicators), and Platinum in ISO 37123 (61 indicators), reflecting the consolidation of structural policies and investments in strategic areas. Integrating performance results into budgetary processes demonstrates results-based governance.

Among the institutional pillars that supported this transformation, Municipal Law No. 9.563/2017 stands out, which instituted the Program for the Incentive of Scientific, Technological, and Sustainable Innovation, creating a favorable legal environment for experimenting with innovative urban solutions aimed at improving public management. A legal framework supportive of innovation is a key factor for the development of smart cities.

In the area of public safety, the city implemented the Security and Intelligence Center (CSI), featuring over a thousand cameras equipped with artificial intelligence and facial recognition, thereby



increasing the effectiveness of monitoring and violence prevention. In the health sector, the active listening channel at the Municipal Hospital is noteworthy, achieving a 95% user approval rate in 2022. The use of advanced technologies and citizen-centric approaches to improve public services is a central theme in modern public administration.

In education, the Educação 5.0 Program introduced a pedagogical approach based on digital transformation and active methodologies, in addition to expanding STEAM (Science, Technology, Engineering, Arts, and Mathematics) initiatives in partnership with educational institutions and research centers. In the field of energy efficiency, the municipality fully replaced public lighting with LED lamps—more than 70,000 units in urban and rural areas—and acquired 100% electric vehicles for the Municipal Civil Guard fleet, a pioneering initiative in Latin America. These innovations demonstrate a commitment to education and environmental sustainability.

Environmental policies were also strengthened: the city possesses 11 urban parks, participates in the international Tree Cities of the World program, and maintains approximately 170,000 trees in public spaces. In urban mobility, the creation of the Green Line (*Linha Verde*)—a bus corridor featuring electric vehicles on tires (VLPs), exclusive lanes, and intelligent traffic control—generated positive impacts on connectivity, fluidity, and the sustainability of public transport. Furthermore, smart mobility solutions were implemented, such as sensors for monitoring rotating parking (*Zona Sul Eletrônica*), integrated with applications and digital panels. Public connectivity was expanded, with the installation of approximately 300 free Wi-Fi spots in schools, health units, squares, and community centers. These initiatives exemplify how sustainable urban planning and smart mobility contribute to the quality of life.

In the realm of innovation and entrepreneurship, the city consolidated its position as a regional innovation hub, strengthening the São José dos Campos Technological Innovation Park (PIT), which houses over 330 institutions, including businesses, universities, and research centers. The Startup São José Program boosted the local creative and technological economy, connecting new entrepreneurs to the innovation ecosystem. The role of technology parks and startup ecosystems in regional development is widely recognized in the literature on regional economics and innovation management.

Among the critical success factors, the following stand out: (i) the clear definition of strategic objectives for digital and sustainable transformation; (ii) the engagement of public, private, and civil society actors; (iii) the adoption of evidence-based planning instruments; and (iv) the formation of technical-financial partnerships that enabled the implementation of solutions in line with international standards. These factors are consistently pointed out in the literature as essential for the realization of complex public policies and smart city initiatives.

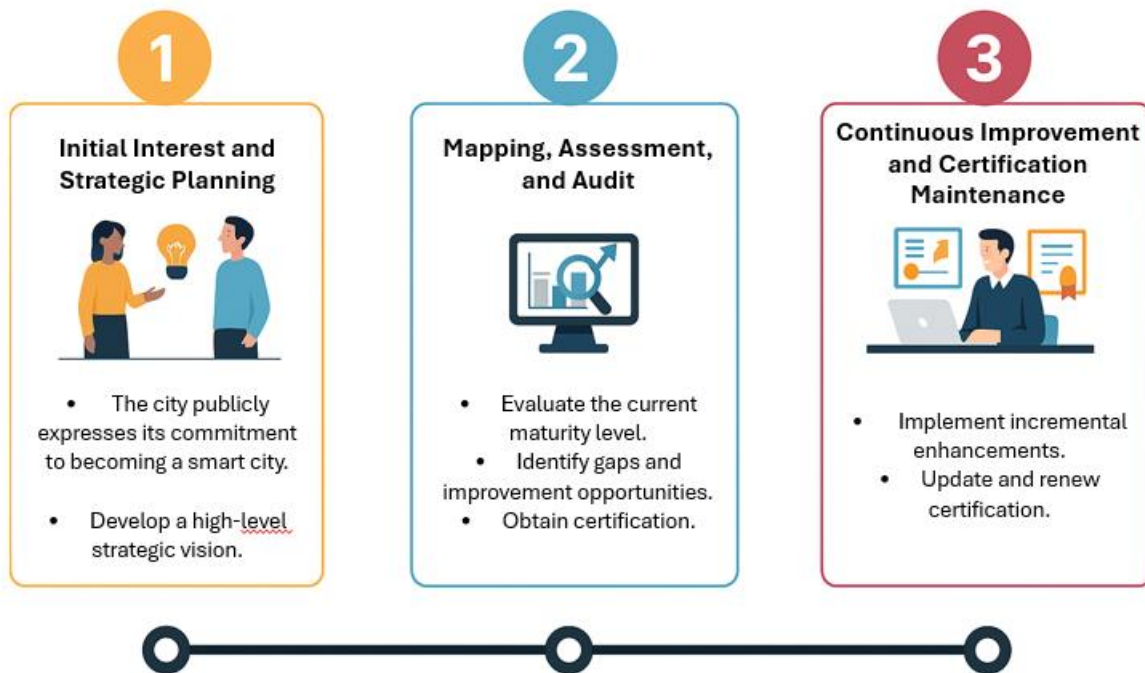
#### 4.1. Proposed Roadmap for Smart City

Based on the literature review conducted, which addressed fundamental concepts regarding smart, resilient, and sustainable cities, and on the systematization of the main criteria and requirements for certification according to ABNT standards (NBR ISO 37120, 37122, and 37123), a preliminary roadmap model is proposed to guide municipalities interested in pursuing this process. The development of practical roadmaps and frameworks is crucial for translating theoretical smart city concepts into tangible and replicable actions (Mora et al., 2023).

This proposal also incorporates empirical evidence obtained from the documentary analysis of the São José dos Campos (SP) case, the first Brazilian city simultaneously certified under all three standards. The municipality's experience revealed that the development of a smart city cannot be conceived linearly or standardized, but rather as a continuous, adaptive process anchored in strategic planning, institutionalization, monitoring, and learning.

International certification, in this context, should be understood not merely as an end in itself, but as a tool for qualifying urban management, capable of inducing institutional innovation, digital transformation, sustainability, and improvement in the population's quality of life. This perspective highlights the role of certifications as catalysts for the modernization and continuous improvement of municipal governance (Naphade et al., 2021).

The modeling of the smart, resilient, and sustainable city certification process, structured based on the key stages identified in the literature and observed practice, can serve as a reference for other cities wishing to follow this path. It is emphasized, however, that each municipality has territorial, institutional, socio-economic, and cultural specificities, requiring that the model proposed here be adapted in a contextualized and participatory manner. Figure 4 graphically illustrates this roadmap proposal, divided into three major sequential stages.



**Figure 4.** Proposed Roadmap for the Smart City Certification Process.

Flexibility and contextualization are critical success factors in implementing governance models and public policies across different urban contexts. As presented in Figure 4, the proposed roadmap consists of three fundamental stages for obtaining certification, described below:

- ✓ **Stage 1 - Interest and Initial Planning:** This phase represents the starting point for the municipality seeking international certification. It begins with the manifestation of interest and the identification of specific objectives the city aims to achieve with the certification. This is followed by stakeholder engagement, which involves mobilizing key actors from the government, private sector, universities, and civil society. Simultaneously, strategic planning takes place, defining the long-term guidelines and goals for urban transformation. Based on this planning, essential strategic partnerships are established to enable and implement actions. The phase culminates in the implementation of initial actions and, subsequently, the continuous monitoring and evaluation of progress, preparing the municipality for the formal certification process.
- ✓ **Stage 2 - Mapping, Diagnosis, and Audit:** The second stage focuses on an in-depth analysis of the municipality's adherence to normative standards. It begins with the mapping of indicators and evidence according to the ABNT NBR ISO 37120, 37122, and 37123 standards, along with an analysis of the city's current maturity. To ensure data integrity and articulation, forming a Municipal Consultative Committee is crucial. A detailed diagnosis is then prepared, with evidence registration and metric calculation according to the standards. This diagnosis is followed by a pre-audit phase, where conformities and non-conformities with the standards' guidelines are verified. The process then moves to the certification audit, conducted by



ABNT Certification Body. The results of this audit provide lessons learned and define the municipality's next steps toward obtaining certification, which may include revisions of Stage 1 and a restart of Stage 2.

- ✓ Stage 3 - Continuous Improvement and Certification Maintenance: The final phase of the roadmap emphasizes the continuous nature of the smart city process and the maintenance of certification. It starts with the diagnosis of results for unachieved indicators and the preparation of recommendations for areas requiring improvement. These recommendations are then incorporated into the municipality's strategic planning, being integrated into instruments such as the Multi-Year Plan (PPA) and the Annual Budget Law (LOA). The stage proceeds with the implementation of corrective actions and the monitoring of already implemented actions and projects. Finally, it culminates in the ABNT certification maintenance process, which requires periodic audits for revalidation, ensuring the municipality's commitment to continuous improvement and advancement toward higher levels of recognition.

As a result of the assessment and certification process, municipalities that follow this path are capable of constructing, at minimum, a comprehensive Strategic Map, grounded in the identification of their strengths and weaknesses across various areas of public management. This structured diagnosis allows for a systemic understanding of the local reality and solidifies itself as a valuable instrument for guiding the formulation of public policies, the planning of actions, and the efficient allocation of public resources (Mora et al., 2023).

Concurrently, the process culminates in obtaining an international certification, conferred based on rigorous technical criteria for sustainability, urban intelligence, and resilience. More than a formal recognition, this certification functions as a seal of commitment to continuous improvement, consolidating the municipality's institutional image and signaling, both to the population and to investors and strategic partners, the adoption of best practices in urban governance and the promotion of quality of life (Naphade et al., 2021).

## CONCLUSIONS

Starting from the premise that cities are highly complex and dynamic systems, adopting an overarching view of their functioning becomes essential for qualifying urban management and planning processes. This approach contributes to the construction of more efficient, sustainable, and resilient territories in the face of contemporary urbanization challenges.

Smart cities emerge as a promising perspective for the evolution of metropolises, offering innovative solutions based on the integration of technology, participatory governance, and sustainability. By articulating digital resources, institutional innovation, and civil society engagement, these urban environments can become more inclusive, efficient, and prepared to face adversities. However, it must be recognized that the development of smart cities is not without challenges, and it is fundamental to ensure that the benefits of this transformation are equitably distributed among all citizens - a critical point of discussion in the literature on urban justice and technology.

This work aimed to analyze the trajectory of the municipality of São José dos Campos in obtaining the ISO 37122 certification, highlighting the main institutional, technical, and strategic factors that enabled its consolidation as the first certified smart city in Brazil, and to propose a roadmap that can be used by other cities seeking certification. The analyzed experience demonstrates that the process of becoming a smart city is complex, demanding strategic planning, process governance, technical capacity, financial investments, and, above all, a collective commitment to innovation and sustainability, along with continuous efforts to maintain certification over time.

The success of this journey is conditioned on the articulation of various stakeholders, such as government, the private sector, universities, and civil society, and on the implementation of evidence-driven public policies. It became evident that the engagement of these actors is decisive in ensuring not only the execution of projects but also their continuity and adaptation to local specificities.



Smart city certification, in this context, represents a strategic tool for monitoring urban progress, based on internationally recognized indicators. It provides a solid methodological structure for measuring the efficiency of public management, the population's quality of life, and the capacity of cities to respond to contemporary socio-environmental challenges.

Thus, the initiatives presented in this study pave the way for future research, which may deepen the understanding of the multiple pillars supporting the smart city concept. Such investigations can contribute not only to the replicability of best practices but also to the continuous refinement of urban public policies, promoting more equitable, innovative, sustainable, and resilient cities.

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