Smart and Inclusive Cities: Challenges and Perspectives for Aging in Salvador, Bahia

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Abstract: This article explores the intersection between smart cities and the challenges posed by global population aging, with a focus on the city of Salvador, Bahia. It addresses whether current smart city initiatives are genuinely inclusive and human-centered, especially for the elderly. Drawing on updated data from the United Nations, IBGE, and WHO, combined with a bibliographic review of recent studies, the methodology follows a documentary and exploratory approach that allows for the correlation between demographic indicators, smart city rankings, and the WHO age-friendly city framework. The study highlights demographic shifts and the accelerated aging process in Brazil, which demands urgent adaptations in public infrastructure, healthcare, and digital inclusion. The concept of age-friendly cities, guided by the WHO framework, is used to discuss strategies that support active aging, emphasizing mobility, accessibility, social participation, and technological access. The paper also examines the role of smartphones and wearable health-monitoring technologies in promoting digital inclusion and improving the quality of life for elderly citizens, even when direct interaction with devices is limited. Salvador ranks highly in national smart city indices, particularly among northeastern capitals, yet falls behind in key indicators for elderly support, such as health and accessibility. Although some efforts are underway — such as adapted public transport and metro systems — structural urban barriers persist. The analysis concludes that while Salvador has the potential to evolve into a model of an inclusive smart city, significant gaps remain in aligning technological innovation with the social and human dimensions of aging. Bridging this gap will require coordinated public policies, community engagement, and a redefinition of what "smart" truly means in a society increasingly shaped by its older population.

1. Introduction

The concept of smart cities has received growing attention in recent decades, particularly in the context of the digitalization of urban spaces. However, the question remains: can such cities be considered truly humane and inclusive? [1]. This study is based on this issue, seeking to analyze the limits and potential of smart cities in the face of population aging and digital inclusion. This article was prepared based on data from the Brazilian Institute of Geography and Statistics (IBGE), where we bring recent data from the 2022 Census, in addition we seek data from the World Health Organization (WHO), the Global Guide to Age-Friendly Cities, Urban Systems, with the Ranking of Smart Cities, in addition to a bibliographic survey of articles from 2020 to 2024.

Accordingly, this study employs a methodology grounded in documentary analysis and bibliographic review, combining official statistical data with recent literature to correlate urban indicators, population aging, and the challenges of digital inclusion.

In the context of care for the elderly, smart cities can play a strategic role by implementing

solutions such as remote health monitoring, fall detection, accessible transportation, and adapted public lighting. By using real-time data and Internet of Things (IoT) devices, it becomes possible to guarantee greater safety and autonomy for the elderly who live alone, in addition to also supporting family members, caregivers, and public services in making faster and more effective decisions, promoting active aging and social inclusion. This study is organized into the following sections: Section 2, Methodology. Here, we justify the choice of the applied methodology and provide a brief explanation. Section 3, Population aging. Here we bring statistical data about the elderly population from institutions such as IBGE and the World Health Organization (WHO), in addition to reflecting on the topic; Section 3.1 - Age-Friendly Cities. We explain the concept according to the WHO and reflect on it; Section 3.2 - Smart Cities. Here we bring the concept and reflect on it from the perspective of several authors, in addition to establishing a convergence with the concept of Age-Friendly Cities. Finally, Section 4 - Conclusion, where we reflect on the topic for the city of Salvador, State of Bahia.

2. Methodology

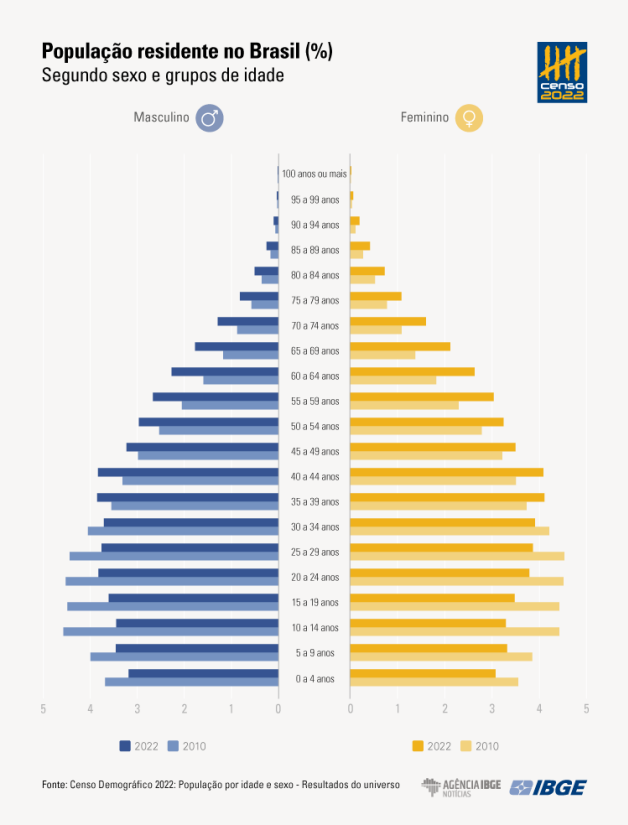
This study adopts an exploratory and qualitative approach, structured through a bibliographic review (articles published between 2020–2024) and documentary analysis of official reports and databases (IBGE, WHO, Urban Systems, ISO). This methodological design made it possible to examine the interactions between demographic aging, smart city indicators, and the WHO framework for age-friendly cities, enabling the identification of both gaps and opportunities in the specific case of Salvador.

3. Population aging

According to the IBGE[2] , the population of people aged 65 or older increased by 57.4% between the 2010 and 2022 censuses. This represents 10.9%.

The graph in (Figure 1) shows a narrowing at the base of the Brazilian age pyramid, which is accentuated between the years 2010 and 2022, indicating an aging of the population in recent years.

Figure 1 - Brazilian age pyramid (2010-2022)



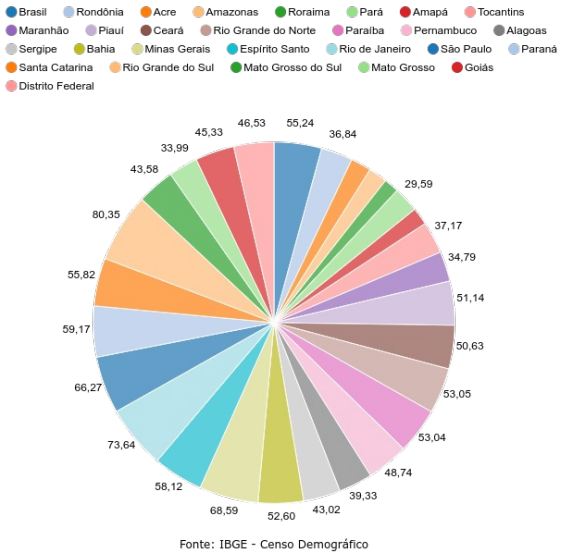
Source: IBGE (2022)

According to the World Health Organization (WHO)[3], the global population aged 60 or over reached 1 billion in 2020 and is projected to reach 1.4 billion by 2030 and 2.1 billion by 2050, representing the fastest growth in history. Furthermore, according to the WHO[8], the number of people aged 80 or over is expected to triple between 2020 and 2050, reaching 426 million. Since 2015, the proportion of individuals over 60 is expected to increase from 12% to 22% by 2050, with 80% of this group residing in low- and middle-income countries.

According to Li et al.[4], in Latin America and the Caribbean, 13.1% of the population was aged 60 or older in 2021, with a projection to reach 20.6% by 2050, showing a continuous process of demographic aging. The authors emphasize that countries like Brazil, Chile, and Argentina have an accelerated pace of population aging, which requires significant adaptations in areas such as health, social security, and the provision of social services.

In the Brazilian context, the population aging process presents significant differences between the states, reflecting historical and structural regional inequalities. According to data from the IBGE[2], the national average aging rate reaches 52.24%, revealing that more than half of the Brazilian population is already in advanced age stages when considering the aging index. However, this average hides significant disparities: the state of Rio Grande do Sul has the highest rate in the country, 80.35%, showing a strongly aged population structure, resulting from a combination of factors such as low fertility and higher life expectancy. In contrast, states in the Northeast, such as Bahia, have more moderate rates, 52.60%, but which still signal a growing trend of aging, with direct implications for public policies in areas such as health, social security, and social assistance (Figure 2).

Figure 2 – Brazil and Federative Units – Aging Rate (2022)



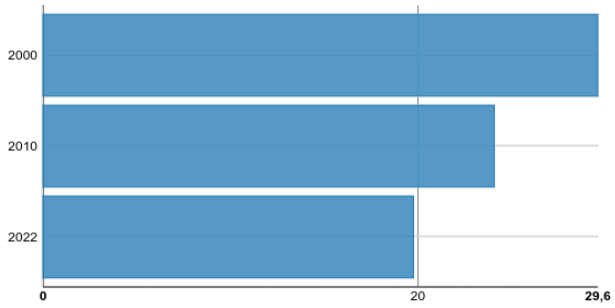
Source: Sidra IBGE (2022) - https://sidra.ibge.gov.br/pesquisa/censo-demografico/demografico-2022/universo-populacao-por-idade-e-sexo

This regional variation raises reflections on the challenges of public management in the face of Brazil's demographic heterogeneity. Regions with a more aged population require greater attention to specialized health services, urban adaptation, and social inclusion strategies for the elderly. In contrast, states with intermediate rates, such as Bahia, are in a phase of demographic transition that requires preventive planning to avoid future overload on social protection systems.

Observing the local context, according to the IBGE [2], the population of people aged 65 or over in Bahia increased by 48.5% compared to the 2010 census. At the time, this population was equivalent to 7.2% of the population, and by 2022, it already represented 10.6%. This significant difference shows that the population is also growing in our state.

Paralleling the growth of the elderly population, there is a significant reduction in the proportion of people aged 0 to 14 in Brazil, a phenomenon that highlights the advance of the country's demographic transition. In 2000, this age group represented 29.6% of the total population; in 2010, it dropped to 24.08%, and in 2022, it reached only 19.76% (Figure 3).

Figure 3 – Brazilian population aged 0 to 14 (2022)



Source: Sidra IBGE (2022) - https://sidra.ibge.gov.br/pesquisa/censo-demografico/demografico-2022/universo-populacao-por-idade-e-sexo

The continuous decrease of this age group results in a progressive narrowing of the base of the age pyramid, signaling that the country is moving towards an aged population structure. This phenomenon has direct implications for the planning of public policies, especially with regard to the reorganization of investments in basic education, social security, and health, in addition to alerting to the future impact on the workforce and the sustainability of social protection systems. This is a problem not only for public bodies but for all of civil society.

3.1 Age-Friendly Cities

The "Age-Friendly Cities" is a global project whose main objective is to respond to questions of contemporary, daily urban life [5]. According to the WHO's Guide to Age-Friendly Cities[3], policies, services, settings, and structures should support active aging by:

1) Recognize the wide range of older people's abilities and services;
2) Respond to the needs and preferences of older people;
3) Respect individual lifestyle decisions and choices;
4) Protect the most vulnerable;
5) Promote the inclusion and contribution of these individuals in all aspects of community life.

According to the World Health Organization (WHO) guide[5], active aging results from a dynamic interaction among multiple determinants that act throughout life. Among them, individual factors stand out, such as biological and behavioral characteristics, family and community contexts, and social and economic determinants, which include conditions of income, education, and access to services. The combination of these elements, interacting continuously, has a decisive

influence on how each individual experiences the aging process, which can favor or limit their autonomy and quality of life. Furthermore, according to the WHO's Guide to Age-Friendly Cities[3], these cities should incorporate many of these aspects into their characteristics (Figure 4).

Figure 4 – Determinants of active aging.

Source: Global Guide to Age-Friendly Cities (OMS, 2009)

According to Duque and Oliveira [6], this guide chooses eight aspects of urban life: outdoor spaces and buildings; transportation; housing; social participation; respect and social inclusion; civic participation and employment; communication and information; and community support and health services (Figure 5).

Figura 5 – Axes of the Global Age-Friendly Cities Guide – Aspects of urban life.

Source: Guide to Age-Friendly Cities (OMS, 2009)

The authors conclude that although these aspects are linked and directly influence one another, transportation, communication, and information have a strong influence on active aging in the city.

3.2 – Smart Cities

When discussing smart cities, concepts such as the Internet of Things (IoT), Artificial Intelligence (AI), and the Internet emerge as the focus of enabling technologies[1]. However, technology is not the only necessary tool for a city to be considered intelligent. Other factors must be taken into account.

According to the International Organization for Standardization (ISO) [7], the evaluation of smart cities is based on 80 indicators distributed across different dimensions, such as Sports and Culture, Urban Planning, Environment and climate change, among others. Although these parameters allow for the ranking of municipalities, their placement does not always fully reflect the quality or effectiveness of local public policies, sometimes revealing discrepancies between numerical performance and urban reality.

The municipality of Salvador, the capital of Bahia, holds the sixth position among Brazilian capitals in the 2024 smart cities ranking, according to a report by Urban Systems[8], which evaluated 100 municipalities. Considering the overall ranking, which includes cities of different sizes, Salvador achieved the tenth position and first in the Northeast, standing out

in indicators such as technology (7th), economy (8th), and mobility (14th).

Despite this favorable performance, such a classification does not guarantee that the city is effectively inclusive, since urban intelligence indicators do not, by themselves, reflect the capacity to equitably meet the needs of the entire population. This is because the criteria adopted for evaluating smart cities generally prioritize technological indicators, such as digital infrastructure, connectivity, and the adoption of innovative solutions for urban management. However, social inclusion, understood as equitable access to services and the effective participation of historically marginalized groups, demands a more in-depth analysis.

According to Caragliu, Del Bo, and Nijkamp [9], a smart city is one that invests in human and social capital, communication infrastructure, and sustainable development to promote economic growth and quality of life, with participatory governance. This concept, which defines a smart city, leads us to the idea of an inclusive, technological city that facilitates citizen mobility, with respect for the environment and its citizens. However, this is a topic to be studied and discussed.

Fernandes [1] conducted a study on inclusion in smart cities. To do this, he performed a literature review with various authors who discuss the topic. From this study, the author concludes that social inclusion is a fundamental factor and can be achieved through digital inclusion, but digital inclusion is affected by the lack of access to technology.

For Soja [10], spatial justice is fundamental to address the socio-spatial inequalities that permeate the urban environment, ensuring that all citizens have fair access to available resources and opportunities. Complementarily, Sen's capability approach[11] emphasizes that social inclusion should be understood in terms of the real opportunities individuals have to develop their potential and participate fully in community life, which goes beyond simple physical access to urban spaces.

Thus, the assessment of urban intelligence must be complemented by social and spatial indicators that allow for a broader understanding of the conditions of inclusion, ensuring that technological development goes hand in hand with the promotion of social justice and equity.

The use of smartphones has been a great ally of smart cities, especially in terms of communication and accessibility. Through this device, people communicate with relatives and friends while keeping themselves informed[12]. In a study conducted in the city of Santa Cruz do Sul, in the interior of Rio Grande do Sul, Tilvtz and Areosa[12] found that 64% of seniors who own smartphones do not know how to use the device, while 12% do not even have one. In another survey with 230 elderly people, Borges et al. [13] concluded that the most used medium to access the internet is the cell phone, accounting for 76.5% of the total sample, which

demonstrates a significant number of seniors who already have access to mobile technologies.

In the context of smart cities, mobile devices are important for the inclusion of elderly citizens, but there are also other technologies. An approach to wearable systems for monitoring the elderly, such as that proposed by Sanfilipo and Pachierotti[14] and Elahi et al.[15], involves the use of portable ECG, temperature sensors, and other sensors, associated with the use of artificial intelligence, and aims to reduce hospitalizations and improve quality of life. In this approach, there is a two-way street, as these technologies rely on others, such as communication technologies, whether WiFi or 5G. In this way, there is an inclusion of the elderly, even if they do not interact directly with these devices or need to deeply understand their operation, but they can count on an improvement in quality of life and health.

But technology is not the only enabler of a smart city; quality of life, mobility, urbanization, and other elements, even if somehow linked to technology, can be analyzed separately.

Leisure is an important source of well-being and quality of life, and for this reason, it is present in smart cities[16]. Salvador, being a coastal city, has a rich source of leisure, which are the beaches. Although public and with free access to all people, Vila Verde et al.[16] report accessibility problems that hinder free movement for the elderly or people with mobility difficulties. The main problems reported by the authors include uneven, damaged, or illegally occupied sidewalks, as well as issues related to transportation, such as a low fleet of adapted buses on the waterfront circuit. The lack of public restrooms and signage was also identified.

Given the above, it becomes possible to establish a convergence between the concepts of Smart Cities and Age-Friendly Cities. Both models share the goal of promoting more inclusive, safe, and functional urban environments and find in technology and information strategic tools to enable the structural axes proposed by the guide. By integrating technological solutions with the perspective of active aging, the cities' capacity to efficiently respond to contemporary demographic and social challenges is strengthened.

4. Conclusions

Salvador holds a relevant position in the national ranking of smart cities, demonstrating the potential to use technology and information to implement solutions aimed at mobility, urban monitoring, and improving the quality of life for the elderly population. However, the capital of Bahia is not yet part of the Age-Friendly Cities network, according to the Global Age-Friendly Cities Guide[5]; in Brazil, only Rio de Janeiro has this certification.

This discrepancy reveals that, although Salvador has technological infrastructure and some accessibility initiatives, such as adapted subways and buses, there is still a lack of integrated

public policies and projects that guarantee broad and equitable coverage. To move towards a truly inclusive city, it is essential to articulate the principles of a smart city with the structural axes of an age-friendly city, promoting urban environments capable of ensuring safety, autonomy, and social participation for everyone, especially for the growing elderly population.

The analysis shows that Salvador's potential as a smart city has not yet fully translated into benefits for its elderly population. The absence of certification as an Age-Friendly City indicates that the available technological infrastructure is not enough on its own: it is necessary to convert it into effective public policies capable of promoting accessibility, safety, and quality of life.

The convergence between the principles of smart cities and the structural axes of age-friendly cities therefore represents a strategic opportunity for the urban environment to be inclusive and adapted to the ongoing demographic transition. This integration not only strengthens the commitment to active and healthy aging but also prepares the city for the social challenges that accompany the accelerated process of population aging.

These conclusions were made possible through the integrated analysis of official data and specialized literature, a methodology that not only mapped demographic aging but also critically assessed smart city indicators in light of the specific demands of the elderly population.

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