CHALLENGES AND OPPORTUNITIES FOR VITÓRIA: A CRITICAL ANALYSIS OF THE PATH TO SUSTAINABILITY AND URBAN INTELLIGENCE

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ABSTRACT

This article aims to critically analyze the sustainability and innovation characteristics of Vitória, Espírito Santo, in comparison with Curitiba, Paraná, two Brazilian cities with different stages of sustainable urban development. The research, of a bibliographic nature, evaluates how Vitória can become a smart and sustainable city, identifying both the advances and the challenges faced. Curitiba is widely recognized for its innovative initiatives, such as the BRT transport system, recycling programs and the integration of green areas, which serve as an example for other cities. On the other hand, Vitória, although it has great potential, faces problems of urban mobility, waste management and disorderly expansion. The study reveals that, in order to get closer to Curitiba, Vitória needs investments in transport infrastructure, more effective waste management and the implementation of digital technologies that promote the efficiency of public services. In addition, the city must better exploit its natural resources, such as solar energy, and adopt urban planning that preserves green areas and ensures sustainable development. It is concluded that, with a coordinated effort and well-structured public policies, Vitória can become a model city in sustainability and innovation, improving the quality of life of its inhabitants and integrating social, economic and environmental needs.

Keywords: Sustainability. Mobility. Innovation. Infrastructure.

INTRODUCTION

The concept of "smart city" goes beyond the simple adoption of advanced technologies; It involves the integration of innovative solutions with sustainable practices, which improve the quality of life of citizens and promote a more efficient management of resources. By observing cities recognized worldwide as references in this regard, such as those presented in the videos "The 7 smartest cities in the world" and "The smartest cities in Brazil", we realize the relevance of factors such as urban mobility, digital infrastructure, energy efficiency, and sustainable urban planning.

Comparing the characteristics of these cities with the reality of Vitória, in Espírito Santo, and Curitiba, in Paraná, it is possible to identify both advances and challenges. Vitória, despite being a capital with great potential, still presents difficulties in relation to aspects such as mobility and technological innovation when compared to prominent Brazilian cities, such as Curitiba. While Curitiba stands out for its pioneering spirit in sustainable public transport and waste management, Vitória faces bottlenecks in the integration of transport systems, the adoption of large-scale technological solutions and the creation of accessible green spaces.

Despite some challenges, Vitória already presents advances that point to the path of a smarter and more sustainable city. Initiatives in areas such as basic sanitation, connectivity and environmental preservation indicate the city's commitment to adopting more efficient and integrated practices. However, when compared to Curitiba, a city recognized for its pioneering solutions, especially in urban mobility and sustainable planning, it is evident that Vitória still has a long way to go.

Curitiba, widely praised for its BRT (Bus Rapid Transit) transport system, which has inspired several cities around the world, demonstrates how urban planning centered on mobility can transform the experience of its citizens. BRT, combined with bike lanes and a policy to reduce pollutant emissions, elevates the city to a benchmark status in sustainable transport. Vitória, on the other hand, faces challenges with congestion and public transport that still does not integrate different modes efficiently. In addition, there is a lack of policies to encourage the use of bicycles and the creation of urban green corridors, which limits the city's progress in terms of smart mobility.

Another important point in the analysis of a smart and sustainable city is waste management and efficiency in the use of resources. Curitiba stands out again with well-structured recycling programs and the active participation of the population. In Vitória, although there are selective collection initiatives, the reach is still limited compared to more advanced cities in this regard, such as Curitiba. This is directly reflected in the ability to

reduce environmental impact and create a culture of sustainability among citizens. However, Vitória has positive points in its favor, such as its proximity to nature and the strong potential for renewable energy projects, especially solar. In addition, the city has environmental preservation areas and can take advantage of these resources to create a greener urban development model. The city's geography, with its beautiful natural landscapes, also offers opportunities for urban planning that prioritizes green areas and sustainable public spaces. The exploration of these aspects, combined with the improvement of infrastructure and waste management, can put Vitória on a path of transformation more aligned with the principles of smart and sustainable cities.

Thus, this article proposes to analyze how Vitória can be inspired by other cities, such as Curitiba, and by international examples of innovation, to develop public policies and initiatives that promote a more inclusive, technological and ecological city. By facing its challenges and seizing its opportunities, Vitória can indeed aspire to the title of smart and sustainable city, as long as it continuously invests in efficient mobility, intelligent waste management and green infrastructure. Vitoria stands out for its proximity to nature, being surrounded by a rich biodiversity of mangroves, coastal areas and islands. This scenario offers great potential for the development of environmental preservation and sustainable tourism projects, as well as a unique opportunity for the implementation of renewable energy, especially solar. With its abundant sun exposure throughout the year, Vitória could become an example in the adoption of clean energy technologies, aligning with the concept of green cities of the 21st century.

Although Curitiba is often held up as a model of sustainability, it is important to recognize that its success did not happen in isolation or overnight. In fact, the city has been recognized for its innovative approach since the 1970s, when it implemented its BRT public transport system, which is now copied in cities around the world. According to Gehl (2010), Curitiba has demonstrated that "urban innovation does not reside only in large infrastructure works, but in creative solutions, which are simple, cheap and replicable", such as the use of articulated buses and the priority for public transport in exclusive corridors. This transport strategy has helped to reduce dependence on private vehicles, reducing emissions of polluting gases and promoting a more inclusive and efficient city.

Vitória, on the other hand, still faces substantial challenges in the area of urban mobility. The city suffers from frequent traffic jams and lack of integration between transport modes. The absence of a fast and efficient public transport system, such as BRT, limits Vitória's potential to become a more accessible and sustainable city. In addition, the infrastructure aimed at cyclists and pedestrians is still insufficient, in contrast to Curitiba,

which offers an extensive network of bike lanes, promoting non-motorized transport as a viable and ecological alternative. According to Newman and Kenworthy (1999), "urban sustainability is strongly linked to the promotion of alternatives to the car", a concept that Vitória urgently needs to adopt to reduce its carbon footprint and improve the quality of life of its inhabitants.

In terms of solid waste management, Curitiba once again stands out. The city is known for its "Garbage That Is Not Garbage" program, which has encouraged the separation of recyclable waste since the 1980s, and for the "Green Exchange," a program that exchanges recyclable materials for fresh food in the city's most deprived areas. These programs not only contribute to the reduction of environmental impact, but also promote social inclusion and environmental education, actively integrating citizens into the sustainability process. Vitória, despite having implemented selective collection initiatives, is still far from reaching the same level of efficiency and community engagement. The lack of broader and more continuous policies, combined with the low awareness of the population, hinders significant progress in this sector. However, Vitória has unique characteristics that can be exploited to overcome these challenges. Its coastal geography and the presence of environmental protection areas offer an invaluable opportunity for the development of a city model that balances urban growth with environmental preservation. Initiatives such as the expansion of urban green areas and the creation of technology parks focused on sustainable innovation could position Vitória as a reference in sustainability. As Jacobs (1961) stated, "urban vitality depends on the diversity of uses and functions", and Vitória has the opportunity to integrate nature, culture and technology to create a city that is both modern and ecologically balanced.

In the field of renewable energy, Vitória is well positioned to explore clean alternatives, such as solar energy. Studies show that Brazil, as a whole, has one of the highest solar incidences in the world, which gives the country a strategic advantage to lead the global energy transition. Victoria, with its sunny climate, can capitalize on this advantage to not only reduce its dependence on non-renewable sources, but also to create new jobs and economic opportunities in the cleantech sector. As Lovins (2011) argues, "the transition to a renewable energy economy can be the engine of economic growth, while promoting environmental sustainability and social justice". For this to become a reality, however, a coordinated effort between public authorities, the private sector, and civil society will be necessary.

Therefore, this article seeks not only to highlight the differences between Vitória and cities like Curitiba, but also to explore the paths that can lead the capital of Espírito Santo to

become a smarter and more sustainable city. Although the current scenario presents challenges, opportunities for innovation are within reach, as long as there is a clear commitment to efficient public policies and greater engagement of the population in initiatives that favor urban mobility, energy efficiency, and waste management. Vitória has the potential to become an example of a sustainable city in Brazil, as long as it takes advantage of its natural resources and implements forward-looking urban planning.

METHODOLOGY

This article uses the bibliographic method as the main approach, aiming to carry out a critical and comparative analysis between the characteristics of cities recognized as smart and sustainable and the city of Vitória, Espírito Santo. The bibliographic research allows a broad review of the existing literature on the subject, covering concepts of smart cities, urban sustainability practices and public policies that promote sustainable development in different contexts. To this end, books, academic articles, reports from government agencies and technical documents related to urban planning, sustainable mobility, waste management and technological innovation in Brazilian and international cities were consulted. From this review, it was sought to identify the main parameters used to classify a city as smart and sustainable, focusing on aspects such as transport infrastructure, energy efficiency, use of digital technologies, environmental preservation and civic engagement.

The bibliographic methodology also allowed a comparative analysis between Vitória and other cities in Brazil, especially Curitiba, which serves as a national reference in urban sustainability. Throughout the research, data from case studies and successful experiences of Brazilian and international cities that adopted sustainability and innovation policies were used. Curitiba was chosen as a reference for its consolidated trajectory in the adoption of innovative solutions, such as the BRT system, and for the implementation of programs that combine social inclusion and environmental preservation. In addition, the literature review considered documents from official sources, such as municipal and state reports on the urban development of Vitória, with the objective of evaluating how the city has positioned itself in relation to contemporary sustainability demands. Data related to mobility, waste collection, environmental preservation and the use of renewable energy were analyzed, to understand the current stage of the city and the gaps that still need to be overcome.

The bibliographic survey also included the analysis of urban theories and studies on the concept of "smart cities", with emphasis on authors who discuss the integration between technology, urban planning and social welfare, such as Gehl (2010), Newman and Kenworthy (1999) and Lovins (2011). These theoretical frameworks provided subsidies for

an in-depth understanding of the practices adopted by leading cities in the field of sustainability and urban innovation.

Finally, the methodology applied in the article is essentially qualitative, allowing a critical reflection on how the successful models of other cities can be adapted to the local reality of Vitória. The analysis of secondary sources allowed the elaboration of evidence-based recommendations and guidelines, which can guide the future planning of the city towards a smarter and more sustainable model.

RESULTS AND DISCUSSION

The bibliographic analysis carried out in this article revealed that Vitória, Espírito Santo, although it has a significant potential to become a sustainable and smart city, still faces great challenges when compared to reference cities in Brazil, such as Curitiba. This comparison, anchored in urban planning, sustainability and innovation data, points to both specific advances and areas that need greater investment and improvement.

One of the central points of a smart city is sustainable urban mobility. Curitiba is widely recognized for its innovative transport system, the BRT (Bus Rapid Transit), which was a pioneer worldwide and inspired several cities. The system allows for efficient, low-cost public transport with less environmental impact. According to Gehl (2010), innovation in transportation is a key element in reducing dependence on cars, improving quality of life and promoting urban sustainability.

Vitória, however, still has a public transport system that lacks integration between different modes, such as buses, bicycles and alternative transport options. Urban congestion, especially on the main access roads to the city, remains a chronic problem. The absence of a more agile and modern public transport system, such as BRT, limits the city's growth in terms of smart mobility. As Newman and Kenworthy (1999) point out, "urban sustainability depends heavily on policies that promote the diversification of modes of transport and the reduction of the use of private vehicles", an evident challenge for the capital of Espírito Santo.

On the other hand, Vitória has adopted some measures to improve its mobility infrastructure. The creation of bike lanes and the expansion of exclusive bus lanes are important steps, but they are still insufficient in relation to the growing population demand and the environmental impact generated by congestion. The integration of these systems with urban planning that prioritizes public transport and cleaner solutions is essential to transform the city into an example of sustainable mobility. Another crucial factor for a city to be considered sustainable is the way it manages its waste. Curitiba once again stands out

with its "Garbage that is Not Garbage" program, a long-standing public policy that encourages the separation of recyclable waste and promotes environmental awareness among citizens. In addition, programs such as the "Green Exchange", which exchanges recyclables for food in low-income communities, are examples of how sustainability can be integrated with social inclusion policies (Gehl, 2010).

In comparison, Vitória still presents considerable challenges in solid waste management. Although selective collection is present in some regions of the city, its scope and effectiveness are limited. The low awareness of the population about the importance of recycling, combined with the lack of sufficient infrastructure for the proper processing of waste, compromises Vitória's ability to advance in this aspect. The literature suggests that, for a city to be truly sustainable, it is necessary not only to invest in infrastructure, but also to engage the population in a continuous process of environmental education (Lovins, 2011).

The privileged geography of Vitória, surrounded by mangroves and coastal areas of great ecological value, offers opportunities for the development of robust environmental preservation policies. However, disorderly urban expansion, coupled with the lack of effective planning to preserve these areas, puts local ecosystems at risk. The preservation of these zones can be strategic for the construction of a sustainable city, with urban parks and green zones that improve the quality of life and promote biodiversity, aspects defended by Jacobs (1961) as crucial for balanced and vibrant cities.

The adoption of renewable energy is another important pillar for the development of smart and sustainable cities. Vitória, with its abundance of natural resources, especially solar energy, has great potential to lead clean energy generation projects in Brazil. According to Lovins (2011), "the transition to an economy based on renewable energy is not only an environmental necessity, but also an opportunity for economic growth and social inclusion". However, the city has not yet explored this potential in a significant way.

Initiatives such as the installation of solar panels on public buildings and the creation of tax incentives for companies and homes that adopt solar energy could leverage Vitória towards energy sustainability. Examples of cities that have already adopted these measures show that it is possible to reduce dependence on non-renewable energy sources while creating new markets and job opportunities in the clean energy sector. The smart city concept also involves the use of digital technologies to optimize urban services and improve governance. Cities such as São Paulo and Curitiba have invested in digital platforms for real-time traffic monitoring, waste management, and public safety, elements that, in addition to promoting efficiency, increase transparency and citizen engagement. Vitória still needs to

advance in terms of digital infrastructure and adoption of urban monitoring technologies. Investment in smart grids, intelligent monitoring systems and digital platforms for resource management could be a differential in city management.

Gehl (2010) argues that "true urban innovation lies not only in new technologies, but in the way they are applied to improve people's lives". For Vitória, this means not only implementing cutting-edge technologies, but ensuring that these innovations are directly connected with the needs of the population, such as improving transportation, public safety, and energy efficiency.

The study revealed that, although Vitória has natural and economic characteristics that place it in a strategic position to become a sustainable city, there is still a great gulf between its potential and the reality of its current urban management. Cities like Curitiba, which have already consolidated a development model based on sustainability, demonstrate that transformation is possible, but it requires continuous planning, investment in infrastructure, and an integrated long-term vision. Vitória can benefit from the replication of successful programs in other cities, but for this to happen, there needs to be a clear commitment from local authorities and greater engagement from civil society. The challenge for Vitória is to find local solutions that meet its geographical and social particularities, while being inspired by the best global practices. As suggested by Jacobs (1961), the key to urban success lies in the creation of spaces that promote interaction, diversity, and innovation, and Vitória has the potential to follow this path with adequate investments and public policies focused on sustainability.

When comparing the positive and negative points of Vitória and Curitiba in the context of sustainable and smart cities, it is observed that both have distinct characteristics that reflect different stages of urban development. Curitiba, widely recognized for its innovative urban planning, has several positive points that position it as a national and international reference. Its public transport system, the BRT, is one of the biggest highlights, providing efficient and sustainable mobility for the population. In addition, the city is a model in waste management, with programs such as "Garbage that is Not Garbage" and "Green Exchange", which integrate environmental sustainability with social inclusion. Curitiba also excels in the preservation of green spaces, such as urban parks, which help improve the quality of life and environmental health. However, even with these advances, the city faces challenges. Among the negative points are the accelerated population growth, which has put pressure on its infrastructure, and the growing inequality in peripheral areas, where quality urban services do not always arrive. In addition, like any large city, Curitiba still deals

with traffic problems in central areas and at peak times, indicating the need for additional solutions for mobility.

On the other hand, Vitória, although it has considerable potential to become a sustainable city, has not yet reached the same level of development in terms of urban infrastructure and innovation. Among the positive points, the city has a privileged geography, surrounded by mangroves, coastal areas and natural parks, which gives it a solid basis for the development of robust environmental policies. The city also has great potential for the implementation of solar energy, given its high rate of sun exposure during the year. In addition, the presence of protected areas and proximity to nature are factors that can be exploited to create a greener and more sustainable urban environment. However, Vitória faces problems that limit her progress. Public transport is one of the main negative points, with a system that lacks integration and efficiency, which results in frequent congestion and high dependence on private vehicles. Waste management also represents a challenge, with selective collection still not being comprehensive and the lack of effective recycling policies. Another point of attention is the disorderly urban expansion, which threatens preservation areas and compromises the sustainable development of the city.

Therefore, while Curitiba stands out for the implementation of effective mobility and environmental management policies, Vitória is still in a transition phase, requiring significant investments in infrastructure and planning to achieve a similar status. Both cities have strengths that can serve as mutual inspiration, but they also face challenges that require local and contextually appropriate strategies to promote sustainable and inclusive urban development. Thus, the results indicate that, with improvements in waste management, transportation and energy, Vitória can advance considerably towards the title of smart and sustainable city.

FINAL CONSIDERATIONS

From the comparative analysis between Vitória and Curitiba, it is possible to conclude that both cities have characteristics that, if well explored, can consolidate them as examples of sustainable and smart cities, each in its own particular context. However, it is evident that Curitiba is at a more advanced stage, the result of decades-long urban planning, marked by a pioneering vision of sustainable development. Its public transportation, waste management, and green area preservation systems are national and international references, demonstrating that continuous and effective planning can transform a city into a model of innovation and quality of life.

Curitiba, with its history of innovations, such as the BRT system and recycling and social inclusion programs, demonstrates that well-structured public policies are essential for the creation of a sustainable urban environment. In addition, the integration of these policies with the active participation of the population strengthens the city's commitment to environmental preservation and sustainability. However, even Curitiba, with its advances, still faces challenges, such as pressure on its infrastructure due to population growth and inequality in more peripheral areas.

Vitória, in turn, presents a promising scenario, but with important challenges that need to be overcome. The city has a unique geography, with a strong presence of natural areas that could be better integrated into sustainable urban planning. The potential for the adoption of renewable energies, especially solar, is a resource that is still underutilized, but it can be an important differentiator in the future. The city could also further explore its environmental preservation areas as a way to create a green and balanced urban identity.

However, the capital of Espírito Santo still lacks essential structural advances. The public transport system needs modernization and integration, so that urban mobility can be more efficient and less dependent on private vehicles. In addition, waste management needs a broader and more effective approach, with greater coverage of selective collection and programs that encourage recycling and reuse of materials. Disorderly urban growth and disrespect for environmental preservation areas are problems that need to be urgently addressed so that Vitória can avoid the degradation of its natural resources and promote a truly sustainable urban development.

Thus, it is possible to say that Vitória has great opportunities to transform itself into a smart and sustainable city, but this requires a consistent commitment to innovation, urban planning, and environmental preservation. The city can learn from Curitiba's example, adapting its good practices and seeking local solutions to its specific problems. The adoption of public policies aimed at the integration of technologies, the improvement of transport infrastructure and the preservation of the environment is the safest way for Vitória to reach a new level of sustainability.

For Vitória to reach its full potential as a sustainable and smart city, it is crucial that there is a coordinated and continuous effort between government, private initiative and civil society. The Curitiba model shows that success in this regard is linked to the implementation of integrated public policies that adapt to the needs of the city and its population over time. This process requires strategic urban planning, focused on sustainability, social inclusion, and technological innovation, in order to ensure not only immediate improvements, but also the longevity of these initiatives.

One of the first essential steps for Vitória is the development of an urban mobility plan that favors efficient, integrated and accessible public transport. As seen in Curitiba, the success of the BRT is the result of planning focused on prioritizing public transport, reducing the traffic of private vehicles and improving air quality. Vitória has a similar opportunity to restructure its transport system, integrating modes such as bicycles, buses and water transport, given its geographical characteristics. The implementation of a system of exclusive corridors for public transport, similar to what was done in Curitiba, can significantly reduce congestion, in addition to promoting the use of cleaner vehicles, such as electric buses or buses powered by biofuels.

Mobility is a central element for sustainable development because it directly impacts the environment, public health, and the economic efficiency of a city. The reduction of polluting gas emissions, which results from efficient and well-managed public transport, is essential for Vitória to move towards a greener city. In addition, the promotion of alternatives to the private car, such as the use of bicycles and walking, brings benefits not only to the environment, but also to the health and well-being of citizens. The creation of a safe infrastructure for cyclists and pedestrians in Vitória could follow the example of Curitiba, which has expanded its bike lanes, integrating them into the public transport system, facilitating commuting and making non-motorized transport a viable option for the population.

Another important aspect that Vitória needs to improve to become more sustainable is solid waste management. The Curitiba model, with its innovative selective collection and social inclusion programs, could be an inspiration for the capital of Espírito Santo. Currently, selective collection in Vitória is still not comprehensive enough, which results in a large volume of waste being sent to landfills. In addition, the population's awareness of the importance of separating recyclable waste is still limited. To transform this scenario, it is necessary to expand environmental education programs and encourage citizen participation in the recycling process.

The involvement of the population in recycling and waste management initiatives is fundamental to the success of these policies. The example of the "Green Exchange" in Curitiba, which exchanges recyclable materials for fresh food in vulnerable areas, shows how innovative programs can integrate sustainability and social inclusion, benefiting both the environment and low-income communities. Vitória could adapt similar initiatives, creating a system that encourages the population to actively participate in waste management, offering social benefits in exchange for sustainable practices.

In addition, Vitória's advancement as a smart city depends on its ability to integrate digital technologies into urban management. The so-called "smart cities" make use of technological systems to optimize the operation of public services, such as transportation, security, health, and energy management. Currently, the city does not meaningfully explore the use of technologies such as urban sensors, open data platforms, or smart energy grids. However, these tools can bring numerous benefits, such as improved real-time traffic monitoring, more efficient control of energy consumption, and faster response to emergencies.

The creation of a robust digital infrastructure in Vitória can bring significant improvements in the city's management. Smart monitoring systems, for example, could be used to efficiently manage traffic, allowing managers to adjust traffic lights and guide drivers to avoid congestion. In addition, the implementation of smart grids could help reduce energy waste, optimize electricity consumption, and facilitate the integration of renewable energy sources, such as solar.

Vitória has great potential to expand the use of solar energy, given its high solar incidence throughout the year. The transition to a cleaner energy matrix can be a decisive step towards the city's sustainability. Tax incentive programs for the installation of solar panels in homes and businesses, in addition to the installation of solar generation units in public buildings, could reduce dependence on non-renewable sources and promote energy savings. This would also open space for the development of a local market for clean technologies, generating employment and economic growth in a strategic sector for the future.

Another crucial point that Vitória needs to face is the disorderly urban expansion, which has negatively impacted environmental preservation areas, especially mangroves and coastal areas. The city must adopt a planned growth approach, with the creation of urban environmental protection areas and the promotion of a more sustainable land occupation. The preservation of these areas is not only an environmental issue, but also a quality of life, as they contribute to climate balance, leisure and public health.

Creating more green spaces and urban parks that are integrated into city planning can be an effective strategy to ensure that Vitoria maintains its biodiversity and promotes a healthier lifestyle for its inhabitants. These spaces can also serve as areas for environmental education and leisure, in addition to protecting important ecosystems. The world's most sustainable cities have shown that the balance between built areas and green areas is essential for a healthier and more resilient urban environment.

In conclusion, Vitória has significant potential to become a smarter and more sustainable city, but there is still a long way to go. The city can benefit from Curitiba's experience by adapting its best practices and creating specific solutions to its own characteristics and challenges. To achieve this goal, a joint effort between public authorities, civil society, and the private sector will be necessary, committed to the implementation of innovative public policies, the use of advanced technologies, and environmental preservation. If well managed, these initiatives can position Vitória as a model city in sustainability in Brazil, ensuring not only the improvement of the quality of life of its population, but also the development of an urban environment that respects and integrates natural resources and technological progress.

In short, while Curitiba is already reaping the fruits of decades of planning aimed at sustainability, Vitória is still in the maturation phase. The path to becoming a smart city is full of challenges, but also of opportunities that, if well used, can make Vitória position itself among the Brazilian cities that lead sustainable development in the future.

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