Initiatives for Smarter and More Sustainable Cities in Two Brazilian Cities: Drivers, Benefits and Challenges

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ABSTRACT

As urban areas grow in population, a lot of pressure is placed on already overburdened urban systems, creating environmental, social and infrastructure problems. In this context, smarter and more sustainable cities can provide quality of life to the urban population, reducing environmental impacts and inequalities while promoting economic opportunities. Thus, the objective of this article is to identify and analyze initiatives related to sustainable and smart cities in two Brazilian cities, considering their local circumstances. Three attributes (drivers, benefits and challenges) related to the implementation of initiatives in these cities were listed. It was possible to verify that initiatives developed in these cities present significant differences in the conceptions and the results sought. Despite this, it is possible to observe that both cities' initiatives lack a holistic approach and focus on specific solutions not integrated with each other.

CCS CONCEPTS

• **Applied computing** → **Computers in other domains** → Computing in government → *E-government*

KEYWORDS

Smart Cities, Sustainability, Governance, Information, and communication technology.

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1. INTRODUCTION

People are migrating to cities around the world. This phenomenon started with the industrial revolution and continues ever since. Today, most people live in densely populated urban areas, where customers, producers and suppliers can more easily meet their needs. The percentage of population living in urban areas in the world increased from about 30% in 1950 to 56% in 2018; while in South and Central America, urban population represented around 40% in 1950, and grew to an impressive 84% and 75% in 2018, respectively [1].

This urban population increase trend is expected to continue in the coming decades. The prediction of the United Nations [1] on the growth of the urban population in South America is that the urban percentage of the population may reach 90% in 2050, where it is possible to verify that several countries are becoming more and more urbanized.

In this context, as urban areas grow in population, a lot of pressure is placed on already overburdened urban systems. From an environmental point of view, it is possible to underline issues related to pollution (air, soil and water), urban waste management, drainage (flooding) and increased local temperature. Social difficulties are also present, such as lack of adequate housing (development of slums), lack of formal employment and education, poverty, crime, spread of diseases, gentrification, among others. Complications in infrastructure, such as power generation and distribution, traffic management and sanitation, are also present in most megacities and in most populated Latin American cities.

Some data that evidence some of the facts mentioned above are: the 50 largest cities in the world, with more than 500 million people, generate about 2.6 billion tCO_{2eq} per year, more than all countries except the United States and China [2]; by

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2030, the global demand for energy and water is expected to grow 40% and 50%, respectively [3], with most of its growth going to be in cities [4]; cities consume up to 80% of energy production worldwide and represent an approximately equal share of global emissions of greenhouse gases [2]; 46 of the 50 most violent cities in the world are not facing armed conflict. However, although these cities are not involved in armed conflicts in the legal sense, their citizens face daily insecurity and violence [5].

As such, cities contribute to the pressure of infrastructure systems and general environmental degradation. However, they offer the opportunity to address environmental and social issues at the local level, in a much more tangible way when compared to global agreements. Smarter and more sustainable cities are the best option to provide quality of life to an urban population, reducing environmental impacts and inequalities and promoting economic opportunities.

Thus, the objective of this article is to identify and analyze initiatives related to sustainable and smart cities in two Brazilian cities, considering their local circumstances, and to understand practices implemented by these cities. Thus, initiatives to identify evidence of practices in Sustainable and Smart Cities (SSC) in the cities of São Paulo and Curitiba were mapped, as well as the motivating factors that drive these activities, the benefits achieved to date and the challenges encountered implementation of these initiatives.

2. METHOD

The selection of cities that make up this study was based on the Brazilian national panorama of smart cities published in the Connected Smart Cities Ranking since 2016, in which cities of Curitiba and São Paulo alternated at the top two places until 2019 when they were overtaken by Campinas/SP. These two cities also meet other criteria that allow the development of this study: a well-established and current smart and sustainable city initiative; national and/or international recognition for its innovative character; documentation available online; evidence of a systematic approach to developing and maintaining the skills needed to preserve the initiatives; evidence of collaboration established between the municipality and training providers, particularly the academy.

For data analysis, a research methodology developed by [6] was used as reference, which has a repository of 21 case studies of initiatives in smart and sustainable cities. Three attributes that make up the referred study for analysis were listed: drivers, benefits and challenges to the implementation of initiatives in smart and sustainable cities. For further methodological information, report developed by [6] can be consulted.

Data collection was carried out on the digital platforms of the city halls of São Paulo and Curitiba, as well as in training institutions, agencies and departments linked to the initiatives, such as Curitiba Agency (*Agência Curitiba*) and Mobilab+.

3. RESULTS AND DISCUSSION

In the case of Curitiba, initiatives related to aspects of smart cities are more related to the promotion of entrepreneurship and innovation ecosystems. However, the city also presents several aspects in terms of urbanism aligned with good international practices, such as the creation of the public transport system based on the BRT (Bus Rapid Transit) system, planned as a structuring element of growth and urban form. Urban planning is used as an incentive to urban densification in areas adjacent to the BRT axes, to promote its use. Another initiative that adds entrepreneurial stimulation to urban planning actions is the creation of an innovation ecosystem (*Pinhão* Valley) as a revitalization strategy for a degraded industrial area. In the area of ICTs, another initiative consists of an application (*Saúde Já* – Health Right Now – our translation) to optimize services to the population in health systems and facilitate their access.

In the city of São Paulo, the "Digital São Paulo" Program encompasses initiatives aimed at the use of ICTs to offer or increase public services. Among these services it is possible to highlight: a) Easy Entrepreneurship (*Empreenda Fácil* – our translation): a system that allows licensing of low-risk companies in up to 5 days, based on self-declarations; b) Free Fab Lab SP (*Fab Lab Livre SP* – our translation): a network of public manufacturing laboratories, inspired by the maker culture; c) Free WiFi SP (*WiFi Livre SP* – our translation): a program with the purpose of providing free internet to the population in public spaces, increasing digital inclusion; d) Open Data Portal (*Portal Dados Abertos* – our translation): open data from all municipal departments and municipal public companies; e) Mobilab+: an innovation laboratory with the aim of prospecting and promoting co-creation of solutions to urban problems.

In addition to the initiatives included in São Paulo Digital Program, the municipality is recognized for its innovation in terms of urban legislation, notably the Strategic Master Plan, sanctioned in 2014. The referred plan brings as innovations, the abolition of the minimum number of parking spaces per housing units built along public transport corridors and imposes a maximum number of parking spaces per housing unit, making it possible to offer apartments without a garage to the population who do not own a car and want to live close to public transport. Another initiative in the urban aspect is the promotion of sustainable mobility, by encouraging the use of bicycles as a means of transport resulting from the expansion of the city's cycling network, which currently has 504 km [7].

Despite being large cities located in the same country, the initiatives in these two cities present significant differences in conceptions and the results sought. Hereafter, an analysis of the initiatives of these two cities will be presented, addressing drivers, challenges and benefits for each city.

3.1. Drivers

Drivers attribute is represented by factors that motivate, drive and justify the idealization and implementation of initiatives related to smart and sustainable cities [6]. As part of the initial context of the initiative, they can be modified during its implementation, due to changes in the context and the identification of new potential.

According to [8], the main motivators for the implementation of a smart city are the creation of an image of modernity and intelligence for city marketing campaigns; development of science parks, technological cities and technological centers; development of urban services using digital technology; improve economic and political efficiency; stimulate social, cultural and urban development; develop urban intelligence to optimize management; and to develop new ways of interacting with citizens to promote their participation in decisions and processes for formulating public policies. Table 1 lists the main drivers for the initiatives implemented in São Paulo and Curitiba.

Table 1: Drivers of Initiatives in Smart and Sustainable Cities in Curitiba and São Paulo

CURITIBA	SÃO PAULO
Economic: Make Curitiba a reference in the technological and creative industry;	**Economic**: Promote entrepreneurship by facilitating the opening of companies; reduce bureaucracy in administrative processes; reduce costs for solving urban mobility problems;
Environmental: Promote attractive and efficient public transport, reduce the use of cars in daily commuting;	**Governance**: Open public data, reduce bureaucracy of operations;
Social: Facilitate access to health services; improve city accessibility via public transport; promote training on topics related to technology.	**Social**: Facilitate access to housing close to public transport networks; centralize administrative processes; facilitate the use of bicycles as a means of transport; promote digital inclusion of population.

Considering the economic drivers, it is clear that Curitiba highlights the concept of an innovation ecosystem to attract companies and investors, while São Paulo is betting on the simplification of administrative processes and facilities for this purpose. In the social aspect, both demonstrate an interest in investing in the city's human capital, whether through digital inclusion or training.

3.2. Benefits

Benefits attribute consists of a panorama of positive results following from the implementation of SSC initiatives. According to [9], the potential benefits of smart cities are directly linked to promoting sustainable economic development while protecting the environment.

[10] categorizes potential benefits according to groups of stakeholders (citizens, local authorities and local economy) being: a) for citizens: social cohesion, opportunities for continuous learning; better connectivity within the community, improved health conditions, independence and employment opportunities; b) for local authorities: reduction of operating costs; better government transparency, increased collaboration, better decision-making process, dissemination of knowledge and experiences; c) for the local economy: promoting innovation, encouraging the development of new products and services, catalyzing the community of small and medium entrepreneurs, stimulating the creation and acceleration of start-ups. The author also reports the benefits shared between the categories of stakeholders, such as: d) for citizens and local authorities: greater participation in public life; resilient public services and social equity; e) for citizens and the local economy: increased economic activity; f) to all stakeholders: more efficient use of resources, sustainable mobility, environmental sustainability and economic prosperity.

Table 2 shows the benefits of implementing smart city initiatives in both cities. There is a predominance of benefits for citizens, such as the possibilities of training, quality in public transport and digital inclusion through Wi-Fi access in public places. In the case of initiatives aimed at the economic area, both cities enjoy advantages that encourage economic activity and thus benefit both citizens and local authorities.

Table 2: Benefits of Initiatives in Smart and Sustainable Cities in Curitiba and São Paulo

CURITIBA	SÃO PAULO
Public transport network has 329 stations and 21 terminals, which allows integration of the lines. BRT system was cited among the 50 most innovative projects of the 20th century.	12 Free FabLabs were implemented, which offer more than 30 training courses and workshops and have equipment such as 3D printers, milling machines and laser cutters.
Worktiba - public coworking space created by the Curitiba City Hall to serve small and medium-sized entrepreneurs whose core business is social responsibility projects.	Implementation of digital administrative processes represented, in 2018, an annual reduction of R$ 2 million in processes, in addition to a time reduction varying between 50 to 90% in the resolution processes.
Use of Health app reduces queues for scheduling appointments at healthcare units.	The *WIFI Livre SP* Program is available in 120 different public spaces, such as squares and parks.
Business development program, (Pinhão Valley), with more than 800 graduates.	*Empreenda Fácil* system reduced the time needed to open low-risk companies from 100 to 5 days. Category that represents 80% of the economic activity in the city.
84 companies supported by Tecnoparque Program, which supports technology-based companies and science and technology.	By establishing a maximum number of parking spaces, instead of a minimum, the Strategic Master Plan boosted the offer of apartments without a garage along the public transport routes.

3.3. Challenges

Challenges attribute corresponds to barriers and obstacles that can interfere in the smooth progress of the implementation of SSC initiatives, which can be of a technological, social, political, economic and environmental nature.

According to [11], technological challenges are recurrent due to the need to develop an integrated infrastructure system and an integrated platform for operational activities, management, control and optimization of resources. Regarding social aspects, for [12], the biggest challenges are related to citizens' engagement and participation in decision-making processes, strengthening social and territorial cohesion, and providing better quality of life to the population. In relation to economic challenges, [13] cite the importance of improving the competitiveness of the local economy, based on the identification of the city's strengths within global urban networks. In the environmental aspect, [14] affirm that making efficient use of resources and including the need to protect the environment in the decision-making process are some of the main issues.

Table 3 presents challenges for implementing smart city initiatives in both cities. In the context of attractiveness for investments and improvement of the business environment, both cities seek to maintain a favorable environment to these aspects in the long run. Curitiba emphasizes on incentives to technology-oriented companies, while São Paulo aims to facilitate the creation of low-risk companies, regardless of their area of activity.

Table 3: Challenges of Initiatives in Smart and Sustainable Cities in Curitiba and São Paulo

CURITIBA	SÃO PAULO
Regarding the public transport network: maintain the attractiveness of mass transport in comparison to increasing rates of individual transport on demand; reduce greenhouse gas emissions generated by the fleet;	Change of organizational culture in the transition to digital processes;
	Increase the attractiveness of bicycle as a means of transport;
	Integrate digital processes between municipal, state and federal agencies;
In the innovation ecosystem: maintaining an attractive environment for start-ups and technology-related companies; increase the number of jobs related to skills related to technology and ICTs.	Integrate citizens in decision-making processes related to urban planning;
	Ensure intelligent inspection in self-reporting processes;
	Digital inclusion.

Concerning urban mobility, creating and maintaining the attractiveness of means of transport other than the automobile is one of the key elements for establishing more sustainable mobility. In the case of São Paulo, in addition to the creation of bicycle infrastructure as an incentive for cyclists, campaigns to raise awareness and motivate the use of bicycles were also created. In Curitiba, the BRT system remains attractive due to terminal integration and network coverage, but with the fleet powered by fossil fuels, there are still advances to be made in the environmental aspect.

4. FINAL REMARKS

In view of the urban population growth and the pressure given to already overburdened urban systems, this article aimed to identify and analyze initiatives related to sustainable and smart cities in two Brazilian cities, considering their local circumstances, and to understand practices implemented by these cities.

The development of initiatives to reach SSC in Brazil has great potential to involve a large number of inhabitants and benefit different stakeholders in different areas. As it was possible to identify in this research, several initiatives are already being put into practice in São Paulo and Curitiba, two of the most intelligent and sustainable cities in Brazil.

However, it is clear that even the cities considered the most intelligent in the country, lack a holistic approach that encompasses social, environmental and financial aspects in a long-term view, since most of the initiatives were not designed and structured with an interconnection in mind. Since in the great majority, initiatives were punctual actions developed by some public or private entity. Therefore, it is important to provide these municipalities with a comprehensive understanding of the many dimensions that involve smart and sustainable cities initiatives and their relationship to each other, as well as which tools, techniques or competencies are needed for successful development.

Due to the specific characteristics of the Brazilian context in which a large part of the population still lacks basic infrastructure to live a dignified quality of life, another important factor is the continued need to provide basic urban infrastructure to that population that does not yet have it, in parallel with the smart city initiatives. Therefore, it is hoped that the use of Information and Communication Technologies can make cities more administratively efficient and that there is an improvement in the provision of all services to the population, from the most basic to the most complex.

As propositions for future studies, it is suggested to expand the study sample to more Brazilian and Latin American cities in order to identify initiatives related to smart and sustainable cities that are being developed in a similar context to the reality of developing countries in Latin America. In addition, it would be interesting to identify what are the necessary skills of public managers to overcome barriers that are present today, in order that smarter and more sustainable cities become a reality.

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