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CHALLENGES AND OBSTACLES TO TRANSFORMATION OF JUAZEIRO DO NORTE INTO A SMART CITY

DESAFIOS E OBSTÁCULOS PARA A TRANSFORMAÇÃO DE JUAZEIRO DO NORTE EM UMA CIDADE INTELIGENTE

DESAFÍOS Y OBSTÁCULOS PARA LA TRANSFORMACIÓN DE JUAZEIRO DO NORTE EN UNA CIUDAD INTELIGENTE

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ABSTRACT

This article addresses the challenges and obstacles that the city of Juazeiro do Norte currently faces in becoming a smart city and shows issues such as limited technological infrastructure, financial investments, technological education and community participation to be discussed and therefore prevent the city from achieve this much-desired purpose. The objective of this study is to verify what challenges need to be faced by municipal management to turn the city into a smart city. The methodology adopted was based on a bibliographical review and through data obtained from city hall websites to highlight the problems that need to be resolved and what actions should be taken. The analysis is enriched by dialogues with other authors who highlight the importance of collaboration and interoperability and mainly by data research that shows the flaws and what is still missing for the city to achieve the title of smart city. The article concludes by emphasizing the need for collaborative strategies and investments to drive the transformation of the city of Juazeiro do Norte into a smart city. It highlights the main points that managers need to resolve, such as digital infrastructure, citizen participation and sustainable urban planning, to make this desire real and effective.

Palavras-chave:
cidade inteligente, tecnologia, sustentável, infraestrutura.

RESUMO

Este artigo aborda os desafios e obstáculos que a cidade de Juazeiro do Norte enfrenta no atual momento para se tornar uma smart city e mostra questões como infraestrutura tecnológica limitada, investimentos financeiros, educação tecnológica e participação comunitária para serem discutidas e por isso impedem que a cidade alcance esse propósito tão almejado. O objetivo desse estudo é verificar quais os desafios que precisam ser enfrentados pela gestão municipal para tornar a cidade em uma smart city. A metodologia adotada foi baseada em revisão bibliográfica e através de dados obtidos em sites da prefeitura para

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evidenciar os problemas que precisam ser resolvidos e quais atitudes que devem vir a ser tomadas. A análise é enriquecida por diálogos com outros autores que destacam a importância da colaboração e interoperabilidade e principalmente por pesquisa de dados que mostram a falhas e o que ainda falta para a cidade alcançar o título de cidade inteligente. O artigo conclui enfatizando a necessidade de estratégias colaborativas e investimentos para impulsionar a transformação da cidade de Juazeiro do Norte em uma cidade inteligente. Destaca os pontos principais que os gestores precisam resolver, como infraestrutura digital, participação cidadã e planejamento urbano sustentável, para tornar esse desejo real e efetivo.

RESUMEN

Palabras clave:
ciudad inteligente, tecnología, sostenible, infraestructura.

Este artículo aborda los desafíos y obstáculos que enfrenta actualmente la ciudad de Juazeiro do Norte para convertirse en una ciudad inteligente y muestra temas como la infraestructura tecnológica limitada, las inversiones financieras, la educación tecnológica y la participación comunitaria que deben discutirse y, por lo tanto, impedir que la ciudad logre tanto. propósito deseado. El objetivo de este estudio es verificar qué retos debe afrontar la gestión municipal para convertir la ciudad en una ciudad inteligente. La metodología adoptada se basó en una revisión bibliográfica y a través de datos obtenidos de los sitios web de los ayuntamientos para resaltar los problemas que deben resolverse y qué acciones deben tomarse. El análisis se enriquece con diálogos con otros autores que resaltan la importancia de la colaboración y la interoperabilidad y principalmente con investigaciones de datos que muestran las fallas y lo que aún falta para que la ciudad alcance el título de ciudad inteligente. El artículo concluye enfatizando la necesidad de estrategias e inversiones colaborativas para impulsar la transformación de la ciudad de Juazeiro do Norte en una ciudad inteligente. Destaca los principales puntos que los gestores deben resolver, como la infraestructura digital, la participación ciudadana y la planificación urbana sostenible, para que este deseo sea real y efectivo.

Introduction

In the 21st century, faced with the challenges of urban overpopulation, environmental problems and the complexities of city planning and management, discussions on urban reorganization and the implementation of efficient and sustainable management strategies have become highly relevant topics on public agendas (LEITE, 2012).

According to the World Urbanization Prospects 2018 Report by the United Nations (UN, 2018), it is estimated that by 2050 around 6.6 billion people will live in urban conglomerations. Against this backdrop, debates on the organization of cities have intensified, and in 2015 the UN launched the 2030 Agenda, which sets out 17 goals with 169 targets for Sustainable Development (SD). These goals cover diverse national realities, capacities and levels of development, including social, economic, political and cultural issues, such as poverty eradication, reduction of inequalities, access to drinking water, basic sanitation, clean energy, sustainable agriculture, sustainable communities, responsible consumption and production, and action against global climate change, among others.

According to the Sustainable Cities Index 2016, most cities face challenges in balancing the three pillars of sustainability: social, environmental and economic. Many cities score favorably in up to two of these areas, but few achieve positive results in all three. The survey, carried out in 100 of the world's major cities, used 32 different indicators to develop a ranking indicative of sustainability.

Faced with the need to optimize services, improve quality of life and foster innovative and sustainable environments, the concept of Smart Cities has emerged, closely linked to technological innovations. In general, Smart Cities are characterized by the integration of Information and Communication Technology (ICT) with the needs of an ecologically balanced urban environment. These cities aim to use knowledge and technological advances to improve and optimize urban management, making it more sustainable and efficient for users (IDB, 2016).

The transformation of Juazeiro do Norte into a Smart City represents an ambitious and necessary step towards the future, seeking to optimize citizens' quality of life through the intelligent integration of innovative technologies. However, this journey is far from without its challenges and obstacles that need to be carefully analyzed and overcome. In this introduction, we will explore the various aspects that make the transition to a Smart City in Juazeiro do Norte a complex endeavor, from infrastructural issues to challenges related to social acceptance and governance, highlighting the importance of a comprehensive and collaborative approach to achieving this visionary goal.

Juazeiro do Norte, a Brazilian city known for its rich culture and traditions, has been the subject of discussions about the possibility of becoming a "smart city" - a city that uses information and communication technologies to improve the quality of life of its inhabitants. Although the concept of a smart city is attractive, several challenges and obstacles need to be overcome if Juazeiro do Norte is to effectively make this transition.

On June 14, 2018, Complementary Law No. 117/2018 was sanctioned, making Juazeiro do Norte the first municipality in the country to implement a municipal Innovation and Smart City law.

One of the main challenges facing Juazeiro do Norte is its limited technological infrastructure. The successful implementation of a smart city requires a robust network of high-speed connectivity, efficient communication systems and a solid digital

infrastructure. The lack of these essential elements can hinder the effective implementation of technological solutions that characterize a smart city.

Transforming a city into a smart city requires substantial investment in technology, research and development. Juazeiro do Norte may face difficulties in attracting the financial resources needed to implement large-scale projects. Without significant investment, it is difficult to achieve the technological infrastructure and innovations required to become a smart city.

In today's society, marked by global cities with a constantly growing population, the emergence of various local challenges is becoming increasingly noticeable. These issues often impact the daily lives of the population, requiring specific solutions and approaches to deal with complex urban dilemmas.

The successful adoption of innovative technologies depends on the training and education of the population. In Juazeiro do Norte, there may be a need for comprehensive training and education programs to ensure that residents have the necessary skills to interact with new technologies. The lack of technological training can hinder the acceptance and effective use of the solutions proposed for a smart city.

Another crucial point is the need for effective governance and community participation. The implementation of technologies on a large scale must be accompanied by solid policies, guaranteeing data security, privacy and fair access to technologies. The absence of an adequate regulatory framework and the lack of community involvement can jeopardize the success of the transition to a smart city.

The objectives of the study on "Challenges and Obstacles for the Transformation of Juazeiro do Norte into a Smart City" can be outlined to address different aspects related to the process of urban transformation and thus be able to verify the problems that the city faces in order to become a smart city, thus seeking to identify important points for this transformation.

Theoretical Foundation

Before we go into the analysis of the most recent academic production on the concept of Smart Cities, it is imperative to introduce the theoretical framework. In this sense, this section comprises a bibliographical review that aims to delimit the essential concepts, thus establishing the theoretical foundation underlying the theme in question.

The methodological approach of this article is based on an in-depth review of the literature related to smart cities, with an emphasis on the challenges faced by Juazeiro do Norte. The analysis includes discussion of relevant academic work and research on the topic, providing a comprehensive understanding of the barriers to city transformation.

Smart cities are a relatively recent phenomenon, coined from the case study of Singapore's initiative to become a smart city, as documented by Mahizhnan in 1999.

However, different research indicates that this concept addresses new technologies and their implementation in the urban environment (LIU et al., 2010; KUIKKANIEMI et al., 2011), as well as the adoption of technology-centered public management (ODENDAAL, 2003).

Definition of Smart City

Smart cities have become one of the main topics of study in relation to urban development (GIL-GARCIA et al., 2016; JOSS et al., 2017). This is mainly due to the challenges presented by the rapid process of urbanization on all continents, as well as the emergence of megacities, which are those with more than 10 million inhabitants. In 2020,

approximately 4 billion people lived in urban areas, and this number is projected to rise to 7 billion by 2050 (representing two-thirds of the world's population), according to data from the United Nations report (UN, 2018).

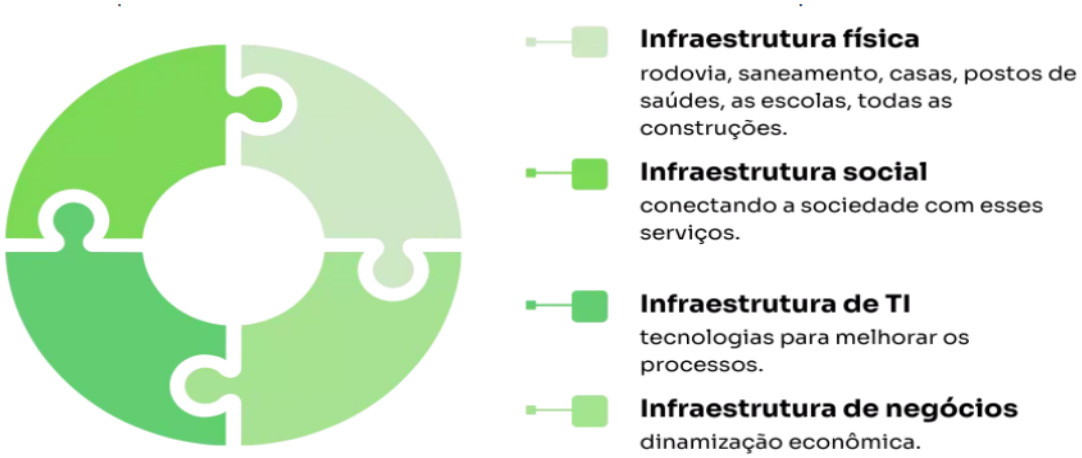
The term "smart cities" has various definitions, having emerged in the 1990s with a primary focus on the new Information and Communication Technologies (ICT) that were being integrated into urban infrastructure. The California Institute for Smart Communities was one of the pioneers in examining how communities could become smart and how cities could be designed to implement these information technologies (Alawadhi et al., 2012). Later, the Centre for Governance at the University of Ottawa criticized the idea that smart cities should only be linked to technical issues. In this vision, a smart city should adopt a governance-oriented approach, emphasizing the role of social capital in urban development. However, the term "smart city" spread in the early years of the 21st century as an "urban label" phenomenon. In recent years, researchers have drawn attention to the fact that cities that call themselves "smart" must demonstrate the various aspects that would justify this self-declared award of the label (Hollands, 2008).

In an IBM corporate document, Harrison et al. (2010) defined the term "smart city" as a city that is "instrumented, interconnected and intelligent". The term "instrumented" refers to the ability to capture and integrate citizen data through the use of sensors, meters, appliances, personal devices and other similar technologies. In turn, "interconnected" refers to the synchronization of this data on a computing platform that allows integration between the city's various services. Finally, "intelligent" refers to the inclusion of complex analysis, modeling, optimization and visualization services to support more efficient operational decisions (Harrison et al., 2010).

For Harrison et al. (2010), this is a city that integrates physical infrastructure, IT infrastructure, social infrastructure and business infrastructure to enhance the city's collective intelligence.

It is important to note that Harrison also emphasizes the interconnection of these parts as shown in figure 1.

Figure 1
Interconnecting Smart Cities



Note. Source: Harrison et al., 2010.

In the field of urban planning, the concept of the "smart city" is often considered an ideological dimension that implies strategic directions for a smarter approach. Governments and public agencies at all levels are adopting this notion of intelligence to differentiate their policies and programs, aiming for sustainable development, economic growth and improved quality of life for their citizens (Ballas, 2013). Alves et al. (2019) clarify that the term "smart" covers two broad areas: on the one hand, it brings a technopolis logic, involving the use of new technologies such as IoT, big data, algorithmic governance, among others; on the other hand, it represents the idea of an innovative city, with an emphasis on inclusion and citizen participation in urban governance.

Possibly the reason why there is no general consensus on the term "smart cities" is that it has been applied to two different types of "domains". On the one hand, it has been associated with more "hard" domains, such as buildings, energy networks, natural resources, water management, waste management, mobility and logistics (Neirotti et al., 2014), in which Information and Communication Technologies (ICT) can play a crucial role in system operations. On the other hand, the term has also been attributed to "soft" domains, such as education, culture, politics, social inclusion and governance, in which the application of ICT is generally not decisive.

Urban Sustainability

Urban sustainability encompasses a series of measures aimed at preserving and protecting the environment in which a city is located, which includes the conservation of local wildlife and plants. This allows inhabitants to remain in harmony with nature, without causing damage, through educational and awareness-raising initiatives.

The concept of "sustainable development", according to Sachs (1986), although it has often been interpreted in different ways, originates from a broader perspective that involves an analysis of the sustainable results of cities. In the 1960s, a new focus emerged on discussion agendas, with the environmental-economy-humanity triad, which sought to tackle the serious environmental impacts around the world (CARSON, 1962).

The changes in the situation in recent decades have highlighted the importance and scope of public policies in academic studies. Several factors have contributed to this growth, one of which is the adoption by governments of policies aimed at restricting

spending, saving resources and promoting social policies focused on health (SOUZA, 2007).

According to Mahler (2016), the Green City Index points to seven key elements for a city to become sustainable: i) effective governance, ii) integrated approaches, iii) promotion of the population's health, iv) encouragement of citizen participation, v) efficient use of technology, vi) balance between economic development and environmental preservation, and vii) actions by non-governmental organizations.

In this context, Secchi (2016) defines public policy, highlighting the importance of understanding two fundamental concepts: the public problem and public policy. The public problem is the starting point of the analysis and represents the difference between the current state and the desired state for a given public situation. On the other hand, public policy is a guideline designed to deal with a public problem.

Understanding these restrictions, it is important to reflect on their contributions to sustainability. According to Strapazzon (2009), with reference to the document drawn up by the European smart cities project, in order to be considered smart a city needs to perform adequately in six areas. These expressions define cities as suitable vital spaces, good places for economic development, in other words, they are essential when drawing up public policies.

Considering these concerns in the context of public policies, it becomes crucial to find a balance between the options available when implementing, for example, policies to encourage energy efficiency and decentralized energy generation, including the integration of surplus energy into the utility companies' grid (FERREIRA et al., 2015).

Thus, when developing public policies for smart cities, it is essential to consider the creation of healthy and sustainable environments. The interaction between local ecosystems is crucial, since the search for society's quality of life is one of the main contemporary challenges. To meet these challenges, it is essential to understand the social, economic and environmental aspects that are closely linked to the context of smart cities (CURY; MARQUES, 2017).

Smart Cities Around the World

The Inter-American Development Bank (IDB), in collaboration with the Korea Research Institute for Human Settlements (KRIHS), conducted a series of case studies on smart cities, financed by the Korean Knowledge Alliance Fund for Technology and Innovation of the Republic of Korea. The cities investigated included: Anyang, Medellín, Namyangju, Orlando, Pangyo, Rio de Janeiro, Santander, Singapore, Songdo and Tel Aviv. These case studies offer insights into the process of implementing a smart city and its impact on promoting urban sustainability.

Over the last thirty years, the global urban population has increased by an average of 65 million people a year, an unprecedented rate in history. By 2050, cities are expected to add another 2.5 billion inhabitants, almost 90% of which will be concentrated in Asia and Africa. However, as urbanization, industrialization and consumption grow, environmental pressures also intensify. Environmental degradation can have cascading effects on the health and quality of life of urban dwellers, as well as on the long-term sustainability of the city itself (McKinsey Company, 2018).

The city of Anyang in South Korea, with a population of over 600,000, began its smart city project in 2003. The initial focus of this project was the information system for public transport, aimed at improving the use of buses by citizens. This is how the Intelligent Transport System (ITS) came about, and in the last twelve years the Crime Prevention System and the Disaster Prevention System have also been developed, all integrated in a coordinated manner.

"The implementation of the crime prevention system resulted in a reduction in the crime rate, [...] Anyang city saw a significant average annual reduction in the crime rate, with a drop of 17.8%" (LEE et al, 2016, p. 34).

The control center developed in the city, known as U-City, was created to unify all these systems. Through the Anyang city center website, citizens have access to real-time information, based on videos and maps.

The city of Namyangju in South Korea, with a population of over 650,000, started its smart city project in 2008 in response to population growth. The initial focus was on implementing an intelligent traffic control and crime fighting system. The project has been divided into three main categories: ITS, which includes the Advanced Traffic Management System (ATMS), the Bus Information Service (BIS) and the U - Ubiquitous project. The active participation of citizens is crucial for collecting data on the performance of systems, using social media resources.

The city of Orlando, in the United States, with a population of over 250,000, has faced significant population growth and was also impacted by a natural disaster in 1997. In response to these challenges, a project to create the Orlando Operations Center (OOC) began in 1998 and was completed in 2001. This project integrated four essential sub-centers: the Traffic Management Center, the Emergency Operations Center, the 911 Communications Center (Fire Department and Police Department) and the Network Operations Support Center.

"The working group collects citizens' opinions and looks for ways to provide more accurate traffic information. Currently, there are 15,255 followers on twitter (@nyjtraffic) and 2,095 on facebook" (LEE, et al, 2016, p. 11).

Method

Juazeiro do Norte is a Brazilian municipality located in the state of Ceará, in the Cariri Metropolitan Region, in the south of the state, as we can see in figure 2. Located 491 km from the capital Fortaleza, the city is 350 meters above sea level and covers an area of 258.788 km^2. With an estimated population of 286,120, Juazeiro do Norte is the third most populous municipality in Ceará, surpassed only by Fortaleza and Caucaia. It is also the largest city in the interior of Ceará and ranks 104th in population in Brazil (IBGE, 2022).

Figure 2
Detailed area of the study region

Note. Source: Barros *et al* 2020.

Standing out as one of the main centers of popular religiosity in the country, Juazeiro do Norte gained notoriety due to the figure of Padre Cícero, and is considered one of the three largest centers of popular devotion in Brazil, alongside Aparecida (SP) and Nova Trento (SC). The city also stands out as a significant cultural hub, being recognized as one of the largest handicraft and cordel centers in the Brazilian Northeast (IBGE, 2022).

In addition to its cultural contributions, Juazeiro do Norte stands out as an important academic center in the interior of the Northeast, housing one of the largest academic centers in the region. The city is recognized as a "regional capital" and is considered the "metropolis of Cariri". With an urbanization rate of 95.3%, the city represents a central and dynamic point in the Northeast region of Brazil (IBGE, 2022).

As outlined by Caragliu, Del Bo and Nijkamp (2011, p. 6), a city achieves smart status by integrating investments in human capital, social capital and communication infrastructure, harmonizing traditional and modern elements. This process aims to drive sustainable economic development, promoting effective management of natural resources and adopting participatory governance, always keeping the focus on the quality of life of citizens. In a later contribution, the authors highlighted that smart cities emerge through the intelligent application of digital information, covering areas such as human health, mobility, energy consumption, education, knowledge transfer and urban governance (Caragliu et al., 2015, p. 114).

Sampaio and Mancini (2007) define a systematic review, along with other types of review studies, as a research approach that is based on analyzing the literature related to a specific topic. This methodology provides a summary of the evidence associated with a given intervention strategy, and is conducted through methods of searching, critically evaluating and synthesizing the information selected in an explicit and systematized way.

For this research, the inclusion criteria were articles related to the topic and that were current, as this brings recent research results to better support the discussion on the topic.

Results and Discussion

Presentation The results highlight the limited technological infrastructure, the need for financial investment, the importance of technological education and community participation as the main obstacles faced by Juazeiro do Norte. Dialogues with authors such as Caragliu et al. (2011) and Batty et al. (2012) emphasize collaboration and interoperability as essential elements to overcome these challenges.

When dialoguing with other authors on the subject, we see that the barriers faced by Juazeiro do Norte are not exclusive to this city. Many locations around the world face similar challenges in their quest to become smart cities. Authors such as Caragliu et al. (2011) highlight the importance of collaboration between the public and private sectors, as well as the need for clear government policies to overcome these challenges.

According to Batty et al. (2012), interoperability between different systems and the creation of innovative ecosystems are crucial aspects for the success of a smart city. Therefore, Juazeiro do Norte can benefit from learning from the experiences of other cities, implementing effective cooperation strategies and promoting public-private partnerships.

In the article "Smart Cities: A Conjuncture of Four Forces," published by Angelidou in 2015, the author carries out a comprehensive historical survey of discussions related to the use of technology in the urban environment. The historical journey, from the mid-1850s to the present day, highlights the significant transformations that have taken place in this scenario. The bibliographical research undertaken by the author aims to identify little-explored aspects of the meaning of intelligence in the urban context, while at the same time offering strategic guidelines for the planning and development of Smart Cities in contemporary times.

Among the most important elements in the Smart Cities concept, Angelidou highlights the integration between the urban environment, the Knowledge Economy and Innovation. In the context of technological advancement, the merging of these previously independent spheres promotes a fundamental transformation in the contemporary understanding of Smart Cities. The author emphasizes the importance of approaching urban and technological planning in a cohesive manner, ensuring that strategies balance demand and supply in the implementation of these technologies, as shown in figure 3.

Issues related to social concerns, such as quality of life, privacy and accessibility, have been addressed by scholars such as Van Zoonen (2016), Macke et al. (2018) and Alperstedt Neto, Rolt and Alperstedt (2018). On the other hand, Colding and Barthel (2017) were the only ones to highlight the problem associated with urban ecology and the growing concern about environmental aspects, questioning the dominance of economic interests in the implementation of smart cities, thus showing the difficulty that cities encounter in becoming smart cities.

Figure 3
Examples of sectors that could be impacted by Smart Cities

Note. Source: Adapted from http://www.blog.researchonglobalmarkets.com/.

It was possible to evaluate the current infrastructure of Juazeiro do Norte, and by analyzing the existing technological, communication and public services infrastructure in Juazeiro do Norte, it was possible to identify gaps and areas of improvement needed to become a Smart City, data from the City Hall show that Juazeiro do Norte had, in January 2021, more than 40% of its road network without any type of paving, Source, SEINFRA.

The topics below are information obtained from the city council's website. In order to identify technological barriers, the technological limitations that prevent the implementation of smart solutions in the city were analyzed. This includes issues related to information technology infrastructure, connectivity and interoperability of systems.

Regarding community acceptance, the local community's acceptance and willingness to adopt smart technologies was investigated. The population's perceptions, expectations and concerns regarding the city's digital transformation were understood.

When it comes to financial capacity, studies show that the city's financial capacity to invest in smart technologies includes identifying possible sources of funding, public-private partnerships and sustainable business models, and this has already been demonstrated in the city.

The challenge is already underway. The participation of the public, industry and other interested groups in the development of innovative governance solutions for Brazilian cities can be promoted through additional studies, such as this one, which highlight viable approaches to implementing smart cities. Finally, this work has summarized that, as well as the results presented, sharing knowledge and data represents a viable path on this journey. There is much more to be done, and more studies must be carried out to support the development and implementation of integrated solutions for smart, healthy and sustainable cities.

On the issue of security and privacy, cyber security and data protection issues were considered when implementing intelligent solutions. ensuring that the collection and

processing of information respects privacy and security standards, all of which is still in process.

In order to develop engagement strategies, the city government must propose strategies to actively involve citizens in the transformation process, promoting participation and collaboration, in figure 4 we can see the giradoudo square, which is an example of integration in the city. However, the results show that there have been few awareness-raising, education and public consultation initiatives.

Another important point is to promote sustainability by integrating environmental and sustainable aspects into the transformation plan, seeking solutions that contribute to reducing environmental impact and promoting sustainable practices.

Figure 4

Praça do Giradouro, in Juazeiro, is known as a model site with Wi-Fi and other services

Note. Source: Photo, Antonio Rodrigues

Finally, establishing strategic partnerships identified potential partners in both the public and private sectors who could collaborate in implementing smart projects and overcoming specific challenges.

Discussion and Conclusions

Although Juazeiro do Norte has the potential to become a smart city right now, it is essential to face and overcome the challenges mentioned. Collaboration between governments, the private sector and the community is key, and the city can benefit from experiences and lessons learned in other parts of the world. With adequate investment, technological education and a strategic approach, Juazeiro do Norte can pave the way to becoming a smart city and thus provide advantages for the well-being of its inhabitants.

There are many advantages to technological innovation. They provide significant improvements in various sectors, driving progress and efficiency. These innovations have the potential to positively transform society, optimizing processes, facilitating

communication, promoting advances in medicine, stimulating economic growth and contributing to solving global challenges. In short, technological innovations play a fundamental role in constantly improving quality of life and sustainable development.

A smart city in Juazeiro do Norte could include:

1. Connected Infrastructure: Streets equipped with sensors to monitor traffic, manage street lighting and optimize the use of resources.

2. Sustainable transportation: Promoting sustainable means of transport, such as cycle paths, efficient public transport and the implementation of electric vehicles.

3. Technology in Education: Schools equipped with state-of-the-art technology, high-speed internet access and innovative educational programs.

4. Digital Health: Use of digital health technologies to improve the provision of medical services, such as electronic patient records and telemedicine.

5. Smart Waste Management: Optimized waste collection systems, efficient recycling and the use of technologies to reduce environmental impact.

6. Citizen participation: Digital platforms for civic engagement, online voting and direct communication channels between citizens and the government.

7. Efficient energy: Adoption of renewable energy sources, such as solar and wind, and the use of smart technologies to monitor and optimize energy consumption.

8. Intelligent Public Security: Intelligent surveillance systems, camera monitoring, and the use of data to improve security in urban areas.

It is important to note that the transformation of a city into a smart city involves the collaboration of governments, companies, communities and other stakeholders to ensure the success and sustainability of these initiatives.

Given the challenges identified, the transformation of Juazeiro do Norte into a smart city requires collaborative strategies and substantial investments. The lesson learned from other cities highlights the importance of clear government policies and public-private partnerships. We conclude that, with targeted efforts, the city can overcome the obstacles and reap the benefits of technological innovation.

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