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Smart Cities: An analysis of publications about Brazilian startups providing digital solutions

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ABSTRACT
This article aims to analyze how Brazilian startups are promoting technological solutions for the development of smart cities. The literature review was based on published material obtained through the survey of startups focused on smart cities in the Smart City Report Distrito 2020 digital archive. In addition, searches were conducted in the Scopus, Science Direct, Scielo, and Web of Science databases, using keyword combinations such as "Technology Transfer," "Startup," and "Smart City." The research resulted in 56 papers, but none of them related to startups promoting digital solutions for smart cities in the Brazilian context. From the analysis of Smart City Report data, it was possible to observe that smart cities are becoming an increasingly growing theme worldwide, especially in the context of digital and urban transformation. However, solutions for municipal governance and administration are less frequent, with only 10% of startups directing their solutions to governments, suggesting that the country is still in an early stage of implementing smart cities. Collaboration between companies and municipal governments is essential to achieve more efficient city management. The theoretical contribution of this work helps to reduce the gap in this topic in the academic field, bringing analyses of data from the Brazilian market. Showing socially stimulating business opportunities so that there is digital entrepreneurship in market gaps. Promoting that the city environment is more developed to meet these smart cities.

KEYWORDS: Smart City. Technology Transfer. Startups.

1 INTRODUCTION

Nowadays, we are experiencing a period where technology has reached an advanced stage, enabling the implementation of solutions that aim to enhance the experience of living in cities sustainably (NEIROTTI, 2014). There is a need for adaptation of existing cities so that they can play a prominent role in the future. Clean, safe, healthy, and economically prosperous cities require a feasible plan, with technologies capable of achieving a desirable urban structure. The digitization of urban management, artificial intelligence, the internet of things, blockchain, new clean energies, and waste treatment are some of the highlighted technologies that have a high impact on urban quality of life and are increasingly common in the lives of citizens (DISTRITO, 2020).

The rapid growth of cities is a global challenge (DISTRITO, 2020). The Ministry of Science, Technology, Innovations, and Communications (MCTIC, 2017) considers "smart (and human and sustainable) cities as people, communities, systems, services, and activities connected with the goal of improving the quality of life and preserving planetary resources" (OLIVEIRA, 2020). These cities have integrated technology systems capable of optimizing operations and processes in various sectors, fostering economic growth, sustainability, and quality of life (DISTRITO, 2020). Smart cities place people at the centre of development and incorporate technologies that can help in urban management, promoting efficient governance through participatory processes and sustainable integrated development (DISTRITO, 2020).

Smart cities are the result of the combination of two typical contemporary trends: the intensification of the urbanization process and the digital revolution (DISTRITO, 2020). It is in this context that the significance of entrepreneurship, especially start-ups, lies: the ability to use technology for the benefit of citizens, offering solutions that can improve urban life and thereby contribute to building better and economically prosperous cities. Across the world, we can witness various entrepreneurial initiatives seeking to implement and transfer their technologies to tomorrow's urban solutions, improving the lives of millions of people, creating economic development, and preparing for a future where cities will be even better for the billions of people living in them (DISTRITO, 2020).

Technology transfer is the process by which technology, products, or knowledge is shared between two or more parties, usually from a technology holder to a technology receiver. Technology transfer can occur between companies, countries, or academic and government institutions. Efficient technology transfer is becoming increasingly important in a context of accelerated transformation of socioeconomic processes due to technological development. In this environment, technology transfer (TT) is a crucial factor in improving the competitiveness of companies through technological advancements and innovations (NICODEMUS, 2019), as well as contributing to the socioeconomic development of regions and countries (DE MOORTEL and CRISPEELS, 2018).

Technology transfer between companies and government can be done in various ways, depending on the context and the involved needs. Some possible forms of technology transfer include licensing and concessions (ANTUNES, 2017), strategic partnerships, where public agents have the legal possibility of partnering with the private sector (BRASIL, 2004), contracts, and bidding processes (BRASIL, 1993), and Public-Private Partnerships (PPPs), which are long-term contractual agreements between governmental entities and private companies to provide public services or infrastructure projects (DE BRITO and SILVEIRA, 2005).

PPPs present themselves as a possible option to implement smart city concepts (OLIVEIRA, 2020). In innovation ecosystems, PPPs allow creating a portfolio of unique technologies in areas where long-term competitive advantages for consistently high profits can be achieved (SHMELEVA, 2021). In addition to bringing various benefits, such as cost and risk reduction for the government, the solutions promoted by these innovative companies, startups, improve the quality of services provided, increase efficiency and innovation, and generate business opportunities for these startups (OLIVEIRA, 2020). Startups are companies that create innovative products or services capable of solving real consumer problems in various markets, with rapid growth potential and high scalability (RIES, 2012).

Entrepreneurship involves discovering, evaluating, and seizing opportunities to create products, services, or production processes, innovative strategies, organizational forms, and new markets for products and services (GUSUL, 2019). Smart entrepreneurship is part of the concept of smart cities, focusing on a new business management approach that considers technology as a factor enabling innovation and improvement in the IT field, with the aim of enhancing the quality of life (GUSUL, 2019). It is precisely in this aspect that the greatest importance of startups lies: the ability to harness technology for the benefit of citizens, offering solutions capable of improving urban life and, thereby, contributing to the construction of better and economically prosperous cities (DISTRITO, 2020).

Thus, this article addresses the issue of how Brazilian startups are promoting technological solutions for the development of smart cities. Considering that the development of innovative solutions brings benefits that help cities become smart cities. The following will present the objectives addressed in this article, as well as the materials used for analysis. Subsequently, the methodology, results, conclusions, and bibliographic references will be described.

2 OBJECTIVE

This article aims to analyze how Brazilian startups are promoting technological solutions for the development of smart cities. Thus, this objective can be divided into three specific goals.

The first specific goal developed in this article is to conduct a literature review that relates to the topics of smart cities, technology transfer, and startups. Next, the second specific goal is to gather results from the study of startups that develop solutions for smart cities. Finally, the third specific goal is to analyze the behavior of startups, market challenges, and entrepreneurship opportunities for the smart cities segment.

3 METHODOLOGY

This study is characterized as applied research, aiming to generate knowledge for practical application and specific problem-solving (GIL, 2008). Regarding the technical procedures, bibliographic research methods will be used. The bibliographic research will be conducted based on already published material (GIL, 2008), obtained through consulting the survey of startups focused on smart cities and made available in the digital file Smart City Report Distrito 2020. The proposed methodology for conducting the research will be divided into three stages:

In the first stage, articles relating to the topics of smart cities, technology transfer, and startups will be identified through research databases. The objective of this stage is to establish the originality of the research, reducing any gaps in works that address this theme. The research databases used will be Scopus, Web of Science, and Science Direct.

The second stage will involve gathering data from the digital file Smart City Report Distrito 2020. The objective of this stage is to present the results of the survey conducted with startups that develop digital solutions for the smart cities segment.

Finally, the third stage will consist of analyzing the data presented in the study report, providing insights into the behavior of startups, market challenges, and entrepreneurship opportunities for the smart cities segment.

4 RESULTS

First, searches were conducted in research databases, where a literature gap was identified regarding studies of startups promoting solutions for smart cities in the Brazilian scenario. This statement is based on the search conducted in databases such as Scopus, Science Direct, Scielo, and Web of Science, where few works were found from the combination of keywords such as "Technology Transfer," "Startup," and "Smart City," as shown in Table 1. Out of these 56 articles found through the keywords, no articles were related to startups promoting digital solutions for smart cities in the Brazilian scenario.

Table 1 - Result of the word search in the databases

Group	SCOPUS	WEB OF SCIENCE	SCIENCE DIRECT	SCIELO
"technology transfer" AND "startup" AND "smart city"	0	0	56	0
Total		**56**		

Source: Authors, 2023.

In Brazil, there are several companies that follow the development of startups, and one of them is Distrito. Based in São Paulo, Distrito defines itself as an innovation platform that facilitates the connection of the ecosystem with startups. One of the activities carried out by Distrito is the development of studies on the behavior of the startup market, focusing on segments, regions, and market needs.

In 2020, Distrito published a study called Smart Cities Report Distrito. In this material, they presented the categories used to segment the topic of smart cities, provided data from the Distrito Smart Cities Radar 2020, as well as statistics and investment data, international scenarios, and segment trends.

Initially, the topic of smart cities was segmented into the categories presented in Table 2:

Table 2 – Smart Cities categories

Category	Definition	Main Difficult
Urban infrastructure	Startups that aim to promote effective management of water and energy resources.	● Dependence on fossil fuels. ● Inefficient use and inadequate distribution of electricity. ● Poor management of water resources and lack of basic sanitation.
Waste Management	Technological solutions for more efficient collection and treatment of solid waste.	● Among the sustainability-related issues, we can highlight improper waste disposal, inefficient recycling, and food and resource wastage.
Mobility	Solutions that improve the accessibility and mobility of the population in urban environments.	● Limited alternatives for sustainable transportation. ● Lack of integration between different modes of transportation. ● Issues such as heavy traffic and congestion.
Security	Technological solutions that help prevent and monitor crimes and accidents.	● Issues such as lack of infrastructure for accident prevention, challenges in monitoring and combating crimes, and a high number of cases of sexual violence.
Ecological Solutions	Solutions that aim to promote environmental management in cities and the promotion of ecologically friendly technologies.	● Issues such as lack of green spaces in cities, challenges in combating pollution in its various forms (atmospheric, noise, among others), and inefficiency in measures for the recovery of contaminated areas.
Quality of Life	Solutions aimed at enhancing public spaces in cities, with a focus on making them more accessible, inclusive, and comfortable for citizens.	● Lack of accessible and well-maintained public spaces, as well as difficulties in renovating residences and businesses, and scarcity of services and communal spaces for the population, emphasizing the need for citizen empowerment.

Municipal Operations	Technologies that help make governmental administration in urban areas more efficient.	• Inefficiencies in governmental management, such as delays in decision-making, lack of effective communication with citizens, and excessive bureaucracy, which hinder the delivery of quality services.
Planning and management	Technologies and innovative solutions that contribute to the design and execution of constructions, urban planning projects, and other initiatives in cities.	• Inefficiency in the management of urban works. • Lack of proper integration between urban services. • Difficulty in accurately predicting costs and timelines of works.

Source: Adapted of Smart Cities Report Distrito, 2020.

In this material, 166 technological solutions were identified that contribute to these categories to transform cities into smart cities. Of these, 42.8% are concentrated in the state of São Paulo. The Southern states of Brazil account for 25.4% of startups, showing the second highest occurrence of startups for smart cities.

Another characteristic presented in this material is the number and percentage of startups per category, shown in Table 3.

Table 3 – Quantity of startups per category.

Category	Number of Solutions	% of Total
Mobility	54	32,5%
Urban infrastructure	20	12,0%
Ecological Solutions	18	10,8%
Planning and management	16	9,6%
Waste Management	16	9,6%
Municipal Operations	16	9,6%
Security	14	8,4%
Quality of life	12	7,2%

Source: Smart Cities Report Distrito, 2020.

The study reveals that two-thirds of startups focused on smart cities were established after 2014, with 66.7% between the years 2015 and 2018, which was the period of greatest startup growth. Although the studied segment employs over 4,000 people, the median number of employees per startup is 6, indicating that most startups are small-scale ventures. Specifically, 84.1% of startups employ up to 20 collaborators.

The most prevalent business model for startups aiming to foster smart cities is Business to Business (B2B), accounting for 47.9% of startups, providing solutions to other businesses. Following this, there is B2B combined with Business to Customer (B2C) at 18.6%, and then B2C, offering solutions to end consumers, also at 18.6%.

The top 10 Brazilian startups presented in the Distrito's study are listed in Table 4. The characteristics analyzed to reach this conclusion include the number of employees and their growth in the last year, estimated revenue through CNPJ analysis, investment raised, website traffic, and social media metrics.

In the third section, an analysis of this data was conducted, which revealed that in the current context of digital and urban transformation, smart cities have become a growing topic worldwide. However, identifying recently established startups with little visibility in the market

is a significant challenge, which may result in some early-stage companies not being included in this report.

Table 4 – Top 10 startups for *smart cities*

Startup	**Categories**
99	Mobility
UpLexis	Planning and Management
Tembici	Mobility
Altave	Security
Cobli	Mobility
Colab	Planning and Management
Camerite	Security
Solfacil	Mobility
Gove	Planning and Management
Easy Carros	Mobility

Source: Smart Cities Report Distrito, 2020.

While there is a strong connection between public-private partnerships and smart cities, solutions for municipal governance and administration are less common. This is due to various barriers present in developing synergies between the public and private sectors, including regulatory, policy, and cultural issues.

Despite being an important connection for smart cities, public-private partnerships receive little attention from Brazilian startups. Only 10% of them direct their solutions towards governments, signaling that the country is still in an early stage of smart city implementation. During this phase, startups focus on addressing specific urban life issues without centralized planning.

It is essential to highlight that municipal administration and governance are crucial for the success of smart cities. Technology can provide innovative solutions for urban problems, but the successful implementation of these solutions depends on efficient and integrated management between the public and private sectors.

Thus, collaboration between companies and municipal governments is essential to achieve more efficient city management. Joint efforts to overcome existing barriers and develop innovative solutions for municipal governance can help advance the implementation of smart cities in Brazil and worldwide.

5 CONCLUSION

Cities are becoming increasingly important for global economic and social development. However, uncontrolled urban growth, lack of planning, and the challenge of ensuring citizens' quality of life have become increasingly complex. In this context, innovation has become a fundamental piece to find solutions that generate positive outcomes and sustainable economic opportunities in complex areas such as culture, education, health, security, mobility, environment, and connectivity.

Innovation is particularly crucial in smart cities, which incorporate technologies to aid urban management and promote efficient governance through participatory processes and sustainable integrated development. Technology is essential to improve the quality of lighting, surveillance systems, environmental indicators, connectivity, and to offer public management savings in human, environmental, and financial resources.

Smart cities are built to meet the needs of their citizens based on three main pillars: technology, people, and sustainability. Technology is vital to ensure the efficiency and transparency of public services, as well as citizens' quality of life. People are at the core of development, and technology should be used to enhance urban life. Sustainability is crucial to ensure cities can continue growing and developing in a balanced way, respecting the environment and the needs of future generations.

In this context, entrepreneurship plays a significant role, especially through startups. Startups are companies that emerge with innovative ideas and the potential to generate economic growth and social impact. In urban settings, startups are crucial agents of innovation, helping to find solutions to complex urban challenges and promoting sustainable development.

Startups can bring innovation to various areas, such as mobility, environment, energy, security, education, and health. They could identify urban problems and offer practical and efficient solutions. These solutions can range from transportation apps to waste recycling platforms, from air quality monitoring sensors to traffic management solutions. Startups can also collaborate with the public sector to offer solutions that can be integrated into existing systems.

However, startups face significant challenges when entering the urban market. Bureaucracy and lack of funding are some of the main barriers to their entry into the urban market. Moreover, many startups struggle to understand the needs of the public sector and develop solutions that can be integrated into existing systems.

To tackle these challenges, it is essential for startups to be encouraged and supported by both the public and private sectors. Investment in policies and entrepreneurship support programs is necessary.

In conclusion, smart cities present a complex and challenging challenge, requiring innovative and sustainable solutions to address urban issues. Startups play a fundamental role in this context, offering creative and efficient solutions to urban problems. However, for startups to effectively contribute to the development of smart cities, a supportive environment of public policies and private investments, as well as an integrated and collaborative approach to urban governance, is needed.

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