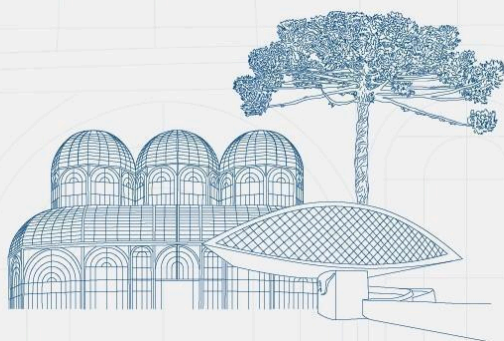




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SMART CITIES: AN ANALYSIS OF BRAZILIAN STARTUPS AS PROVIDERS OF DIGITAL SOLUTIONS RELATED TO THE SDGS

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Resumo

Brazilian startups play an important role in seeking technological solutions for sustainable smart cities. While progress has been made, there are still challenges to overcome. Collaboration between the public and private sectors, coupled with an entrepreneurial-friendly environment, can drive the development of innovative and efficient solutions to address urban challenges and promote smart cities aligned with 17th sustainable development goals (Gue et al., 2020; Niestroy, 2016; Ramirez et al., 2019). This article analyzes how Brazilian startups are contributing to sustainable development in smart cities and fills an academic gap by providing specific market data analysis in Brazil. Based on scientific articles and the Smart City Report Distrito 2020 startup survey, specific studies on startups promoting solutions for sustainable smart

cities were not found, but an increase in global interest in this topic was observed (Distrito, 2020). However, a gap was identified in solutions for municipal governance and administration, with only 10% of startups focusing their efforts on serving governments (Distrito, 2020). This indicates that the country is still in the early stages of implementing smart cities. While some areas such as mobility and energy already have a significant number of solutions, there are opportunities to stimulate the development of startups addressing other sustainable development goals. The importance of favorable public policies, private investments, and an integrated and collaborative approach to urban governance is emphasized.

Palavras-chave: *Smart Cities. Technology Transfer. SDGs - Sustainable Development Goals. ESG - Environmental, Social, and Governance.*

1. Introduction

Nowadays, we are experiencing a period in which technology has reached an advanced stage, allowing for the implementation of solutions that seek to enhance the experience of living in cities in a sustainable manner (NEIROTTI, 2014).

In 2015, two global agreements were established, bringing consensus to achieve sustainable and inclusive development within the bounds of planetary and social justice: the Paris Agreement at the Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change (UNFCCC, 2015), and the adoption of the resolution "Transforming Our World: The 2030 Agenda for Sustainable Development" (UN, 2015a). This agenda was agreed upon by all 193 United Nations members (UN, 2015; COSTANZA et al., 2016) and developed 17 Sustainable Development Goals (SDGs) aimed at addressing economic, social, and environmental issues that hinder global progress towards sustainable development (GUE et al., 2020; NIESTROY, 2016; RAMIREZ et al., 2019).

One of the main characteristics of smart cities is placing people at the center of development, prioritizing the well-being of citizens. Additionally, these cities seek to adopt technologies that contribute to efficient urban management, promoting citizen participation and integrated sustainable development (DISTRITO, 2020). In this context, BISCHOFF and VOLKMANN (2018) define a sustainable entrepreneurial ecosystem as an interconnected and collaborative group of stakeholders that provide sustainability-focused support to entrepreneurs, promoting entrepreneurial activities that address the economic, ecological, and social dimensions of sustainability, thus contributing to the transformation of a sustainable regional economy.

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 MOORTELE and CRISPEELS, 2018).

In addition to bringing various benefits, 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).

Thus, this article addresses the issue of how Brazilian startups are promoting technological solutions to support the sustainable development goals in smart cities. Considering that the development of innovative solutions brings about solutions that help cities become smart cities. The following section 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. Objectives

The objective of this article is to analyze how Brazilian startups are promoting technological solutions to support the sustainable development goals in smart cities. To achieve this objective, three specific goals have been defined.

The first specific objective is to conduct a literature review that relates the topics of smart cities, technology transfer, Sustainable Development Goals (SDGs), and environmental, social, and corporate governance (ESG). The second specific objective is to obtain results from the study conducted with startups that are developing technological solutions to support the sustainable development goals in smart cities. Finally, the third specific objective is to analyze the behavior of startups, market challenges, and entrepreneurship opportunities that contribute to the sustainable development goals in smart cities.

3. Methodology

This study takes an applied approach, aiming to generate knowledge that can be applied in practice and in the solution of specific problems (GIL, 2008). To achieve this objective, bibliographic research methods will be used. The bibliographic research will be based on previously published materials (GIL, 2008), obtained through consultation of the Smart City Report Distrito 2020 digital archive, which contains a survey of startups focused on smart cities.

The proposed methodology for conducting the research will be divided into three stages:

In the first stage, articles related to the topics of smart cities, technology transfer, Sustainable Development Goals (SDGs), and environmental, social, and corporate governance (ESG) will be collected. The objective of this stage is to demonstrate the originality of the research by filling a gap in the literature that addresses these topics. The research databases used will be Scopus, Web of Science, SciELO, and Science Direct.

In the second stage, data from the Smart City Report Distrito 2020 digital archive will be collected. This stage aims to present the results of the survey conducted with

Brazilian startups that are providing technological solutions to support the sustainable development goals in smart cities.

Finally, in the third stage, the data presented in the report will be analyzed, providing insights into the behavior of startups, market challenges, and entrepreneurship opportunities for sustainable development in smart cities.

4. Results

Initially, research was conducted in various databases, revealing a gap in the literature regarding studies on startups that offer solutions to support sustainable development goals in smart cities in the Brazilian context. This finding is supported by the search conducted in the Scopus, Science Direct, Scielo, and Web of Science databases, where few papers were found when combining keywords such as "Technology Transfer," "SDGs," "ESG," and "Smart City," as illustrated in Table 1. Among the 8 articles identified through the keywords, no studies related to startups offering digital solutions to support sustainable development goals in smart cities were found.

Table 1 - Result of keyword search in the databases

ARRANGEMENT	SCOPUS	WEB OF SCIENC E	SCIENC E DIRECT	SCIEL O
"technology transfer" AND "ESG" AND "SDG" AND "smart city"	0	0	8	0
Total	8			

Source: Authors, 2023.

In 2020, Distrito published a study titled "Smart Cities Report Distrito". In this material, categories were presented to segment the topic of smart cities. Additionally, the study provided data from the Distrito Smart Cities Radar 2020, including statistics and investments, as well as international scenarios and industry trends.

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

Table 2 - Smart Cities Categories

Categories	Definition
Urban Infrastructure	Startups aiming to promote efficient management of water and energy resources.
Waste Management	Innovative technologies for more efficient collection and treatment of solid waste.
Mobility	Innovations that enhance accessibility and mobility of the population in urban environments.
Security	Innovative technologies that contribute to crime and accident

	prevention and monitoring.
Ecological Solutions	Technological solutions focused on environmental management in cities and the promotion of ecologically sustainable technologies.
Quality of Life	Technological solutions with the aim of improving public spaces in cities, making them more accessible, inclusive, and comfortable .
Municipal Operations	Technologies that optimize government management in urban areas, promoting greater efficiency and agility.
Planning and Management	Innovative solutions and technologies that drive the design and implementation of buildings, urban projects, and other initiatives in cities.

Source: Adapted from Smart Cities Report Distrito, 2020.

In this material, 166 technological solutions were identified that contribute to the transformation of cities into smart cities, covering various categories. Of the total, 42.8% of the startups are concentrated in the state of São Paulo. The Southern states of Brazil, on the other hand, account for 25.4% of the startups, representing the second highest occurrence of startups focused on smart cities. Furthermore, the material also presents the number and percentage of startups per category, as shown in Table 3.

Table 3 - Quantity of startups per category

Categories	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 significant growth between 2015 and 2018, representing 66.7% of the total. Despite the segment employing over 4000 people, the median number of employees per startup is 6, indicating that the majority of startups are small-scale. Approximately 84.1% of companies employ up to 20 collaborators. The most predominant business model among startups driving smart cities is Business to Business (B2B), representing 47.9% of the total. Following that, we have B2B combined with Business to Customer (B2C), at 18.6%, and B2C, which caters to end consumers, also at 18.6%. Only 10% of these companies direct their solutions towards governments, indicating that the country is still in an early stage of smart city implementation. At this stage, startups focus on solving specific problems in cities without centralized planning. Understanding the classifications of these startups for smart cities, we can address the goals described in the report, in Table 4.

Table 4 - SDGs and related goals addressed by digital solutions for smart cities.

Goal - SDG	Main Topics Activities – Relations with SDG
Goal 1.	• 1.4;
Goal 2.	• 2.a;
Goal 3.	• 3.d;
Goal 4.	• 4.1; 4.3; 4.4
Goal 5.	• 5.b;
Goal 8.	• 8.2;
Goal 9.	• 9.5; 9.b; 9.c
Goal 11.	• 11.2; 11.3; 11.7; 11.c
Goal 12.	• 12.7; 12.8; 12.a; 12.b
Goal 13.	• 13.b;
Goal 16.	• 16.6; 16.7;
Goal 17.	• 17.6; 17.7; 17.17; 17.18; 17.19

Source: United Nations Brazil, 2023.

After identifying the goals and objectives for sustainable development in which the classifications of startups for smart cities make contributions, it was possible to relate the categories of startups to objectives, as shown in Figure 01, and the relationship between categories and objectives in Figure 02.

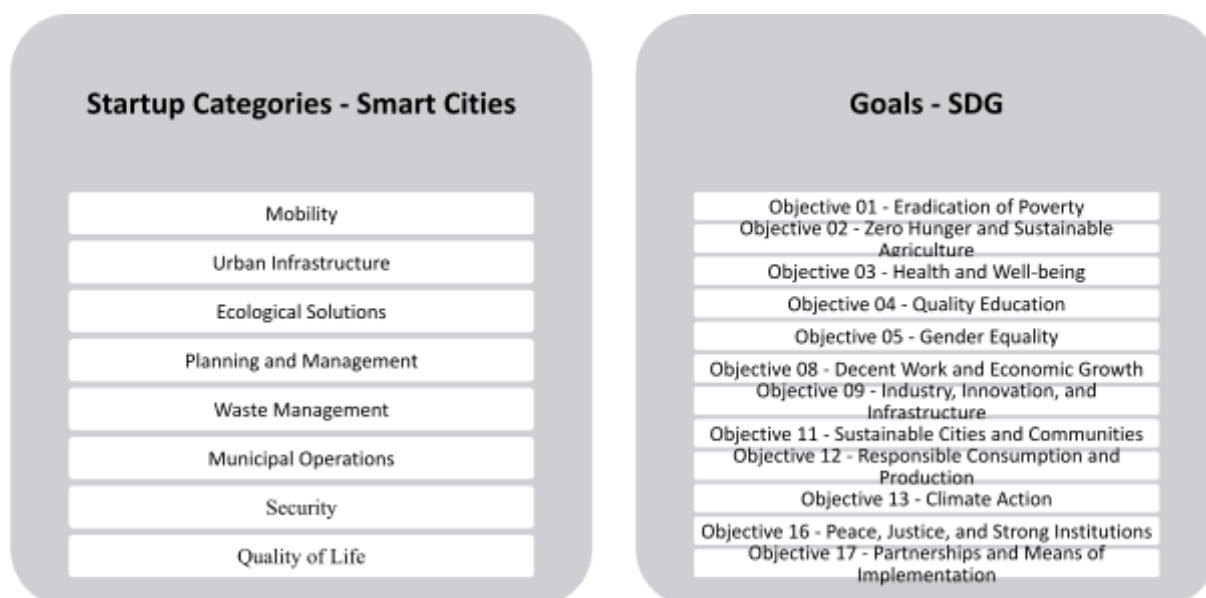


Figure 1 – Relations of Smart City Solutions Categories and SDG Objectives

After identifying the categories of startup solutions for smart cities and the objectives, an analysis was conducted to determine the presence of relationships with solutions in the Distrito study for achieving the targets of the SDG objectives.

STARTUPS CATEGORY - SMARTCITIES	GOALS - SDG												Contribution
	• Objective 01 - Eradication of Poverty	• Objective 02 - Zero Hunger and Sustainable Agriculture	• Objective 03 - Health and Well-being	• Objective 04 - Quality Education	• Objective 05 - Gender Equality	• Objective 08 - Decent Work and Economic Growth	• Objective 09 - Industry, Innovation, and Infrastructure	• Objective 11 - Sustainable Cities and Communities	• Objective 12 - Responsible Consumption and Production	• Objective 13 - Climate Action	• Objective 16 - Peace, Justice, and Strong Institutions	• Objective 17 - Partnerships and Means of Implementation	
Mobility	No Relationship	No Relationship	Relationship	No Relationship	No Relationship	No Relationship	Relationship	Relationship	No Relationship	Relationship	No Relationship	Relationship	42%
Urban Infrastructure	No Relationship	No Relationship	Relationship	Relationship	No Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	75%
Ecological Solutions	Relationship	Relationship	Relationship	No Relationship	No Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	No Relationship	No Relationship	87%
Planning and Management	Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	100%
Waste Management	No Relationship	Relationship	Relationship	No Relationship	No Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	No Relationship	Relationship	87%
Municipal Operations	No Relationship	No Relationship	Relationship	Relationship	No Relationship	Relationship	No Relationship	Relationship	No Relationship	No Relationship	Relationship	Relationship	50%
Security	No Relationship	No Relationship	Relationship	No Relationship	Relationship	Relationship	No Relationship	Relationship	No Relationship	No Relationship	Relationship	No Relationship	42%
Quality of Life	Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	No Relationship	Relationship	Relationship	Relationship	Relationship	Relationship	92%
Solution Presence	38%	50%	100%	50%	38%	88%	63%	100%	63%	75%	63%	75%	

Figure 2 - Analysis of the relationship between startup categories for smart cities and SDG objectives

With the analysis of the relationship between the categories of startups and the SDG objectives, it is possible to visualize in Table 5, the percentage of presence of startups that meet the objectives (goals – SDG). Therefore, the objectives that present the greatest number of solutions are Health and Well-being, and Sustainable Cities and Communities. Those with a smaller presence are Eradication of Poverty and Gender Equality.

Table 5 – Percentual of ODS with Solution Presence

STARTUPS CATEGORY - SMARTCITIES		Solution Presence
GOALS - SDG	• Objective 01 - Eradication of Poverty	38%
	• Objective 02 - Zero Hunger and Sustainable Agriculture	50%
	• Objective 03 - Health and Well-being	100%
	• Objective 04 - Quality Education	50%
	• Objective 05 - Gender Equality	38%
	• Objective 08 - Decent Work and Economic Growth	88%
	• Objective 09 - Industry, Innovation, and Infrastructure	63%
	• Objective 11 - Sustainable Cities and Communities	100%
	• Objective 12 - Responsible Consumption and Production	63%
	• Objective 13 - Climate Action	75%
	• Objective 16 - Peace, Justice, and Strong Institutions	63%
	• Objective 17 - Partnerships and Means of Implementation	75%

Source: Authors, 2024.

In Table 6, we see how startups by category contribute to achieving the SDGs. In this configuration we see that what contributes most is the Planning and Management category and what contributes to a lesser extent are Mobility and Security.

Table 6 – Percentual of Startup Category

STARTUPS CATEGORY - SMARTCITIES	GOALS - SDG
	% of Contribution for the Objectives
Mobility	42%
Urban Infrastructure	75%
Ecological Solutions	67%
Planning and Management	100%
Waste Management	67%
Municipal Operations	50%
Security	42%
Quality of Life	92%

Source: Authors, 2024

5. Conclusion

Cities play an important role in economic and social development, but they face challenges such as unplanned growth and lack of planning, which affect the quality of life for citizens. To address these issues, innovation is essential, especially in the context of smart cities. These cities incorporate technologies to enhance urban management, promoting efficiency and sustainability. The pillars of smart cities are technology, people, and sustainability, aiming to improve the quality of life for citizens while considering the environment and future needs. Startups have a relevant role in this scenario, offering innovative and sustainable solutions aligned with the Sustainable Development Goals (SDGs). They can contribute to SDGs such as access to clean energy, resilient infrastructure, sustainable cities, and responsible consumption. With proper support, startups can play a fundamental role in building smart and sustainable cities. This requires a favorable environment with public policies that encourage sustainable innovation and private investments, along with a collaborative approach among governments, businesses, and communities. Together, it is possible to drive progress towards more sustainable, inclusive, and resilient cities, benefiting present and future generations.

This article sought to answer how Brazilian startups have been developing digital solutions to meet the sustainable development goals in smart cities. To do so, scientific articles were analyzed, and a report developed by Distrito in 2020, the Smart City Report, was used to examine how Brazilian startups are promoting technological solutions to support sustainable development goals in smart cities.

This research found an opportunity for the development of solutions for smart cities, as only 10% of these solutions are aimed at government purposes. It was also presented that the categories in which the solutions were segmented in the report contribute

differently to the achievement of sustainable development goals. In this analysis, the categories that contribute the most to the SDGs are planning and management, quality of life, and urban infrastructure, which coincidentally have the lowest number of solutions, as presented in the report. Another analysis conducted in this material presents the objectives that have a higher presence of digital solutions: Goal 3 - Good Health and Well-being, Goal 11 - Sustainable Cities and Communities, and Goal 8 - Decent Work and Economic Growth. This analysis shows that there is a need and an opportunity for entrepreneurship in objectives that have the lowest presence of digital solutions, such as Goal 1 - No Poverty and Goal 5 - Gender Equality.

The limited presence of research on digital solutions for smart cities and the lack of materials that relate them to sustainable development goals were some of the limitations faced by this research. As a result, there is an opportunity for such a relationship in studies that will be published based on new reports, analyzing solutions from other countries. This study presented an analysis of how Brazilian startups have been developing digital solutions to meet the sustainable development goals in smart cities. As a future opportunity, the intensities of how startups in the categorized sectors contribute to the achievement of the SDGs could be analyzed, as well as an analysis of each target included in the 17 sustainable development goals.

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