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Towards Smart Urban Developments? Innovation Habitats and Tech Parks in Brazil

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Abstract

In line with the UN's global agenda of sustainable development goals (SDG), to achieve a positive transformation towards the sustainability of cities, urban planning practitioners should draw on a series of action plans aimed at combining smart infrastructure to high-density and mixed-use developments. In Brazil, these endeavors are likely to be fostered from the Innovation Habitats – such as tech-parks, coworking spaces, incubators, living labs, etc. – understood as spaces conducive for innovations to occur, as they are the locus of information and knowledge sharing, particularly regarding cutting-edge technology development. However, there is limited knowledge on the extent to which innovation habitats cope with smart urban planning. Therefore, this paper intends to verify this issue through an analysis of the 43 tech parks currently in operation in the country and their integration into respective urban contexts. The results account for three fronts from which it is possible to reflect on the extent to which these parks play a prominent role in promoting a smarter and more sustainable urban development: (i) their legal personality; (ii) their rapport with the city region; and (iii) their relation with the surrounding neighborhoods.

Keywords: smart city, tech parks, sustainable urban planning, Brazil

Riassunto. *Verso sviluppi urbani intelligenti? Habitat innovativi e parchi tecnologici in Brasile*

In linea con l'agenda globale delle Nazioni Unite sugli obiettivi di sviluppo sostenibile (OSS), per realizzare una trasformazione positiva verso la sostenibilità delle città, i professionisti della pianificazione urbana dovrebbero attingere ad una serie di piani d'azione volti a combinare le infrastrutture intelligenti ad alta densità e ad uso misto. In Brasile, è probabile che questi sforzi vengano promossi dagli habitat di innovazione – come parchi tecnologici, spazi di coworking, incubatori, laboratori viventi, ecc. – intesi come spazi favorevoli alla realizzazione di innovazioni, in quanto sono il luogo della condivisione di informazioni e conoscenze, in particolare per quanto riguarda lo sviluppo tecnologico all'avanguardia. Tuttavia, esistono conoscenze limitate sulla misura in cui gli habitat di innovazione affrontano la pianificazione urbana intelligente. Perciò, questo documento intende verificare questo problema mediante un'analisi dei 43 parchi tecnologici attualmente in funzione nel paese e la loro integrazione nei rispettivi contesti urbani. I risultati spiegano tre fronti da cui è possibile riflettere sulla misura in cui questi parchi possono svolgere un ruolo di primo piano nella promozione di uno sviluppo urbano più intelligente e sostenibile: (i) la loro personalità giuridica; (ii) il loro rapporto con la regione della città; e (iii) la loro relazione con i quartieri circostanti.

Parole chiave: città intelligente, parchi tecnologici, pianificazione urbana sostenibile, Brasile

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1. Introduction

Research in smart cities is increasingly receiving attention in several approaches such as knowledge management (Teixeira, Pires Junior and Matos, 2019), sustainable development (Sachs *et al.*, 2019), future studies (Bibri and Krogstie, 2019), urban and regional studies (Hollands, 2014; Neirotti *et al.*, 2014), and many others. While this conceptual evolution is discussed and elaborated in different milieus, the task of providing it with a precise

definition capable of transcending its various understandings is equally problematic. With no intention to overlap the importance of one approach over another, nor to propose a final mediation for this myriad of interpretations, this article aims, instead, to contribute to the literature by providing an analysis that copes the overall notion of smart city with sustainable urban development.

More specifically, we analyze the extent to which the Tech Parks, understood as differentiated spaces where innovation activities take place, align with this development paradigm. As a type of Innovation Habitat (Teixeira, Pires Junior and Matos, 2019), Tech Parks stand out for mixing businesses and research & development at the same place. Thus, they are also spaces conducive for attracting large flows of people and stimulate urban services and amenities. To verify how they relate to smart urban development, we present a legal personality and urban morphology analysis of the 43 technology parks currently in operation in Brazil (MCTI, 2019, a study developed by the ministry on indicators for Tech Parks). While these spaces have received particular attention of Brazilian policy-making both at national and regional levels to support innovation and technological development, there remains several gaps about how they integrate with the urban contexts in which they are located.

The structure of the paper is as follows. To start, we conduct a literature review bridging the concepts of smart cities and sustainable urban development, as well as introducing the concepts of Innovation Habitats (of which Tech Parks are one type) and contextualizing their occurrence into Brazilian administrative law and policy-making. Following, we present the methodology used for searching the primary data and the morphological analysis.

2. Literature review

2.1 Smart and sustainable: a trend for future cities

The notion of inhabiting intelligent/smart cities has been disseminated since the early

1990s (Batty, 1990; Gibson, Kozmetsky and Smilor, 1992), with particular academic recognition from 2010 onwards as a «new urban planning paradigm or set of business strategies rather than as an operating urban system» (Komninos, 2016, p. 197). In general terms, they offer less a delimited conceptual formulation than a general narrative pivoted by distinct approaches related to urban planning and management integrated to solutions based on the deployment of new Information and Communication Technologies (hereafter, ICT) (Neirotti *et al.*, 2014).

On the one hand, this axiom surface critical remarks about how the paradigm reinforces the "smart" rather than the "city" character of the debate. According to Hollands (2014), for instance, this is manifested in the occurrence of a "corporate-oriented smart city", related to ideological appropriations that draw upon narratives of "urban smartness" to capture local development as part of an increasingly globalized private competition. In addition, Vanolo (2013) highlights political discourses adopted by bodies such as the European Union, that tends to produce deterministic classifications about cities being "good" or "bad" according to the level of smart development adopted. On the other hand, this partially broad idea of Smart City can also allow more integrated, look-ahead approaches, with a focus on «smartening up sustainable cities in ways that can improve, advance, and maintain their contribution to the goals of sustainable development, as well as on incorporating these goals in smart city approaches in a bid to enhance their sustainability performance» (Bibri and Krogstie, 2019, p. 46).

The feasibility of planning cities in a smarter and sustainable way is highly contingent in bridging cutting-edge technologies – such as Big Data, Internet of Things (IoT), Building Information Modelling (BIM), among others – and the increasing quest of cities to meet their own needs for the present generation without compromising the needs of the future ones, as the most notable definitions of sustainable development adds (United Nations, 1987; Kidd, 1992). In particular, this reasoning matches the well-recognized United Nations (UN) 2030 Agenda and its 17 Sustainable Development Goals (SDG). According to Sachs (2012), the 2030 agenda is crucial to determine the quality of governance – at all levels – behind this search, as governments «will share information, exchange ideas, encourage

meetings and brainstorming, and work in good faith across cultures» (Sachs, 2012, p. 2209). More specifically, Sachs *et al.* (2019) argue that six transformations are required to achieve the 17 SDG: 1) Education, gender and inequality; 2) Health, well-being and demography; 3) Energy decarbonization and sustainable industry; 4) Sustainable food, land, water and oceans; 5) Sustainable cities and communities; and 6) Digital revolution for sustainable development. Although they all seem to address the Smart City axiom at first glance, transformation no. 5 is effectively the one related to this subject, as initiatives like reducing air pollution in transport and planning compact, safe and healthy environments are at the heart of what governments shall achieve to promote a smart and sustainable quality of life in cities and communities.

2.2 Innovation Habitats and Tech Parks within Brazilian local and regional development

A key-point, then, is to understand how different stakeholders engage with local and regional smart and sustainable development strategies. Globally this research has accelerated in recent years as scholars across social and economic sciences investigate how urban economies are transitioning from an industrial base to another, whose impulse is often attributed to activities of innovation, knowledge and creativity. Emblematic of Porter's (2000) clustering theory, these experiences also have been decisive to the processes of social, cultural and spatial reconfiguration of cities (Scott, 2006; Evans, 2009; Florida, 2014). Indeed, evidence suggests that the more knowledge-based the economic activity, the more geographically concentrated it tends to be, thus reflecting the central role played by spatial proximity (Asheim and Gertler, 2004) – although other research also emphasize the importance of cognitive, organizational, social and institutional proximities (Boschma, 2005) – in the innovation process.

As a result, cities have been witnessing a hatch of spaces conducive for innovation through the sharing of knowledge and technology. For the purposes of this article, these spaces will be framed as Innovation Habitats (hereafter, IH), better represented by Tech

Parks, Innovation Centers, Creative Districts, Incubators and Accelerators, as well as shared spaces such as Coworking Spaces, Makerspaces, Fab Labs, Living Labs, etc. (Teixeira, Pires Junior and Matos, 2019). Particularly within the Brazilian context, six specific IH are regulated by the Federal Law N. 13.243/2016, which provides incentives to scientific development, research, scientific and technological education and innovation, as disposed in table 1:

Type of IH	Description and purpose
1. Development Agency	A body or Institution of public or private nature aimed at the financing of actions for stimulating and promoting the development of science, technology and innovation.
2. Incubator	An organization or structure created to stimulate or provide logistical, managerial and technological support to the creation and development of innovative and knowledge-intensive Startup business.
3. Scientific, Technological and Innovation Institution (STII)	A body or entity of the direct or indirect public administration or a legal private non-profit entity legally constituted under Brazilian laws, headquartered within the country, which includes in its institutional mission or its social or statutory objective, basic or applied scientific or technological research or the development of new products, services or processes.
4. Technological Innovation Center	A structure instituted by one or more STII to manage the institutional innovation policy.
5. Support Foundation	An entity aimed to support research, teaching and outreach projects, institutional, scientific and technological development projects and other projects of interest to the STII to stimulate innovation.
6. Tech Park	A planned complex for business and technological development aimed to promote a culture of innovation, industrial competitiveness, business education, as well as synergies between scientific research, technological development and innovation activities, between companies and one or more STII.

Table 1 - Types of Innovation Habitats legally accredited in Brazil. Prepared by the authors. Source: adapted from DOU – Brazilian Official Gazzette (2016).

Among these IH recognized by the Brazilian government, Tech Parks receive particular attention. According to the Brazilian Ministry of Science, Technology, Innovation and Communications, they have gradually assumed a leading role in the national scientific and technological development because they offer a favourable environment for enabling the innovation of new products, services and processes (MCTI, 2019). In particular, their potential scenario for public policies in this area is valued because «a differential that a

Technology Park offers is the management of innovation, attracting and integrating its elements for the operationalization of mobilizing projects with potential to boost the development of a region, supporting the organization of local clusters and, consequently, generating greater added value to the productive chains» (MCTI, 2015, p. 18-19)[1].

Although Brazilian policy-making instruments indicate an approximation to development oriented by the promotion of science, technology and innovation, little is known about how the deployment of HI – particularly Tech Parks – dialogues with the local dynamics of where they are located. With these ideas in mind, in the remainder of paper we present the methods adopted to perform the intended and analysis and the discussion of the results.

3. Methods

To analyse all operating Brazilian Tech Parks, we departed from the latest report published by the Brazilian Ministry of Science, Technology, Innovations and Communications (MCTIC, 2019), which accounts for 43 parks operating in the country until 2019. Following, we conducted an online search on publicly available information to identify the legal status of each park, assigning the following types: private association, private foundation, public foundation, public company, mixed capital company, municipal authority and no legal personality. To triangulate data on legality, we also looked for an instrument known in Brazil as *Management Contract*, which grants a Public Interest Status to a private foundation or association, therefore making it a Social Organization.

To carry out the proposed analysis on the extent to which Brazilian Tech Parks integrate with their respective urban contexts, we based on the *Lynch Diagram* analysis model (Lynch, 1960). This methodology is particularly widespread among urban planning practitioners and allows assessing specifics of urban morphology aspects. In this case, there is an emphasis on the three relationships levels of each park to its surrounding area – based

1 Both MCTI and MCTIC correspond to the same ministry. The letter "C" was adopted after the 2019 Brazilian federal government ministry reform, which incorporated the Communications area to the former Ministry of Science, Technology and Innovation.

on the concept of *barrier* proposed by Lynch – and also its location in rapport with the city-region, as summed in table 2:

Levels	Relation to Surrounding Area	Rapport with City-Region
1st	**Integrated:** no substantial barrier for pedestrians between the park and the surrounding neighborhood and continuity of streets. This conformation promotes sustainable mobility patterns.	**Urban:** inserted in downtown or consolidated neighborhoods.
2nd	**Adjacent:** the park does not constitute a continuous neighborhood along its surrounding and there might be some barriers to pedestrians around parts of the park.	**Peri-urban:** located on the fringes of the city.
3rd	**Segregated:** there are substantial barriers for pedestrians around most of the park and there is no continuity of streets. This conformation promotes individual motorized patterns.	**Rural:** separated from the urban dynamics, mostly surrounded by rural areas.

Table 2 - Considered elements of morphological analysis. Prepared by the authors. Source: adapted from Lynch (1960).

4. Case Study

4.1 Territorial dispersion of Tech Parks in Brazil

After georeferencing the location of the 43 Tech Parks currently in operation in the country, a first analysis that stands out relates to their proportional distribution across the territory, as shown in Figure 1:

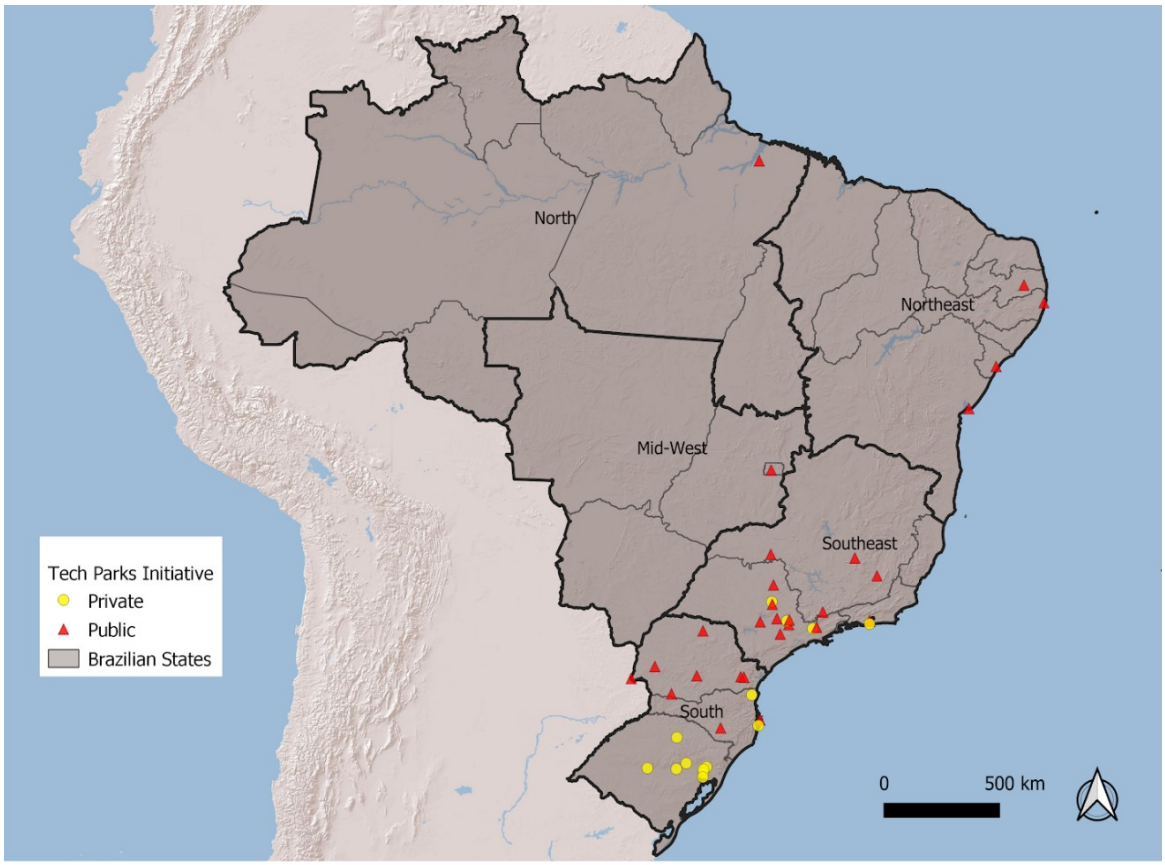

Fig. 1 - Map of Brazilian Tech Parks. Prepared by the authors.

The map presents an evident concentration of parks in the South and Southeast regions of the country, corresponding to more than 85% of the national total. Such unbalance is nothing but a reflection of the chronic inequality of Brazilian regional development, expressed in detail in Table 3:

Region	Public Initiative of Tech Parks	Private Initiative of Tech Parks	Total	Percentage	Population (IBGE, 2019)	Tech Parks per 10m inhabitants	Human Development Index – IDH-M 2010
North	1	0	1	2.33%	18,430,980	0.543	667
Northeast	4	0	4	9.30%	57,071,654	0.701	0.663
Mid-west	1	0	1	2.33%	16,297,074	0.614	0.757
Southeast	14	4	18	41.86%	88,371,433	2.037	0.766
South	9	10	19	44.19%	29,975,984	6.338	0.754
Total	29	14	43	100.00%	210,147,125	2.046	-

Table 3 - Unequal regional development and distribution of Tech Parks in Brazil. Prepared by the authors. Source: adapted from IBGE (2019); Fabiancic et al. (2016).

While the socioeconomic contradictions behind Brazil's uneven development poses a complex challenge – already elaborated by several notable Brazilian urban and regional scholars (Arantes, Vainer and Maricato, 2002; Santos, 1993; Souza, 2010) – an in-depth analysis would require a research effort that is beyond the scope of this study. However, and importantly, this background influences how Brazilian public policies tend to be thought with priority focus on reducing inequalities. On the one hand, figure 1 indicates that the dispersion of Tech Parks across the territory is almost exclusively due to public sector initiatives, thus being a reliable indicator in this regard. On the other hand, is no surprise that all private Tech Parks are concentrated in the South and Southeast regions, as these are the two regions where Brazilian industrial development has been most successful over time.

4.2 Legal personality

Besides partially mirroring the uneven patterns of regional and urban development in Brazil, the analysis also revealed that Tech Parks have existed in the country since the 1980s. However, more than 80% of them (or, 36 out of 43 parks in operation) were opened from the 2000s onwards, as shown in figure 2:

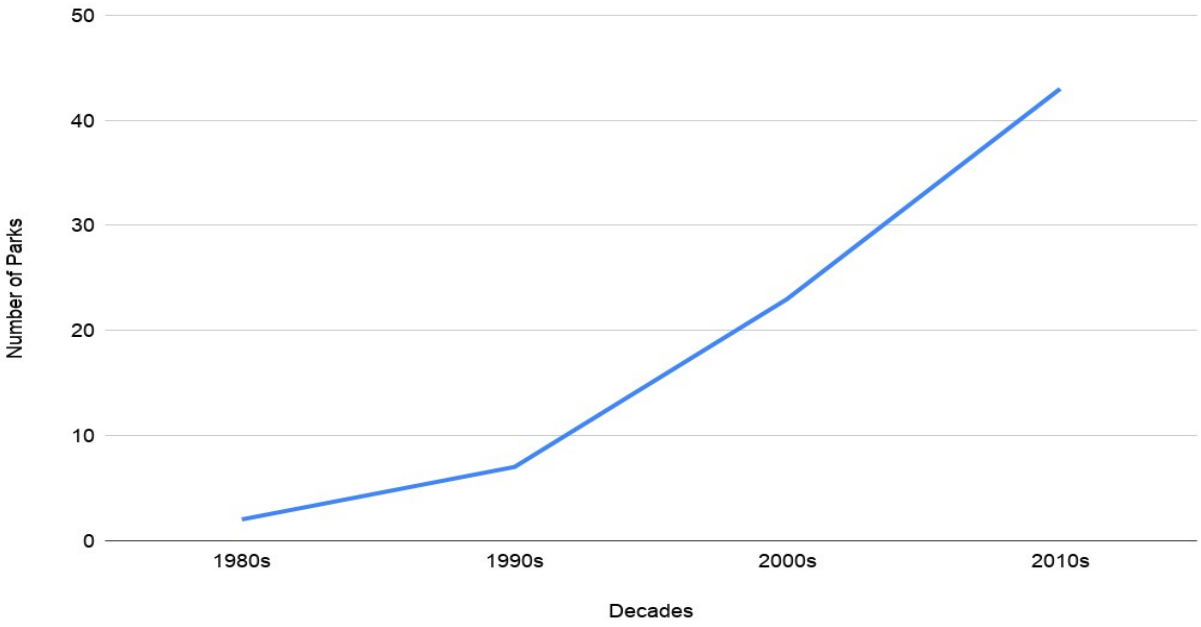

Fig. 2 - Operating Tech Parks in Brazil by decades. Prepared by the authors.

According to Teixeira, Santos and Moré (2018), their legal structure directly reflects in different legal systems and different management models. These differences can play an important role in the Park's ability to offer adequate conditions for innovation. More specifically, table 4 presents the legal personality of the 43 tech parks researched:

Legal Personality	**No.**	**Percentage**
Private Association	17	39.53%
Private Foundation	8	18.60%
Public Foundation	2	4.65%
Mixed Capital Company	2	4.65%
Municipal Authority	1	2.33%
Public Company	1	2.33%
No Independent Legal Personality	12	27.91%
Total	43	100.00%

Table 4 - Legal personality of Tech Parks in Brazil. Prepared by authors.

Based on this information, up to 58.13% of the parks are constituted as private

associations or private foundations and 32% of them were granted Social Organization status upon the signing of a management contract with a government entity. The favorable possibilities of being a Social Organization are associated with obtaining resources through budget amendments by parliamentarians, considering that Social Organizations enjoy the same tax exemptions and immunities as foundations and, being non-profit entities, can participate in public notices of science funding agencies.

In addition, while 67.44% of tech parks are public initiatives, only 9.31% are managed as legal persons within the Public Administration (public foundations, municipal authority and public company). Likewise, just two parks – accounting for 4.65% of the total – are operated by mixed capital companies, thus having a more market-oriented approach. Up to 27.91% of Tech Parks studied do not hold an independent legal personality and are departments of existing public and private universities. It can be limiting to a flexible management and possible partnerships tech parks could pursue with the public or the private sector.

4.3 Macro-morphology: location of Tech Parks within the city-region

As claimed by Sachs *et al.* (2019), the promotion of sustainable cities and communities is the 2030 Agenda axis most relatable to smart urban development. For instance, within the SDG 11 – about sustainable urbanization – there is an indicator related to the rate of land consumption and the rate of population growth. In practical terms, this indicator means that the more compact the land use, the more successful its measurement will be (ECOSOC, 2017). With this in mind, it is possible to admit that a Tech Park located in an area with good connectivity and easy access to public spaces, housing, services, among other amenities, will tend to have a greater potential to be considered a built environment favorable to smart and sustainable development. From this background, the first analysis concerning the urban morphology of the parks accounts for how they are inserted within their respective city-regions:

Rapport with the city-region	Number of parks	Percentage
Urban	11	25.58%
Peri-urban	21	48.84%
Rural	11	25.58%
TOTAL	43	100.00%

Table 5 - Location of the park in regard to the city-region. Prepared by the authors.

Importantly, being located in an area with amenities does not mean that urban-type parks are necessarily more sustainable than those of peri-urban or rural types. Urban parks are expected, for instance, to be fully integrated to their neighborhood context, even as a part of a requalification strategy. However, data indicates that only one of the eleven existing urban Tech Parks matches this integration. Likewise, peri-urban parks can also be representative of good opportunities to decentralize jobs and economic development by stimulating new centralities with housing, public spaces and services. Nevertheless, while 45.45% of urban parks were considered integrated to their urban context, only 19.05% of peri-urban parks hold the same condition. Therefore, both cases show strong evidence that these potentials might not have been taken fully yet.

As to Tech Parks of rural type, 90.90% are segregated from their surroundings. Moreover, all of them are accessed directly by highways and none is adjacent to housing, meaning a very weak connection with ideals of sustainable urbanization, especially regarding transport and reducing emissions. Such a burden, however, is partially justified in the extent that these parks rely mainly on agricultural activities, where open space and specific conditions are needed.

Data also indicates that all private parks, except for one, tend to localize in urban or peri-urban regions, while parks of public initiative are 38.46% of rural type, 42.30% are peri-urban, and only 19.24% are located in urban areas. These figures indicate that although the public sector is striving to provide instruments favorable to the development of innovative habitats, the private sector is the one who can effectively bridge Tech Parks to sustainable and intelligent urban development strategies. However, to verify to what extent this is true, a

more nuanced analyze on how these parks are related to their surroundings is needed.

4.4 Micro-morphology: Tech Parks and their vicinities

Regarding the level of a location, each park has a set of characteristics and challenges concerning their positioning in a smart and sustainable scenario. However, how they interact with the neighborhood is essential to determine the potential to conduct smarter urban development. In this sense, table 6 indicates that 48.84% of Brazilian operating Tech Parks are segregated from their immediate surroundings, hence not providing adequate conditions of active mobility and urbanity. Up to 30.23% of them are adjacent to existing neighborhoods, but still cannot be recognized as a part of the same urban fabric. Less than 1 out of 5 tech parks fully integrates into the city.

Relationship to Surroundings	**Number of Parks**	**Percentage**
Integrated	9	20.93%
Adjacent	13	30.23%
Segregated	21	48.84%
Total	43	100.00%

Table 6 - Relationship of tech parks to surroundings. Prepared by the authors.

As cities around the world move forward a compact city model, they intend to configure more continuous road patterns. Up to 72.09% of Tech Parks are campuses, meaning they have entrances connected with roads and therefore go in the opposite direction of city blocks. Combining this data with the fact that 51.16% of technology parks are fully fenced and gated, it is possible to conclude that most parks add very little in terms of promoting accessible public space to the neighborhood. According to Table 7, 58.14% of tech parks are associated with an adjacent university which improves its knowledge exchange possibilities, but only in 51.16% of cases there is housing available within walkable distance. The latter

factor limits the exchange possibility that a complete mixed-use development has in keeping its citizens connected and foster innovation.

Aspects of surrounding neighborhood	Number of parks	Percentage
University	25	58.14%
Housing	22	51.16%
Direct access to highways	20	46.51%

Table 7 - Aspects of surrounding neighborhoods. Prepared by the authors.

Just as the history of uneven regional development is reflected in the concentration pattern of Tech Parks in the South and Southeast regions, the urban planning model adopted in Brazil throughout the 20th century is also critical to the analysis of how Tech Parks interact with specific local contexts. To be sure, Latin American cities have long lacked an effective planning standard. As Abramo (2007) points out, the Latin urbanization is contradictory and diffuse – or, as the author calls it: a *CON-FUSE City*. More specifically, the contradiction lies in territorial plans socially and spatially uneven, and the diffusion regards on the occurrence of urban agglomerations highly dispersed and segregated.

Moreover, Brazilian Master Plans tend to be influenced by 1930s modernist urbanism, particularly in its imaginary, design and political will. This is confirmed both by urbanistic experiences such as the construction of the federal capital in the early 1960s – the city of Brasilia perhaps represents the most successful modernist plan ever (Holston, 1993) – and by the legacy of a highly technical development model, based on the construction of continent-sized roads (Barat, 1978). These two factors overlapped over time, forming a kind of elective affinity, whose result is an urban planning model favoring individual motorized transport over sustainable, carbon-reduced alternatives (Costa *et al.*, 2020).

Thus, it is hard to precise to what extent the lack of integration of Tech Parks with their neighborhood contexts is contingent on the IH model, or if they are spaces that also reflect a more comprehensive socio-spatial evolution, or if it is a combination of both ends. One way or another, our data shows that there is potential to be developed in this regard. Ultimately, it

is up to stakeholders, whether public, private or mixed economy, to also engage the intra-urban dimension to the Tech Parks planning and management.

5. Conclusion

In a century permeated by dramatic socio-environmental challenges, from climate change to the recent (and still ongoing) COVID-19 pandemic, the combination of technological development and urban planning in an intelligent and sustainable way proves timely and necessary. In this article, we sought to analyze the extent to which Brazilian Tech Parks currently in operation meet some of the requirements to constitute favorable spaces to stimulating smart and sustainable urban development. This analysis is based on the understanding that Tech Parks concentrate large flows of people and businesses daily. Therefore, they can be understood as an example of urban centrality, from where daily demands such as mobility, housing, services and amenities arise increasingly.

We started from a contextualization of the 43 Tech Parks currently operating in Brazil according to their legal precepts and how they are framed in the national science, technology and innovation policy-making. Following, we carried out a twofold analysis of these parks urban morphology. The first one regarded a macro reading of the relationship between Tech Parks and the urban context in which they are located. Subsequently, the analysis focused on its micro-scale, that is, on aspects of the interaction of the parks with their neighborhoods.

Concerning the rapport with the context of urban insertion, our data indicate that urban-type parks have a potential to play a leading role in urban requalification strategies, whether located in city center or consolidated neighborhoods. Regarding the parks of peri-urban types, although they are the majority in the country, less than 20% are entirely integrated into their respective contexts, thus revealing an untapped potential for attracting and promoting more centrality. In turn, rural type parks present conditions isolated from any context of urban density because their existence relate to a different nature of activities,

mainly focused on agricultural innovation. As to the micro-scale analysis, data indicates a critical relationship between Tech Parks and their neighborhood context in terms of sustainable urbanization. While it is hard to determine whether this challenge is due to the Tech Park model or to a contradictory and diffuse urban planning historical pattern, there is evidence of the potential of Tech Parks to catalyze sustainable and smart urbanities by promoting active mobility and creating high-quality public spaces.

As an exploratory study, we do not intend to conclude any analysis of a fatalistic nature. Instead, we hope that contributions given here may spark future endeavors and investigation in two fronts: First, Brazilian parks can improve their strategic visions, assuming their inherent role in the smart and sustainable urban development policy-making. Second, we want this study to be a starting point for future research on urban morphology of Tech Parks or other innovation habitats and their respective potentials to also contribute in the literature about smart and sustainable cities.

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