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URBAN LIVING LABS AS PUBLIC POLICY FOR SMART CITIES: EVIDENCE FROM TECH PARKS IN SÃO PAULO, BRAZIL

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ABSTRACT

Technology Park projects have been developed as Urban Living Labs to plan compact and multifunctional cities that integrate sustainability and innovation. Due to accelerated urbanization, the climate crisis, and post-pandemic challenges in the Global South, governments, businesses, and academia are working together on solutions for smarter and more sustainable cities. In this regard, a case study of the International Hub for Sustainable Development (HIDS) in Campinas, São Paulo, was conducted to comprehend these projects' potential in urban planning processes. This exploratory research is based on data collection following a mix of primary and secondary data and semi-structured interviews with 11 members of the HIDS advisory board with a technical profile. The results demonstrate how this type of initiative in Brazil has been configured as a public policy of innovation with the potential to boost urban planning for smart and sustainable cities. Over time, these projects have multiplied in the country, reaching 93 in 2021, with 58 in operation, 13 in the implementation stage, and 22 in planning.

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INTRODUCTION

Technology parks are defined as a complex for business, research, and development to promote a culture of innovation, industrial competitiveness, and education, as well as the synergy between science and technology, to enable new products, services, and processes (MCTI, 2022). In general, this model requires an institutional structure that guides processes and projects in which governance plays a central role, that is, the definition of how different stakeholders should engage with local actors to ensure smart and sustainable development based on the concept of Urban Living Labs (ULL). This approach encompasses multiple methods of learning and research from public-private partnerships, with innovation as a foundation (Lucchesi & Rutkowski, 2019). It also presupposes collaborative partnerships and sharingof best practices in processes, knowledge, and resources (Veeckman *et al*., 2013). Additionally, issues impacting urban infrastructure, such as water, waste, energy, climate, and mobility, are at the center of priorities in this model of an innovation district, in line with the emerging environmental challenge resulting from population density in urban spaces. In this context, sustainable cities are guided by the UN's 2030 Agenda, a global action plan that unites government and civil society to build a fairer and more equitable socio-environmental agenda. Among the 17 Sustainable Development Goals (SDGs), goal 11 reinforces the importance of "making cities and human settlements inclusive, safe, resilient, and sustainable." There are many definitions for urban living laboratories. However, according to Schliwa (2013), they can be considered a geographically and institutionally delimited arena with a collaborative and experimental multi-stakeholder approach. Its format varies between public-private sector partnerships in which universities play a crucial role (Evans & Karvonen, 2010). As an incentive for the transition from an industrial-based economy to one driven by innovation, science, and technology, in the face of accelerated urbanization and the impact of environmental changes, the Brazilian Ministry of Science, Technology, Innovation and Communications (MCTIC) created, in 2012, the Sustainable Cities Technologies Program to foster innovative solutions in sustainable construction, mobility, and public transport, environmental sanitation and efficient energy systems. In 2018, MCTIC started the execution of CITinova - Integrated Planning and Technologies for Sustainable Cities. Funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Program (UNEP). CITinova also seeks to integrate innovative urban planning tools with participatory management and sustainable development. To this end, the project is structured on three fronts of action: Sustainable Cities Platforms, Integrated Urban Planning, and Investment in Innovative Technologies (Raposo *et al*., 2021). From the perspective of smart cities, urban living laboratories enable innovation applied in shorter time intervals compared to traditional models, allowing prior testing in a controlled environment by transforming technological tools such as the Internet of Things (IoT) and Big Data into solutions for

sustainable development and a low carbon economy (Bulkeley & Castán Broto, 2013).

Innovation districts and public policies in Brazil: The term innovation district refers to concentrations of activities to enhance the innovation agenda through the exchange of knowledge mediated by collaborative governance and sustainable use of urban space (São Paulo, 2022). These projects are developed to associate economic activity and science with quality of life, therefore, they include proposals for urban planning for housing, leisure, mobility, and facilities in the same place, in line with education and research institutes (universities, urban living labs, funding agencies and businesses). Connecting innovation with services and spatial infrastructure of a city amplifiesthe interaction among different actors so that applied research and development are connected with practical application in "urbanliving laboratories." Therefore, the aspect of diverse and inclusive governance, with the ability to adapt to the demands of the participating organizations and, at the same time, guarantee that the sustainable development agenda is contemplated, gains relevance in this innovation model, converging these interests with those of society. Regarding socio-spatial planning, innovation districts are compact, accessible, and connected structures with mixed land use (residential, administrative, and business) in an urban model that connects people. Another relevant feature is the aspect of sustainable urbanity, with solutions designed to promote mobility and the intelligent management of resources and waste. Thus, they represent the possibility of revitalizing city spaces, which can follow three models, according to Katz & Wagner (2014):

i) anchor-plus: regions in which anchor organizations play a central role in the formation and dynamism of the district;
ii) re-imagined urban areas: old or deactivated industrial areas that are re-qualified;
iii) urbanized science parks located in peripheral areas with science parks that start to attract populations in their surroundings.

Furthermore, Van der Veer (2017) added that an innovation district should include the following:

1. Economic Viability, through its technical capabilities to produce products and services and generate business;
2. Sources of funding: investors, government subsidies, philanthropic funding, and venture capital, among others;
3. Human capital: people willing to work, live or visit the space;
4. Infrastructure: easy access to means of transport and high-quality information and connectivity networks, in addition to a physical structure that must include a wide range of services, such as restaurants, shops, hotels, and cultural facilities;
5. Affordable housing: offering housing at a fair price to attract different profiles of residents and avoid gentrification;
6. Integration: the district must be integrated into the urban and social dynamics and not restricted to its territorial limits;
7. Innovation ecosystem: different sectors and activities must connect through collaborative research and cross-cutting technologies that optimize the value chain.

In summary, an innovation district corresponds to an urban concentration that facilitates social and organizational interactions that favor innovation, articulated by physical assets (architecture, mobility, and sustainability), economic (people, public and private organizations, sources of financing and supply of work) and relationship networks (connections based on trust that help to reduce transaction costs) that are motivated to create innovations (Katz & Wagner, 2014). The relationship networks actively cultivated in an innovation district occur between actors in the same sector of activity and agents from different fields of activity. Brazil seeks to enter the international agenda of knowledge production with the growth of graduate programs and research centers. However, the process of transforming knowledge into solutions is more complex, although the country has compelling examples of success, as is the case of its national agriculture, knew how to take advantage of productive lands and favorable climate, in addition to the agricultural technology developed by the Brazilian Agriculture Research Corporation.[1] (Embrapa), in partnership with leading universities such as the Luiz de Queiroz College of Agriculture (Esalq-USP) in Piracicaba (São Paulo). International experience shows that there are several ways to configure the creation of technology parks, with two models related to their conformation with the public power: the government as the primary agent, in a state or mixed format, or via private law entities with public participation (cases of Europe and China), or the American model, in which universities undertake these projects in partnership with private entities (Steiner *et al*., 2008). In both cases, according to the authors, the commitment of the different levels of government, businesses, universities, and research institutes is critical for the success of the project, in addition to being part of programs and strategies of regional and local development for competitiveness. Regarding its strategy, according to Bolton (1996), tech parks can be static (they only offer the physical structure for companies to settle in with low interaction between the manager and the firms) or dynamic (spaces aimed at the generation and growth of new technological ventures with ties to strong and active relationships between research institutions and companies).

Historically, in Brazil, in terms of public innovation policy, the first incubators came from a 1985 Federal Government project, through the National Council for Scientific and Technological Development (CNPq), an entity linked to the Ministry of Science, Technology, Innovation and Communications (MCTIC), to encourage research in Brazil. And, in 1987, the National Association of Entities Promoting Innovative Enterprises (Anprotec) was created to articulate the agenda of Technological Parks and Incubators. In the case of the State of São Paulo, the government is responsible for implementing and guaranteeing the maintenance of higher education and technological development institutions. The public policy of São Paulo for the Technological Parks configures them as a legal entity with specific social interests and must have a management model that presents economic viability adequate to regional economic vocations in partnerships with the private sector to ensure financial sustainability. Therefore, they need to be conceived with real estate projects for a mixed-use profile that should enable investments in infrastructure. According to the National Association of Entities Promoting Innovative Enterprises (Anprotec),a technological park is described as a "planned, formal, concentrated and cooperative industrial complex focused on products and services with a scientific-technological basis, which brings together companies whose production is based on research developed in R&D centers linked to the park" (Anprotec, 2022). Likewise, the International Association of Science Parks (IASP) defines this type of project as "organizations managed by specialized professionals to increase the wealth and well-being of their community, through the promotion of a culture of innovation and competitiveness of businesses and associated techno-scientific institutions". Therefore, these projects must reinforce three main initiatives, according to IASP (2022):

a) manage and stimulate the flow of knowledge and technology between universities, research institutions, companies, and markets;
b) facilitate the creation and growth of technology-based companies through incubation and spin-offs;
c) provide other services in a physical space with high-quality support services.

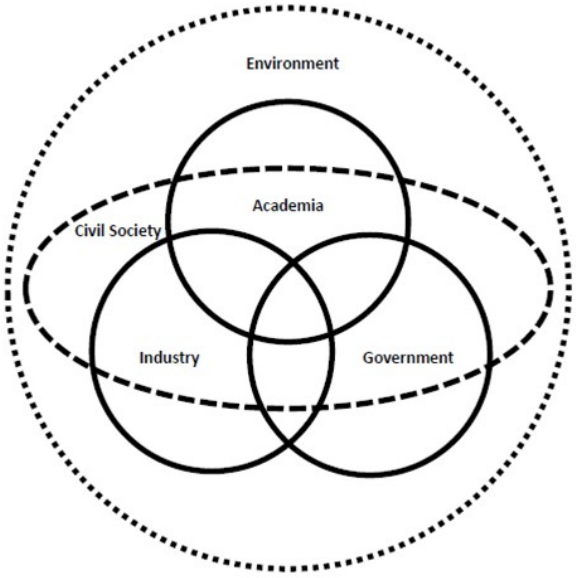
It is an enterprise that is based on the transfer of knowledge and technology to increase the production of wealth in a given region. In short, they are spaces that offer opportunities for companies to transform research into solutions by bringing research centers and

[1]The country's federal government established Embrapa in 1973 to develop the technological foundation for a genuinely tropical agriculture and animal farming model. The initiative has been tasked with providing Brazil with food security and a leading position in the international market for food, fiber, and energy. Embrapa today is one of the largest agricultural research corporations in the world, with half a century of contributions focused on innovation, efficiency, sustainability, and social inclusion. Source: Brazilian Agriculture Research Corporation. Available at: https://www.embrapa.br/en/international

universities closer to companies and entrepreneurs. This model is already an innovative instrument in developed countries to stimulate competitiveness and generate jobs, social welfare, and taxes (Steiner *et al*., 2008). However, the concept of technology parks is a recent development. For example, the establishment of Stanford Industrial Park in 1951 was critical in the emergence of Silicon Valley, a project anchored to Stanford University, which was facing financial difficulties at the time and negotiated using some campus land for commercial purposes. In addition to the fundamental role of the university, research institutes and private companies worked together in the valley's development. At the same time, Stanford University sought support from the public sector to strengthen the area of electronics, motivating the beginning of the semiconductor industry (Etzkowitz & Leydersdorff, 2000). Other experiences in tech parks around the world that are also linked to universities inspired similar investments in Brazil, such as the Paris-Saclay, in France, and Coventry, in the United Kingdom, although this synergy between scientific knowledge and the productive sector is still a recent issue in South America. Most recently, tech parks were highlighted by configuring a public policy of the state government of São Paulo with the creation of the Paulista System of Technological Parks (SPTec), whose objective is to "attract investments and generate new knowledge-intensive or technology-based companies that promote the economic development of the State" (São Paulo, 2006). Furthermore, in several Brazilian cities, there are already innovation ecosystems that call themselves Brazilian Silicon Valleys, such as the Electronics Valley in the municipality of Santa Rita do Sapucaí, in Minas Gerais, the Sandwich Valley, in Bauru (São Paulo), the Rapadura Valley, in Fortaleza (Ceará), or the Pinhão Valley, in Curitiba (Paraná), all of which unite and strengthen the entrepreneurial ecosystem of these regions through investments in startups.

Urban sustainability as a strategic driver for HIDS: Annerstedt and Haselmayer (2004) describe three generations of technology parks. The first is characterized by being an extension of universities and research projects that generated companies aiming at creating technology-based companies and the interaction between university and industry. This generation encompasses the "Pioneering Parks." However, an emblematic piece of this group is the philosophy adopted by "Science Push," that is, a linear idea of how to 'make innovation,' where the original, unusual ideas arise from research and development (R&D) with remote participation of some researchers and university departments. Furthermore, these first-generation parks are managed entirely by the park's core university (ANPROTEC, 2008; European Commission, 2007; Giuliani, 2011). The second generation arose, incorporating a new characteristic to the model through the transition from science-push to demand-pull. If, on the one hand, the guiding premise of the first generation stems from the knowledge of basic scientific research, on the other hand, this new generation emerged during the 1970s to 1990s in the central countries of capitalism and is configured by the autonomy of the new tech parks.Although it can still organize itself as an extension of the university, it is also possible for the model to act as an institution independent of the teaching and research bodies. In this sense, its management becomes more linked to companies. According to ABDI and ANPROTEC (2007), the focus is strengthening the university-industry interaction to the first generation's detriment. There is also more evaluative content in the financial or institutional spheres of the physical areas linked to university campuses, intending to generate spaces for the implementation of companies in the context of a particular region with projections for a Technological Pole. The exploration of scientific results in the initial stages of the innovative process becomes detailed, prioritizing the final impacts that guide R&D within the park.

According to Vedovello (2000), technology parks present adaptations to accommodate stakeholders with multiple and heterogeneous interests and expectations, such as universities, research centers, entrepreneurs and so-called academicentrepreneurs, financial agents, and venture capitalists. In the same period, the institutionalization of parks-promoting associations took place with the creation of the International Association of Science Parks (IASP) and the United Kingdom Science Park Association (UKSPA) in 1984. Following this advance, the third generation, in particular, is essentially centered on the local community, having as starting points the human being, open innovation, and creativity, arising from the favorable environment for economic, academic, and governmental actors (Annerstedt & Haselmayer, 2004). A third-generation park offers a range of services that contribute to developing the entrepreneurial culture of its region to establish interactive communication between creators and users of knowledge and technologies. The main difference between this generation of parks from the previous ones is their concern with an interactive model of governance to deal with academics, entrepreneurs, government, and the local community demands. Its governance model is based on a long-term partnership between the public and private sectors, in which stakeholders work together at the strategic level. While the first two generations of science parks were established mainly on the outskirts of cities, consciously separated from the central region, the third-generation parks are an organic part of the urban and peri-urban regions that host them, and their objectives are not tailored to suit the market interests alone (Annerstedt & Haselmayer, 2004). As a result, this model questions the linear logic of economic utility only toincorporate socially responsible activities with transparent flow between the actors participating in the process. In this case, the success of this type of tech park is also measured by its socio-environmental impact. Although universities remain the prominent participants in science parks, cooperation between stakeholders gains centrality and becomes the nucleus of third-generation science parks. Multi-level and multi-actor governance models are highlighted as an important aspect of implementing initiatives that move towards the quadruple helix with the addition of a fourth element, the civil society, given the need to align the strategic objectives of the actors with the policies and objectives of the arrangement as a whole (Bellandi *et al*., 2021). Furthermore, interaction arrangements between universities, government, business, and community have recently introduced a fifth element, as stated by Carayannis & Campbell (2010): sustainability. This model highlights the dynamics of the co-construction of knowledge and innovation, considering social objectives that encompass sustainable development. Sanches, Lemes de Oliveira & Celani (2021) point out that HIDS was planned as a five-helix innovation model, that is, society and the environment are incorporated into the triple helix model formed by academia, industry, and government (Figure 1).



Source: adapted from Carayannis *et al*. (2012)

Figure 1. Five-Helix Innovation Model

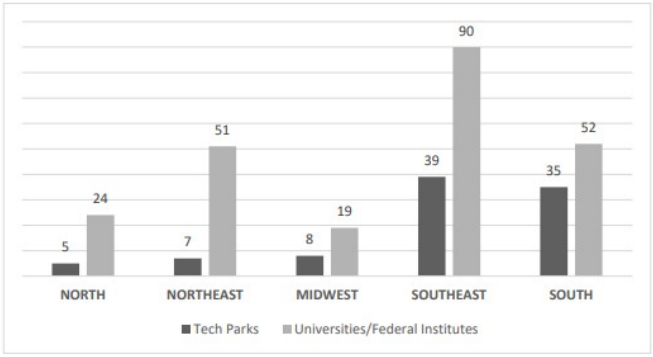
The São Paulo System of Technological Parks: Developing countries such as Brazil have only recently awakened to the importance of technological innovation. However, some instruments,

including laws and tax incentives, have been created to advance this agenda, including technology parks. The perception of the importance that these projects to induce innovation and development in the United States and European and Asian countries led to the implementation of these activities in South America. Only in Brazil, tech park initiatives have multiplied over time, reaching 93 in 2021, with 58 in operation, 13 in the implementation stage, and 22 in the planning stage. Despite a greater concentration in the South and Southeast regions in the country, there are already parks in operation in all Brazilian regions, involving initiatives in 20 states and the Federal District, as shown in Figure 2.

Source: MCTI-InovaData-Br Platform (2021).

Figure 2. Geographic distribution of the 71 technology parksin Brazil

Thus, in partnership with the São Paulo Research Foundation (Fapesp) and with resources from the Secretariat of Development, a project was started to implement the "Paulista System Technology Parks" (SPTec). Itsregulation defined the support entities and technology-based companies that could benefit from state incentives. Additionally, the granting of incentives to companies that install themselves in SPTec parks was established by decree in 2006, which defined the objectives of "fostering, promoting, and supporting the initiatives of Technological Parks in the State of São Paulo" (São Paulo, 2006). Brazil already has other consolidated regions in terms of technology parks. The best known is Porto Digital, in Recife (Pernambuco), with more than 250 companies, and the São José dos Campos Tech Park (São Paulo), in operation since 2009, with around 300 companies and teaching and research institutions, among them some of the international relevance such as Airbus, Boing, and Embraer. In the latter case, the Aeronautics Institute of Technology (ITA) has academic centers of excellence in the region and a favorable geographical location in the country's most populous, wealthy, and industrialized state. Currently, there are 32 initiatives to implement technology parks throughout São Paulo. Of this total, 17 are already provisionally accredited by SPTec: Barretos, Botucatu, Campinas (Unicamp Research and Innovation Hub and CPqD), Ilha Solteira, Mackenzie-Tamboré, Piracicaba, Ribeirão Preto, Santo André, Santos, São Carlos (ParqTec and EcoTecnológico), São José do Rio Preto, São José dos Campos, São Paulo (Jaguaré and East Zone) and Sorocaba. Furthermore, according to data from Amprotec (2022), Brazil has 363business incubators, 43 technology parks in operation, and 60 in implementation and design, in addition to 57 accelerators. To be part of this type of entity, Wasim (2014) lists three main infrastructure flows: physical, social, and communication. In addition, it requires a good location, incentives, and services, anetwork of contacts to attract technology-based companies, and entrepreneurial culture. In general, these projects comprise four types of infrastructure: buildings (land use, water system, energy, and security), technology, green areas, communication (connectivity, data center), and social facilities (medical center, sports area, commercial space, food court, housing, and daycare centers) in a mimetic process of a city planning. In addition, for participating companies, there are several benefits, such as access to knowledge and R&D equipment from universities, qualified human resources, training, and tax incentives. However, it is interesting to note that if the construction of a technology park in a given region is justified by the existence of knowledge-generating institutions, such as universities and research institutes, some regions of Brazil, such as the North and Midwest, are less favored by this policy in contrast to the high concentration of initiatives in the Southeast region, exposing the internal inequalities of access and financing of Science, Technology, and Innovation in the country, as shown in Figure 3.



Source: adapted from MCTIC (2021).

Figure 3. Brazilian Initiatives by Parks, Universities, and Federal Institutes by Region

DATA AND METHODS

A case study of the International Hub for Sustainable Development (HIDS) in the city of Campinas (São Paulo) was carried out to investigate the potential of these projects in urban planning processes. From an exploratory approach, this study was based on an analysis of official government documents on innovation strategies via technology parks, for example, federal and municipal plans, and semi-structured interviews with 11 technical profile representatives of the HIDS advisory board. The data were collected based on the 2021 report on Technological Parks in Brazil, whose base is the MCTI-InovaData-Br Electronic Platform[2], which allows the integration and monitoring of the development of technology parks in Brazil and allows the parks to update your information at any time, including financial indicators. The questions raised in the interviews for this work were divided into four key themes: (i) how the urban living laboratory approach was planned (ii) types of partnerships and the role of research institutions in this project; (iii) smart and sustainable infrastructure challenges, and (iv) the role of the Sustainable Development Goals (SDG).

Case study: HIDS Campinas as anUrban Living Lab: With around 50,000 daily visitors, the campus of Campinas State University can be compared to a small city. The challenge of managing the campus mimics the complexity of governing a municipality. Amid discussions about solutions for more sustainable cities, Unicamp researchers saw the campus as an opportunity to work in a living laboratory to create a model of energy efficiency. In partnership with the private sector, the

[2]InovaData-BR is a communication and information technology system that collects and processes quantitative and qualitative data for the systematization, integration, and monitoring of Technological Parks in Brazil and their resident companies and organizations. The Platform is an initiative of the Ministry of Science, Technology, Innovations, and Communications (MCTIC) with the technical and methodological support of the Center for Management Technologies (NTG) of the Federal University of Viçosa (UFV).

campus launched the Sustainable Campus Project in 2017, in partnership with the Brazilian energy company CPFL Energia, which combines energy savings with Internet of Things (IoT) technology to connect appliances and capture data from sensors connected to the internet. This project is expected to save the university between R$1.5 million and R$500,000 in lighting costs per year. With smart technology, managers can monitor its operation remotely, in real time, making it possible to identify failures in some equipment and quickly fix them, improving energy efficiency. Campinas and its metropolitan region stand out as a technological center of innovation and entrepreneurship, with incubators, startups, universities, research institutes, and investors. The region is the so-called "Brazilian Silicon Valley" and encompasses cities that stand out as specialized centers of innovation and entrepreneurship. It concentrates more than 50,000 companies, including multinationals such as Honda, 3M, Bosch, HP, Basf, IBM, and Dell, forming the third largest industrial park in the country. Another relevant point in the region is the presence of more than 12 research and development centers, including the CPqD, the former Telebrás Research and Development Center, which, after the privatization of the company, became a private foundation, in addition to the universities Pontifical Catholic University (PUC), Campinas State University (Unicamp), Mackenzie, Paulista University (Unip), and Facamp. It is 99 km northwest of São Paulo, the state capital, and occupies an area of 794,571 km2. With a population of 1,223,237, it is the third most populous municipality in São Paulo and the fourteenth in the entire country (IBGE, 2021).The region comprises 19 municipalities and has more than 2.6 million inhabitants, concentrating about 3% of the Brazilian GDP. The municipality is close to the capital, So Paulo (96 km), Brazil's financial center, and the port of Santos (172 km), Latin America's largest, which is critical for the success of these ventures. Unlike industrial districts, which should be close to sources of raw materials, labor, and the consumer market, technology parks depend on proximity to knowledge-generating institutions, highly qualified human resources, and multimodal transport infrastructure. Campinas encompasses all these favorable characteristics, as shown in Figure 4.

Source: Campinas City Hall (Campinas, 2022).

Figure 4. Multimodal map of Campinas

The Development Company of Campinas High Technology Pole (Ciatec), a mixed capital municipal company, is responsible for planning and executing the city's science and technology policy in partnership with the Micro and Small Business Support Service (Sebrae) and universities. In August 2021, the Municipality of Campinas sent to the City Council a statement based on the legal framework for startups, sanctioned by President Jair Bolsonaro at the time, in June 2021, to encourage the installation of new companies, creating a fund to make projects viable, strengthen an environment for innovative solutions and the possibility for the government to hire startups. As a result, the expectation is to increase the number of startups in the city by up to 30% (500 new businesses) in the first two years (Campinas, 2022). Other recent investments in innovation include the Bioethanol Science and Technology Center (CTBE), where the Federal Government will develop research, and the National Synchrotron Light Laboratory (LNLS), which is part of the National Center for Research in Energy and Materials (CNPEM), social organization supervised by MCTIC. Another initiative at the local level was the launch, in August 2019, of the Joint Parliamentary Front to Support Technological Parks with the function of stimulating and supporting the development of public policies for the creation or improvement of Technological Parks in Brazil. Minister Marcos T. Pontes (MCTIC) presented the study of Technological Park Indicators at the event. According to published data, in the 2000s, there were only ten technology park initiatives in Brazil. This number increased to 43 consolidated parks in the country and 12,000 startups. In line with this government commitment, Unicamp made available an area of 1.4 million m² acquired in 2013, known as Fazenda Argentina, located on the outskirts of the campus. This space represents 60% of the university's main campus and is part of a strategic region for the development of the municipality integrated by the High Technology Pole Ciatec II, composed of research, technology, andinnovation institutions, including CNPEM, SPTec, Santander Data Processing Center, the Eldorado Research Institute, Embrapa and the Unicamp Innovation Agency (INOVA). Despite being still in the planning and legal formatting stage, the International Hub for Sustainable Development (HIDS) aims to attract the interest of more national and international institutions. Thus, the participation and involvement of different actors in the planning, implementation, and execution stages of its activities represent a differential in governance. Among the 14 institutions that form the HIDS,6 are universities (Unicamp, PUC-Campinas, Facamp, CPQD, Instituto Eldorado, and CNPEM), 4 are private companies (TRB Pharma, Cariba Empreendimentos e Participações, Cargill and CPFL), 1 is a public company (Embrapa), 1 is a mixed-capital company (Sanasa), and 2 are government representatives (Campinas Municipality and São Paulo State Government) as shown in Figure 5.

Source: HIDS (2022).

Figure 5. Aerial view of HIDS and its member institutions

Faced with the scenario of strong urbanization and its environmental impacts, especially climate change, and the urgency for the transition to sustainable development, HIDS proposes to bring together innovative solutions that, at the same time, support the adaptation and mitigation of socio-environmental impacts aligned to the United Nations Sustainable Development Goals (SDG). The post-pandemic perspective accelerates urban transformations and gives even more centrality to science and technology in reducing inequalities and improving citizens' quality of life. For example, in the field of technology parks, each park needs to develop a specific CTI project, which details its profile and areas of specialization.

However, all of them must comply with the criterion of being environmentally sustainable (Steiner *et al*., 2008). Historically, the United Nations has always been at the forefront of discussions and proposals for sustainable development models. In 1972, the United Nations Conference on the Human Environment (Stockholm Conference) promoted a worldwide debate on global environmental problems for the first time. One of the first references to consolidate the expression sustainable development appeared in 1987, entitled Our Common Future, or Brundtland Report, which established the incorporation of the environment into economic aspects to guarantee the needs of the current generation without compromising the ability of future generations to meet their needs. In 2000, the UN adopted the Millennium Development Goals (MDGs), however broad and complex to measure. The need for sustainable development to be measured to become an object of monitoring set precedence to the creation of the Sustainable Development Goals (SDGs) in 2015, listing 17 objectives and 169 goals that should be achieved by 2030. The relevance of sustainability in the link with innovation, according to Nidumolu *et al*. (2009), is that it should be a business driver based on the profile of companies, clean technology, and environmental education, among other initiatives. The authors propose five transversal stages to justify that sustainability is now the critical driver of innovation through five distinct stages of change:

1. Viewing compliance as an opportunity besides to follow the rules and procedures by the laws;
2. Making value chains sustainable;
3. Designing sustainable products and services;
4. Developing new business models; and
5. It is creating new practices with a sustainability lens that questions the current production model.

the sustainable development agenda. When considering this practice, the HIDS, through its Sustainability Assessment component, relied on tools already developed at a global level to incorporate the SDGs in an effective, efficient, and measurable way (DEPI, 2020).

Smart and sustainable urban design: The HIDS proposal is to be a model hub of innovation and urbanism based on the concept of a "15-minute city", with easy access to safe and pleasant walking paths, or by bicycle, which, in practice, reflects the reduction in the need to travel to access services, work, leisure and education (Moreno *et al*., 2021). Some aspects of sustainable urban planning were prioritized in its socio-spacial design:

Squares, parks, and green areas*:* the territory in which the HIDS is located has several areas of natural vegetation, environmental reserves, and springs that must be preserved considering their ecological and social relevance. Therefore, preserving local fauna and flora is a criterion for maintaining the balance of the local ecosystem. In line with the HIDS sustainability proposal, the creation of new green spaces, such as squares, must also be prioritized to guarantee the presence of vegetation cover and minimize impacts.

Bike and walking paths*:* HIDS will adhere to the guidelines of the Brazilian National Urban Mobility Policy, which states that infrastructure should be planned to allow for connected bike paths and walkability, streets with sustainable drainage systems, leisure activities, ecological corridors, and good afforestation to integrate mobility with nature.

Housing*:* sustainable and inclusive housing models are also foreseen and must be integrated into the study, work, commerce, and leisure structures to meet different housing profiles and demands.

Table 1. Characteristics and general aspects of the HIDS sustainability assessment

CATEGORIES AND GENERAL ASPECTS OF THE HIDS SUSTAINABILITY ASSESSMENT			
ECONOMIC	**ENVIRONMENTAL**	**SOCIAL**	
· Financial performance	· energy	· Good labor practices	· Occupational health and safety
· Direct economic impacts	· Water		· Labor relations, equal opportunities, and, remuneration
· Purchasing management	· Emissions		· Training and Education
	· Waste and Effluents	· Human Rights	· Supervise possible child and slave labor
	· Impacts of products and services		· Non-discrimination
	· Transportation		· Human Rights supplier assessment
	· Biodiversity	· Social Responsability	· Support to local communities
	· Compliance with environmental laws		· Anti-corruption policies

Source: Adapted from HIDS (2022)

Bearing in mind that HIDS is expected to be a regional development model that encourages sustainable innovation, it aims to: (i) support scientific and technological activities (CTI), integrating the university and technological campuses with the rest of Campinas; (ii) provide a regional development model that encourages innovative and sustainable development; and (iii) position itself as a leading innovation center in Latin America, to integrate STI knowledge to achieve the UN Sustainable Development Goals (HIDS, 2021). The HIDS proposal, according to its mission, is to be a "model district of smart and sustainable urban development in the form of a living laboratory," inspired by the 17 SDGs. For this, the hub was born with the vision of:

> "Contribute to sustainable development, joining national and international efforts to produce knowledge, innovative technologies, and education for future generations, mitigating and overcoming contemporary society's social, economic, and environmental weaknesses." (HIDS, 2021)

Its priorities connected to the SDGs are water savings, renewable energy, active mobility, adaptation and mitigation of climate impacts, and waste management. It is interesting to point out that, concerning the proposals of its predecessor MDGs, the SDGs encourage companies to apply creativity and innovation to solve development challenges sustainably. In the business sphere, launched in 2000, the Global Compact is the UN initiative for companies to get involved in

Schools*:* Training youth and promoting science and technology will help to train and retain talent at the local level, as well as supportthe quality education of children of HIDS employees.

Public transport*:* public transport must cover internal displacement and connectivity to other points in Campinas and the region. Low-carbon mobility must include new technologies, such as electric vehicles.

Markets, shops, restaurants, and cafes*:* taking into account the mixed land use proposal, small businesses integrated with other services, such as housing and education, must meet local demands for products and services, such as markets, stationery stores, bakeries, and restaurants distributed throughout the territory, avoiding their concentration.

Hospitals and health clinics*:* the development of new hospital facilities should allow the provision of public and private health services and expand the offer of health treatments.

Other services of general interest*:* providing basic private and public services to the population, such as post offices, banks, and registry offices, avoid the need to travel to external areas.

Aspects of multi-level and multi-stakeholder urban governance: Technology parks have been configured as environments for

experimenting with new models of urban governance to create and develop solutions aligned with the challenges of sustainability and climate change (Bulkeley & Castán Broto, 2013). In this model, the formalization of governance structures, policies, and decision-making processes is strategic to manage the resources necessary for its implementation and to channel civil society participation. This characteristicimplies new forms of governance with the moreactive participation of public, private, and hybrid actors in new arrangementsthrough partnerships and collaborative networks (Newell *et al*., 2012). Aspects of administrative bodies, management indicators, financial aspects, partnerships, alliances, and actors are essential to materialize the project and ensure that short, medium, and long-term objectives are met. Table 2 shows the governance aspects suggested to HIDS according to its Business Model.

Table 2. Governance aspects suggested for HIDS

Actors and roles	Communication	Ownership	Law	Autonomy	Control	Market
Who makes the strategic decisions?	Accountability modalities	Who owns the land, sites, infrastructure, and buildings that comprise it	Who decides land uses?	Are the owners managing their land following pre-established rules?	What control does HIDS have over activities and tenants in the district?	Are prices regulated or set by the market?
Who makes operational decisions?						

Source: adapted from interviews

Table 3. Governance aspects defined for HIDS

administrative bodies	performance indicators	financial guidelines
•General Assembly composed of all members •Administrative Council •Asset Council to coordinate owner interests •Admissions Committee •Executive Team to manage the operation	•Economic: cash flow, tax and budget management •Operational: security, cleaning, services and maintenance •Communication: implementation of the marketing, communication and events plan •Business, Technology and Innovation: new businesses, patents, projects, incubated and accelerated startups, jobs generated •Community: activities with stakeholders and satisfaction index	•Infrastructure costs: construction and acquisition of equipment •Cost with staff •Communication and marketing costs •Operation and maintenance costs: software and hardware •Revenue streams: (i) membership fees; (ii) sale of services; (iii) public funding; (iv) international funding; (v) private investment

Source: adapted from interviews

To define the above aspects, some governance indicators were supported by the parameters of actors and roles, communication, ownership, law, autonomy, control, and market (Table 3). Decisions must be made on various issues: suitability, participation, goals and performance indicators, anexternal board of directors, accountability, and reports.The effectiveness of the governance model, which must be networked, given the scenario of different actors and interests, is related to critical factors such as trust, consensus, and specific competencies (Newell *et al*., 2012). Achieving the strategic goals of HIDS and fulfilling its value proposition depends on its ability to create strategic partnerships with complementary institutions at the local, regional, and national levels. The institutions and networks with which HIDS could collaborate were identified considering the convergence of their fields, the relevance of their actions, and the projection of institutions with the potential for effective collaboration with HIDS. Such partnerships and alliances will be implemented by various means: memoranda of understanding (MOU), consortia, and associations, among others.

DISCUSSION AND CONCLUSION

The construction ofmore inclusive, resilient, and sustainable city le cities, as foreseen in the Sustainable Development Goals, requires the integration of different actors and levels of government to combat historic urban problems, such as, social inequality, poverty, and lack of access to services (sanitation, green spaces, culture, health, education, and security). After all, there is already a consensus that the costs of environmental degradation, especially the effects of climate change, generate a more significant impact precisely on the most vulnerable and urban populations. Given this scenario, it is evident from the case study presented on the HIDS-Campinas that the model of smart and sustainable cities tested in technology parks as an urban living lab can provide innovative solutions to improve the population's quality of life and, at the same time, balance economic development with the environment. In partnership with universities and research centers, the formulation and implementation of innovation policies based on scientific evidence have significant potential to broaden the spectrum of opportunities for sustainable development and equitable promotion of social and environmental rights.

Therefore, rethinking urban planning to enable environmental resilience requires a broad and diversified dialogue with the different actorsto contemplate effective and equitable socio-environmental impacts. This plural participation can help public managers to effectively meet the demands arising from current and future urban challenges, as population growth and urban density tend to increase worldwide. What has been developed within the scope of technology parks such as HIDS is also in line with its proposal to provide information, tools, methodologies, and innovative business models in services and products that fully contemplates environmental and social aspects in their value chain. This article examined how the urban living labs concept is being operationalized in the contemporary urban setting by exploring a case study. As suggested, ULLs are emerging as a form of collective urban governance and experimentation to address various urban challenges by integrating sustainability intothe innovation process. The paper concludes that the role of research institutions and universities in Brazihas been changing as they are being recognized more than knowledge producers. However, they also have the responsibilityto bring social and economic benefit to society. It requires a new governance model in which different urban actors come together to create solutions for sustainable urban development.

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