RELISE

DIGITAL-AGE ENTREPRENEURIAL ECOSYSTEMS: TECHNOLOGIES AND THE TRANSFORMATION OF INNOVATION GEOGRAPHIES[1]

ECOSSISTEMAS EMPREENDEDORES NA ERA DIGITAL: TECNOLOGIAS E A RECONFIGURAÇÃO ESPACIAL DA INOVAÇÃO

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ABSTRACT

The evolution of digital technologies has the potential to profoundly transform entrepreneurial ecosystems, challenging the territorial logic that has historically shaped their formation and development. Digital platforms, connectivity infrastructure, and new forms of interaction among economic and institutional actors create a decentralized innovation environment, where knowledge, capital, and talent are no longer confined to geographic boundaries traditionally associated with cluster models. This essay discusses how digital technologies support the configuration, management, and dynamics of entrepreneurial ecosystems by articulating evidence and theoretical implications. It concludes that technological transformation does not eliminate the importance of local factors but requires public policies to adopt a hybrid perspective, integrating digital and physical dimensions to foster more inclusive and resilient ecosystems.

Keywords: entrepreneurial ecosystems, digital transformation, innovation, public policy.

RESUMO

A evolução das tecnologias digitais tem potencial de transformar profundamente os ecossistemas empreendedores, desafiando a lógica territorial que historicamente articulou sua formação e desenvolvimento. Plataformas digitais, infraestrutura de conectividade e novas formas de interação entre atores econômicos e institucionais geram um ambiente de inovação descentralizado, no qual o conhecimento, o capital e os talentos não se restringem mais a fronteiras geográficas existentes nos modelos de cluster. Este ensaio, discute

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como tecnologias digitais têm apoiado a configuração, a administração e a dinâmica dos ecossistemas empreendedores articulando evidências e implicações teóricas. Conclui-se que a transformação tecnológica não elimina a importância dos fatores locais, mas exige que as políticas públicas incorporem uma visão híbrida, integrando o digital e o físico para fomentar ecossistemas mais inclusivos e resilientes.

Palavras-chave: ecossistemas empreendedores, transformação digital, inovação, políticas públicas.

INTRODUCTION

Historically, entrepreneurial ecosystems have been understood as phenomena rooted in specific territorial contexts, dependent on geographic proximity for knowledge sharing, capital mobilization, and social interaction (SPIGEL, 2017; STAM, 2015). This approach, largely influenced by studies on clusters and industrial districts such as Silicon Valley, emphasized the centrality of location as a structuring element for innovation (ADAMS, 2021).

However, the expansion of digital technologies—such as cloud-based platforms, high-speed networks, artificial intelligence, and blockchain—has substantially altered the conditions for the emergence and development of these ecosystems. As argued by Autio et al. (2018), physical space is no longer the sole space for interaction, giving way to a hybrid model in which digital and territorial possibilities coexist and complement each other.

In this new scenario, the geography of innovation becomes more fluid, enabling entrepreneurs to access markets, resources, and knowledge remotely, without the need for physical presence in traditional innovation hubs (AUDRETSCH et al., 2019; ACS et al., 2020). This transformation raises crucial questions for public policy design: how can we support ecosystems that operate both locally and digitally? How can we ensure that digitalization expands - instead of restricting - the inclusion of new actors?

METODOLOGY

The present study is characterized as a comparative theoretical essay, employing a qualitative approach with the integration of secondary data. Three ecosystems were selected - Porto Digital (Brazil), IPT Open Experience (Brazil), and Zhongguancun (China) - as they represent different configurations of integration between physical and digital elements, diversity of governance, and relevance in public policies.

The choice of an essay format is due to the exploratory nature of the topic and the need to articulate different levels of analysis (theoretical, empirical, and public policy) without the intention of statistical generalization.

A documentary and statistical survey was conducted, prioritizing official and peer-reviewed sources. The primary sources included institutional reports, data from public agencies (IBGE, MCTI), policy documents, and communications from sectoral associations. The secondary sources comprised indexed scientific articles (Scopus, Web of Science), books, and international reports (OECD, World Bank). Quantitative data covered the period from 2018 to 2024, while the literature review, aimed at theoretical grounding, was based on publications from 1990 to 2024.

For data processing and analysis, a comparative analysis was carried out with standardized indicators: annual revenue, number of companies, direct jobs, growth rate, human capital training programs, and incentive policies.

The operationalization of concepts led to the following definitions:

- **Quality of entrepreneurship**: Indicators such as average revenue per company, startup survival rate after five years, and percentage of companies with international operations.
- **Hybrid digital ecosystem**: Coexistence of physical infrastructure (technology parks, laboratories) and digital infrastructure (collaborative platforms,

marketplaces), measured by the proportion of interactions and business conducted through digital channels.

- **Cognitive proximity**: Degree of alignment of technical competencies among actors, assessed indirectly by the number of partnerships between universities and companies, and joint participation in R\&D projects.

THEORETICAL BASIS

Over the past two decades, the concept of the entrepreneurial ecosystem has become established as an analytical approach aimed at understanding the coexisting set of actors, institutions, networks, and socio-territorial dynamics that sustain the emergence and growth of new ventures (Stam & van de Ven, 2021). The notion, which initially emerged from work focused on regional competitiveness (Porter, 1990; Feldman, 2001), has been progressively enriched by perspectives from network theory, economic geography, and innovation studies, incorporating social, institutional, and cultural dimensions. Stam and van de Ven (2021) emphasize that an entrepreneurial ecosystem is not merely a geographical concentration of companies and institutions, but rather a complex system composed of elements such as physical infrastructure, human capital, financial support, knowledge networks, governance, and entrepreneurial culture. This conception goes beyond the traditional logic of industrial clusters, introducing the idea that the quality of interactions among the elements is as important as, if not more important than, their mere quantitative presence.

Recent literature also distinguishes between high-performing ecosystems - characterized by the presence of skilled entrepreneurs, continuous flows of innovation, and effective mechanisms for collective learning - and low-performing ones, in which interactions are fragile, fragmented, or overly dependent on a few central actors (Szerb et al., 2019). In this context, the role of

collaborative governance is highlighted, whether in coordinating public–private initiatives or in creating a favorable regulatory environment.

From the physical to the digital ecosystem

Sussan and Acs (2017) define the “digital entrepreneurial ecosystem” as a movement reflecting the emergence of new productive arrangements mediated by digital platforms, global networks, and data flows. In this configuration, geographical barriers are reduced, and assets such as reputation, intellectual property, and algorithms become central. The authors propose that digital ecosystems retain elements of traditional models - human capital, financial support, networks - but reconfigure their forms of interaction, replacing part of the physical infrastructure with digital infrastructures such as cloud services, marketplaces, and remote collaboration tools.

This shift entails new performance metrics and different strategies for competitive positioning, especially for emerging economies seeking to overcome infrastructure deficiencies through digital assets. The impact of this transition is particularly significant for ecosystems located in developing economies. Theodoraki and Catanzaro (2021) argue that, by expanding the ecosystem’s boundaries through international connections, local actors can access knowledge, investment, and market networks that were previously limited to established technology hubs, thus reducing dependence on small domestic markets.

Quality versus quantity of entrepreneurship

Szerb et al. (2019) introduce the distinction between the quantity and the quality of entrepreneurship as a critical factor for assessing regional impact. The mere multiplication of new businesses does not guarantee competitive gains if these ventures are low value-added or have limited scalability. In digital

ecosystems, this distinction takes on new nuances: scalable platforms and solutions may generate rapid growth but can also present vulnerabilities linked to the volatility of technological trends.

The implication for public policy is clear: simply investing in more startups is not enough; it is necessary to foster structural conditions that attract and retain entrepreneurs with the potential for disruptive and sustainable innovation.

Social capital and sustainability

The dimension of social capital is central to understanding the resilience and sustainability of ecosystems. Theodoraki et al. (2018) analyze how networks of trust, reciprocity, and shared norms influence not only the speed of information circulation but also the capacity for collective mobilization in times of crisis. In digital ecosystems, this issue is expressed in the ability to create active communities of users, developers, and investors that reinforce the innovation cycle.

In parallel, recent literature incorporates the perspective of sustainability as an element of the entrepreneurial ecosystem. Volkmann et al. (2021) suggest that sustainable ecosystems not only promote economic growth but also balance social and environmental objectives, creating conditions for responsible innovation. This approach resonates with Mazzucato's (2018) discussions on public missions oriented toward systemic challenges, in which innovation policies are designed to address concrete problems such as climate change or digital inclusion.

Research agenda and theoretical integration

Wurth, Stam, and Spigel (2021) advocate for an integrated research agenda on entrepreneurial ecosystems, proposing a synthesis between structural approaches - which map constituent elements and local conditions - and

processual approaches - which analyze interactions and evolution over time. According to the authors, the growing adoption of hybrid models by ecosystems requires methodologies capable of capturing multiscale dynamics, in which municipal policies, global corporate strategies, and entrepreneur networks interact simultaneously. In the realm of public policy, this integration implies recognizing that digital ecosystems do not replace physical ones but complement them, and that a territory's competitive advantage will increasingly depend on its ability to orchestrate both.

RECONFIGURING ENTREPRENEURIAL ECOSYSTEMS

The emergence of new digital technologies has brought about profound transformations in the structure, dynamics, and governance of entrepreneurial ecosystems. In the classic model described by Porter (1990), territorial competitive advantage relied on factors such as productive specialization, sectoral clusters, and localized supply chains. The current environment, however, introduces a logic of connectivity and scalability that transcends physical boundaries. Since the 2000s, with the spread of digital platforms, the notion of geographical proximity as an indispensable condition for innovation has been challenged by forms of virtual and cognitive proximity (Boschma, 2005; Nambisan et al., 2019).

The concept of entrepreneurial ecosystems, as developed by Isenberg (2010) and expanded by Stam (2015), presupposes interaction among public, private, academic, and civil society actors around flows of knowledge, capital, and talent. However, authors such as Autio, Nambisan, Thomas, and Wright (2018) argue that technological concentration is redefining the structure of these ecosystems: networks that were once hierarchical are becoming more distributed; governance mechanisms are increasingly mediated by algorithms

and platforms; and the boundaries between producers, intermediaries, and consumers are becoming more open.

One example of this reconfiguration is the role of digital platforms as ecosystem orchestrators. Srnicek (2017) describes these platforms as digital infrastructures capable of capturing, processing, and monetizing data at scale, thereby altering the material basis of competition. For him, the “platform economy” is not merely a new sector but a logic of accumulation that spans multiple domains - from urban mobility to advanced industrial production. This perspective aligns with Mazzucato’s (2013) emphasis on the role of the State as an “entrepreneur” in market creation and in enabling the technological infrastructures that support such platforms.

In the context of entrepreneurial ecosystems, this shift entails strategic realignments: companies no longer compete solely for market share but for the ability to attract and retain developers, users, and partners within their digital ecosystems. Parker, Van Alstyne, and Choudary (2016) call this phenomenon “cross-side network effects,” in which the value for one group of users increases as the other group expands. The implication is that the success of startups and scaling firms is no longer limited to their internal capabilities but depends on their ability to mobilize global digital communities.

However, technological reconfiguration is not uniform. Literature on regional innovation systems shows that the adoption of digital technologies occurs unevenly, conditioned by local capabilities, historical trajectories, and public policies. In the Brazilian case, Lastres and Cassiolato (2005) already warned that the mere introduction of new technologies - without strategies to strengthen local productive and scientific bases - tends to deepen regional asymmetries. This critique remains relevant, particularly as successful digital ecosystems are typically the result of long-term investments in human capital, infrastructure, and cooperation networks.

Furthermore, digitalization alters the nature of interdependence among ecosystem actors. Nelson and Winter (1982) had already highlighted that organizational routines and cumulative learning are central to technological development. In the current context, learning also occurs in a distributed manner, through open-source communities, online mentoring networks, and global acceleration programs, leading Dosi (1988) to reformulate the notion of “technological paradigms” to include trajectories where incremental and disruptive innovation overlap in short cycles.

International cases such as Silicon Valley and Zhongguancun illustrate distinct models of this reconfiguration. While Silicon Valley is characterized by a combination of abundant venture capital, world-class universities, and a culture of experimentation tolerant of failure (Saxenian, 1994), Zhongguancun has emerged as a digital hub strongly supported by state policies, with an emphasis on industrial scalability (Liu & Kenney, 2021). Both cases demonstrate that, although technology serves as a vector for global integration, the final configuration of the ecosystem depends on local policies and on the way, actors are interconnected.

This hybrid perspective - in which physical and digital elements interpenetrate - requires a renewed view of the role of public policy. Mazzucato and Penna (2016) argue that in the digital economy, the State should act not only as a regulator but also as a co-creator of markets, defining missions that guide private investment and foster collaboration around social and technological challenges. In the case of entrepreneurial ecosystems, this involves everything from building public digital infrastructure to implementing training programs for advanced digital skills.

In Brazil, initiatives such as Porto Digital show how technology can reconfigure the economic base of a region. Created in the early 2000s in Recife, this technology park brought together universities, companies, and government

around a project of urban revitalization and strengthening of the software industry. Studies show that, beyond attracting startups and global companies, the ecosystem has generated spillover effects for creative and cultural economy sectors (Arruda et al., 2013). The IPT Open Experience in São Paulo adopts a model more oriented toward Industry 4.0, connecting traditional companies with tech-based startups in a format that combines physical laboratories with digital interaction platforms.

Thus, technology does not replace but reconfigures entrepreneurial ecosystems. This reconfiguration involves new forms of interdependence, more distributed governance models, and expanded operational scales. However, the analyzed cases indicate that the success of this process depends on institutional conditions, local capacities, and deliberate strategies for integrating actors - a point where evolutionary economics (Nelson & Winter, 1982; Dosi, 1988) and platform economy approaches (Srnicek, 2017; Parker et al., 2016) converge in recognizing that innovation is as much a technological phenomenon as it is a social and political one.

Porto Digital clearly demonstrates how a hybrid, territorially anchored ecosystem can scale globally through technology. Recently, it reached revenues of R$ 6.2 billion, representing a 14% growth over the previous year, and employed 21,551 people across 475 hosted companies. There has been a continuous trajectory of expansion: between 2018 and 2023, revenues jumped from R$ 1.9 billion to R$ 5.4 billion - an increase of 185.7%. In 2023, the park already had 415 companies and around 18,400 employees.

These figures validate Szerb et al.’s (2019) argument about the importance of quality - rather than just quantity - in ecosystem performance. Here, quality translates into sustainable growth, attraction of major players, and support for high-potential startups.

Initiatives such as *Embarque Digital* highlight social inclusion and human capital formation. Recife became the Brazilian capital with the highest number of IT students per capita, recording 658 IT students per 100,000 inhabitants in 2023 - an increase of 15% over the previous year. This reinforces the local structure of human and social capital, supported by the digital entrepreneurial ecosystem model (Sussan & Acs, 2017). Porto Digital's operations follow the Triple Helix logic, focusing on cohesion among academia, government, and the private sector. In 2023, in addition to training programs, it graduated around 60% of the first *Embarque Digital* cohort, with significant investments in education.

Silicon Valley continues to represent the classic model of a highly connected entrepreneurial ecosystem, with a high concentration of capital, talent, and startups. The region holds more than 225,000 high-tech jobs, one of the highest per capita GDPs in the world, and one of the largest concentrations of venture capital investment in the U.S. This demonstrates the persistence of physical proximity as a source of competitive advantage (Spigel, 2017), while complementing this logic with global connectivity, mentoring networks, and hybrid models of digital governance (Autio et al., 2018).

Zhongguancun, often referred to as the "Silicon Valley of China," has consolidated itself as the country's main technological innovation hub, concentrating high-tech companies, research centers, and an ecosystem strongly supported by state policies. In 2022, the total revenue of companies located in the region reached 8.7 trillion yuan (approximately US$1.2 trillion), 3.5 times the figure recorded in 2012. Currently, the ecosystem hosts more than 19,600 high-tech companies, including 92 unicorns, underscoring its global weight in the innovation economy (CHINA.ORG.CN, 2023).

Zhongguancun's innovation capacity is sustained by a substantial base of human capital and continuous investments in research and development (R\&D). In the first half of 2023, approximately 617,000 professionals were

directly engaged in R&D activities in the region, which recorded a total investment of 184 billion yuan in the same period. Monitored companies generated “technical income” of 850 billion yuan, equivalent to 22.4% of the total revenue of 3.8 trillion yuan for the semester (ENGLISH.SCIO.GOV.CN, 2023).

Between 2012 and 2022, the aggregated revenue of Zhongguancun’s companies grew by more than 230%, rising from 2.5 trillion to 8.4 trillion yuan. This trajectory has consolidated the hub as responsible for more than 30% of Beijing’s economic growth (ENGLISH.SCIO.GOV.CN, 2022). Moreover, in 2021, exports reached 389 billion yuan, nearly double the figure from a decade earlier. That same year, there were around 24,000 high-tech companies operating in the ecosystem, of which 4,106 had annual revenues exceeding 100 million yuan. The hub also accounted for 466 publicly listed companies and 102 unicorns, ranking second in the world in this indicator (CHINA.QIANLONG.COM, 2022).

To summarize the structural and institutional differences among the analyzed cases, Chart 1 was developed. The organization of the information follows the dimensions proposed by Isenberg (2010) and Spigel (2017), allowing for a synthesized comparison of aspects such as infrastructure, digital readiness, human capital, and governance forms. This visualization seeks to understand how each ecosystem articulates physical and digital elements, along with the influence of public policies on its performance.

Ecosystem	Infrastructure	Digital: Global Readiness	Human Capital and Education	Public Policy and Digital Governance
Porto Digital	Strong regional integration (Recife)	Digital expansion, attraction of global companies	*Embarque Digital*, proximity to UFPE	Tax incentives, digital training
Silicon Valley	Concentrated and dense	Global ecosystem, VC networks	High qualification and high salaries	Innovation culture, open capital
Zhongguancun	Planned and industrial	Global companies from the outset	Academia and startups in synergy	Strategically integrated state-market relations

Chart 1 - Comparative Analysis of Structural and Institutional Characteristics of Three Innovation Ecosystems Based on the Dimensions Proposed by Isenberg (2010) and Spigel (2017)

An analysis of Chart 1 reveals three central patterns. First, the relevance of territorial proximity and regional density. Porto Digital maintains strong regional anchoring, while Silicon Valley and Zhongguancun have operated with global reach since their inception. Second, governance differs significantly, reflecting typologies already discussed by Stam and van de Ven (2021) - Recife adopts a collaborative model based on the Triple Helix logic, Silicon Valley maintains diffuse governance anchored in private capital, and Zhongguancun operates under centralized state planning. Third, although all invest in human capital, the intensity and strategy vary, confirming the conclusions of Szerb et al. (2019) that the training and retention of high-quality talent are decisive for sustainable ecosystems.

These cases precisely illustrate the theoretical layers discussed earlier:

- **Quality vs. quantity**: Porto Digital grows not only in the number of companies but also in revenue, social impact, and the quality of the actors involved, confirming Szerb et al. (2019).
- **Hybrid digital ecosystem**: The coexistence of robust physical infrastructure with global digital networks in Porto Digital reflects the concept of a digital entrepreneurial ecosystem (Sussan & Acs, 2017), while Silicon Valley and Zhongguancun also combine physical and digital elements but with distinct institutional models.
- **Human capital and inclusiveness**: The *Embarque Digital* program contributes not only to the quantitative scale in talent development but also to social inclusion, aligning with the sustainable ecosystem model of Volkmann et al. (2021) and democratic innovation models.
- **Technological governance and scalability**: The attraction of large companies to Porto Digital demonstrates the role of platforms and incentives in regional digital transformation (Srnicek, 2017; Mazzucato & Penna, 2016).

The comparative analysis shows that Porto Digital represents a well-structured hybrid ecosystem, with consistent integration between physical infrastructure (technology parks and R&D centers) and digital infrastructure (interaction platforms and project management tools). The growth figures (+185.7% in revenue from 2018–2023) suggest high dynamism, but caution is warranted. Such numbers come from institutional sources and have not been independently audited.

The IPT Open Experience exhibits more incipient characteristics of a hybrid digital ecosystem, focusing on connecting traditional industry to Industry 4.0. The lack of consolidated data on revenue and employment limits comparability and makes it difficult to assess the quality of entrepreneurship.

These results reinforce three points. First, physical proximity remains relevant in digital contexts, especially for human capital and the transfer of tacit knowledge (Boschma, 2005). Second, public governance is decisive in structuring hybrid ecosystems but takes different forms (triple helix partnerships, state intervention models, public–private consortia). Third, performance evaluation requires standardized indicators combining quantitative metrics (revenue, jobs, internationalization) and qualitative ones (collaboration, responsible innovation).

To deepen the comparison, Chart 2 presents consolidated quantitative indicators for 2023, complementing the previous qualitative analysis. The data include number of companies, direct jobs, total revenue, growth rate, training programs, and governance structures, allowing for the identification of relationships between economic performance, public policies, and digital integration strategies.

Indicator (2023)	Porto Digital	IPT Open Experience	Zhongguancun
Installed companies	475	110	>20,000
Direct jobs	21,551	~2,000	>400,000
Total revenue (R$ billion)	6.2	0.9	N/A (estimated >US$ 100 billion)
Growth 2018–2023	+185.7%	N/A	N/A
Training programs	*Embarque Digital* (IT)	Industry 4.0 training	University–industry integration
Governance	Triple Helix	Government–institute partnership	Strong state intervention

Chart 2 – Comparative Indicators (2023) of Three Innovation Ecosystems Based on the Dimensions Proposed by Isenberg (2010), Spigel (2017), and Autio et al. (2018)

The indicators in Chart 2 reinforce the argument of Szerb et al. (2019) that the quality of entrepreneurship, rather than simply the volume of new businesses, is decisive for regional impact. Porto Digital, despite operating on a smaller scale than Silicon Valley and Zhongguancun, shows robust growth (+185.7% in revenue between 2018 and 2023) and strong investment in human capital, aligning with Sussan and Acs' (2017) concept of a digital entrepreneurial ecosystem. Silicon Valley maintains its global leadership in technological density and capital attraction but illustrates the decentralized governance model described by Autio et al. (2018), while Zhongguancun, with its high level of state centralization, exemplifies a "state–market" governance arrangement as discussed by Brown and Mawson (2019). This diversity confirms that there is no single model for success, but multiple possible configurations, provided they are sustained by coherent institutional conditions and strategies.

CHALLENGES AND IMPLICATIONS FOR PUBLIC POLICY

The digital transformation of entrepreneurial ecosystems raises several challenges for policymaking:

- **Digital inclusion**: deterritorialization is only effective if there is equitable access to digital infrastructure (Endeavor; ENAP, 2020).

- **Platform regulation**: it is necessary to balance market freedom with protection against digital monopolies (Mazzucato, 2018).
- **Capacity building**: policies should promote digital skills among entrepreneurs and workers to fully leverage digital affordances (Cavallo, Ghezzi & Balocco, 2019).

At the same time, opportunities arise from the alignment of regional policies with digital strategies, enabling peripheral regions to integrate into global innovation networks without requiring the physical relocation of actors.

CONCLUSIONS

Analyzing entrepreneurial ecosystems in light of technological transformations reveals that digitalization not only changes the way companies and actors connect and the range of possible configurations but also expands the scope and scale of innovation dynamics. The transition from the classic, territorial model based on physical infrastructure to a hybrid, distributed model incorporating digital platforms, global networks, and intangible capital represents a shift with profound implications for public policy.

The cases discussed demonstrate that the success of entrepreneurial ecosystems is not based solely on the number of startups or the accumulation of physical resources but on the quality of interactions, the capacity for coordination among actors, and the presence of governance that fosters collaboration and experimentation. In this sense, the theory of digital ecosystems proposed by Sussan and Acs (2017) stands out as a framework that complements and expands traditional models, especially by emphasizing the importance of digital infrastructure, data, and platforms as structuring elements.

Empirical evidence from Porto Digital shows that, even in emerging contexts, it is possible to build competitive and sustainable ecosystems when there is effective integration between universities, government, and the private

sector, along with strategic investments in human capital development and inclusion policies. This combination strengthens the argument that the State should take an active role, as advocated by Mazzucato and Penna (2016), going beyond simple regulation to act as a market co-creator and network facilitator.

For public policy, the challenge lies in adapting to this new hybrid environment, promoting both physical and digital infrastructure, ensuring broad access to digital technologies, and encouraging the development of specialized skills. Furthermore, it is essential to design innovation policies that consider the internationalization of ecosystems, enabling local actors to participate in global networks and seize international opportunities, as suggested by Theodoraki and Catanzaro (2021).

In conclusion, the technological reconfiguration of entrepreneurial ecosystems calls for a collaborative, multidimensional, and adaptive governance model capable of addressing local specificities while engaging actors in global networks. The combination of theory, empirical evidence, and public policy points to the need for an integrated agenda that promotes inclusive and sustainable digital innovation, driving competitiveness and economic development across different territorial scales.

REFERENCES

ACS, Zoltan J.; AUTIO, Erkko; SZERB, László. *National systems of entrepreneurship: measurement issues and policy implications*. Research Policy, v. 43, p. 476-494, 2014.

ACS, Zoltan J. et al. *The Digital Platform Economy Index 2020*. GEDI - Global Entrepreneurship and Development Institute, 2020.

ADAMS, Stephen B. *From orchards to chips: Silicon Valley's evolving entrepreneurial ecosystem*. Entrepreneurship & Regional Development, v. 33, n. 1-2, p. 1-21, 2021.

AUDRETSCH, David B.; GRIMM, Hans; WESSNER, Charles W. *Local heroes in the global village: globalization and the new entrepreneurship policies*. New York: Springer, 2005.

AUDRETSCH, David B. et al. *Entrepreneurial ecosystems: economic, technological, and societal impacts*. The Journal of Technology Transfer, v. 44, n. 2, p. 313-325, 2019.

AUDRETSCH, David B.; BELITSKI, Maksim. *Entrepreneurial ecosystems in cities: establishing the framework conditions*. The Journal of Technology Transfer, v. 42, n. 5, p. 1030-1051, 2017.

AUERSWALD, Philip E.; DANI, Lokesh. *The adaptive life cycle of entrepreneurial ecosystems: the biotechnology cluster*. Small Business Economics, v. 49, n. 1, p. 97-117, 2017.

AUTIO, Erkko; NAMBISAN, Satish; THOMAS, Llewellyn D. W.; WRIGHT, Mike. *Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems*. Strategic Entrepreneurship Journal, v. 12, n. 1, p. 72-95, 2018.

BOSCHMA, Ron. *Proximity and innovation: a critical assessment*. Regional Studies, v. 39, n. 1, p. 61-74, 2005.

BROWN, Ross; MAWSON, Suzanne. *Entrepreneurial ecosystems and public policy in action: a critique of the latest industrial policy blockbuster*. Cambridge Journal of Regions, Economy and Society, v. 12, n. 3, p. 347-368, 2019.

CHINA.ORG.CN. Zhongguancun companies' revenue hits 8.7 trillion yuan in 2022. 27 mai. 2023. Disponível em: https://www.china.org.cn/business/2023-05/27/content_85680709.htm. Acesso em: 11 ago. 2025.

CHINA.QIANLONG.COM. Zhongguancun Forum 2022 overview. 21 nov. 2022. Disponível em: https://china.qianlong.com/zgcforum/en/xwdt/2022/1121/7820759.shtml. Acesso em: 11 ago. 2025.

COOK, Peter. *Regional innovation systems: an analytical framework*. In: *Clusters and Regional Development*. London: Routledge, 2001.

DOSI, Giovanni. *Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change*. Research Policy, v. 11, n. 3, p. 147-162, 1988.

ENGLISH.SCIO.GOV.CN. Zhongguancun's technical revenue reaches 850 billion yuan in H1 2023. 7 ago. 2023. Disponível em: https://english.scio.gov.cn/pressroom/2023-08/07/content_99563638.htm. Acesso em: 11 ago. 2025.

ENGLISH.SCIO.GOV.CN. Zhongguancun's contribution to Beijing's economic growth. 3 nov. 2022. Disponível em: https://english.scio.gov.cn/chinavoices/2022-11/03/content_78499435.htm. Acesso em: 11 ago. 2025.

LASTRES, Helena M.; CASSIOLATO, José Eduardo. *Novas tecnologias, globalização e o desenvolvimento regional*. São Paulo: Editora UNESP, 2005.

MAZZUCATO, Mariana. *The entrepreneurial state: debunking public vs. private sector myths*. London: Anthem Press, 2013.

MAZZUCATO, Mariana; PENNA, Claudia Cristina. *Mission-oriented finance for innovation: new ideas for investment-led growth*. Industrial and Corporate Change, v. 25, n. 5, p. 621–635, 2016.

NAMBISAN, Satish; WRIGHT, Mike; AUTIO, Erkko. *The digital transformation of innovation and entrepreneurship: progress, challenges and key themes*. Research Policy, v. 49, n. 1, p. 103937, 2020.

NELSON, Richard R.; WINTER, Sidney G. *An evolutionary theory of economic change*. Cambridge: Harvard University Press, 1982.

PARKER, Geoffrey G.; VAN ALSTYNE, Marshall W.; CHOUDARY, Sangeet Paul. *Platform revolution: how networked markets are transforming the economy and how to make them work for you*. New York: W. W. Norton & Company, 2016.

PORTER, Michael E. *The competitive advantage of nations*. New York: Free Press, 1990.

PORTO DIGITAL. Porto Digital cresce 14% em 2023 e passa de 18 mil colaboradores. Recife, 2024. Disponível em:

https://www.portodigital.org/noticias/porto-digital-cresce-14-em-2023-e-passa-de-18-mil-colaboradores. Acesso em: 8 ago. 2025.

PORTO DIGITAL. Recife é a capital com mais estudantes de TI do Brasil. Recife, 2023. Disponível em: https://portodigital.org/noticias/recife-e-a-capital-com-mais-estudantes-de-ti-do-brasil. Acesso em: 8 ago. 2025.

PODER360. Faturamento de parque tecnológico do Recife sobe 186% em 6 anos. São Paulo, 2024. Disponível em: https://www.poder360.com.br/poder-empreendedor/faturamento-de-parque-tecnologico-do-recife-sobe-186-em-6-anos. Acesso em: 8 ago. 2025.

REVISTA NE. Porto Digital cresce 14% e atrai mais empresas para o Recife. Recife, 2025. Disponível em: https://revistane.com.br/2025/02/21/porto-digital-cresce-14-e-atrai-mais-empresas-para-o-recife. Acesso em: 8 ago. 2025.

SRNICEK, Nick. *Platform capitalism*. Cambridge: Polity Press, 2017.

SPIGEL, Ben. *The relational organization of entrepreneurial ecosystems*. Entrepreneurship Theory and Practice, v. 41, n. 1, p. 49-72, 2017.

STAM, Erik. *Entrepreneurial ecosystems and regional policy: a sympathetic critique*. European Planning Studies, v. 23, n. 9, p. 1759-1769, 2015.

STAM, Erik; VAN DE VEN, Andrew. *Entrepreneurial ecosystem elements*. Small Business Economics, v. 56, n. 2, p. 809-832, 2021.

SZERB, László; LAFUENTE, Esteban; HORVÁTH, Krisztina; PÁGER, Balázs. *The relevance of quantity and quality entrepreneurship for regional performance: the moderating role of the entrepreneurial ecosystem*. Regional Studies, v. 53, n. 9, p. 1308-1320, 2019.

THEODORAKI, Christina; CATANZARO, Alexis. *Widening the borders of entrepreneurial ecosystem through the international lens*. The Journal of Technology Transfer, p. 1-24, 2021.

THEODORAKI, Christina; MESSEGHEM, Karim; RICE, Mark P. *A social capital approach to the development of sustainable entrepreneurial ecosystems: an explorative study*. Small Business Economics, v. 51, n. 1, p. 153-170, 2018.

VOLKMANN, Christine et al. *Sustainable entrepreneurial ecosystems: an emerging field of research*. Small Business Economics, v. 56, n. 3, p. 1047-1055, 2021.

WIRED. Porto Digital is the Quixotic tech hub that worked. 2024. Disponível em: https://www.wired.com/story/porto-digital-is-the-quixotic-tech-hub-that-actually-worked. Acesso em: 8 ago. 2025.

WURTH, Benedikt; STAM, Erik; SPIGEL, Ben. *Toward an Entrepreneurial Ecosystem Research Program*. Entrepreneurship: Theory and Practice, 2021.