

Evolving Role of Science Parks in Smart and Sustainable Innovation Ecosystems*

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Abstract

Science and Technology Parks (STPs) operate in an environment increasingly shaped by digital transformation, sustainability challenges, and the growing complexity of innovation processes. As innovation becomes more networked and multi-actor in nature, understanding the evolving role of STPs within contemporary innovation ecosystems has become an important research issue.

Despite a substantial body of literature on STPs, existing studies remain fragmented and predominantly focus on individual dimensions of their activity, such as infrastructure provision, university–industry collaboration, or entrepreneurship support. Longitudinal evidence explaining how STPs have evolved over time remains limited, particularly in relation to emerging theoretical perspectives such as the Quintuple Helix framework.

To address this gap, the study employs a longitudinal qualitative comparative analysis of the IASP Global Survey Reports from 2015 and 2024. The analysis is based on thematic coding across multiple dimensions, including governance models, service portfolios, sustainability practices, urban integration, internationalisation, and performance measurement systems.

The findings reveal a fundamental transformation of STPs from infrastructure-oriented organisations focused on technology transfer into knowledge-based actors that coordinate and support innovation ecosystems. Contemporary STPs increasingly adopt hybrid governance structures, provide knowledge-intensive services, strengthen international linkages, integrate sustainability principles, and implement multidimensional performance measurement frameworks. The study contributes to the literature by providing longitudinal evidence of this transformation and by advancing the conceptualisation of STPs as knowledge organisations and ecosystem orchestrators operating within smart and sustainable innovation ecosystems.

Introduction

Science and Technology Parks (STPs) were historically established as spatial policy instruments supporting regional innovation through infrastructure provision and proximity to universities (Germain et al., 2023; Dabrowska & de Faria, 2020). Property management, laboratory facilities, and technology transfer mechanisms constituted their primary functions, while performance was predominantly evaluated using tangible indicators such as occupancy rates, rental income, and space utilisation (Dabrowska, 2024).

However, the global innovation landscape has evolved significantly. Digital transformation, sustainability imperatives, global competition for talent, and the increasing complexity of metropolitan ecosystems have fundamentally reshaped the mechanisms through which innovation emerges. Innovation is no longer understood as a linear transfer from university to industry but rather as a systemic, multi-actor, and socially embedded process. Recent research increasingly highlights the strategic role of STPs within innovation ecosystems, suggesting that their functions extend well beyond traditional technology transfer and intermediary activities (Dabrowska & de Faria, 2020; Dąbrowska, 2024; Dąbrowska & Manczak, 2025).

Research Objective and Method

The objective of this paper is to analyse the evolution of STPs within modern innovation ecosystems over the period 2015–2024, with a particular focus on identifying structural, functional, and strategic transformations and interpreting these changes within the framework of smart and sustainable innovation ecosystems.

The study is based on a longitudinal comparative analysis of the IASP Global Survey Reports from 2015 and 2024. A qualitative comparative approach was applied using thematic coding to identify patterns of change across time. The coding process combined deductive and inductive elements. Initial analytical categories were derived from the literature on innovation ecosystems and STPs, while additional themes emerged during the analysis of empirical material. The analytical framework included the following categories: Identity and role in the Ecosystem, Location and Urbanisation, Ownership and Governance, Relations with Universities, Service Portfolio, Funding Structure, Scale and Expansion, Internationalisation, Sectoral Focus, Sustainability and ESG Integration, Management Teams, Resident Company Profile, Strategic Orientation and Performance Measurement. To ensure consistency, identical categories were applied to both datasets, enabling systematic comparison across time.

The qualitative comparative approach enables capturing systemic transformations rather than isolated changes, thereby supporting the identification of structural shifts and the interpretation of STPs as evolving organisational forms within complex innovation ecosystems.

Science Parks as Knowledge Organisations within Innovation Ecosystems

Knowledge organisation theory provides a valuable analytical lens for interpreting the evolution of STPs. In the literature, knowledge is clearly distinguished from data and information, as it requires contextualisation, interpretation, and application, and is inherently embedded in social interaction and professional expertise (Davenport & Prusak, 1998; Nonaka, 1994). Knowledge-intensive organisations are therefore characterised by their reliance on intellectual capital, highly qualified human resources, and the production of intangible yet strategically valuable outputs (Alvesson, 2004; Miles et al., 1995).

Traditionally, STPs were not classified as knowledge organisations due to their strong focus on property management and physical infrastructure (Hansson, 2007). Their primary functions were associated with providing space, facilities, and proximity to universities, while knowledge creation and processing were considered secondary activities. However, more recent studies challenge this perspective, demonstrating that contemporary parks increasingly operate as knowledge-intensive organisations embedded within innovation ecosystems (Campanella et al., 2014; Díez-Vial & Montoro-Sánchez, 2016; Germain et al., 2023).

Recent empirical evidence indicates that STPs have significantly expanded their knowledge-based functions. Modern park management organisations rely on highly qualified professionals who design acceleration programmes, manage cluster initiatives, coordinate cross-sector partnerships, and translate research outputs into structured innovation pathways (Ratinho & Henriques, 2010; Dabrowska & de Faria, 2020). Their outputs extend beyond physical infrastructure and include curated networks, mentoring systems, innovation services, governance mechanisms, and strategic platforms for collaboration.

Furthermore, the literature emphasises that knowledge organisations operate through both input and output dimensions. On the one hand, they depend on human capital and expertise as key inputs; on the other, they generate knowledge-based services as outputs and tenant collaboration and growth as outcomes (Alvesson, 2000; Nurmi, 1998). This dual perspective is particularly relevant in the context of STPs, where managerial competencies, relational networks, and organisational learning processes are transformed into innovation support services and ecosystem-level value creation.

Equally significant is the transformation in performance logic. Traditional evaluation systems of STPs focussed on tangible indicators such as occupancy rates or financial returns are increasingly being replaced by multidimensional frameworks that capture financial resilience, innovation outputs, and broader societal impacts (Dabrowska & de Faria, 2020; de Faria et al., 2023). Contemporary STPs assess their performance through the provision of structured innovation services, cluster management activities, knowledge diffusion, and ecosystem facilitation rather than through the delivery of physical goods.

This gradual shift towards knowledge-based activities and multidimensional evaluation systems signals a deeper reorientation of organisational identity. STPs are no longer peripheral infrastructure providers but are increasingly

positioned as knowledge organisations that actively create, process, and diffuse knowledge within innovation ecosystems. This transformation aligns with broader developments in innovation theory, which emphasise non-linear, network-based, and collaborative processes of knowledge creation (Nonaka, 1994; Wenger, 2000). The evidence of the STPs' shift will be further explored in the subsequent sections of this paper.

Expanding Innovation Frameworks: From Triple to Quintuple Helix

The Triple Helix model conceptualises innovation as the outcome of interactions between three key institutional spheres: universities, industry, and government. This framework has been widely used to explain the dynamics of knowledge production, technology transfer, and regional innovation systems. However, contemporary innovation processes increasingly extend beyond these three actors, reflecting growing societal and environmental challenges.

In response, the Quintuple Helix framework expands the analytical scope by incorporating civil society and the natural environment as integral components of innovation systems. This extended perspective emphasises that innovation is not only an economic and technological process but also a socially embedded and environmentally conditioned phenomenon. It highlights the role of sustainability, public engagement, and ecological considerations in shaping innovation trajectories.

Previous studies indicate that STPs increasingly operate within this expanded innovation governance model, moving beyond the traditional Triple Helix configuration (Dąbrowska, 2024; Carayannis & Campbell, 2010; Carayannis, Grigoroudis & Campbell, 2022). The growing importance of sustainability strategies, ESG integration, urban collaboration, and global networking demonstrates a clear alignment with the principles of the Quintuple Helix. These developments reflect the inclusion of civil society and environmental stakeholders as active participants in innovation ecosystems.

As a result, STPs are increasingly conceptualised as institutional nodes that connect universities, industry, government, civil society, and environmental actors. They facilitate knowledge exchange and collaborative innovation across multiple domains, acting as platforms that integrate diverse forms of knowledge and coordinate interactions among heterogeneous stakeholders (Lecluyse, Knockaert & Spithoven, 2021; Germain et al., 2023). This transformation signifies a broader shift in the role of STPs from technology transfer intermediaries toward orchestrators of complex, multi-layered innovation ecosystems. Rather than merely enabling interactions between predefined actors, contemporary parks actively design and manage the conditions under which innovation emerges, evolves, and diffuses.

Importantly, this transition is not purely conceptual but is reflected in observable organisational and strategic changes. The increasing integration of sustainability objectives, the adoption of ESG frameworks, the strengthening of cross-sector partnerships, and the growing involvement in urban innovation agendas all indicate that STPs are aligning their operations with the logic of the Quintuple Helix.

Therefore, the evolution from the Triple Helix to the Quintuple Helix framework provides a critical theoretical foundation for understanding the changing role of STPs. It enables the interpretation of these organisations not only as intermediaries within innovation systems but as active agents shaping the direction, inclusiveness, and sustainability of innovation processes.

Further empirical evidence on the role of STPs within Quintuple Helix innovation systems is presented in the following sections of this paper, where the longitudinal transformation of STPs is analysed.

Longitudinal Insights into the Transformation of Science Parks

The comparative analysis of the IASP Global Surveys from 2015 and 2024 reveals a significant and multidimensional transformation in the global landscape of STPs. The results are presented in accordance with the analytical criteria outlined in the methodology, including identity and scope, role in the ecosystem, spatial distribution, governance, university relations, service portfolios, funding structures, scale, internationalisation, sectoral focus, sustainability, management, tenant profile, and strategic orientation. Together, these dimensions capture observable structural changes in STPs within contemporary innovation ecosystems.

Identity and Role in the Ecosystem

In 2015, STPs were primarily understood as infrastructure-based organisations supporting technology transfer, defined as physical spaces facilitating collaboration between universities and industry, with a focus on research commercialisation and enterprise incubation. By 2024, the broader notion of Organised Innovation Spaces (OIS), encompassing STPs, innovation districts, and areas of innovation, is increasingly adopted (IASP, 2024). STPs are now described as actors embedded within innovation ecosystems rather than solely physical infrastructures. Their role includes coordination of activities related to knowledge exchange, sustainability initiatives, and entrepreneurial support.

Location and Urbanisation

The spatial configuration of STPs has undergone a significant transformation. In 2015, most parks were located on the peripheries of cities, often in proximity to universities or within industrial zones. By contrast, the 2024 data indicate that 87.9% of parks are now located within urban environments, integrated into innovation districts or mixed-use developments.

Ownership and Governance

Ownership and governance structures have become increasingly diversified. In 2015, public ownership dominated the sector, with most parks operated by universities, municipalities, or regional governments. By 2024, ownership models had become more heterogeneous, with 50.8% of parks remaining public, 31% operating under public-private partnerships, and 18.3% privately owned (IASP, 2024).

Relations with Universities

Collaboration with universities remains a central feature of STPs, but its nature has evolved considerably. In 2015, university relations were often transactional, focussed primarily on technology transfer and student entrepreneurship. By 2024, these relationships have become more integrated and strategic. According to the data, 80.2% of parks have formal agreements with universities, 47.6% host research groups within their facilities, and 75.4% are located within a five-kilometre radius of academic institutions (IASP, 2024).

Service Portfolio

The service portfolios of STPs have expanded significantly. In 2015, services were primarily limited to incubation, research facilities, and technology transfer support. By 2024, these offerings have become much more diversified and sophisticated. A large majority of parks now provide incubators (93.7%), acceleration programmes (81.7%), and cluster management services (75.4%) (IASP, 2024). Additional services such as mentoring, networking, training, and internationalisation support have also become widespread.

Funding Structure

Funding models have evolved from reliance on public subsidies to more diversified and resilient revenue structures. In 2015, most parks depended heavily on government funding and rental income. By 2024, funding sources include a combination of public funding, private investment, service fees, rental income, and participation in international projects.

Scale and Expansion

The scale and organisational structure of STPs have also expanded. While in 2015 most parks operated as single-site entities, by 2024, 37.4% manage multi-site campuses with two to five locations (IASP, 2024). Additionally, 87.3% of parks plan further expansion.

Internationalisation

Internationalisation has become a defining feature of contemporary STPs. In 2015, international engagement was relatively limited. By 2024, 70.7% of parks have established formal international cooperation agreements (MoUs) and actively participate in global innovation networks (IASP, 2024).

Sectoral Focus

The sectoral orientation of STPs has become more focussed and strategic. While in 2015 parks hosted firms from broad technological domains, by 2024 they increasingly concentrate on a limited number of priority sectors,

typically three to five. Key areas include artificial intelligence, information and communication technologies, biotechnology, clean technologies, and life sciences (IASP, 2024).

Sustainability and ESG Integration

Sustainability has emerged as a central dimension of STPs. In 2015, environmental considerations were relatively marginal. By 2024, most parks have implemented formal sustainability strategies and ESG frameworks. Approximately 65.8% of parks allocate more than 15% of their area to green spaces, while 19% dedicate more than half (IASP, 2024).

Management Teams

Management structures have become more professionalised. In 2015, management teams were typically small and administratively oriented. By 2024, teams have expanded and diversified, with an average size of 11 to 25 professionals, including specialists in innovation management, sustainability, and internationalisation.

Resident Companies Profile

The composition of resident companies has also evolved. While micro and small enterprises continue to dominate, there is an increasing presence of international firms and research-intensive startups.

Strategic Orientation and Performance Measurement

Finally, the strategic orientation of STPs has undergone a fundamental transformation over the past decade. In 2015, their primary focus was on regional economic development and technology transfer. By 2024, this orientation has expanded to encompass global connectivity, sustainability, and talent attraction. At the same time, a significant transformation has occurred in the performance measurement logic of STPs. Contemporary parks increasingly adopt multidimensional evaluation frameworks that assess value creation rather than infrastructure utilisation or technological outputs alone. These frameworks incorporate more advanced intangible indicators and clearly distinguish between inputs, outputs, and outcomes, aligning measurement systems with ecosystem-based innovation models.

Input indicators capture diversified revenue streams, financial resilience, investment capacity, and long-term sustainability, thereby signalling institutional maturity and strategic autonomy. Output indicators measure operational activities, including the number of startups supported, partnerships initiated, cluster initiatives coordinated, research collaborations facilitated, and innovation projects implemented. Outcome indicators assess broader and long-term impacts, such as job creation, regional innovation capacity, talent attraction and retention, ESG performance, and contributions to the Sustainable Development Goals.

Discussion

The findings of this study demonstrate that STPs have undergone a profound transformation from infrastructure-based support mechanisms facilitating technology transfer into strategically managed organisations that actively orchestrate innovation ecosystems at multiple scales. This transformation involves changes in governance, operational priorities, performance measurement and alignment with more inclusive and sustainability-oriented priorities. More importantly, the findings indicate that this transformation is not merely functional but reflects a deeper reconfiguration of how innovation is organised and governed. In this respect, the empirical evidence supports the theoretical transition from Triple Helix coordination mechanisms toward Quintuple Helix ecosystem governance, illustrating how organisational transformations reflect broader systemic shifts in innovation theory.

The observed evolution of STPs from infrastructure providers to coordinators of innovation processes confirms their repositioning within innovation systems. This shift suggests that STPs increasingly operate as multi-actor platforms rather than passive intermediaries, actively shaping innovation dynamics. This interpretation is consistent with the literature, which highlights the growing role of STPs as orchestrators within complex innovation environments (Carayannis, Grigoroudis & Campbell, 2022). At the same time, their increasing engagement with sustainability and societal dimensions reflects alignment with the Quintuple Helix framework, which extends innovation beyond economic and technological domains (Carayannis & Campbell, 2010; Carayannis et al., 2022; Dąbrowska, 2024). This interpretation is further supported by recent research emphasising the role of STPs as ecosystem orchestrators actively shaping innovation dynamics and coordinating multi-actor interactions (Dąbrowska & Manczak, 2025).

Over the past decade, ownership and governance models of STPs have evolved from predominantly public and administratively driven structures towards more diversified and hybrid configurations. While most parks were publicly owned in 2015, by 2024 nearly one third operate under public-private partnership models, with a growing share privately owned (IASP, 2024). This diversification indicates increasing institutional maturity and professionalisation, reflecting a transition toward more autonomous and performance-oriented organisational forms. As noted by Germain et al. (2023), hybrid governance enhances strategic responsiveness, while Jacobides et al. (2018) emphasise that distributed structures strengthen ecosystem resilience by allocating roles across multiple actors. However, this transformation may also introduce tensions between public objectives and private interests, particularly in balancing economic efficiency with broader societal and environmental goals.

This shift is closely linked to changes in performance measurement systems. STPs increasingly adopt multidimensional evaluation frameworks that capture value creation rather than infrastructure utilisation alone. By distinguishing between inputs, outputs, and outcomes, these systems reflect the complexity of ecosystem-based innovation processes and reinforce the role of STPs as knowledge organisations within interconnected innovation ecosystems. This development also suggests a broader redefinition of value in innovation systems, where long-term impact and systemic outcomes gain importance over short-term outputs.

This transition reflects a broader move from administrative coordination to strategic orchestration. STPs are no longer extensions of public policy but autonomous organisations capable of shaping their own development trajectories. As argued by Dąbrowska (2024), this institutional maturity enables parks to coordinate complex networks of actors, redefining their role as strategic actors within innovation systems. At the same time, this increased autonomy may create new challenges related to governance complexity and accountability.

This shift is also reflected in the transformation of their functions and service portfolios. Contemporary STPs have expanded beyond traditional technology transfer and incubation to include acceleration programmes, mentoring, sustainability-oriented services, and internationalisation support, reflecting their shift from infrastructure providers toward active facilitators of innovation processes. This development is consistent with the literature on intermediary organisations, which emphasises their role in enabling knowledge exchange and collaboration (Ratinho & Henriques, 2010), and builds on earlier studies indicating the gradual expansion of STPs toward more active roles in supporting innovation and business development (Ratinho & Henriques, 2010).

In this context, the growing complexity of these knowledge-intensive services implies an increasing demand for specialised managerial capabilities and organisational learning. This observation aligns with knowledge organisation theory, which highlights that organisations create value through the generation, integration, and application of knowledge (Nonaka, 1994; Davenport & Prusak, 1998). It further supports the view that knowledge-intensive organisations rely on intellectual capital and specialised expertise as key drivers of value creation (Alvesson, 2004; Miles et al., 1995). From this perspective, the observed transformation reflects the dual logic of knowledge organisations, where human capital and expertise are translated into innovation outputs and ecosystem-level outcomes (Alvesson, 2000; Nurmi, 1998). Furthermore, the increasing importance of relational networks and collaboration is consistent with the concept of communities of practice as mechanisms of collective learning and knowledge diffusion (Wenger, 2000).

These transformations are further supported by recent empirical evidence indicating that STPs increasingly act as coordinating and orchestrating entities within regional and urban innovation systems (Germain et al., 2023; Lecluyse et al., 2021). They facilitate collaboration among diverse stakeholders and support the development of entrepreneurial ecosystems, contributing to knowledge-intensive entrepreneurship, cluster development, and regional competitiveness (Germain et al. 2023; Lecluyse et al. 2021). Strong university-industry linkages remain central, enhancing innovation performance and knowledge diffusion (Díez-Vial & Montoro-Sánchez, 2016). This observation contrasts with earlier perspectives, which did not recognise STPs as knowledge organisations due to their strong infrastructure orientation, thereby highlighting the significance of the observed transformation (Hansson, 2007). As a consequence of this increasing organisational and relational complexity, STPs face growing coordination challenges, necessitating more advanced governance mechanisms.

Another key dimension concerns the spatial reconfiguration of innovation spaces. The increasing integration of STPs into urban environments reflects the process of the urbanisation of innovation (Lecluyse et al., 2021). This transformation enhances collaboration, visibility, and societal engagement, positioning parks as active contributors to urban sustainability. However, it may also contribute to spatial inequalities, as peripheral regions may be less able to attract and retain such innovation infrastructures.

These organisational and spatial changes are accompanied by the diversification of financial models. The transition from reliance on public subsidies to hybrid revenue structures based on rental income, services, private investment, and international partnerships strengthens financial sustainability and organisational autonomy, enabling long-term strategic planning. At the same time, increased reliance on market-based mechanisms may expose STPs to financial risks and pressures for short-term performance.

A central finding is the growing alignment of STPs with the Quintuple Helix framework. Sustainability considerations, ESG integration, and stakeholder inclusiveness have become core elements of their strategic orientation. As conceptualised by Carayannis and Campbell (2010), this framework extends innovation beyond economic and technological dimensions to include societal and environmental considerations. This expanded perspective is increasingly reflected in practice, as STPs align with global sustainability agendas such as the Sustainable Development Goals and the European Green Deal. Carayannis et al. (2022) further emphasise that this integration represents a fundamental shift in understanding innovation as a driver of both economic and societal development. However, the integration of sustainability may also require balancing competing priorities between economic growth and environmental responsibility.

Internationalisation further reinforces this transformation. Participation of STPs in global innovation networks enhances knowledge exchange, access to international markets, and cross-border collaboration. As highlighted by Germain et al. (2023), such linkages are essential for building resilient innovation ecosystems. At the same time, increasing sectoral specialisation enables STPs to align regional capabilities with global challenges, positioning them as intermediaries between local assets and global innovation flows. Nevertheless, these processes may also deepen disparities between more and less developed regions.

Overall, these developments confirm that STPs have matured into institutional orchestrators of innovation ecosystems. Their evolution across governance, services, spatial organisation, and strategy reflects a transition toward multidimensional and network-based models of innovation. At the same time, this transformation introduces new complexities. Expanding stakeholder involvement and sustainability agendas may generate tensions between economic efficiency and broader social and environmental goals. Hybrid governance structures may lead to conflicting expectations, while sustainability integration may require balancing short-term performance with long-term value. Furthermore, the growing strategic role of STPs may contribute to uneven regional development, as more advanced ecosystems are better positioned to benefit from orchestration processes. These challenges suggest that the transition toward the Quintuple Helix model is context-dependent and non-linear.

The cumulative evidence presented in this study points to a paradigmatic transformation in the identity and operational logic of STPs. The change observed between 2015 and 2024 is structural rather than incremental, affecting governance models, strategic orientation, performance systems, and the underlying understanding of innovation processes.

Table 1. Paradigmatic Transformation of Science and Technology Parks

Traditional STPs	Contemporary STPs
Property-based infrastructure	Knowledge-based organisation
Tech transfer intermediaries	Ecosystem orchestrators
Public administrative governance	Hybrid strategic governance
Regional policy tools	Global innovation nodes
Tangible performance focus	Multidimensional impact logic

Source: Own work

Traditional STPs functioned primarily as infrastructure providers embedded within regional development policies. Their legitimacy was derived from their contribution to technology transfer and local economic growth. In contrast, contemporary parks operate as knowledge-based ecosystem orchestrators embedded within smart and sustainable cities. Their primary asset is no longer physical infrastructure but intellectual and relational capital. They actively design, coordinate, and manage innovation processes, integrating diverse stakeholders and aligning technological, social, and environmental objectives. This transformation reflects a broader shift from linear to

systemic models of innovation, in which STPs act as institutional architects shaping the conditions under which innovation emerges and evolves.

Infrastructure remains a necessary foundation, but it no longer defines organisational identity. Laboratories, office space, and shared facilities constitute enabling conditions rather than strategic objectives.

The organisational core has moved toward:

- Intellectual capital – professional management teams, specialised expertise in innovation acceleration, sustainability, and internationalisation;
- Relational networks – structured partnerships across sectors and borders, cluster coordination, and global connectivity;
- Governance capabilities – the ability to align diverse stakeholder interests, manage hybrid funding models, and integrate ESG and SDG frameworks into strategic planning.

As a result, STPs increasingly shape innovation zones rather than merely hosting them. They influence regional specialisation strategies, attract global talent and investment, contribute to urban transformation, and embed sustainability principles into innovation governance. Their role extends beyond supporting firms to configuring the institutional architecture within which innovation unfolds.

This paradigmatic shift from property logic to knowledge logic marks the maturation of STPs as strategic actors in innovation ecosystems. It repositions them from auxiliary infrastructure providers to institutional architects of resilient, networked, and sustainability-oriented innovation environments.

This study contributes to the literature by providing longitudinal evidence of the systemic transformation of STPs, demonstrating that their evolution is not only functional but also conceptual, involving a shift toward ecosystem orchestration within the Quintuple Helix framework.

Conclusions

Between 2015 and 2024, STPs have undergone a profound structural, functional, and conceptual transformation that has fundamentally redefined their organisational identity and strategic role within innovation ecosystems. Over this period, they have evolved from infrastructure-based organisations into knowledge-driven institutions, from technology transfer intermediaries into ecosystem orchestrators, from regionally focused policy instruments into globally connected actors, and from technology-centred environments into platforms emphasising human capital and sustainability.

This transformation reflects a broader shift in the understanding and governance of innovation. STPs no longer act solely as facilitators of knowledge exchange but increasingly design and coordinate knowledge flows within complex, multi-stakeholder systems. Their role extends beyond enabling collaboration to shaping strategic priorities and integrating sustainability into innovation processes. In this context, STPs emerge as key partners in the development of smart and sustainable cities, contributing to both technological progress and the long-term adaptability of innovation systems.

The findings of this study support a reconceptualisation of STPs as active agents of change rather than passive platforms for innovation. They should be understood as strategic actors that influence development trajectories, shape regional specialisation pathways, and enhance the resilience of innovation ecosystems. Their function increasingly involves organising, coordinating, and scaling innovation dynamics across sectors, technologies, and levels of governance.

This shift has significant practical implications. The key asset of contemporary STPs is no longer physical infrastructure but organisational capability, including professional management, coordination of partnerships, expertise in sustainability, and advanced competencies in ecosystem governance. These competencies encompass cluster facilitation, investor relations, implementation of environmental social and governance principles, management of international projects, data analysis, and technology scouting. Consequently, investment priorities should also focus on strengthening intellectual capital and strategic management capacity of STPs rather than on physical expansion alone.

For policymakers, these findings imply the need to design funding and evaluation mechanisms that prioritise ecosystem outcomes over infrastructure expansion, including models based on achieved results and incentives supporting the integration of sustainability principles. For managers, this requires embedding performance measurement into strategic decision-making processes, ensuring transparency, benchmarking against international peers, and fostering continuous organisational learning.

In conclusion, the evolving roles of STPs within smart and sustainable innovation ecosystems require their reconceptualisation not as real estate assets but as institutional platforms generating multidimensional value. Their strategic function increasingly lies in enabling the integration of technological innovation, sustainability objectives, and systemic coordination across diverse actors. In this context, STPs contribute to strengthening the long-term competitiveness, sustainability, and resilience of smart and sustainable innovation ecosystems in an increasingly complex and interconnected environment.

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